THE VALIDITY OF FAMA-FRENCH FOUR FACTOR MODEL IN ISTANBUL STOCK EXCHANGE

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ABSTRACT

The Validity of Fama-French Four Factor Model in Istanbul Stock Exchange

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The aim of this thesis is to investigate the size, book-to-market ratio (B/M), and profitability patterns in average returns and testing the viability of Fama-French four factor model in Istanbul Stock Exchange (ISE) over the period between July 2004-June 2013. The comparative performances of capital asset pricing model (CAPM), Fama-French three factor model, and Fama-French four factor model will be examined. Each of these three models is regressed on two different sets of portfolios. That is, monthly excess returns of six size-B/M and eighteen size-B/M-profitability portfolios are used as dependent variables in time-series regressions following Fama-French methodology. Confronted with the excess returns of six portfolios, the three factor model outperforms both CAPM and four factor model based on the results of adjusted R-squared values, GRS-F test of Gibbons, Ross, and Shanken (1989) and mean absolute value of intercept terms. Confronted with the excess returns of eighteen portfolios, based on R-squared value and GRS, four factor model is superior to both models. However, regarding the mean absolute value of alphas, three factor model fares slightly better than four factor model. Thus, in the light of the statistical results, although four factor model is not rejected and proves its viability in ISE, it does not show a

strong superiority to three factor model, which is in line with Fama and French results.

Keywords: CAPM, Fama-French Three Factor Model, Fama-French Four Factor Model, Common Risk Factors in Excess Returns, Istanbul Stock Exchange

ÖZ

Fama-French Dört Faktör Modelinin IMKB'de Geçerliliği

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Bu tezin amacı Temmuz 2004 – Haziran 2013 döneminde IMKB deki beklenen getirilerdeki firma büyüklüğü, DD/PD ve karlılık etkilerini araştırmak ve Fama-French Dört Faktör modelinin geçerliliğini test etmektir. İki farklı portföy setinin üzerine, Sermaye Varlıkları Fiyatlama Modeli, Fama-French Üç Faktör Modeli ve Fama-French Dört Faktör Modeli kullanılarak yapılan regresyonlar kullanılarak bu üç model kaşılaştırılmıştır. Fama ve Frech'in metodu izlenerek, firma büyüklüğü-DD/PD gruplarına göre oluşturulmuş altı portföy ve firma büyüklüğü-DD/PD-karlılık gruplarına göre oluşturulmuş onsekiz portföyün risksiz faiz oranı aşan aylık getirileri bağımlı değişken olarak kullanılmıştır. Altı portföyün fazla getirileri kullanıldığı durumda düzeltilmiş R-kare, GRS-F testi ve alfa değerlerinin ortalama mutlak değeri göz önünde bulundurulduğunda üç faktörlü modelin hem SVFM hem de dört faktörlü modele göre daha iyi bir performans sergilediği saptanmıştır. Onsekiz portföyün fazla getirilerinin kullanıldığı durumda ise R-kare ve GRS-F testi sonuçlarına dayanarak, dört faktörlü modelin diğer iki modele göre üstün olduğu sonucuna varılmıştır. Ancak, alfa değerlerinin ortalama mutlak değeri baz alındığında, üç faktörlü modelin az da olsa dört faktörlü modele nazaran daha iyi performans gösterdiği görülmektedir. Kısacası, çalışma sonucunda ulaşılan istatistiki sonuçların ışığında, dört faktörlü modelin

IMKB'de geçerli olduğu saptanmış olmasına rağmen, üç faktörlü modele kıyasla kayda değer bir performans artışı sağlayamadığı iddia edilebilir.

Anahtar Kelimeler: SVFM, Fama-French Üç Faktör Modeli, Fama-French Dört Faktör Modeli, Fazla Getirilerde Ortak Risk Faktörleri, Borsa İstanbul

To My Parents

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LIST OF ABBREVIATIONS

AMEX	American Stock Exchange
B/M	Book-to-market ratio
BE	Book Equity
BIST	Borsa Istanbul
C/P	Cash Flow-to-price ratio
CAPM	Capital Asset Pricing Model
DD/PD	Defter Değeri/Piyasa Değeri
E/P	Earnings-to-price ratio
FF	Fama and French
GRS	Gibbons, Ross, and Shanken
ISE	Istanbul Stock Exchange
LHS	Left Hand Side
MAV	Mean Absolute Value
ME	Market Equity
NASDAQ	National Association of Securities Dealer Automated Quotations
NYSE	New York Stock Exchange
OP	Operating Profit
Rf	Return of the Risk-Free Asset
RHS	Right Hand Side
Rm	Return of the Market

Std.Dev.	Standard Deviation
SVFM	Sermaye Varlıkları Fiyatlama Modeli
UK	United Kingdom
SMB	Small minus big
HML	High minus low
RMW	Robust minus weak
SL	Portfolio consisting small size and low B/M stocks
SN	Portfolio consisting small size and neutral B/M stocks
SH	Portfolio consisting small size and high B/M stocks
BL	Portfolio consisting big size and low B/M stocks
BN	Portfolio consisting big size and neutral B/M stocks
BH	Portfolio consisting big size and high B/M stocks
SLW	Portfolio consisting small size, low B/M and weak profitability stocks
SLN	Portfolio consisting small size, low B/M and neutral profitability stocks
SLR	Portfolio consisting small size, low B/M and robust profitability stocks
SNW	Portfolio consisting small size, neutral B/M and weak profitability stocks
SNN	Portfolio consisting small size, neutral B/M and neutral profitability stocks
SNR	Portfolio consisting small size, neutral B/M and robust profitability stocks

SHW	Portfolio consisting small size, high B/M and weak profitability stocks
SHN	Portfolio consisting small size, high B/M and neutral profitability stocks
SHR	Portfolio consisting small size, high B/M and robust profitability stocks
BLW	Portfolio consisting big size, low B/M and weak profitability stocks
BLN	Portfolio consisting big size, low B/M and neutral profitability stocks
BLR	Portfolio consisting big size, low B/M and robust profitability stocks
BNW	Portfolio consisting big size, neutral B/M and weak profitability stocks
BNN	Portfolio consisting big size, neutral B/M and neutral profitability stocks
BNR	Portfolio consisting big size, neutral B/M and robust profitability stocks
BHW	Portfolio consisting big size, high B/M and weak profitability stocks
BHN	Portfolio consisting big size, high B/M and neutral profitability stocks
BHR	Portfolio consisting big size, high B/M and robust profitability stocks

CHAPTER 1

INTRODUCTION

Asset pricing has always been one of the main areas of modern financial economics. It can be claimed that the introduction of capital asset pricing model (CAPM) by Sharpe (1964), Lintner (1965), and Black (1972) made a breakthrough in the area of financial economics. Even today, it is apparent that the CAPM is one of the most widely used models among academicians and practitioners. The fact that CAPM can be used in performance evaluation, estimating the cost of capital, selecting portfolios, and measuring abnormal returns etc., is one of the main reasons why this model is so much appreciated. Despite its popularity and success, since its introduction there have always been critisims, with claims that CAPM is not sufficient to explain the variations in excess returns. In line with this argument Fama and French (1992,1993,1996) showed that there is a relationship between size and average return on one side, and B/M and average return on the other side. Moving from this claim, they laid the foundations of their three factor model by adding two more risk factors to CAPM. Fama-French model gained big importance in modern finance as CAPM. Interestingly, one of the most sound and efficient critical approach to the Fama- French models introduced in 1990's came from Fama and French in 2013. Having considered the possibility of the existence of profitability patterns in average returns, they wanted to add another explanatory variable to their three factor model reflecting profitability. They claimed that four factor model may fare a better job than three factor model in capturing the common variation in returns.

The main aim of this thesis is to test the validity of Fama-French four factor model in Istanbul Stock Exchange over the period July 2004-June 2013. In

line with this objective, the rest of the thesis is organized as follows: The next chapter gives some theoretical background in detail regarding the development of four factor model starting from the invention of CAPM. The second section gives the summary and main points of the international studies for Fama-French models and the last section examines the studies made in Turkish stock market. The third chapter explains the data and methodology used in this thesis. Data elimination process, portfolio formation, and factor construction methods are described in detail. The second section of this chapter gives information about sample characteristics, descriptive statistics of dependent and independent variables. Chapter four continues with regression details and regression results of CAPM, three factor and four factor model for six size-B/M portfolios and eighteen size-B/M-profitability portfolios. In chapter five the comparison of the performances of three models is made based on some statistical tests and indicators. The last chapter summarizes the findings and the results and their indications are interpreted.

CHAPTER 2

LITERATURE REVIEW ON FAMA-FRENCH MODELS

2.1 Introduction

In this chapter of the thesis, the evolution of Fama-French four factor model will be presented. In the following section, a theoretical framework of the model will be explained starting from the introduction and development of capital asset pricing model. In the third section, the international studies on Fama-French models will be mentioned and results will be summarized. In the fourth section of this chapter, the reader will be provided with the information on the literature regarding the studies on Fama-French models in Turkey.

2.2 Fama-French Model

One of the main attempts of the financial economics has been to describe, predict or assess the relation between risk and return since 1950's. After Markowitz introduced his renowned and famous mean-variance model in 1952, many models were developed based on his theorem. One of the most important models based on his theorem was CAPM (Capital Asset Pricing Model) which was introduced by Sharpe (1964), Lintner (1965), and Black (1972). Since its introduction, it still continues to constitute one of the cornerstones of modern finance theory. It is widely used in performance evaluation, estimating the cost of capital, selecting portfolios, and measuring abnormal returns.

To be able to comprehend CAPM better, we should examine some details about the development and assumptions of the model. In his paper ‘’Capital Asset Prices: Theory of Market Equilibrium under Conditions of Risk’’ (1964), William Sharpe put forward an argument to construct a relation between average return and standard deviation. He claimed that in equilibrium there will be a simple linear relationship between the expected return and standard deviation of return for efficient combinations of risky assets. (Sharpe,1964). This relationship was described by beta, which implied the systematic risk. Each individual asset or portfolio has a beta value, which shows the riskiness of that asset or portfolio relative to the riskiness of the market. In other words, this beta shows the level of responsiveness to the movements in market. In Sharpe’s own words :

> “Diversification enables the investor to escape all but the risk resulting from swings in economic activity-this type of risk remains even in efficient combinations. And, since all other types can be avoided by diversification, only the responsiveness of an asset’s rate of return to the level of economic activity is relevant in assessing its risk. Prices will adjust until there is a linear relationship between the magnitude of such responsiveness and expected return. Assets which are unaffected by changes in economic activity will return the pure interest rate; those which move with economic activity will promise appropriately higher expected rates of return.”

The assumptions underlying CAPM are as follows:

1. All investors are single-period expected utility of terminal wealth maximizers who choose among alternative portfolios on the basis of mean and variance (or standard deviation) of return.
2. All investors can borrow or lend an unlimited amount at an exogenously given risk free rate of interest and there are no restrictions on short sales of any asset.
3. All investors have identical subjective estimates of the means, variances and covariances of return among all assets.

4. All assets are perfectly divisible and perfectly liquid, i.e., all assets are marketable and there are no transaction costs.
5. There are no taxes.
6. All investors are price takers.
7. The quantities of all assets are given (Jensen, 1972).

CAPM can be described by the following equation:

$$E(Ri) = Rf + \beta_i [E(RM) - Rf]$$

where $E(Ri)$ is the expected return of asset or portfolio i, Rf is the risk free rate, $E(RM)$ is the expected return of the market portfolio. β_i ($\frac{cov\ (Ri,RM)}{var(RM)}$) , beta, reflects the systematic risk for asset or portfolio i. As can be seen in the above relation, CAPM claims that there is a linear relationship between average return and risk. In other words, expected returns on securities are a positive linear function of their market betas and these betas suffice to describe the cross-section of expected returns. This means that the excess return of as asset or portfolio can be explained by using only one factor, the excess return on market.

In spite of its considerably wide area of use both in academic and practical spheres, CAPM was criticized by empiricists and claimed to be insufficient to explain average excess returns. One of the most important and effective contradictions was developed by Banz (1981). In his paper, he found out that the market equity of a firm makes a contribution to beta in explaining cross section of average returns. According to his empirical results, there was a negative relation between size of a stock and average return. On the other hand, in 1988 Bhandary concluded that there is a positive relation between leverage and average return. In addition to beta and size, he included a leverage factor, which helps to explain the cross-section of average returns. Stattman (1980) and Rosenberg, Reid, and Lanstein (1985) find that average returns on U.S stocks are positively related to the ratio of a firm's book value

of common equity, BE, to its market value, ME. Chan, Hamao, and Lakonishok (1991) find that book-to-market equity, BE/ME, also has a strong role in explaining the cross-section of average returns on Japanese stocks (Fama, French 1992). Basu (1983) included earnings-price ratios (E/P) his tests to show that this ratio also adds to the explanation of cross-section of average returns. Maybe most importantly, Ball (1978) claimed that E/P is a catch-all proxy for unexplained part for cross-section of average returns. This argument led Fama and French to study the presence of such a proxy variable or variables which can capture the variation in average returns. They claimed that Ball's proxy argument for E/P might also apply to size, leverage, and BE/ME. Due to the fact that all these variables are scaled versions of price, it was possible that they could contribute to the description of average returns. Therefore, they examined the roles of β, size, E/P, leverage and BE/ME in average returns on NYSE, AMEX, and NASDAQ stocks. The results obtained in this paper were as follows: They concluded that β does not explain the cross-section of average stock returns. So CAPM failed according to their empirical tests. The combination of size and BE/ME in average stock returns seems to absorb the roles of leverage and E/P in average stock returns, at least during their 1963-1990 sample period. Two easily measured variables, size and book-to-market equity (BE/ME), provide a simple and powerful characterization of the cross-section of average stock returns for the 1963-1990 period (Fama-French 1992).

One year later, in their 1993 paper, *Common Risk Factors in the Returns on Stocks and Bonds,* Fama and French changed their approach to testing asset-pricing models. They used the time-series approach of Black, Jensen, and Scholes (1972). Monthly returns on stocks and bonds were regressed on the returns to a market portfolio of stocks and mimicking portfolios for size, book-to-market equity and term structure risk factors in returns. They used monthly excess returns as dependent variables and excess return on market, SMB and HML as independent variables. These two portfolios were

constructed to mimic risk factors related to size and BE/ME. In their study, they showed that these two factors capture the common variation in returns. And furthermore, intercepts produced from three factor models were close to zero, which can be seen as an evidence that the model does a good job. To summarize, they concluded that Fama-French Three Factor model is superior to CAPM regarding model performance, although both models were rejected on GRS-test.

In their article *Multifactor Explanations of Asset Pricing Anomalies*, which was published in 1996, they claimed that their three factor model is able to capture the average return anomalies. To put differently, they asserted that the patterns in average stock returns, which could not be explained by CAPM, were to be captured by three factor model. They concluded that the model captures the returns to portfolios formed according to earnings/price (E/P), cash flow/price (C/P), and past sales growth. In their own words : ‘’The model captures much of the variation in the cross-section of average stock returns, and it absorbs most of the anomalies that have plagued the CAPM.’’

To be able to follow the path from Fama-French three factor model to Fama-French four factor model, the paper of Novy-Marx (2012) should be mentioned. In his paper, *The Other Side of Value: The Gross Profitabilty Premium,* he argues that profitability has roughly the same power as book-to-market predicting the cross-section of average returns. According to his results, there is a profitability pattern in average returns in line with the dividend discount model. This model can be represented with the equation

$$\frac{M_t}{B_t} = \frac{\sum_{t=1}^{\infty} E(Y_{t+\tau} - dB_{t+\tau})/(1+r)^{\tau}}{B_t}.$$

Where M_t: Market value of equity at time t

B_t: Book equity at time t

Y_t: Total equity earnings at time t

dB_t: The change in total book equity

r: Long term average expected stock return

In this equation, if we fix everything except expected future earnings $E(Y_{t+\tau} - dB_{t+\tau})$ and the discount rate (the expected stock return), higher expected future earnings imply higher expected stock return. Marx also reaches a similar result using empirical tests. Considering the portfolios produced using sorts on B/M and profitability, average returns generally increase with profitability. Based on this result of Novy-Marx, Fama and French examined whether their three factor model should be augmented by a profitability factor, in their paper *A Four-Factor Model for the Size, Value, and Profitability Patterns in Stock Returns (2013)*. They detected obvious patterns in average returns related to Size, B/M and profitability. The GRS test of Gibbons, Ross, and Shanken (1989) rejected the four factor model like in the case of three factor model and CAPM. However, they claim that the model seems to provide acceptable descriptions of average returns on size-B/M, size-OP and size-B/M-OP portfolios for applied purposes, since for investors, rejection on the GRS test may be irrelevant due to small deviations of average returns from model predictions. The favorite statistics in evaluating a model for investment purposes are the average absolute intercept according to Fama and French (2013).

2.3. International Studies on Fama-French Models

Fama and French (1998) examined the relation between B/M and average returns in thirteen major markets and in sixteen emerging markets. According to the empirical results, in twelve out of thirteen major markets, value stocks

(high B/M) tend to have higher average returns than growth stocks (low B/M) in the period between 1975-1995. And they also detected a value premium in emerging markets in the period between 1987-1995.

Connor and Sehgal (2001) empirically examined Fama and French three factor model in Indian stock market for the period 1989-1999. They found that cross section of average returns are explained by exposures to market factor, SMB and HML.

Ajili (2002) tested the validity of CAPM and Fama French three factor model in French stocks exchange. In this study, monthly returns of 274 stocks are examined for a 300 months period. He concluded that the common variation in the stock returns are explained by Fama French three factor model better than CAPM. In other words, three factor model outperformed capital asset pricing model in French case in the period between 1976-2001.

Drew and Veeraraghavan (2002) studied the existence of size and value premium in Malaysian market. Furthermore they showed to which extent the Fama French three factor model can explain excess returns. As a result, they found evidence for size and value premium, and concluded that three factor model is successful in explaining variation in returns.

Drew, Naughton and Veeraraghavan (2003) compared the performance of CAPM and Fama-French three factor model in Shangai stock exchange. They found evidence supporting that small firms have higher average returns than big firms and low B/M firms have higher average returns than high B/M firms, the latter of which contradicts with the results of Fama-French study. However, they concluded that Fama French three factor model is more successful in explaining variation in returns in Shangai stock exchange.

Billou (2004) investigated the superiority of Fama-French three factor model by extending the time period used in Fama and French article (1993) from 1993 to 2003. He used the excess returns of 25 Fama-French portfolios based on the sorts of size and B/M and additionally he tested the validity of

the model using regressions on industry returns. According to the time-series analysis results, he concluded that Fama-French three factor model outperformed CAPM. This means that the extension of the period of the study left the results unchanged and three factor model maintained its superiority.

Malin and Veeraraghavan (2004) investigated the robustness of Fama French three factor model in France, Germany and UK. They obtained contradictory results with Fama and French. While for France and Germany they detected a small firm effect, in the case of U.K they find a big firm effect. And regarding B/M effect, they could not find an evidence for value effect.

Charitou and Constantinidis (2004) examined the Fama-French three factor model for the period 1992-2001 in Japanese stock market. They confirmed that SMB and HML factors can explain common variation in stock returns. Having evaluated the performances of CAPM and three factor model, they found evidence supporting the superiority of three factor model in Japanese stock market.

Djajadikerta and Nartea (2005) examined the size and B/M effects and tested the validity of three factor model in New Zeland stock market between 1991 and 1995. Their study documented a weak B/M effect and a significant size effect. Despite the addition of size and B/M factors to the CAPM, they could not detect a significant increase in explanatory power of the model. The superiority of the three factor model was weak according to the statistical results.

Lam (2005) compared the CAPM and Fama French three factor model in U.S stock market over the period from July 1926 to November 2004. Two models were regressed on excess returns of 25 Fama-French portfolios and 30 Industry returns. Based on the time-series analysis, Fama French proved to be superior to the CAPM. However, having confronted with the excess

returns of industry returns, it can be said that the story changed. Regarding 30 industry returns, CAPM had a better performance than three factor model.

Iatridis, Messis and Blanas (2006) made a comparison between the explanatory powers and validity of two models; Fama-French three factor model and Arbitrage pricing theory in the period between 2001-2006. Regarding the time series approach, they concluded that three factor model outperformed APT significantly.

Walid and Ahlem (2008) showed that there exists a negative relationship between size and stock returns in Japanese market. On the other hand they found a positive relationship between B/M and returns. They also made a comparison between CAPM and three factor model, which showed that three factor model has a better performance in explaining average excess returns in Japanese stock market between 2002 and 2007.

Pena, Forner, and Espinosa (2010) analyzed the relationship between size, B/M and stock returns in Spanish stock market and tested the validity of Fama-French three factor model. They demonstrated that there are SMB and HML factors in fundamentals similar to those observed in returns.

Al-Mwalla and Karasneh (2011) investigated the presence of size and B/M patterns in stock returns for Amman stock market over the period 1999-2010 and compared the performances of CAPM and three factor model. As in line with the general literature, they found a negative relationship between average returns and size. Regarding the B/M effect, they detected a strong positive relationship as expected. The salient result was that three factor model is able to provide better explanation for the variation in returns in Amman stock market for the studied period.

O'Brien, Brailsford and Gaunt (2012) analyzed the size and B/M ratio effects and applied both CAPM and Fama-French three factor model to the Australian equities to gauge the relative performances of the models in the period between 1982-2006. In contrary to the results of the most researches

and studies, the three factor model in this study was not rejected based on GRS test. And based on the statistical results obtained, three factor model's explanatory power was found to be quiet higher than that of CAPM.

Dolinar (2013) examined the relative performances of CAPM and Fama-French three factor model over the period from 2007 to 2013 using the stocks listed in Zagreb stock exchange. Although empirical results indicated that three factor model does a better job than CAPM in explaining common variation in returns, the addition of two factors slightly increased the explanatory power of the model. Thus, SMB and HML factors can be said to capture only a small part of the common variation in stock returns.

Meng and Ju (2013) investigated the size and value patterns in average returns and tested the power of Fama French three factor model in Chinese A-share market. The study proved the existence of size and value effect in Chinese stock market. Furthermore, based on the statistical results, the three factor model could explain much of the variation in average returns.

Wu, Cuong, and Gregoriou compared the performances of CAPM and Fama-French three factor model in Vietnamese stock market over the period from 2007 to 2012. Their results were in line with most of the studies, which supports that three factor model is dominant over CAPM.

Xu and Zhang (2014) tested the effectiveness of Fama-French three factor model in Chinese stock market. Both CAPM and three factor model were used in this study. The results supported that three factor model explained the variation in returns better than CAPM in Chinese A-share stock market.

2.4. Studies in Turkey on Fama-French Models

Gonenc and Karan (2003) studied the existence of size and value premium in Istanbul Stock Exchange over the period between 1993-1998. They obtained contradictory results with the theory, and concluded that there is no value

premium in ISE. Based on their empirical results, they claimed that there is a positive relation between size and average return, which means larger firms generate higher average returns than smaller ones. Furthermore, despite the improvement of the explanatory power of the model, the addition of SMB and HML factors still left an unexplained variation in returns.

Arioglu (2007) tested the validity of Fama – French three factor model in ISE while examining the relation between size and average returns over the period 1993-2004. He concluded that the model can explain the excess returns, based on high R-squared values. However, highly significant alpha values, which indicates pricing errors, caused some suspects arise regarding the need for additional factors.

Erismis (2007) investigated the role of firm-specific factors in ISE stock returns between years 1992-2005. Having examined six intersection portfolios based on size and B/M, he showed that small size portfolios generated higher average returns than big size portfolios, where high B/M portfolios generated higher average returns than low B/M portfolios. Detection of these patterns supported the existence of value and size premiums in ISE. Regressing on the excess returns of six Fama-French portfolios, the relative performances of CAPM and three factor model were examined statistically. Considering the improvements in R-squared values and t-statistics, he reached the conclusion that three factor model has superiority to the CAPM in ISE.

