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TESTING THE CAPITAL ASSET PRICING MODEL BETA, SIZE, BOOK-TO-MARKET RATIO AND MOMENTUM EFFECTS: ISTANBUL STOCK EXCHANGE APPLICATION

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To my dear parents...

APPROVAL PAGE

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ABSTRACT

Rümeysa BİLGİN **June 2012**

TESTING THE CAPITAL ASSET PRICING MODEL BETA, SIZE, BOOK-TO-MARKET RATIO AND MOMENTUM EFFECTS: ISTANBUL STOCK EXCHANGE APPLICATION

One of the most important models in the finance literature is the Capital Asset Pricing Model (CAPM). The model assumes the existence of a positive and linear relationship between the systematic risk and required rates of return on stocks when they are held in well-diversified portfolios. This systematic risk is measured with the beta coefficient of the stock and it is assumed to be stable over time.

Empirically testing the validity of the CAPM always became an attractive subject among finance scholars. From the works of the earliest researchers, to the more recent studies, there is a huge literature about the model and its derivations. This extensive testing process led to the identification of a number of other factors that capture risk beside the CAPM beta. Book-to-market ratio, firm size, and momentum can be given as the most prominent ones of these factors.

The aim of this study is to assess the predictive abilities of the CAPM beta, book-to-market ratio, firm size, and stock price momentum factors on stock returns in Istanbul Stock Exchange (ISE). ISE is a very volatile emerging market and the examination of the predictors of the stock returns in this market will also be beneficial for the understanding of the nature of the risk-return relationship in emerging markets.

In the first part, the unconditional and conditional approaches of the CAPM is tested and it is found that neither one of the two models are helpful in explaining the volatility of the stock returns in ISE during the sample period. In the second part, the predictive abilities of a number of factors proposed by previous researchers are examined. The result of this second study indicates the existence of a reversed book-to-market effect in the ISE during the sample period. Nevertheless, there is a high probability of the effect's being sample or period specific.

Key words

Asset Pricing, The Conditional CAPM, Beta, Book-to-Market Effect, Firm Size Effect, Momentum Effect.

KISA ÖZET

Rümeysa BİLGİN **June 2012**

FİNANSAL VARLIKLARI FİYATLAMA MODELİ BETASI, FİRMA BÜYÜKLÜĞÜ, DEFTER DEĞERİ - PİYASA DEĞERİ ORANI VE MOMENTUM ETKİLERİNİN TEST EDİLMESİ: İSTANBUL MENKUL KIYMETLER BORSASI UYGULAMASI

Finansal Varlıkları Fiyatlama Modeli (FVFM), finans literatüründeki en önemli modellerden biridir. Modele göre, yeterince çeşitlendirilmiş portföylerde tutuldukları takdirde hisselerin beklenen getirileri ve sistematik riskleri arasında pozitif ve lineer bir ilişki vardır. Bu ilişki, hisse senedinin beta katsayısı ile ölçülür ve zamana göre değişken olmadığı farz edilir.

Finans ile ilgilenen akademisyenler için FVFM'nin geçerliliğinin ampirik olarak test edilmesi hep ilgi çekici bir uğraş olmuştur. Modelin ilk geliştirilmesinden bugüne kadar geçen yaklaşık elli yıl boyunca yapılan çalışmalar sonucunda, konu ile ilgili geniş bir literatür oluşmuş ve hisse senetleri için risk göstergesi olabilecek FVFM betası dışında bir dizi faktör tanımlanmıştır. Defter değeri-piyasa değeri oranı, firma büyüklüğü ve momentum bu faktörlerin öne çıkanları olarak zikredilebilir.

Bu çalışmanın amacı, FVFM betası, defter değeri-piyasa değeri oranı, firma büyüklüğü ve momentum faktörlerinin İstanbul Menkul Kıymetler Borsası (İMKB)'ndaki hisse senedi getirilerini açıklayabilme kapasitelerini belirlemektir. Oldukça değişken/dalgalı ve gelişmekte olan bir piyasa olarak İMKB'de hisse senedi getirilerini etkileyen faktörlerin belirlenmesine yönelik olarak yapılacak bir çalışma, gelişmekte olan piyasalardaki risk getiri ilişkisini anlamak açısından da faydalı olacaktır.

Çalışmanın ilk bölümünde, standart ve koşullu FVFM yaklaşımları test edilmiş ve her iki modelin de araştırmaya konu olan zaman periyodunda İMKB'de geçerliliğinin olmadığı sonucuna varılmıştır. İkinci bölümde, literatürde kullanılan bir dizi faktörün hisse senedi getirilerini açıklama kapasitesi araştırılmıştır. Bu ikinci çalışmanın sonucunda IMKB'de ters çevrilmiş bir defter değeri-piyasa değeri etkisi gözlemlenmiştir. Ancak, bu etkinin kullanılan örneklem ya da zaman periyodundan kaynaklanma ihtimali büyüktür.

Anahtar Kelimeler

Varlık Fiyatlama, Koşullu FVFM, Beta, Defter Değeri-Piyasa Değeri Etkisi, Firma Büyüklüğü Etkisi, Momentum Etkisi.

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LIST OF ABBREVIATIONS

CAPM:	Capital Asset Pricing Model
ISE:	Istanbul Stock Exchange
US:	United States
MPT:	Modern Portfolio Theory
PDF:	Public Disclosure Platform
VIF:	Variance Inflation Factor
WFE:	World Federation of Exchanges

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I dedicated this study to my dear parents for their endless patience with me during the last two years. I am grateful to my father Abdullah Bilgin for his unconditional support of my academic studies and for his countless sacrifices on behalf of them. I would like to give special thanks to my mother Güzide Bilgin who is always compassionate and supportive towards me.

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INTRODUCTION

Finance is all about value creation and deciding on prices. Asset pricing is one of the fundamental subjects of finance. In its broadest form, everything that has a value can be an asset. However, the subject mainly deals with pricing the marketable securities. The price of an asset depends on the willingness of buyers to buy it. And according to the mainstream finance, buyers consider only the riskiness of an asset to decide the amount they are willing to pay for the ownership of it. Thus, assets are priced according to their risks. Based on this resolution, the Capital Asset Pricing Model (CAPM) was developed half a century ago as the first asset pricing model. Since then, the area maintains its liveliness with the introduction of many derivations of this first model and empirical findings against and on behalf of their validity. Nevertheless, the subject is still in needs of theoretical and practical improvements because it is currently far from answering the question of how to price an asset correctly. In addition, risk based view of asset pricing assumes rational investor behavior while the irrationality of it is a well known fact. When the assumption of rational investors is relaxed, the stage becomes much more crowded as the behavioral approach of finance makes its entrance to it.

In this study, asset pricing is explained in the light of CAPM and two empirical tests of it are conducted in Istanbul Stock Exchange (ISE). The aim is to make a contribution to the asset pricing literature by bringing fresh evidence from this emerging stock market and by evaluating the predictive ability of various asset pricing models based on this evidence.

The results of the two tests conducted for this study are somewhat in consensus with each other because none of the tested models showed any superior performance over others. Thus, the test results showed what methods does not useful in asset pricing in ISE, while not giving any answer to the question of what is useful.

In the first chapter of the study, the theoretical development of the CAPM is explained. Then, the factor model approach of asset pricing is introduced and some empirical test methodologies are mentioned. Lastly, the connection between the concept of market anomalies and asset pricing is highlighted.

In the second chapter, asset pricing literature is reviewed by mentioning the main works in the area. Also studies conducted in ISE are mentioned in a separate section in order to assess the place of this study in the literature and to relate it with previous studies about the same stock market.

In the last chapter, the two asset pricing tests conducted for the research part of the study are explained in detail and their results are analyzed.

CHAPTER 1

ASSET PRICING AND THE CAPITAL ASSET PRICING MODEL

The Capital Asset Pricing Model (CAMP) is the first and the simplest asset pricing model in finance literature. It is widely used in business world and extensively researched in academia since its development in early 1960s. Because the model is based on a number of unrealistic assumptions related to the investing world, its validity in the real life conditions is frequently questioned. Empirical findings of the CAPM tests are also far from giving a clear answer to the question of its robustness. Early studies usually support the model, but late works have not found much favorable evidence. In addition, many of the CAPM test methodologies are criticized for being subject to various statistical biases. Even, the testability of the CAPM as an ex-ante model is questioned by some finance scholars. Despite all this, as the CAPM is a normative model of asset pricing, problems related to its testability do not invalidate it.

During the past half-century, a considerable effort was made to cover the shortcomings of the model and to improve it. As a result of this process, numerous derivations of the standard CAPM and two separate asset pricing models have been developed. But the standard CAPM is still popular in business world due to the simplicity of its application and the empirical results of other models being no superior.

The model aims to predict the rate of return that an investor expects on an asset, assuming that this rate is dependent only on a single factor. This single factor is described as the relative volatility of the asset to the aggregate volatility of all assets in the investments universe.

Although many different investment types exist, the CAPM is mainly concerned with the pricing of financial assets. For ease of use, in the remaining part of the text, the words; investment, asset, and security are used interchangeably.

1.1. Basic Concepts

1.1.1 Return and Risk

In finance literature, return is the increase in the total wealth of an investor at the end of an investment period. By making an investment, an investor postpones consumption of his/her wealth for a specified time period. Received return of the investment must worth his/her sacrifice. There are three determinants of required rate of return; the time value of money, the expected rate of inflation and the uncertainty related to the rate of return (Brown & Reilly, 2009).

If the rate of return is known with certainty in advance, then, required return only reflects the time value of money and the inflation premium. But in most cases, future return of an investment is not known definitely at the beginning of the investment period. Only, a number of possible returns with their probabilities are known. Therefore, instead of the required return of the investment, the expected return is calculated. The expected return of an investment is the weighted sum of all possible returns (which is also the mean of the probability distribution of possible returns). Let return of an investment, R, is a random variable with n possible values $r_1, r_2, r_3 \ldots\ldots r_n$ with probabilities of $p_1, p_2, p_3 \ldots\ldots p_n$ respectively. Expected rate of return, $E(R)$, is calculated as;

$$(1.1)\ E(R) = \sum_{i=1}^{n} p_i r_i$$

Risky investments rarely provide exactly their expected returns. In general, the realized return of an investment is either above or below its expected value. Then, there is the risk of the future return of an investment's being below the expected amount. Investment risk is defined as the uncertainty related to the future return of an investment (Brown & Reilly, 2009, p. 182). Investors require some increase in the expected future value of their investments for bearing risk. Otherwise, they would not invest in risky assets. So, required return on a risky investment must have an extra component beside the return on a risk free investment. The additional component is called *risk premium on a risky asset* and determined by the risk level of the investment. Risk is measured by the variance/standard deviation of the probability distribution of expected returns. The variance of the investment mentioned above is calculated as follows;

$$(1.2)\ \sigma^2 = \sum_{i=1}^{n} p_i \left[r_i - E(R) \right]^2$$

1.1.2 Diversification and Risk

The concepts of return and risk for individual assets are explained in the previous section. In real world, investors do not hold their assets in isolation. Instead, they hold portfolios that contain numerous assets to derive the benefits of diversification. These benefits occur because; any asset which is hold together with other assets is less risky than when the same asset is hold alone. In other words, with efficient diversification, the risk (variance) of a portfolio may be smaller than the total sum of the variances of assets it contains. Efficient diversification occurs when the assets hold in a portfolio affected from different risk factors or from the same factors in different ways. Investors prefer to hold their assets in portfolios in order to minimize the amount of risk they have to bear for a given amount of return.

By holding their assets in well-diversified portfolios, investors can decrease the total risk of their assets but they cannot fully eliminate it. Some portion of risk will always remain after the diversification. The eliminated portion of the risk of an asset is called unique/nonsystematic/firm-specific risk. This risk is caused by microeconomic factors. Since the effects of these factors are not same for all assets, the risk of one asset is offset by the risk of the other. Remaining portion, which is called systematic/nondiversifiable risk, is caused by macroeconomic factors. These factors affect all companies in a similar way and diversification (holding assets together in portfolios) has no decreasing effect on this kind of risk.

1.1.3 Portfolio Return and Risk

Since investors hold their assets in portfolios instead of holding them alone, the return and risk on a portfolio as a whole is more important for an investor than the individual return and risk of any single asset in his/her portfolio. The expected return of a portfolio that contains *n* assets is the weighted average of the expected returns of these individual assets;

$$(1.3)\ E(R_p) = \sum_{i=1}^{n} w_i E(R_i)$$

In this equation w_i is the relative weight of the asset i and $E(R_i)$ is the expected return of the asset i in the portfolio. Sum of all weights must equal to one.

Due to the diversification effect mentioned above, the risk of a portfolio is smaller than the weighted average of the risks of the individual assets it contains. Before explaining how to measure portfolio risk, two important concepts; covariance and correlation, must be introduced.

'Covariance is a measure of the degree to which two variables move together relative to their individual mean values over time' (Brown & Reilly, 2009, p.185). When the returns of two assets have a positive covariance, their returns move in the same direction at the same time. Similarly, when they have a negative covariance, their returns tend to move in different directions. Let A and B be two assets with r_{ai} and r_{bi} are their returns with a probability of p_i. N is the number of possible outcomes and $E(R_a)$ and $E(R_b)$ are expected returns of assets, then, their covariance is;

$$(1.4)\ Cov_{ab} = \sum_{i=1}^{n} \left[r_{ai} - E(R_a) \right] \left[r_{bi} - E(R_b) \right] p_i$$

The second concept is the correlation coefficient. It standardizes covariance and is calculated for the two assets A and B above as;

$$(1.5)\ \rho_{ab} = \frac{Cov_{ab}}{\sigma_a \sigma_b}$$

Correlation coefficient takes a value between -1 and 1 for all asset pairs. Standardization enables the comparison of the relationships between different asset pairs. A correlation coefficient of -1 indicates a perfect negative linear relationship between the returns of the two assets. If the correlation coefficient between two assets is -1, then, when the return of the first asset is above its mean, the return of the other asset will be below its mean by a comparable amount. The total risk of this portfolio will be zero. Likewise, a correlation coefficient of 1 indicates a perfect positive linear relationship between the returns of the two assets. In such a case diversification will have no decreasing effect on the riskiness of the portfolio. The risk of this portfolio is the weighted average of the risks of the stocks it contains.

Portfolio risk is measured by the variance/standard deviation of the probability distribution of possible returns and is calculated using the following formula;

$$(1.6)\ \sigma_p^2 = \sum_{i=1}^{n} w_i^2 \sigma_i^2 + \sum_{i=1}^{n} \sum_{j=1}^{n} w_i w_j Cov_{ij}$$

In this formula, w_i is the weight of asset i in the portfolio, σ_i^2 is the variance of the same asset and Cov_{ij} is the covariance between the rates of return for assets i and j. (Brown & Reilly, 2009, p.190)

As long as correlation coefficient is smaller than 1*, ‘the standard deviation of a portfolio of two securities is less than the weighted average of the standard deviations of the individual securities’* it contains (Ross, Westerfield & Jaffe, 2010, p. 339). Diversification effect occurs only when the correlation between two assets is less than perfectly positive. The total risk can be completely eliminated when the correlation is perfectly negative. This rule can be generated for portfolios with more than two assets. '*As long as correlations between pairs of securities are less than 1, the standard deviation of a portfolio of many assets is less than the weighted average of the standard deviations of the individual securities'* it contains (Ross et al., 2010, p. 339).

