A HALF CENTURY DEBATE: CAPM AND ITS EMPIRICAL TESTING FOR ISE

A THESIS SUBMITTED TO

THE GRADUATE SCHOOL OF SOCIAL SCIENCES

OF

İZMİR UNIVERSITY OF ECONOMICS

BY

ÖZGÜR URAL

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ART IN THE GRADUATE SCHOOL OF SOCIAL SCIENCES

June 2006

ABSTRACT

A HALF CENTURY DEBATE: CAPM AND ITS EMPIRICAL TESTING FOR ISE

Ural, Özgür

MA in Financial Economics, Graduate School of Social Sciences

Supervisor: Assistant Professor Hasan Baklacı

June 2006, 127 pages

The capital asset pricing model (CAPM) developed by William Sharp (1964) and John Litner (1965) is considered to be the birth of asset pricing theory among academicians. CAPM, which brought Sharp the Nobel Prize in 1990, is still widely being used in measuring the estimated return of assets as well as building the capital budgeting processes. This model was apparently the first successful attempt to estimate the expected rate of return that investors will demand if they are to invest in an financial asset. Although CAPM was criticized by many academicians due to its many simplifying assumptions, results of empirical tests performed in many developed markets, particularly in US, supported the model till the last decade. Fama and French's study (1992) is one of the pioneer studies that challenged the validity and applicability of CAPM in financial markets. Since then, researchers have been trying to find out the pitfalls of CAPM. Currently, there are very few studies that have examined CAPM in Turkey. This particular study attempts to fill in this gap by testing the validity of CAPM in İstanbul Stock Exchange (hereinafter ISE). In this paper; formulation of CAPM model, as well as the recent critics forwarded to CAPM, will be discussed and model's predictivity power will be tested for the ISE market.

ÖZET

YARIM ASIRLIK TARTIŞMA: CAPM ve İMKB İÇİN TEST EDİLMESİ

Ural, Özgür

Finans Ekonomisi Yüksek Lisans Tezi, Sosyal Bilimler Enstitüsü

Danışman: Yard. Doç. Hasan Baklacı

Haziran 2006, 127 sayfa

William Sharp (1964) ve John Litner tarafından tasarlanan CAPM, akademik çevrelerce finansal varlık fiyatlandırma teorilerinin doğuşu olarak nitelendirilmektedir. Sharp'a 1990 yılında Nobel Ekonomi Ödülü'nü getiren CAPM, varlıkların getiri tahminlerinin oluşturulmasında ve sermaye bütçelemesi çalışmalarında hala sıklıkla kullanılmaktadır. Bu model, aslında herhangi bir finansal varlığa yatırım yapan bir yatırımcının beklediği getirinin teorik olarak belirlenebilmesi açısından yapılan ilk başarılı girişimdir. CAPM'in, gerçek yatırım dünyasının karmaşık yapısını oldukça sadeleştiren varsayımları pek çok akademisyenin eleştirisini çekerken, özellikle Amerika ve diğer gelişmiş piyasalar için yapılan testlerin sonuçları modelin teorik sonuçlarını 1990'lı yılların başına değin desteklemiştir. Fama ve French tarafından 1992 yılında yapılan bir çalışma, CAPM'in geçerliliğini ve uygulanabilirliğini sorgulayan çalışmalar arasında ön plana çıkmıştır. Bu tarihten itibaren, araştırmacılar CAPM teorisinin zayıf noktaları ile ilgili çeşitli açıklamalar getirmeye başlamışlardır. Şu an itibariyle, CAPM'in Türkiyede finansal piyasalar açısından geçerliliğini sorgulayan çok sınırlı sayıda çalışma bulunmaktadır. Bu çalışma, CAPM uygulamasının İstanbul Menkul Kıymetler Borsası (İMKB) için geçerliliğini sorgulayarak, söz konusu boşluğu doldurmayı hedeflemektedir. Yayın içerisinde, önce CAPM'in teorik formulasyonu ve literatürde modele yöneltilen eleştiriler tartışılacak, daha sonra da modelin tahmin gücü İMKB için test edilecektir.

To my little daughter

ACKNOWLEDGMENT

I express sincere appreciation to Asist. Prof. Hasan Baklacı for his guidance and insight throughout the research. Thanks go to Assoc. Profersor Adnan Kasman and Asist. Prof. Ayla Ouş for their valuable comments and guidance as well. To my parents, wife and daughter; I thank them all for understanding my frequent absences.

TABLE of CONTENTS

TABLE of CONTENTS

LIST of FIGURES

LIST of TABLES

LIST of APPENDICES

CHAPTER 1: INTRODUCTION

The foundations for the development of asset pricing models were laid by Markowitz and Tobin (Markowitz (1952); Tobin (1958)). Early theories suggested that the risk of an individual security is the standard deviation of its returns – a measure of return volatility. Thus, the larger the standard deviation of a security return the greater the risk. However, an investor's main concern is about the risk of all of his wealth; which, in fact, is a portfolio composed of different securities. Markowitz observed that;

- When two risky assets are combined, their standard deviations are not additive, provided that the returns from the two assets are not perfectly positively correlated,
- When a portfolio of risky assets is formed, the standard deviation of the portfolio is less than the sum of standard deviations of its components unless they are positively perfectly correlated.

Markowitz was the first to develop a specific measure of portfolio risk and to derive the expected return and risk of a portfolio. The Markowitz portfolio selection model generates an efficient frontier of portfolios and the investors are expected to select a portfolio from the frontier. That is, all investors behave rationally in their investment decisions and aim to maximize their utility by choosing the portfolio with the highest reward-to-risk ratio.

A decade later, Sharp developed a computationally efficient method, *the single index model CAPM,* where return on an individual security is related to the return on a common index (Sharp (1964)). The common index may be any variable thought to be the dominant influence on stock returns and need not be a stock index (Jones (1991)).

According to Sharp's theory; when analysing the risk of an individual security, the individual security risk must be considered in relation to other securities in the portfolio. In particular, the risk of an individual security must be measured in terms of the extent to which it adds risk to the investor's portfolio. Thus, a security's contribution to portfolio risk is different from the risk of the individual security. In other words; risk should not simply be defined as the volatility of a stock's return but as the stock's contribution to a well diversified portfolio's risk. The single index model can be extended to portfolios as well. This is possible because the expected return on a portfolio is a weighted average of the expected returns on individual securities. This means a portfolio's risk should be measured as its contribution to a well diversified portfolio.

It is well known that investors demand a premium for bearing risk; that is, the higher the riskiness of a security, the higher the expected return required to induce investors to buy (or to hold) it. However, if investors are primarily concerned with portfolio risk rather than the risk of the individual securities in the portfolio, how can we measure the contribution of an individual stock to a portfolio? The answer is provided by the *Capital Asset Pricing Model*, which is an important tool to define the relation between *risk* and *return*. The primary conclusion of the CAPM is that; *"The relevant riskiness of an individual stock is its contribution to the riskiness of a well-diversified portfolio."* (Brigham (1994)).

In fact, CAPM gives a precise prediction of the relationship that one should observe between the risk of an asset and its expected return. This relationship provides two important functions. First, it provides a benchmark rate of return for evaluating possible investments. For example, one analyzes the securities, he/she may be interested in whether the expected return forecasted for a stock is *more* or *less* than its “fair” return given its risk. Second, the model helps to make a good guess as to the expected return on assets that have not yet been traded in the marketplace. For example; how an initial public offering stock should be priced? How will a major new investment project affect the return investors require on a company stock? Although CAPM is widely criticized due to its over-simplifying assumptions, it is widely used because of the insights it offers and beacuse its accuracy suffices for important applications.

Since its foundation, CAPM has attracted attention of academic environment as well as professionals. During its half century history, the theory has been tested in many of the developed markets and attracted many critiques due to its over-simplifying assumptions. In any case; CAPM, which has brought its founder the Nobel prize in 1990, is being widely used by both academicians and professional and thus, predictivity power of the model is crucial in investment decisions.

In this paper, our aim is to test the predictibility power of CAPM for the ISE. As a relatively young market compared to developed markets, there exist only a few studies regarding CAPM application in ISE. Hence, this particular study attempts to fill in this gap by testing the predictivity power of CAPM for İstanbul Stock Exchange.

As an outline of the paper, the Markowitz’s portfolio selection theory will be discussed firstly since it is the fundamental assumption of CAPM. Then, CAPM theory and its formulation will be explained theoretically including its assumptions and formulation. A detailed literature review in a separate section follows the theory and provides information about the testing methods performed to date as well as the critiques forwarded to the model. Finally, CAPM's prediction power for ISE will be tested for a specific sample by re-performance of Sharp's Single Index Model. The last section will include the concluding remarks.

For the testing purposes, monthly stock returns during the 1990-2004 period will be used in order to measure the predictivity power of CAPM. This study may be considered as the first study which analyzes such a large number of observations for the CAPM testing in ISE.

As the testing methodology, a time-series regression analysis will be performed in order to estimate beta value of each stock which; in fact, measures the risk contribution of the stock to the market. Results of the first-pass regression will then be used in a second regression analysis to investigate if CAPM's suggestion – *risk premium of a stock is a function of its beta and no other factor adds to return of the stock* – holds for ISE.

CHAPTER 2: PORTFOLIO THEORY

2.1. <u>Risk Diversification</u>

The presence of risk means that there exists the probability that an outcome may be different than expected. And, diversification is a mean to control portfolio risk whereby investments are made in a wide variety of assets so that exposure to the unsystematic risk of any particular security is limited (Bodie et al (2001)). To examine the diversification effect precisely, it would be better to review the statistics underlying portfolio risk and return characteristics.

To make an easier interpretation, we will consider a portfolio comprised of two mutual funds; a long term debt bond fund (denoted D), and a stock fund (denoted E). A proportion denoted by w_D is invested in the bond fund and the remainder, 1- $w_{D,}$ denoted by w_E is invested in the stock fund. Then; the rate of return on this portfolio, P;

$$r_P = w_D{*}r_D + w_E{*}r_E \qquad \text{(Eq - 1)}$$

When we re-arrange the portfolio return equation for expectations;

$$E[r_P] = w_D * E[r_D] + w_E * E[r_E] \qquad \text{(Eq – 2)}$$

In general terms, for a portfolio composed of n risky assets; expected return can be stated as:

$$E[r_P] = \Sigma\, w_i * E[r_i] \quad \text{where } i = 1, 2,\ldots,n \quad \text{(Eq – 3)}$$

On the other hand, the variance of the two asset portfolio is;

$$\sigma_p^2 = w_D^2\sigma_D^2 + w_E^2\sigma_E^2 + 2w_D w_E Cov(r_D, r_E) \qquad \text{(Eq – 4)}$$

where;

$$Cov(r_D, r_E) = \rho_{DE}\, \sigma_D\, \sigma_E \qquad \text{(Eq – 5)}$$

The first observation regarding the above equations is that, the variance of the portfolio, unlike the expected return, is not a weighted average of the individual asset variances. Referring to Eq – 5, it can be stated that;

$$\begin{aligned} Cov(r_D, r_D) &= \sigma_D^2 \\ Cov(r_E, r_E) &= \sigma_E^2 \end{aligned} \qquad \text{(Eq – 6)}$$

By using Eq – 6, we can reword Eq – 4 as follows:

$$\sigma_p^2 = w_D^2 Cov(r_D, r_D) + w_E^2 Cov(r_E, r_E) + 2w_D w_E Cov(r_D, r_E) \qquad \text{(Eq – 7)}$$

In words; the variance of the portfolio is a weighted sum of covariances, and each weight is the product of the portfolio proportions of the pair of assets in the covariance term.

On the other hand, combining Eq – 4 and Eq – 5; we can re-construct the portfolio variance as follows:

$$\sigma_p^2 = w_D^2\sigma_D^2 + w_E^2\sigma_E^2 + 2w_D w_E\, \sigma_D\sigma_E\rho_{DE} \qquad \text{(Eq – 8)}$$

In the case of perfect positive correlation, the correlation coefficient can have a value of 1 at most (ρ_{DE} = 1). A value of 1 for ρ_{DE} equals the right hand side of Eq – 8 to a perfect square and simplifies to;

$$\sigma_p^2 = (w_D\sigma_D + w_E\sigma_E)^2; \qquad \text{or}$$

$$\sigma_p = w_D\sigma_D + w_E\sigma_E \qquad \text{(Eq – 9)}$$

Therefore, the standard deviation of the portfolio with perfect positive correlation is just the weighted average of the component standard deviations. In all other cases, where the correlation coefficient is less than 1, the portfolio standard deviation is less than the weighted average of the components' standard deviation.

Because the portfolio's expected return is the weighted average of its component expected returns, whereas its standard deviation is less than the weighted average of the component standard deviation, portfolios of less than perfectly correlated assets always offer better risk-return opportunities than the individual component securities offer on their own. This is in fact the power of diversification which reduces the portfolio risk. The lower the correlation between the assets, the greater the gain in efficiency.

To describe the mentioned statistics in words, one can say that investors face two kinds of risks, namely, diversifiable (unsystematic) and non-diversifiable (systematic or market). Diversifiable risk is the risk that can be associated to events unique to a particular firm. Since these events are essentially random, their effects on a portfolio can be eliminated by diversification – bad events in one firm will be offset by good events in another. On the other hand, non-diversifiable risk can be associated with overall movements in the general market or economy – like economic recession, fluctuations in interest rates, labor market, etc. Thus, non-diversifiable risk cannot be eliminated by constructing portfolios.

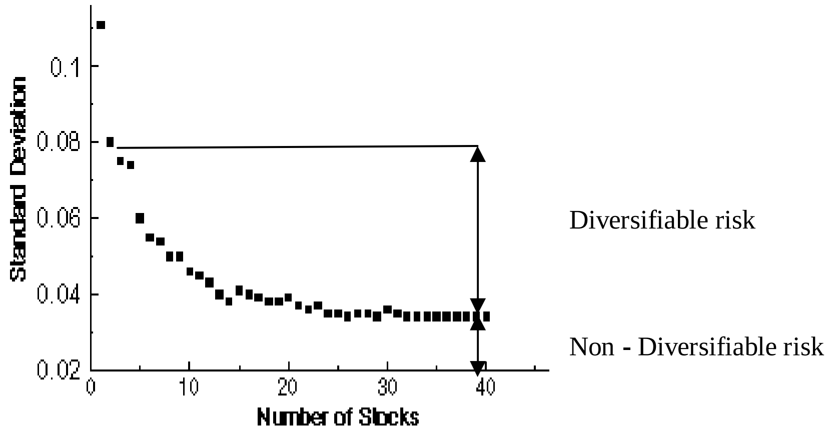

Figure – 1 Risk Diversification

Figure - 1 represents how a portfolio risk reduces with the increasing number of stocks in a portfolio. In fact, adding a new stock eliminates the firm specific risk of other stocks and thus reduces the diversifiable risk. On the other hand, adding new stocks do not help in reducing the portfolio risk after a certain number of stocks. The remaining risk, which cannot be eliminated is the non-diversifiable risk, which mainly depends on the macro factors that affect all the firms whose stocks are included in the portfolio.

By using Eq -8, the relation between expected return and portfolio risk can easily be interpreted for varying correlation coefficients and varying weights of securities.

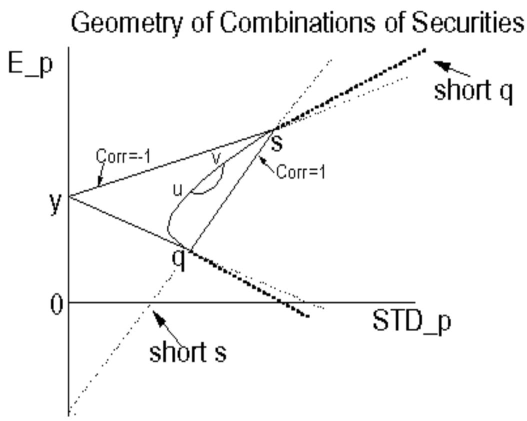

Figure – 2 Geometry of Combinations of Securities

In Figure – 2, the straight line between points q and s, represents the return-risk relationship in case of perfect correlation ($\rho_{DE} = 1$).

On the other hand, the triangle touching the y-axis, is the case for perfect hedge correlation ($\rho_{DE} = -1$). It can easily be noted that, the portfolio risk can be reduced to “0” with a positive expected return for perfect hedge case. Moreover, the curve, passing through points u and v, is the case for a correlation coefficient between -1 and 1. From Figure - 2, it can be interpreted that; by altering the assets weights, one can increase the expected return while decreasing the portfolio risk for any correlation coefficient value except 1. Those mentioned lines in Figure - 2 are called as portfolio opportunity sets for different values of correlation coefficient.

2.2. <u>Efficient Frontier and Optimal Portfolio</u>

2.2.a. Efficient Frontier

As mentioned before, the idea of diversification is a very old debate. A model of portfolio selection embodying the diversification principles was first formalized by Harry Markowitz in 1952. The model begins with the identification of the efficient set of portfolios; or, as it is often called, the *efficient frontier of risky assets*.

The first step is the determination of the risk-return opportunities available to the investors. This set of opportunities is called as the *minimum-variance frontier of risky assets*. This frontier is a graph of the lowest possible variance that can be attained for a given portfolio expected return.