Canbas and Arioglu (2008) tested the Fama –French three factor model in ISE over the period between July 1993-June 2004. Having investigated value and size patterns in line with Fama-French results, they examined the explanatory power of the model using time series approach. They used six Fama-French portfolios produced according to size and B/M as dependent variable and considering the t-statistics and R-squared values, they concluded that the model can capture the common variation in average returns. However, owing to statistical significance of alphas, namely pricing

errors, they stated that despite high R-squared values, there may be some missing factors in three factor model.

Gokgoz (2008) evaluated the viability of Fama-French three factor model in ISE between years 2001-2006. He used five of ISE indices to represent the industry returns. ISE Services Index, ISE Technology Index, ISE Industrial Index, ISE Real Estate Investment Trust Index, and ISE Investment Trust Index were used as dependent variables in regressions to test the power of the model in ISE. He found that all of the factors are statistically significant and F-values indicated that the model is statistically significant regarding each regression individually. Whereas, like in many related studies, he ended up with a high value of GRS-F statistics which indicates that intercept terms are significant jointly. So the model was rejected based on GRS test, in spite of the high R^2 values.

Atakan and Gokbulut (2010) adopted panel data approach to gauge the effectiveness of Fama-French three factor model in ISE. Their sample encompassed only firms quoted in the ISE Industrial Index between the years 1993-2007. Their analysis suggested that all of the factors are statistically significant and that the model has high explanatory power over the period examined.

Dibo (2012) investigated the size and value effects in average returns and compared the performances of CAPM and Fama-French three factor model in Istanbul Stock Exchange over the period between 2004 and 2010. Regarding the patterns in average returns, he found that while there is a strong B/M effect, the same can not be claimed regarding size effect. More importantly, he concluded that three factor model shows its superiority to CAPM regarding explanatory power, significance of model and elimination of pricing errors.

Unlu (2012) compared the performances of different asset pricing models in ISE. Fama-French three factor model, Carhart (1997) four factor model, and

Pastor and Stambough (2003) five factor models were used in regressions over the time period July 1992-June 2011. To put differently, after testing Fama-French three factor model, a momentum factor was added to the model. And after testing four factor model, a factor reflecting liquidity was added to the model. According to the regression results, all of the models were found to be successful at explaining the variation in average returns. Although R^2 values generated by three models were close to each other, based on GRS values, the best model was five factor model followed by three factor and four factor models consecutively.

Yalcin (2012) compared the efficacies of CAPM and Fama-French three factor model in performance evaluation of A-type mutual funds in Turkey. The study encompasses the period between 2003 and 2010. According to the results, three factor model had a slightly better performance than CAPM in explaining variation in mutual funds' returns.

Eraslan (2013) investigated to what extent, Fama-French three factor model can explain common variation in stock returns in ISE between 2003-2010. His analysis showed that three factor model can explain a considerable part of variation in excess returns, but the t-statistics and R^2 values obtained suggested that some additional factors are needed for the unexplained part.

Yuksel (2013) tested the existence of common risk factors in the returns in ISE applying Fama-French three factor model over the period between 2001-2012. He compared the relative performances of CAPM, three factor model and another model which adds two bond market risk factors (maturity risk and default risk) to the three factor model. His analysis shows that while the model which consists additional bond market risk factors fares a slightly better job than three factor model, three factor model apparently outperforms CAPM. Another result of the study is that the addition of bond market factors increased the significance of stock market factors, SMB and HML.

2.6. Conclusion

Considering the studies made both in Turkey and abroad, it is apparent that in most of the cases, size and B/M effects were detected. And if we evaluate the studies based on the relative performances of CAPM and Fama-French model, it can be easily recognized that the former was outperformed by the latter almost in all cases. To conclude, the presence of size and B/M effects and the superiority of Fama-French models proved themselves to be independent of sample and time period , considering the studies in literature.

CHAPTER 3

DATA, METHODOLOGY AND DESCRIPTIVE STATISTICS

3.1. Introduction

In this chapter, data, methodology and descriptive statistics will be depicted in detail. The following section will show how and where the data is gathered from. The data elimination and sample formation process will be explained. Chapter will continue with description of portfolio formation methods. The way in which six size-B/M and eighteen size-B/M-profitability portfolios formed will be showed to make the reader familiar with these two sets of portfolios. After this step, the factor construction methods will be explained, which will provide a deeper comprehension of the factors used in three and four factor models.

In the third section, firstly, the sample characteristics and descriptive statistics of six size-B/M and eighteen size-B/M-profitability portfolios will be examined in detail. The existence of size, value and profitability patterns will be investigated. Secondly, the descriptive statistics of our dependent variables, excess returns of six size-B/M and eighteen size-B/M-profitability portfolios are represented and interpreted. The folowing part will exhibit the descriptive statistics for factor returns, SMB6, HML6, SMB18, HML18, and RMW18. The chapter will end with representation of correlations between factors used in three and four factor models

3.2. Data And Methodology

3.2.1. Data

Istanbul Stock Exchange (IMKB) was founded in 26 December 1986 and it was combined with Istanbul Gold Exchange and the Derivatives Exchange of Turkey to form Borsa Istanbul (BIST) on 3rd of April 2013. The number of the stocks listed in the exchange and total market capitalization of the stocks can be seen in the Figure 1 and Figure 2.

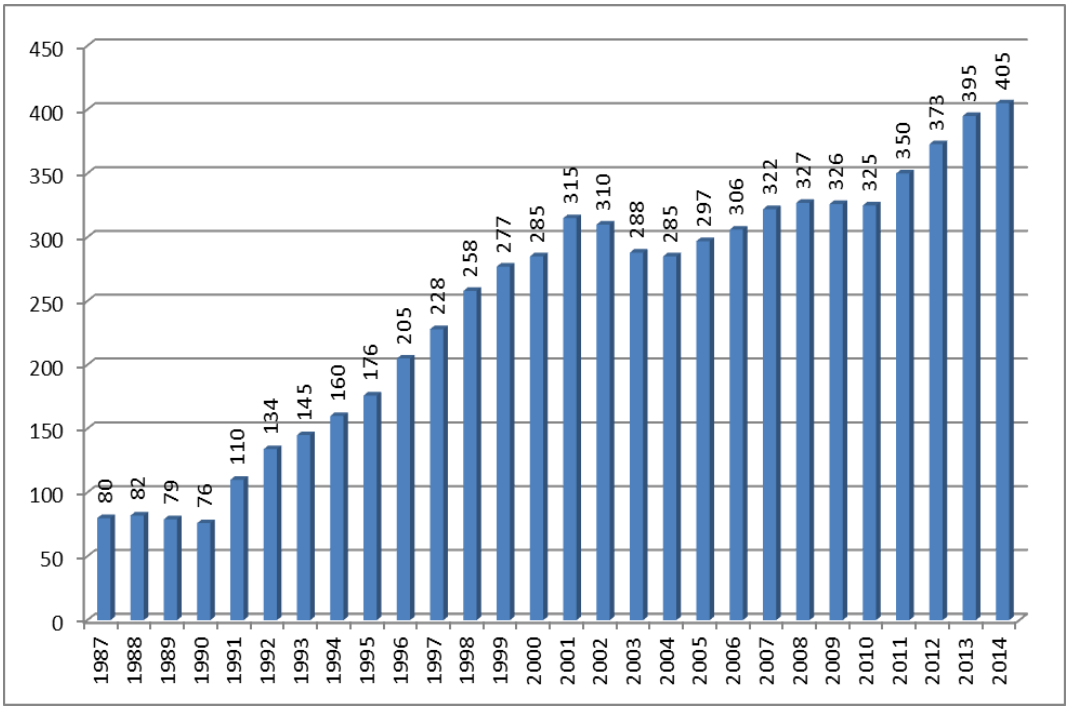

Figure 1: Number of Stocks Listed in ISE

Notes: Figure shows the number of the stocks as of the first day of the year.

Data source : http://www.borsaistanbul.com/veriler/verileralt/aylik-konsolide-veriler

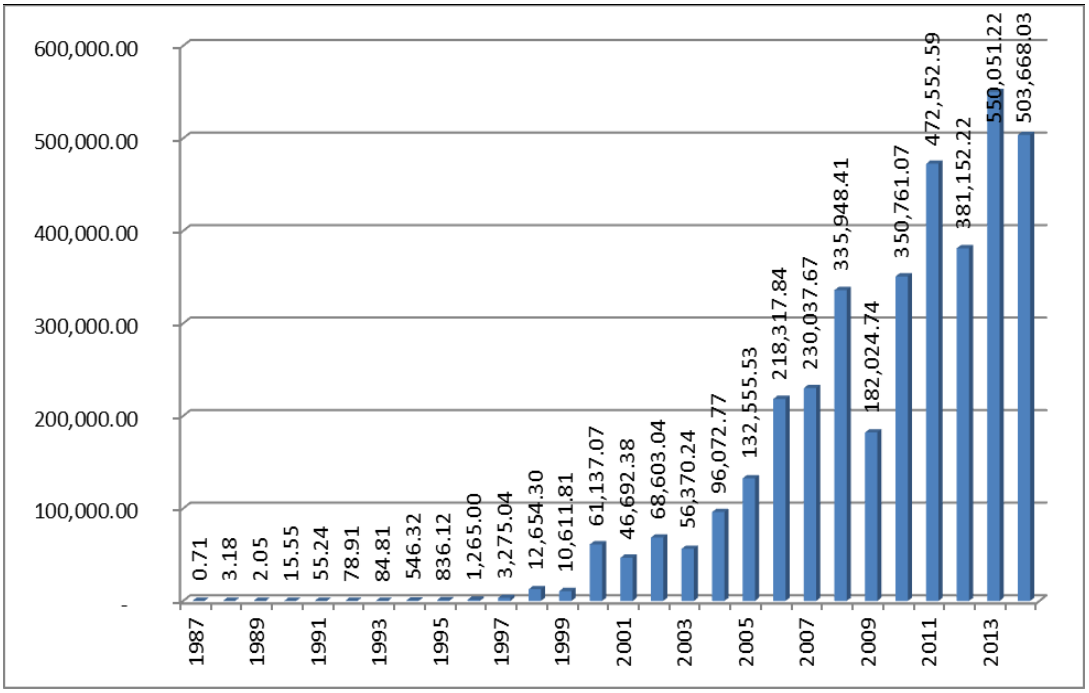

Figure 2: Total Market Capitalization of Stocks Listed in ISE

Notes: Figure shows the total capitalization as of the first day of the year.

Data source : http://www.borsaistanbul.com/veriler/verileralt/aylik-konsolide-veriler

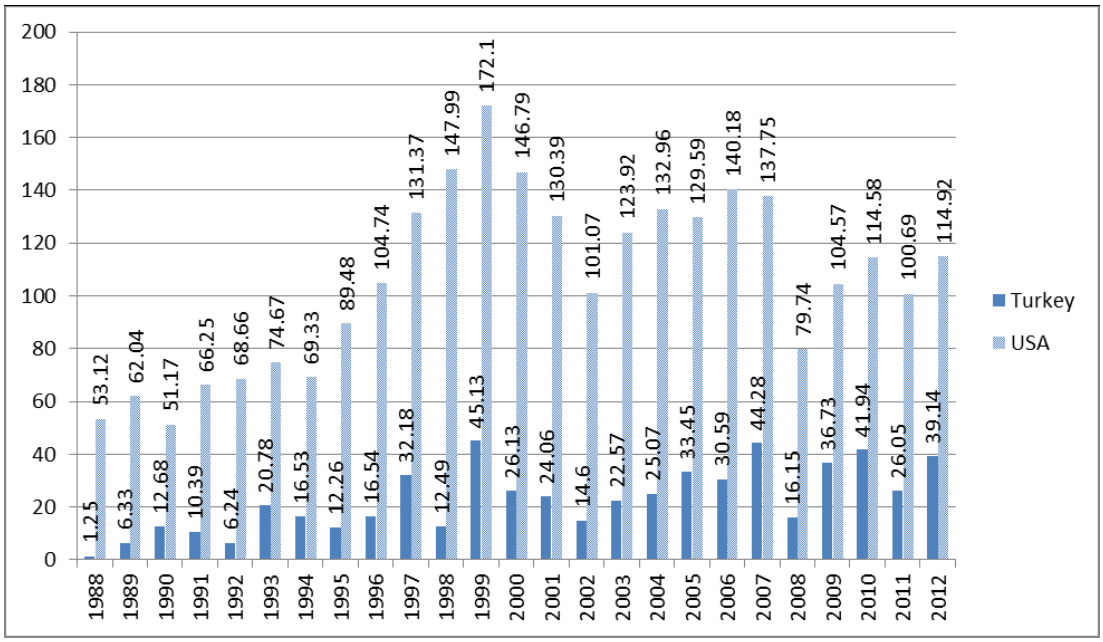

Figure 3: Market Capitalization of Listed Companies (% of GDP)

Note: Data downloaded from http://data.worldbank.org/indicator/CM.MKT.LCAP.GD.ZS

Figure 3 shows the ratios of total market capitalization to GDP as percentages for Turkey and U.S. As can be seen, the percentage of total capitalization to GDP in U.S is far higher than in Turkey. The low percentage rates in Turkey indicates the undervaluation of companies listed in stock exchange and growth potential of stock market in Turkey.

The sample includes all stocks listed on the ISE-ALL Index between July 2004 and June 2013. Although Fama and French (1992) excluded financial firms from their sample, in this thesis, they are also included in the sample. The reason for the exclusion of companies in the financial sector was related to the leverage ratio. In their study, leverage was one of the factors examined and they claimed that high leverage ratio for financial firms, which is a normal

situation for them, does not mean the same thing for non-financial firms. In case of non-financial firms, high leverage ratio indicated financial distress. Due to this reason, they did not include financial firms in their sample. However, in our case, leverage is not one of the factors used or examined. Therefore, the sample includes all companies listed in ISE after some elimination process has taken place.

1. The stocks with negative equity were excluded from the sample since we follow the Fama-French methodology. However it should be noted that a firm having a negative equity value at time t was included in the sample if its equity becomes positive in year t+1.
2. Stocks which were listed in Watchlist Companies Market were not included in the sample, even if the stock was listed in National Market in consecutive years.
3. Stocks traded in Second National Market and Emerging Companies Markets were also not included in the sample. However, although a company was listed in Second National Market or Emerging Companies Market in year t, it was included in the sample of year (t+1) if it has started to be listed in National Market.
4. Lastly, since we need Market Value, B/M Ratio and Net Profit for every company, if a company lacks the regarding data in December of year t, it was also excluded from the sample for the period of (t+1). However if the necessary data was found for December (t+1) till December 2012, the stock was included in the sample starting from June of (t+2) in line with Fama-French methodology.

Since the number of the companies listed on the ISE Index increased from year to year, the number of the firms included in our sample also increased as expected. The stocks, returns of which were used in this study can be found in the table A1 in the Appendix.

The monthly return data of the stocks included in the sample was downloaded from the database of BIST. The monthly returns were calculated according to the formula below.

$$Gi = \frac{Fi^{*}(BDL+BDZ+1) - R^{*}BDL + T - F\,i\text{-}1}{F\,i\text{-}1}$$

Gi : Return for the month "i"
Fi : The closing price the equity on the last trading day of the month "i"
BDL : The number of rights issues received during the month
BDZ : The number of bonus issues received during the month
R : The price for exercising rights (i.e. subscription price)
T : The amount of net dividends received during the month for a equity with a nominal value of TL 1,000/TRY 1
F i-1 : The closing price of a equity on the last trading day of the month "i-1"

Note: Formula taken from http://www.borsaistanbul.com/veriler/verileralt/fiyat-getiri/

BIST Debt Securities Market Value Weighted Portfolio Performance Index (180-) (which includes securities maturity shorter than 180 days) was used as a proxy for the risk free short term interest rate. Daily data was gathered from the internet site of BIST and monthly return was calculated for the period between July 2004 and June 2013.

The B/M and the profitability ratio, which is Annual Net Profit/Equity in this study, were obtained from the tables of Basic Ratios which can be found on the internet site of BIST under the section of Companies Data.

The market value of the stocks which constitute our sample was also obtained from the data base of BIST under the Index Data.

Our last data set is BIST All Share Index, which is thought to be the best proxy for market portfolio. The monthly return data, which can be found on the internet site of BIST was used in this study.

3.2.2. Portfolio Formation

i) Size – B/M Portfolios

Fama and French (1992) method was adopted to produce size-B/M portfolios. In first step, all the stocks in the sample were divided into two groups according to their size in June of year t. The size breakpoint is sample median market capitalization. Hereafter, when we mention size of a stock, the market value or capitalization will be meant. Size of a company in a certain date means shares outstanding times the closing value of that stock in that certain date. In our case, in the end of June 2004, all stocks which will be included in the sample of July 2004-June 2005 period were ranked according to their size. In each year from 2004 till 2013, in the end of June this segmentation was repeated. In this way, two portfolios were formed, which will be called Small Size Portfolio and Big Size Portfolio.

Secondly, all the stocks in the sample were divided into three groups based on their B/M ratios. The breakpoints used here are 30^{th} and 70^{th} percentiles. The B/M ratio is obtained by dividing the book value of a firm to its market value. To put differently, the B/M is the ratio of net asset value per share to its price. The ratio was calculated according to the accounting data of the previous year. To elaborate, for instance, in the end of the June 2004, the stocks in the sample for the period July 2004-June2005 were divided into three groups according to the year end data of 2003. Following Fama-French, due to the fact that annual year end reports are made public with lags reaching 5-6 months in some cases, the portfolios were formed in the end of June to guarantee that the investor has data regarding last years` financial statements. This process of portfolio formation according to B/M ratio is repeated in the end of the June each year between 2004 and 2013. For every year we obtained three portfolios based on the B/M ratio. We will call these portfolios High B/M, Neutral B/M and Low B/M portfolios.

The intersection of the portfolios mentioned above forms 6 portfolios ranked according to two criteria. Size-B/M portfolios are classified as in Table 1.

Table 1: Definition of Size-B/M Portfolios

Portfolio		***Size***	***B/M***
1	**SL**	Small	Low
2	**SN**	Small	Neutral
3	**SH**	Small	High
4	**BL**	Big	Low
5	**BN**	Big	Neutral
6	**BH**	Big	High

Then the six portfolios are composed as follows:

1. SL : Portfolio consisting small size and low B/M stocks
2. SN : Portfolio consisting small size and neutral B/M stocks
3. SH: Portfolio consisting small size and high B/M stocks
4. BL : Portfolio consisting big size and low B/M stocks
5. BN: Portfolio consisting big size and neutral B/M stocks
6. BH : Portfolio consisting big size and high B/M stocks

It should be mentioned, that the returns of these portfolios were value weighted. That is, after determining the content of the portfolio, the market capitalization in the portfolio formation time (in the end of June every year), were considered, and the weight of each stock in the portfolio was defined accordingly.

ii) Size-B/M-Profitability Portfolios

Fama and French (2013) methodology was followed to create size-B/M-profitability portfolios. After first two steps regarding size-B/M portfolio formation were repeated, the stocks in the sample were divided into three groups according to their profitability. As in case of sorts produced according to B/M ratios, here we also use 30^{th} and 70^{th} percentiles as breakpoints. In spite of the fact that, Fama and French use the operating profit minus interest expenses divided by book equity to reflect the future profitability, another profitability measure, net income/book equity ratio, was used because of reasons related to the data availability. After ranking the stocks according to their profitability, three sorts were obtained, which are called Robust Profitability, Neutral Profitability and Weak Profitability portfolios. And the intersection of these portfolios with six portfolios created according to Size-B/M ratios, gave us 18 portfolios. In the end of the June each year, this formation process was repeated. Classification of size-B/M-profitability portfolios are shown in Table 2.

Table 2: Definition of size-B/M-profitability portfolios

Portfolio		***Size***	***B/M***	***Profitabillity***
1	**SLW**	Small	Low	Weak
2	**SLN**	Small	Low	Neutral
3	**SLR**	Small	Low	Robust
4	**SNW**	Small	Neutral	Weak
5	**SNN**	Small	Neutral	Neutral
6	**SNR**	Small	Neutral	Robust
7	**SHW**	Small	High	Weak
8	**SHN**	Small	High	Neutral
9	**SHR**	Small	High	Robust
10	**BLW**	Big	Low	Weak
11	**BLN**	Big	Low	Neutral
12	**BLR**	Big	Low	Robust
13	**BNW**	Big	Neutral	Weak
14	**BNN**	Big	Neutral	Neutral
15	**BNR**	Big	Neutral	Robust
16	**BHW**	Big	High	Weak
17	**BHN**	Big	High	Neutral
18	**BHR**	Big	High	Robust

Then the eighteen portfolios are composed as follows:

1. SLW : Portfolio consisting small size, low B/M and weak profitability stocks
2. SLN : Portfolio consisting small size, low B/M and neutral profitability stocks
3. SLR : Portfolio consisting small size, low B/M and robust profitability stocks
4. SNW : Portfolio consisting small size, neutral B/M and weak profitability stocks
5. SNN : Portfolio consisting small size, neutral B/M and neutral profitability stocks

6. SNR : Portfolio consisting small size, neutral B/M and robust profitability stocks
7. SHW :Portfolio consisting small size, high B/M and weak profitability stocks
8. SHN : Portfolio consisting small size, high B/M and neutral profitability stocks
9. SHR : Portfolio consisting small size, high B/M and robust profitability stocks
10. BLW : Portfolio consisting big size, low B/M and weak profitability stocks
11. BLN : Portfolio consisting big size, low B/M and neutral profitability stocks
12. BLR : Portfolio consisting big size, low B/M and robust profitability stocks
13. BNW :Portfolio consisting big size, neutral B/M and weak profitability stocks
14. BNN : Portfolio consisting big size, neutral B/M and neutral profitability stocks
15. BNR : Portfolio consisting big size, neutral B/M and robust profitability stocks
16. BHW : Portfolio consisting big size, high B/M and weak profitability stocks
17. BHN : Portfolio consisting big size, high B/M and neutral profitability stocks
18. BHR : Portfolio consisting big size, high B/M and robust profitability stocks

The returns of these portfolios were value weighted as in the case of 6 portfolios. That is, after determining the content of the portfolio, the market capitalizations in the portfolio formation time (in the end of June), was considered, and the weight of each stock in the portfolio was determined accordingly.

3.2.3 Factor Constructions

i) SMB6 and HML6 Factors for FF 3 factor Model

In Fama-French three factor model, in addition to market factor, two more factors are used. These two factors will be constructed using 6 portfolios formed based on Size and B/M and Fama and French (1993) methodology will be adopted.

SMB6 factor is constructed as follows:

SMB6 is obtained by subtracting the average return of 3 big size portfolios from the average return of small size portfolios. We can represent SMB6 as

$$\mathbf{SMB6=[((SL+SN+SH)-(BL+BN+BH))/3]} \quad (3.1)$$

In this way, we obtain monthly returns for SMB6.

HML6 factor is constructed as follows:

This factor is produced in a similar way to SMB6. To produce the returns needed, we use the returns of 2 high B/M portfolios and 2 low B/M portfolios. HML6 factor can be represented as

$$\mathbf{HML6=[((SH+BH)-(SL+BL))/2]} \quad (3.2)$$

Having calculated the difference between the average returns of high B/M and low B/M portfolios, our third factor in FF 3 factor model is produced.

ii) SMB18, HML18 and RMW18 Factors for FF 4 Factor Model

In Fama French Four Factor Model, a fourth factor, RMW, will be added to the model. However, it should be noted that the way, in which SMB and HML factors were constructed, also changes. So we will call these factors SMB18

and HML18. The Fama-French (2013) factor construction methods are as follows.