'The variance of the return on a portfolio with many securities is more dependent on the covariances between the individual securities than on the variances of the individual securities' (Ross et al., 2010, p. 346).

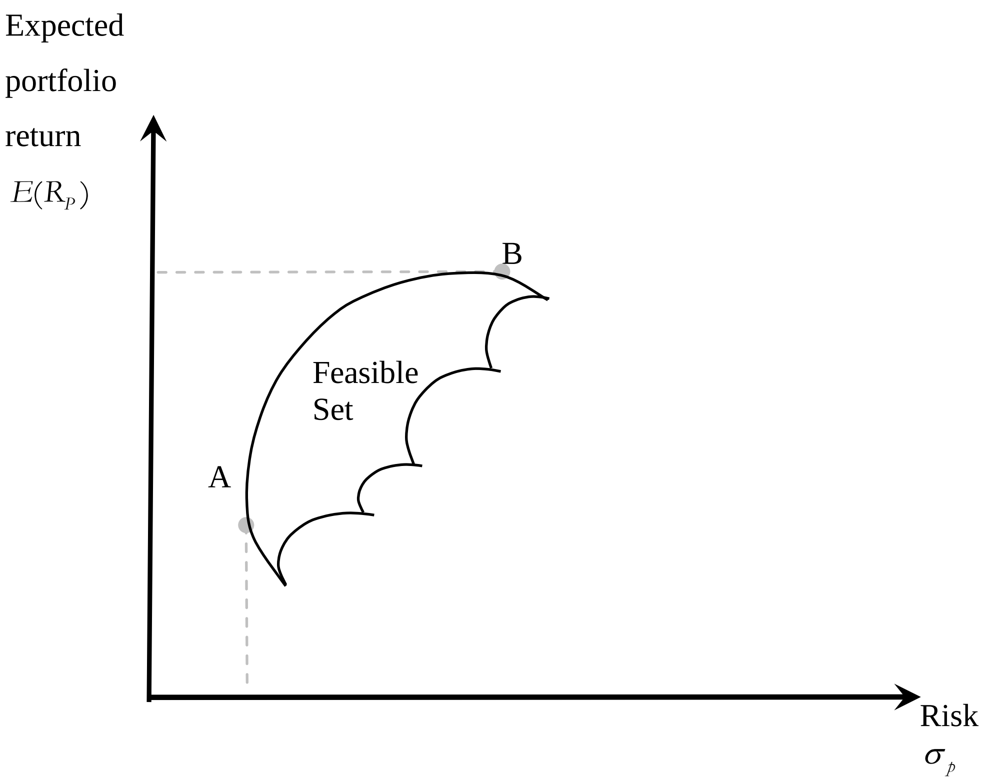
1.2. Development of the CAPM

1.2.1 Modern Portfolio Theory

The foundations of the CAPM lie in the Modern Portfolio Theory (MPT) which was developed by Harry Markowitz and introduced in his seminal paper "Portfolio Theory" in 1952. MPT based on the assumption that investors have identical beliefs about the risk and relative expected return of available investment opportunities and they avoid bearing extra risk without any increase in expected return. According the MPT, when investors have to choose between two investment alternatives with same degree of volatility (risk), they all prefer the one with higher expected return. Similarly, if they have to choose between two investment options with equal returns, they prefer the less risky one. In other words, they make rational decisions to maximize the expected returns of their investments while minimizing the risks of them at the same time.

Once these assumptions are accepted, the investment choices of rational investors can be modeled. The feasible set in Figure 1.1 below comprises of all possible risky investment options that investors can hold. This feasible set includes all individual assets and all attainable portfolio choices. Because of the assumptions mentioned above, investors chose the investment option that offers the highest expected return with a given amount of risk or one that offers lowest risk for a given amount of expected return. AB curve, which contains portfolios with maximum rate of return for any level of risk or minimum risk for any rate of return, is called *the efficient frontier*. MPT argues that all investors make their choices from the portfolios on the efficient frontier because of their mean-variance efficiency. (Markowitz, 1952, p. 82)

FIGURE 1.1 All Possible Risky Investment Options



Every portfolio on the efficient frontier dominates all portfolios beneath the frontier but they can not dominate each other. While feasible set contains both portfolios and individual assets as attainable investment choices, efficient frontier only contains well-diversified portfolios. Even so, there are two assets in the two ends of the frontier; the one with the highest return and the one with the lowest risk (Brown & Reilly, 2009, p. 198).

Investors choose a portfolio from the efficient frontier based on their risk aversion. Risk aversion is an investor's behavior toward risk. A high risk-averse investor prefers less risky portfolios on the efficient frontier while a less risk-averse one bears a higher amount of risk with the expectation of higher return. Thus, a relatively risk averse investor will prefer places closer to point A on the efficient frontier while investors with a high risk tolerance will place themselves on points closer to point B. Risk aversion of an investor is shown by his/her utility curve and an investor chooses a portfolio which is on the intersection point with the efficient frontier and his/her utility curve. Two investors choose the same portfolio only if their utility curves are identical (Brown & Reilly, 2009, p. 199).

1.2.2 Risk Free Rate and Capital Allocation Line

According to Markowitz's Portfolio Theory, every possible investment option is accepted to have risk. But, it was showed by James Tobin in his 1958 paper that, in reality, investors can also hold risk free securities (they can lend their money at risk free rate). A risk free asset is an asset with zero variance. In other words, there is no uncertainty about the future returns of this asset and it has zero correlation with risky assets.

As the riskiness of an investment increases, its rate of return also increases. This occurs because investors require higher risk premiums for the additional risk they have to bear. There are three main kinds of risks for debt securities; liquidity, default and maturity risks. Existence of each kind of risk necessitates an increase in the required return of the security. Then, required rate of return of a debt security, *R*, is calculated using the following formula;

$$(1.7)\ R = r^{*} + IP + DRP + LP + MRP$$

Here, real risk free interest rate, r^{*}, is the rate of return on a riskless security when expected rate of inflation during the investment period is zero percent. Inflation premium, *IP*, is the average expected inflation rate during the investment period. It is measured by the percentage change in the Consumer Price Index (Bodie, Kane & Marcus, 2007, p. 141). Default Risk Premium, *DRP*, is the risk premium that is added to real risk free rate of interest in order to reflect the bond issuer's risk of not paying interest or the principal (Brigham & Ehrhardt, 2005, p. 29). *LP*, liquidity premium, is included in the required rate of return because investors want to convert their assets to cash '*quickly and at a fair market value'* (Brigham & Ehrhardt, 2005, p. 30). Lastly, the longer the time to maturity of an asset, the riskier it is found by investors due to a probable rise in interest rates during the investment period. Thus, maturity risk premium, *MRP*, is also included in the required rate of return on a debt security.

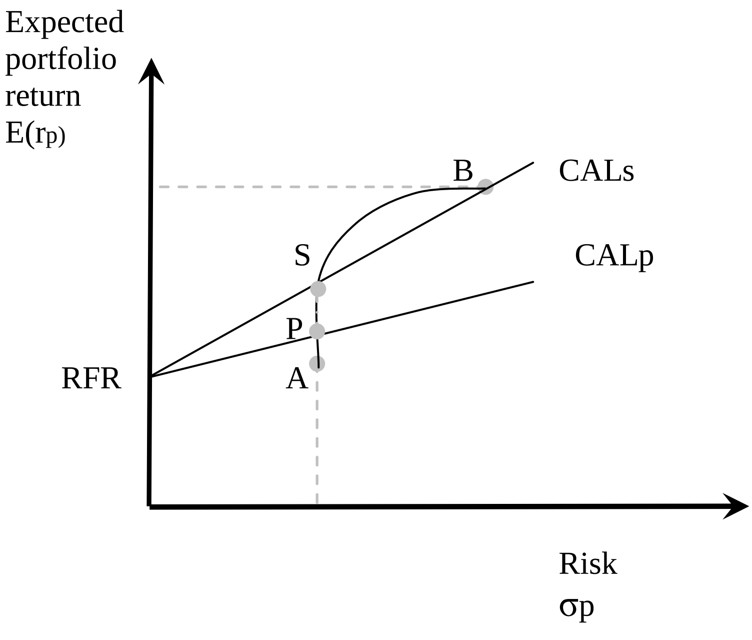
A risk free asset should be free from all these risks except inflation. Securities issued by governments in their own currency are not subject to default risk and they can be easily liquidated in money markets. Short term government securities are also not subject to maturity risk.

Because of the reasons mentioned above, short term Treasury Bills are accepted as risk free assets and the rate of return on them is the risk free rate of return. Risk free rate is used to calculate *the excess return of a risky asset* which is the difference between the return on the risky asset and the return on risk free asset (Ross et al., 2010, p. 311).

After the existence of the risk free security as an investment option is accepted, the next step is to consider investment options which combine the risk free asset with a portfolio of risky assets. The line that consists of all possible combinations of the risk free asset and a risky portfolio is named as *Capital Allocation Line* (CAL) of this portfolio (Bodie et al., 2007, p. 147).

In Figure 1.2, AB curve is the Markowitz efficient frontier and point P represents a portfolio on this curve. The line which starts from risk free rate, *RFR*, and intersects the AB curve at point P is the Capital Allocation Line of Portfolio P which is denoted as CAL_P. All the points on this line are superior investment choices than the portfolios on the AP curve. However, combinations of *RFR* and portfolio S provide higher expected return for every given level of risk compared to the combinations of *RFR* and portfolio P. For every point that an investor can obtain at CAL_P, she can obtain a point with same standard deviation and higher expected return on CAL_S (Ross et al., 2010, p. 353). The slope of a CAL is called reward to variability ratio because it denotes excess return for every percentage point of additional risk (Bodie et al., 2007, p. 147). CAL_S has a steeper slope than the slope of CAL_P and its reward to variability ratio is also higher. With the introduction of risk free asset, every single point on the Markowitz efficient frontier dominates all other points on the frontier which have lower reward to variability ratios than it has. Then, the portfolio at the point where a CAL is tangent to the efficient frontier is the portfolio with the highest reward to variability ratio. This steepest slope or highest reward to variability ratio portfolio is the *optimal risky portfolio*. This portfolio dominates all other portfolios on the efficient set.

FIGURE 1.2 Capital Allocation Lines (Bodie et al., 2007, p. 177)



1.2.3 Portfolio Risk and Risk Free Asset

When a risk free asset is combined with a risky portfolio, the volatility of the new portfolio is the linear proportion of the volatility of the risky portfolio (Brown & Reilly, 2009, p. 208). Let $E(R_M)$ is the risky portfolio *M* and *RFR* is the (expected) return of a risk free asset. Then expected return of a new portfolio that includes the risk free asset with a weight of w_{rf} and the risky portfolio *M* with a weight of $(1-w_{rf})$ is;

$$(1.8)\ E(R_p) = w_{rf} RFR + (1-w_{rf}) E(R_m)$$

Variance of this portfolio is;

$$(1.9)\ \sigma_p^2 = w_{rf}^2 \sigma_{rf}^2 + (1-w_{rf})^2 \sigma_m^2 + 2 w_{rf} (1-w_{rf}) \sigma_{rf} \sigma_m \rho_{rfm}$$

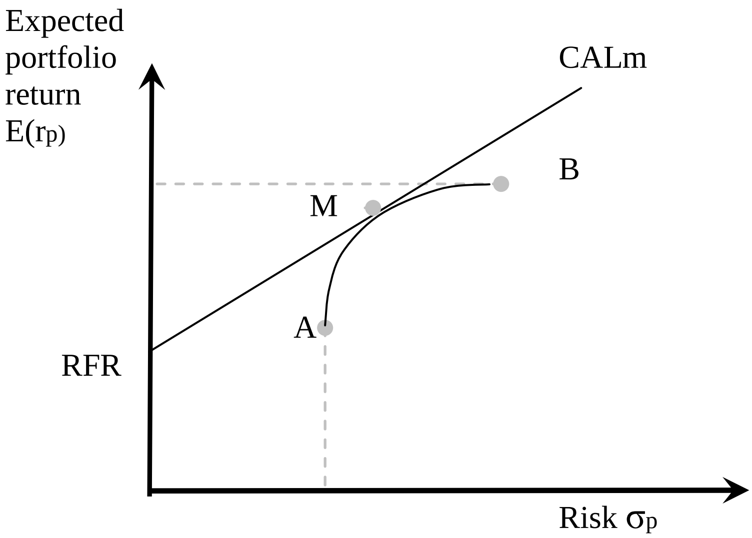
Since $\sigma_{rf}^2 = 0$ and $\rho_{rfm} = 0$, replace them with zero in the above equation to find;

$$(1.10)\ \sigma_p^2 = (1-w_{rf})^2 \sigma_m^2$$

1.2.4 Capital Market Line

When the existence of the risk free security as an investment option is accepted, the portfolios on the AB curve in the Figure 1.3 are no longer considered efficient. Instead, the CAL of the optimal risky portfolio is the new efficient frontier. If portfolio M is the optimal risky portfolio, then, every point in curve AB is dominated by the point M. In asset pricing literature, portfolio M is named as “the market portfolio” and its CAL is called Capital Market Line (CML).

FIGURE 1.3 Capital Market Line



Points on CML are portfolios which have combinations of risk free asset and the market portfolio in different weights. Using the formula for the expected return of a portfolio, a general model for the expected return of every portfolio on the CML can be derived.

$$
\begin{aligned}
E(R_p) &= w_{rf}E(RFR) + (1-w_{rf})E(R_m) + \{RFR - RFR \quad\} \\
&= (1+w_{rf}\ -1)RFR + (1-w_{rf})E(R_m) \\
&= RFR - (1-w_{rf})RFR + (1-w_{rf})E(R_M) \\
(1.11) \qquad &= RFR + (1-w_{rf})\left[E(R_m) - RFR\right] \\
&= RFR + (1-w_{rf})\{\sigma_m / \sigma_m \quad\}\left[E(R_m) - RFR\right] \\
&= RFR + (1-w_{rf})\sigma_m\left[(E(R_m) - RFR)/\sigma_m\right]
\end{aligned}
$$

Lastly, we can rewrite this using the equation 0.10 as;

$$(1.12)\ E(R_p) = RFR + \sigma_P\left[(E(R_m) - RFR)\right] / \sigma_m$$

This equation is called CML equation and it is one of the building blocks of the CAPM. Expected return of a portfolio on the CML has two components; the rate of return on the risk free asset and the rate of return expected for bearing the risk of investing on the risky market portfolio. This second part is called *risk premium of the portfolio* (Brown & Reilly, 2009).

Benefits of diversification are fully realized in the market portfolio. Correlation of assets causes the risk of the portfolio to be less than the weighted sum of the risks of the individual assets. Thus, as the market portfolio is perfectly diversified, the only risk for the portfolios on the CML is the systematic risk.

Investors choose among the portfolios on CML based on their risk aversion. A relatively risk averse investor may lend some portion of his wealth at risk free rate and may invest the remaining portion in market portfolio. This strategy causes a point that is on line (RFR)M in Figure 1.3. Another investment option is to borrow at risk free rate and invest this amount in addition to investor's own funds in risky market portfolio. This time, the chosen portfolio will be on the line above the point M. In all cases, the risk of a portfolio on CML is decided by the amount invested in market portfolio. As CML is a straight line, all portfolios on CML are perfectly positively correlated. '*The slope of the CML reflects the aggregate attitude of investors toward risk'* (Brigham & Ehrhardt, 2005, p. 185).