Figure – 3 below presents a graphical definition to minimum variance portfolios. It is clear that all the individual assets lie to the right inside the frontier. This, in fact, tells that risky portfolios constituted of only one single asset are inefficient. Diversifying investments leads to portfolios with higher expected returns and lower standard deviation.

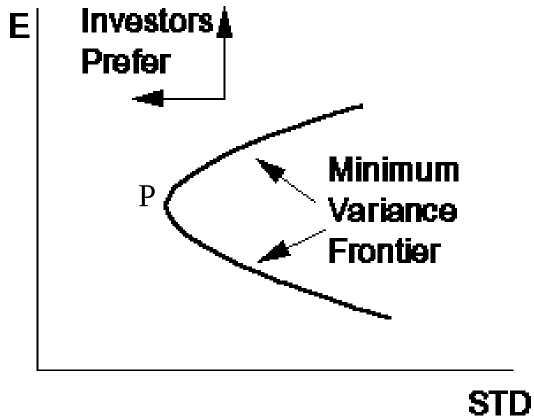

Figure – 3 Minimum Variance Frontier

Moreover, all the portfolios above the global minimum-variance portfolio (point P on Figure - 3) and upward provide the best risk-return combinations and thus become an optimal portfolio candidate. Therefore, the part of minimum variance frontier above the global minimum variance portfolio is called as the efficient frontier of risky assets. For any portfolio on the lower portion of the minimum variance frontier, there is a portfolio with the same standard deviation but with a higher expected return on the efficient frontier. Hence, the lower part of the minimum variance frontier is inefficient.

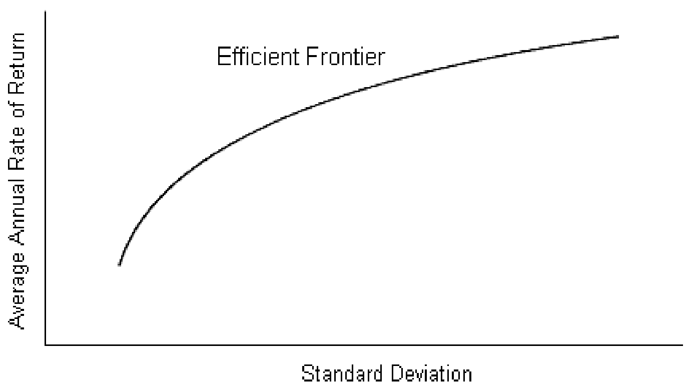

Figure – 4 Efficient Frontier

Figure – 4 is the graphical presentation of the efficient frontier; which is just the upper part of the minimum variance frontier in Figure – 3.

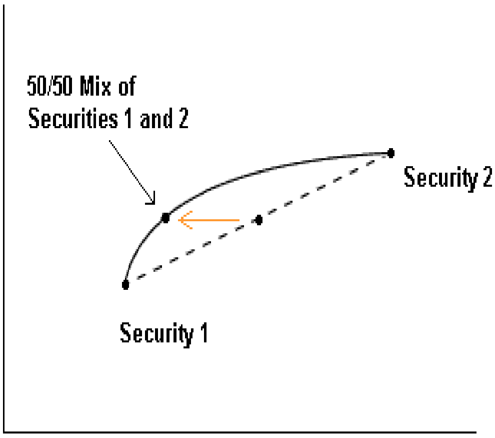

Figure – 5 Diversification and Frontier

An important property of the efficient frontier is that it's *curved*, not straight. In fact, it's the key to explain how diversification lets the improvement of reward-to-risk ratio. To see why, imagine a 50/50 allocation between just two securities. Assuming that the year-to-year performance of these two securities is not perfectly in sync. That is, assuming that the great years and the bad years for Security 1 don't correspond perfectly to the great years and bad years for Security 2. Then, the standard deviation of the 50/50 allocation will be *less* than the average of the standard deviations of the two securities separately. Graphically, this stretches the possible allocations *to the left* of the straight line joining the two securities.

In statistical terms, this effect is due to lack of covariance. The smaller the covariance between the two securities - the more out of sync the securities are - the smaller the standard deviation of a portfolio that combines them. The ultimate would be to find two securities with *negative* covariance (very out of sync: the best years of one happen during the worst years of the other, and vice versa). This also explains the different risk –return characteristics for varying correlation coefficient shown in Figure - 2.

2.2.b. Reward-To-Variability Ratio (Sharpe Ratio)

In the previous section, efficient frontier is defined to be the set of most efficient portfolios for a given collection of securities in terms of return and risk relationship. The reward-to-variability ratio goes further and it actually helps to find the best possible proportion of these securities to use, in a portfolio that also contains a risk free asset. The definition of the reward-to-variability ratio is:

$$S(X) = (r_X - r_f) / \sigma_X \qquad \text{(Eq – 10)}$$

Where;

- x is an investment portfolio,
- r_X is the average annual rate of return of x,
- r_f is the risk free rate,
- σ_X is the standard deviation of r_X

As the name indicates, reward to variability ratio is a measure of gain against each unit of risk beared. To see how it helps in creating an optimal portfolio, the efficient frontier diagram, which also includes the risk free asset, will be beneficial (Figure-6).

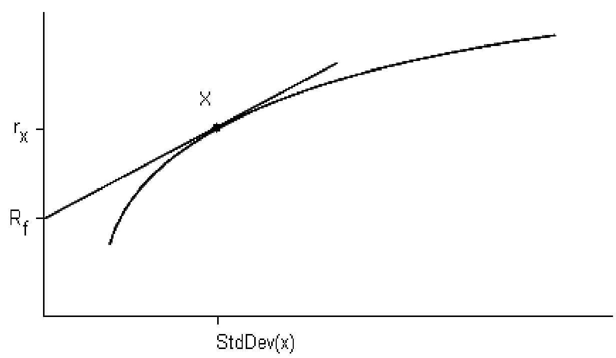

Figure – 6 Capital Allocation Line

Two important results can be inferred from this diagram:

If an investment like "x" is combined with a risk-free asset, the resulting portfolio will lie somewhere along the straight line joining risk free asset with “x”. (There is not a damping out effect between risk free asset and investment “x” since no risk is associated with the risk-free asset. So, the diagram is just a straight line but not a curve.)

Since any rational investor would like to maximize the reward to variability ratio (maximizing the rate of return per risk taken), the objective is to maximize the slope of line drawn in the diagram, which is also the reward-to-variability ratio.

Putting this all together suggests the method for finding the best possible portfolio from any collection of securities. First, the investment with the highest possible reward-to-variability ratio should be found; next, the linear combination of this investment should be taken with risk-free asset that provides the maximum return for a given level of risk. The resulting portfolio will be the most efficient portfolio.

In mathematical terms, the objective is;

$$\text{Max } S(X) = (r_X - r_f) / \sigma_X \qquad \text{s.t. } \Sigma w_i = 1 \qquad (\text{Eq} – 11)$$

Taking derivative of this objective function with respect to weights will define the optimum weights of each risky asset in the risky portfolio. Once the weight of each risky asset is calculated by using the above equation, the utility function of the investors must be maximized to find the allocation between the risky portfolio and risk-free asset. To show the mathematical interpretation, assume the utility function, U, is;

$$U = E[r_p] – 0.005A\, \sigma_P^2 \qquad (\text{Eq} – 12)$$

Where; A is the coefficient of risk aversion and 0.005 is a scale factor. This function indicates that the utility from a portfolio increases as the expected rate of return increases and it decreases when the variance increases. The relative magnitude of these changes is governed by the coefficient of risk aversion.

An investor who faces a risk free rate, r_f, and a risky portfolio with expected return $E(r_X)$ and standard deviation σ_X, will find that for any weight of risky portfolio y, the expected return and variance of the portfolio is;

$$E(r_p) = r_f + y\,[E(r_X) - r_f] \qquad \text{(Eq – 13)}$$

$$\sigma_p^2 = y^2\,\sigma_X^2 \qquad \text{(Eq – 14)}$$

Substituting Eq – 13 and Eq -14 in Eq -12 leads to;

$$U = r_f + y\,[E(r_X) - r_f] - 0.005Ay^2\sigma_X^2 \qquad \text{(Eq – 15)}$$

Maximizing the utility function and solving for y leads to the equation below;

$$y = (E(r_X) - r_f) / 0{,}01A\,\sigma_X^2 \qquad \text{(Eq – 16)}$$

In other words; allocation problem of each risky asset in the optimal portfolio is solved by maximizing the reward-to-variability ratio (Eq – 11), whereas the weight of risky portfolio is set by maximizing the utility function of each investor.

If we combine the mathematics above with the interpretation of Figure – 6, we can conclude that;

- If the risk tolerance level is reduced, the allocation ratio of risky assets (stocks to bonds, i.e) will remain constant, and the amount of risk free asset will increase. (Graphically, the new point will be on the straight line joining risk free asset to the Efficient Frontier, and moving to the left.)

- By decreasing the covariance between the risky assets (stocks and bonds, i.e.) one can allocate more money to risky portfolio and less to the risk-free asset, thus raising the rate of return. (This is taking advantage of the curved shape of the Efficient Frontier, stretching it further to the left and tilting the line up.)
- By increasing risk tolerance to a high enough level, one will get a portfolio composed of solely risky assets. This means reaching a point on the efficient frontier, but to the right of the point where it intersects the straight line.

CHAPTER 3: CAPM THEORY

Capital Asset Pricing Model (CAPM) is a set of predictions regarding equilibrium expected returns on risky assets. CAPM was developed by William Sharp, John Lintner and Jan Mossin after foundation of modern portfolio management by Markowitz (Lintner (1965); Mossin (1966)). The model is built on the idea that the appropriate risk premium on any asset will be determined by its contribution to the risk of investors' overall portfolio.

3.1. Assumptions of CAPM

To derive its famous risk-return relationship, Sharp makes some assumptions to simplify the complexity of investment arena. In fact, these assumptions became the center of critics forwarded to the model during the last few decades.

a. Perfect Competition Assumption

The perfect competition assumption requires that wealth of each investor is small compared to the total wealth traded in the market. Moreover; investors are price takers, that is, they act as if security prices are not affected by their own trades.

b. Myopic Behaviour

All investors plan for one identical holding period. In other words, they ignore everything that may happen after the holding period. So, this assumption is usually called as myopic behavior; which, in general, is found to be suboptimal.

c. Limited Number of Assets

The model assumes that investments are limited to a universe of publicly traded financial assets; such as, stocks, bonds and risk free borrowing-lending arrangements. This assumption excludes investments in non traded assets like human capital, social government investments, etc.

d. Costless Trading

Investors pay no tax for their profit on asset returns and pay no commission for their trade transactions. In other words; there is no cost associated with the trade decisions.

e. Rational Investors

All investors are rational mean variance optimizers, meaning that they all use the same Markowitz portfolio selection model.

f. Homogenous Expectations

All investors analyze securities in the same way and share the same economic view of the world. That is; all investors consider the same probability distribution of future cash flows for the same assets. In other words; all investors use the same input data list while deriving the Markowitz model.

Obviously, assumptions mentioned above ignore many real world complexities. However, these assumptions create a simple arena where market equilibrium can be created in a hypotetical world.

Firstly, lendings and borrowings will cancel out each other so that the aggregate risky portfolio equals the entire wealth of economy; which is the market portfolio M. The proportion of each stock in this portfolio equals the market value of the stock divided by the sum of entire wealth of market. CAPM implies that as individuals attempt to optimize their portfolios, they each arrive at the same portfolio with weights on each asset equal to those of the market portfolio.

Based on the assumptions, investors will desire to hold identical risky portfolios. That is; if all investors use identical Markowitz analysis (assumption e) applied to the same assets (assumptions c) for the same holding period (assumption b) and use the same input list (assumption f), they all must arrive at the same optimal risky portfolio. This is figured in Fig – 7 below.

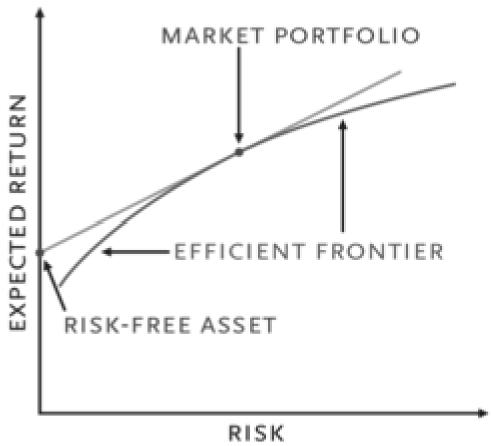

Figure – 7 Optimal Risky Portfolio (Market Portfolio)

Since the risky portfolio is composed of all risky assets, Capital Allocation Line of Figure-6, becomes the Capital Market Line (CML) in Figure -7 for the CAPM case.

With complete agreement about the distribution of returns, all investors see the same opportunity set and they combine the same risky tangency portfolio (market portfolio, M) with risk-free lending or borrowing.

Since all investors hold the same same portfolio M of risky assets, it must be the value weighted market portfolio of risky assets.

Specifically, each risky asset's weight in the tangency portfolio must be the total market value of all outstanding units of the asset divided by total market value of all risky assets. In addition, the risk-free rate must be set to clear the market for risk-free borrowing and lending. In other words; CAPM assumptions imply that the market portfolio must be on the minimum variance frontier if the asset market is to clear.

3.2. <u>Formulation of CAPM</u>

CAPM is built on the idea that the appropriate risk premium on an asset will be determined by its contribution to the risk of investors' overall portfolio. Portfolio risk is what matters to investors according to CAPM. Therefore, to derive CAPM, one must concentrate on determining the amount of risk that an asset contributes to a portfolio.

Consider a portfolio that consists of *n* different assets. As per Eq -7; the variance of the portfolio is a weighted sum of covariances, and each weight is the product of the portfolio proportions of the pair of assets in the covariance term. It should also be noted that all the investors use the same input list for Markowitz Portfolio according to assumption-f; that is, the same estimates of expected returns, variances and covariances are used by all investors.

In line with Eq-7 and the definition above, risk contribution of an asset "X" to the portfolio may be defined as;

$$w_X\,[w_1 Cov(r_1, r_X) + w_2 Cov(r_2, r_X) + .. + w_X Cov(r_X, r_X) + .. + w_n Cov(r_n, r_X)] \quad \text{(Eq-17)}$$

Eq-17 defines risk contribution of asset X to the market as the weighted sum of covariances, where each weight is the product of the portfolio proportions of the pair of assets in the covariance term. When there are many assets in the market, there will be many more covariance terms than variance terms. Consequently, the covariance of a particular stock with all other stocks will dominate stock X's contribution to total market portfolio, M. Eq - 17 may be summarized as follows:

$$\text{Stock X's risk contribution to the market M} = w_X \, Cov(r_X, r_M) \qquad \text{(Eq – 18)}$$

This can also be demonstrated mathematically. In line with Eq – 3, the rate of return on the market portfolio may be written as;

$$r_M = \Sigma\, w_i * r_i \quad \text{for } i = 1,2,\ldots,n \qquad \text{(Eq – 19)}$$

Hence, the covariance of the return on asset X with the market portfolio is;

$$Cov\,(r_X, r_M) = Cov\,(r_X, \Sigma\, w_i * r_i) = \Sigma\, w_i\, Cov(r_X, r_i) \quad \text{for } i = 1,2,\ldots,n \quad \text{(Eq – 20)}$$

Comparing the last term in Eq – 20 and Eq – 18, it can be implied that the covariance of X with the market portfolio is indeed proportional to the contribution of X to the variance of the market portfolio.

Result of Eq – 18 implies that; by providing returns that move inversely with the rest of the market, asset X stabilizes the return on the overall portfolio if the covariance between X and market is negative. On the contrary, if the covariance is positive, asset X makes a positive contribution to overall portfolio risk because its returns amplify swings in the rest of portfolio.

Having measured the contribution of asset X to the market variance, the appropriate risk premium of asset X can be measured. But, firstly, we should note that the market portfolio has a risk premium of $E[r_M] – r_f$ and a variance of σ_M leading to a reward to variability ratio of;

$$E[r_M] – r_f / \sigma_M^2 \qquad \text{(Eq – 21)}$$

It should be noted that the risk is measured in percent squared as the variance of market return since the appropriate risk measure of X is its covariance with the market portfolio (that is; its contribution to the variance of the market portfolio). This ratio is also called as the market price of risk which explains how much extra return must be earned per unit of portfolio risk.