SMB18 factor is constructed as follows :

The returns of this factor is obtained by subtracting average return of 9 big size portfolios from average return of 9 small size portfolios. That is,

SMB18=[((SLW+ SLN+ SLR+ SNW+ SNN+ SNR+ SHW+ SHN+ SHR)-(BLW+ BLN+ BLR+ BNW+ BNN+ BNR+ BHW+ BHN+ BHR))/ 9] (3.3)

HML18 factor is constructed as follows:

The returns of this factor is obtained by subtracting average return of 6 low B/M portfolios from average return of 6 high B/M portfolios. So, HML18 can be represented as

HML18=[((SHW +SHN +SHR +BHW +BHN +BHR) - (SLW +SLN +SLR +BLW +BLN +BLR))/ 6] (3.4)

RMW18 factor is constructed as follows:

The returns of this factor is obtained by subtracting average return of 6 weak profit portfolios from average return of 6 robust profit portfolios. So, RMW18 is equal to

RMW18=[((SLR +SNR +SHR +BLR +BNR +BHR) -(SLW +SNW +SHW + BLW +BNW +BHW)) / 6] (3.5)

3.3. Sample Characteristics and Descriptive Statistics

3.3.1 Sample Characteristics and Descriptive Statistics of 6 Size-B/M Portfolios

The tables below (Table 3 and Table 4) show the number and percentage of stocks included in six portfolios formed according to size and B/M.

Table 3 : Number of Stocks In Six Size-B/M Portfolios

	Number of Stocks In Portfolios						
Time Period	**SL**	**SN**	**SH**	**BL**	**BN**	**BH**	**Total Number**
July 2004-June 2005	16	36	41	40	37	15	**185**
July 2005-June 2006	21	36	41	38	41	18	**195**
July 2006-June 2007	19	43	40	42	39	21	**204**
July 2007-June 2008	20	44	45	46	42	21	**218**
July 2008-June 2009	19	42	51	48	48	16	**224**
July 2009-June 2010	20	46	49	49	46	20	**230**
July 2010-June 2011	24	42	53	47	53	18	**237**
July 2011-June 2012	26	51	53	52	52	25	**259**
July 2012-June 2013	30	54	48	49	52	31	**264**
Av. No of Stocks	**21.67**	**43.78**	**46.78**	**45.67**	**45.56**	**20.56**	

Notes: S=Small Size // B=Big Size //L=Low B/M // N=Neutral B/M // H=High B/M

Table 4: Percentage of Stocks In Six Size-B/M Portfolios

	Percentage of Stocks					
Year	**SL**	**SN**	**SH**	**BL**	**BN**	**BH**
July 2004-June 2005	8.65%	19.46%	22.16%	21.62%	20.00%	8.11%
July 2005-June 2006	10.77%	18.46%	21.03%	19.49%	21.03%	9.23%
July 2006-June 2007	9.31%	21.08%	19.61%	20.59%	19.12%	10.29%
July 2007-June 2008	9.17%	20.18%	20.64%	21.10%	19.27%	9.63%
July 2008-June 2009	8.48%	18.75%	22.77%	21.43%	21.43%	7.14%
July 2009-June 2010	8.70%	20.00%	21.30%	21.30%	20.00%	8.70%
July 2010-June 2011	10.13%	17.72%	22.36%	19.83%	22.36%	7.59%
July 2011-June 2012	10.04%	19.69%	20.46%	20.08%	20.08%	9.65%
July 2012-June 2013	11.36%	20.45%	18.18%	18.56%	19.70%	11.74%
Av. Percent of Stocks	**9.62%**	**19.53%**	**20.95%**	**20.44%**	**20.33%**	**9.12%**

Notes: S=Small Size // B=Big Size //L=Low B/M // N=Neutral B/M // H=High B/M

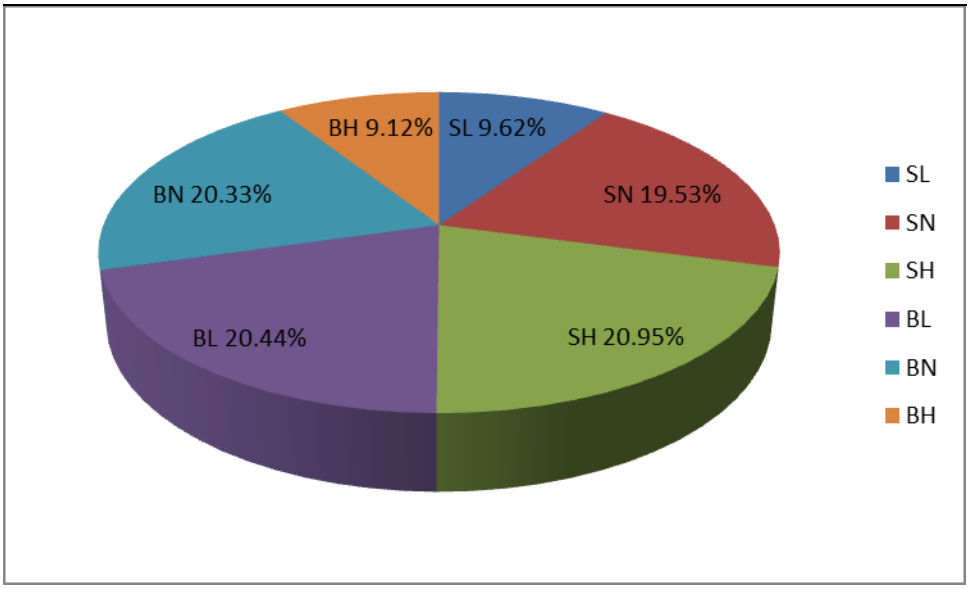

Figure 4 : Percentage of Stocks In Six Size-B/M Portfolios

Notes: S=Small Size // B=Big Size //L=Low B/M // N=Neutral B/M // H=High B/M

We can see in Figure 4 that stocks cluster in SN, SH, BL and BN. The number of the stocks in SL and BH is less if compared to the other 4 portfolios. This result is expected, since the B/M ratio and size are negatively correlated, larger firms are more likely to have smaller B/M ratios, and smaller ones higher B/M ratio.

Table 5 shows mean and standard deviation of monthly returns for six Size-B/M portfolios in percentage terms. The number of observations for each portfolio is 108. That is, the monthly return data for 9 years (July 2004-June 2013). We can state, that small portfolios outperform big stocks in the case of low and neutral B/M columns. This result is in line with the hypothesis of size effect. To put differently, the return of a portfolio consisting of large stocks has lower expected return than a portfolio consisting of smaller stocks with respect to market value. But in third column, we observe that the situation is

reversed. Namely, for high B/M portfolios, which includes value stocks, size and average return are negatively related. However, we can express that the spread is small compared to other two columns (%0.421). The reason for the lack of size effect in the case of high B/M portfolios will be investigated in further parts of this study. Considering the standard deviation part, we can draw similar conclusions. Since, in theory, average return and risk are positively correlated, small size portfolios have higher standard deviations than big size portfolios except the last column. If we examine the B/M effect, keeping the size constant, it can be claimed that for small portfolios, as B/M increases, average return increases when we compare low B/M and neutral B/M group (spread=%0.356), but average return decreases as we compare neutral and high B/M portfolio (in spite of the small spread %0.1). The expected result was a positive correlation between B/M and average return. The reason for this result is the challenging characteristics of small size portfolios and a deeper analysis will be made in the following sections of this study. However, considering the big size portfolios, a B/M effect is obvious in line with the theory. That is, the average return of the portfolios increase monotonically with B/M.

Table 5 : Means and Standard Deviations of Six Size-B/M Portfolios

6 Size-B/M Portf.	Mean				Std.Dev.			6 Size-B/M Portf.
	Low	Neutral	High		Low	Neutral	High	
Small	2.093	2.449	2.349		11.897	9.461	8.111	**Small**
Big	1.692	1.865	2.770		7.752	9.411	8.891	**Big**

3.3.2 Sample Characteristics and Descriptive Statistics of 18 Size-B/M-Profitability Portfolios

In this part of the study, we will focus on the sample characteristics and descriptive statistics of the 18 portfolios formed from the sorts of size, B/M and profitability.

In the tables below (Table 6 and Table 7), the number and percentage of stocks included in each portfolio is presented for each period. It can be stated that there is no clustering pattern considering the numbers and percentages of stocks included in portfolios as seen in figure 5.

Table 6 : Numbers of Stocks In Eighteen Size-B/M-Profitability Portfolios

	Number of Stocks In Portfolio																		
Year	SLW	SLN	SLR	SNW	SNN	SNR	SHW	SHN	SHR	BLW	BLN	BLR	BNW	BNN	BNR	BHW	BHN	BHR	Total Number
July 2004-June 2005	6	3	7	12	14	10	20	13	8	5	18	17	8	19	10	5	6	4	**185**
July 2005-June 2006	11	8	2	12	11	13	19	18	4	7	14	17	3	18	20	7	8	3	**195**
July 2006-June 2007	7	5	7	18	19	6	18	19	3	4	7	31	4	22	13	10	10	1	**204**
July 2007-June 2008	8	5	7	14	19	11	21	21	3	9	8	29	8	20	14	6	13	2	**218**
July 2008-June 2009	13	4	2	22	12	8	17	25	9	6	14	28	5	25	18	4	10	2	**224**
July 2009-June 2010	10	7	3	17	21	8	22	25	2	10	8	31	5	21	20	5	10	5	**230**
July 2010-June 2011	14	5	5	21	12	9	17	24	12	8	18	21	10	22	21	1	14	3	**237**
July 2011-June 2012	15	5	6	19	22	10	20	23	10	8	12	32	11	23	18	5	18	2	**259**
July 2012-June 2013	18	6	6	18	22	14	16	26	6	8	13	28	12	22	18	7	17	7	**264**
Av. No of Stocks	**11.33**	**5.33**	**5.00**	**17.00**	**16.89**	**9.89**	**18.89**	**21.56**	**6.33**	**7.22**	**12.44**	**26.00**	**7.33**	**21.33**	**16.89**	**5.56**	**11.78**	**3.22**	

Notes: First letter indicates size group: S=Small // B=Big

Second Letter indicates B/M group : L=Low B/M // N=Neutral B/M // H=High B/M

Third Letter indicates profitability group : W=Weak Pr. // N=Neutral Pr. // R=Robust Pr.

Table 7: Percentages of Stocks In Eighteen Size-B/M-Profitability Portfolios

	Percentage of Stocks																	
Year	SLW	SLN	SLR	SNW	SNN	SNR	SHW	SHN	SHR	BLW	BLN	BLR	BNW	BNN	BNR	BHW	BHN	BHR
July 2004-June 2005	3.24%	1.62%	3.78%	6.49%	7.57%	5.41%	10.81%	7.03%	4.32%	2.70%	9.73%	9.19%	4.32%	10.27%	5.41%	2.70%	3.24%	2.16%
July 2005-June 2006	5.64%	4.10%	1.03%	6.15%	5.64%	6.67%	9.74%	9.23%	2.05%	3.59%	7.18%	8.72%	1.54%	9.23%	10.26%	3.59%	4.10%	1.54%
July 2006-June 2007	3.43%	2.45%	3.43%	8.82%	9.31%	2.94%	8.82%	9.31%	1.47%	1.96%	3.43%	15.20%	1.96%	10.78%	6.37%	4.90%	4.90%	0.49%
July 2007-June 2008	3.67%	2.29%	3.21%	6.42%	8.72%	5.05%	9.63%	9.63%	1.38%	4.13%	3.67%	13.30%	3.67%	9.17%	6.42%	2.75%	5.96%	0.92%
July 2008-June 2009	5.80%	1.79%	0.89%	9.82%	5.36%	3.57%	7.59%	11.16%	4.02%	2.68%	6.25%	12.50%	2.23%	11.16%	8.04%	1.79%	4.46%	0.89%
July 2009-June 2010	4.35%	3.04%	1.30%	7.39%	9.13%	3.48%	9.57%	10.87%	0.87%	4.35%	3.48%	13.48%	2.17%	9.13%	8.70%	2.17%	4.35%	2.17%
July 2010-June 2011	5.91%	2.11%	2.11%	8.86%	5.06%	3.80%	7.17%	10.13%	5.06%	3.38%	7.59%	8.86%	4.22%	9.28%	8.86%	0.42%	5.91%	1.27%
July 2011-June 2012	5.79%	1.93%	2.32%	7.34%	8.49%	3.86%	7.72%	8.88%	3.86%	3.09%	4.63%	12.36%	4.25%	8.88%	6.95%	1.93%	6.95%	0.77%
July 2012-June 2013	6.82%	2.27%	2.27%	6.82%	8.33%	5.30%	6.06%	9.85%	2.27%	3.03%	4.92%	10.61%	4.55%	8.33%	6.82%	2.65%	6.44%	2.65%
Av. Percentof Stocks	**4.96%**	**2.40%**	**2.26%**	**7.57%**	**7.51%**	**4.45%**	**8.57%**	**9.57%**	**2.81%**	**3.21%**	**5.65%**	**11.58%**	**3.21%**	**9.58%**	**7.54%**	**2.55%**	**5.15%**	**1.43%**

Notes: First letter indicates size group: S=Small // B=Big

Second Letter indicates B/M group : L=Low B/M // N=Neutral B/M // H=High B/M

Third Letter indicates profitability group:W=Weak Pr. // N=Neutral Pr. // R=Robust Pr.

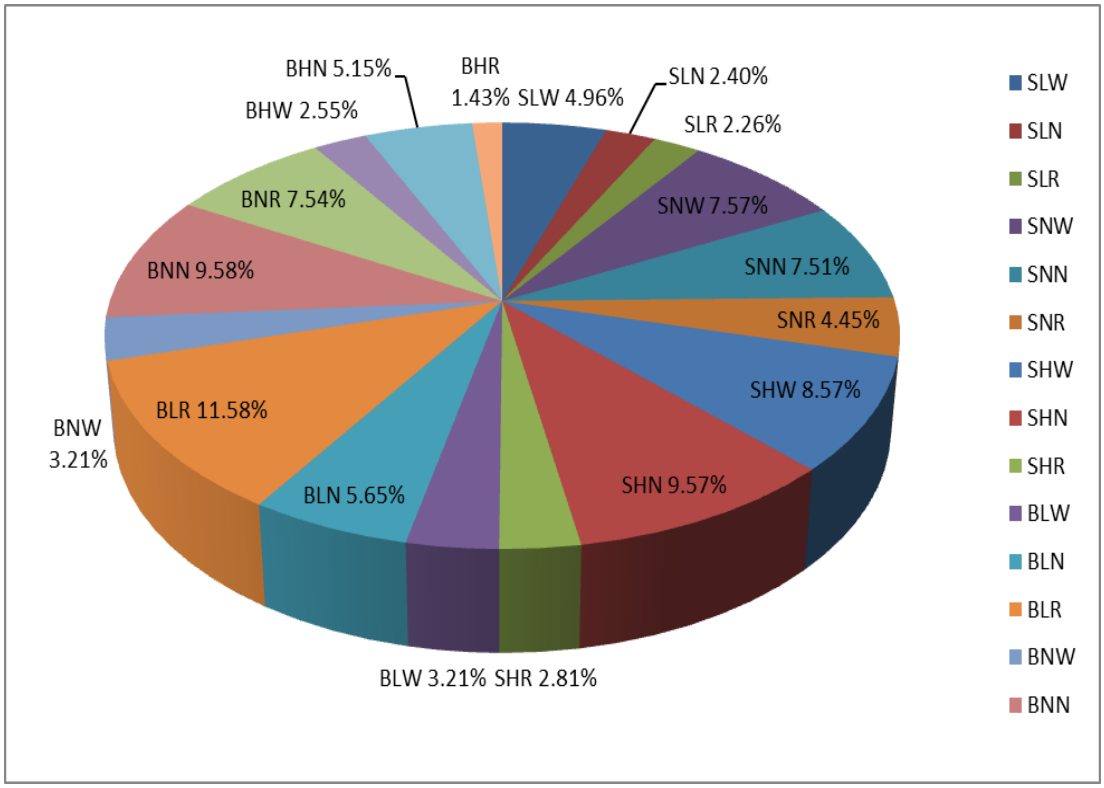

Figure 5: Percentage of Stocks In Eighteen Size-B/M-Profitability Portfolios

Notes:First letter indicates size group: S=Small // B=Big

Second Letter indicates B/M group : L=Low B/M // N=Neutral B/M // H=High B/M

Third Letter indicates profitability group : W=Weak Pr. // N=Neutral Pr. // R=Robust Pr.

Table 8 shows the mean values and standard deviation for 18 portfolios all in percentages. We can observe pattern regarding the size. Keeping the B/M and profitability constant, we observe a negative relation between the size and average return. Only in two cases (SNN compared to BNN // SHN compared to BHN) there is a positive correlation. In other cases, big size

portfolios have lower average returns than small size portfolios. However, we can not observe an obvious pattern in case of examining the B/M effect. Here the challenging part is small size portfolios. For small size portfolio case, the average return is following a random pattern. For big size portfolios, however, the average return is increasing monotonically with B/M ratio. The last pattern, which we want to detect, if it is present, is the profitability pattern. The expected result is a positive relation between profitability and average returns considering our 18 portfolios. Again, like in the case of B/M portfolios, there can not be detected an obvious pattern regarding small size portfolio group. As can be seen in the table 8, while for SL group (small size-low B/M) average return is increasing with profit, for SN group (small size-neutral B/M) average return is decreasing and after that increasing again with profitability. For big size portfolios, a similar situation is observed.

Table 8: Means and Standard Deviations of Eighteen Size-B/M-Profitability Portfolios

Mean of 18 Portfolios								
	Small Size				**Big Size**			
	Low B/M	**Neutral B/M**	**High B/M**		**Low B/M**	**Neutral B/M**	**High B/M**	
Weak Prof.	0.658	2.427	2.204		0.610	1.273	2.173	**Weak Prof.**
Neutral Prof.	2.152	2.011	2.633		1.887	2.080	3.657	**Neutral Prof.**
Robust Prof.	2.511	3.172	1.960		1.794	1.855	1.955	**Robust Prof.**
Std.Deviation of 18 Portfolios								
	Small Size				**Big Size**			
	Low B/M	**Neutral B/M**	**High B/M**		**Low B/M**	**Neutral B/M**	**High B/M**	
Weak Prof.	10.917	12.880	8.944		10.121	9.947	10.834	**Weak Prof.**
Neutral Prof.	18.308	9.692	8.068		9.941	9.783	9.719	**Neutral Prof.**
Robust Prof.	11.784	9.853	9.536		7.803	9.549	10.348	**Robust Prof.**

3.3.3 Descriptive Statistics of Excess Returns of 6 Portfolios

In this section we will examine the excess returns of 6 portfolios, which are represented by **Ri(t)-RF(t)** where Ri(t) is the return on portfolio i=SL, SN, SH, BL, BN, BH and RF(t) is the risk free rate.

Table 9: Summary statistics of Excess Returns of Six Size-B/M portfolios

	ESL	ESN	ESH	EBL	EBN	EBH
Mean	1.032	1.388	1.288	0.631	0.804	1.709
Median	-0.234	1.486	1.387	1.589	1.177	2.387
Maximum	70.828	35.158	16.443	21.822	27.279	20.716
Minimum	-27.089	-27.193	-24.693	-23.416	-29.148	-27.634
Std. Dev.	11.867	9.438	8.091	7.736	9.382	8.859

Notes: The letter E indicates Excess Return

S=Small Size // B=Big Size //L=Low B/M // N=Neutral B/M // H=High B/M

Table 9 above shows the summary statistics for the excess returns of six portfolios constructed according to sorts on size and B/M. The first letter stands for excess return. What is meant by excess return is the difference between the monthly return of the portfolio and monthly return of risk free asset. Mean values are all in percentage terms. If we compare the mean values (which is equal to the average of the monthly return of the portfolio), we can easily state that we draw the same conclusions with the case of 6 portfolio returns (not excess returns). We can detect a size effect which is in line with the expected result except high B/M portfolios. As the average excess return decreases with size for low and neutral B/M portfolios

(comparison between ESL-EBL and ESN-EBN), the situation is reversed regarding the high B/M portfolios. If we skip to the observation of B/M patterns, there is also a similar situation. What we expect here is a monotonically increasing average excess return pattern. That is, the average return of portfolios which consists of higher B/M stocks (value stocks), is expected to be higher in line with Fama and French results (1992). For big size portfolios, this value effect is obvious and strong, whereas for small stocks, average excess return increases and then decreases, though slightly.

As seen in figure 6 , the excess returns can be sorted as EBH > ESN > ESH > ESL > EBN > EBL.

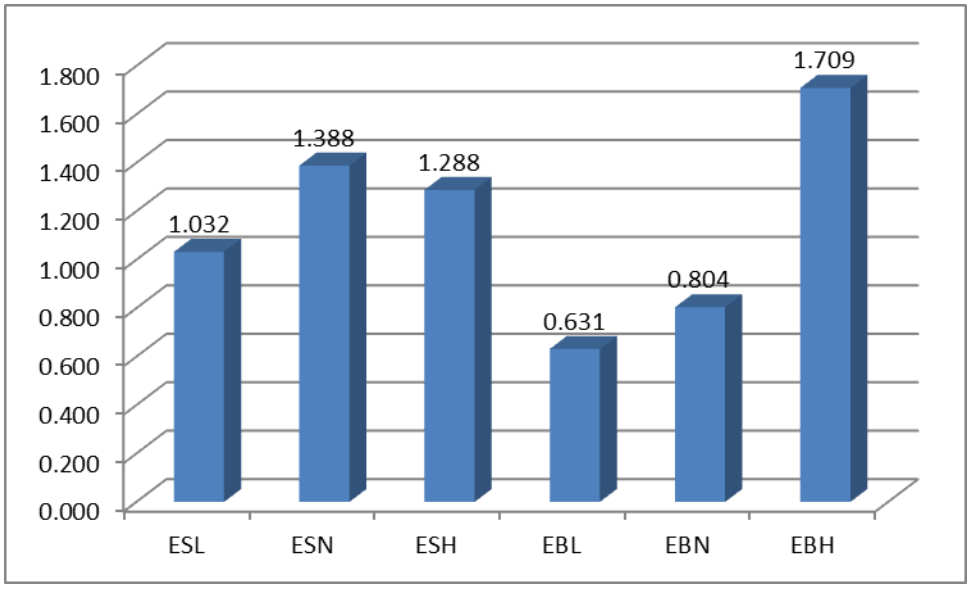

Figure 6: Average Excess Returns of Six Size-B/M portfolios

Notes: The letter E indicates Excess Return

S=Small Size // B=Big Size //L=Low B/M // N=Neutral B/M // H=High B/M

Another point, which is worth mentioning is the minimum and maximum values of excess returns. As can be seen in the table 9, there is a wide spread between maximum and minimum values. This spread may be caused because of the unusually high risk free rates (the return of government bonds) in the times of high inflation and mounting need of government to borrow. This can be a candidate reason to explain unusually negative excess return of portfolios. Another reason may be the fragile structure of the stock market, which is highly exposed to speculation, manipulation and crises. The response of BIST to crises can be claimed more reactionary and it can be affected more negatively compared to the other countries (i.e U.S stock exchange which is much deeper in volume, much larger in terms of capitalization). The exceptionally high excess returns which can be detected from maximum values, can be partially explained by the poor diversification of portfolios. Since the number of stocks which are listed in exchange is substantially less than in developed countries like U.S, the number of stocks included in portfolios are also small in some cases. So in spite of the endeavors to eliminate the stocks the prices of which are suspected to move speculatively etc., some of the stocks may be still irrationally priced or speculatively attacked. In such a situation, the volatility may be reflected to the whole portfolio because of poor diversification.