1.2.5 Separation Theorem

An investor's investment decision can be divided into two separate sub-decisions; formation of an optimal risky portfolio and allocation of investment funds between the optimal risky portfolio and the risk free asset. Firstly, investors decide to invest on CML, because every portfolio beneath this line is dominated by a portfolio on it. Secondly, they choose the specific point on the line based on their risk preferences. This principle, which is first introduced by James Tobin in 1958, is called "Separation Theorem".

According to this theorem, in the first step of the investment process, investors identify the portfolios on the efficient frontier based on the expected returns and variances of all possible securities. When all investors act rationally and decide based on the same information related to securities, they all find the same efficient set of portfolios. At the end of their analysis, all investors decide to hold the same optimal portfolio which is the market portfolio on CML. Risk aversion of an individual investor makes no effect on his/her decision in this stage.

In the second step, investors determine the combination of risk free asset and market portfolio they want to hold. They make this decision based on their risk aversion and two investors chose the same point on the CML only if their risk aversions are identical.

1.2.6 The Market Portfolio and Market Risk Premium

The market portfolio has two important characteristics that should be explained briefly.

Firstly, the market portfolio is the optimal risky portfolio for all investors, so they all hold this portfolio. Feasible set of all attainable risky investment options are same for all investors. They analyze these assets in the same way and reach identical results about the mean return and variance of each asset. As they are all rational, the efficient sets are also identical for them. Also, exogenously determined risk free rate is same for all investors and they draw identical CALs from the risk free asset to portfolios in the efficient set. Again, because of their rationality, they will choose the CAL that has a tangency with the efficient set. As it is explained above, the portfolio at the tangency point of this CAL to the efficient frontier is the market portfolio and it is the optimal risky portfolio for all investors. Thus all investors hold the market portfolio.

Secondly, the market portfolio contains all assets in the asset universe. This second attribute (characteristics) of the market portfolio is a result of the first one explained above. As all investors hold only the market portfolio, investment options which are not included in this portfolio will not be chosen by any investor. When there is no demand for an investment option, its price will decrease until it became an attractive investment choice for the average investor. In other words, its price will take a free fall until it is cheap enough to be included in the market portfolio. Similarly, when an investment option is seen most preferable by all investors and everyone wants to hold it in large amounts, its price will continuously increase until it became a less preferable choice. Thus, in equilibrium, all investments will be included in the market portfolio.

According to Tobin's separation theorem, after deciding to invest in the market portfolio, investors should decide how to divide their funds among the risk free asset and the risky market portfolio. Each investor makes this decision based on his/her risk aversion.

As explained above, risk premium of the market is the expected return of the market portfolio in excess of the risk free rate. This is the risk premium that investors require for bearing the risk of the market portfolio and it is strictly related to the risk aversion of the average investor in the market.

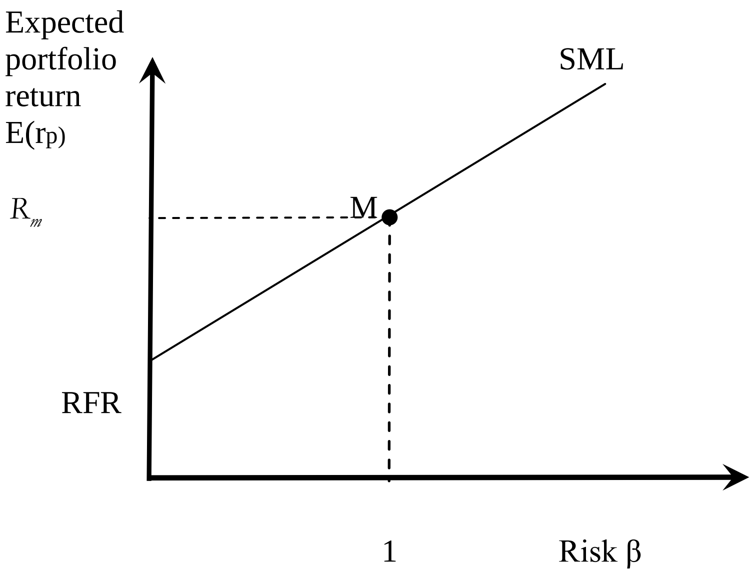
1.2.7 Security Market Line and Beta

CML equation explains risk-return relationship for portfolios but it is inapplicable to individual assets. When an individual asset is added to a well-diversified portfolio, instead of the total risk of the asset, only its systematic risk is added to the total risk of the portfolio. However, if standard deviation of the asset is used in the CML equation, total risk of the asset is considered. But, investors cannot expect compensations for risks that are diversifiable. To solve this problem, CML equation must be rewritten for individual asset i as;

$$\begin{aligned} E(R_i) &= RFR + \sigma_i r_{im} \left[E(R_m) - RFR / \sigma_m \right] \\ &= RFR + (\sigma_i r_{im} / \sigma_m) \left[E(R_m) - RFR \right] \\ E(R_i) &= RFR + \beta_i \left[E(R_m) - RFR \right] \end{aligned} \tag{1.13}$$

This last equation, which is called Security Market Line (SML) equation, is the main finding (primary conclusion) of the CAPM. As can be seen in Figure1.4 below, the SML line is very similar to the CML line; however, the variable on the x-axis is beta, instead of standard deviation.

FIGURE 1.4 Security Market Line



According to the CAPM, all fairly priced assets are placed on the SML. When an asset is overpriced, its return is smaller than what the CAPM predicts and similarly when an asset is underpriced, its return is greater than the one calculated using the SML equation.

The slope of the SML is the risk premium of the market portfolio (Bodie et al., 2007, p. 210).

The main contribution of the SML equation is to simplify the process of calculating the risk of an asset which is included in a portfolio. Before the development of the SML, whenever a new asset is included in a portfolio, the covariances of the asset with every other asset in the portfolio should be estimated to calculate the new variance/standard deviation/risk of the portfolio. As the number of assets increases, the process become increasingly cumbersome and time consuming. In 1964, William F. Sharpe developed the SML equation as a factor model where the single factor that affects the rate of return of an asset is its volatility to the movements of the market portfolio. In his model, the relative measure of the risk is beta coefficient instead of variance/standard deviation of the probable returns.

Beta, β, is a variable that measures the relative riskiness of the asset i to the market portfolio. In other words, beta is the risk an individual asset contributes to the riskiness of the overall market portfolio. '*Beta measures the responsiveness of a security to movements in the market portfolio'* (Ross et al., 2010, p. 356). Theoretically, beta of the market portfolio is 1. An asset's beta is greater than 1 if it is more volatile than the market and smaller than 1 if it is less volatile than the market. Theoretically an asset may have a negative beta but in real life almost all financial assets traded in stock markets have positive betas. Actually, '*most stocks have betas in range 0.50 to 1.50 and the average beta for all stocks is 1.0 by definition'* (Brigham & Ehrhardt, 2005, p.150).

Beta of a portfolio is estimated by taking the weighted average of the betas of the assets it contains. When an asset, whose beta is greater than the beta of a portfolio, is added to that portfolio, the overall risk of the portfolio will increase with the inclusion of this new asset. In the same way, the risk of a portfolio may be decreased by adding an asset whose beta is smaller than the beta of the portfolio.

Beta of an asset i can be calculated using the following formula;

$$(1.14)\ \beta_i = (\sigma_i r_{im} / \sigma_m) = Cov(r_i, r_m) / \sigma_m^2$$

Here, σ_i is the standard deviation of asset i, while r_{im} represents the correlation between asset i and the market portfolio.

1.2.8 Market Portfolio and Stock Market Indexes

In order to use the SML equation, the rate of return on the market portfolio that contains all risky assets in the world should be known. Theoretically, this market portfolio should include all stocks, bonds, leases, private equity, real estate, options and futures contracts, arts, antiques and even "human capital" in the world (Brigham & Ehrhardt, 2005, p.194;Brown & Reilly, 2009, p. 228) . In other words, the true market portfolio should contain all valuable assets in the world. And these assets should have weights in the market portfolio in proportion to their relative market values (Brown & Reilly, 2009, p. 228). In reality, investors are incapable of detecting all of these assets that are spread around the world. Also, some of these assets are not being traded. Even if investors were be able to identify all assets that must be included in the market portfolio, and calculate their relative weights, it would still be practically impossible to hold this portfolio. Because of this impossibility, the CAPM is implemented using a proxy for the market portfolio. Since stocks are the most widely traded assets and their return data are easily available, the most common proxy of the true market portfolio is a broad stock exchange index.

It is reasonable to believe that all nonsystematic risk of a completely diversified portfolio is eliminated. The only remaining risk for this well-diversified portfolio is the systematic risk which is also the risk of the true market portfolio. Because of this, it is assumed that a completely diversified portfolio will be perfectly positively correlated with the true market portfolio. Stock exchange indexes are accepted as well-diversified portfolios and used as proxies for the true market portfolio when testing the CAPM in academia or using it in the business world.

1.3. The CAPM

1.3.1 Assumptions of the CAPM

The CAPM is based on a number of assumptions which are first listed in Jensen's 1972 paper (Brigham & Ehrhardt, 2005, p.182). These are;

1. All investors have a single period investment horizon.
2. All investors are price takers. In other words, there are such a huge number of investors that the transaction activity of any single investor does not affect the stock prices.
3. All investors are rational mean variance optimizers; they all prefer the portfolio which provides the highest (mean) return for a given amount of risk or the lowest risk (variance) for a given amount of return.
4. All investors make investment choices based on the expected returns and the standard deviations of assets.
5. All investors have homogenous expectations about the means, variances (standard deviations) and covariances of returns of all assets because they all have the same economic view of the world and analyze the securities in the same way.
6. All investors can borrow and lend an unlimited amount at a given risk free rate.
7. Short sales are allowed without any restrictions.
8. There are no transaction costs.
9. There are no taxes.
10. All assets are perfectly liquid and perfectly divisible.
11. The quantities of all assets are given and fixed (Jensen, 1972, p. 358-359;Brigham & Ehrhardt, 2005, p, 182;Bodie et al., 2007, p.205).

These assumptions draw an unrealistic view, because many of them are not hold in the real world. Nevertheless, during the development of the CAPM, they became very helpful in simplifying the problem by assuming that all investors are same in almost all aspects and they differ only in their risk attitude and in the amount each invested (Bodie et al., 2007, p. 205).

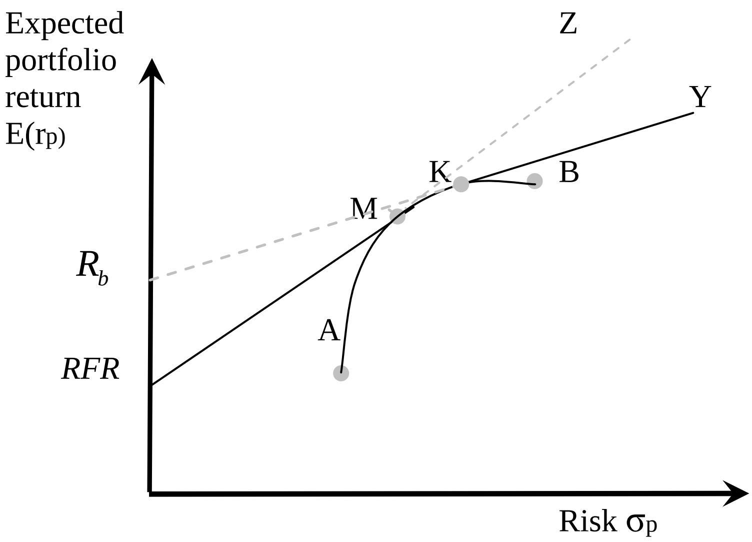
According to the CAPM, in such a simplified world, the expected return of an individual asset can be calculated using the SML equation.

1.3.2 Relaxing the Assumptions

Since the first development of the model, the assumptions mentioned above are found to be over-simplifications of the real world. However, when some of these assumptions are relaxed, the resulting models are still consistent with the original form. Information related to the extensions of the basic model is given below.

According to one of the assumptions, investors can borrow and lend at risk free rate. But in real life, even though lending at risk free rate as much as desired (by buying short term government securities) is possible, investors can not borrow unlimited amounts at this rate. This restriction changes the form of CML as seen in Figure 1.5. If R_b is the rate at which investors can borrow unlimitedly, then the new CML consists of (*RFR*)M line plus MK arch and KY line while the old one consist of the line (*RFR*)MZ. This new CML consists of more than one efficient portfolio and provides less return for a given level of risk.

FIGURE 1.5 Changes in CML without the Assumption of Borrowing at Risk Free Rate (Brown & Reilly, 2009, p.223)



The assumption of the need for a risk free asset is also relaxed and an extension of the CAPM, known as "zero-beta model", is developed by Fischer Black in 1972. This model bases on the existence of a portfolio whose correlation with the market portfolio is zero. Thus, its beta and systematic risk are also zero. When the risk free rate in the simple CAPM equation is replaced with the rate of return of this zero beta portfolio, a linear line similar to the SML can be drawn. This new line intersects the y-axis at the rate of return on the zero-beta portfolio instead of the risk free rate.

Another assumption of the CAPM is related to transaction costs. When transaction costs do not exist, investors continue to trade mispriced securities until they all are placed on the SML. On the other hand, when investors have to pay transaction costs, these costs will prevent them from conducting all of the necessary transactions to place all securities on the SML. Thus, many securities will be placed very close to the SML but not exactly on it. As a result, the SML will be a band of securities instead of a single line (Brown & Reilly, 2009, p.224).

Another assumption states that all investors have a single period investment horizon. In reality, investments may last more than one period and the SML with a single time horizon is different from the SML with an investment horizon that consists of multiple periods. The existence of heterogeneous expectations also causes unique lines for each investor. Similar to the effect of transaction costs, all this extensions causes a band of line instead of a single SML line. This band comprises the SML of the simple CAPM.

Lastly, the CAPM predicts pretax returns, but there is a heavy tax burden in real life for individual investors. This situation also affects the SML.

1.4. Testing the CAPM

1.4.1 Factor Models

The actual return on any stock can be divided into two parts. The first one is the return that investors expect to have at the end of the investment period. This is called expected return and can be calculated using the publicly available information in the market. The remaining portion is what makes the stock returns risky and it is unanticipated in advance. Then, the return of a stock can be written as;

$$(1.15)\ R = \overline{R} + U$$

(Ross et al., 2010, p. 371)

Here, R is the return of the stock for the coming month, $\overline{R}$ is the expected return and U is the unexpected portion which can be called as *the risk*.

The Risk of a stock can be broadly divided into two parts. The first part of the risk affects almost all assets. The second part is specific to individual assets and therefore this part affects returns of individual assets differently. Hence, the risky return of an asset consists of two parts; systematic risk which is caused by developments in the general macroeconomic environment and unsystematic risk which is resulted from firm specific factors. Then, R can also be written as;

$$(1.16)\ R = \overline{R} + m + \varepsilon$$

(Ross et al., 2010, p. 371)

Here, *m* represents the systematic risk while ε is the unsystematic portion.

As stated previously, unsystematic risk can be eliminated through efficient diversification. The systematic risk is caused by one or more factors that affect all stocks. For every single stock, the amount of systematic risk caused by a single factor is determined by the responsiveness of the stock to this specific factor. We can denote the *i*th factor as F_i and the responsiveness of the stock to the change on this factor as β_i. It can be written as follows;

$$(1.16)\ R = \overline{R} + \beta_i F_i + \varepsilon$$

Statistically speaking, the last equation is called a “factor model”. Factor models are frequently used in asset pricing and SML equation is also written as a single factor model where the factor is the excess return of market portfolio over its expected return.

$$(1.18)\ R = \overline{R} + \beta(R_m - \overline{R}_m) + \varepsilon$$

(Ross et al., 2010, p. 374)

This model is called *the market model* and could also be written as;

$$(1.19)\ R = \alpha + \beta R_m + \varepsilon$$

Here α is equal to $(\overline{R} - \beta\overline{R}_m)$. (Ross et al., 2010, p. 374)

The unsystematic risk, ε , decreases as the number of stocks increases and it can be completely ignored when the number of stocks is large enough. In other words, when assets are hold in well-diversified portfolios, unsystematic risk is eliminated completely.