Consider an investor who is currently invested %100 in the market portfolio and suppose he is willing to increase his position in the market portfolio by a small fraction, δ, financed by borrowing at the risk free rate. The new portfolio will be a combination of three assets: the original position in the market with a return of r_M, plus a short position in risk free asset that will return - δr_f, plus a long position in market with a return of δr_M. Summing up all the returns lead to a portfolio return of $r_M + \delta(r_M – r_f)$. Taking expectations and comparing with the original expected return, the incremental expected rate of return with the new position becomes;

$$\Delta E[r] = E[r_M + \delta(r_M – r_f)] – E[r_M]$$

$$\Delta E[r] = \delta\ [E(r_M) – r_f] \qquad \text{(Eq – 22)}$$

To measure the impact of new position on the market price of risk, the relevant change on the portfolio variance should also be calculated. The new portfolio has a weight of $(1 + \delta)$ in the market and $-\delta$ in the risk free asset. Therefore, the variance of the adjusted portfolio is;

$$\sigma_P^2 = (1 + \delta)^2 * \sigma_M^2 = (1 + 2\delta + \delta^2) * \sigma_M^2 = \sigma_M^2 + (2\delta + \delta^2)\, \sigma_M^2 \qquad \text{(Eq – 23)}$$

Since δ has a very small value; which is less than 1, δ^2 is very negligible compared to 2δ, so it can be ignored in portfolio variance calculation. Therefore, variance of the new portfolio can be written as $\sigma_M^2 + 2\delta\sigma_M^2$. Finally, it can be concluded that the increase in the variance of new portfolio is;

$$\Delta\sigma^2_P = \sigma_M^2 + 2\delta\, \sigma_M^2 - \sigma^2_M$$

$$\Delta\sigma_P^{\,2} = 2\delta\sigma_M^2 \qquad \text{(Eq – 24)}$$

Summarizing Eq - 22 and Eq – 24, the trade-off between the incremental risk premium and incremental risk, referred to as the marginal price of risk can be stated as;

$$\Delta E[r] / \Delta\sigma^2 = [E(r_M) - r_f] / 2\sigma_M^2 \qquad \text{(Eq – 25)}$$

It can easily be noted that the marginal price of risk is half of the market price of risk given in Eq – 21.

Now, suppose the investors prefers to invest the proportion δ in asset X instead of market. The new investment is financed by risk free borrowing. In this case; increase in the mean excess return will be;

$$\Delta E[r] = E[r_M - \delta r_f + \delta r_X] - E[r_M]$$

$$\Delta E[r] = \delta\, [E(r_X) - r_f] \qquad \text{(Eq – 26)}$$

On the other hand; since the new portfolio will have a weight of 1 in the market, δ in asset X and $-\delta$ in the risk free asset; variance of the new portfolio will be $1^2\sigma_M^2+\delta^2\sigma_X^2+[2*1*\delta*Cov(r_X, r_M)]$. Comparing the new variance with the 100% market portfolio's variance, increase in the variance can be stated as;

$$\Delta\sigma_P^2 = 1^2\sigma_M^2+\delta^2\sigma_X^2+[2*1*\delta*Cov(r_X, r_M)] - \sigma_M^2$$

$$\Delta\sigma^2 = \delta^2\sigma_M^2 + 2\delta Cov(r_X, r_M) \qquad (Eq – 27)$$

Dropping the negligible term and summarizing Eq - 26 and Eq – 27, the marginal price of risk of X is;

$$[E(r_X) – r_f] / 2Cov(r_X, r_M) \qquad (Eq – 28)$$

In equilibrium, the marginal price of risk of asset X must equal that of the market portfolio. Otherwise, if the marginal price of risk of X is greater than the market's, investors would prefer to increase their portfolio reward for bearing risk by increasing the weight of X in their portfolio (It should be noted that CAPM assumption requires rational behaviour of all investors and usage of the same input lists). Until the price of asset X rises relative to the market, investors will keep buying asset X. The process will continue until stock prices adjust so that marginal price of risk of X equals that of market. The same process, in reverse, will equal marginal prices of risk when X's initial marginal price of risk is less than that of the market portfolio. Equating the marginal price of risk of X's to that of market results in a relationship between the risk premium of X and that of market (Equaling Eq – 25 and Eq – 28);

$$[E(r_M) – r_f] / 2\,\sigma_M^2 = [E(r_X) – r_f] / 2Cov(r_X, r_M) \qquad (Eq – 29)$$

By re-arranging Eq – 29;

$$E(r_X) - r_f = \{Cov(r_X, r_M) / \sigma_M^2\} * [E(r_M) - r_f] \qquad \text{(Eq – 30)}$$

In fact; in line with Eq -18, ratio of $Cov(r_X, r_M) / \sigma_M^2$ measures the contribution of asset X to the variance of the market portfolio as a fraction of the total variance of the market portfolio and is defined as beta, β. Using this measure; Eq – 30 can be reworded as Sharpe's famous CAPM expected return-beta relationship.

$$E(r_X) = r_f + \beta_X [E(r_M) - r_f] \qquad \text{(Eq – 31)}$$

In fact, CAPM's final conclusion above explains the necessity of many assumptions. If everyone holds an identical risky portfolio, then everyone will find the beta of each asset with the market portfolio equals the asset's beta with his or her own risky portfolio. Therefore, everyone will agree on the appropriate risk premium for each asset.

3.3. <u>Security Market Line</u>

The expected return – beta relationship can be viewed as a reward-risk equation. The beta of a security is the appropriate measure of its risk because beta is proportional to the risk that the security contributes to the optimal portfolio.

The expected return – beta relationship can be portrayed graphically as the security market line (SML) in Figure - 8 below.

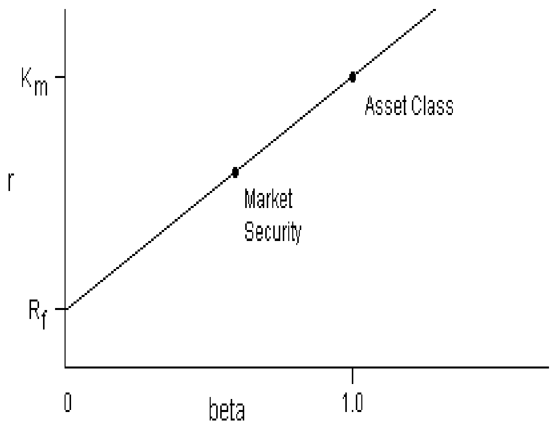

Figure – 8 Security Market Line (SML)

Because the market beta is 1, the slope is the risk premium of the market portfolio. At the point on the horizantal axis where $\beta = 1$ (which is the market portfolio's beta), the return just equals the market return.

It should be noted that Capital Market Line (CML) graphs the risk premiums of efficient portfolios (portfolios composed of risky assets and risk-free assets) as a function of portfolio standard deviation. This is appropriate because standard deviation is a valid measure of risk for efficiently diversified portfolios that are candidates for an investor's overall portfolio. The SML, in contrast, graphs individual asset risk premiums as a function of asset risk. The relevant measure of risk for individual assets held as parts of well diversified portfolios is not the asset's standard deviation or variance; instead the contribution of the asset to the portfolio variance, which we measure by the asset's beta. The SML is valid for both efficient portfolios and individual assets. The slope of SML is the risk premium for individual assets which can be deducted from Equation-31.

Since the SML is the graphic representation of the expected return-beta relationship, "fairly priced" assets plot exactly on the SML; that is, their expected returns are commensurate with their risk. In case of validity of CAPM assumptions, all securities must lie on the SML in market equilibrium. However; if a stock is perceived to be underpriced in the market, this will mean that it will provide an expected return in excess of the fair return stipulated by SML. In other words; underpriced stocks will plot above SML. On the other hand, any over-priced stock will plot below SML indicating that it will provide a less return than stipulated by SML.

However, any under or over-priced stock has to move to the equilibrium in the long-run. Particularly, investors will tend to buy under-priced stocks and the expected return of these stocks will go down getting closer to their fair return stipulated by SML. Likewise, investors will tend to sell over-priced stocks, causing their expected return to go up and move towards their fair return on SML.

3.4. <u>Risk Factor of CAPM –Beta-</u>

In the CAPM, the beta of an investment is the risk that the investment adds to a market portfolio. An invesment with a beta greater than one is expected to rise more than the market in a bull market, but also to fall more than in a bear market. Investments with beta’s less than one are typically more defensive. By contrast, they are expected to rise less than the market on a market upturn and to fall less than the market on a market downturn. The beta coefficient also serves an important role in risk quantification and turns out to be the primary determinant of the market risk exposure of an investment.

Hence, the roles of beta in investment decisions may be summarized as follows:

- To aid active portfolio design,
- To control risk,

- To analyze performance,
- To establish expected returns using the traditional CAPM.

In fact, beta has evolved as a result of the attempts to reduce the complexity of calculations required to implement the Markowitz portfolio selection theory. The idea behind beta is to reduce the computational problem size by linking all stocks in a market through a market index. The model that captures this relationship is known as *Market Model* which is simply the estimation of beta coefficient instead of computing huge number of complex covariance relationships (Jones (1991)).

There are three approaches available for estimating the beta. The first is to use the historical data on market prices for individual investments. The second is to estimate the betas from the fundamental characteristics of the investment. And finally, the third is to use the accounting data.

3.4.a. Historical Market Betas

The conventional approach for estimating the beta of an investment is a regression of the historical returns on the investments against the historical returns on a market index (Jones (1991)). For firms that have been traded in a stock exchange for a sufficient amount of time, it is relatively straightforward to estimate returns that an investor would have made on investing in stock in intervals (such as weekly or monthly) over that period. In theory, these stock returns on the assets should be related to returns on a market portfolio, i.e. a portfolio that includes all traded assets, to estimate the betas of the assets. In practice, one might tend to use a stock index, such as the ISE-100, as a proxy for the market portfolio, and might estimate betas for stocks against the index.

The standard procedure for estimating betas is to regress stock returns (r_i) against market returns (r_M).

$$r_i = a + b\, r_M \qquad \text{(Eq - 32)}$$

where;

a = Intercept from the regression

b = Slope of the regression; $Cov(r_i, r_M) / \sigma_M^2$

The slope of the regression corresponds to the beta of the stock and measures the riskiness of the stock.

The intercept of the regression provides a simple measure of performance of the investment during the period of the regression, when returns are measured against the expected returns from the capital asset pricing model. By re-arranging the CAPM equation, this can be empasized easily.

$$r_i = r_f + \beta\,(r_M - r_f) = r_f\,(1- \beta) + \beta\, r_M \qquad \text{(Eq - 33)}$$

Comparing Eq - 33 of the return on an investment to the return equation from the regression:

$$r_i = a + b\, r_M \qquad \text{(Eq - 34)}$$

Thus a comparison of the intercept (a) to $r_f\,(1- \beta)$ should provide a measure of the stock's performance, at least relative to the capital asset pricing model. In summary then;

If $a > r_f(1- \beta)$, Stock did better than expected during the regression.

If $a = r_f(1- \beta)$, Stock did as well as expected during regression period.

If $a < r_f(1- \beta)$, Stock did worse than expected during regression period.

The difference between (a) and $r_f(1- \beta)$ is called Jensen's alpha and provides a measure of whether the investment earned a return greater than or less than its required return, given both market performance and risk (Jensen (1968)).

Many investment and data service companies provide beta estimates for the stocks being traded in developed markets. Merrill Lynch and Bloomberg may be reminded as the leading ones among these companies. Including the mentioned two famous firms, professionals usually prefer to use *adjusted beta* instead of historical market beta.

The idea behind the adjusted beta is that; on average, the beta coefficients of stocks move towards one over time (Jones (1991)). One explanation for this approach is intuitive. A business enterprise is usually established to produce a specific product or service, and a new firm may be more unconventional than an older one in many ways, from technology to management style. As it grows, however, a firms diversifies first expanding to similar products and later to more diverse operations. As the firm becomes more conventional, it starts to resemble the rest of the economy even more. Thus its beta coefficient will tend to change in the direction of 1.

Another explanation for this approach is statistical. It is known that the average beta of all stocks is 1. Thus, before estimating the beta of a stock the best estimate would be 1. When the beta coefficient is estimated over a sample period, some unknown sampling error is sustained. The greater the difference between the beta estimate and

1, the greater is the chance that there will be a huge estimation error incurred. The historical market beta estimate is a good guess for the *sample period*. However, a *forecast of the future beta* should be adjusted if the beta coeeficient tends to move to 1 in long-run.

Many investment professionals (including Merrill Lynch and Bloomberg) adjust betas with the following formulation:

$$\text{Adjusted beta} = (2/3)*(\text{Historical Beta}) + (1/3)*(1) \qquad \text{(Eq - 35)}$$

Data providers and investment companies usually prefer the mentioned weights (2/3 and 1/3) in their computations; but, in fact they are totally subjective numbers. This process only aims to adjust beta forecast towards 1 which should also be the average beta of all securities.

3.4.b. Fundamental Beta

A second way to estimate betas is to look at the fundamental financial variables of the firm (Jones (1991)). According to this approach the beta of a firm may be estimated from a regression which also considers the financial power indicators such as financial leverage, firm size, etc.

For example, if one believes that firms size and debt ratios are two determinants of beta, the beta forecast regression can be established as follows:

$$\text{Current beta} = a + b_1 \text{ (Historical beta)} + b_2 \text{ (Firm size)} + b_3 \text{ (debt ratio)} \qquad \text{(Eq - 36)}$$

By estimating b_1, b_2 and b_3 future betas can be estimated. Of course there is no reason to limit beta factors with firm size and debt ratio. Such an approach was followed by

Rosenberg and Guy who found the following variables to help predict betas (Rosenberg (1976)).

1. Variance of earnings,
2. Variance of cash flows,
3. Growth in earnings per share,
4. Market capitalization,
5. Dividend yield,
6. Debt-to-asset ratio

An interesting finding of Rosenberg and Guy is that even after controlling for a firm’s financial characteristics, industry group (sector) helps to predict beta. For example, they found that the beta values of gold mining companies in US are on average 0.827 lower than would be predicted based on financial characteristics alone. In fact, the adjustment factor, 0.827, for the gold industry reflect the fact that gold values are inversely related to market returns.

3.4.c. Accounting Betas

A third approach is to estimate the market risk parameters from accounting earnings rather than from traded prices (Jones (1991)). Thus, changes in earnings at a division or a firm, on a quarterly or annual basis, can be related to changes in earnings for the whole market, in the same periods to calculate the accounting beta. However, there are strong challenges against this approach:

First, accounting earnings tend to be smooth relative to the underlying value of the company, since expenses and incomes are spread to multiple periods. This results in betas that are “biased down” for risky firms and “biased up” for safer firms. In other words, betas are likely to be closer to 1 for all firms using accounting data.

Second, accounting earnings are affected by non-operating factors such as changes in depreciation or inventory methods and by allocation of corporate expenses at the divisional level.

Finally, accounting earnings are measured at most every quarter and often once a year. Hence, limited number of observation feed the regression model which does not provide a much explanatory power as a result. (low R-squared, high standard errors, etc.)

CHAPTER 4: LITERATURE REVIEW

After its foundation, CAPM has found great attraction among academicians and investment professionals. Especially, the assumptions that allowed Sharp to derive the simple version of CAPM were found unrealistic. Since then, financial economists have been working on extending the model to describe more realistic scenarios. Hence, CAPM has found a huge place in literature. In this part, the major CAPM extension studies will be summarized first and then the recent testing methodologies and challenges of CAPM will follow the literature regarding the CAPM extensions. Finally, previous CAPM and price anomoly studies for ISE will be discussed.

4.1. <u>CAPM Extensions</u>

4.1.a. CAPM for Portfolios

The logic behind CAPM theory is that; if everyone holds an identical risky portfolio, then everyone will find that the beta of each asset with the market portfolio equals the asset's beta with his or her own risky portfolio. Hence, everyone will agree on the appropriate risk premium for each asset.

The crucial question with this assumption is that what if only few investors hold the market portfolio: Several authors showed that CAPM will hold true even if the investors hold different portfolios due to any reason. For example, Brennan examined the impact of variaton in investors' personel tax rates on market equilibrium (Brennan (1973)). On the other hand, Mayers searched the impact of non-traded assets such as human capital (Mayers (1972)). Both authors found that although the market portfolio is no longer each investor's optimal risky portfolio, the expected return-beta relationship should still hold in a modified form.

The main idea of these two studies is that; if the expected return-beta relationship holds for any individual asset, it must hold for any combination of assets. Suppose that some portfolio *P* has weight w_k for stock k, where k = 1,2,3,…..,n. By writing the CAPM equation for each stock and multiplying each equation by the weight of the stock in the portfolio, the following equations are obtained:

$$w_1E(r_1) = w_1r_f + w_1\beta_1[E(r_M) - r_f]$$

$$+ w_2E(r_2) = w_2r_f + w_2\beta_2[E(r_M) - r_f]$$

$$+ \ldots\ldots\ldots = \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$

$$+ \underline{w_nE(r_n)} = \underline{w_nr_f + w_n\beta_n[E(r_M) - r_f]}$$

$$E(r_P) = r_f + \beta_P[E(r_M) - r_f] \qquad (Eq - 37)$$

In fact; summing all the CAPM equations of individual assets show that CAPM holds for the overall portfolio because $E(r_P) = \sum w_k\beta_k$ is the expected return on the portfolio and $\beta_P = \sum w_k \beta_k$ is the portfolio beta. It is also clear that this result must be also true for the market portfolio.

$$E(r_M) = r_f + \beta_M[E(r_M) - r_f] \qquad (Eq - 38)$$

Since; $\beta_M = Cov(r_M, r_M) / \sigma_M^2 = \sigma_M^2 / \sigma_M^2 = 1$, the CAPM equation also holds for the market portfolio. In fact, these studies also establish 1 as the weighted average value of beta across all securities. If the market beta is 1, and the market portfolio consists of all assets in the economy, the weighted average beta of all assets must be 1. Hence, betas greater than 1 are considered *aggressive* meaning that these stocks shows above average sensitivity to market fluctuations. On the contrary, betas below than 1 are described as *defensive*.