3.3.4 Descriptive Statistics of Excess Returns of 18 Portfolios

In this part of the study, we will focus on the descriptive statistics of excess returns of 18 portfolios which were constructed according to size, B/M and profitability. The excess returns are represented **Ri(t)-RF(t)** where Ri(t) is the return on portfolio i=SLW, SLN, SLR, SNW, SNN, SNR, SHW, SHN, SHR, BLW, BLN, BLR, BNW, BNN, BNR, BHW, BHN, BHR, and RF(t) is the risk free rate.

Table 10: Summary statistics of Excess Returns of Eighteen Size-B/M-Profitability Portfolios

	ESLW	ESLN	ESLR	ESNW	ESNN	ESNR	ESHW	ESHN	ESHR	EBLW	EBLN	EBLR	EBNW	EBNN	EBNR	EBHW	EBHN	EBHR
Mean	-0.403	1.091	1.450	1.366	0.950	2.112	1.143	1.573	0.899	-0.450	0.827	0.733	0.213	1.020	0.794	1.113	2.597	0.894
Median	-0.954	-0.573	0.039	0.980	0.832	2.406	1.681	2.294	0.302	-0.500	0.868	1.107	0.430	1.545	0.646	1.596	1.997	2.078
Maximum	31.852	153.201	53.886	90.394	38.343	29.546	20.051	16.350	25.106	21.578	28.869	22.121	26.182	27.477	29.169	31.491	30.792	28.655
Minimum	-29.343	-27.806	-27.730	-27.615	-26.148	-28.654	-29.668	-22.422	-24.881	-29.108	-33.234	-21.847	-33.769	-28.142	-30.870	-30.821	-27.322	-29.335
Std. Dev.	10.920	18.301	11.719	12.866	9.688	9.797	8.935	8.050	9.500	10.114	9.944	7.790	9.954	9.752	9.524	10.822	9.642	10.359
Skewness	0.107	5.352	1.251	2.855	0.263	-0.460	-0.473	-0.450	0.149	-0.350	-0.058	-0.104	-0.245	-0.220	0.032	-0.312	-0.024	-0.129
Kurtosis	3.697	45.434	7.159	22.680	4.560	3.864	3.593	3.183	3.245	3.212	4.206	3.731	4.051	3.332	3.747	3.631	3.651	3.138

Notes: The letter E indicates Excess Return

Second letter indicates size group: S=Small // B=Big

Third Letter Indicates B/M group : L=Low B/M // N=Neutral B/M // H=High B/M

Fourth Letter Indicates profitability group : W=Weak Pr. // N=Neutral Pr. // R=Robust Pr.

Table 10 shows descriptive statics for excess returns of 18 portfolios over risk free rate as percentages. A size effect, namely a negative relation between average excess return and size can be detected examining the mean values. However, for neutral B/M-neutral profitability portfolios and for high B/M-neutral profitability portfolios, as the size increases, average return also increases. As the spread between BNN and SNN is only %0.07, the difference between BHN and SHN is %1.02. As mentioned earlier, in line with the Fama French study (1993), we expect that the value stocks (high B/M) have higher average excess returns than growth stocks (low B/M). Therefore, we hope to observe a positive correlation between average return and B/M. Interestingly, this kind of a pattern, which reflects the positive relation is only present for big size portfolios. For big size portfolios, if we keep profitability constant, average excess returns are monotonically increasing with B/M. However, no pattern can be detected in case of small portfolios. Regarding the profitability effect, we encounter a different situation. We can not detect a positive or negative pattern, namely a profitability effect. The expected result was a positive relation between profitability and average excess return. Whereas, neither for small size portfolios, nor for big size portfolios, such a relation is observed.

As seen figure 7, the excess returns can be sorted as :

EBHN > ESNR > ESHN > ESLR > ESNW > ESHW > EBHW > ESLN > EBNN > ESNN > ESHR > EBHR > EBLN > EBNR > EBLR > EBNW > ESLW> EBLW.

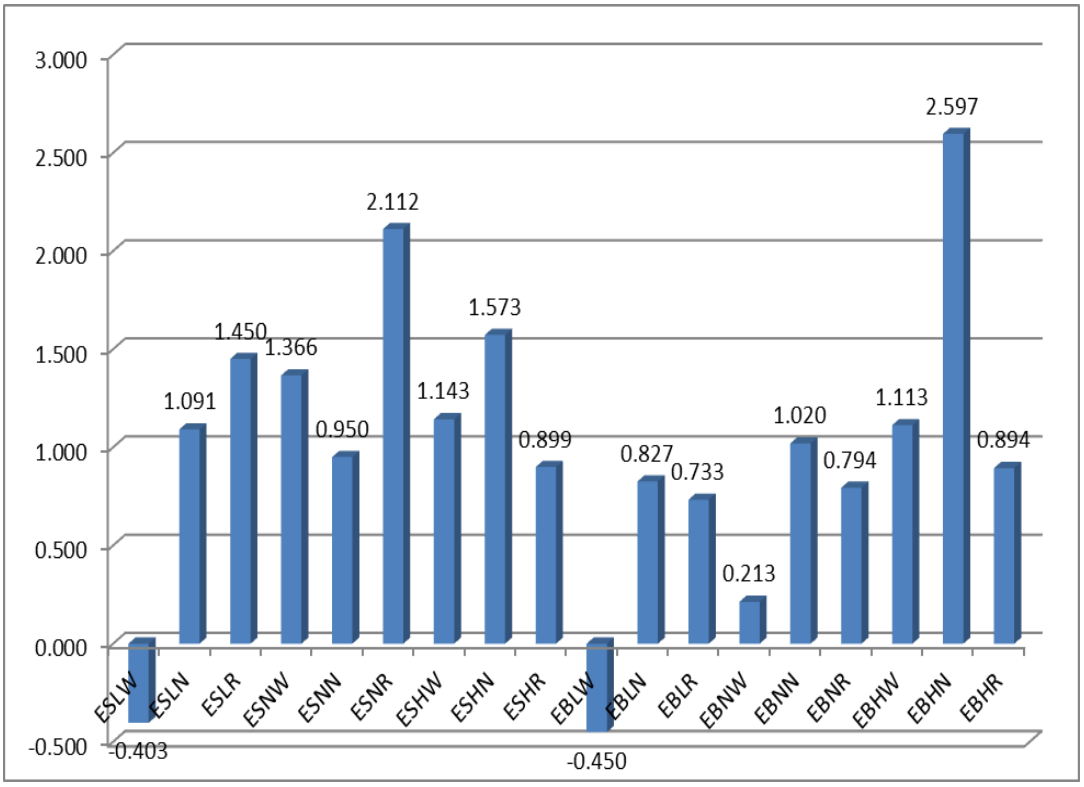

Figure 7 : Average Excess Returns of Eighteen Size-B/M-Profitability Portfolios

Notes: The letter E indicates Excess Return

Second letter indicates size group: S=Small // B=Big

Third Letter Indicates B/M group : L=Low B/M // N=Neutral B/M // H=High B/M

Fourth Letter Indicates profitability group : W=Weak Pr. // N=Neutral Pr. // R=Robust Pr.

A salient point is that low B/M-weak profitability portfolios have negative average excess returns for both size groups. This fact may produce challenging results for our empirical asset pricing models which will be constructed in further parts of this study like in Fama French (2013) However, this result, negative return, may be more challenging than in Fama –French study, since the only negative average excess returned in their study was

obtained for small size, low profitability and low B/M portfolio. In our case, we have two negative average returns. The potential reasons and effects of this negative average excess returns will be elaborated in the following sections in this study.

Regarding the maximum and minimum returns, the same reasons in the case of six portfolio can be asserted.

3.3.5 Descriptive Statistics of Factor Returns

In this part, our focus will be on the descriptive statistics of our factor returns, which will be used in CAPM, FF Three Factor Model and FF Four Factor Model. That is, Rm-Rf, SMB6, HML6, SMB18, HML18, RMW18. (See equations 3.1, 3.2, 3.3, 3.4, and 3.5 for factor constructions)

If we compare the mean returns (see Table 11), we can sort the mean factor returns as;

Rm-Rf > HML18 > HML6 > RMW18 > SMB18 > SMB6

Thus, we can state that the average excess return of market over risk free rate is larger than the average excess return of small size over big size portfolios, high B/M over low B/M portfolios and robust over weak profitability portfolios. This result is in line with Fama-French 2013 paper. And if we consider, the premiums, it is apparent that the value premium (HML) is larger than profitability premium and size premium. This result is the inevitable result of factor construction. To elaborate, since we use three sorts to produce both HML and RMW, the middle %40 are dropped. This in turn causes a focus on the extremes of the two variables according to Fama-French (2013) But in case of SMB, the story changes a bit. We use two sorts and our break point is Istanbul Stock Exchange median market cap. So the spread of average returns between two groups of portfolios is smaller.

Table 11: Summary Statistics of Factor Returns

	Rm-Rf	SMB6	HML6	SMB18	HML18	RMW18
Mean	0.846	0.188	0.667	0.271	0.828	0.650
Median	1.695	-0.345	1.300	-0.106	1.156	0.344
Maximum	20.870	25.526	13.204	17.547	11.908	9.124
Minimum	-24.580	-11.100	-28.333	-7.838	-24.126	-8.340
Std. Dev.	8.087	5.104	4.803	4.382	4.465	3.575

3.3.6. Correlation Between Factors

Table 12 shows the correlation between the factors which will be used in FF Three Factor Model. All factors are negatively correlated. The correlation between HML6 and Rm-Rf is close to zero, whereas the correlation between SMB6 and Rm-Rf can be described weak. The strongest correlation is between SMB6 and HML6.

Table 12 : Correlation Between Factors of Three Factor Model

	Rm-Rf	SMB6	HML6
Rm-Rf	1.00	-0.16	-0.04
SMB6	-0.16	1.00	-0.43
HML6	-0.04	-0.43	1.00

Table 13 shows the correlations between the factors which will be used in Fama-French Four Factor Model. Both negative and positive correlation coefficients are obtained in contrast to the correlations in Table 12. The sign of the correlation between market excess return and HML has changed from negative to positive. The addition of a fourth factor, profitability factor, may

have caused this alteration. The weakest correlation is observed between Rm-Rf and HML 18, which is close to zero. The strongest correlation shows up between HML18 and SMB18 like in the case of three factor model correlation table. The sign is negative, which indicates that these premiums move mostly in opposite directions during our analysis.

Table 13 : Correlation Between Factors of Four Factor Model

	Rm-Rf	SMB18	HML18	RMW18
Rm-Rf	1.00	-0.15	0.03	-0.13
SMB18	-0.15	1.00	-0.47	-0.28
HML18	0.03	-0.47	1.00	0.18
RMW18	-0.13	-0.28	0.18	1.00

3.4. Conclusion

In the first section of this chapter, data selection, portfolio formation and factor construction processes were explained in detail. Fama-French (1992,1993,2013) methodology was used in data selection, portfolio formation and portfolio construction processes. Six size-B/M portfolios were formed by dividing the sample into two size and three B/M groups (See table 1). SMB6 and HML6 factors which reflect the risk factors related to size and B/M are constructed using the portfolios mentioned above. (See equations 3.1 and 3.2) These factors are used in Fama-French three factor model as explanatory variables. In a similar way, eighteen size-B/M-profitability portfolios are formed by dividing the sample into two size, three B/M, and three profitability sorts (See table 2). The intersection of these portfolios gives us eighteen portfolios. The SMB18, HML18, and RMW18 factors, which are

used as explanatory variables in Fama-French four factor model are constructed using these eighteen portfolios (See equations 3.3,3.4, and 3.5)

In the second section of the chapter, firstly, size, value and profitability patterns in average returns were examined for six size-B/M and eighteen size-B/M-profitability portfolios. After that, descriptive statistics for two sets of dependent variables, namely, excess returns of these portfolios, and factor returns were represented. And lastly, the correlations between factors were investigated. Summary of the main points is as follows:

Regarding six size-B/M portfolios, except high B/M group, a size effect was detected. On the other hand, speaking of value effect, an increase in average return with B/M is observed in big portfolios as expected. However, in small portfolio case, a similar conclusion can not be drawn because of the lack of a value pattern.

Regarding eighteen size-B/M-profitability portfolios, a size effect is present, which means that average return is decreasing with size. Like in the case of six portfolios, there is a value effect in big size portfolios, while there is not an obvious pattern in small size portfolios. Lastly, a random pattern is detected regarding the profitability effect. An obvious relation between profitability and average return does not exist considering descriptive statistics.

When the excess returns of six size-B/M portfolios were evaluated, similar results were obtained with the case of portfolio returns. The average excess returns can be sorted as:

$$EBH > ESN > ESH > ESL > EBN > EBL$$

When the excess returns of eighteen size-B/M-profitability portfolios were evaluated, similar results were obtained with the case of portfolio returns. The average excess returns can be sorted as:

EBHN > ESNR > ESHN > ESLR > ESNW > ESHW > EBHW > ESLN> EBNN > ESNN > ESHR > EBHR > EBLN > EBNR > EBLR > EBNW > ESLW > EBLW

Having examined the correlations between factors used in Fama-French models, it can be asserted that the level of correlations is low with the highest value of -0.47 between HML18 and SMB18.

CHAPTER 4

EMPIRICAL RESULTS OF CAPM AND FAMA-FRENCH MODELS IN ISTANBUL STOCK EXCHANGE

4.1. Introduction

In this chapter, the regression results for two sets of portfolios are demonstrated. As left hand side (LHS) variables, both excess returns of 6 size-B/M portfolios and excess returns of 18 size-B/M-profitability portfolios are used. The regressions are conducted using three different models; CAPM, Fama French Three Factor Model and Fama French Four Factor Model. The time series approach is adopted where the time period encompasses 108 months, between July 2004 and June 2013. Intercept values, slopes, t-statistics, R^2 values and F statistics are evaluated and interpreted.

4.2. Regression Results for Six Size-B/M Portfolios

In this part, the excess returns of six size-B/M portfolios are used as dependent variables. The time series regressions are conducted using three different models; CAPM, Fama French Three Factor Model and Fama French Four Factor Model.

4.2.1 Regression Results For CAPM

According to CAPM, the excess return of an asset or a portfolio can be explained only by a market factor. The CAPM equation employed here is

$$R_i(t)-RF(t) = \alpha + \beta\,[RM(t)-RF(t)] + e(t) \quad (4.1)$$

where $R_i(t)$ is the return on portfolio i=SL, SN, SH, BL, BN, BH. (See table 1) $RF(t)$ is the risk free rate, $RM(t)$ is the return on the market index, and $e(t)$ is the error term.

Table 14 shows the regression intercepts, slopes, t statistics, adjusted R^2 values and F statistics obtained using the CAPM model to explain the monthly excess returns of six portfolios [$R_i(t)$-$RF(t)$], namely, ESL, ESN, ESH, EBL, EBN, EBH.

Considering α values, we can say that when the intercept for small size portfolios are positive, a contrary situation shows up for big size portfolios. If we evaluate t-statistics of intercept term, except the EBH, excess return of Big Size-High B/M portfolio, all of the α's are statistically insignificant. In our case, this is a desired result, since α indicates the pricing error in this model.

Focusing on the regression slopes, which are represented by β, we can say that all of them are positive and statistically significant.

R^2 values shows some kind of pattern and while explanatory power regarding the small size portfolios are low, the explanatory power for big portfolios are high. It ranges between 0.42 and 0.96. Indeed, this result shows that we need some additional factors to explain increase the explanatory power of the model.

F statistics are high enough to prove that model is statistically significant for each portfolio.

Table 14: Regression Results of CAPM for Six Size-B/M Portfolios

Model : $R(t)$-$RF(t) = \alpha + \beta\ [RM(t)$-$RF(t)] + e(t)$

	CAPM					
	α	**t(α)**	**β**	**t(β)**	**Adj R^2**	**F-stat**
ESL	0.22	0.26	0.96	8.84	0.42	78.15
ESN	0.59	1.10	0.95	14.39	0.66	207.01
ESH	0.58	1.34	0.83	15.42	0.69	237.63
EBL	-0.14	-0.61	0.91	32.29	0.91	1042.37
EBN	-0.16	-0.86	1.14	50.05	0.96	2504.61
EBH	0.88	2.32	0.98	21.05	0.81	442.99

Notes: The letter E indicates Excess Return ($R(t)$-$RF(t)$)

S=Small Size // B=Big Size //L=Low B/M // N=Neutral B/M // H=High B/M

4.2.2 Regression Results For Fama French Three Factor Model

In this section, time series regressions are conducted using Fama-French Three Factor Model which is represented by the equation below;

$$R_i(t)\text{-}RF(t) = \alpha + \beta\ [RM(t)\text{-}RF(t)] + sSMB6(t) + hHML6(t) + e(t) \quad (4.2)$$

where $R_i(t)$ is the return on portfolio i=SL, SN, SH, BL, BN, BH (See Table 1). $RF(t)$ is the risk free rate and $RM(t)$ is the return on the market index. $SMB6(t)$ is the difference between average returns of small size portfolios and big size portfolios, $HML6(t)$ is the difference between average returns of high B/M portfolios and low B/M portfolios (See equation 3.1 and 3.2). $e(t)$ shows the error term.

As can be seen above, LHS variables are the six portfolio excess returns $[R_i(t)\text{-}RF(t)]$,namely, ESL, ESN, ESH, EBL, EBN, EBH. RHS variables are excess market return, SMB6 and HML6. The factor constructions are

explained in detail in chapter 3. The model tries to explain the average excess return of an asset or portfolio with the help of three risk factors. These factors are excess return of market portfolio, excess return of small size portfolios over big size portfolios (a proxy for size risk factor) and excess return of high B/M portfolios over low B/M portfolios (a proxy for value risk factor).

Table 15 shows the regression intercepts, slopes, t statistics, R^2 values and F statistics obtained as a result of six regressions.

The sign of the alphas does not show any pattern like in the case of CAPM (see table 14). The regression intercepts for ESL, EBL and EBH are positive, where intercepts for ESN, ESH and EBN are negative. The t-statistics of α's are low enough to guarantee statistically insignificance of intercepts. In other words, the hypothesis of α being equal to zero can not be rejected for any of the alphas, which is a positive result for model performance. However, a joint test will be conducted in the following section to see whether the regression intercepts are indistinguishable from zero for all of the LHS portfolios.

The high level of t-statistics for *β*'s indicate that the coefficient of the market risk factor is strongly significant for all six portfolio excess returns.

If we move on to the coefficient of SMB6 factor, namely s, we observe two negative and four positive slopes. Four of them are statistically significant based on the values of t-statistics. Furthermore, the slope on SM6 factor are related to size. That is, in regressions with big size portfolios (keeping B/M constant), the slope is less than in regressions with small size portfolios. This result is in line with Fama French (1993) results.

Considering the regression slope for HML6, namely h, a similar result is obtained regarding the signs of the coefficients. We have three positive and three negative slopes. Only one of the slope coefficients (BN) is statistically insignificant, which has a t value of -0.25. The slope on this factor is increasing monotonically with B/M. That is, for regressions of high B/M

portfolios (keeping size group constant) the slope is higher than regressions of low B/M portfolios.

R^2 values range between 0.87 and 0.96, which indicates that model has high explanatory power. Despite the slopes can not be qualified as strong especially for big size groups (BL-BN-BH), the improvement in adjusted R^2 values is apparent compared to CAPM.

Referring to considerably high F-statistics in Table 15, FF model can be qualified as significant for each individual regression.

Table 15: Regression Results of Fama-French Three Factor Model for Six Size-B/M Portfolios

Model : R(t)-RF(t) = α + β [RM(t)-RF(t)] + sSMB6(t) + hHML6(t) + e(t)

	FF Three Factor Model									
	α	**t(α)**	**β**	**t(β)**	**s**	**t(s)**	**h**	**t(h)**	**Adj R^2**	**F-stat**
ESL	0.39	1.11	1.06	24.54	1.23	16.22	-0.72	-9.05	0.91	367.30
ESN	-0.01	-0.03	1.06	31.13	1.05	17.51	0.45	7.16	0.91	369.94
ESH	-0.01	-0.08	0.93	42.38	0.91	23.47	0.51	12.60	0.95	679.74
EBL	0.05	0.26	0.90	35.31	-0.06	-1.37	-0.26	-5.50	0.93	455.18
EBN	-0.15	-0.78	1.13	48.55	-0.01	-0.33	-0.01	-0.25	0.96	820.13
EBH	0.45	1.42	1.02	25.81	0.26	3.70	0.51	7.02	0.87	230.66

Notes: The letter E indicates Excess Return

S=Small Size // B=Big Size //L=Low B/M // N=Neutral B/M // H=High B/M

4.2.3 Regression Results For Fama French Four Factor Model

The FF Four Factor Model employed here is represented by equation

$$R_i(t)-RF(t) = \alpha + \beta[RM(t)-RF(t)]+sSMB18(t) + hHML18(t) +rRMW18(t) + e(t) \quad (4.3)$$

where $R_i(t)$ is the return on portfolio i=SL, SN, SH, BL, BN, BH (See Table 1). $RF(t)$ is the risk free rate and $RM(t)$ is the return on the market index. $SMB18(t)$ is the difference between average returns of small size portfolios and big size portfolios, $HML18(t)$ is the difference between average returns of high B/M portfolios and low B/M portfolios, $RMW18(t)$ is the difference between the average returns of robust profitability portfolios and weak profitability portfolios (See equations 3.3, 3.4, and 3.5). $e(t)$ is the error term in the regression model.

The model has four RHS variables, which reflect the underlying risk factors which are represented by market excess return, excess return of small size portfolios over big size portfolios (a proxy for size risk factor), excess return of high B/M portfolios over low B/M portfolios (value factor), and excess return of robust profitability portfolios over weak profitability portfolios (profitability factor). LHS variables are the six portfolio excess returns $[R_i(t)-RF(t)]$, namely, ESL, ESN, ESH, EBL, EBN, EBH

Table 16 shows that except the intercept for EBN, all of the constants are positive and all of them are statistically insignificant or indistinguishable from zero.

In case of market betas or the slope coefficient of market excess return, only positive values are obtained. The statistical significance level is obviously high relying on the t-statistics.

The coefficient of SMB18 takes both positive and negative values. Furthermore, two of slope coefficients are statistically insignificant in %95 confidence interval. This insignificance problem shows up in two portfolios which consist the largest stocks.

The HML18 slopes take both positive and negative values and do not show any pattern. For the fifth portfolio (Big size-Neutral B/M), h is statistically insignificant. However, for the rest of the portfolio returns, the slope coefficients are significant.

Regarding RMW18, five slope coefficients out of six have negative values and only two of the coefficients are statistically significant. For the regressions on the small size portfolios, none of the r's is significant.

R^2 values range between 0.84 and 0.96, which indicates that model has high explanatory power. However, compared to FF Three Factor Model, in average there is no improvement regarding the R^2 values. The insignificance of 4 out of 6 slopes on RMW also indicates that we should not expect a higher explanatory power from the model. Interestingly, the addition of RMW18 factor, decreases also the significance of SMB18 and HML18 slope coefficients.

And like in the cases of CAPM and Three Factor Model, the high F-statistics proves the overall significance of model.

Table 16: Regression Results of Fama-French Four Factor Model for Six Size-B/M Portfolios

Model : R(t)-RF(t) = α+β [RM(t)-RF(t)]+sSMB18(t)+hHML18(t)+rRMW18(t) + e(t)

	FF 4 Factor Model											
	α	**t(α)**	**β**	**t(β)**	**s**	**t(s)**	**h**	**t(h)**	**r**	**t(r)**	**Adj R^2**	**F-stat**
ESL	0.61	1.28	1.06	18.42	1.15	9.43	-0.87	-7.58	-0.11	-0.81	0.84	146.39
ESN	0.19	0.67	1.01	29.21	1.07	14.66	0.41	5.92	-0.43	-5.35	0.91	279.41
ESH	0.10	0.36	0.88	25.75	0.86	11.78	0.43	6.33	-0.23	-2.88	0.88	200.80
EBL	0.19	0.91	0.90	35.00	-0.11	-2.01	-0.27	-5.19	-0.12	-1.92	0.93	341.54
EBN	-0.20	-1.03	1.14	48.55	-0.01	-0.18	-0.01	-0.20	0.08	1.39	0.96	622.34
EBH	0.57	1.60	0.98	22.82	0.16	1.78	0.46	5.34	-0.17	-1.71	0.85	147.38

Notes: The letter E indicates Excess Return

S=Small Size // B=Big Size //L=Low B/M // N=Neutral B/M // H=High B/M

4.3. Regression Results for 18 Size-B/M-Profitability Portfolios

In this section, the same procedure will be followed and three different models will be examined in detail. This time, the dependent variables are the excess returns of 18 size-B/M-profitability portfolios.