When the model is written for the stock i, it takes the following form;

$$(1.20)\ R_i = \alpha_i + \beta_i R_m + e_i$$

(Bodie et al., 2007, p.185)

This is also a simple linear regression equation with α_i as the intercept and β_i as the slope of the regression line. e_i is the residual that represents the difference between the actual and the expected stock returns.

1.4.2 The Single Index Model

The first factor model that is used in asset pricing is the single index model which is developed by William F. Sharpe for the CAPM (Sharpe, 1964). This model takes a proxy of the market portfolio as the only factor that affects asset returns. A proxy is used because it is practically impossible to create the market portfolio of the CAPM which must include all assets of the security universe. In general, a stock market index is taken as the proxy of market portfolio. The single index model is written in terms of excess returns in order to make it similar to the SML equation of the CAPM.

$$(1.21)\ r_i - RFR = \alpha_i + \beta(r_m - RFR) + e_i$$

Here, r_i is the return of stock i for a specific period, r_m is the return on the market index for the same period. α_i and β_i are intercept and slope coefficients respectively and e_i is the error term which measures the firm specific risk for this period.

When, this equation is rewritten with expected excess returns instead of the realized ones, e_i becomes zero and the equation takes the following form;

$$(1.22)\ E(r_i) - RFR = \alpha_i + \beta_i \left[E(r_m) - RFR \right]$$

The above equation is widely used in asset pricing in order to test the validity of the CAPM. For the model to hold, the intercept must be equal to zero and the slope must be greater than zero.

1.4.3 Multifactor Models

In the single index model, systematic risk is represented by the response of a stock to the movements of the market portfolio. This approach provides a good simplification to understand risk-return relationship. But, a more realistic approach accepts that stock returns are responsive to more than one factor. Multifactor asset pricing models use various factors to explain the systematic risk. The general formula of a n-factor model can be written as follows;

$$(1.23)\ R_i = \alpha_i + \beta_{i1}F_1 + \beta_{i2}F_2 + \beta_{i3}F_3 + \dots\dots\dots + \beta_{in}F_n + \varepsilon_i$$

When a multifactor model used, a stock will have more than one beta and the number of betas will be equal to the number of factors in the model. The most crucial part of applying a multi factor model is to decide the risk factors. One option is to identify macroeconomic factors such as changes in expected inflation or GDP growth rate. Alternatively, microeconomic factors such as firm size or book-to-market ratios can be used.

Multifactor models are better than the basic single index model to the extent that the additional factors are forecasted accurately. Otherwise, they will not be preferable over the basic model (Bodie et al., 2007, p. 226).

1.4.4 Testing the CAPM and Estimation Issues

The CAPM is an ex-ante model which aims to predict investors' expectations relative to future stock returns. The model was developed to estimate stock betas using expectations of investors about the future stock returns. All of the model variables are expectations of future values. Nevertheless, it is practically impossible to know these expectations and only historical realized returns are available.

In order to deal with this problem, beta values, which are calculated using realized past returns, are assumed to be stable in the future. In other words, the relationship between stock returns and the market return is assumed to be the same through time. Then, betas calculated from realized returns in the past are used for estimating future expected returns.

In order to calculate betas, realized excess returns of a stock for a specific period are regressed on realized excess market returns for the same period. The line of this regression is named as Security Characteristic Line (SCL) (Bodie et al., 2007, p.185). The beta estimated with this process is called *the historical beta of the stock* (Brigham & Ehrhardt, 2005, p. 193). A few issues are crucial in making these calculations.

Firstly, the time interval of the realized returns must be decided. Although any time interval (yearly, quarterly, monthly, weekly, daily and so on) is theoretically acceptable, monthly or weekly holding period returns are usually preferred in beta calculations. The regression results are highly sensitive to the chosen time interval even if data is taken from the same time period (Brigham & Ehrhardt, 2005, p.194).

The number of observations used also affects the estimated beta values. Statistically, the greater the number of observations taken is, the greater the statistical confidence of the results is. In order to increase the number of observations in a sample period, time interval between them should be kept short. However, if the time interval is too short, the probability of the *random noise* in the data increases (Brigham & Ehrhardt, 2005, p.194). Another option to increase the number of observations taken is to increase the time span of the sample period. However, this alternative also has a drawback. As the number of years of data increases, the probability of the company's changing its '*basic risk position*' also increases (Brigham & Ehrhardt, 2005, p. 194).

So, researchers should make a balance between the advantages and disadvantages of alternative time interval and time period combinations. In practice, using five years realized returns and taking monthly observations is seen as a preferable choice. This combination provides enough number of observations for conducting a valid statistical test while it is not too long time for a firm to make important changes in its business to affect its beta (Bodie et al., 2007, p. 218).

Another issue that needs consideration is the selection of the market index. The index choice has a vital effect on the estimated beta. The most important problem faced by the users of CAPM is to find a true proxy of the theoretical market portfolio. In most tests, a value weighted broad stock index is taken as a proxy to the market portfolio. However, some writers try to find better proxies such as; an index that includes human capital (Jagannathan & Wang, 1996). Despite these efforts, data measurement problems restrict proxy choices to stock indexes for most tests (Brigham & Ehrhardt, 2005, p. 194).

1.4.5 Regression Tests

Two different regression types are frequently used in testing the CAPM. The first one is called time series regression which is run over time for each security in order to decide their responsiveness to the changes in the risk factor. (Cochrane,

2001) This type of regression is used to calculate security betas. A general time series regression equation for a single factor model can be written as;

$$R_{it} = \alpha_i + \beta_i F_t + \varepsilon_{it} \quad (1.24)$$
$$t = 1, 2, 3.......T$$

Here, return on the ith security is denoted by R_i, while β_i and F_t are beta and the factor variable respectively. ε_{it} represents the firm specific risk of the security which is assumed to have zero mean. Subscript t denotes the time period. The aim of this regression is to found out the slope, b_i and the intercept, a_i which are same for all values of R_{it}. R_i and F_t values changes randomly for each time *t* and these data is measured over time as time series data. In other words, intercept and slope is same for all observations in time series regressions of a security while dependent and independent (explanatory) variables vary for each time *t*.

The second type of regression is the cross sectional regression. The aim of this regression model is '*to explain the variation in average returns across assets'* (Cochrane, 2001, p.). Beta is the explanatory variable in a cross sectional equation while factor value becomes the slope. In time series regression, a separate regression is run using the time series returns of a single asset, but in cross-sectional regression, returns of many assets are regressed over their betas at a specific instant in order to calculate the intercept and the slope of the equation. Here, if returns are used as dependent variables, then, the intercept is the risk free rate but if excess stock returns are used instead of raw returns, the intercept must be equal to zero. A cross-sectional regression model for n assets using excess stock returns can be written as:

$$R_i = \gamma + \beta_i \lambda + \varepsilon_i \quad (1.25)$$
$$i = 1, 2, 3......n$$

Here, intercept γ and slope λ is common for all n assets.

In a typical CAPM test, the mean values of all γ and λ are estimated and t-tests are applied on them in order to asses whether they are significantly different from zero or not. For the validity of the basic CAPM to be verified, λ, which represents the excess return on the market portfolio, must be greater than zero and γ must be equal to zero.

1.4.6 Some Influential Early Tests (Classic Empirical Studies)

The CAPM is a model that is being tested for more than forty years by now. The first published test of the CAPM is conducted by Douglas in 1969 (Jensen, 1972, p. 364). He ran cross sectional regressions on a large sample of stock returns and on their variance and covariance with a market proxy constructed from the sample. The results showed a significant positive relation with the variances and returns which is against what the CAPM predicts. Later Miller and Scholes showed that these results may be caused by measurement errors and do not prove anything about the validity of the model. (Jensen, 1972)

Two early tests of the CAPM became classics of this literature.

The first one is conducted by Fischer Black, Michael C. Jensen, and Myron Scholes and is published in 1972. Black, Jensen, and Scholes used the following time series regression to test the CAPM.

$$(1.26)\ R_{it} = \alpha_i + \beta_i R_{mt} + e_{it}$$

Here, R_{it} and R_{mt} are excess returns of security i and market observed at time *t* respectively. Authors reasoned that if the CAPM is valid, the intercept α_i, would be zero for each security i. In order to solve what they call an aggregation problem, they used portfolios to test their assumption and formed ten portfolios from all stocks in NYSE in the period 1931-1965 (Black, Jensen & Scholes, 1972). They ran regressions using average portfolio returns and portfolio betas. The results of the study showed that intercept is different from zero and slope is smaller than what is predicted by the CAPM. Even though these results seem to contradict the CAPM predictions, using a proxy instead of the true market portfolio and the non existence of a riskless security may be given as the possible causes of them (Jagannathan & McGrattan, 1995). In addition, the authors reported a positive relation between portfolio betas and portfolio returns where high beta portfolios have high average returns, and vice versa.

The second classic study was conducted by Eguene F. Fama and James D. MacBeth in 1973. Many of the subsequent tests used their methodology either by modifying it or using its original form. As a result, the most widely applied test methodology in the CAPM literature is Fama-McBeth three-step methodology. In their study, they used three testable implications to test the validity of the CAPM. According to the first implication, the risk-return relationship of a security is linear. The second one states that beta is the unique measure of the risk of a security. And the last one is about the belief that higher risk brings higher return. It is explained by the authors that all three implications mentioned above are made under the condition of the validity of the CAPM assumptions. They gave the SML equation as;

$$(1.27)\; E(R_i) = E(R_0) + \left[E(R_m) - E(R_0)\right]\beta_i$$

Then, they used the following stochastic generalization of the SML equation above to test these three statements;

$$(1.28)\; \overline{R}_{it} = \overline{\gamma}_{0t} + \overline{\gamma}_{1t}\beta_i + \overline{\gamma}_{2t}\beta_i^2 + \overline{\gamma}_{3t}S_i + \overline{\eta}_{it}$$

Here, R_{it} is the rate of return on the stock i on period t and β_i is the stock beta which is stable for all periods. The stock beta is also included by squaring it to test the linearity implication. In order to test the existence of any other measure of risk than beta, S_i is used. The error term, η_{it}, is assumed to have zero mean and to be independent from all other variables (Fama & McBeth, 1973).

Following hypotheses were tested using mean results obtained from the above multiple regression equation.

$$(1.29)\quad \begin{aligned} &E(\gamma_{1t}) = \left[E(R_m) - E(R_0)\right] > 0 \\ &E(\gamma_{2t}) = 0 \\ &E(\gamma_{3t}) = 0 \\ &E(\gamma_{0t}) = E(R_0) \end{aligned}$$

Data used for the test consists of monthly returns of all stocks traded on NYSE. The sample period comprises forty two years from 1926 to 1968. It was divided into sub-periods and regression tests were conducted for each sub-period and for the whole sample period separately. First of all, the time span of each test period was divided into three parts. Then, a three-step process was applied for estimations. In the first step, betas of individual securities were calculated using return information from the first part and individual stocks were allocated into twenty portfolios according to their calculated beta values. In the second step, the stock returns from the second part of the test period were used to recalculate the stock betas. Then, the beta of each portfolio was estimated by averaging the betas of individual stocks it contains. In the last step, portfolio returns were calculated using the information from the third part and the following cross sectional regression model was run for each month of this last part;

$$(1.30)\quad \begin{aligned} &R_{pt} = \gamma_{0t} + \gamma_{1t}\beta_{p,(t-1)} + \gamma_{2t}\beta^2_{p,(t-1)} + \gamma_{3t}\bar{s}_{p,(t-1)}(\varepsilon_i) + \eta_{pt} \\ &p = 1, 2, 3, ..., 20 \end{aligned}$$

Here, R_{pt} is the return on the portfolio p at time t. $\beta_{p,(t-1)}$ is the beta of the portfolio p which is calculated by averaging the betas of the individual securities this portfolio contains at time $t-1$. $\bar{s}_{p,(t-1)}(\varepsilon_i)$ is the average of the standard deviations for securities in portfolio p.

The above equation was run in four different styles for each test period; once fully and in other times by suppressing one or more variables. Standard t-tests were used to test the hypotheses.

Results of the tests supported the implication that there is a positive risk-return tradeoff between return and risk. Besides this finding, other hypotheses of the test were also failed to be rejected. On the conclusion, the results of this study support the CAPM.

Another prominent test was conducted by Eugene F. Fama and Kenneth R. French in 1992. They used Fama-MacBeth (1973) type cross sectional regressions to investigate portfolio risk-return relationship over a period 1963 to1990. The results of this study indicated that stock returns are more prone to the changes in factors other than the return on the market portfolio. They found out that size, leverage, E/P and BE/ME have explanatory power over asset returns (Brown & Reilly, 2009). The researchers argued that systematic risk is *multidimensional* and book-to-market ratio and size of a firm can be used as proxies to the some dimensions of risk. (Fama &French 1993) In other words, they recommended a multi factor model instead of a single index one which accepts the CAPM beta as the only relevant risk indicator. Their findings drew attention to market anomalies in asset pricing tests.

1.4.7 Market Anomalies

Market anomalies are empirical results that are against the predictions of mainstream theories like the CAPM and the Efficient Markets Hypothesis. Fama and French defined anomalies as patterns in stock returns that can not be explained by the CAPM (Fama & French, 2008). Anomalies can be divided into three sub-groups as fundamental anomalies (such as firm size, book-to-market equity ratio and earnings-price ratio), calendar anomalies (such as January effect and turn of the year effect), and technical anomalies (such as momentum effect) (Latif, Arshad, Fatima, & Farooq 2011). Only book-to-market, size, and momentum anomalies are investigated in this study.

Size effect is the existence of a situation in stock market where returns on small market capitalization stocks are greater than the returns on large market capitalization stocks (Ross et al., 2010, p. 448). Fama and French stated that size anomaly owes its power to very small "microcap" firms in the market (Fama & French, 2008).

In his review of the research about the size effect, Van Dijk (2011) summarizes the suggested explanations of the effect as;

1. proxy for the default risk,
2. proxy to transaction costs and liquidity risk,
3. resulting from irrational investor behavior,
4. resulting from data mining, caused by extreme observations or by January effect.

Book-to-market effect is described as the anomalous situation where "stocks with high book-to-market ratios have higher average returns than what CAPM predicts" (Ang & Chen, 2007). In other words, it is the situation where average returns of stocks with high book-to-market ratios are higher than the average returns of the stocks with low book-to-market ratios. It has a stronger background and more robustness than size effect (Davis, Fama &French 2000). Two possible explanations for this effect can be given as;

1. proxy for default risk (Fama & French, 1992;1993;1995;1996),
2. mispricing due to systematic bias in expectations and market overreaction (Ashiq, Hwang & Trombley, 2003).

Since anomalies have no strong theoretical background, their validity as risk factors is frequently questioned. Some scholars argued that they are sample/time period, or market specific findings and cannot be generalized (Black, 1993; Mac Kinlay, 1995). To answer these kinds of arguments and to the criticism of data mining and sample selection bias, Fama and French tested their three factor model in 13 markets around the world and found support for the global existence of these effects (Fama & French, 1998). Nevertheless, there is no consensus among finance scholars about the generality of these anomalies.