4.1.b. Multifactor Models

The idea behind the multifactor model is that market return reflects macro factors as well as the average sensitivity of firms to those factors. When a single-index regression is estimated, there is an incorrect assumption that each stock has the same relative sensitivity to each risk factor. Hence, if stocks differ in their betas relative to macro-economic factors, then summing all the systematic risks into one variable (in the case of single-index model) such as the market return ignores the variance of stocks' sensitivities for each factor. Therefore, the multifactor model is formed as follows:

$$r_t = \alpha + \beta_{X1}X_1 + \beta_{X2}X_2 + \ldots\ldots\ldots\ldots\ldots\ldots + \beta_{Xn}X_n \qquad \text{(Eq – 39)}$$

where X_i denotes the macro-economic risk factors and β_{Xi} denotes the sensitivity of security regarding the risk factor.

An important study regarding the multifactor model belongs Chen, Roll and Ross who used the following set of macro-economic risk factors in their model (Chen et al (1986));

IP = % change in industrial production

EI = % change in expected inflation

UI = % change in unanticipated inflation

CG = excess return of long term corporate bonds over long-term bonds

GB = excess return of long-term government bonds over T-bills.

Their model was set as follows:

$$R_{it} = \alpha_i + \beta_{iIP}IP_t + \beta_{iEI}EI_t + \beta_{iUI}UI_t + \beta_{iCG}CG_t + \beta_{iGB}GB_t \qquad \text{(Eq – 40)}$$

Chen, Roll and Ross found that stock returns are highly correlated with the mentioned five macro-factors they used in their model. In fact, impact of any macro-economic variable - other than the mentioned ones - on stock returns can be measured with the multifactor model.

4.1.c. Conditional CAPM

One of the mostly criticized assumptions of CAPM is that it ignores an important asset; human capital. The value of future wages and compensation for expert services is a significant component of the wealth of investors. Moreover, it is reasonable to expect that changes in human capital are more less than perfectly correlated with asset returns and hence they diversify the risk of investor portfolios.

Jaganathan and Wang used a proxy for changes in the value of human capital based on the rate of change in aggregate labor income (Jaganathan (1996)). In addition to the standard stock betas estimated using the value-weighted stock market index, which will be denoted as β^{vw}, they also estimated the betas of assets with respect to labor income growth, which will be denoted as β^{Labor}. Finally, they considered the possibility that business cycles affect assets betas. They used the difference between the yields on low and high grade corporate bonds as a proxy for the state of the business cycle and estimate asset betas relative to this business cycle variable, which will be denoted as β^{Prem}.

With the estimates of these three betas for several stock portfolios, Jaganathan and Wang estimated a second-pass regression which includes firm size (market value of equity, ME):

$$E(r_i) = c_0 + c_{Size}\log(ME) + c_{vw}\beta^{vw} + c_{Prem}\beta^{Prem} + c_{Labor}\beta^{Labor} \qquad \text{(Eq – 41)}$$

Results of this second-pass regression are found to be much more supportive than the single-index model's. In fact, explanatory power of the equations that include, Jaganathan and Wang's expanded set of explanatory variables (which the authors called "conditional") is much greater than Sharp's tests, and the significance of the size variable disappears.As a result of this study, authors concluded that firm size does not improve return predictions once the variables stated in conditional CAPM are accounted for.

4.1.d. The Zero Beta Model

The simplest extension to the standard CAPM involves dropping the assumption of no lending/borrowing constraints while maintaining the assumption of short sales. In reality, although lending funds is free at the riskless rate, borrowing is not, or if it is allowed it involves a higher borrowing rate. An equilibrium expected return-beta relationship in the case of restrictions on risk-free investments was developed by Fischer Black (Black (1972)).

Black concentrated on the case where there is no riskless rate of interest, so neither lending nor borrowing are allowed. He concluded that different portfolio combinations will all lie on the capital market line.

In particular, the market portfolio will also lie on CML as it is a linear combination of all individual risky assets. Therefore, one may select a portfolio Z with zero beta lying on the vertical axis and the market portfolio M as two points which together specify the straight line. It should be noted that although a riskless asset uncorrelated with the market portfolio (zero-beta) does not exist under assumptions, one can always find a risky portfolio uncorrelated with the market which lies on the minimum variance frontier by extending the horizontal line corresponding to the riskless asset's expected return. The straight line linking *Z* and *M* then becomes the security market line, and the resulting version of the CAPM is commonly known as the zero-beta, or two-factor CAPM, in reference to the fact that all portfolios are formed as combinations of two portfolios (factors), the zero-beta portfolio and the market portfolio.

The optimal portfolio choice for each investor results from a similar exercise as in the case of two assets or portfolios explained previously in part 2.2. Assuming, λ denotes the scale relating the weighted sum of variance and covariances of asset i with all other assets, the assets's expected return over the riskless rate of return would be:

$$E(R_i) - E(R_Z) = \lambda X_i \sigma_i^2 + \lambda \sum X_j \sigma_{ij} \qquad \text{where } i = 1,2,3,\ldots N \quad (Eq - 42)$$

In fact, this is a system of *N* equations, one for each risky asset. The right hand side of the above equation is just the covariance of asset *i* with the market, so:

$$E(R_i) - E(R_Z) = \lambda \sigma_{iM} \qquad (Eq - 43)$$

which can be expressed as:

$$E(R_i) = E(R_Z) + \lambda \sigma_{iM} \qquad (Eq - 44)$$

Since above equation holds for every asset, it also holds for the market portfolio, which is a linear combination of all assets. Substituting $i=M$ gives the coefficient λ as the ratio of the excess market expected return over the zero-beta portfolio and the market variance:

$$\lambda = E(R_M) - E(R_Z)) / \sigma_M^2 \qquad \text{(Eq – 45)}$$

Substituting this expression for λ back into equation-42 yields the equilibrium relationship between risk and expected return for any asset for the zero-beta model:

$$E(R_i) = E(R_Z) + (\sigma_{im} / \sigma_M^2) * [E(R_M) - E(R_Z)]$$

$$E(R_i) = E(R_Z) + \beta_i * [E(R_M) - E(R_Z)] \quad \text{(Eq – 46)}$$

So the standard CAPM relationship between market risk and expected return is maintained in the absence of a riskless asset. As argued above, there is an unlimited number of potential zero-beta portfolios offering expected return $E(R_Z)$. Rational investors will choose the combination of *Z* and *M* lying on the minimum variance frontier in $[E(R_Z), \sigma]$ space. It is easy to check that the minimum-variance zero-beta portfolio cannot be on the efficient frontier: on the one hand, it is not the global minimum variance portfolio, and on the other hand, linear combinations of *Z* and the market portfolio offer higher expected return than *Z* itself. However, the zero-beta CAPM shows that all investors optimize by holding some combination of *Z* and *M*. Since the aggregate portfolio is the market portfolio, the aggregate holding of *Z* must be zero (long positions must net out short positions).

4.2. <u>Test Methodology</u>

Tests of the CAPM are based on three implications of the relation between expected return and market beta implied by the model. First, expected returns on all assets are linearly related to their betas, and no other variable has marginal explanatory power. Second, the beta premium is positive, meaning that the expected return on the market portfolio exceeds the expected return on assets whose returns are uncorrelated with the market return. Third, in the Sharpe-Lintner version of the model, assets uncorrelated with the market have expected returns equal to the risk-free interest rate, and the beta premium is the expected market return minus the risk-free rate. Most tests of these predictions use either cross-section or time-series regressions.

4.2.a. Tests on Risk Premiums

The early cross-section regression tests focus on the Sharpe – Lintner model's predictions about the intercept and slope in the relation between the expected return and market beta. The approach is to regress a cross-section of average asset returns on estimates of asset betas. The model predicts that the intercept in these regressions is the risk-free rate, r_f, and the coefficient on beta is the expected return on the market in excess of the risk-free rate, $E[r_M] - r_f$.

Two problems arise regarding this type of test methodology. First, estimates of beta for individual assets are imprecise, creating a measurement error problem when they are used to explain average returns. Second, the regression residuals have common sources of variaton such as industry effects in average returns. Positive correlation in the residuals produces downward bias in the usual ordinary least squares estimates of the standard errors of the cross-section regression slopes.

To improve the precision of estimated betas, researchers such as Blume, Friend Black, Jensen, and Scholes work with portfolios, rather than individual securities (Blume (1970); Friend et al (1970); Black et al (1972)). Since expected returns and market betas combine in the same way in portfolios, if the CAPM explains security returns it also explains portfolio returns.

Formally, if x_{ip}, $i = 1,\ldots,N$, are the weights for assets in some portfolio p, the expected return and market beta for the portfolio are related to the expected returns and betas of assets as;

$$E[r_P] = \sum x_{ip} E(r_i) \qquad \text{(Eq – 47)}$$

$$\beta_P = \sum x_{ip} \beta_i \qquad \text{(Eq – 48)}$$

Thus, the CAPM relation between expected return and beta;

$$E[r_P] = r_f + \beta_P [E(r_M) - r_f] \qquad \text{(Eq – 49)}$$

holds when asset i is a portfolio, as well as when i is an individual security.

Estimates of beta for diversified portfolios are more precise than estimates for individual securities. Thus, using portfolios in cross-section regressions of average returns on betas reduces the critical errors in variables problem. Grouping, however, shrinks the range of betas and reduces statistical power. To mitigate this problem, researchers sort securities on beta when forming portfolios; the first portfolio contains securities with the lowest betas, and so on, up to the last portfolio with the highest beta assets.

Fama and MacBeth propose a method for addressing the inference problem caused by correlation of the residuals in cross-section regressions (Fama et al (1973)). Instead of estimating a single cross-section regression of average monthly returns on betas, they estimate month-by-month cross-section regressions of monthly returns on betas. The times series means of the monthly slopes and intercepts, along with the standard errors of the means, are then used to test whether the average premium for beta is positive and whether the average return on assets uncorrelated with the market is equal to the average riskfree interest rate. In this approach, the standard errors of the average intercept and slope are determined by the month-to-month variation in the regression coefficients, which fully captures the effects of residual correlation on variation in the regression coefficients, but ignores the problem of actually estimating the correlations. The effects of residual correlation are, in effect, captured via repeated sampling of the regression coefficients.

Jensen was the first to note that the Sharpe – Lintner version of the relation between expected return and market beta also implies a time-series regression (Jensen (1968)). The Sharpe – Lintner CAPM says that the average value of an asset's excess return (the asset's return minus the riskfree interest rate, R_{it} - R_{ft}) is completely explained by its average realized CAPM risk premium (its beta times the average value of R_{Mt} - R_{ft}). This implies that "Jensen's alpha," the intercept term in the time-series regression;

$$R_{it} - R_{ft} = \alpha_i + \beta_{iM} (R_{Mt} - R_{ft}) + \varepsilon_{it} \qquad \text{(Eq – 50)}$$

is zero for each asset.

The early tests firmly reject the Sharpe – Lintner version of the CAPM. There is a positive relation between beta and average return, but it is too "flat". Recall that, in cross-section regressions, the Sharpe – Lintner model predicts that the intercept is the risk free rate and the coefficient on beta is the expected market return in excess of the riskfree rate, $E(R_M)$ - R_f. The regressions consistently find that the intercept is greater than the average riskfree rate (typically proxied as the return on a one-month Treasury bill), and the coefficient on beta is less than the average excess market return (proxied as the average return on a portfolio of U.S. common stocks minus the

Treasury bill rate). This is true for many of the early tests performed by authors like Douglas, Black, Jensen, Miller, Blume, Fama as well as in more recent cross-section regression tests, like Fama and French (Douglas (1968); Black et al (1972); Miller et al (1972); Blume et al (1973); Fama et al (1973); Fama et al (1992)).

The evidence that the relation between beta and average return is too flat is confirmed in time series tests, such as Friend and Blume, Black, Jensen and Scholes, Stambaugh (Friend et al (1970); Black et al (1972); Stambaugh (1982)). The intercepts in time series regressions of excess asset returns on the excess market return are positive for assets with low betas and negative for assets with high betas.

The Sharpe – Lintner and Black versions of the CAPM share the prediction that the market portfolio is mean-variance-efficient. This implies that differences in expected return across securities and portfolios are entirely explained by differences in market beta; other variables should add nothing to the explanation of expected return. This prediction plays a prominent role in tests of the CAPM. In the early work, the weapon of choice is cross-section regressions.

In the framework of Fama and MacBeth, one simply adds pre-determined explanatory variables to the month-by-month cross-section regressions of returns on beta. If all differences in expected return are explained by beta, the average slopes on the additional variables should be reliably zero. Clearly, the trick in the cross-section regression approach is to choose specific additional variables likely to expose any problems of the CAPM prediction that, because the market portfolio is efficient, market betas suffice to explain expected asset returns.

For example, in Fama and MacBeth's study, the additional variables are squared market betas (to test the prediction that the relation between expected return and beta is linear), and residual variances from regressions of returns on the market return (to test the prediction that market beta is the only measure of risk needed to explain expected returns). The results show that the average slopes on the additional variables are zero within a statistically significant range. These variables do not add to the explanation of average returns provided by beta. Thus, the results of Fama and MacBeth are consistent with the hypothesis that their market proxy – an equal-weight portfolio of NYSE stocks – is on the minimum variance frontier.

4.2.b. Time Series Regressions

The hypothesis that market betas completely explain expected returns can also be tested using time-series regressions. In the time-series regression described above (the excess return on asset i regressed on the excess market return), the intercept is the difference between the asset's average excess return and the excess return predicted by the Sharpe – Lintner model, that is, beta times the average excess market return. If the model holds, there is no way to group assets into portfolios whose intercepts are reliably different from zero. For example, the intercepts for a portfolio of stocks with high ratios of earnings to price and a portfolio of stocks with low earning-price ratios should both be zero. Thus, to test the hypothesis that market betas suffice to explain expected returns, one estimates the time-series regression for a set of assets (or portfolios), and then jointly tests the vector of regression intercepts against zero. The trick in this approach is to choose the left-hand-side assets (or form portfolios) in a way likely to expose any shortcoming of the CAPM prediction that market betas suffice to explain expected asset returns.

In early applications, researchers use a variety of tests to determine whether the intercepts in a set of time-series regressions are all zero. The tests have the same asymptotic properties, but there is controversy about which has the best small sample properties. Gibbons, Ross and Shanken settle the debate by providing an F-test on the intercepts that has exact small sample properties (Gibbons et al (1989)). They also show that the test has a simple economic interpretation. In effect, the test constructs a candidate for a tangency portfolio by optimally combining the market proxy and the left-hand-side assets of the time series regressions. The estimator then tests whether the efficient set provided by the combination of this tangency portfolio and the riskfree asset is reliably superior to the one obtained by combining the riskfree asset with the market proxy alone. In other words, the Gibbons, Ross, and Shanken statistic tests whether the market proxy is the tangency portfolio in the set of portfolios that can be constructed by combining the market portfolio with the specific assets used as dependent variables in the time series regressions.

Enlightened by this insight of Gibbons, Ross, and Shanken, one can see a similar interpretation of the cross-section regression test of whether market betas suffice to explain expected returns. In this case, the test is whether the additional explanatory variables in a crosssection regression identify patterns in the returns on the left-hand-side assets that are not explained by the assets' market betas. This amounts to testing whether the market proxy is on the minimum variance frontier that can be constructed using the market proxy and the left-handside assets included in the tests.

According to Ross, time-series and cross-section regressions do not test the CAPM. What is literally tested is whether a specific proxy for the market portfolio (typically a portfolio of stocks) is efficient in the set of portfolios that can be constructed from it and the left-hand-side assets used in the test. One might conclude from this that the CAPM has never been tested, and prospects for testing it are not good because:

1) the set of left-hand-side assets does not include all marketable assets, and

2) data for the true market portfolio of all assets are likely beyond reach.

But this criticism is leveled at tests of any economic model when the tests are less than exhaustive or when they used proxies for the variables called for by the model. The bottom line from the early cross-section regression tests of the CAPM, such as Fama and MacBeth, and the early time-series regression tests, like Gibbons and Stambaugh, is that standard market proxies seem to be on the minimum variance frontier (Gibbons et al (1982); Stambaugh (1982)).

That is, the central predictions of the Black version of the CAPM, that market betas suffice to explain expected returns and that the risk premium for beta is positive, seem to hold. But the more specific prediction of the Sharpe – Lintner CAPM that the premium per unit of beta is the expected market return minus the riskfree interest rate is consistently rejected.

The success of the Black version of the CAPM in early tests produced a consensus that the model is a good description of expected returns. These early results, coupled with the model's simplicity and attracted a great deal of attention.

4.3. <u>Recent Tests</u>

Starting in the late 1970s, empirical works challenged even the Black version of the CAPM. Specifically, evidence mounts that much of the variation in expected return is unrelated to market beta.