4.3.1 Regression Results For CAPM

The CAPM equation employed here is

$$R_i(t)-RF(t) = \alpha + \beta\,[RM(t)-RF(t)] + e(t) \qquad (4.4)$$

where $R_i(t)$ is the return on portfolio i=SLW, SLN, SLR, SNW, SNN, SNR, SHW, SHN, SHR, BLW, BLN, BLR, BNW, BNN, BNR, BHW, BHN, BHR (See

Table 2). ***RF*(*t*)** is the risk free rate, ***RM(t)*** is the return on the market index***,*** and ***e(t)*** is the error term.

Table 17 shows the regression intercepts, slopes, t statistics, R^2 values and F statistics obtained using the CAPM model to explain the excess returns of eighteen portfolios [R_i(t)-RF(t)], namely, ESLW, ESLN, ESLR, ESNW, ESNN, ESNR, ESHW, ESHN, ESHR, EBLW, EBLN, EBLR, EBNW, EBNN, EBNR, EBHW, EBHN, EBHR

5 of the alphas are negative, where 13 of them are positive. On the other hand, 3 of the intercepts are significant, while the rest 15 are insignificant. Whereas, a GRS-F value should be calculated to test the joint significance of alphas. This test will be left to the following section.

According to Table 17, all of the betas are positive and considerably high t-statistics for β's indicates statistical significance. The null hypothesis β=0 is strongly rejected for each regression.

Considering the adjusted R^2 values, it can be seen that that range is between 0.17 and 0.91. When faced with 18 portfolios, CAPM can be claimed to be insufficient in explaining the excess returns.

Although not strong for SLN, SLR and SNW, in individual regressions, model can be qualified as significant, based on F-statistics.

Table 17: Regression Results of CAPM for Eighteen Size-B/M-Profitability Portfolios

Model : $R(t)$-$RF(t) = \alpha + \beta\ [RM(t)$-$RF(t)] + e(t)$

	CAPM					
	α	**t(α)**	**β**	**t(β)**	**Adj R^2**	**F-stat**
ESLW	-1.26	-1.81	1.02	11.79	0.56	139.08
ESLN	0.27	0.17	0.97	4.87	0.17	23.67
ESLR	0.80	0.83	0.77	6.41	0.27	41.12
ESNW	0.53	0.54	0.99	8.20	0.38	67.31
ESNN	0.15	0.26	0.94	13.14	0.62	172.62
ESNR	1.29	2.25	0.97	13.58	0.63	184.40
ESHW	0.40	0.76	0.88	13.46	0.63	181.15
ESHN	0.90	1.91	0.79	13.61	0.63	185.14
ESHR	0.13	0.22	0.91	12.70	0.60	161.28
EBLW	-1.27	-2.05	0.97	12.63	0.60	159.52
EBLN	0.08	0.12	0.88	10.54	0.51	111.17
EBLR	-0.02	-0.09	0.90	26.01	0.86	676.55
EBNW	-0.60	-1.01	0.97	13.05	0.61	170.43
EBNN	0.05	0.16	1.15	32.95	0.91	1085.77
EBNR	-0.14	-0.42	1.10	27.32	0.87	746.63
EBHW	0.18	0.30	1.11	15.15	0.68	229.65
EBHN	1.77	3.30	0.98	14.73	0.67	216.83
EBHR	0.10	0.15	0.94	11.01	0.53	121.32

Notes: The letter E indicates Excess Return

Second letter indicates size group: S=Small // B=Big

Third Letter Indicates B/M group : L=Low B/M // N=Neutral B/M // H=High B/M

Fourth Letter Indicates profitability group : W=Weak Pr. // N=Neutral Pr. // R=Robust Pr.

4.3.2 Regression Results For Fama French Three Factor Model

Table 18 shows the regression results for FF Three Factor Model:

$$R_i(t)\text{-}RF(t) = \alpha + \beta\ [RM(t)\text{-}RF(t)] + sSMB6(t) + hHML6(t) + e(t) \quad (4.5)$$

where $R_i(t)$ is the return on portfolio i=SLW, SLN, SLR, SNW, SNN, SNR, SHW, SHN, SHR, BLW, BLN, BLR, BNW, BNN, BNR, BHW, BHN, BHR (See Table 2). ***RF(t)*** is the risk free rate and ***RM(t)*** is the return on the market index. ***SMB6(t)*** is the difference between average returns of small size portfolios and big size portfolios, ***HML6(t)*** is the difference between average returns of high B/M portfolios and low B/M portfolios (See equations 3.1 and 3.2) and ***e(t)*** is the error term.

As can be seen above, LHS variables are the eighteen portfolio excess returns $[R_i(t)-RF(t)]$, namely, ESLW, ESLN, ESLR, ESNW, ESNN, ESNR, ESHW, ESHN, ESHR, EBLW, EBLN, EBLR, EBNW, EBNN, EBNR, EBHW, EBHN, EBHR. RHS variables are excess market return, SMB6 and HML6. The factor constructions are explained in detail in chapter 3. The model tries to explain the average excess return of an asset or portfolio with the help of three risk factors. These factors are excess return of market portfolio, excess return of small size portfolios over big size portfolios (a proxy for size risk factor) and excess return of high B/M portfolios over low B/M portfolios (a proxy for value risk factor).

11 negative and 7 positive alphas were obtained according to Table 18. 3 of them are statistically significant, which means the constant term or pricing error for three of the regressions is not zero in %95 confidence interval.

All of the betas are positive and strongly significant.

Most of the slope coefficients of SMB6 factor take positive values and four of 18 coefficients are statistically insignificant. Additionally, the coefficient s is depending on the size group, to which portfolio belongs. Keeping B/M and profitability group constant, for big size portfolio excess returns, the coefficients are less than for small size portfolio excess returns.

The estimated h's have both positive and negative signs and eight out of 18 coefficients are insignificant. If we compare the coefficients obtained, keeping

the size and profitability groups constant, except one case out of 6 cases, coefficient rises with B/M.

R^2 values range between 0.52 and 0.91 and it can be stated that a considerable part can not be explained by the factors used in the model. Indeed, the R^2 values improve obviously compared to CAPM.

The F-statistics shows that for each individual regression, the overall significance of model is high.

Table 18: Regression Results of Fama French Three Factor Model for Eighteen Size-B/M-Profitability Portfolios

Model : R(t)-RF(t) = α + β [RM(t)-RF(t)] + sSMB6(t) + hHML6(t) + e(t)

	FF Three Factor Model									
	α	**t(α)**	**β**	**t(β)**	**s**	**t(s)**	**h**	**t(h)**	**Adj R^2**	**F-stat**
ESLW	-1.36	-2.47	1.09	15.99	0.82	6.85	-0.18	-1.41	0.74	100.53
ESLN	0.84	0.78	1.08	8.18	1.57	6.75	-1.44	-5.90	0.65	66.34
ESLR	0.51	0.64	0.88	8.90	1.16	6.70	-0.03	-0.19	0.52	39.92
ESNW	-0.19	-0.24	1.13	11.32	1.32	7.49	0.53	2.85	0.59	52.72
ESNN	-0.40	-1.02	1.05	21.43	0.99	11.49	0.42	4.63	0.83	172.34
ESNR	0.83	1.74	1.05	17.87	0.78	7.56	0.37	3.42	0.76	112.47
ESHW	-0.25	-0.86	0.99	27.46	1.01	15.95	0.55	8.26	0.89	290.62
ESHN	0.32	1.13	0.89	25.17	0.86	13.88	0.50	7.64	0.87	239.57
ESHR	-0.35	-0.78	1.01	18.02	0.87	8.84	0.36	3.48	0.77	118.61
EBLW	-1.51	-2.71	1.04	15.01	0.65	5.40	0.10	0.75	0.69	79.28
EBLN	0.19	0.27	0.89	10.54	0.13	0.87	-0.20	-1.29	0.52	39.27
EBLR	0.23	0.91	0.87	27.99	-0.13	-2.46	-0.32	-5.48	0.89	295.24
EBNW	-0.89	-1.64	1.03	15.41	0.63	5.39	0.16	1.31	0.70	82.29
EBNN	-0.02	-0.07	1.16	32.38	0.03	0.53	0.08	1.25	0.91	360.96
EBNR	-0.05	-0.16	1.09	26.52	-0.08	-1.08	-0.09	-1.23	0.87	249.19
EBHW	-0.08	-0.13	1.15	16.09	0.41	3.26	0.21	1.56	0.71	86.35
EBHN	1.31	2.68	1.01	16.77	0.19	1.76	0.60	5.40	0.74	101.04
EBHR	-0.46	-0.71	0.99	12.40	0.34	2.44	0.68	4.64	0.60	55.22

Notes: The letter E indicates Excess Return

Second letter indicates size group: S=Small // B=Big

Third Letter Indicates B/M group : L=Low B/M // N=Neutral B/M // H=High B/M

Fourth Letter Indicates profitability group : W=Weak Pr. // N=Neutral Pr. // R=Robust Pr.

4.3.3 Regression Results For Fama French Four Factor Model

Fama-French four factor model is employed as ;

$$R_i(t)-RF(t) = \alpha + \beta[RM(t)-RF(t)]+sSMB18(t) + hHML18(t) + r\,RMW18(t) + e(t) \quad (4.6)$$

where $R_i(t)$ is the return on portfolio i=SLW, SLN, SLR, SNW, SNN, SNR, SHW, SHN, SHR, BLW, BLN, BLR, BNW, BNN, BNR, BHW, BHN, BHR (See Table 2). $RF(t)$ is the risk free rate and $RM(t)$ is the return on the market index. $SMB18(t)$ is the difference between average returns of small size portfolios and big size portfolios, $HML18(t)$ is the difference between average returns of high B/M portfolios and low B/M portfolios, $RMW18(t)$ is the difference between the average returns of robust profitability portfolios and weak profitability portfolios (See equations 3.3, 3.4, and 3.5). $e(t)$ is the error term in our regression model.

The model has four RHS variables, which reflect the underlying risk factors which are represented by market excess return, excess return of small size portfolios over big size portfolios (a proxy for size risk factor), excess return of high B/M portfolios over low B/M portfolios, and excess return of robust profitability portfolios over weak profitability portfolios. LHS variables are the eighteen portfolio excess returns, $[R_i(t)-RF(t)]$, namely, ESLW, ESLN, ESLR, ESNW, ESNN, ESNR, ESHW, ESHN, ESHR, EBLW, EBLN, EBLR, EBNW, EBNN, EBNR, EBHW, EBHN, EBHR.

8 of the alphas are negative and only one of the alphas (in the 17^{th} regression – BHN) is statistically significant.

All of the betas are positive and significant like in all of the former regression results.

Of note that slope coefficients for SMB18 show an interesting pattern considering the size of the portfolios. To elaborate, for the 8 of the 9 big size portfolio excess returns, the s coefficients are statistically insignificant according to t-statistics. The reverse is true in the case of small size

portfolios. When four factor model is regressed on small size portfolios, all of the regression slopes of SMB18 are statistically significant. The same relation in the previous models and regressions regarding the slope pattern persists also in this set of regressions. Namely, the slope on SMB18 is decreasing from small size groups towards big size groups.

The sign of the coefficient of the HML18 factor is negative for seven regressions. Regarding the insignificance of the coefficients, the same situation also holds. That is, h's are insignificant in seven regressions, whereas they are significant in remaining eleven regressions. To check whether h has a relation to B/M groups, we should check B/M terciles keeping size and profitability constant. This comparison of h's shows us that in the regressions on high B/M portfolios, we obtain higher h values than on low B/M portfolios.

In 11 of the regressions, r takes a negative value and the half of estimated r's are insignificant. To check whether r has a relation to profitability groups, we should check profitability terciles keeping size and profitability constant. This comparison shows us that in the regressions on high profitability portfolios, we obtain higher r values than on low profitability portfolios.

R^2 values range between 0.55 and 0.91. Since there is a wide spread between R^2 values, it can be said that the explanatory power of the model depends on the returns explained. Thus, to gauge the performance of the model, calculating the average R^2 would be a better way. Although this will be left to the following section, it should be noted that there is almost no improvement in R^2 values compared to three factor model.

Table 19: Regression Results of Fama French Four Factor Model for Eighteen Size-B/M-Profitability Portfolios

Model : R(t)-RF(t) = α+β [RM(t)-RF(t)]+sSMB18(t)+hHML18(t)+rRMW18(t)+e(t)

	FF 4 Factor Model											
	α	t(α)	β	t(β)	s	t(s)	h	t(h)	r	t(r)	Adj R^2	F-stat
ESLW	-0.88	-1.65	1.05	16.20	0.75	5.45	-0.22	-1.73	-0.65	-4.32	0.77	90.62
ESLN	1.24	1.03	1.11	7.66	1.48	4.84	-1.60	-5.58	-0.24	-0.71	0.59	39.53
ESLR	0.09	0.11	0.93	9.56	1.32	6.42	-0.34	-1.76	0.76	3.38	0.55	33.51
ESNW	0.52	0.75	1.01	12.19	1.30	7.37	0.57	3.44	-1.28	-6.62	0.72	71.35
ESNN	-0.34	-0.73	1.01	18.21	0.99	8.41	0.30	2.73	-0.13	-1.04	0.78	97.62
ESNR	0.65	1.29	1.04	17.08	0.90	6.99	0.35	2.87	0.07	0.52	0.75	79.63
ESHW	-0.01	-0.02	0.92	20.37	0.90	9.40	0.48	5.34	-0.41	-3.92	0.83	133.34
ESHN	0.47	1.26	0.84	18.70	0.79	8.27	0.38	4.23	-0.21	-1.98	0.79	104.55
ESHR	-0.68	-1.47	1.00	18.03	1.07	9.12	0.44	3.94	0.12	0.93	0.77	93.05
EBLW	-0.75	-1.27	0.96	13.45	0.20	1.34	-0.27	-1.91	-0.52	-3.13	0.67	55.70
EBLN	1.04	1.59	0.83	10.46	-0.42	-2.49	-0.60	-3.83	-0.47	-2.55	0.58	38.31
EBLR	0.17	0.60	0.90	26.43	-0.05	-0.66	-0.23	-3.46	0.02	0.23	0.87	188.18
EBNW	-0.25	-0.43	0.95	13.73	0.24	1.64	0.02	0.13	-0.65	-4.04	0.68	58.63
EBNN	0.01	0.04	1.15	31.70	0.03	0.43	0.08	1.07	-0.06	-0.69	0.91	268.22
EBNR	-0.29	-0.88	1.12	28.16	-0.02	-0.28	-0.07	-0.91	0.31	3.37	0.89	207.18
EBHW	0.56	1.02	1.06	15.95	0.10	0.67	0.19	1.41	-0.82	-5.25	0.75	81.16
EBHN	1.31	2.57	0.97	15.73	0.17	1.27	0.62	5.07	-0.16	-1.08	0.73	73.37
EBHR	-0.75	-1.12	0.97	11.92	0.26	1.52	0.62	3.85	0.37	1.97	0.60	40.33

Notes: The letter E indicates Excess Return

Second letter indicates size group: S=Small // B=Big

Third Letter Indicates B/M group : L=Low B/M // N=Neutral B/M // H=High B/M

Fourth Letter Indicates profitability group : W=Weak Pr. // N=Neutral Pr. // R=Robust Pr.

4.4 Conclusion

Firstly, when excess returns of six size-B/M portfolios were regressed on CAPM, five out of six alphas were found to be statistically insignificant, which is a desired result in our case, since it shows that pricing errors are low. When three factor model was applied, none of the alphas were statistically significant, which indicates an improvement regarding pricing error. Like in the case of CAPM, regressions for four factor model also gave only one statistically significant alpha. Regarding the regressions for CAPM, all of the slope coefficients of market factor were statistically significant. Three factor model gave statistically significant *β'*s. However, two of the slope coefficients of SMB6 and one of the slope coefficient of HML6 factor were found to be insignificant. Four factor model produced statistically significant *β'*s. Like in case of three factor model, in two regressions out of six, the coefficient of SMB18 factor is insignificant. It should be noted, that for both models, insignificant coefficients were obtained in regressions on the excess returns of big size portfolios. Another similarity arises regarding the regression slope of HML factor. One out of six regressions gave us an insignificant coefficient. Regarding the coefficients of RMW18 factor, it can be said that only two of them are statistically significant. R^2 values for CAPM ranges between 0.42 and 0.96,which indicates a large spread depending on the excess returns explained. In contrast to CAPM, there is not a large spread in R^2 values in case of three factor model, which ranges between 0.87 and 0.96. A similar situation exists for four factor model, R^2 values of which range between 0.85 and 0.96.

The second section examined the regression results for eighteen size-B/M-profitability portfolios. CAPM and the three factor model produces three significant alphas and fifteen insignificant ones, while four factor model produced only one insignificant alpha. Thus, in general, the pricing errors were insignificant. Regarding *β'*s, the coefficients of market risk factor, all of the three models produced statistically significant coefficients in all of the

regressions. Four insignificant and fourteen significant slope coefficients were obtained examining the t –statistics of s's for three factor model. Eight insignificant and ten significant s's were obtained examining the t-statistics of four factor model. Here it should be underlined that in regressions on excess returns of big size portfolios, only one of the slope coefficients was statistically significant. The regression slopes of HML6 factor in three factor model, h's , are significant in ten of the regressions. In case of four factor model, we obtained eleven significant h's, which represents the coefficient of HML18 factor. Skipping to the RMW18 factor, it can be stated that half of the coefficients were statistically significant. R^2 values for CAPM ranges between 0.17 and 0.91,which indicates a considerably large spread. So, CAPM was not able to explain the average excess returns of some portfolios. Though smaller than in case of CAPM, there is also a large spread in R^2 values in case of three factor model, which ranges between 0.52 and 0.91. A similar situation exists for four factor model, R^2 values of which range between 0.55 and 0.91.

CHAPTER 5

MODEL PERFORMANCE

5.1. Introduction

In this section, the performance of three models will be compared using three different statistical indicators. The first one is average adjusted R^2 values, which is also called coefficient of determination. This will give an idea about the explanatory powers of the models. The second one is GRS-F statistics of Gibbons, Ross, and Shanken (1989), which gives information about whether the estimated intercepts from the regressions are jointly zero. And the third statistical value will be mean absolute value of intercept term, which reflects the pricing error in the model.

5.2. Comparison of the Performances of Three Models

Three models, the performances of which will be compared CAPM, Fama-French three factor model and Fama-French four factor model. The regression equations are shown below:

CAPM:

$$R_i(t)-RF(t) = \alpha + \beta\,[RM(t) - RF(t)] + e(t)$$

FF 3 Factor Model:

$$R_i(t) -RF(t) = \alpha + \beta\,[RM(t)-RF(t)] + sSMB6(t) + hHML6(t) + e(t)$$

FF 4 Factor Model:

$$R_i(t) - RF(t)= \alpha+ \beta\,[RM(t)-RF(t)] + sSMB18(t) + hHML18(t) + rRMW18(t) + e(t)$$

Table 20 shows the dependent variable, model used in the regression, average R^2 values, GRS-F statistics and corresponding p-values and mean absolute value of the intercept terms.

Table 20: Statistics for Comparison of Model Performances

№	Dependent Variable	Model	Ave R^2	GRS-F	p-value	MAV
1	Excess Return of 6 Portfolios	CAPM	0.740	1.091	0.373	0.428
		FF 3 Factor	0.920	0.545	0.773	0.178
		FF 4 Factor	0.900	0.820	0.557	0.311
2	Excess Return of 18 Portfolios	CAPM	0.600	2.413	0.003	0.553
		FF 3 Factor	0.742	2.280	0.006	0.544
		FF 4 Factor	0.745	1.623	0.071	0.557

Notes : Regression models are shown below:

CAPM → $R_i(t)-RF(t) = \alpha + \beta\,[RM(t)-RF(t)] + e(t)$

FF 3 Factor Model → $R_i(t)-RF(t) = \alpha + \beta\,[RM(t)-RF(t)] + sSMB6(t) + hHML6(t) + e(t)$

FF 4 Factor Model → $R_i(t)-RF(t)=\alpha+ \beta[RM(t)-RF(t)]+sSMB18(t)+hHML18(t)+ rRMW18(t) + e(t)$

Firstly, if the R^2 values are compared for 6 portfolios, it can be easily said that, FF three factor model is superior to CAPM. The addition of SMB6 and HML6 factors to CAPM has caused a considerable improvement in R^2 value from 0.74 to 0.92. Thus, this result shows that these two factors together with market factor explains excess returns well. If we make a comparison

between three factor model and four factor model, it seems that addition of the fourth factor does not make a contribution to explanatory power of the model. In contrary, three factor model can be claimed to be more successful in explaining the excess returns of six portfolios than four factor model is. The decline in the value from 0.92 to 0.90 is a proof of this situation. Both of these results comply with the results of Fama French 1993 and Fama French 2013 papers. In their 1993 paper, they concluded that addition of SMB and HML factors to the CAPM substantially increased the explanatory power of the model. The difference is the portfolios they used were 25 portfolios formed according to size and B/M. And in their 2013 paper, they detected that the addition of the profitability factor to the three factor model slightly decreased R^2 from 0.92 to 0.91 if we consider the results of the models, whose factors are constructed by 2x3x3 size, B/M and profitability groups.

If we continue examining R^2 values of the models for explaining excess returns of 18 portfolios, we can state that none of the models can capture the variation in excess returns. However, again the addition of size and B/M factors increases the explanatory power considerably. Although, a large part of the variation still remains unexplained by three factor model (R^2=0.74), a 0.14 is gained compared to CAPM. So we get a similar result for the performance of the models like in the case of six portfolios. If we compare the level of the explanatory power of three and four factor models when faced with 18 portfolios, it is clear that the fourth factor makes a really minor contribution as 0.003 which can even be neglected. So both three and four factor models are superior to CAPM based on R^2 values.

The next statistics which will be used to gauge the performance of three models is GRS statistic of Gibbons, Ross, and Shanken (1989), which tests whether the estimated intercepts from the regressions are jointly zero. In Fama and French's words:

> "If a model completely captures expected returns, the regression slopes for the model's factors and the average returns on the

> factors combine to explain the average excess returns on all assets. In other words, the ideal model's regression intercepts are indistinguishable from zero for all left hand side assets."

To put differently, the null hypothesis H_0: $\alpha i = 0$ is tested to see whether the intercept terms are insignificant jointly. GRS values are calculated using the formula ;

$$J = \frac{(T-N-k)}{N}\left(1+\boldsymbol{\mu}_k{}'\boldsymbol{\Omega}^{-1}\boldsymbol{\mu}_k\right)^{-1}\hat{\boldsymbol{\alpha}}'\hat{\boldsymbol{\Sigma}}^{-1}\hat{\boldsymbol{\alpha}}$$

Where T is number of time series observations (108), N is the number of assets or portfolios (6 and 18 depending on LHS portfolios), k is the number of the factors in the model (1 -3- 4 in our case). μ_k is a k-vector of factor means, Ω is a k x k covariance matrix of the factor returns and alphas are estimated constants obtained from the regressions. The GRS-F values and corresponding p-values were calculated using excel.