Sometimes anomalies may change direction or completely vanish in a stock market after the first broad publication of papers which document these effects in this market. Book-to-market and size effects in US markets are first documented in late 1970s and early 1980s but the researchers' attention turned to these anomalies after the influential studies of Fama and French in 1990s. Size anomaly is found to decrease at the beginning of 1980s and come back after 2000 in US markets (Van Dijk, 2011). International evidence is also conflicting. The existence of size and book-to-market anomalies in emerging markets are also documented (Fama & French, 1998; Chan, Hamao & Lakonishok, 1991), while there are other researchers who do not document any anomaly (Novak & Petr, 2010; Artmann, Finter, Kempf, Koch, & Theissen, 1012). There are also studies revealed that size effect do not exist in some markets and periodic in some others (Dimson & Marsh, 1999; Al-Rjoub, Varela & Hassan, 2005). Further, in some markets a reverse size effect where a positive relation is exist between stock returns and market value or a reverse book-to-market effect is documented (Al-Rjoub, Varela & Hassan, 2005; Lin & Wang, 2003). Another genre of studies found a relationship between the anomalies and the market direction (Kim & Burnie, 2002; Guo, 2004; Rutledge, Zhang & Karim, 2008).

The strongest argument about the anomalies is that book-to-market and size effects are proxies for the additional part of non diversifiable risk. Fama and French developed their famous three factor model based on this view and stated that their model captures these anomalies in stock returns (Fama & French, 1998). Nevertheless, the debate about the reason and robustness of the size and book-to-market effects still continues and further research is needed to reach a certain conclusion.

Momentum is another anomaly that is found in many stock markets. There are two versions of momentum. De Bondt and Thaler (1985) showed the existence of a contrarian effect where past losers outperform past winners while Jegadeesh and

Titman (1993) found a continuation effect where past winners have higher returns than past losers (Schwert, 2003). A few possible reasons are proposed for the existence of this anomaly;

1. the proxy for some dimension of risk,
2. caused by the investor's biased interpretation of stock price information,
3. the result of the statistical test method used (Jegadeesh & Titman, 2001).

The three factor model of Fama and French does not capture momentum effect (Fama & French 2008). In 1997, Carhart improved the three factor model by adding another risk factor for stock price momentum.

CHAPTER 2
LITERATURE REVIEW

2.1 Early Classical Studies

The first asset pricing model in the literature is the CAPM which was developed by Sharpe (1964), Lintner (1965), Treynor (1965) and Mossin (1966) independently and later improved by Black (1972). It theorizes that stock returns are dependent on only the return on the market portfolio. Researchers immediately began to test this theory in real life. Earliest studies, conducted by Black, Jensen and Scholes (1972) and Fama and MacBeth (1973), supported the model. However, subsequent research contradicted their supportive findings (Basu 1977; Banz 1981; Rosenberg, Reid & Lanstein 1985; Fama & French 1992). These later research indicated that stock returns are affected by a number of other factors beside the single market factor of the CAPM. Researchers found out that abnormal returns can be acquired by forming portfolios based on some characteristics of stocks. The most important characteristics are the firm size and the book-to-market equity ratio, the earnings to price ratio and, as a more recent phenomenon, the stock price momentum.

The size effect was first documented by Banz in 1981. He formed portfolios by ranking stocks based on firm size and found out that firm size which is represented by market value of equity has a negative relation with stock returns. The results indicate that returns of portfolios which consist of small size firms can be higher than what is predicted by the CAPM. Thus, there is a negative relationship between firm size and stock returns. Reiganum (1981) also showed that small firms' stocks earn much higher returns than large firms'.

Basu (1977) noticed that portfolios of firms with high price-earning ratios earn higher returns than portfolios of firms with low price-earning ratios.

Stattman (1980) and Rosenberg et al. (1985) were the first researchers to document the book-to-market equity ratio effect. Their results indicated that firm's book-to-market equity ratios and market equities are positively associated to average stock returns (Fama & French, 1992).

De Bondt and Thaler (1985) tested the momentum effect. They sorted stocks into deciles based on the cumulative excess returns of past 36 months and found out that portfolios consisted of firms within the lowest decile (losers) outperform portfolios consist of stocks within the highest decile (winners).

Bhandari (1988) found out that debt to equity ratio has a positive relationship with stock returns when size and beta is controlled.

Jegadeesh (1990) rejected the hypothesis that stock prices follow random walks and showed that there is " negative first order serial correlation and positive higher order serial correlation" with monthly stock returns. Jegaadesh and Titman (1993) documented a positive momentum effect in stock returns.

In 1992, Eguene F. Fama and Kenneth F. French published the first paper of their influential papers series about risk-return relationship and argued that the effect of the CAPM beta becomes insignificant when a number of other factors included in the regression equation. They argued that when used alone, the CAPM beta is not sufficed to explain stock returns as the model claims. They found out that, market equity and book-to-market equity ratio are two factors that capture the cross section of average stock returns better than the CAPM beta (Fama & French, 1995). This paper triggered a debate about the usefulness of the CAPM beta.

2.2 Studies Triggered by Fama & French (1992)

Amihud, Cristensen and Mendelson (1992) challenged the findings of Fama and French (1992). They argued that the Fama and MacBeth (1973) methodology used in Fama and French (1992) study is the cause of the insignificant beta and return relationship. When they used the same methodology, their results indicate an insignificant relationship between risk and return but when they used an improved method, they found a strong and positive risk-return relationship.

Black (1993) criticized the empirical findings of Fama and French (1992) and accused them of performing data mining. Also, he emphasized the importance of theory in asset pricing tests and wrote about the lack of their model's theoretical background.

Kothari, Shanken and Sloan (1995) found out that average returns have a stronger relationship with annually calculated betas than with monthly betas, and concluded that the Fama &French (1992) results are subject to statistical problems related to the database used (like survivorship bias).

Davis answered these criticisms in his 1994 paper. By using a database to minimize the sample selection problems, he confirmed the results of Fama and French (1992, 1993) and concluded that average returns can be predicted by forming portfolios based on some variables such as book-to-market equity or earnings yield. Chan, Jegadeesh and Lakonishok (1995) also confirmed Davis (1994) and answered the criticisms of data selection bias in Fama and French (1992) study. Fama and French (1996) showed that Kothari et al. (1995) was not right in their arguments about the difference between monthly and annually calculated betas.

A few years later Davis, Fama and French (2000) used Davis (1994)'s methodology and portfolio formation approach with a larger sample and confirmed the initial findings of Davis. In 1997, Barber and Lyon showed that Fama and French (1992) findings can be generalized to financial firms. Also, their results indicated that book-to-market and size effects can not be considered as a result of survivorship bias or data-snooping.

Fama and French (1993) developed a three factor model which uses size and book-to-market ratio as factors beside the market factor. This model is thought as a better alternative to the traditional CAPM (Fama & French, 1993; 1995; 1996). Authors later tested their model in international markets and reach similar results (Fama & French, 1998).

Research findings, which indicate that beta has not got much explanatory power, caused many researchers to conclude that the CAPM is not valid, in other words “beta is dead”. Others argue that “beta is still alive” if calculated using a true procedure (Kothari et al., 1995; Hsia, Fuller & Chen, 2000; Jagannathan & McGrattan, 1995; Chen & Lakonishok, 1993). Another approach to this problem is the conditional asset pricing models.

2.3 The Conditional CAPM Literature

Some researchers find supporting evidence to the validity of the CAPM in conditional form. One branch of the conditional CAPM literature investigates the risk-return relationship by separating up and down market periods. Supporters of this view argue that when excess market return is positive, there is a positive relationship between market return and stock returns. Similarly, when market risk premium is negative the risk-return relationship also becomes negative. When research periods are divided into up and down market periods and research findings from these two periods tested separately, substantial support for the validity of the CAPM is found.

Pettengill, Sundaram and Mathur (1995) used a modified version of the traditional Fama and MacBeth (1973) methodology which takes into account the market direction. They closely followed the Fama and MacBeth (1973) in forming portfolios and estimating betas of those portfolios but in the final step, they separated their cross sectional data to up and down market periods based on the sign of the excess market return in each month. Then, the regression coefficients obtained from up and down market months are tested separately to assess whether there is any relationship between risk and return. Their findings support the existence of a highly significant conditional relationship between beta and returns for the full sample period and all three sub periods. Their influential method is replicated by many researchers using data from various stock markets. Fletcher (1997), Hodoshima, Garza-Gomez, and Kunimura (2000), Elsas, El-Shaer, and Theissen (2003), Fraser, Hamelink, Hoesli, and McGregor (2004), and Theriou, Aggelidis, Maditinos and Sevic (2010) are among the researchers who examined the conditional relationship in various stock markets all around the world and reached similar results. However, Cooper (2009) claimed that Pettengill et al. (1995)’s conditional methodology has a serious bias which causes it to provide supportive evidence for the conditional CAPM even if there is no relationship between beta and return. This bias arises from dividing research data based on ex-post market return information and using this to test ex-ante risk-return relationship. Returns of high beta stocks move up when market return goes up and move down when market return goes down. Thus, beta and returns will have a positive relationship in up markets. Using the same reasoning, it can be realized that their relationship will be a negative one during down markets periods.

Some other researchers found that the conditional CAPM may not hold in one or both of the up and down markets for each test period. Al Refai (2009) tested the unconditional and the conditional CAPM in the Amman Stock Exchange of Jordan using portfolios which are formed based on industries. He found a significant risk-return relationship in up markets but did not find any significant relationship in down markets for some of the portfolios. In contrast, Fletcher (2000) investigated the conditional relationship in international stock returns. He found significant risk return relationships in down market months for two sub-periods of his research, but documented an insignificant risk-return relationship for one of the up market periods. He concluded that since the risk-return relationship is significant during the up and down market periods of the full sample, there is still some support for the conditional CAPM. Fraser et al. (2004) applied the conditional methodology using UK data and found that the risk-return relationship is insignificant for up markets while there is significance at 0.01% level for down markets. Recently, Theriou et al. (2010) tested the unconditional and the conditional CAPM approaches in Athens Stock Exchange. They found that the conditional model holds for only one of two sub periods while it is valid for the full sample. Verma (2011) also investigated the explanatory power of the conditional model using international stock returns from 18 countries for 1970-1998 period. His findings are not supportive of the conditional CAPM. The results of the full sample and two sub-periods are all insignificant.

There are other conditional CAPM models in the literature. Jagannathan and Wang (1996) used a conditional approach where expected returns and betas are time-varying and market portfolio comprises human capital. Their complex model explains the cross section of stock returns rather well.

Lewellen and Nagel (2006) showed that the conditional CAPM has no superiority over the static one in explaining stock returns. They estimate time varying alphas and betas using short window regressions and high frequency data. Their results show that the conditional CAPM does not explain asset pricing anomalies like size and book-to-market effects.

Ang and Chen (2007) tested a complicated conditional model with time varying beta and market premium over the long run from 1926 to 2001 and found out that their model explains the spread in average returns of portfolios sorted by book-to-market ratios.

2.4 Studies Related to Beta Stability

Stability of stock beta is one of the assumptions of the CAPM tests. Beginning with Blume (1971), researchers found out that beta is unstable. Levy (1971) argued that beta is considerably stable over time for large portfolios but varies with time for individual stocks. Bos and Newbold (1984) showed that monthly beta is randomly changing but they did not reach any conclusion about whether beta is autocorrelated or not. Kim (1993) found out that beta is less stationary for high beta firms than for low beta firms. He also concluded that average length of stationary interval for beta is 54 months. Markus and Thorsten (2005), Chen and Huang (2007), Bali, Cakıcı and Tang (2009), Mollik and Bepari (2010) can be given as examples of recent studies which found beta instability. To sum up, There is consensus among finance scholars that beta is not stationary, but it becomes more stationary when the estimation period increases (Odabası, 2000).

2.5 Recent Developments in the Asset Pricing Literature

In this part, recent developments in the asset pricing literature are reviewed in the light of some recent papers.

Subrahmanyam (2010) gives a review of the past twenty five years of asset pricing literature. He emphasizes the difficulty of assessing the current state of the literature due to the large amount of methods used in asset pricing studies. The robustness of methodology variants and the generality of the empirical results are the most prominent problems for current researchers.

Lewellen, Nagel and Shanken (2010) criticize the currently used asset pricing tests, stating that they all seem to explain the cross section of book-to-market and size portfolios but still they are far from convincing. The main reason is the model evaluation criteria used in these tests. They suggest using portfolios formed on other characteristics than size and book-to-market ratio and changing the evaluation criteria to overcome the problems.

Goyal (2012) reviews the empirical asset pricing models and highlights the main concerns of current literature like deciding the pervasiveness and continuance of anomalies in all stock markets or the number of factors used to explain stock returns.

In such an environment, it may be beneficial to test different methodologies in different settings. Since emerging markets provides interesting conditions for these tests, many researchers try to test the predictive ability of asset pricing models in those markets. In the following section, studies conducted in the Istanbul Stock Exchange, which is a very volatile emerging market, are explained in detail.

2.6 Studies Conducted in The Istanbul Stock Exchange

The Istanbul Stock Exchange (ISE) began operating in 1986 as the only stock market of Turkey. It is a fast growing emerging market with a daily average trading volume of 1.7 billion US dollars by the end of 2010. Foreign investors own a very high amount of free float of shares traded in the ISE (Akin & Basti, 2008). The exchange is ranked as the eleventh in the best performed exchanges in terms of return in the list of World Federation of Exchanges (WFE) in 2010. In terms of market capitalization, the ISE is the fourteenth emerging market with a market capitalization of 308 billion dollars by 2010. In recent years, numerous asset pricing tests are conducted in the ISE. Investigating the risk-return relationship in the ISE would be beneficial for understanding emerging stock markets.

Odabası (2000) investigated the beta stationarity and forecasting power in the ISE using a sample data that comprises the time period from 1992 to 1997. He concluded that the beta stationarity is strictly related to the time interval used to estimate it. Betas are more stable when they are calculated using long estimation intervals and large portfolios.

Aksu and Onder (2003) applied the traditional CAPM and three factor model to search for size and book-to-market equity effects in the ISE between the years of 1993-1997. They used both portfolio and individual stock regressions. Market factor and size is found significant for individual stocks while book-to-market equity factor is noticed in their portfolio results.

Gonenc and Karan (2003) investigated book-to-market equity and size effects in the ISE over the period of 1993-1998. They compared value and growth portfolio returns to asses the existence of value premium and small and large capitalization portfolio returns to evaluate the size effect. They concluded that these two effects do not exist in the ISE during the full sample period.

Ozer and Ozcan (2003) investigated the size effect in the ISE in the full sample period of 1991-2000 and in sub-periods. They concluded that size effect exists in the full sample. However, the effect is either not found or has a reversed sign when data from yearly sub-periods are tested.

Karacabey and Karatepe (2004) applied the well known conditional CAPM approach of Pettengill et al. (1995) in the ISE and found the validity of this model over the period of 1990-2000 for this market.

Bildik and Gulay (2007) used the methodology of Jegadeesh and Titman (1993) to investigate the momentum effect in the ISE between the years of 1991 and 2000. They found out that portfolios of prior loser stocks outperform portfolios of prior winner stocks. They also encountered size, book-to-market equity ratio and earnings- price ratio effects in the ISE.