The first challenge is Basu's evidence that when common stocks are sorted on earnings-price ratios, future returns on high E/P stocks are higher than predicted by the CAPM (Basu (1977)). Banz documents a size effect; when stocks are sorted on market capitalization (price times shares outstanding), average returns on small stocks are higher than predicted by the CAPM (Banz (1981)). Bhandari finds that high debt-equity ratios (book value of debt over the market value of equity, a measure of leverage) are associated with returns that are too high relative to their market betas (Bhandari (1988)). Finally, Statman and Rosenberg document that stocks with high book-to-market equity ratios (B/M, the ratio of the book value of a common stock to its market value) have high average returns that are not captured by their betas (Statman (1980); Rosenberg et al (1985)).

There is a theme in the contradictions of the CAPM summarized above. Ratios involving stock prices have information about expected returns missed by market betas. In fact, this is not surprising. A stock's price depends not only on the expected cash flows it will provide, but also on the expected returns that discount expected cash flows back to the present. Thus, in principle the cross-section of prices has information about the cross-section of expected returns. (A high expected return implies a high discount rate and a low price.) The cross-section of stock prices is, however, arbitrarily affected by differences in scale (or units). But with a rational choice of scaling variable X, the ratio X/P can reveal differences in the cross-section of expected stock returns. Such ratios are thus prime candidates to expose shortcomings of asset pricing models – in the case of the CAPM, shortcomings of the prediction that market betas suffice to explain expected returns (Ball (1978)). The contradictions of the CAPM summarized above suggest that earnings-price, debt-equity, and book-to-market ratios indeed play this role.

Fama and French update and show the evidence on the empirical failures of the CAPM. Using the cross-section regression approach, they confirm that size, earnings-price, debt-equity, and book-to-market ratios add to the explanation of expected stock returns provided by market beta. Fama and French reach the same conclusion using the time-series regression approach applied to portfolios of stocks sorted on price ratios (Fama et al (1996)). They also find that different price ratios have much the same information about expected returns. This is not surprising given that price is the common factor in the price ratios, and the numerators are just scaling variables used to extract the information in price about expected returns.

Fama and French also confirm the evidence that the relation between average return and beta for common stocks is even flatter after the sample periods used in the early empirical work on the CAPM.

However, estimate of the beta premium may be challenged due to statistical uncertainty (a large standard error). Kothari, Shanken, and Sloan try to support the Sharpe – Lintner CAPM by arguing that the weak relation between average return and beta is just a chance result (Kothari et al (1995)). But the strong evidence that other variables capture variation in expected return missed by beta makes this argument irrelevant. If betas do not suffice to explain expected returns, the market portfolio is not efficient, and the CAPM does not work. Evidence on the size of the market premium can neither save the model nor further challenge.

Chan, Hamao, and Lakonishok find a strong relation between book-to-market equity (B/M) and average return for Japanese stocks (Chan et al (1991)). Capaul, Rowley, and Sharpe observe a similar B/M effect in four European stock markets and in Japan (Capaul et al (1993)). Fama and French find that the price ratios that produce problems for the CAPM in U.S. data show up in the same way in the stock returns of twelve non-U.S. major markets, and they are also present in emerging market returns (Fama et al (1998)). This evidence suggests that the contradictions of the CAPM associated with price ratios are not sample specific.

4.3.a. Explanations - Irrational Pricing or Risk -

There are two distinct arguments among those who conclude that the empirical failures of the CAPM are fatal. First one is the behavioralists. Their view is based on the evidence that stocks with high ratios of book value to price are typically firms that have fallen on bad times, while low B/M is associated with growth firms (Lakonishok et al (1994); Fama et al (1995)). The behavioralists argue that sorting firms on book-to- market ratios exposes investor overreaction to good and bad times. Investors over-extrapolate past performance, resulting in stock prices that are too high for growth (low B/M) firms and too low for distressed (high B/M, so-called value) firms. When the overreaction is eventually corrected, the result is high returns for value stocks and low returns for growth stocks. This view is supported by DeBondt, Lakonishok, Shleifer and Haugen who are considered to be mfounders of behavioural finance (DeBondt et al (1987); Lakonishok (1994); Haugen (1995)).

The second argument for the empirical contradictions of the CAPM is that they point to the need for a more complicated asset pricing model. The CAPM is based on many unrealistic assumptions. For example, the assumption that investors care only about the mean and variance of distributions of one-period portfolio returns is extreme. It is reasonable that investors also care about how their portfolio return covaries with labor income and future investment opportunities, so a portfolio's return variance misses important dimensions of risk. If so, market beta is not a complete description of an asset's risk, and we should not be surprised to find that differences in expected return are not completely explained by differences in beta. In this view, the search should turn to asset pricing models that do a better job explaining average returns.

4.3.b. Intertemporal CAPM and Fama-French's Three Factor Model

Merton's intertemporal capital asset pricing model (ICAPM) is a natural extension of the CAPM (Merton (1973)). The ICAPM begins with a different assumption about investor objectives. In the CAPM, investors care only about the wealth their portfolio produces at the end of the current period. In the ICAPM, investors are concerned not only with their end-of-period payoff, but also with the opportunities they will have to consume or invest the payoff. Thus, when choosing a portfolio at time t-1, ICAPM investors consider how their wealth at t might vary with future *state variables*, including labor income, the prices of consumption goods, and the nature of portfolio opportunities at t, and expectations about the labor income, consumption, and investment opportunities to be available after t. Like CAPM investors, ICAPM investors prefer high expected return and low return variance. But ICAPM investors are also concerned with the covariances of portfolio returns with state variables. As a result, optimal portfolios are "multifactor efficient," which means they have the largest possible expected returns, given their return variances and the covariances of their returns with the relevant state variables.

Fama shows that the ICAPM generalizes the logic of the CAPM. That is, if there is riskfree borrowing and lending or if short-sales of risky assets are allowed, market clearing prices imply that the market portfolio is multifactor efficient (Fama (1996)). Moreover, multifactor efficiency implies a relation between expected return and beta risks, but it requires additional betas, along with a market beta, to explain expected returns.

An ideal implementation of the ICAPM would specify the state variables that affect expected returns. Fama and French take a more indirect approach, which is more similar to Ross's arbitrage pricing theory (APT) (Fama et al (1993); Ross (1976)). They argue that though size and book-to-market equity are not themselves state variables, the higher average returns on small stocks and high book-to- market stocks reflect unidentified state variables that produce undiversifiable risks (covariances) in returns that are not captured by the market return and are priced separately from market betas. In support of this claim, they show that the returns on the stocks of small firms covary more with one another than with returns on the stocks of large firms, and returns on high book-to-market (value) stocks covary more with one another than with returns on low book-to-market (growth) stocks. Fama and French show that there are similar size and book-to-market patterns in the covariation of fundamentals like earnings and sales.

Based on this evidence, Fama and French propose a three- factor model for expected returns;

$$E[r_{it}] - r_{ft} = \beta_{iM} (E[r_{it}] - r_{ft}) + \beta_{is} E(SMB_t) + \beta_{ih} E(HML_t) \qquad \text{(Eq – 51)}$$

In this equation, SMB_t (small minus big) is the difference between the returns on diversified portfolios of small and big stocks, HML_t (high minus low) is the difference between the returns on diversified portfolios of high and low B/M stocks, and the betas are slopes in the multiple regression of R_{it} - R_{ft} on R_{Mt} - R_{ft}, SMB_t, and HML_t.

One implication of the expected return equation of the three-factor model is that the intercept α_i in the time series regression;

$$r_{it} - r_{ft} = \alpha_i + \beta_{iM} (r_{Mt} - r_{ft}) + \beta_{is} SMB_t + \beta_{ih} HML_t + \varepsilon_{it} \qquad \text{(Eq - 52)}$$

is zero for all assets i. Using this criterion, Fama and French find that the model captures much of the variation in average return for portfolios formed on size, book-to-market equity, and other price ratios that cause problems for the CAPM. Fama and French show that an international version of the model performs better than an international CAPM in describing average returns on portfolios formed on scaled price variables for stocks in 13 major markets.

The three- factor model is widely used in empirical research that requires a model of expected returns. Estimates of α_i from the time-series regression above are used to calibrate how rapidly stock prices respond to new information; for example, Loughran and Ritter, Mitchell and Stafford (Loughran et al (1995); Mitchell et al (2000)) . They are also used to measure the special information of portfolio managers, for example, as it is in Carhart's study of mutual fund performance (Carhart (1997)).

From a theoretical perspective, the main shortcoming of the three-factor model is its empirical motivation. The small-minus-big (SMB) and high-minus- low (HML) explanatory returns are not motivated by predictions about state variables of concern to investors. Instead they are clear force constructs meant to capture the patterns uncovered by previous work on how average stock returns vary with size and the book-to-market equity ratio.

However, the ICAPM does not require that the additional portfolios used along with the market portfolio to explain expected returns “mimic” the relevant state variables. In both the ICAPM and the arbitrage pricing theory, it suffices that the additional portfolios are well diversified (they are multifactor minimum variance) and that they are sufficiently different from the market portfolio to capture covariation in returns and variation in expected returns missed by the market portfolio. Thus, adding diversified portfolios that capture covariation in returns and variation in average returns left unexplained by the market is in the spirit of both the ICAPM and the APT.

The behavioralists are not impressed by the evidence for a risk-based explanation of the failures of the CAPM. They typically concede that the three-factor model captures covariation in returns missed by the market return and that it picks up much of the size and value effects in average returns left unexplained by the CAPM. But their view is that the average return premium associated with the model’s book-to-market factor – which does the heavy lifting in the improvements to the CAPM – is itself the result of investor overreaction that happens to be correlated across firms in a way that just looks like a risk story. In short, in the behavioral view, the market tries to set CAPM prices, and violations of the CAPM are due to mispricing.

The conflict between the behavioral irrational pricing story and the rational risk story for the empirical failures of the CAPM is a still a going-on debate. Fama emphasizes that the hypothesis that prices properly reflect available information must be tested in the context of a model of expected returns, like the CAPM (Fama (1970)). Intuitively, to test whether prices are rational, one must take a stand on what the market is trying to do in setting prices, that is, what is risk and what is the relation between expected return and risk. Thus, when tests reject the CAPM, one can't say whether the problem is its assumption that prices are rational (the behavioral view) or violations of other assumptions that are also necessary to produce the CAPM.

The way one uses the three-factor model does not depend on one's view about whether its average return premiums are the rational result of underlying state variable risks, the result of irrational investor behavior, or sample specific results of chance. For example, when measuring the response of stock prices to new information or when evaluating the performance of managed portfolios, one wants to account for known patterns in returns and average returns for the period examined, whatever their source. Similarly, when estimating the cost of equity capital, one might be unconcerned with whether expected return premiums are rational or irrational since they are in either case part of the opportunity cost of equity capital (Stein (1996)). But the cost of capital is forward- looking, so if the premiums are sample specific they are irrelevant.

The three-factor model is not the sole and best solution of the asset pricing model. Its most serious problem is the momentum effect of Jegadeesh and Titman (Jegadesh et al (1993)). Stocks that do well relative to the market over the last three to twelve months tend to continue to do well for the next few months, and stocks that do poorly continue to do poorly. This momentum effect is distinct from the value effect captured by book-to-market equity and other price ratios. Moreover, the momentum effect is left unexplained by the three-factor model, as well as by the CAPM. Following Carhart, one response is to add a momentum factor (the difference between the returns on diversified portfolios of short-term winners and losers) to the three- factor model. This is again legitimate in applications where the goal is to abstract from known patterns in average returns to uncover information-specific or manager-specific effects. But since the momentum effect is short- lived, it is largely irrelevant for estimates of the cost of equity capital. Some other recent researches point to problems in both the three-factor model and the CAPM. Frankel and Lee, Dechow, Hutton and Sloan, and finally Piotroski show that in portfolios formed on price ratios like book-to-market equity, stocks with higher expected cash flows have higher average returns that are not captured by the three-factor model or the CAPM (Frankel et al (1998); Dechow et al (1999); Piotroski (2000)). The authors interpret their results as evidence that stock prices are irrational; they do not reflect available information about expected profitability.

4.3.c. The Market Proxy Problem

Roll argues that the CAPM has never been tested and probably never will be (Roll (1997)). The problem is that the market portfolio of the model is theoretically and empirically elusive. It is not theoretically clear which assets (for example, human capital) can legitimately be excluded from the market portfolio, and data availability substantially limits the assets that are included. As a result, tests of the CAPM are forced to use proxies for the market portfolio, in effect testing whether the proxies are on the minimum variance frontier. Roll argues that because the tests use proxies, not the true market portfolio, we learn nothing about the CAPM.

According to Fama and French, the relation between expected return and market beta of the CAPM is just the minimum variance condition that holds in any efficient portfolio, applied to the market portfolio (Fama et al (2004)). Thus, if we can find a market proxy that is on the minimum variance frontier, it can be used to describe differences in expected returns.

The strong rejections of the CAPM described above, however, say that researchers have not uncovered a reasonable market proxy that is close to the minimum variance frontier.

Stambaugh tests the CAPM using a range of market portfolios that include, in addition to U.S. common stocks, corporate and government bonds, preferred stocks, real estate, and other consumer durables. He finds that tests of the CAPM are not sensitive to expanding the market proxy beyond common stocks, basically because the volatility of expanded market returns is dominated by the volatility of stock returns.

Fama and French argue that; one need not be convinced by Stambaugh's results since his market proxies are limited to U.S. assets. If international capital markets are open and asset prices conform to an international version of the CAPM, the market portfolio should include international assets. Fama and French find, however, that betas for a global stock market portfolio cannot explain the high average returns observed around the world on stocks with high book-to- market or high earning-price ratios.

4.4. <u>Prior Research on ISE</u>

As Bruner notes, investment flows to emerging markets like Turkey are material and will continue to grow due to higher economic growth rates compared to developed countries (Bruner et al (2002)). Emerging markets provide investors two primary benefits. Although emerging markets are riskier than developed markets, they provide diversification opportunity due to their low or negative correlations with each other and with the developed countries (Divecha et al (1992)). For example, the correlations between the US stock market and the stock markets in Peru, Turkey and Venezuela have been negative during the 1991-1995 period (Khanna (1996)). Divecha documents an average correlation of 0,07 among emerging markets in the past five years (Divecha et al (1992)).

In addition to the few studies mentioned above, there are a few more researches about the price determination process in ISE. Using the IFC Emerging Markets Database, Rouwenhorst report that high E/P and high BE/ME stocks outperform those with lower ratios but has found no size, market beta or momentum effects during the 1989 – 1997 period (Rouwenhorst (1999)). However, the findings based on this database may be biased due to its shortcomings noted by the author itself: missing data, data error problems, and return outliers that range from zero entries for insignificant returns to %10,000 per month. Furthermore, the IFC database is biased toward larger stocks which reduces power as one searches for a size effect. This may be the reason why Claressens found limited evidence of a size effect in emerging markets and Rouwenhorst could not identify a size effect in the ISE (Claressens et al (1995)).

Karan reports that low P/E portfolios overperform high P/E ones during the 1988 - 1993 period (Karan (1995)). Karan also finds evidence of price/sales (P/S), P/E, and ME/BE effect in average and risk adjusted returns during the same time period and the P/E effect absorbs the P/S and ME/BE effects (Karan (1996)). On the other hand, Demir formed portfolios on P/E and size for the 1990-1996 period and showed that the average returns to low P/E portfolios are greater than those of high P/E portfolios, but the difference disappears when risk adjusted returns are used (Demir et al (1996)). They also report a significant size effect and a negative earning effect. In contrast, using value-weighted portfolio returns, Gonenç and Karan found that growth stocks and big stocks outperform small, value stocks and they both perform worse than the local market index (Gonenç et al (2001)).

On the other hand, Aksu employed the two common asset pricing test (three factor and CAPM) on both ranked size/book to market portfolio returns and monthly excess returns on individual securities for the 1993-1997 period to identify the relationship between the size and book-to-market factors and firm-specific and macro-economic fundamentals in the ISE (Aksu (2000)). They found reasonable evidence for both size and value effects and concluded that these premiums are proxies for additional distress related risk factors in returns not captured by the one factor CAPM.

CHAPTER 5: TESTING of CAPM for ISE

5.1. Methodology

5.1.a. Data

Three important decision regarding the data establishment process had to be given for the single-index CAPM testing purpose. The first concerns the *length of the estimation*. In fact; the trade-off is simple. A longer estimation period provides more data, but the firms themselves might have changed in its risk characteristics over the time period. In the previous literature studies, a much more longer estimation lenth (duration) were used (e.g. Sharp's study covers the 1927 – 1963 period); whereas investment and rating institutions like Value Line and Standard & Poors use five years of data and Bloomberg uses two years of data.

Investment environment in Turkey is very dynamic for companies as well as the individual investors who trades securities. During the last two decades, many holdings invested in many different sectors or many companies changed their business with the increasing know-how and technology. For example; telecommunication sector became one of the leading ones according to GNP calculations whereas exportation became a major income of some sectors (such as automative/electronic equipment etc.) with Turkey's participation to EU's customs union. Hence, the risk character of firms varied a great deal since ISE's establishment in 1986. As a result, to cover the impact of this change in risk character of companies, test period is determined as Jan 1990 – Dec 2004.

