TESTING THE VALIDITY OF FAMA FRENCH FIVE FACTOR ASSET PRICING MODEL: EVIDENCE FROM TURKEY[1]

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Abstract

Fama and French introduced a five-Factor Asset Pricing Model (FF5), adding a new perspective to asset pricing models in the literature in 2015. The aim of this paper is to investigate the validity of Fama French (2015) Five Factor Asset Pricing Model for 18 companies whose shares are listed in Istanbul Stock Market Sustainability Index. According to obtained findings, the coefficient of the profitability factor, from the new variables added to the three-factor model to build the FF5 asset pricing model, was positive and statistically significant, whereas the coefficient of investment factor was not statistically significant. As a result of the study covering 1995Q1-2017Q3 period, there was not enough evidence that the FF5 Model was valid for Istanbul Stock Market Sustainability Index. In this context, the model will not be beneficial for investors in the estimation of the returns of the companies in the Istanbul Stock Market Sustainability Index.

Keywords: Fama French, Five-Factor Model, Asset Pricing, Istanbul Stock Market Sustainability Index.

JEL Classification: C23, G12

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1. Introduction

Until the 1950s, the investors thought they could reduce the risk of their portfolios by increasing the number of securities in the portfolio. Hary Markowitz (1952), the founder of modern portfolio theory, determined that the risk can be reduced by bringing together the securities with negative correlation. Although he took a serious step towards the calculation of risk and return, he did not make any judgments on how to determine the relationship between these two variables.

Sharpe (1964), Lintner (1965), and Mossin (1966) discussed how to determine the relationship between risk and return with different studies through Capital Assets Pricing Model (CAPM). Markowitz demonstrates how investors create effective portfolios, on the other hand, CAPM reveals how financial assets are priced in effective market conditions. The Arbitrage Pricing Model was introduced by Stephen Ross (1976) to eliminate the missing variables such as the only independent variable in CAPM, normal distribution of returns, necessity of market portfolio, borrowing from risk free interest rate, and single term assumption. Arbitrage pricing theory has been seen as a new development stage in asset pricing literature, and it has been believed that multiple variables affect the return on assets thanks to this model.

The criticism of the arbitrage pricing model is that the aforementioned factors have not been fully defined. In this regard, the studies carried out in the following years have been designed to determine what are these factors. One of the most important research in asset pricing literature is the three factor model of Fama and French (1992, 1993, 1996). According to this model, the return of a stock is affected by the size of the company and the B / M ratio as well as the market risk premium. Compared to smaller companies, larger companies have lower returns. On the other hand, firms with higher B / M have higher returns.

One of the most recent asset pricing models up to this point was created by adding profitability and investment factors to the three factor model by Fama-French (2015). This new model is called Fama-French Five Factor Model (2015).

The number of studies conducted at the international level investigating the Five Factor Model is very low. In addition, there is no study examining the Turkish market in terms of aforementioned issues except the study of Acaravcı and Karaömer (2017). Moreover, the first

study examining the FF5 model on a sectoral basis for Turkish stock market is the motivation of this study when compare to study of Acaravcı and Karaömer (2017). The purpose of this study is to investigate the validity of the five-factor model in Borsa Istanbul Sustainibilty Index. In this context, the findings of turkey where is developing country on a sectoral basis will also provide a valuable contribution to other developing countries.

In the first part of the study, general explanations about the subject is given. Empirical findings on FF5 model in the literature are presented in the following second section. In the third part, the data and the methods used are explained. In the fourth section, the empirical findings are explained, and the fifth section includes the general evaluation and the conclusions.