Gokgoz (2007) applied the traditional version of the CAPM and the three factor model in the ISE using index data from the 2001-2006 period. Both of the models were found applicable; however the three factor model was superior in terms of pricing errors.

Gursoy and Rejepova (2007) also used the well-known conditional CAPM approach of Pettengill et al. (1995). The results support the validity of the conditional CAPM in the ISE during the research period of 1995-2004.

Oran and Soytas (2008) investigated the beta stability in the ISE using data from the sample period of 1996-2007. Their results show that beta is instable for both individual stocks and portfolios during their research period.

Akin and Basti (2008) examined the place of momentum trading in the investment choices of foreign investors in the ISE for the time period from 2000 to 2008. They found that foreign investors are positive feedback traders. However, there is no evidence about the superiority of their investment strategy in terms of providing higher returns during the sample period.

Arıoglu and Canbas (2008) investigated the explanatory power of the three factor model in the ISE over 1993-2004 period. They concluded that the three factor model does not explain all the variation in stock returns for the sample period.

Korkmaz, Yıldız and Gokbulut (2010) used panel data analysis to test the validity of the standard unconditional CAPM in the ISE. Their results are supportive to the model for 1993-2007 time period.

Yalcın and Ersahin (2010) tested the validity of the conditional CAPM in the ISE over the years 1997-2008 by closely following the methodology of Lewellen and Nagel (2006). They found similar results to Lewellen and Nagel (2006) and concluded that the conditional CAPM performs as poorly as its unconditional version in the ISE during their sample period.

Bilgin and Bastı (2011) tested the unconditional version of the CAPM in the ISE for the period of 2006-2010. They found out that the CAPM does not hold in its unconditional form in the ISE over their sample period.

CHAPTER 3
APPLICATIONS

3.1 Testing Asset Pricing Theories

In this chapter, two research studies conducted in the ISE are explained and their results are analyzed. For the first study, two popular versions of the CAPM are tested. The unconditional model is tested using Fama and MacBeth (1973) methodology and Pettengill et al. (1995)’s methodology is used for testing the conditional CAPM. Test results support neither one of the versions mentioned above. Then, another study is conducted to further investigate the risk-return relationship in the ISE. This time, the original approach used by Novak and Petr (2010) is applied. Results are intriguing as they revealed a strong negative relationship between stock returns and one of the test factors. The two studies mentioned are explained in detail in the rest of the chapter.

3.2 Testing the Unconditional and the Conditional CAPM

3.2.1 Data and Methodology

The research period for the study extends from January 2003 to December 2010. Data is the monthly closing prices of all common stocks traded on the ISE during the research period except investment trusts. Market returns are obtained from the ISE All Index which is taken as a proxy for the market portfolio. Three-month Government Debt Securities (GDS) price index is considered to be the risk free interest rate. Data are obtained from the ISE database.

The research period is divided into three six-year sub-periods just like Theriou et al. (2010) but with one overlapping year in each consecutive period in order to smoothen possible volatility of beta coefficients as suggested by Gursoy and Rejepova (2007). Each sub-period is further separated into three two-year time slices as portfolio formation, portfolio beta estimation and test periods in accordance with the traditional three-step test approach of Fama and Macbeth (1973). For each six-year test period only stocks which have return information for all the months in that period is included in the test. In order to avoid survivorship bias, non-survival stocks are also included in the research. Full research period is also tested in the same way but with 32 month time-slices for each test step. The information about the test periods and the number of stocks in each period is given in Table 3.2.1 below.

TABLE 3.2.1 Test Periods and the Number of Stocks in Each Period

	Full Period 2003-2010	First Sub-Period 2003-2008	Second Sub-Period 2004-2009	Third Sub-Period 2005-2010
Portfolio Formation Period	1/2003-8/2005	1/ 2003-12/ 2004	1/ 2004-12/ 2005	1/ 2005-12/2006
Portfolio Estimation Period	9/ 2005-4/ 2008	1/2005-12/ 2006	1/ 2006-12/ 2007	1/2007-12/ 2008
Testing Period	5/ 2008-12/ 2010	1/ 2007-12/ 2008	1/ 2008-12/ 2009	1/ 2009-12/ 2010
Number of Stocks in ISE All Index	296	296	304	310
Number of Stocks Included in the Study	228	228	235	236

In the portfolio formation period, time series of excess returns of individual stocks and the market portfolio are calculated by subtracting risk free rate from the raw returns for each month of this period. Then, excess returns of individual stocks are regressed on the market risk premium in order to estimate beta of each individual stock for the formation period. At the end of this process, individual stocks are sorted in ascending order and the portfolio formation approach explained in Fama and MacBeth (1973) is applied to form portfolios.

20 equally sorted portfolios are constructed as follows. The number of available securities is denoted as N and the largest integer value smaller than or equal to N/20 as int(N/20). When individual stocks are sorted in ascending order by their betas, the first (lowest beta) portfolio and the last (highest beta) portfolio have int(N/20)+1/2[N-(20int(N/20)] securities if N is even. If N is odd the last portfolio has the additional one security. Each of the remaining 18 portfolios has int(N/20) securities. The number of stocks in each portfolio for each period can be seen in Table 3.2.2 below.

TABLE 3.2.2 The Number of Stocks in Each Portfolio for Each Period

Test Period	Total Number of Stocks	Number of Stocks in the First Portfolio	Number of Stocks in the Each One of the Middle 18 Portfolio	Number of Stocks in the Last Portfolio
Full Sample	228	15	11	15
2003-2008	238	15	11	15
2004-2009	235	18	11	19
2005-2010	236	19	11	19

In order to avoid the regression phenomenon known as reversion to the mean, Fama and MacBeth (1973) suggested the formation of the portfolios from ranked betas computed using data from one time period and the estimation of the portfolio betas using data from the next time period. In the portfolio beta estimation period, beta of each individual stock is calculated by regressing the excess returns of the stock on the market risk premium using data from the second time-slice. Then betas of portfolios are estimated by averaging the betas of the individual stocks they contain.

In the testing period, the excess returns of each portfolio is calculated by averaging the excess returns of the stocks they contain using the information from the third time-slice. Then, two different approaches are used to test the validity of the CAPM in the ISE for the given time period.

Firstly, traditional unconditional test procedure used by Fama and MacBeth (1973) is applied. The following regression equation is used;

$$R_{pt} - R_{ft} = \gamma_{0t} + \gamma_{1t}\beta_p + \varepsilon_{pt} \quad (3.1) \quad p = 1\ldots\ldots\ldots\ldots\ldots 20 \quad t = 1\ldots\ldots\ldots\ldots\ldots\ldots T$$

$R_{pt} - R_{ft}$ is the excess return of the portfolio *p* in month *t* and β_p is the beta of the portfolio *p* which is calculated in the previous time slice (portfolio beta estimation period). ε_{pt} is the error term with an expected value of zero. T is the number of months in the test period. Monthly regression coefficients γ_0 and γ_1 which are obtained from the regressions are averaged and the mean values $\bar{\gamma}_0$ and $\bar{\gamma}_1$ are used to test the following hypotheses using standard one sample t-test. The validity of the traditional CAPM will be accepted if $\bar{\gamma}_0 = 0$ and $\bar{\gamma}_1 \neq 0$.

$$(3.2)\quad \begin{array}{l} H_0 : \bar{\gamma}_0 = 0 \\ H_1 : \bar{\gamma}_0 \neq 0 \\ H_0 : \bar{\gamma}_1 = 0 \\ H_1 : \bar{\gamma}_1 \neq 0 \end{array}$$

Secondly, Pettengill et al. (1995)'s conditional approach is used. Pettengill et al. (1995) argue that risk and return relationship is conditional on the market risk premium of the test period. If market return is greater than the risk free rate, there is a positive relationship between betas and excess returns. On the other hand, if market return is lower than the risk free return, there is a negative risk-return relationship. To test the existence of this conditional relationship the following regression equation is used;

$$(3.3)\quad \begin{array}{l} R_{pt} - R_{ft} = \gamma_{0t} + \gamma_{1t}\beta_p\delta + \gamma_{2t}\beta_p(\delta - 1) + \varepsilon_{pt} \\ p = 1................20 \\ t = 1..................T \end{array}$$

δ is equal to 1 when the market risk premium in month t is positive $(R_{mt} - R_{ft} > 0)$ and it is equal to 0 when the market risk premium in month t is negative $(R_{mt} - R_{ft} < 0)$.

As regression coefficient $\hat{\gamma}_1$ is calculated only when the market risk premium is positive, and as its expected value is the expected market risk premium $E(R_{mt} - R_{ft})$, its expected sign is positive. Because of the similar reasoning the expected sign of $\hat{\gamma}_2$ is negative. Lastly, following joint hypotheses are tested using the standard t-test.

$$(3.4)\quad \begin{array}{l} H_0 : \bar{\gamma}_1 = 0 \\ H_1 : \bar{\gamma}_1 > 0 \\ H_0 : \bar{\gamma}_2 = 0 \\ H_1 : \bar{\gamma}_2 < 0 \end{array}$$

Pettengill et al. (1995) argue that if both of the null hypotheses are rejected in favor of the alternatives, then the conditional relationship between beta and returns is validated. They further explained that the existence of the conditional risk-return relationship does not guarantee a positive risk-return tradeoff. It can be exist, only if the average market risk premium is positive and the risk-return relationship is symmetrical between up and down market periods. The first condition is tested using standard one sample t-test. Pettengill et al. (1995) used the following hypothesis and applied a standard two-population t-test to test the symmetrical relationship;

$$(3.5)\; H_0 : \bar{\gamma}_1 - \bar{\gamma}_2 = 0$$

The sign of γ_2 should be reversed to test the symmetry using a two sample t-test (Pettengill et al., 1995).

3.2.2 Results

3.2.2.1 Results of the Unconditional CAPM Test

Results of the unconditional Fama and MacBeth test are given in Table 3.2.3. $\bar{\gamma}_0$ is the mean of regression intercepts and $\bar{\gamma}_1$ is the mean of the regression slope. $s(\hat{\gamma}_0)$ and $s(\hat{\gamma}_1)$ are standard deviations of the coefficients and N is the number of observations (months) for the test period. $t(\bar{\gamma}_0), p(\bar{\gamma}_0), t(\bar{\gamma}_1)$ and $p(\bar{\gamma}_1)$ are t-statistics and p-values of the respective coefficient means. Test statistics show that no relation exists between betas and returns neither in the full sample nor in any one of the sub-periods. For the CAPM to hold, $\bar{\gamma}_1$ should be greater than zero and $\bar{\gamma}_0$ should be equal to zero. According to the results of the unconditional test, $\bar{\gamma}_0$ is not found different from zero in any one of the test periods. However, $\bar{\gamma}_1$ is never significantly different from zero and it has a negative sign for 2003-2008 sub-period. In conclusion, validity of the unconditional CAPM in the ISE during the test period is rejected. These results are consistent with the findings of many of the earlier researchers including Fama and French (1992).

TABLE 3.2.3 Results of the Unconditional Test

Test Period	$\bar{\gamma}_0$	$s(\gamma_0)$	$t(\bar{\gamma}_0)$	$p(\bar{\gamma}_0)$	N	$\bar{\gamma}_1$	$s(\gamma_1)$	$t(\bar{\gamma}_1)$	$p(\bar{\gamma}_1)$
Full Sample	1,897	12,525	0,857	0,398	32	0,142	11,133	0,072	0,943
2003-2008	-1,922	9,913	0,950	0,352	24	-0,828	5,663	0,716	0,481
2004-2009	-0,413	10,385	0,195	0,847	24	1,040	5,666	0,899	0,378
2005-2010	2,184	9,143	1,170	0,254	24	3,610	10,771	1,642	0,114

3.2.2.2 Results of the Conditional CAPM Test

The results of the conditional Pettengill test are presented in Table 3.2.4 and 3.2.5. The coefficient mean $\bar{\gamma}_1$ has the expected sign in all sub-periods and in the full sample. In up market periods (when market risk premium is positive) portfolios with higher betas have higher returns and in down market periods (when market risk premium is negative) same high beta portfolios have lower returns. This situation implies that there is a relationship between betas and returns. However, a statistically significant conditional relationship between betas and returns for both up and down market periods is only found in 2005-2010 sub-period. For the full period and 2003-2008 sub-period, the relationships are significant only in down market months. Similarly, there is a significant conditional relationship between betas and returns in up market months of the 2004-2009 sub-period, but unlike any of the other test periods, there is no significant relationship in down market months for the same sub-period.

To sum up, the results show that there is a statistically significant conditional relationship between betas and returns for the 2005-2010 sub-period and either only up or only down market months for other test periods. These results are not consistent with the two previous studies conducted in ISE by Gursoy and Rejepova, (2007) and Karacabey and Karatepe (2003) who found strong conditional relationships for both up and down markets for all test periods of their research studies.

TABLE 3.2.4 Results of the Conditional Test (Up Market)

Test Period	$\bar{\gamma}_0$	$s(\gamma_0)$	$t(\bar{\gamma}_0)$	$p(\bar{\gamma}_0)$	N	$\bar{\gamma}_1$	$s(\gamma_1)$	$t(\bar{\gamma}_1)$	$p(\bar{\gamma}_1)$
Full Sample	5,766	13,661	1,791	0,091	18,000	3,246	13,432	1,025	0,320
2003-2008	2,534	8,350	1,094	0,295	14,000	1,115	6,169	0,652	0,527
2004-2009	6,293	6,606	3,300	0,007	12,000	3,943	5,415	2,522	0,028
2005-2010	3,000	9,983	1,202	0,248	16,000	7,328	11,141	2,631	0,019

TABLE 3.2.5 Results of the Conditional Test (Down Market)

Test Period	$\bar{\gamma}_0$	$s(\gamma_0)$	$t(\bar{\gamma}_0)$	$p(\bar{\gamma}_0)$	N	$\bar{\gamma}_1$	$s(\gamma_1)$	$t(\bar{\gamma}_1)$	$p(\bar{\gamma}_1)$
Full Sample	-3,078	9,091	1,267	0,228	14,000	-3,848	5,400	2,666	0,019
2003-2008	-7,189	9,276	2,570	0,028	11,000	-3,123	4,170	2,325	0,042
2004-2009	-7,120	9,150	2,696	0,021	12,000	-1,862	4,406	1,464	0,171
2005-2010	0,552	7,520	0,208	0,841	8,000	-3,826	4,517	2,396	0,048

The existence of a significant risk-return relationship in 2005-2010 period does not guarantee a positive risk-return trade off. It can be accepted only if average excess market returns are positive and the risk premiums in up and down markets are symmetrical (Pettengill et al., 1995). It can be seen in Table 3.2.6 that the average market risk premium is positive for 2005-2010 period. However, the risk premium in up and down markets is not found symmetrical for any of the test periods. This result is consistent with Fletcher (1997)'s findings and inconsistent with Pettengill et. al.'s. Table 3.2.7 shows the results of symmetry test for all periods.