A high GRS value is not desired, since it produces a low p-value and causes the rejection of null hypothesis. Firstly, if we look at the GRS values of three models regarding the regressions on six portfolio excess returns, none of the models is rejected. This result contradicts with Fama and French 1993 and 2013 papers. In their 1993 paper, all of the models used to explain the 25 size-B/M portfolios were rejected strongly based on GRS test. And in their 2013 paper, both three factor and four factor models were rejected again when confronted with 25 size-B/M and 32 size-B/M-OP portfolios. However, the addition of the fourth factor decreases the GRS statistics slightly. In our case, considering the GRS values, we can say that FF three factor model is obviously superior with a GRS value 0.545 (p-value 0.773) both to CAPM and FF four factor model. The best model for explaining the excess returns of six portfolios is FF Three Factor Model according to Table 20.

When we use the excess returns of 18 portfolios as LHS variables, we encounter with a different result. While CAPM and FF three factor models are strongly rejected with p-values close to zero, FF four factor model is not

rejected in 95% confidence interval with a p-value 0.07. Nevertheless, the GRS and p-value corresponding to that shows that even this model does not fare well when regression is run on 18 portfolios. Although the other two models are rejected, we can use GRS values to compare the effectiveness of the models, since the aim is not to find the perfect model, but the best one in explaining the expected returns. Since FF three factor produces slightly lower GRS value, this model can be said to have superiority to CAPM.

According to Fama and French, rejection or not rejection on the GRS test may be irrelevant for investors, if this is caused by small deviations of expected returns from model predictions. And they state that their favorite statistics for evaluating a model for investment purposes are the average absolute intercepts or mean absolute value of alphas (MAV). Even if a model is rejected on GRS test, MAV of alphas should be checked to identify the most successful model. The smaller MAV of alphas for a model, the more successful it explains average returns. Regarding MAV values, which were obtained taking the average of estimated alphas for each model, FF three factor shows its superiority to CAPM and four factor model. And four factor model fares a better job than CAPM in explaining excess returns if we compare 0.311 and 0.428.

When we compare the MAV of alphas produced by regressing three models on the excess returns of 18 portfolios, although three factor model again outperforms other two models, this time the MAV are very close to each other. Thus the model performances are almost the same regarding MAV. The result indicated by MAV also contradicts the conclusion reached in the light of GRS statistics. While the only model which is not rejected on GRS test was FF four factor model, it has the highest MAV among three models.

5.3. Conclusion

In this chapter, three different statistical measures were used to compare the performances of three models, namely CAPM, Fama-French three factor model and Fama-French four factor model.

First statistical measure is average adjusted R^2 values. These values show that when faced with the excess returns of six size-B/M portfolios, the most successful model is Fama-French three factor model as seen in Table 20. In case of eighteen size-B/M-profitability portfolios, we observe that three and four factor models produce almost similar R^2 values. Four factor model fares slightly better job than three factor model with a difference of 0.003. On the other hand, it is concluded that CAPM can not explain the excess returns based on low R^2 values. Furthermore, the relative explanatory powers of the models depend on the returns explained. That is, three factor model is better than four factor model in explaining excess returns of six size-B/M portfolios, while four factor model fares a better job in case of eighteen size-B/M-profitability portfolios.

The second statistical measure is GRS-F test. Regarding the regressions on the excess returns of six size-B/M portfolios, the three factor model again proves to be the most successful model with the lowest GRS-F value. None of the models is rejected based GRS-F value. Regarding the regressions on the excess returns of eighteen size-B/M-profitability portfolios, both CAPM and three factor model are rejected due to the high GRS-F values. However, four factor model is not rejected and proves itself to be the most successful model.

The third statistical measure is mean absolute value of alphas, which is the most important statistics for evaluating a model for investment purposes according to Fama and French. MAV of intercept terms show that the best model is three factor model with the lowest value (see Table 20). This result

is valid both for the regressions on the excess returns of six size-B/M portfolios and eighteen size-B/M-profitability portfolios.

CHAPTER 6

CONCLUSION

The aim of this study is testing the validity of Fama French Four Factor model in ISE between July 2004 and June 2013, evaluating the effectiveness of model in explaining variation of expected returns. Not only the performance of four factor model was evaluated, but also the performances of CAPM and three factor model were compared to four factor model to determine the most effective model.

In contrast to the results of Fama and French papers (1993,2013), for the regressions on the six portfolios formed on 2x3 size-B/M sorts, none of the models were rejected on GRS test. In spite the fact that, four factor model was not rejected and performs well in explaining excess returns, three factor model was apparently superior to four factor model. The same situation also persisted regarding the measurement of performance based on MAV. The MAV of alphas showed that four factor model fares a good job in capturing the patterns in average returns related to size and B/M but not as good as three factor model. In addition, the R^2 values, which are the indicators of a model's explanatory power leads us to the same conclusion, that three factor model is superior to both models. To sum up, when faced with the excess returns of 6 portfolios, three factor model outperforms both CAPM and four factor model based on three different statistical values. So the four factor model is not rejected and has high explanatory power, but compared to three factor model it is less effective. This means that the addition of profitability factor did not make any contribution in explaining the average excess returns of six portfolios.

Considering the GRS statistics obtained for three models which were regressed on 18 portfolios produced by 2x3x3 size-B/M-profitability sorts, we can claim that the most successful model is four factor model. This means that four factor model captures the patterns in average returns related to size, B/M and profitability better than other two models. CAPM and three factor model are rejected on GRS. This means that pricing error in these models are not different than zero and the factors used can not explain the variation in excess returns. Based on R^2 values, we reach a similar conclusion. Although the increase in value is quiet small, skipping from three to four factor model improves the explanatory power. Thus, the addition of the profitability factor increases the effectiveness of the model and eliminates the rejection. Interestingly, when we judge the models on MAV of alphas, which is the most important indicator for investors, the outcome changes. The three factor model seems more effective than four factor model because of the smaller MAV, which indicates smaller regression intercepts and higher power to explain excess returns.

To conclude, it can be said that Fama-French four factor model is valid in ISE, because the model is not rejected on GRS and high R^2 values with small MAV of alphas indicate the effectiveness of model. However, three factor model fares better in explaining the excess returns of six portfolios based on GRS and fares better in explaining the excess returns of 18 portfolios based on MAV.

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APPENDIX A

Table A.1: List of the Stocks Included In the Sample

Period	July 2004-June 2005	July 2005-June 2006	July 2006-June 2007	July 2007-June 2008	July 2008-June 2009	July 2009-June 2010	July 2010-June 2011	July 2011-June 2012	July 2012-June 2013
No of Firms	**185**	**195**	**204**	**218**	**224**	**230**	**237**	**259**	**264**
1	ADANA	ADANA	ADANA	ADANA	ADANA	ADANA	ADANA	ADANA	ADANA
2	ADBGR	ADBGR	ADBGR	ADBGR	ADBGR	ADBGR	ADBGR	ADBGR	ADBGR
3	ADEL	ADEL	ADEL	ADEL	ADEL	ADEL	ADEL	ADEL	ADEL
4	ADNAC	ADNAC	ADNAC	ADNAC	ADNAC	ADNAC	ADNAC	ADNAC	ADNAC
5	AEFES	AEFES	AEFES	AEFES	AEFES	AEFES	AEFES	AEFES	AEFES
6	AFYON	AFMAS	AFMAS	AFMAS	AFMAS	AFMAS	AFMAS	AFMAS	AFMAS
7	AGYO	AFYON	AFYON	AFYON	AFYON	AFYON	AFYON	AFYON	AFYON
8	AKBNK	AGYO	AGYO	AGYO	AGYO	AGYO	AGYO	AGYO	AGYO
9	AKCNS	AKBNK	AKBNK	AKBNK	AKBNK	AKBNK	AKBNK	AKBNK	AKBNK
10	AKENR	AKCNS	AKCNS	AKCNS	AKCNS	AKCNS	AKCNS	AKCNS	AKCNS
11	AKGRT	AKENR	AKENR	AKENR	AKENR	AKENR	AKENR	AKENR	AKENR

Table A.1 (continued)

Period	July 2004-June 2005	July 2005-June 2006	July 2006-June 2007	July 2007-June 2008	July 2008-June 2009	July 2009-June 2010	July 2010-June 2011	July 2011-June 2012	July 2012-June 2013
12	AKSA	AKGRT	AKGRT	AKGRT	AKGRT	AKGRT	AKGRT	AKFEN	AKFEN
13	AKSUE	AKSA	AKMGY	AKMGY	AKMGY	AKMGY	AKMGY	AKGRT	AKGRT
14	ALARK	AKSUE	AKSA	AKSA	AKSA	AKSA	AKSA	AKMGY	AKMGY
15	ALCAR	ALARK	AKSUE	AKSUE	AKSUE	AKSUE	AKSUE	AKSA	AKSA
16	ALCTL	ALCAR	ALARK	ALARK	ALARK	ALARK	ALARK	AKSEN	AKSEN
17	ALGYO	ALCTL	ALCAR	ALCAR	ALBRK	ALBRK	ALBRK	AKSUE	AKSUE
18	ALKA	ALGYO	ALCTL	ALCTL	ALCAR	ALCAR	ALCAR	ALARK	ALARK
19	ALKIM	ALKA	ALGYO	ALGYO	ALCTL	ALCTL	ALCTL	ALBRK	ALBRK
20	ALNTF	ALKIM	ALKA	ALKA	ALGYO	ALGYO	ALGYO	ALCAR	ALCAR
21	ALTIN	ALNTF	ALKIM	ALKIM	ALKA	ALKA	ALKA	ALCTL	ALCTL
22	ANACM	ALTIN	ALNTF	ALNTF	ALKIM	ALKIM	ALKIM	ALGYO	ALGYO
23	ANHYT	ANACM	ALTIN	ALTIN	ALNTF	ALNTF	ALNTF	ALKA	ALKA
24	ANSGR	ANHYT	ALYAG	ALYAG	ALTIN	ALTIN	ALTIN	ALKIM	ALKIM
25	ARCLK	ANSGR	ANACM	ANACM	ALYAG	ALYAG	ALYAG	ALNTF	ALNTF
26	ARENA	ARCLK	ANHYT	ANELT	ANACM	ANACM	ANACM	ALTIN	ALTIN
27	ARFYO	ARENA	ANSGR	ANHYT	ANELT	ANELT	ANELT	ALYAG	ALYAG
28	ARSAN	ARFYO	ARCLK	ANSGR	ANHYT	ANHYT	ANHYT	ANACM	ANACM

Table A.1 (continued)

Period	July 2004-June 2005	July 2005-June 2006	July 2006-June 2007	July 2007-June 2008	July 2008-June 2009	July 2009-June 2010	July 2010-June 2011	July 2011-June 2012	July 2012-June 2013
29	ASELS	ARSAN	ARENA	ARCLK	ANSGR	ANSGR	ANSGR	ANELE	ANELE
30	ASUZU	ASELS	ARFYO	ARENA	ARCLK	ARCLK	ARCLK	ANELT	ANELT
31	ATEKS	ASUZU	ARSAN	ARFYO	ARENA	ARENA	ARENA	ANHYT	ANHYT
32	ATLAS	ATEKS	ASELS	ARSAN	ARFYO	ARFYO	ARFYO	ANSGR	ANSGR
33	AYEN	ATLAS	ASUZU	ASELS	ARSAN	ARSAN	ARSAN	ARCLK	ARCLK
34	AYGAZ	AYEN	ATEKS	ASUZU	ASELS	ASELS	ASELS	ARENA	ARENA
35	BAGFS	AYGAZ	ATLAS	ASYAB	ASUZU	ASUZU	ASUZU	ARFYO	ARFYO
36	BAKAB	BAGFS	AVIVA	ATEKS	ASYAB	ASYAB	ASYAB	ARSAN	ARSAN
37	BANVT	BAKAB	AYEN	ATLAS	ATEKS	ATEKS	ATEKS	ASELS	ASELS
38	BFREN	BANVT	AYGAZ	AVIVA	ATLAS	ATLAS	ATLAS	ASUZU	ASUZU
39	BJKAS	BFREN	BAGFS	AYEN	AVIVA	AVIVA	AVIVA	ASYAB	ASYAB
40	BOLUC	BJKAS	BAKAB	AYGAZ	AYEN	AYEN	AYEN	ATEKS	ATEKS
41	BOSSA	BOLUC	BANVT	BAGFS	AYGAZ	AYGAZ	AYGAZ	ATLAS	ATLAS
42	BRISA	BOSSA	BFREN	BAKAB	BAGFS	BAGFS	BAGFS	AVGYO	AVGYO
43	BRSAN	BRISA	BIMAS	BANVT	BAKAB	BAKAB	BAKAB	AVIVA	AVIVA
44	BRYAT	BRSAN	BJKAS	BFREN	BANVT	BANVT	BANVT	AYEN	AYEN
45	BSOKE	BRYAT	BOLUC	BIMAS	BFREN	BFREN	BFREN	AYGAZ	AYGAZ

Table A.1 (continued)

Period	July 2004-June 2005	July 2005-June 2006	July 2006-June 2007	July 2007-June 2008	July 2008-June 2009	July 2009-June 2010	July 2010-June 2011	July 2011-June 2012	July 2012-June 2013
46	BTCIM	BSOKE	BOSSA	BJKAS	BIMAS	BIMAS	BIMAS	BAGFS	BAGFS
47	BUCIM	BTCIM	BRISA	BOLUC	BJKAS	BJKAS	BOLUC	BAKAB	BAKAB
48	BURCE	BUCIM	BRSAN	BOSSA	BOLUC	BOLUC	BOSSA	BANVT	BANVT
49	CELHA	BURCE	BRYAT	BOYNR	BOSSA	BOSSA	BOYNR	BFREN	BFREN
50	CEMTS	BURVA	BSOKE	BRISA	BOYNR	BOYNR	BRISA	BIMAS	BIMAS
51	CIMSA	CELHA	BTCIM	BRSAN	BRISA	BRISA	BRSAN	BOLUC	BMEKS
52	CLEBI	CEMTS	BUCIM	BRYAT	BRSAN	BRSAN	BRYAT	BOSSA	BOLUC
53	CMBTN	CIMSA	BURCE	BSHEV	BRYAT	BRYAT	BSHEV	BOYNR	BOSSA
54	CMENT	CLEBI	BURVA	BSOKE	BSHEV	BSHEV	BSOKE	BRISA	BOYNR
55	DENCM	CMBTN	CELHA	BTCIM	BSOKE	BSOKE	BTCIM	BRSAN	BRISA
56	DENTA	CMENT	CEMTS	BUCIM	BTCIM	BTCIM	BUCIM	BRYAT	BRSAN
57	DERIM	DENCM	CIMSA	BURCE	BUCIM	BUCIM	BURCE	BSHEV	BRYAT
58	DEVA	DENTA	CLEBI	BURVA	BURCE	BURCE	BURVA	BSOKE	BSHEV
59	DITAS	DERIM	CMBTN	CARFA	BURVA	BURVA	CARFA	BTCIM	BSOKE
60	DMSAS	DESA	CMENT	CARFB	CARFA	CARFA	CARFB	BUCIM	BTCIM
61	DNZYO	DEVA	DENCM	CCOLA	CARFB	CARFB	CCOLA	BURCE	BUCIM
62	DOHOL	DITAS	DENIZ	CELHA	CCOLA	CCOLA	CELHA	BURVA	BURCE

Table A.1 (continued)

Period	July 2004-June 2005	July 2005-June 2006	July 2006-June 2007	July 2007-June 2008	July 2008-June 2009	July 2009-June 2010	July 2010-June 2011	July 2011-June 2012	July 2012-June 2013
63	DYHOL	DMSAS	DENTA	CEMTS	CELHA	CELHA	CEMTS	CARFA	BURVA
64	DYOBY	DNZYO	DERIM	CIMSA	CEMTS	CEMTS	CIMSA	CARFB	CARFA
65	ECBYO	DOHOL	DESA	CLEBI	CIMSA	CIMSA	CLEBI	CCOLA	CARFB
66	ECILC	DYHOL	DEVA	CMBTN	CLEBI	CLEBI	CMBTN	CELHA	CCOLA
67	ECYAP	DYOBY	DGZTE	CMENT	CMBTN	CMBTN	CMENT	CEMTS	CELHA
68	ECZYT	ECBYO	DITAS	DENCM	CMENT	CMENT	COMDO	CIMSA	CEMTS
69	EDIP	ECILC	DMSAS	DENIZ	DENCM	CRDFA	CRDFA	CLEBI	CIMSA
70	EGEEN	ECYAP	DNZYO	DENTA	DENIZ	DENCM	DENCM	CMBTN	CLEBI
71	EGGUB	ECZYT	DOAS	DERIM	DENTA	DENIZ	DENIZ	CMENT	CMBTN
72	EGSER	EDIP	DOHOL	DESA	DERIM	DENTA	DENTA	COMDO	CMENT
73	ENKAI	EGEEN	DYHOL	DEVA	DESA	DERIM	DERIM	CRDFA	COMDO
74	ERBOS	EGGUB	DYOBY	DGZTE	DEVA	DESA	DESA	DENCM	COSMO
75	EREGL	EGSER	ECBYO	DITAS	DGZTE	DEVA	DEVA	DENIZ	CRDFA
76	ERSU	EMKEL	ECILC	DMSAS	DITAS	DGGYO	DGGYO	DENTA	DENCM
77	ESCOM	ENKAI	ECYAP	DNZYO	DMSAS	DGZTE	DGZTE	DERIM	DENIZ
78	FENIS	ERBOS	ECZYT	DOAS	DNZYO	DITAS	DITAS	DESA	DENTA
79	FFKRL	EREGL	EDIP	DOHOL	DOAS	DMSAS	DMSAS	DEVA	DERIM

Table A.1 (continued)

Period	July 2004-June 2005	July 2005-June 2006	July 2006-June 2007	July 2007-June 2008	July 2008-June 2009	July 2009-June 2010	July 2010-June 2011	July 2011-June 2012	July 2012-June 2013
80	FINBN	ERSU	EGEEN	DURDO	DOHOL	DNZYO	DNZYO	DGGYO	DESA
81	FMIZP	ESCOM	EGGUB	DYHOL	DURDO	DOAS	DOAS	DGZTE	DEVA
82	FNSYO	FENER	EGSER	DYOBY	DYHOL	DOHOL	DOHOL	DITAS	DGGYO
83	FRIGO	FENIS	EMKEL	ECBYO	DYOBY	DURDO	DURDO	DMSAS	DGZTE
84	FROTO	FFKRL	ENKAI	ECILC	ECBYO	DYHOL	DYHOL	DNZYO	DITAS
85	FVORI	FINBN	ERBOS	ECYAP	ECILC	DYOBY	DYOBY	DOAS	DMSAS
86	GARAN	FMIZP	EREGL	ECZYT	ECYAP	ECBYO	ECBYO	DOCO	DNZYO
87	GARFA	FNSYO	ERSU	EDIP	ECZYT	ECILC	ECILC	DOHOL	DOAS
88	GENTS	FRIGO	ESCOM	EGCYO	EDIP	ECYAP	ECYAP	DURDO	DOHOL
89	GEREL	FROTO	FENER	EGEEN	EGCYO	ECZYT	ECZYT	DYHOL	DURDO
90	GOLTS	FVORI	FENIS	EGGUB	EGEEN	EDIP	EDIP	DYOBY	DYHOL
91	GOODY	GARAN	FFKRL	EGSER	EGGUB	EGCYO	EGCYO	ECBYO	DYOBY
92	GRNYO	GARFA	FINBN	ENKAI	EGSER	EGEEN	EGEEN	ECILC	ECBYO
93	GSDHO	GENTS	FMIZP	ERBOS	ENKAI	EGGUB	EGGUB	ECYAP	ECILC
94	GSRAY	GEREL	FNSYO	EREGL	ERBOS	EGSER	EGSER	ECZYT	ECYAP
95	GUBRF	GOLTS	FRIGO	ERSU	EREGL	EMBYO	EMBYO	EDIP	ECZYT
96	GUSGR	GOODY	FROTO	ESCOM	ERSU	ENKAI	EMKEL	EGCYO	EDIP

Table A.1 (continued)

Period	July 2004-June 2005	July 2005-June 2006	July 2006-June 2007	July 2007-June 2008	July 2008-June 2009	July 2009-June 2010	July 2010-June 2011	July 2011-June 2012	July 2012-June 2013
97	HEKTS	GRNYO	FVORI	FENER	ESCOM	ERBOS	ENKAI	EGEEN	EGCYO
98	HURGZ	GSDHO	GARAN	FENIS	FENER	EREGL	ERBOS	EGGUB	EGEEN
99	IDAS	GSRAY	GARFA	FFKRL	FENIS	ERSU	EREGL	EGSER	EGGUB
100	IHEVA	GUBRF	GENTS	FINBN	FFKRL	ESCOM	ERSU	EKGYO	EGSER
101	IHLAS	GUSGR	GEREL	FMIZP	FINBN	FENER	ESCOM	EMBYO	EKGYO
102	INTEM	HEKTS	GLYHO	FNSYO	FMIZP	FENIS	ETYAT	EMKEL	EMBYO
103	ISCTR	HURGZ	GOLTS	FRIGO	FNSYO	FFKRL	FENER	ENKAI	EMKEL
104	ISGYO	IDAS	GOODY	FROTO	FRIGO	FINBN	FENIS	ERBOS	ENKAI
105	ISYAT	IHEVA	GRNYO	FVORI	FROTO	FMIZP	FFKRL	EREGL	ERBOS
106	IZMDC	IHLAS	GSDHO	GARAN	FVORI	FNSYO	FINBN	ERSU	EREGL
107	IZOCM	INDES	GSRAY	GARFA	GARAN	FRIGO	FMIZP	ESCOM	ERSU
108	KAPLM	INTEM	GUBRF	GDKYO	GARFA	FROTO	FNSYO	ETYAT	ESCOM
109	KARSN	ISCTR	GUSGR	GENTS	GDKYO	FVORI	FRIGO	FENER	ETYAT
110	KARTN	ISFIN	HEKTS	GEREL	GENTS	GARAN	FROTO	FENIS	FENER
111	KCHOL	ISGSY	HURGZ	GLYHO	GEREL	GARFA	FVORI	FFKRL	FENIS
112	KENT	ISGYO	IDAS	GOLTS	GLYHO	GDKYO	GARAN	FINBN	FFKRL
113	KIPA	ISYAT	IHEVA	GOODY	GOLTS	GENTS	GARFA	FMIZP	FINBN

Table A.1 (continued)

Period	July 2004-June 2005	July 2005-June 2006	July 2006-June 2007	July 2007-June 2008	July 2008-June 2009	July 2009-June 2010	July 2010-June 2011	July 2011-June 2012	July 2012-June 2013
114	KLMSN	IZMDC	IHLAS	GRNYO	GOODY	GEREL	GDKYO	FNSYO	FMIZP
115	KONYA	IZOCM	INDES	GSDHO	GRNYO	GLYHO	GENTS	FRIGO	FNSYO
116	KORDS	KAPLM	INTEM	GSRAY	GSDHO	GOLTS	GEREL	FROTO	FRIGO
117	KRDMA	KARSN	ISCTR	GUBRF	GSRAY	GOODY	GLYHO	FVORI	FROTO
118	KRDMB	KARTN	ISFIN	GUSGR	GUBRF	GRNYO	GOLTS	GARAN	GARAN
119	KRDMD	KCHOL	ISGSY	HEKTS	GUSGR	GSDHO	GOODY	GARFA	GARFA
120	KRSTL	KENT	ISGYO	HURGZ	HALKB	GSRAY	GRNYO	GDKYO	GDKYO
121	KRTEK	KIPA	ISYAT	IDAS	HEKTS	GUBRF	GSDHO	GENTS	GENTS
122	KUTPO	KLMSN	IZMDC	IHEVA	HURGZ	GUSGR	GSRAY	GEREL	GEREL
123	LINK	KONYA	IZOCM	IHLAS	IDAS	HALKB	GUBRF	GLYHO	GLYHO
124	LOGO	KORDS	KAPLM	INDES	IHEVA	HEKTS	GUSGR	GOLTS	GOLTS
125	MAALT	KRDMA	KARSN	INTEM	IHLAS	HURGZ	HALKB	GOODY	GOODY
126	MERKO	KRDMB	KARTN	ISCTR	INDES	IDAS	HEKTS	GRNYO	GOZDE
127	MIPAZ	KRDMD	KCHOL	ISFIN	INTEM	IHEVA	HURGZ	GSDHO	GRNYO
128	MNDRS	KRSTL	KENT	ISGSY	ISCTR	IHLAS	IDAS	GSRAY	GSDDE
129	MRDIN	KRTEK	KIPA	ISGYO	ISFIN	INDES	IHEVA	GUBRF	GSDHO
130	MRSHL	KUTPO	KLMSN	ISYAT	ISGSY	INTEM	IHLAS	GUSGR	GUBRF