2. Previous empirical studies

The number of studies investigating the Five Factor Model was relatively few in 2015, there has been increasing interest in the following years. One of the first studies belongs to Nguyen et al. (2015). In their study investigating the FF5 model, the authors explained that the new asset pricing model had a greater clarity of explanation for anomalies than traditional CAPM and three-factor model. In a similar study, Chiah et al. (2016) examined the Australian market and found that five factor models could explain the asset pricing anomalies more strongly than the three-factor model. Çakıcı (2015) showed that the results of the five factor model for North America, Europe and other global markets were similar to the five factor model results for US stock markets. On the other hand, as a result of the analysis, it was seen that these two new factors did not have a high degree of explanatory power in Japan and Asia Pacific portfolios. Mustafa and Ali (2016) stated that FF5 was better in explaining volatility than previous pricing models in their study of Norwegian markets. Dhaoui and Bensalah (2016) examined the New York Stock Market and found that the FF5 model had a standard validity. Chen et al. (2017) examined the FF5 model for the Chinese market. According to the results, FF5 model was found to be more sensitive to fluctuations in stock prices than FF3 model. In another study examining Chinese markets, Guo et al. (2017) used the factor spread test and found that the investment factor was not statistically significant between July-1995 and June-2015 and between July-1997 and December-2013. Lin (2017) examined Chinese markets

for the period 1997-2015 and found that the profitability factor was statistically valid but the investment factor was not. In their study using GMM and covering 12 different sectors to test the FF5 model of Fama and French, Racicot and Rentz (2017) found that each variable was of high importance. Huynh (2017) applied the FF5 model for Australian markets. The findings indicated that investment and profitability variables played an important role, but a better asset pricing model should also be investigated. Jiao and Lilti (2017) compared the Chinese and American markets by using multiple regression models, and found that profitability and investment factors in China did not have a very high explanatory power compared to American markets. Yang et al. (2017) tested the validity of the FF5 model by taking three different samples of five factors (Global, North America and USA). The study using the EGARCH model proved the validity of FF5 model. In their studies covering monthly data for the period 2005-2016, Acaravcı and Karaömer (2017) found that the FF5 model was valid for Borsa İstanbul. Mosoeu and Kodongo (2017) examined the developing countries. According to the findings, FF5 model could explain the portfolio returns in emerging markets, but it was not sufficient to explain the average returns of the global portfolio. In all countries, except India and South Korea, the market risk factor was statistically insignificant.

Finally, a lot of work was carried out in 2018 about. Zhang et. al. (2018) investigated the Chinese A-share Market and determine that FF5 model has explanation ability less than three-factor model. Dirxy and Peter (2018) examined the five factor model does for German stock market. According obtained findings, new factors have added significant explanatory power to the analysis. The summary of the transmitted to this stage studies in the literature is presented in Appendix 1.

When the studies are evaluated in general, it is obvious that the validity of the FF5 model is lower in the studies conducted on the Asian region, while it is higher in the European and US markets. In other words, an investor who uses the ff5 model in the Asian region has the opportunity to generate more than normal returns, while an investor in the European region will not be able to obtain the return. Thus, it is intended to determine whether Turkey stock market has a quality closer to Europe or Asia markets in terms of market condition and market structure. The main purpose of the study is to investigate the validity of FF5 model in Turkish markets, located right in the middle of

the Asian and European markets, and contribute to the relevant literature.

In the following sections of the study, the data used and the details of the FF5 model were firstly presented, and then the empirical findings were introduced. After that, the results were discussed and recommendations for future studies were presented.

3. Data and methodology

This study was carried out on 18 companies whose shares were listed in the Borsa İstanbul Sustainability Index during the period 1995Q1 -2017Q3. In the mentioned period, finance sector companies traded in the Sustainability Index were excluded from the scope of the study due to their different balance sheet structures. In order to determine whether the Five Factor Asset Pricing Model developed by Fama and French (2015) is valid in Borsa Istanbul Sustainability Index, a dataset covering 91 quarterly period which consisted of the unbalanced panel of the 18 companies traded in the index was used. The data used in the study were obtained from Finnet Electronic Publishing Data Communication platform. The dependent and independent variables used in the study as well as the symbols shown during the study period and the possible effects of these variables on the return of firms are presented in Table 1.

Table 1

Definitions, Symbols and Possible Effects of Independent Variables

Variables	Symbols	Definitions	Possible Effects
Panel A: Dependent variable			
Company's risk premium	$R_{it} - R_{Ft}$	Company Return - Risk Free Interest Rate	
Panel B: Independent Variables			
Market Risk Premium	$R_{Mt} - R_{Ft}$	Market Return - Risk Free Interest Rate	None
Size	LNSMB	The natural logarithm of Market Value	-
Value	HML	B/M ratio	+
Profitability	RMW	EBIT / Total Assets ratio	+
Investment	CMA	Active Growth Rate	-

Except the size, the other variables presented in Table 2 were used in the raw state during the analysis as they were proportional. In order to avoid return volatility, the natural logarithm of the market value representing the size variable was taken.