TABLE 3.2.6 Average market Excess Returns

	Unconditional					Up market					Down market			
Test Period	Full Sample	2003-2008	2004-2009	2005-2010		Full Sample	2003-2008	2004-2009	2005-2010		Full Sample	2003-2008	2004-2009	2005-2010
Number of months	32	24	24	24		18	13	12	16		14	11	12	8
Excess market return	1,44	-1,40	0,19	3,41		8,43	5,84	9,83	8,07		-7,55	-9,95	-9,45	-5,13
t-stat	0,84	0,69	0,08	2,17		5,83	3,59	4,99	6,28		6,16	5,48	5,53	4,95
p-value	0,41	0,50	0,94	0,04		0,00	0,00	0,00	0,00		0,00	0,00	0,00	0,00

TABLE 3.2.7 Statistics for Symmetry Test

Test Period	Full Sample	2003-2008	2004-2009	2005-2010
$\bar{\gamma}_1$ *(up)*	8,431	5,843	9,833	8,068
$\bar{\gamma}_2$ *(down)*	-7,552	-9,954	-9,453	-5,133
t-stat	0,447	1,690	0,146	1,488
p-value	0,658	0,105	0,886	0,151

3.2.3 Analysis of Results

In this study, two different test approaches are used to test the validity of the CAPM in the ISE between January 2003 and December 2010. Firstly, the unconditional test procedure developed by Fama and MacBeth (1973) is applied and no statistically significant risk-return relationship is found. This result is consistent with the previous findings in the literature.

Secondly, Pettengill et al. (1995)'s conditional test procedure is applied. Although a positive risk-return relationship during up market periods and a negative risk return relationship during down market periods is documented, the results are not statistically significant for all sub-periods of research. For 2003-2008 sub-period, down market results indicate a significant negative relationship between risk and return. In contrast, for 2004-2009 sub-period and for the full sample, there are positive risk return relationships in the up market months but relationships are not significant in the down market months. Only for 2005-2010 sub-period, both up and down market tests give statistically significant results. Nevertheless, as the risk premiums in up and down markets are not symmetrical, the existence of a positive risk-return tradeoff cannot be validated for 2005-2010 sub-period.

The test results obtained from the application of the second approach are inconsistent with the previous studies conducted in the ISE using the Pettengill et al. (1995)'s methodology (Karacabey & Karatepe, 2004; Gursoy & Rejepova, 2007). The main reason of this may be the usage of different test periods and proxies for the market portfolios and for risk free rates. For instance, Gursoy and Rejepova (2007) used US 3-month T-Bill rates as a proxy for the Turkish risk free rate after adjusting it for the inflation difference between two countries. They also used weekly returns on the ISE 100 index to calculate excess market returns. As beta calculations are usually exceedingly sensitive to the time intervals of the observations and to the proxies used for the market portfolio and the risk free rate, the difference of the results should not be surprising.

However these two previous tests conducted in the ISE found statistically significant results in both up and down markets for all test periods; there are some studies in other stock markets (Al Raif, 2009; Fraser et al., 2004; Verma, 2011) that have results similar to those documented in this study. Actually, history of the test results of the conditional approach of Pettengill et al. (1995)'s methodology is somewhat similar to the unconditional CAPM. Early tests results are supportive while later research findings have some contradictory evidence.

On the conclusion, the results of this study indicate that neither the standard CAPM nor its conditional version may be useful in estimating risk in the ISE.

3.3 Testing Empirical Models

3.3.1 Data and Methodology

The goal of this second research study is to asses the ability of some proposed risk factors in explaining the variation in stock returns in the ISE. The CAPM beta, size, book-to-market ratio, and stock price momentum are the four risk factors which are investigated. The overall research period covers 75 months from July 2005 to September 2011. Monthly cross-sectional Fama-MacBeth type regressions are run on dividend adjusted excess stock returns and each set of risk factors separately and in combination.

3.3.1.1 Data

Dividend adjusted monthly stock returns for all stocks in ISE All index are the sample data of the study. Monthly returns for ISE All Index are taken as a proxy for the market portfolio. Three-month Government Debt Securities (GDS) Price Index is considered to be the risk free interest rate.

Monthly returns of market and risk free rate are calculated using the following formula;

$$\text{Rate of return}=\frac{(\text{Index value at the end of the term-Index value at the beginning of the term})}{\text{Index value at the beginning of the term}}\times 100$$

Realized excess returns are used as a proxy of expected excess returns. Excess returns are calculated by subtracting the risk free return from the raw returns.

The data collection methods for proxies of risk factors are explained below.

3.3.1.1.1 The CAPM Beta

Monthly excess returns for each stock are calculated by subtracting risk free rate of return from stock return for all months between January 2001 and September 2011. Monthly market risk premium is also calculated in the same way. Then, the following equation is used to calculate stock betas for each month.

$$(3.6)\ r_i - RFR = \alpha_i + \beta_i (r_m - RFR) + e_i$$

r_i = divident-adjusted monthly return for stock i
r_m = monthly return on ISE All Index
r_{fr} = monthly return on three-month Government Debt Securities (GDS) Price Index

The time-varying nature of the CAPM beta is accepted in this study. The CAPM beta is re-estimated for each month using rolling window regressions of stock excess returns on market excess returns over the preceding 54 months due to data availability. However 60 months (5year) rolling window regressions are frequently used for time varying beta estimations in the literature, it is documented that the difference in resulting betas is not important with 24, 36 or 48 months rolling windows (Petkova & Zhang, 2005). There is also evidence that average length of stationary interval for beta is 54 months (Kim,1993).

3.3.1.1.2 Book-to-Market Ratio

The second risk factor, book-to-market ratio, is estimated using the following formula;

$$(3.7)\ \frac{\text{BE}}{\text{ME}} = \frac{\text{Shareholder's Equity}}{\text{Number of Shares} \times \text{Share Price}}$$

For every company, shareholder’s equity is taken from the company financial tables which are issued at least three months before the month of estimation. The minimum lag of three months is used to ensure that the accounting information is spread to the market (Fama-French, 1993; 1996; Novak & Petr, 2010). Price is the market price of the company stock at the month of estimation. Similarly, the number of shares is the number of shares issued by the company at the month of estimation.

3.3.1.1.3 Size

Natural logarithm of market value of a company is taken as a proxy for size. Market value is calculated by multiplying the share price of the month of estimation with the total number of shares by the same month.

3.3.1.1.4 Momentum

Stock price momentum is proxied by the mean value of the dividend adjusted past stock raw return of the previous six-month period including the month of estimation. It is calculated monthly for each stock as follows;

$$M_i = \frac{1}{6}\sum_{j=0}^{5} R_{i-j}$$

$$(3.8)\ M_i = \text{Stock momentum for month i}$$

$$R_i = \text{ Stock return for month i}$$

3.3.1.2 Methodology

3.3.1.2.1 Sample

The research period for this study comprises 75 months from July 2005 to September 2011. Five 75-month time-series data are estimated for each stock in the sample for its excess return, the CAPM beta, BE/ME ratio, natural logarithm of market value and momentum. All stocks in the ISE All index constitute the population of the study. Only stocks of companies which satisfy all of the following criteria are included in the sample;

1. It should have stock price information for all months from July 2005 to September 2011.
2. It should have the rate of return information for all months between January 2001 and September 2011.
3. The company should have relevant information about the number of shares issued for all months between July 2005 and September 2011 and the book value of equity for all months between January 2005 and June 2011.
4. The company should not have negative book value for any month between January 2005 and June 2011.
5. The company should not have more than one share class.
6. The company should not be an investment trust.

In Table 3.3.1, the information related to the number of stocks that satisfy each of the above criteria is given.

TABLE 3.3.1 The Number of Stocks that Satisfy Research Criteria

Number of Companies	Number of Stocks
ISE All	371
Investment Trusts	31
Negative Book Value	22
More Than One Share Class	10
Without Relevant Information	118
Included in the sample	190

There are 371 companies in the ISE All Index by year 2011. Investment trusts, companies which have negative book value at least one month during the research period, companies which have more than one share class and those which do not have relevant information for all months of the sample period are excluded from the sample. 29 of the companies without relevant information have all data except rate of returns. 190 companies which satisfy all of the requirements listed above are included in the sample.

3.3.1.2.2 Winsorization

In order to see the effects of the outliers in the sample results, data is winsorized at three standard deviations. For this process, data is explored to find the extreme values and if they exist, observations which are greater/lower than mean value plus/minus three standard deviations are replaced with a value equal to the mean plus/minus three standard deviations.

Data is taken from the ISE database and Public Disclosure Platform (PDP) website. PDP is electronic system managed by the ISE, through which notifications of ISE firms publicly disclosed.

In data preparations, rolling window, linear and multivariate regressions are run using Stata Statistical Software, (release 11) while winsorization is conducted and hypotheses are tested using SPSS Statistical Package, (version 17).

3.3.1.2.3 Hypotheses

Thus, the research hypotheses are set as follows;

H1; There is a positive relationship between the CAPM beta of a stock and its excess returns.

H2; There is a negative relationship between the size of a company and its excess returns.

H3; There is a positive relationship between the BE/ME ratio of a company and its excess returns.

H4; There is a positive relationship between momentum and excess returns.

3.3.1.2.4 Descriptive Statistics

Descriptive statistics based on the monthly observations of all the variables used in full data sample and the winsorized data sample is provided in Table 3 and 4. Number of monthly observations (n), mean, standard deviations (sd), minimum (min), first quartile (p25), median (p50), third quartile (p75), and maximum (max) for the excess stock returns (exert), the CAPM beta estimations (beta), size proxy (ln(ME)), book-to-market ratio (BE/ME), and stock price momentum (momentum) are given in the Table 3.3.2 and 3.3.3 below.

TABLE 3.3.2 Descriptive Statistics of the Full Sample

	exret	beta	ln(ME)	BE/ME	momentum
n	14250	14250	14250	14250	14250
mean	1,300	0,930	12,109	1,002	2,764
sd	17,718	0,330	1,698	0,856	8,013
min	-63,160	-0,300	4,960	0,010	-21,630
p25	-7,380	0,720	10,890	0,471	-1,404
p50	-0,015	0,920	12,010	0,791	2,040
p75	8,490	1,140	13,140	1,243	6,230
max	886,030	2,410	17,430	16,000	164,902

TABLE 3.3.3 Descriptive Statistics of the Winsorized Sample

	exret	beta	ln(ME)	BE/ME	momentum
n	14250	14250	14250	14250	14250
mean	0,981	0,926	12,081	0,990	2,570
sd	14,898	0,333	1,733	0,792	6,712
min	-63,160	-0,193	5,998	0,010	-21,630
p25	-7,330	0,720	10,870	0,471	-1,380
p50	0,030	0,920	11,990	0,791	2,020
p75	8,460	1,140	13,140	1,243	6,210
max	213,723	2,011	17,430	7,096	44,870

Winsorized sample is used to eliminate the effect of potential mistakes in the database and the effect of outliers. For example, the range of excess stock returns is reduced from (886,030%, -63,160%) to (213,723%,-63,160%) with winsorizing.

3.3.2 Results

In this section, mean intercept, and slope coefficients (mean), corresponding t-statistics (t-stat) and p-values (p-value) from monthly cross-sectional regressions of stock excess return on its CAPM beta, size and stock price momentum factors for both full and winsorized samples are presented.

3.3.2.1 Single Factor Models

Firstly, the significance of each one of the four risk factors in explaining the stock returns are investigated by running simple linear regressions. Results of the monthly regressions of the dividend adjusted realized excess returns on the CAPM Beta estimates, natural logarithms of market values, book-to-market ratios and stock price momentum factors for full and winsorized samples are given in the Table 3.3.4 and 3.3.5 below.

TABLE 3.3.4 Full Sample Results for Simple Linear Regressions

	N	intercept	beta	intercept	ln(ME)	intercept	BE/ME	intercept	momentum
mean	75	1,417	-0,169	-2,559	0,319	3,467	-2,367	1,118	-0,024
t-stat	74	1,306	-0,215	-1,240	2,676	-7,551	-7,551	1,058	-0,583
p-value	74	0,196	0,830	0,219	0,009	0,002	0,000	0,294	0,562

TABLE 3.3.5 Winsorized Sample Results for Simple Linear Regressions

	N	intercept	beta	intercept	ln(ME)	intercept	BE/ME	intercept	momentum
mean	75	0,780	0,171	-2,614	0,298	2,865	-2,046	0,866	-0,044
t-stat	74	0,847	0,252	-1,418	2,977	2,839	-8,674	0,818	-1,085
p-value	74	0,400	0,802	0,160	0,004	0,006	0,000	0,416	0,281

3.3.2.1.1 The CAPM Beta

The CAPM predicts a positive linear relationship between expected stock returns and betas. The results do not support the CAPM predictions. The slope coefficient of the CAPM beta factor is not significantly different from zero at 5% significance level with a p-value of 0,830. Winsorized sample results in Table 5 shows that this result is not driven by the outlying extreme observations with a p-value of 0,743. The slope coefficient of the CAPM beta remains insignificant after winsorization of the observations at 3 standard deviations. Thus, the first hypothesis, which proposes a statistically significant positive relationship between stock returns and the CAPM betas, is rejected. This result is consistent with the previous literature on the subject.

3.3.2.1.2 Size

Previous empirical studies predict a statistically significant negative relationship between the expected stock return and the proxy of size. Both for the full and for the winsorized samples, there is a highly statistically significant relationship between stock return and size proxy with p values of 0,009 and 0,004 respectively. However, neither one of the mean slope coefficients are negative. In other words, the relationship between the size and stock returns is statistically significant but positive instead of negative. Hence, H2 is rejected.

3.3.2.1.3 Book-to-Market Ratio

A statistically significant positive relationship between excess stock returns and book-to-market ratios is found by many of the previous researchers. The results of this study show the existence of a highly statistically significant relationship between these two variables for both full and the winsorized samples with p-values of 0,000. Thus, the results are not caused by extreme observations. Nevertheless, the sign of the mean slope coefficients for both samples are negative. Hence, the relationship is not positive. These seems to indicate that book-to-market ratios does indeed predict stock returns but the relationship between them is negative instead of being positive as it is suggested by the main branch of book-to-market anomaly literature. Thus, H3 is rejected.

3.3.2.1.4 Momentum

Short term persistence of stock returns are observed by many researchers before. Excess returns are regressed separately with the momentum factor, and it is realized that slope coefficient has a negative sign and the relationship is statistically insignificant with p-values of 0,562 for the full sample and 0,281 for the winsorized one.

3.3.2.2 The Three Factor Model

In the second step, the three-factor model is tested by regressing the dividend adjusted realized excess returns on the CAPM Beta estimates, natural logarithms of market values, book-to-market ratios in a multiple regression model. The aim is to understand the ability of these three factors in explaining stock returns when they all used in combination. Results are presented in Table 3.3.6 and 3.3.7 below.

The mean slope coefficient for the CAPM beta is still insignificant with a p-value of 0,912 for the full sample. Book-to-market ratio is also remains to be highly statistically significant for both full and winsorized samples. However, size loses its significance when it is used in the three factor model. Its p-values became 0,428 for the full sample and 0,205 for the winsorized one.

TABLE 3.3.6 Full Sample Results for The Three Factor Model

	N	intercept	beta	ln(ME)	BE/ME
mean	75	2,1846	-0,0851	0,0994	-2,2454
t-stat	74	1,025	-0,111	0,797	-8,081
p-value	74	0,308	0,912	0,428	0,000

TABLE 3.3.7 Winsorized Sample Results for the Three Factor Model

	N	intercept	beta	ln(ME)	BE/ME
mean	75	0,9487	0,1394	0,1347	-1,9203
t-stat	74	0,513	0,206	1,28	-8,54
p-value	74	0,610	0,838	0,205	0,000

3.3.2.3 The Four Factor Model

In the last step, the collective explanatory power of all four factors are investigated by regressing the dividend adjusted realized excess returns on the CAPM Beta estimates, natural logarithms of market values, book-to-market ratios and stock price momentums in a four factor model. From all the factors used, only two of them is found to be statistically significantly different from zero at 95% confidence interval. Book-to-market ratio is once again highly statistically significant with negative mean values of slope coefficients for both samples. Stock price momentum is the second factor that gives significant results with p-values of 0,032. The significance level increases to 0.002 when extreme values are replaced with mean plus/minus 3 standard deviations in the winsorized sample. Furthermore, the relationship between the stock returns and the momentum factor seems to be negative due to negative sign of slope coefficients. Thus, the existence of a negative momentum effect for individual firms in the ISE is found and hypothesis 4 is rejected based on the evidence obtained from the research period.