Comparing with the previous researchs made for the ISE, it can be claimed that this study is the one which considers the longest test period. In fact, this is a period during which the economic, political and financial environment changed a great deal. Currency crises, high inflation, budget and balance of payment deficits as well as unemployment were the major problems challenging economic stability during the mentioned period. On the other hand; high growth rates, participation to customs union and increasing regulatory standards were some factors that had positive impact on risk characters of firms.

The second estimation issue relates to the return interval. Using daily or intra-day returns would increase the number of observations in the regression; but it would expose the estimation process to a significant bias in beta estimates related to non-trading. For instance; the betas estimated for small firms, which are more likely to suffer from non-trading, would be more biased downwards if daily returns were used. On the contary, using weekly or monthly returns could reduce the non-trading significantly. However, considering the fourteen years of sample period, monthly returns and risk free rates were found to be significant enough to be used for the purpose of this study.

The third estimation issue relates to the choice of a *market index* to be used in the regression. The standard practice used in previous literature is to estimate the betas of companies relative to the index of the market in which the stocks are traded. The crucial problem in selection of the market index is that the indices which measure market returns in small markets like ISE tend to be dominated by a few large companies or companies of a holding or a group. Hence, using XU-030 or XU-050 indices could provide biased results in beta estimates of the companies not included in the index calculation. In fact, these indices are mainly dominated by banking and holding companies. This could lead approximation of these companies' beta to one whereas beta of remaing firms diverge from one. Hence, it was decided to use the XU-100 index which considers more firms as the market proxy for the testing purpose.

In fact, XU-100 index is the only index which is being calculated since ISE's establishement; and hence, the only one providing more clue as the market proxy. The index is a kind of weighted average index and is calculated with the formula below:

$$E_t = \frac{\sum_{i=1}^{n} F_{it} * N_{it} * H_{it}}{B_t} \qquad (Eq - 53)$$

Where;

E_t is the index value at time t;

n is the number of stocks in the index (which is 100);

F_{it} is the price of stock i at time t;

N_{it} is the total number of issued stocks of i;

H_{it} is the ratio of public offer of stock i at time t;

B_t is the adjusted base market cap.

Since, the index is calculated with the weighted average principle one may anticipate that no particular company or a group will have a dominant impact on beta regressions.

i) Stock Returns: Monthly stock returns, adjusted for dividends and splits, are obtained from the ISE electronic database. Only the stocks, which have been traded more than 30 months, are included in our analysis to make the linear regression results more significant. Moreover, stocks which were stopped for trading by ISE / Board of Capital Market Management for temporary periods were also excluded from the analysis. Appendix-1 presents the list of stocks which are excluded from the analysis. As a conclusion, 278 stocks and a total of 34,262 monthly stock returns were considered in the analysis. Moreover, stocks are also grouped according to the sectors/industries that the companies are operating in order to discuss/investigate any sectoral anomolies, if any.

ii) Risk free rate: To calculate the market and stock risk premiums, annually compounded interest rates were obtained from the Treasury's electronic database. The annual compounded rates are the average values calculated according to the IPO volumes. Monthly risk free rates (r_f) were calculated simply by using the compounded interest rate formula;

$$EAR=[1+r_f]^{12}-1 \qquad \text{(Eq – 54)}$$

where EAR is the effective annual rate. Results are provided in Appendix - 2. During the sample period, monthly risk free rate fluctuates between 1,73% and 12,86%. In fact, even this fluctuation indicates how economic conditions have changed during the testing period.

iii) Risk Premiums: Risk Premium of a stock is simply the expected excess return of a stock over the risk-free rate. Hence; once obtaining the monthly stock returns and the risk free rate, it is easy to measure the risk premium of stock *i* in month *t* by using simply the following equation.

$$\text{Risk premium of stock } i \text{ in month } t = r_{it} - r_{ft} \qquad \text{(Eq – 55)}$$

In a similar way, the market risk premium is calculated for the Jan 1990 – Dec 2004 period as presented in Appendix - 3.

In the bottom line of this table, average of monthly market risk premiums is also indicated. In fact, the average risk premium of market (or a stock) represents how well or worse it has performed over risk-free rate during the sample period. In other words, one may anticipate that stock i will have over-under perform the risk free rate at the average risk premium rate.

In Appendix - 3, it is seen that the market risk premium varies between -44,63% and 75,45%. This is a huge range which is due to ISE's speculative nature with low market cap. It should be noted that the lowest market risk premium (-44,63%) occured in Sep 98, during which a huge international portfolio capital outflow took place bacause of the currency crises in emerging markets started in Eastern Asia. On the other hand, the largest market risk premium (75,45%) is observed in Dec 99. One may remember the bull market in ISE started in the second half of 1999 and continued till 2000 during which the number of accounts in the clearing system more than tripled with the participation of small investors. Ir-rational investment decision during that period led over-pricing of stocks which then followed by a bear market in the following three years.

Average risk premium of each stock is calculated in a similar way via Eq – 55. An important point noticed regarding the average risk premiums is that 30% of the stocks have a negative average risk premium (84 of 278 stocks). These results are summarized in Appendix-4. In fact, this remark contradicts with the fundamental of Markowitz portfolio selection theory. That is, estimated return of stocks must exceed the risk free rate since there is a risk associated with the stock investment. Again, one should notice that the previous performance of stock is used as the proxy of expected future risk premiums of stocks in the regression methodology. Hence, although a negative risk premium should not be expected according to the theoretical model of CAPM –that is if the expected future risk premium is zero for a stock, then all the investors would sell it short which will provide the risk-return equilibrium – the average risk premiums may be below zero because the previous realized returns are used in the testing methodology. In any case, average risk premiums of stocks should tend to converge the market risk premium.

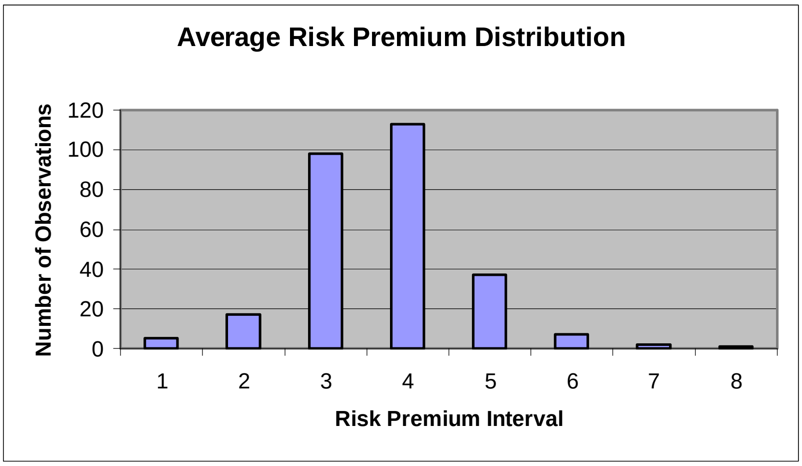

Figure – 9 Average Risk Premium Distribution

Figure -9 above indicates that average risk premium of 76% of all stocks (211 of 278 stocks) is between -1,12% and 2,18 during the sample period. Since the average market risk premium is 0,12%, one may conclude that the average risk premium of stocks tend to converge to market risk premium in the long-run.

Appendix-5 indicates that the average risk premium of stocks vary between -4,42% (BJK) and 8,81% (TSKB Yatırım Ortaklığı) during the sample period . That is; one may anticipate that BJK's stock performance will be 4.42% less than the risk free rate whereas TSKB Yatırım Ortaklığı's stock performance 8,81% more than the risk free rate. Of course this is just a prediction based on previous stock performance since the future expected stock returns cannot be known accurately beforehand as required by CAPM.

Table - 1 below summarizes the average of average risk premium of stocks in sectoral groups. As per the table below, one may anticipate that food&beverage, sport services and technology stocks will under-perform the risk free rate whereas the other industries outperform the risk free rate.

Table -1: Average of average risk premiums

Sector	**Average of Average Risk Premiums**
Automative	0.97%
Banking	1.37%
Chemistry	0.77%
Construction	0.84%
Electronic Equipment	1.37%
Energy	0.80%
Financial Services	1.92%
Food and Beverage	-0.02%
Forestry Goods	0.34%
Holdings	0.59%
Insurance	0.70%
Machinery and Metal Equipment	1.17%
Media	2.63%
Real Estate	0.46%
Retailer	1.17%
Social Services	1.56%
Sport Services	-2.26%
Technology	-0.58%
Textile	0.10%
Tourism	0.90%
Transportation	2.06%

It was also noted that the average risk premium is the highest for the media sector which is followed by financial services, social services, banking and electronic equipment sectors, respectively.

5.1.b. Single Index Model Methodology

As per Eq – 31, if the expected return – beta relationship holds with respect to an observable ex ante efficient index, M, the expected rate of return on any security i is;

$$E(r_i) = r_f + \beta_i [E(r_M) - r_f] \qquad \text{(Eq – 56)}$$

where β_i is defined as $Cov(r_i, r_M) / \sigma_M^2$.

Our test methodology will be similar to the early tests of CAPM and will follow up two steps:

- Estimating the security characteristic line (SCL),
- Estimating the security market line (SML)

5.1.b.i. <u>Estimating SCL:</u> To construct the single-index model, realized rate of return on a stock is first separated into macro (systematic) and micro (firm-specific) components in a manner similar to that in Eq - 56. Thus, the rate of return on each stock is established as a sum of three components:

Table – 2: Return Components

Component	***Symbol***
1. Stock's expected return if the market is neutral, that is, if the market's excess return is $r_M - r_f = 0$	a_i

Component	*Symbol*
2. The component of return due to movements in the overall market; b_i is the stock's responsiveness to market movements	$b_i\ (r_M - r_f)$
3. The unexpected component due to unexpected events that are relevant only to this stock (firm specific)	e_i

Then, the holding period excess return on the stock is stated as ;

$$r_{it} - r_{ft} = a_i + b_i\ (r_{Mt} - r_{ft}) + e_{it} \qquad \text{(Eq - 57)}$$

The model is constructed in terms of excess returns over r_f rather than in terms of total returns because the level of the stock market return represents the state of the macro-economy only to the extent that it exceeds or falls short of the rate of return on risk-free rate. For example; 4,31% return of market in Oct 2004 would be considered as a good news compared to the risk free rate of 1,73%. In contrast, when risk-free rate was offering 12,86% in May 1994, that same 4,31% of market return would signal a disapponting macro-economic news.

In fact, Eq-57 suggests how one should measure the market and firm-specific risk. Once the risk premium of market and the stock *i* is measured, the security characteristic line is predicted by a first-pass regression. The following scatter diagram explains the regression terminology and methodology.

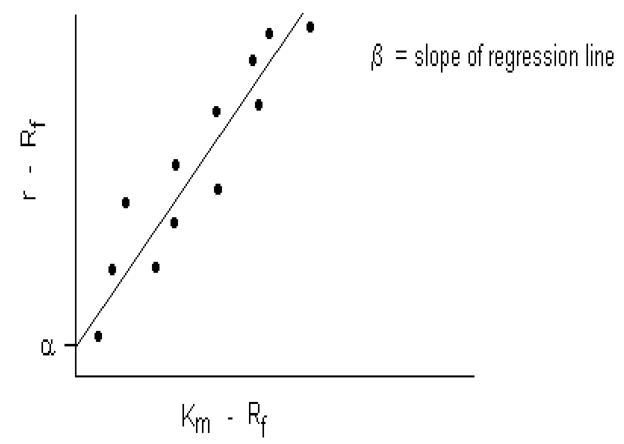

Figure – 10 SCL Regression

The horizantal axis in Figure-10 measures the excess return (over the risk free rate) on the market index, whereas the vertical axis measures the excess return on the stock *i*. A pair of excess returns (one for the market index, one for stock *i*) constitutes one point on the scatter diagram. These points are assumed for all the applicable sample months from Jan 1990 to Dec 2004.

The figure is a single-variable regression equation, the dependent variable plots around a straight line with an intercept α and a slope β. The deviations from the line, e_{it}, are assumed to be mutually uncorrelated as well as uncorrelated with the independent variable. Because these assumptions are identical to those of the index model, the index model is viewed as the regression line. The sensitivity of stock i to the market, measured by b_i (β in Figure – 10), is the slope of the regression line. The intercept of the regression line is a_i (α in Figure – 10) representing the average return when the market's excess return is zero. Deviations of particular observations from the regression line in any period are denoted as e_{it} and called residuals. Each of these residuals is the difference between the actual stock return and the return that would be predicted from the regression equation describing the usual relationship between the stock and the market; therefore residuals measure the impact of firm specific events during the particular month. Finally, the parameters of interest; a_i ,b_i, and $Var(e_{it})$ are estimated using the standard regression techniques.

For the regression purposes, a %95 confidence interval is considered and the statistical test results are summarized in the following section.

5.1.b.ii. **<u>Estimating SML:</u>** CAPM theory defines the expected return-beta relationship as $E(r_i) = r_f + \beta_i [E(r_M) – r_f]$. If the index M represents the true market portfolio, one can take the expectation of each side of the equation -57 to show that the index model specification is;

$$E(r_i) - r_f = \alpha_i + \beta_i [E(r_M) – r_f] + E(e_{it}) \qquad \text{(Eq – 58)}$$

A comparison of the index model relationship to the CAPM expected return-beta relationship shows that the CAPM predicts that a_i should be zero for all assets. The alpha of a stock is its expected return in excess of (or below) the fair expected as predicted by the CAPM. If the stock is fairly priced, its alpha must be zero.

It should be noted that this is a statement about the expected return on a stock. After the fact, of course, some stocks will do better or worse than expected and will have returns higher or lower than predicted by the CAPM; that is they will exhibit positive or negative alphas over the sample period. But this superior or inferior performance could not have been forecasted in advance.

Therefore, when the index model is estimated for several stocks using Eq - 58, the ex post or realized alphas for the stocks in the sample should center around zero. The CAPM states that the expected value of alpha is zero for all stocks, whereas the index model representation of the CAPM holds that the realized value of alpha should average out to zero for the sample period.

On the other hand, to be inline with the CAPM theory, expected firm specific return (or risk) should be zero on average. In fact, expected firm specific risk is indeed zero due to the nature of risk definition. Firm specific risk is impact of *unanticipated* firm specific events.

Hence, Eq – 56 is considered as a security market line and the second pass regression equation is constructed with the estimates b_i from the first pass regression as the independent variable:

$$\text{Average } (r_i - r_f) = \gamma_0 + \gamma_1 b_i + \gamma_2 \sigma^2(e_i) \qquad \text{(Eq – 59)}$$

Comparing Eq – 56 and Eq – 59, if CAPM is valid, it should be concluded that γ_0, γ_1 and γ_2 must satisfy the following requirements:

$$\gamma_0 = 0 \qquad \text{(Eq - 60)}$$

$$\gamma_1 = \text{Average } (r_M - r_f) \qquad \text{(Eq – 61)}$$

$$\gamma_2 = 0 \qquad \text{(Eq – 62)}$$

The hypothesis that $\gamma_2 = 0$ is consistent with the notion that nonsystematic risk should not be priced, that is, there is no risk premium earned for bearing nonsystematic risk. Moreover, $\gamma_0 = 0$ should also hold that the realized alphas average out to zero. Finally, if the index is a good proxy of the market, average of all stocks' risk premium must be equal to the market premium (0,12% given in

Appendix - 3) to conclude that CAPM is an acceptable theory to estimate stock returns in the market.

In general terms, according to CAPM, the risk premium depends only on beta. Therefore, any additional right hand side variable in Eq – 59 except beta should have a coefficient that is insignificantly different from zero in the second pass regression.

5.2 <u>Test Results</u>

5.2.a. Security Characteristic Line (SCL) Regression

Test results for SCL regressions are reported in both Appendix-5 and Appendix-6. In these tables;

Intercept; represents the monthly expected risk premium of stocks when expected market risk premium and company specific risk is zero.

Beta estimate; is the slope of regression line which will be used as beta in security market line regression.

Var (e) is the variance of residuals which may be defined as the expected risk premium due to company specific risk – nonsystematic risk - .

Findings regarding each of the above variables as well as the risk premiums are analyzed below.

i. Regression Intercepts: According to the regression model, the intercept point indicates the estimation of risk premium of stock i when the market risk premium and company specific risk is zero. That is, if the beta of stock is “null” (b_i = 0) and there is no company specific risk (e_{it} = 0); then $a_i = r_{it} - r_{ft}$ should hold in Eq – 57. Regression results are given in Appendix - 5.

In fact, according to the single index model given in Eq - 57, a_i should be zero for all assets. The value a_i of a stock (in fact it's the Jensen's α) is its expected return in excess of (or below) the fair expected return as predicted by the CAPM. If the stock is fairly priced, a_i should be "0".

However, one should notice that this is a statement about *expected* returns on a stock. After the fact, some stocks will do better or worse than expected and will have returns higher or lower than predicted by the CAPM; that is they will exhibit positive or negative alphas over a sample period. But, this superior or inferior performance could not have been forecasted in advance.

Therefore, by estimating the index model for all the stocks in the market by using Eq - 38, we should find that the ex-post or realized alphas (the regression intercepts) for the firms in the sample center around zero. Figure - 11 below presents the alpha distribution of the securities.