Table A.1 (continued)

Period	July 2004-June 2005	July 2005-June 2006	July 2006-June 2007	July 2007-June 2008	July 2008-June 2009	July 2009-June 2010	July 2010-June 2011	July 2011-June 2012	July 2012-June 2013
131	MUTLU	LINK	KONYA	IZMDC	ISGYO	ISCTR	INDES	HALKB	GUSGR
132	NETAS	LOGO	KORDS	IZOCM	ISMEN	ISFIN	INTEM	HEKTS	HALKB
133	NTHOL	MAALT	KRDMA	KAPLM	ISYAT	ISGSY	ISCTR	HURGZ	HEKTS
134	NTTUR	MERKO	KRDMB	KAREL	IZMDC	ISGYO	ISFIN	IDAS	HURGZ
135	NUGYO	MIPAZ	KRDMD	KARSN	IZOCM	ISMEN	ISGSY	IDGYO	IDAS
136	NUHCM	MNDRS	KRSTL	KARTN	KAPLM	ISYAT	ISGYO	IHEVA	IDGYO
137	OTKAR	MRDIN	KRTEK	KCHOL	KAREL	IZMDC	ISMEN	IHGZT	IHEVA
138	PARSN	MRSHL	KUTPO	KENT	KARSN	IZOCM	ISYAT	IHLAS	IHGZT
139	PENGD	MUTLU	LINK	KIPA	KARTN	KAPLM	IZMDC	IHYAY	IHLAS
140	PETKM	NETAS	LOGO	KLMSN	KCHOL	KAREL	IZOCM	INDES	IHYAY
141	PETUN	NTHOL	MAALT	KONYA	KENT	KARSN	KAPLM	INTEM	INDES
142	PIMAS	NTTUR	MERKO	KORDS	KIPA	KARTN	KAREL	ISCTR	INTEM
143	PINSU	NUGYO	MIPAZ	KRDMA	KLMSN	KCHOL	KARSN	ISFIN	IPEKE
144	PNSUT	NUHCM	MNDRS	KRDMB	KONYA	KENT	KARTN	ISGSY	ISCTR
145	PRKAB	OTKAR	MRDIN	KRDMD	KORDS	KIPA	KCHOL	ISGYO	ISFIN
146	PTOFS	PARSN	MRSHL	KRSTL	KRDMA	KLMSN	KENT	ISMEN	ISGSY
147	RAYSG	PENGD	MUTLU	KRTEK	KRDMB	KONYA	KIPA	ISYAT	ISGYO

Table A.1 (continued)

Period	July 2004-June 2005	July 2005-June 2006	July 2006-June 2007	July 2007-June 2008	July 2008-June 2009	July 2009-June 2010	July 2010-June 2011	July 2011-June 2012	July 2012-June 2013
148	SAHOL	PETKM	NETAS	KUTPO	KRDMD	KORDS	KLMSN	ISYHO	ISMEN
149	SANKO	PETUN	NTHOL	LINK	KRSTL	KRDMA	KONYA	ITTFH	ISYAT
150	SARKY	PIMAS	NTTUR	LOGO	KRTEK	KRDMB	KORDS	IZMDC	ISYHO
151	SASA	PINSU	NUGYO	MAALT	KUTPO	KRDMD	KOZAA	IZOCM	ITTFH
152	SERVE	PNSUT	NUHCM	MERKO	LINK	KRSTL	KRDMA	KAPLM	IZMDC
153	SISE	PRKAB	OTKAR	MIPAZ	LOGO	KRTEK	KRDMB	KAREL	IZOCM
154	SKBNK	PTOFS	PARSN	MNDRS	MAALT	KUTPO	KRDMD	KARSN	KAPLM
155	SKPLC	RAYSG	PENGD	MRDIN	MERKO	LINK	KRSTL	KARTN	KAREL
156	SKTAS	SAHOL	PETKM	MRSHL	MIPAZ	LOGO	KRTEK	KCHOL	KARSN
157	SODA	SANKO	PETUN	MUTLU	MNDRS	MAALT	KUTPO	KENT	KARTN
158	TBORG	SARKY	PIMAS	NETAS	MRDIN	MERKO	LINK	KIPA	KCHOL
159	TCELL	SASA	PINSU	NTHOL	MRSHL	MIPAZ	LOGO	KLMSN	KENT
160	TEBNK	SERVE	PNSUT	NTTUR	MUTLU	MNDRS	MAALT	KLNMA	KILER
161	TEKST	SISE	PRKAB	NUGYO	NETAS	MRDIN	MARTI	KONYA	KIPA
162	TEKTU	SKBNK	PTOFS	NUHCM	NTHOL	MRSHL	MERKO	KORDS	KLMSN
163	THYAO	SKPLC	RAYSG	OTKAR	NTTUR	MUTLU	MGROS	KOZAA	KLNMA
164	TIRE	SKTAS	SAHOL	PARSN	NUGYO	NETAS	MIPAZ	KOZAL	KONYA

Table A.1 (continued)

Period	July 2004-June 2005	July 2005-June 2006	July 2006-June 2007	July 2007-June 2008	July 2008-June 2009	July 2009-June 2010	July 2010-June 2011	July 2011-June 2012	July 2012-June 2013
165	TOASO	SODA	SANKO	PENGD	NUHCM	NTHOL	MNDRS	KRDMA	KORDS
166	TRCAS	TBORG	SARKY	PETKM	OTKAR	NTTUR	MRDIN	KRDMB	KOZAA
167	TRKCM	TCELL	SASA	PETUN	PARSN	NUGYO	MRSHL	KRDMD	KOZAL
168	TSKB	TEBNK	SERVE	PIMAS	PEGYO	NUHCM	MUTLU	KRSTL	KRDMA
169	TUDDF	TEKST	SISE	PINSU	PENGD	OTKAR	NETAS	KRTEK	KRDMB
170	TUKAS	TEKTU	SKBNK	PNSUT	PETKM	OYAYO	NTHOL	KUTPO	KRDMD
171	TUPRS	THYAO	SKPLC	PRKAB	PETUN	PARSN	NTTUR	LATEK	KRSTL
172	UNYEC	TIRE	SKTAS	PTOFS	PIMAS	PEGYO	NUGYO	LINK	KRTEK
173	USAK	TOASO	SODA	RAYSG	PINSU	PENGD	NUHCM	LOGO	KUTPO
174	VAKFN	TRCAS	TBORG	RYSAS	PNSUT	PETKM	OTKAR	MAALT	LATEK
175	VAKKO	TRKCM	TCELL	SAHOL	PRKAB	PETUN	OYAYO	MARTI	LINK
176	VESTL	TSKB	TEBNK	SANKO	PTOFS	PIMAS	OZGYO	MERKO	LOGO
177	VKGYO	TTRAK	TEKST	SARKY	RAYSG	PINSU	PARSN	METRO	MAALT
178	VKING	TUDDF	TEKTU	SASA	RYSAS	PNSUT	PEGYO	MGROS	MARTI
179	YATAS	TUKAS	THYAO	SELEC	SAHOL	PRKAB	PENGD	MIPAZ	MERKO
180	YAZIC	TUPRS	TIRE	SERVE	SANKO	PTOFS	PETKM	MNDRS	METRO
181	YKBNK	ULKER	TOASO	SISE	SARKY	RAYSG	PETUN	MRDIN	MGROS

Table A.1 (continued)

Period	July 2004-June 2005	July 2005-June 2006	July 2006-June 2007	July 2007-June 2008	July 2008-June 2009	July 2009-June 2010	July 2010-June 2011	July 2011-June 2012	July 2012-June 2013
182	YKGYO	UNYEC	TRCAS	SKBNK	SASA	RYSAS	PIMAS	MRGYO	MIPAZ
183	YKSGR	USAK	TRKCM	SKPLC	SELEC	SAHOL	PINSU	MRSHL	MNDRS
184	YUNSA	VAKFN	TSKB	SKTAS	SERVE	SANKO	PKART	MUTLU	MRDIN
185	ZOREN	VAKKO	TSPOR	SODA	SISE	SARKY	PNSUT	NETAS	MRGYO
186		VESTL	TTRAK	TBORG	SKBNK	SASA	PRKAB	NTHOL	MRSHL
187		VKGYO	TUDDF	TCELL	SKPLC	SELEC	PTOFS	NTTUR	MUTLU
188		VKING	TUKAS	TEBNK	SKTAS	SERVE	RAYSG	NUGYO	NETAS
189		YATAS	TUPRS	TEKST	SODA	SISE	RYSAS	NUHCM	NTHOL
190		YAZIC	ULKER	TEKTU	TAVHL	SKBNK	SAHOL	OTKAR	NTTUR
191		YKBNK	UNYEC	THYAO	TBORG	SKPLC	SANKO	OYAYO	NUGYO
192		YKGYO	USAK	TIRE	TCELL	SKTAS	SARKY	OZGYO	NUHCM
193		YKSGR	VAKFN	TOASO	TEBNK	SNGYO	SASA	PARSN	OTKAR
194		YUNSA	VAKKO	TRCAS	TEKST	SODA	SELEC	PEGYO	OYAYO
195		ZOREN	VESTL	TRKCM	TEKTU	TAVHL	SERVE	PENGD	OZGYO
196			VKGYO	TSKB	THYAO	TBORG	SISE	PETKM	PARSN
197			VKING	TSPOR	TIRE	TCELL	SKBNK	PETUN	PEGYO
198			YATAS	TTRAK	TKFEN	TEBNK	SKPLC	PIMAS	PENGD

Table A.1 (continued)

Period	July 2004-June 2005	July 2005-June 2006	July 2006-June 2007	July 2007-June 2008	July 2008-June 2009	July 2009-June 2010	July 2010-June 2011	July 2011-June 2012	July 2012-June 2013
199			YAZIC	TUDDF	TOASO	TEKST	SKTAS	PINSU	PETKM
200			YKBNK	TUKAS	TRCAS	TEKTU	SNGYO	PKART	PETUN
201			YKGYO	TUPRS	TRKCM	THYAO	SODA	PNSUT	PIMAS
202			YKSGR	ULKER	TSKB	TIRE	TAVHL	PRKAB	PINSU
203			YUNSA	UNYEC	TSPOR	TKFEN	TBORG	PTOFS	PKART
204			ZOREN	USAK	TTRAK	TOASO	TCELL	RAYSG	PNSUT
205				VAKBN	TUDDF	TRCAS	TEBNK	RHEAG	PRKAB
206				VAKFN	TUKAS	TRKCM	TEKST	RYGYO	PRKME
207				VAKKO	TUPRS	TSKB	TEKTU	RYSAS	PTOFS
208				VESBE	ULKER	TSPOR	THYAO	SAHOL	RAYSG
209				VESTL	UNYEC	TTKOM	TIRE	SANKO	RHEAG
210				VKGYO	USAK	TTRAK	TKFEN	SARKY	RYGYO
211				VKING	VAKBN	TUDDF	TOASO	SASA	RYSAS
212				YATAS	VAKFN	TUKAS	TRCAS	SELEC	SAFGY
213				YAZIC	VAKKO	TUPRS	TRKCM	SERVE	SAHOL
214				YKBNK	VESBE	ULKER	TSKB	SISE	SANKO
215				YKGYO	VESTL	UNYEC	TSPOR	SKBNK	SARKY

Table A.1 (continued)

Period	July 2004-June 2005	July 2005-June 2006	July 2006-June 2007	July 2007-June 2008	July 2008-June 2009	July 2009-June 2010	July 2010-June 2011	July 2011-June 2012	July 2012-June 2013
216				YKSGR	VKGYO	USAK	TTKOM	SKPLC	SASA
217				YUNSA	VKING	VAKBN	TTRAK	SKTAS	SELEC
218				ZOREN	YATAS	VAKFN	TUDDF	SNGYO	SERVE
219					YAZIC	VAKKO	TUKAS	SODA	SISE
220					YKBNK	VESBE	TUPRS	TAVHL	SKBNK
221					YKGYO	VESTL	ULKER	TBORG	SKPLC
222					YKSGR	VKGYO	UNYEC	TCELL	SKTAS
223					YUNSA	VKING	USAK	TEBNK	SNGYO
224					ZOREN	YATAS	VAKBN	TEKST	SODA
225						YAZIC	VAKFN	TEKTU	TAVHL
226						YKBNK	VAKKO	THYAO	TBORG
227						YKGYO	VESBE	TIRE	TCELL
228						YKSGR	VESTL	TKFEN	TEBNK
229						YUNSA	VKGYO	TOASO	TEKST
230						ZOREN	VKING	TRCAS	TEKTU
231							YATAS	TRGYO	THYAO
232							YAZIC	TRKCM	TIRE

Table A.1 (continued)

Period	July 2004-June 2005	July 2005-June 2006	July 2006-June 2007	July 2007-June 2008	July 2008-June 2009	July 2009-June 2010	July 2010-June 2011	July 2011-June 2012	July 2012-June 2013
233							YKBNK	TSGYO	TKFEN
234							YKGYO	TSKB	TOASO
235							YKSGR	TSPOR	TRCAS
236							YUNSA	TTKOM	TRGYO
237							ZOREN	TTRAK	TRKCM
238								TUDDF	TSGYO
239								TUKAS	TSKB
240								TUPRS	TSPOR
241								ULKER	TTKOM
242								UNYEC	TTRAK
243								USAK	TUDDF
244								UYUM	TUKAS
245								VAKBN	TUPRS
246								VAKFN	ULKER
247								VAKKO	UNYEC
248								VESBE	USAK
249								VESTL	UYUM

Table A.1 (continued)

Period	July 2004-June 2005	July 2005-June 2006	July 2006-June 2007	July 2007-June 2008	July 2008-June 2009	July 2009-June 2010	July 2010-June 2011	July 2011-June 2012	July 2012-June 2013
250								VKGYO	VAKBN
251								VKING	VAKFN
252								YATAS	VAKKO
253								YAZIC	VESBE
254								YKBNK	VESTL
255								YKBYO	VKGYO
256								YKGYO	VKING
257								YKSGR	YATAS
258								YUNSA	YAZIC
259								ZOREN	YGYO
260									YKBNK
261									YKBYO
262									YKGYO
263									YKSGR
264									YUNSA

APPENDIX B

TURKISH SUMMARY

BÖLÜM 1

GİRİŞ

Varlık fiyatlandırma her daim modern finansal ekonominin ana alanlarından biri olagelmiştir. Sharpe (1964), Lintner (1965) ve Black(1972) tarafından ortaya konulan Sermaye Varlıkları Fiyatlama Modeli (CAPM) finansal ekonominin bu alanında büyük yankı uyandırmış ve başarı yakalamıştır. Bu modelin, performans değerlendirme, sermaye maliyeti hesaplama, portföy seçme ve normal üstü getirilerin ölçülmesi için kullanılabiliyor olması modelin yaygın kullanımını ve popülerliğini etkileyen faktörlerdendir. Yaygın kullanım alanına rağmen, SVFM ortalama getirilerin risksiz faiz oranını aşan getirilerini açıklamada yetersiz kaldığı yönünde ciddi eleştirilere maruz kalmıştır. Fama ve French (1992,1993,1996) hem firma büyüklüğü hem de DD/PD ile hisse senetlerinin beklenen getirileri arasında bir ilişki mevcut olduğunu göstererek, üç faktör modelinin temelini atmışlardır. SVFM'ye iki adet daha açıklayıcı faktör eklemişlerdir. Ancak, kendi oluşturmuş oldukları modele karşı yapılmış olan en etkili eleştirilerden biri yine Fama ve French tarafından yapılmıştır. 2013 yılında yaptıkları çalışmada, ortalama getiri ile firma karlılığı arasında olması muhtemel ilişkiden yola çıkarak üç faktör modeline, karlılığı yansıtan dördüncü bir faktör ekleyerek Fama-French Dört Faktör Modelini oluşturmuşlardır.

Bu tezin ana amacı, Temmuz 2004-Haziran 2013 arası dönemde, Fama-French Dört Faktör Modelinin Borsa İstanbul'da geçerliliğini test etmektir. Bu amaç çerçevesinde, çalışma şu şekilde düzenlenmiştir: İkinci bölüm, dört faktörlü modelin teorik çerçevesini ve gelişimini özetleyecektir. Bölümün devamında literatürdeki önemli çalışmalara değinilecektir. Üçüncü bölüm, veri ve yöntem hakkında bilgi verdikten sonra portföy ve faktörlerin oluşturulma yöntemleri ile devam edecektir. Bu bölümün son kısmında ise bağımlı ve bağımsız değişkenlerin tanımlayıcı istatistikleri verilecektir. Dördüncü bölümde ise SVFM, Üç Faktör Modeli ve Dört Faktör Modelinin iki farklı portföy seti üzerine uygulanması sonucu elde edilen regresyon sonuçları ortaya koyulacaktır. Beşinci bölümde, test ettiğimiz üç modelin performansları ölçülecek ve kıyaslanacaktır. Son bölüm ise bulguları özetleyerek işaret ettiği sonuçları ortaya koyaktır.

BÖLÜM 2

LİTERATÜR TARAMASI

2.1 Giriş

Bu bölümde, Fama-French Dört Faktör Modelinin teorik temelleri ve gelişimi aktarılacaktır. İlk kısımda, modelin gelişimi SVFM den başlayarak anlatılacaktır. Devam eden kısımda, SVFM ve Fama-French modelleri üzerine yurtdışı piyasalarda yapılmış olan çalışmalardan bahsedilecektir. Sonraki kısımda ise Türkiye'de yapılmış olan bazı önemli çalışmalar özetlenecektir.

2.2 Fama-French Modelleri

1950'lerden beri finansal ekonominin temel amaçlarından biri risk ve getiri arasındaki ilişkinin açıklanması olmuştur. 1952 yılında, Markowitz ünlü Ortalama-Varyans modelini oluşturduğundan beri, bu model üzerine pek çok model inşa edilmiştir. Sharpe, Lintner ve Black tarafından oluşturulmuş olan Sermaye Varlıkları Fiyatlama modeli de bu modellerden biridir.

William Sharpe (1964) hisse senetlerinin ortalama getirileri ile standart sapma arasında bir ilişki kurarak, dengede beklenen getiri ile standart sapma arasında basit doğrusal bir ilişki olduğunu öne sürmüştür. Bu ilişki β ile tarif edilmekte olup, sistematik riski yansıtmaktadır. Bir varlığın riskinin, piyasa riskiyle olan ilişkisini yansıtmaktadır. Diğer bir deyişle, beta bir varlığın piyasa hareketlerine verdiği tepkinin bir ölçütüdür. SVFM aşağıdaki denklemle ifade edilir;

$$E(Ri) = Rf + \beta_i [E(RM) - Rf]$$

Yukarıdaki denklemde $E(Ri)$ i varlığının ya da portföyünün beklenen getirisini, Rf risksiz faiz oranını, $E(RM)$ ise piyasa portföyünün beklen getirisini göstermektedir. β_i ($\frac{cov\ (Ri,RM)}{var(RM)}$) , beta, i varlığının ya da portföyünün sistematik riskini temsil etmektedir. Denklemden de görüleceği üzere, ortalama getiri ve risk arasında doğrusal bir ilişki mevcuttur. Aynı zamanda, model bir varlığın risksiz faiz oranını aşan beklenen getirisinin, piyasa risk faktörü ile açıklanabileğini öne sürmektedir.

Hem akademik alanda hem de iş dünyasındaki yaygın kullanımına rağmen SVFM pek çok kişi tarafından ortalama fazla getirileri açıklamada yetersiz kaldığına dair eleştirilmiştir. Banz (1981) firma büyüklüğünün de ortalama getirileri açıklamada beta'ya katkıda bulunduğunu saptamıştır. Ampirik çalışmaları sonucunda, firma büyüklüğü ve ortalama getiri arasında negatif bir ilişki bulunduğunu saptamıştır. Stattman (1980), Rosenberg, Reid ve Lanstein (1985) ABD hisse senedi piyasasında ortalama getiri ile DD/PD arasında pozitif bir ilişki bulunduğunu göstermişlerdir. Ball (1978) kazanç/fiyat oranının regresyonlarda SVFM tarafından açıklanamayan kısmın açıklanmasında katkı sağladığını göstermiştir. Bu fikirden hareketle Fama ve French (1992) β, firma büyüklüğü, kazanç/fiyat, kaldıraç oranı ve DD/PD nin NYSE, AMEX, ve NASDAQ da işlem gören hisse senetlerinin ortalama getirilerini açıklamadaki rolünü araştırmışlardır. Araştırma sonuçlarına göre kolayca ölçülebilen iki değişkenin, firma büyüklüğü ve DD/PD oranının, çapraz kesit regresyonlarında ortalama getirilerin açıklanmasına katkıda bulunduğu tespit edilmiştir. 1993 yılında yayınladıkları 'Tahvil ve Hisse Senedi Getirilerindeki Ortak Risk Faktörleri' isimli çalışmalarında zaman serisi analiz yöntemini kullanarak belli portföylerin fazla getirilerini açıklamak için Fama-French Üç Faktör Modelini uygulamışlardır. Bu çalışma, firma büyüklüğü ve DD/PD risk faktörlerini temsil etmek üzere oluşturulan SMB ve HML faktörlerini ilk defa ortaya koydukları çalışma olması açısından önem

taşımaktadır. Sonuç olarak üç faktörlü modelin SVFM'den daha başarılı olduğu ampirik olarak kanıtlanmıştır. 2013 yılında yaptıkları çalışmada ise, Novy-Marx'ın ortalama getiri ile karlılık arasındaki ilişkiyi gösteren çalışmasından yola çıkarak, kendi kurmuş oldukları üç faktörlü modele, karlılık risk faktörünü yansıtan dördüncü bir değişken eklemişlerdir.

2.3 Uluslararası Piyasalarda Fama-French Modelleri Üzerine Yapılan Çalışmalar

Fama ve French (1998) 1975-1995 yılları arasında onüç gelişmiş ülke ve onaltı gelişmekte olan ülke piyasasında yaptıkları araştırma sonucu, gelişmiş ülkelerin onikisinde ve gelişmekte olan ülkelerin tümünde ortalama getiri ile DD/PD arasında pozitif bir ilişki saptamıştır.

Ajili (2002) 1976-2001 yılları için Fransız borsasındaki hisse senetlerinin getirilerindeki değişkenliğin SVFM'ye kıyasla üç factor modeli tarafından daha iyi açıklanabildiğini göstermiştir.

Drew ve Veeraraghavan (2002) Malezya Borsası'nda işlem gören hisse senetlerinin getirilerinde firma büyüklüğü ve değer primlerinin varlığını saptamış ve üç faktörlü modelin açıklayıcı gücünün SVFM den daha fazla olduğunu göstermişlerdir.