TABLE 3.3.8 Full Sample Results for the Four Factor Model

	N	Intercept	beta	ln(ME)	BE/ME	momentum
mean	75	2,628693	-0,3826	0,100837	-2,43893	-0,09031
t-stat	74	1,227	-0,496	0,843	-9,139	-2,186
p-value	74	0,224	0,622	0,402	0,000	0,032

TABLE 3.3.9 Winsorized Sample Results for the Four Factor Model

	N	Intercept	beta	ln(ME)	BE/ME	momentum
mean	75	1,2506	-0,0566	0,146	-2,1183	-0,1195
t-stat	74	0,674	-0,087	1,416	-9,78	-3,137
p-value	74	0,502	0,931	0,161	0,000	0,002

3.3.3 Analysis of Results

The results of this study can be summarized as follows;

1. Against the predictions of the CAPM, beta is insignificant in all tests for both full and winsorized samples. This result is consistent with findings of the mainstream CAPM research. Beside this, the intercept in the single index model for the CAPM beta is positive but insignificant. Since the results from the full and outlier free sample are very similar, they are not driven by extreme observations.

2. When the natural logarithm of market value is used in the single index model, size is found to have a significant explanatory power for both full and winsorized samples. However the sign of average size proxy coefficient is positive. Thus a reversed size effect is documented (ie. a positive relationship between natural logarithm of market value of a company and its excess stock returns). Since intercept is different from zero, we can conclude that the regression results can be improved by the inclusion of some additional explanatory variables.

3. In the single index model for book-to-market ratio, a very significant negative relation with book-to-market ratios and excess stock returns is found. As it can be seen in tables 3.3.6, 3.3.7, 3.3.8, and 3.3.9, this relation is robust to the inclusion of other explanatory variables and is not driven by extreme observations. The possible reasons of the anomalously negative sign of the relation will be discussed in section 3.3.3.2 below. Intercept term for the single index model is also found statistically significantly different from zero. It means that, there are some other factors than book-to-market ratio to affect stock returns.

4. When momentum is used in the single index model, an insignificant and negative relationship between excess returns and momentum is found.

5. When a three factor model is applied, size loses its significance. Nevertheless, its sign remains to be positive. The book-to-market ratio remains to be statically significantly different from zero and negatively signed in the three factor model. Thus, we can conclude that the explanatory ability of size proxy may be captured by book-to-market ratio. Intercept of the model is not statistically significantly different from zero.

6. The four factor model confirms the effectiveness of book-to-market factor on excess stock returns. The newly added momentum factor also has an explanatory power in this model. The sign of mean coefficient is negative for momentum factor. Thus, a contrarian effect of momentum where past losers outperform past winners is noticed for both full and outlier-free sample. This contrarian momentum effect is consistent with the findings of Bildik and Gulay (2007). Size and the CAPM beta factors remain statistically insignificant in the four factor model.

7. Winsorized sample results showed that none of these results are driven by extreme observations.

The results summarized above highlights a few issues that need further investigation. In section 3.3.3.2 these issues are discussed. But, first of all, a closer examination of the method used is given in the following section.

3.3.3.1 A Few Notes about the Research Study

This research study has some uncommon (distinctive) features that must be mentioned.

First of all, instead of forming portfolios, individual stocks are used to test all the hypotheses in this study. Almost all of the empirical research conducted about size and book-to-market anomalies are based on portfolios. The main reason for this may be the availability and obtainability of prepared portfolios and three-factor model factors for US and many other countries in Kenneth F. French's website. Many researchers prefer to use these ready data sets instead of collecting their own research data (eg. Ang & Chen, 2007; Petkova & Zhang, 2005). However, the sorting style of portfolios in asset pricing tests affects the results (Lewellen et al., 2010). It is found that portfolios built on beta sorting generally favors the CAPM, while the three factor model's explanatory power can be enhanced by using book-to-market or size sorting (Ernstberger, Haupt & Vogler, 2011).

There is also another concern about the usage of portfolios in asset pricing tests. If portfolios are constructed based on sample characteristics, data-snooping may cause certain biases in results (Berk, 2000). Grouping stocks into portfolios also causes the information loss and lowers the power of tests (Hwang & Satchel, 2011).

In their recent paper, Lewellen et al. (2010) stressed that when portfolios are constructed from stocks sorted based on size or book-to-market ratios, its very easy for almost all models to detect book-to-market and size effects. They suggest a number of solutions such as sorting portfolios based on other characteristics. Using individual stocks is also mentioned by them as a good solution if the error in variables problem solved. Aksu and Onder (2003) used both portfolios and individual stocks to solve problems of portfolio formation.

Secondly, the restrictive sample selection criteria of the study may entail these results. All stocks included in the sample are listed on the ISE for at least eleven years. This selection procedure may cause a sample bias that newly founded and for this reason small sized companies may not be included in the sample. As the size effect is usually thought as a phenomenon that is driven by very small firms, this selection procedure may be the reason of not detecting a negative size effect.

When the descriptive statistics of the market value observations used in the study and market values of all companies listed in ISE All index by April 2012 are compared, it can be easily seen that this is not the case. Below some descriptive statistics are given for ISE All market values and the market values of the sample firms.

TABLE 3.3.10 Descriptive Statistics of Market Values of ISE All Index and the Winsorized Sample

	ISE All ME	Sample ME
mean	1212758	964785
stdev.	3552275	3076982
min	1924	2697
p25	49376	54721
p50	158570	166043
p75	676011	508897
max	28812000	37132383

When the difference of the the mean values of the ISE All companies' market values and those of the companies which are used in the research is tested using two sample t-test, the difference is found insignificant with a p-value of 0.4137.

In order to evaluate the robustness of test results and to detect any predominant years, sample period is divided into five yearly sub-periods and t-tests are applied to the regression coefficients of winsorized sample from each sub-period. The results are presented in Table 3.3.11 below. As can be seen from the table, the results of the full sample are generally continual in all sub-periods. Especially a highly statistically significant negatively signed book-to-market effect persistent in all years. Another interesting result is that the CAPM beta is found significant for 2009 sample when used separately and in two multifactor models. A positive size effect is only found for 2008 sub-period, while a negative momentum effect exists in 2009 data.

Before concluding this section, it should also be mentioned that regressions are checked for any violation of assumptions that may cause reversed signs in beta coefficients. Especially, if multicollinearity exists, the estimation of trustworthy beta coefficient becomes problematic (Field, 2009). Since average of Variance Inflation Factors (VIF) of the model is very close to 1, collinearity is not a problem for this study.

TABLE 3.3.11 Yearly Sub-period Tests Results

			Winsorized Sample Regression Slopes					**Winsorized Sample Results for The Three Factor Model**				**Winsorized Sample Results for The Four Factor Model**			
		N	beta	ln(ME)	BE/ME	momentum	Intercept	beta	ln(ME)	BE/ME	Intercept	beta	ln(ME)	BE/ME	momentum
2006	mean	12	0,66	0,51	-2,55	-0,04	-2,32	-0,49	0,31	-2,27	-2,52	-0,76	0,39	-2,59	-0,11
	t-stat	11	0,40	1,75	-3,66	-0,60	-0,47	-0,27	0,93	-3,49	-0,49	-0,40	1,21	-3,79	-1,51
	p-value	11	0,69	0,11	0,00	0,56	0,65	0,79	0,37	0,01	0,63	0,70	0,25	0,00	0,16
2007	mean	12	0,33	0,18	-2,60	-0,04	4,20	-0,04	-0,09	-2,70	4,47	-0,25	-0,06	-2,90	-0,07
	t-stat	11	0,23	0,64	-6,16	-1,07	0,72	-0,03	-0,26	-3,84	0,77	-0,19	-0,18	-4,04	-2,10
	p-value	11	0,82	0,54	0,00	0,31	0,49	0,98	0,80	0,00	0,46	0,86	0,86	0,00	0,06
2008	mean	12	-0,91	0,62	-1,88	-0,06	-7,49	-0,97	0,37	-1,65	-8,04	-1,72	0,47	-1,90	-0,17
	t-stat	11	-0,41	2,22	-3,29	-0,44	-1,43	-0,43	1,31	-3,21	-1,56	-0,94	1,75	-3,78	-1,59
	p-value	11	0,69	0,05	0,01	0,67	0,18	0,68	0,22	0,01	0,15	0,37	0,11	0,00	0,14
2009	mean	12	4,13	0,07	-0,77	-0,20	4,80	4,51	-0,08	-0,92	7,10	4,19	-0,21	-1,30	-0,30
	t-stat	11	2,19	0,21	-2,03	-1,33	0,89	2,44	-0,21	-2,26	1,41	2,43	-0,62	-3,42	-2,27
	p-value	11	0,05	0,84	0,07	0,21	0,39	0,03	0,84	0,05	0,19	0,03	0,55	0,01	0,04
2010	mean	12	-4,24	0,49	-4,26	0,04	6,71	-3,15	0,24	-3,72	7,28	-3,57	0,22	-3,82	0,01
	t-stat	11	-1,58	1,26	-3,04	0,31	1,29	-1,27	0,68	-3,59	1,41	-1,26	0,70	-4,36	0,09
	p-value	11	0,14	0,24	0,01	0,76	0,22	0,23	0,51	0,00	0,19	0,23	0,50	0,00	0,93

3.3.3.2 Negatively Signed Book-to-Market Effect and Positively Signed Size Effect

The explanations for book-to-market effect in literature should be revisited to understand the reasons behind the negative sign of the book-to-market factor. There are different explanations of book-to-market anomaly. Some researchers believe that this is another dimension of financial distress risk (Fama & French 1993; 1996; Davis et al.2000; Novak & Petr 2010) while others argue that it is the systematic mispricing of the stocks with extreme book-to-market securities. The existence of reversed book-to-market effect may be considered as evidence against these explanations. Below some studies that document a reversed book-to-market effect are mentioned.

Kothari and Shanken (1997) tested the forecasting power of book-to-market ratio in detail and found out that it is varying over time and sometimes the effect becomes negative.

A recently published study on the Berlin Stock Exchange found a robust negatively signed book-to-market effect and a periodic positive size effect in years prior the World War I. (Fohlin & Reinhold, 2010). They concluded that a reversed book-to-market effect is the most robust predictor of stock returns. They documented no prominent size or momentum anomalies in returns except a periodical reversed size effect. Their results are very similar to the result of the research study explained here.

The negative book-to-market effect is also found in some of the previous studies conducted in the ISE. Karan (1996) found a positive market value to book value effect using 1988-1995 data. Yildirim (1997) showed that when full sample from 1990-2002 is tested book-to-market and size effects exist. However, when the research period is divided into sub-periods, both effects are only persistent in 4-5 of 12 years. He related these findings with the market index movements and concluded that firm characteristics are more influential in up market periods.

Aksu (2000) found anomalously signed book-to-market and size effects from a sample consisting financially distressed firms that attempt to restructure their debt privately.

Gonenc and Karan (2003) documented a negatively signed book-to-market effect for the period of 1993-1998 and concluded that there is no value premium in the ISE. Their results showed that investing in growth stocks (ie. stocks with low book-to-market ratios) is more profitable than investing in value stocks (ie. stocks with high book-to-market ratios). Unstable economic conditions, specific to the country, might direct foreign and institutional investors to buy the stocks of large and fundamentally strong firms. These may cause the reason of the reversion of signs of anomalies in the ISE.

Size effect is less robust than book-to-market effect. It reverses its sign sometimes or even completely vanishes. Thus, it is difficult to give any reason for this anomaly. The risk proxy explanation of anomalies and most behavioral approaches are based on a negative size effect.

Recently, Mossman and Rahkmayil (2010) investigated the effect of economic conditions on size anomaly. They concluded that as the economic conditions change the risks and opportunities of small and big firms are affected differently from these changes. They proposed that "economic conditions may change the relative risk-adjusted return potential due to firm risk characteristics and changing investor preferences for risk and return" (Mossman & Rahkmayil, 2010).

In conclusion, the consistent and reversed book-to-market anomaly found in this study may be the result of some economic or market-specific characteristics of Turkey during the research period. The determination of these characteristics is beyond the scope of this study. Nevertheless, it would be beneficial to reinvestigate the strong significance of the effect for the full sample period using a suitable portfolio approach.

CONCLUSION

The validity of the CAPM is one of the most prominent debates in financial literature. Many empirical tests showed evidence that the model does not capture the variation in stock returns. Nevertheless, these results do not necessarily mean that the CAPM is invalidated. There are theoretical reasons for this (Black 1972, 1993). First of all, the used proxy for the market portfolio may not be representing the actual market portfolio. Jagannathan and McGrattan (1995) stated that this problem may bias regression slopes toward zero and intercepts away from zero. Beside this, the frequently used time series and cross sectional regression methods do not test the overall validity of the model. What they really test is explained by Fama and French as; "….whether a specific proxy for the market portfolio (typically a portfolio of U.S. common stocks) is efficient in the set of portfolios that can be constructed from it and the left-hand-side assets used in the test" (Fama & French, 2004).

Testing market anomalies is another debate. While book-to-market and size anomalies are continued to be documented in many stock markets beside a handful of other interesting anomalies (eg. January effect and day of the week effect), there is no consensus about the reasons behind these. Beside the lack of theoretical background, the reversal or even completely disappearance of these effects in some markets make the picture more complicated.

The aim of this study is to contribute the existing literature by investigating the validity of the CAPM and the existence of some market anomalies in the ISE. To achieve this aim, some asset pricing tests are conducted in the ISE. The testing process can be divided into two parts.

For the first part, unconditional and conditional CAPM are tested for the sample period of 2003-2010. The eight-year test period is divided into three six-year sub-periods. The unconditional CAPM is rejected for the full sample period and for all sub-periods. The results of the conditional test show that there is a statistically significant conditional relationship in both up and down markets for only one of the three sub-periods. The relationship is significant for only up or for only down markets in the two remaining sub-periods and in the full sample period. However, since the risk-return relationship in up and down markets is not symmetric in any of the periods, this conditional relationship does not indicate a positive risk-return tradeoff. Based on the results obtained in this part, it can be concluded that neither the unconditional nor the conditional CAPM may be a useful asset pricing model in the ISE.

In the second part, the ability of some proposed risk factors in explaining the variation in stock returns in the ISE is investigated. Single, three and four-factor models are constructed using the CAPM beta, size, book-to-market ratio, and stock price momentum as the risk factors. The overall research period consist of 75 months from July 2005 to September 2011. Monthly cross-sectional Fama-MacBeth type regressions are run on dividend adjusted excess stock returns and each set of risk factors separately and in combination. The results indicate the existence of a strong reverse book-to-market effect during the sample period. Also, a positive size effect is found in single index model. However, size loses its significance when combined with other factors in three and four factor models. The CAPM beta is found insignificant for all factor models while a contrarian momentum effect is documented when this factor is tested within a four-factor model. These results indicate that market anomalies are not general phenomena which exist in all stock markets and in all time periods. Instead, they are context-specific and just like stock returns, their direction cannot be previously predicted.

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