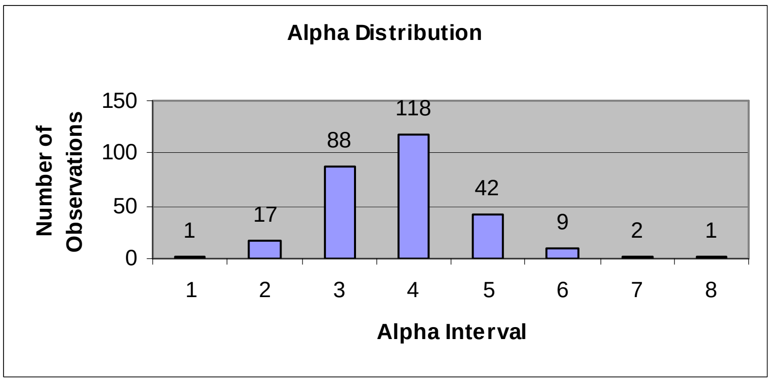

Figure – 11 Alpha Distribution

According to test regression results presented in Appendix - 5, the intercept estimates are accumulated within the -0,0098 and 0,0372 interval (shown with the bars numbered 3, 4 and 5 in Figure - 11). That is, the test results are consistent with the mentioned expectation.

In fact, if the initial expectation for alpha were zero, as many firms would be expected to have a positive as a negative alpha for some period. The CAPM states that the *expected* value of alpha is zero for all stocks whereas the index model representation of CAPM holds that the realized value should average out to zero for the sample. Of course, the sample alphas should be unpredictable, that is, independent from one sample period to the next.

When the alpha values are analyzed in Appendix - 5, it is observed that there is a range between -4,1% and 8,41% which is accumulated around “0”. An important note is that the p-value of alpha estimate is below the confidence probability, 0.05, for only six stocks (BJK, İş C, DOHOL, Ford, Migros and Alarko Holding). That is the alpha estimates for the remaining stocks are not significant enough in statistical terms. Therefore, the conclusion is that the regression model seems not to be a very good fit to predict risk premium in the absence of market related risk factors. In any case, as explained in section 5.1.b.ii SML Regression Methodology, this is not a concern for the purpose of this study since only beta estimates will be used in the second-pass regression.

ii. Beta Estimates: To measure the predictivity power of the regression a 95% confidence interval for t-tests was used. Therefore, any beta estimate with a p-value of less than 5% is accepted as a significant beta estimate. Upon performing the t-tests for beta estimates, it was observed that; beta adds significantly to the predictivity power of the model for 274 of 278 stocks (Appendix-5). This is a significant number which indicates that the regression model is a good fit for beta estimates.

The model's prediction is not significant for only four stock's beta estimates which are Ceylan Tekstil, Galatasaray, TSKB Yatırım Ortaklığı and Vakıf Girişim. The number of observations for these stocks are relatively less than the other stocks which may be described as the reason of model's failure in beta prediction (90, 35, 39 and 54 respectively).

An important point noticed in the study is that the p-value decreases with increasing number of observations. That is, the model provides much more significant estimates for the stocks being traded for a long time. For instance; the p-value is the smallest for the stocks like Şişe Cam, Alcatel, Kordsa, Bagfaş, Arçelik, Sarkuysan, Koç Holding, Ford Otosan, Brisa and Erdemir. It should be noted that a total of 180 observations (beginning from Jan 1990) were used in the regressions for each of these stocks.

Another remark is that, for the stocks which are included in XU-100 index calculation; beta estimate is usually very close to 1 and the p-values indicate a high level of confidence. Some examples are; Erdemir, Beko, Arçelik, Garanti Bankası, Sabancı Holding and Vestel. In fact, this is due to the formulation of beta which is, $Cov(r_i, r_M) / \sigma_M^2$. Any stock included in XU-100 index tend to move in line with the market index fluctuations. Hence, the covariance between the stock and market returns converges to market variance; which then approximates beta to 1 as per the above formula.

If there is no clue about firm-specific risk of a stock, then the best guess for the beta is 1. This is the case because CAPM assumptions require that investors sell short the over-priced stocks and buy long the under-priced stocks rationally. Hence, price fluctuations of stocks should look like similar to market movements. Based on this assumption, one may anticipate that the beta distribution should accumulate near 1.

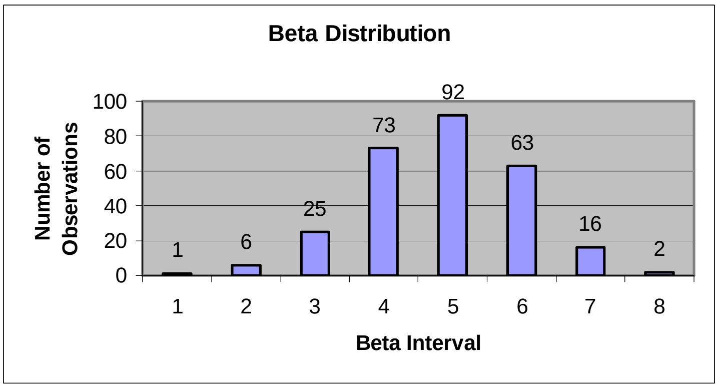

Figure – 12 Beta Distribution

Each beta interval in Figure – 12 is established with 0.2 increments (0.2–04; 0.4-0.6, etc.). With a quick glance, one may realize that Figure - 12 looks like a normal distribution which indicates the beta estimates of the study tend to accumulate near one. In numerical terms; 92 of 277 stocks have a beta value between 0.8 and 1; whereas 63 of them have a beta between 1 and 1,2. In other words; %56 of the stocks in ISE have a beta value between 0,8 and 1,2. In fact, this finding is consistent with the previously mentioned discussion. Beta of any stock; which is being traded for a long time enough, tends to move to 1. As a conclusion of the mentioned statistics and evaluation of t-stats, it is found that the beta estimates of SCL regressions may be considered as a good □roxy for the actual betas that will be used in SML regression.

Moreover, it was also observed that the beta estimates vary between a range of 0.2819 and 1.5781 (Appendix – 5). In addition, 81 stocks have a beta estimation of larger than 1, whereas the beta estimate is less than 1 for the remaining 197 stocks. This means 29% of stocks traded at ISE has more sensitivity to economical and financial risk factors than the overall market proxied by ISE – 100 index.

On the other hand, it was observed that stocks of companies operating in banking, holding and media sectors usually have beta estimates larger or closer to 1 whereas the stocks of companies operating in traditional manufacturing/service sectors usually have beta estimates less than 1. The following table summarizes this observation:

Table – 3: Beta Estimate Results of SCL Regression

Sector	**Beta Estimate Below 0,90**	**Beta Estimate Between 0,9-1,0**	**Beta Estimate Between 1,0 – 1,1**	**Beta Estimate Above 1,1**
Automotive	2	3	3	2
Banking	4	1	4	3
Chemistry	11	2	4	4
Construction	21	7	3	2
Electronic Equipment	4	2	4	1
Energy	3	1	1	-
Financial Services	16	7	2	9
Food&Beverage	17	4	2	-
Forestry Goods	16	1	-	-
Holding	2	1	2	5
Insurance	2	2	1	2
Machinery	9	5	4	4
Media	-	-	1	4
Real Estate Investment	4	-	2	2
Retailer	4	2	-	2
Social Services	-	-	1	-
Sport Services	2	-	-	-
Technology	3	1	-	3
Textile	26	2	4	-
Tourism	4	3	-	-
Transportation	2	1	-	-
TOTAL	**152**	**45**	**38**	**43**

Once analyzing the table above, it can easily be noted that the beta estimates for the major number of stocks of companies operating in banking, holding and media sectors are larger than 1. Moreover, beta estimates for the other sectors are uniformly distributed or less than 1. For instance; it was observed that beta estimates of most of the stocks operating in forestry goods, food&beverage, textile, tourism, transportation, construction are well below one.

The forementioned observation leads to the idea that there are some sectors that responds a great deal to macro-economic factors whereas some others respond up to a smaller limit. In fact, the common base for the banking, holding and media sectors is that they are closely correlated with the other sectors. In other words, success of banking/holding/media sectors depends on the success of all other sectors. Net profit or income of other sectors provides a cash flow input to these three sectors. Their performance is highly correlated with macro-economic factors; especially with the economic growth. In fact, this approach may describe this sectoral anomaly, but this idea will be out of scope for the purpose of this paper.

iii. Regression Residuals: As explained in section 5.1.b.i. SCL Regression Methodology, the dependent variable plots around the SCL with an intercept α and a slope β. The deviations from SCL, e_{it}, are assumed to be uncorrealated with each other and the independent variable, the market risk premium as well. In fact, deviations of particular observations from the regression line in any period are denoted as, e_{it}, or regression residuals. Each of these residuals is the difference between the actual stock return and the return that is predicted from the regression which is describing the relationship between the stock and the market. Therefore, residuals measure the impact of firm-specific risk events and variance of residuals measure the firm-specific risk during the particular month.

The residual variances of each stock (or the company specific risk of each stock) is presented in Appendix - 6. It is observed that the range of company specific risk varies within the range of 0,68% (Soda Sanayi) and 25,97% (Bosch). As the terminology requires, one may conclude that return fluctuations *due to company specific risk* is much lower for Soda Sanayi compared to Bosch.

And when a sectoral comparison is performed, it is noted that energy, tourism, media, machinery, financial services and electronic equipment sectors are the ones with the highest company specific risks (Table – 4). In other words, the risk premium of those stocks due to company specific risk is higher than the ones operating in other sectors. On the other hand, it is noted that the average company specific risk is the smallest for the sport services, social services and the insurance firms.

Table – 4: Residuals of SCL Regression

Sector	**Average of Company Specific Risk**
Automotive	3.46%
Banking	4.03%
Chemistry	3.97%
Construction	3.31%
Electronic Equipment	5.98%
Energy	8.26%
Financial Services	6.15%
Food&Beverage	4.65%
Forestry Goods	4.44%
Holding	3.86%
Insurance	2.75%
Machinery&Metal Equipment	6.18%
Media	6.23%
Real Estate Investment	3.04%

Sector	Average of Company Specific Risk
Retailer	3.33%
Social Services	2.45%
Sport Services	1.91%
Technology	3.78%
Textile	4.83%
Tourism	7.43%
Transportation	4.48%

Company-specific risk is usually defined as the unexpected risk that a company faces due to the nature of its business. However, considering the speculative nature of ISE, some portion of the company specific risk defined above may be simply because of the speculative price movements. Indeed, the stocks with the largest company specific risks (such as Bosch, Kardemir B, Altınyunus Çeşme, Deniz Yatırım, etc.) have lower market caps. Hence, impact of speculative movements on the company specific risk may be investigated in further studies; but this idea will be kept out of this study's purpose.

iv. Adjusted R Sqare: Adjusted R-Square in Appendix-6 shows the square of the correlation between risk premiums of stock *i* and the market (r_i-r_f and r_M-r_f). In statistical terms, adjusted R-square –which is also called as coefficient of determination- gives the fraction of the variance of the dependent variable (the risk premium of stock i) that is explained by movements in the independent variable (the return on the market index). The variance of a stock's risk premium constitutes of the variance due to the market return and the firm-specific risk which can be formulated as follows:

$$\sigma_i^2 = \beta_i^2\sigma_M^2 + \sigma_i^2(e_i) \qquad \text{(Eq – 63)}$$

Hence, coefficient of determination is systematic variance over total variance, which tells us what fraction of a firm's volatility is attributable to market movements:

$$\text{Coefficient of Determination} = (\beta_i^2 \sigma_M^2) / \sigma_i^2 \qquad \text{(Eq – 64)}$$

When the R-Square results are analyzed, it is seen that more than %70 of the volatility of the stocks Yapı Kredi GYO, İş GYO, Sabancı Holding, Soda Sanayi, Aksigorta and Yazıcılar Holding is attributable to market fluctuations. That is, variance of these stock returns depend on the market movements more than the other stocks do.

Table -5: Adjusted R-Square for SCL Regression

Sector	**Adjusted R-Square**
Automotive	44,87%
Banking	42,98%
Chemistry	41,70%
Construction	40,24%
Electronic Equipment	41,69%
Energy	36,76%
Financial Services	32,97%
Food&Beverage	27,52%
Forestry Goods	27,02%
Holding	51,79%
Insurance	49,20%
Machinery&Metal Equipment	37,50%
Media	43,49%
Real Estate Investment	54,50%
Retailer	44,18%
Social Services	53,31%
Sport Services	17,33%
Technology	40,78%
Textile	31,89%
Tourism	26,25%
Transportation	31,21%

Table-5 presents a sectoral comparison of the adjusted R-Square of SCL regressions. It can be concluded that more than half of the variance of holding and real estate investment stocks is due to the market variance. On the other hand, attribute of market variance on tourism, food&beverage and forestry good stocks is less than 30% which means a great portion of variance of these stocks is due to company specific risk. This idea can also be investigated by using the sectoral indexes but for the purpose of this study, this investigation will be kept out of scope.

5.2.b. Security Market Line (SML) Regression

After obtaining significant beta estimates from the SCL regression, these estimations were used as the input to the below second regression.

$$\text{Average } (r_i - r_f) = \gamma_0 + \gamma_1 b_i + \gamma_2 \sigma^2(e_i) \qquad \text{(Eq – 65)}$$

According to CAPM, the risk premium depends only on beta. Therefore, our hypothesis is that all right hand side variables (γ_0 and γ_2) in Eq – 43 except beta should have a coefficient that is insignificantly different from zero. Moreover, coefficient of beta should equal average market risk premium within a statistically significant range. (Eq – 60, Eq – 61 and Eq – 62)

For the Jan 1990 – Dec 2004 period, the average market risk premium is calculated as 0,0012 in Appendix – 3. In other words; the regression result should statistically indicate that $\gamma_0 = \gamma_2 = 0$ and $\gamma_1 = 0{,}0012$.

Table below summarizes the statistical results of the SML regression within a 95% confidence interval.

Table - 6: Statistical Results of SML Regression

	Coefficients	***Standard Error***	***t Stat***	***P-value***
γ_0	-0.012159425	0.003627032	-3.35244	0.000913
γ_1	0.019186569	0.003936334	4.874222	1.85E-06
γ_2	0.075691551	0.012919939	5.858507	1.33E-08

First observation is that the results are significant for all the three coefficients at 95% confidence interval level. That is, the p-value is much more less than 0.05. In other words, the results are reliable enough to test the validity of CAPM model.

The regression model predicts γ_0 = - 0.0122, γ_1 = 0.0192 and γ_2 = 0.0757. Even with a quick glance, it can be noted that these estimations are far apart from the requirements of the hypothesis stated in Eq – 60, Eq – 61 and Eq – 62.

First, the estimated SML is too steep; that is, the γ_1 coefficient is too large. The slope prediction; γ_1 = 0.0192, is 16 times the expected slope which is the average market risk premium, 0,0012. The difference between the prediction and the expected slope is 0,018 and equals 4,87 times the standard error of the estimate, 0.003936. This means that the measured slope of the SML is much more than it should be to accept CAPM as a valid asset pricing theory for ISE.

Second, the intercept of the estimated SML, γ_0, which is hypothesized to be zero, in fact equals -0.0122, which is more than 3 times its standard error, 0,0036. Having a negative intercept states that estimated market risk premium from the model is less than the anticipated market risk premiums. However, our assumption was that; if the market is a good proxy of all stocks portfolio, market risk premium must equal average of all stocks' risk premium which is anticipated to be zero. Therefore, this prediction indicates that the SML regression is inconsistent with the CAPM.

Third, the estimation of residual's variance coefficient is $\gamma_2 = 0.0757$ which is anticipated to be zero. The prediction is 5,86 times its standard deviation indicating a significant statistics. Having a positive coefficient means there is a risk premium earned for bearing nonsystematic risk. However, CAPM's argument requires that risk premiums depends on only betas. Thus, coefficient of non-systematic risk premium is also inconsistent with CAPM.

To sum up, predictions of SML regression are in contradiction with the CAPM hypothesis. Having a too large slope and non-zero coefficients for the intercept and non-systematic risk premium leads to rejection of the hypothesis. In other words, the statistical study indicates that CAPM is not a valid methodology to predict stock returns at ISE market. Since the results indicate that the required return is higher than the expected by the model, risk level should be higher than predicted by traditional CAPM model. Thus, the results signify that the company specific risk and some other risk factors should be taken into consideration and be priced in ISE.

After concluding on failure of CAPM based on traditional beta estimates, performance of *professional's adjusted beta* is also investigated. As explained above, the idea behind the adjusted beta is that; on average, the beta coefficients of stocks move towards one over time. The statistical explanation for this approach is that the average beta of all stocks is 1. Thus, before estimating the beta of a stock the best estimate would be 1. When the beta coefficient is estimated over a sample period, some unknown sampling error is sustained. The greater the difference between the beta estimate and 1, the greater is the chance that there will be a huge estimation error incurred. Hence, the historical market beta estimate used in the anlaysis is a good guess for the *sample period*. However, a *forecast of the future beta* should be adjusted if the beta coeeficient tends to move to 1 in long-run from the adjusted beta point of view.