Drew, Naughton ve Veeraraghavan (2003) Şangay borsasında işlem gören hisse senetlerinde ortalama getiri ile hem firma büyüklüğü hem de DD/PD arasında negatif bir ilişki bulunduğu sonucuna varmıştır. Aynı zamanda üç faktörlü modelin SVFM'ye gore daha üstün bir performans sergilediği kanıtlanmıştır.

Charitou ve Constantinidis (2004) 1992-2001 yılları arasında Japon borsasında işlem gören hisse senetlerinin risksiz faiz oranını aşan getirilerini açıklamada Fama-French Üç Faktör Modelinin başarılı olduğunu göstermişlerdir.

Djajadikerta ve Nartea (2005) Yeni Zelanda borsasında işlem gören hisse senetlerinin ortalama getirilerinde zayıf bir DD/PD ve güçlü bir firma büyüklüğü etkisi saptamışlardır. SVFM ve üç faktörlü modelin açıklayıcı güçleri arasında önemli bir fark saptanmamıştır.

Al-Mwalla ve Karasneh (2011) Amman borsasında yaptıkları çalışmada ortalama getiri ile firma büyüklüğü arasında negatif, ortalama getiri ile DD/PD arasında pozitif bir ilişki tespit etmiş olup, üç faktörlü modelin SVFM'ye nazaran daha başarılı olduğunu göstermişlerdir.

O'Brien, Brailsford ve Gaunt (2012) yapmış oldukları çalışmada,üç faktörlü modelin SVFM'ye kıyasla 1982-2006 yılları arasında Avustralya borsasındaki hisse senetlerinin ortalama getirilerindeki değişkenliğin açıklanmasında daha başarılı olduğu sonucuna varmışlardır.

2.3 Türkiye'de Fama-French Modelleri Üzerine Yapılan Çalışmalar

Erişmiş (2007) IMKB'de işlem gören hisse senetlerinin 1992-2005 yılları arasındaki ortalama getirileri ile firma büyüklüğü ve DD/PD arasında ilişki bulunduğunu ve üç faktörlü modelin açıklayıcı gücünün SVFM'ne kıyasla daha yüksek olduğunu göstermiştir.

Gökgöz (2008) yaptığı çalışmada beş farklı IMKB endeksini bağımlı değişken olarak kullanarak üç faktörlü modelin geçerliliğini test etmiştir. Yüksek R-kare değerlerine ragmen, model GRS-F istatistiği sonuçlarına göre geçersiz kılınmıştır.

Unlu (2012) IMKB'de yer alan hisse senetlerinin getirilerini kullanarak 1992-2011 yılları arasını kapsayan çalışmasında Fama-French Üç Faktör Modeli, Carhart Dört Faktör Modeli ve Pastor ve Stambough Beş Faktör Modelinin performanslarını kıyaslamıştır. Çalışma sonucunda beş faktörlü modelin her iki modele,üç faktörlü modelin ise dört faktörlü modele karşı üstün olduğu gösterilmiştir.

Dibo (2012) üç faktörlü model ve SVFM'nin performanslarını kıyasladığı çalışmasında, 2004-2010 yılları arasında IMKB'de işlem gören hisse senetlerinin ortalama getirilerinin risksiz faiz oranını aşan getirilerini açıklamada üç faktörlü modelin daha üstün olduğu sonucuna ulaşmıştır.

2.4 Sonuç

Türkiye'de ve uluslararası alanda SVFM ve Fama-French Modelleri üzerine yapılan çalışmalar göz önünde bulundurulduğunda, çalışmaların çoğunda ortalama getiri ile firma büyüklüğü arasında negatif, ortalama getiri ile DD/PD arasında pozitif bir ilişkinin varlığının saptandığı görülmektedir. Ayrıca üç faktörlü modelin neredeyse tüm çalışmalarda SVFM'ne nazaran daha iyi performans gösterdiği öne sürülebilir.

BÖLÜM 3

VERİ, YÖNTEM VE TANIMLAYICI İSTATİSTİKLER

3.1 Veri ve Yöntem

3.1.1 Veri

İstanbul Menkul Kıymetler Borsası 26 Aralık 1986 tarihinde kurulmuş olup 3 Nisan 2013 tarihinde İstanbul Altın Borsası ve Türev Piyasası ile birleştirilerek BIST adını almıştır. 1987 yılının başında 80 olan firma sayısı 2014 yılı itibarıyla 405'e ulaşmıştır. 2014 yılı başında BIST'de işlem gören firmaların toplam piyasa değeri 503 milyar TL civarındadır.

Tezde kullanılan örneklem Temmuz 2004-Haziran 2013 tarihleri arasında BIST-TUM endeksinde yer alan firmaları içermektedir. Negatif özkaynağa sabit olan firmalar, gözaltı pazarı ve ikinci ulusal pazar, gelişen işletmeler piyasasında işlem gören firmalar örnekleme dahil edilmemiştir. Ayrıca piyasa kapitilizasyonu, DD/PD ve net kar verilerine ulaşılamayan firmalar da örneklem dışında tutulmuştur.

Risksiz faiz oranı olarak Devlet İç Borçlanma Senetleri Piyasa Değeri Ağırlıklı Kısa Vadeli Endeksi (PDA180-) kullanılmıştır.

DD/PD ve net kar/özkaynak oranları BIST değerleme oranları tablolarından elde edilmiştir.

Firmaların piyasa değeri ve BIST-TUM endeksinin getirileri endeks verileri tablolarından alınmıştır.

3.1.2 Portföy Oluşturmada Kullanılan Yöntem

Bu çalışmada kullanılacak olan ilk portföy seti firma büyüklüğü-DD/PD oranına göre oluşturulmuş olan 6 portföydür. Bu portföylerin oluştutulmasında Fama ve French'in yöntemi kullanılmıştır.

Her t yılının Haziran ayı sonunda, örneklemdeki firmalar piyasa kapitilizasyonlarına küçükten büyüğe sıralanır. Medyan değerin üzerinde kalanlar büyük firma değeri olanları, altında olanlar ise küçük firma değeri olan grubu temsil eder.

Yine her t yılının Haziran ayı sonunda, firmaların t-1 yılı sonundaki DD/PD ne göre örneklemdeki firmalar yüksekten düşüğe doğru sıralanır. En yüksek PD/DD oranına sahip olan %30 ilk grubu, onu takip eden %40 orta grubu, en düşük %30 ise düşük grubu temsil eder.

Yukarıda bahsi geçen portföylerin kesişimi ise 6 adet firma büyüklüğü-DD/PD portföyünü oluşturur.

İkinci portföy seti ise firma büyüklüğü-DD/PD-karlılık oranına göre oluşturulmuş olan 18 portföydür.

Yukarıdaki işlemler tekrarlandıktan sonra, her t yılının Haziran ayında, firmalar, t-1 yılının sonundaki net kar/özsermaye oranına göre büyükten küçüğe sıralanır. Karlılık/özsermaye oranı en yüksek olan %30 luk kısım yüksek karlılık portföyüne, onu takip eden %40lık kısım orta karlılık portföyüne, geri kalan %30luk kısım ise düşük karlılık portföyüne dahil edilir. Bu 3 portföyün 6 adet firma büyüklüğü-DD/PD portföyü ile kesişimi sonucu 18 portföy elde edilir

3.1.3 Faktörlerin Oluşturmasında Kullanılan Yöntem

SMB6 faktörünün getirileri, firma büyüklüğü olarak küçük grupta yer alan üç portföyün ortalama getirisi ile büyük grupta yer alan üç portföyün ortalama getirileri arasındaki fark hesaplanarak elde edilir.

HML6 faktörünün getirileri, DD/PD yüksek olan hisse senetlerini içeren iki portföyün ortalama getirisi ile DD/PD düşük olan hisse senetlerini içeren iki portföyün ortalama getiri arasındaki fark hesaplanarak elde edilir.

SMB18 faktörünün getirileri, firma büyüklüğü olarak küçük grupta yer alan dokuz portföyün ortalama getirisi ile büyük grupta yer alan dokuz portföyün ortalama getirileri arasındaki fark hesaplanarak elde edilir.

HML18 faktörünün getirileri, DD/PD yüksek olan hisse senetlerini içeren altı portföyün ortalama getirisi ile DD/PD düşük olan hisse senetlerini içeren altı portföyün ortalama getiri arasındaki fark hesaplanarak elde edilir.

RMW18 faktörünün getirileri, karlılığı yüksek olan hisse senetlerini içeren altı portföyün ortalama getirisinden karlılığı düşük olan hisse senetlerini içeren altı portföyün ortalama getirisiniçıkararak bulunur.

3.2 Tanımlayıcı İstatistikler

3.2.1 Portföylerin Getirilerinin Tanımlayıcı İstatistikleri

Temmuz 2004-Haziran 2013 arasındaki 108 aylık dönemde, firma büyüklüğü-DD/PD oranına göre oluşturulmuş olan altı adet portföyün ortalama getirileri incelendiğinde, düşük ve orta DD/PD oranına sahip hisse senetlerini içeren portföylerde, firma büyüklüğü etkisinin negatif olduğu tespit edilmiştir. DD/PD oranı yüksek olan kağıtları içeren iki portföy kıyaslandığında ise firma büyüklüğü ile ortalama getiri arasında pozitif bir ilişki gözlenmiştir. Firma büyüklüğü grupları sabit tutularak DD/PD oranının etkisi incelendiğinde,

piyasa değeri küçük firmaların hisse senetlerini içeren portföylerin ortalama getirisiyle DD/PD arasında herhangi bir ilişki bulunamamıştır. Ancak piyasa değeri büyük hisse senetlerini içeren portföylerin ortalama getirisi ile DD/PD arasında beklendiği gibi pozitif bir ilişki saptanmıştır.

Firma büyüklüğü-DD/PD-karlılık ölçütlerine göre oluşturulmuş onsekiz portföyün ortalama getirileri incelendiğinde, firma büyüklüğü ile negatif bir ilişki bulunduğu görülmektedir. Diğer bir deyişle, piyasa değeri küçük hisse senetlerini içeren portföylerin ortalama getirisi, karlılık ve DD/PD grupları sabit tutulduğu takdirde, piyasa değeri büyük hisse senetlerini içeren portföylere göre daha yüksektir. DD/PD etkisi, küçük piyasa değeri olan şirketleri içeren portföyler için saptanamazken, piyasa değeri büyük şirketleri içeren portföylerde saptanmıştır. Söz konusu durumda değer priminin varlığından söz edilebilir. Karlılık ile ortalama getiri arasında ise net bir ilişki tespit edilememiştir.

3.2.2 Faktör Getirilerinin Tanımlayıcı İstatistikleri

CAPM, Fama-French Üç Faktör Modeli ve Fama-French Dört Faktör Modelinde kullanılan açıklayıcı değişkenlerin ortalama getirileri kıyaslandığında aşağıdaki sonuç ortaya çıkmaktadır.

Rm-Rf > HML18 > HML6 > RMW18 > SMB18 > SMB6

BÖLÜM 4

SVFM VE FAMA-FRENCH MODELLERİNİN REGRESYON SONUÇLARI

4.1 Giriş

Bu bölümde, firma büyüklüğü-DD/PD oranına göre oluşturulmuş altı portföyün ve firma büyüklüğü-DD/PD-karlılık oranına göre oluşturulmuş onsekiz portföyün risksiz faiz oranını aşan aylık getirilerinin bağımlı değişken olarak kullanıldığı zaman serisi regresyonlarının sonuçları aktarılacaktır. Regresyonlarda SVFM, Fama-French Üç Faktör Modeli ve Fama-French Dört Faktör Modeli kullanılmıştır.

4.2 Firma Büyüklüğü-DD/PD Portföylerinin Regresyon Sonuçları

Firma büyüklüğü-DD/PD oranına göre oluşturulmuş altı portföyün risksiz faiz oranını aşan aylık getirilerinin SVFM kullanılarak açıklanıp açıklanamadığını görmek için aşağıdaki zaman serisi regresyonu gerçekleştirilmiştir.

$$R_i(t)-RF(t) = \alpha + \beta\,[RM(t)-RF(t)] + e(t)$$

Regresyonlar sonucunda elde edilen t-değerleri göz önünde bulundurulduğunda, altı regresyondan beş tanesinde α kesişim katsayılarının istatistiki olarak anlamlı olmadığı tespit edilmiştir. Piyasa risk faktörünün eğim katsayısı olan β ise tüm regresyonlarda istatistiki olarak anlamlı bulunmuştur. Düzeltilmiş R-kare değerieri ise 0.42 ve 0.96 arasında değşim göstermektedir.

Firma büyüklüğü-DD/PD oranına göre oluşturulmuş altı portföyün risksiz faiz oranını aşan aylık getirilerinin Fama-French Üç Faktör Modeli kullanılarak

açıklanıp açıklanamadığını test etmek için aşağıdaki zaman serisi regresyonu gerçekleştirilmiştir.

$$R_i(t)\text{-}RF(t) = \alpha + \beta\,[RM(t)\text{-}RF(t)] + sSMB6(t) + hHML6(t) + e(t)$$

Kesişim katsayılarının ya da fiyatlandırma hatalarının hiçbirinin istatistiksel olarak anlamlı olmadığı tespit edilmiştir. Tahmin edilen β katsayılarının tümü istatistiksel olarak anlamlı bulunmuştur. SMB6 faktörünün katsayısı olan s ise, altı regresyonun dördünde istatistiksel olarak anlamlı bulunmuştur. HML6 faktörünün katsayısı yalnızca bir regresyonda anlamlı bulunmamıştır. Düzeltilmiş R-kare değerleri 0.87 ve 0.96 arasında değişmekte olup modelin açıklayıcı gücünün oldukça yüksek olduğuna işaret etmektedir.

Firma büyüklüğü-DD/PD oranına göre oluşturulmuş altı portföyün risksiz faiz oranını aşan aylık getirilerinin Fama-French Dört Faktör Modeli kullanılarak açıklanıp açıklanamadığını test etmek için aşağıdaki zaman serisi regresyonu gerçekleştirilmiştir.

$$R_i(t)\text{-}RF(t) = \alpha + \beta[RM(t)\text{-}RF(t)] + sSMB18(t) + hHML18(t) + rRMW18(t) + e(t)$$

α katsayılarının hiçbirinin istatistiksel olarak anlamlı olmadığı tespit edilmiştir. Bunun yanında tüm β katsayıları istatistiksel olarak anlamlıdır. SMB18 faktörünün katsayısı olan s ise altı regresyondan ikisinde istatistiki olarak anlamlı bulunmamıştır. h katsayısı ise altı regresyondan beşinde istatistiksel olarak anlamlı bulunmuştur. Karlılık faktörünü yansıtan RMW18 faktörünün eğim katsayısı olan r, altı regresyondan birinde istatistiksel olarak anlamlı bulunmamıştır. Regresyon sonuçlarına göre düzeltilmiş R-kare değerleri 0.84 ve 0.96 arasında değişmekte olup modelin açıklayıcı gücünün yüksek olduğunu göstermektedir.

4.3 Firma Büyüklüğü-DD/PD-Karlılık Portföylerinin Regresyon Sonuçları

Firma büyüklüğü-DD/PD-karlılık oranına göre oluşturulmuş onsekiz portföyün risksiz faiz oranını aşan aylık getirilerinin SVFM kullanılarak açıklanıp

açıklanamadığını görmek için aşağıdaki zaman serisi regresyonu gerçekleştirilmiştir.

$$R_i(t)\text{-}RF(t) = \alpha + \beta\,[RM(t)\text{-}RF(t)] + e(t)$$

Regresyonlar sonucunda elde edilen t-değerleri göz önünde bulundurulduğunda, onsekiz regresyondan onbeş tanesinde α kesişim katsayılarının istatistiki olarak anlamlı olmadığı tespit edilmiştir. Piyasa risk faktörünün eğim katsayısı olan β ise tüm regresyonlarda istatistiki olarak anlamlı bulunmuştur. Düzeltilmiş R-kare değerieri ise 0.17 ve 0.91 arasında değşim göstermekte olup modele başka faktörlerin eklenmesi gerektiğine işaret etmektedir.

Firma büyüklüğü-DD/PD-karlılık oranına göre oluşturulmuş onsekiz portföyün risksiz faiz oranını aşan aylık getirilerinin Fama-French Üç Faktör Modeli kullanılarak açıklanıp açıklanamadığını test etmek için aşağıdaki zaman serisi regresyonu gerçekleştirilmiştir.

$$R_i(t)\text{-}RF(t) = \alpha + \beta\,[RM(t)\text{-}RF(t)] + sSMB6(t) + hHML6(t) + e(t)$$

Kesişim katsayılarının ya da fiyatlandırma hatalarının onbeş tanesinin istatistiksel olarak anlamlı olmadığı tespit edilmiştir. Tahmin edilen β katsayılarının tümü istatistiksel olarak anlamlı bulunmuştur. SMB6 faktörünün katsayısı olan s ise, onsekiz regresyonun ondördünde istatistiksel olarak anlamlı bulunmuştur. HML6 faktörünün katsayısı ise regresyonların on tanesinde istatistiksel olarak anlamlı bulunmuştur. Düzeltilmiş R-kare değerleri 0.52 ve 0.91 arasında değişmekte olup modelin açıklayıcı gücünün getirileri açıklanan portföye bağlı olduğunu göstermektedir.

Firma büyüklüğü-DD/PD-karlılık oranına göre oluşturulmuş onsekiz portföyün risksiz faiz oranını aşan aylık getirilerinin Fama-French Dört Faktör Modeli kullanılarak açıklanıp açıklanamadığını test etmek için aşağıdaki zaman serisi regresyonu gerçekleştirilmiştir.

$$R_i(t)\text{-}RF(t) = \alpha + \beta[RM(t)\text{-}RF(t)] + sSMB18(t) + hHML18(t) + rRMW18(t) + e(t)$$

α katsayılarının yalnızca bir tanesinin istatistiksel olarak anlamlı olduğu tespit edilmiştir. Bunun yanında tüm β katsayıları istatistiksel olarak anlamlıdır. SMB18 faktörünün katsayısı olan s ise onsekiz regresyondan onunda istatistiki olarak anlamlı bulunmuştur. h katsayısı ise onsekiz regresyondan onbir tanesinde istatistiksel olarak anlamlı bulunmuştur. Karlılık faktörünü yansıtan RMW18 faktörünün eğim katsayısı olan r, onsekiz regresyondan dokuzunda istatistiksel olarak anlamlı bulunmamıştır. Regresyon sonuçlarına göre düzeltilmiş R-kare değerleri 0.55 ve 0.91 arasında değişmektedir.

BÖLÜM 5

MODELLERİN KARŞILAŞTIRMALI PERFORMANSLARI

5.1 Giriş

Bu bölümde, SVFM, Fama-French Üç Faktör Modeli ve Fama-French Dört Faktör Modelinin performansları ortalama düzeltilmiş R-kare değeri, GRS-F istatistiği ve kesişim katsayılarının ortalama mutlak değeri kullanılarak kıyaslanacaktır.

5.2 Üç Modelin Performanslarının Karşılaştırmalı Analizi

Firma büyüklüğü-DD/PD oranına göre oluşturulmuş altı portföyün risksiz faiz oranını aşan aylık getirilerinin bağımlı değişken olarak kullanıldığı durumda, ortalama düzeltilmiş R-kare değerleri göz önünde bulundurulduğunda 0.92 değerine sahip üç faktörlü model her iki modele göre daha iyi performans göstermiştir. Dört faktörlü modelin ortalama düzeltilmiş R-kare değeri 0.90 olurken, SVFM'ninki 0.74 olarak hesaplanmıştır. GRS-F istatistiğine göre her üç model de geçerli olup, fiyatlandırma hatalarının sıfıra eşit olduğu hipotezi reddedilememiştir. GRS-F değeri baz alındığı durumda da en iyi performansın üç faktörlü modele ait olduğu görülmektedir. Fama-French'e göre yatırımcıların model performansını değerlendiriken göz önünde bulundurduğu en önemli istatistik olan kesişim katsayılarının ortalama mutlak değeri kullanılarak karşılaştırma yapıldığında sonuç yine değişmemektedir. 0.178 değeri ile üç faktörlü model her iki modele göre üstün görünmektedir. Dört faktörlü model (0.311) ve SVFM (0.428) sırasıyla üç faktörlü modeli takip etmektedir.

Firma büyüklüğü-DD/PD-karlılık oranına göre oluşturulmuş onsekiz portföyün risksiz faiz oranını aşan aylık getirilerinin bağımlı değişken olarak kullanıldığı durumda, dört faktörlü model 0.745 ortalama düzeltilmiş R-kare değerine sahipken üç faktörlü model 0.742, SVFM ise 0.60 değerine sahiptir. Bu durumda dört faktörlü model az da olsa üç faktörlü modele karşı daha iyi performans sergilemiştir. GRS-F istatistiğine göre, SVFM ve üç faktörlü model %95 güven aralığında reddedilmektedir. Geçerliliğini koruyan tek model dört faktörlü model olarak bulunmuştur. Bu durumda GRS-F istatistiği göz önünde bulundurulursa en başarılı model dört faktörlü model olmuştur. Alfa katsayılarının ortalama mutlak değeri baz alındığında ise durum değimektedir. Değerler arasında küçük sayılabilecek farklar bulunmasına karşın, en başarılı model üç faktörlü model olurken (0.544), en büyük değere (0.557) sahip dört faktörlü model en kötü performansa sahip model olmuştur.

BÖLÜM 6

SONUÇ

Bu çalışmanın amacı Fama-French Dört Faktör modelinin Temmuz 2004-Haziran 2013 arası 108 aylık dönemde Borsa İstanbul'da geçerliliğini test etmektir.

Yürütülen regresyonlarda bağımlı değişken olarak iki portföy seti kullanılmıştır. Birincisi firma büyüklüğü-DD/PD oranına göre oluşturulmuş olan altı adet portföydür. İkinci portföy seti ise firma büyüklüğü-DD/PD-karlılık oranı ölçütlerine göre oluşturulmuş olan onsekiz portföydür. Bu portföylerin oluşturulmasında Fama-French yöntemi izlenmiştir.

Dört faktörlü modelin geçerliliğini test ederken ve performansını ölçerken, konuyla ilgili daha iyi fikir verebilmesi açısından, SVFM ve üç faktörlü model de performans testlerine tabi tutulmuştur. Dört faktörlü model, üç farklı istatistiki değer kullanılarak bu iki modelle kıyaslanmıştır.

Firma büyüklüğü-DD/PD oranına göre oluşturulmuş olan altı adet portföyün bağımlı değişken olarak kullanıldığı testler sonucunda, dört faktörlü modelin yüksek açıklayıcı güce sahip olduğu, GRS-F testi baz alındığında modelin reddedilmediği ve fiyatlama hatalarının düşük seviyede olduğu tespit edilmiştir. Ancak, üç faktörlü modelin her üç kritere göre de daha iyi performans sergilediği saptanmıştır. SVFM ise üç model içinde en kötü performansı sergileyen model olmuştur.

Firma büyüklüğü-DD/PD-karlılık oranı ölçütlerine göre oluşturulmuş olan onsekiz portföyün bağımsız değişken olarak kullanıldığı regresyonlar sonucu elde edilen sonuçlara göre düzeltilmiş R-kare ve GRS-F istatistiği göz önünde bulundurulduğunda, en başarılı modelin dört faktörlü model olduğu

sonucuna ulaşılmıştır. SVFM ve üç faktörlü modeli GRS-F değerine göre reddedilmiştir. Ancak Fama-French'e göre yatırımcılar için bir fiyatlandırma modelinin başarısına işaret eden en önemli kriter olan fiyatlandırma hatalarının ortalama mutlak değeri göz önünde bulundurulduğunda en iyi performansı üç faktörlü modelin sergilediği, en düşük performansın ise dört faktörlü modele ait olduğu saptanmıştır.

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