To perform the SML regression for the adjusted beta case, future beta of stocks were estimated with the following weighted average formula (which is also being used investment professionals like Merrill Lynch and Bloomberg);

Adjusted beta = (2/3)*(Historical Beta) + (1/3)*(1) (Eq - 66)

Adjusted beta of each stock is presented in Appendix - 7 and the SML regression results are summarized below:

Table -7: Statistical Results of SML Regression with Adjusted Beta

	Coefficients	*Standard Error*	*t Stat*	*P-value*
γ_0	-0.021751271	0.005534576	-3.9300697	0.000108
γ_1	0.028778414	0.005904206	4.87422246	1.84869451E-06
γ_2	0.075691551	0.012919939	5.85850667	1.33128056E-08

Again, the results are significant for all the three coefficients at 95% confidence interval level. That is, the p-value is much more less than 0.05 and the results are reliable enough to test the validity of CAPM model.

SML regression predicts market risk premium as γ_1 = 0,0288 which is 24 times the expected market risk premium 0,0012. The t-stats is 4,67 which indicates that the estimation equals 4,67 times the standard error of estimate. This means that the measured slope of the SML is much more steeper than it should be to accept validity of CAPM for ISE.

Second, estimated intercept of SML, γ_0, which is hypothesized to be zero, in fact equals -0.0218, which is approximately four times its standard error. However, the hypothesis requires that $\gamma_0 = 0$ should hold in order to conclude that CAPM is valid.

Finally, SML regression predicts residual's variance coefficient again $\gamma_2 = 0.0757$ which is anticipated to be zero. This result is similar to the one predicted for the historical beta estimates. In fact, this can be anticipated because only the beta coefficients were adjusted, but not the variance residuals. The positive coefficient for the residual variances indicate that there is a risk premium earned for bearing nonsystematic risk. However, CAPM's argument requires that risk premiums depends on only betas and $\gamma_2 = 0$ should hold to accept the hypothesis. Thus, prediction of the non-systematic risk premium coefficient is also inconsistent with CAPM.

To sum up, predictions of SML regression with ajusted beta are either in contradiction with the CAPM hypothesis. Having a too large slope and non-zero coefficients for the intercept and non-systematic risk premium leads to rejection of the hypothesis once more. In other words, the statistical study indicates that CAPM is not a valid methodology to predict stock returns at ISE market even if the adjusted beta is used to regress the SML. Thus, the results signify that the company specific risk and some other risk factors should be taken into consideration and be priced in ISE.

However, there are some issues which may have led to rejection of CAPM in the model. First and foremost, ISE market is an emerging market and market capitalization is very small compared to some other developed markets. This leads to extreme price fluctuations due to speculations and manipulations. In other words, stock returns are extremely volatile, and the volatility lessens the precision of any tests on average returns.

Second, the XU-100 index used in the test is surely not the “Market Portfolio” as required by CAPM. The index includes stocks of companies operating in many sectors but it, of course, excludes some nontraded assets such as education (human capital), private enterprises, and investments financed by government. These observations lead to the idea that XU-100 index may be, somehow, a biased proxy of the macro-economic factors. This, indeed, is a general criticism against CAPM. Further research may be performed by separating and using each macro-economic factor (inflation, economic growth, unemployment rate, etc.) as a regression input in order to eliminate the bias in the XU-100 index. To sum up, XU-100 index may be questioned to measure how well it acts as a proxy of all macroeconomic factors and non-traded assets.

Moreover, in recent years it is observed that the correlations between the emerging and developed markets is increasing. Availability of high-tech communication systems led capital to flow between international markets quickly and easily. As a result, since all the emerging markets turned out to be affected by the international capital flows, a strong correlation between emerging markets has been observed in recent years. That is, the return on XU-100 index not only depends on national macro-economic factors but also depends on the movement of international capital. As a variable to right hand side of the Eq – 65, the capital flow can also be investigated to measure its effect on return predicitivity power.

Fourth, in light of asset volatility, the security betas from the first stage regressions are necessarily estimated with substantial sampling error and therefore cannot readily be used as inputs to the second regression.

Finally, we assumed that investors can borrow at a risk free rate and there exists no cost associated with trading. These are un-realistic assumptions apart from the real world. Further research may be re-performed for the ISE by including trade costs and real interest rates in the case of borrowing.

CHAPTER 6: CONCLUSION

CAPM is known to be the first successful attempt to estimate the expected rate of return that investors will demand if they are to invest in an financial asset. Although CAPM was criticized by many academicians due to its many simplifying assumptions, results of empirical tests performed in many developed markets, particularly in US, supported the model till the last decade. However, recent studies challenged the validity and applicability of CAPM in financial markets and the theory became the center of attention once again. Currently, there are very few studies that have examined CAPM in Turkey. This particular study attempts to fill in this gap by testing the predictivity power of CAPM for İstanbul Stock Exchange.

The model testing was based on a two steps regression analysis. First, beta value of each stock was estimated simply by using a first step regression (SCL regression) and then beta predictions were used in a second-pass regression (SML regression). The hypothesis was that; any coefficient on the SML regression other than beta's must be zero. Otherwise, the variable with non-zero coefficient would also contribute to the estimated stock return and that would be in contradiction with CAPM's argument.

The regression results were confusing. Beta estimates obtained by the SCL regression were statistically significant. Moreover, we also observed that;

- Significancy increases with the increasing number of observations, and
- Beta estimates of stocks included in XU-100 index are generally close to 1 within an acceptable range.

It was also noted that most of the media, holding and banking stocks have a beta estimation of larger than 1. That is, these stocks responds a great deal to macro-economic factors whereas some others respond up to a smaller limit. In fact, the common base for the banking, holding and media sectors is that they are closely correlated with the other sectors. Net profit or income of other sectors provides a cash flow input to these three sectors. They gain more than the other sectors in case of an economic boom whereas they lose more in case of a recession. We concluded that there may be a sectoral effect in stock beta estimations which may be investigated in a further research.

The second SML regression also provided statistically significant results. However, it was observed that the prediction results with a positive coefficient for non-systematic risks and a negative coefficient for the intercept point. According to the hypothesis, these coefficients were anticipated to be zero since CAPM requires pricing of solely beta. Moreover, beta coefficient was expected to equal the average of market risk premium. However, the regression result turned with a larger value than the expected. That is, the regression result was too steep compared to actual slope. These results led to the rejection of the hypothesis. As a result; it was concluded that the CAPM is not a valid methodology to be used as a prediction model for the ISE market.

Failure of the model may be due to speculative structure of ISE, correlation of international markets, sampling errors or inability of XU -100 index to reflect market portfolio as well as CAPM’s over-simplifying assumptions. Furher research is necessary to clarify these questions and the sectoral beta anomolies as stated above.

REFERENCES

Aksu, H.M., Onder, T. 2000. “The Size and Book-to-Market Effects and Their Role as Risk Proxies in the ISE”. *Working Paper, Sabanci University.*

Ball, R. 1978. “Anomalies in Relationships Between Securities’ Yields and Yield-Surrogates.” *Journal of Financial Economics.* 6:2, pp. 103-126.

Banz, R.W. 1981. “The Relationship Between Return and Market Value of Common Stocks”. *Journal of Financial Economics*. 9:1, pp. 3-18.

Basu, S. 1977. “Investment Performance of Common Stocks in Relation to Their Price - Earnings Ratios: A Test of the Efficient Market Hypothesis.” *Journal of Finance*. 12:3, pp. 129-56.

Bhandari, L.C. 1988. “Debt/Equity Ratio and Expected Common Stock Returns:Empirical Evidence.” *Journal of Finance*. 43:2, pp. 507-28.

Black, F., Michael C.J., Scholes M. 1972. “The Capital Asset Pricing Model: Some Empirical Tests,” in *Studies in the Theory of Capital Markets*. Michael C. Jensen, ed. New York: Praeger, pp. 79-121.

Black, F. 1972. “Capital Market Equilibrium with Restricted Borrowing.” *Journal of Business.*

Blume, M. 1970. “Portfolio Theory: A Step Towards Its Practical Application.” *Journal of Business*. 43:2, pp. 152-174.

Blume, M. and Friend, I. 1973. “A New Look at the Capital Asset Pricing Model”. *Journal of Finance*. 28:1, pp. 19-33.

Bodie, Z. Kane, A. Marcus, A.J. 2001. *Investments, 2001*. Boston: McGraw-Hill Irwin.

Brennan, M.J. 1973. “Taxes, Market Valuation and Corporate Finance Policy”. *National Tax Journal.*

Brigham, E.F. 1994. *Fundamentals of Financial Management, 7th Edition.* Orlando: Dryden Press.

Bruner, R.F., Conroy, R.M., Estrada, J., Kritsman, M. And Li, W. 2002. "Valuation in Emerging Markets". *Emerging Markets Review,3* pp. 310-324.

Capaul, C., Rowley, I. and Sharpe, W.F. 1993, "International Value and Growth Stock Returns." *Financial Analysts Journal*. January/February, pp. 27-36.

Carhart, M. 1997. "On Persistence in Mutual Fund Performance." *Journal of Finance.* 52:1, pp. 57-82.

Chan, L.K.C., Hamao, Y. and Lakonishok, J. 1991. "Fundamentals and Stock Returns in Japan." *Journal of Finance*. 46:5, pp. 1739-1789.

Chen, N., Roll, R., Ross, S. 1986. "Economic Forces and the Stock Market". *Journal of Business - 59.* pp. 383 - 403

Claressen, S. Dasgupta, S., and Glen, J. 1995. "The Cross Section of Stock Returns: Evidence from Emerging Markets". *World Bank Policy Research Paper, 1505.*

DeBondt, W.F.M. and Thaler,H.R. 1987. "Further Evidence on Investor Overreaction and Stock Market Seasonality." *Journal of Finance*. 42:3, pp. 557-81.

Dechow, P.M., Hutton, A.P. and Sloan, R.G. 1999. "An Empirical Assessment of the Residual Income Valuation Model." *Journal of Accounting and Economics*. 26:1, pp.1-34.

Demir A., Küçükkiremitçi, O. Pekkaya, S. And Üreten, A. 1996. "An Analysis of Portfolio Returns Formed on the Basis of E/P and Firm Size". *İşletme ve Finans, Kasım.*

Divecha. A.B., Drach, J. and Stefek, D. 1992. "Emerging Markets: A Quantitative Perspective". *Journal of Portfolio Management.* Fall, pp. 41-50.

Douglas, G.W. 1968. "Risk in the Equity Markets: An Empirical Appraisal of Market Efficiency". *Ann Arbor, Michigan: University Microfilms, Inc.*

Fama, E. F. and French, K.R. 1993. "Common Risk Factors in the Returns on Stocks and Bonds." *Journal of Financial Economics*. 33:1, pp. 3-56.

Fama, E.F. 1970. “Efficient Capital Markets: A Review of Theory and Empirical Work.” *Journal of Finance*. 25:2, pp. 383-417.

Fama, E.F. and French, K.R. 1992. “The Cross-Section of Expected Stock Returns.” *Journal of Finance*. 47:2, pp. 427-465.

Fama, E.F. and French, K.R. 1998. “Value Versus Growth: The International Evidence.” *Journal of Finance*. 53:6, pp. 1975-1999.

Fama, E.F. and French, R.K. 1996. “Multifactor Explanations of Asset Pricing Anomalies.” *Journal of Finance*. 51:1, pp. 55-84.

Fama, E.F. and James D. MacBeth. 1973. “Risk, Return, and Equilibrium: Empirical Tests.” *Journal of Political Economy*. 81:3, pp. 607-636.

Fama, E.F., French, K.R. 2004. “The Capital Asset Pricing Model: Theory and Evidence”. *An unpublished draft study.*

Fama, Eugene F. 1996. “Multifactor Portfolio Efficiency and Multifactor Asset Pricing.” *Journal of Financial and Quantitative Analysis*. 31:4, pp. 441-465.

Fama, Eugene F. and Kenneth R. French. 1995. “Size and Book-to-Market Factors in Earnings and Returns.” *Journal of Finance*. 50:1, pp. 131-155.

Frankel, R. and Lee, M.C. 1998. “Accounting Valuation, Market Expectation, and Cross-Sectional Stock Returns.” *Journal of Accounting and Economics*. 25:3 pp. 283-319.

Friend, I., Blume, M. 1970. “Measurement of Portfolio Performance under Uncertainty.” *American Economic Review*. 60:4, pp. 607-636.

Gibbons, M. R., Ross A.S, and Shanken, J. 1989. “A Test of the Efficiency of a Given Portfolio.” *Econometrica*. 57:5, pp. 1121-1152.

Gibbons, M.R. 1982. “Multivariate Tests of Financial Models: A New Approach.” *Journal of Financial Economics*. 10:1, pp. 3-27.

Gönenç, H., Karan, M.B. 2001. “Do Value Stocks Earn Higher Returns in an Emerging Market? Evidence from ISE” *Working Paper*, *Hacettepe University*.

Haugen, R. 1995. *The New Finance: The Case against Efficient Markets*. Englewood Cliffs, New Jersey: Prentice Hall.

Jaganathan, R. and Wang, Z. “The Conditional CAPM and the Cross-Section of Expected Returns.” *Journal of Finance -51.* pp. 3 -54.

Jegadeesh, N. and Titman,S. 1993. “Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency.” *Journal of Finance*. 48:1, pp. 65-91.

Jensen, M.C. 1968. “The Performance of Mutual Funds in the Period 1945-1964.” *Journal of Finance*. 23:2, pp. 389-416.

Jones, P. 1991. *Investment Analysis and Management, 3rd edition*. New York: John Wiley and Sons.

Karan, M.B. 1995. “Hisse Senetlerine Yapılan Yatırımların Performanslarının Fiyat/Kazanç Oranına Göre Değerlendirilmesi: IMKB Üzerine Ampirik Bir Çalışma”. *İşletme ve Finans, February.*

Karan, M.B. 1996. “IMKB’de Fiyat/Satış ve Pazar Değeri/Defter Değeri Oranı Etkileri: Karşılaştırmalı Bir Çalışma”. *İşletme ve Finans, Kasım.*

Khanna, A. 1996. “Equity Investment Prospects in Emerging Markets”. *The Columbia Journal of World Business, 31.* pp. 33-39.

Kothari, S. P., Shanken, J. and Sloan, R.G. 1995. “Another Look at the Cross-Section of Expected Stock Returns.” *Journal of Finance.* 50:1, pp. 185-224.

Lakonishok, J., Shleifer, A. and Vishny, R.W.. 1994. “Contrarian Investment, Extrapolation, and Risk.” *Journal of Finance.* 49:5, pp. 1541-1578.

Lintner, J. 1965. “The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets”. *Review of Economics and Statistics.*

Loughran, T. and Ritter, J.R. 1995. “The New Issues Puzzle.” *Journal of Finance.* 50:1, pp. 23-51.

Markowitz, H. 1952. “Portfolio Selection”, *The Journal of Finance, 7, 77-91*

Mayers, D. 1972. “Nonmarketable Assets and Capital Market Equilibrium under Uncertainty.”, *Studies in the Theory of Capital Markets.*

Merton, R.C. 1973. “An Intertemporal Capital Asset Pricing Model.” *Econometrica*. 41:5, pp. 867-887.

Miller, M., and Scholes, M. 1972. “Rate of Return in Relation to Risk: A Reexamination of Some Recent Findings,” in *Studies in the Theory of Capital Markets*. ed. New York: Praeger, pp. 47-78.

Mitchell, M.L. and Stafford, E.. 2000. “Managerial Decisions and Long-Term Stock Price Performance.” *Journal of Business.* 73:3, pp. 287-329.

Mossin, J. 1966. “Equilibrium in a Capital Asset Market”. *Econometrica*

Piotroski, Joseph D. 2000. “Value Investing: The Use of Historical Financial Statement Information to Separate Winners from Losers.” *Journal of Accounting Research*. 38:Supplement, pp.1-51.

Roll, R. 1997. “A Critique of the Asset Pricing Theory's Tests' Part I: On Past and Potential Testability of the Theory.” *Journal of Financial Economics*. 4:2, pp. 129-176.

Rosenberg, B., Guy, J. “Prediction of Beta from Investment Fundamentals.” *Financial Analysts Journal.* August-1976.

Rosenberg, B., Reid, K. And Lanstein, R. 1985. “Persuasive Evidence of Market Inefficiency.” *Journal of Portfolio Management*. 11, pp. 9-17.

Ross, S. A. 1976. “The Arbitrage Theory of Capital Asset Pricing.” *Journal of Economic Theory*. 13:3, pp. 341-360.

Rouwenhorst, K.G. 1999. “Local Return Factors and Turnover in Emerging Stock Markets”. *The Journal of Finance, 54.* pp. 1439 – 1464.

Sharp, W.F. 1964. “Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk”. *Journal of Finance, 19, 425-442.*

Stambaugh, R. F. 1982. “On The Exclusion of Assets from Tests of the Two-Parameter Model: A Sensitivity Analysis.” *Journal of Financial Economics.* 10:3, pp. 237-268.

Stattman, D. 1980. “Book Values and Stock Returns.” *The Chicago MBA: A Journal of Selected Papers*. 4, pp.25-45.

Stein, J. 1996. “Rational Capital Budgeting in an Irrational World.” *Journal of Business*. 69:4, pp. 429-455.

Tobin, J. 1958. “Liquidity preference as behaviour towards risk”. *Review of Economic Studies, 26, 65-86*