Descriptive statistics on the variables of our study are given in Table 2. There were 1576 observations for each variable in our unbalanced panel data set. It was seen that the company's risk premium variable had a negative average. The negative average shows that the company's returns were lower than the interest rate (the interest rate on treasury bills). The maximum value of the company's risk premium was 2.7762 while the lowest value was -0.9527. The fact that the standard deviation value of the company's risk premiums was higher than the average value indicates that the difference between companies was important.

Table 2

Descriptive Statistics

Variables	Mean	Median	Std. Dev.	Min	Max	Obs
$R_{it} - R_{ft}$	-.0006	-.0140	.324	-.952	2.77	1576
$R_{Mt} - R_{Ft}$	-.024	-.015	.22	-.79	.62	1576
LNSMB	20.38	20.58	2.017	7.426	24.51	1576
HML	.6698	.5555	.5162	.0088	5	1576
RMW	.1791	.049	.8297	-13.42	9.19	1576
CMA	.4433	.26	.615	-.50	9.00	1576

Correlations between the variables in our study and the variance inflation factor (VIF) values are presented in Table 3. VIF determines how much the variance is inflated. The variances of the estimated coefficients are inflated when collinearity exists. When the correlation values were analysed, it was seen that the correlation between the Company's Risk Premium and the Market Risk Premium variables was positive and statistically significant at 1% significance level. The coefficient between these two variables had the highest correlation value of 0.68. When the correlation coefficients between the explanatory variables in the analysis were examined, there were no coefficients greater than 0.80 critical value suggested by Gujarati and Porter (2009). Therefore, it can be stated that there was no problem of

multiple linear regression between variables. In addition, the VIF values based on panel OLS regression in the table confirmed the findings. All VIF values were found to be less than 5.

Table 3

Correlation Matrix and Variance Inflation Factor (VIF) Values

Variables	1	2	3	4	5	VIF
(1) $R_{it} - R_{ft}$						
(2)$R_{Mt} - R_{Ft}$	0.68***					0.96
(3) LNSMB	0.15***	0.18***				0.82
(4) HML	-0.07***	-0.00	0.13***			0.95
(5) RMW	0.02	0.03	-0.05**	0.06***		0.99
(6) CMA	-0.03	-0.14***	-0.38***	-0.22***	-0.01	0.81

*Note: *** p<0.01, ** p<0.05.*

The aim of this study was to determine whether the five-factor asset pricing model developed by Fama and French (2015) was valid for 18 companies listed in the Borsa Istanbul Sustainability Index between 1995 and 2017. For this purpose, the regression model, which is expressed by Equation (1), is estimated:

$$R_{it} - R_{ft} = a_0 + b\,(R_{Mt} - R_{Ft}) + s\,SMB_{it} + h\,HML_{it} + r\,RMW_{it} + c\,CMA_{it} + \varepsilon_{it} \quad (1)$$

Where R_{it}, R_{ft} and R_{Mt} indicate company return, risk free interest rate, market return, respectively. The dependent variable $R_{it} - R_{ft}$ in the model refers to company risk premiums. Company returns (R_{it}) are calculated by subtracting the previous quarter's price from the the quarterly prices of the companies' shares and by dividing into the previous quarter's price ($R_t = \frac{P_t - P_{t-1}}{P_{t-1}}$). Risk free interest rate (R_{Ft}) is calculated by converting annual interest rates of the shortest-term treasury bills issued in quarterly periods into quarterly interest rates. ε is the error term, and the subscripts i in the equation shows the company and t shows the time period.

Here, the first term shows the market risk premium, the second term is the SMB scale effect (size effect), that is, the big firms and the small firms have different returns. The third term demonstrates the HML value effect, that is, B/M ratio differs from firm to firm and this

affects the stock return. In addition to the classical three-factor model, Fama and French (2015) added two new factors to the model.

From these two new factors, RMW refers to the profitability factor and CMA refers to the investment factor. The profitability factor, which is not included in the three-factor model of Fama French (1992, 1996), and added to the five factor model as it is thought to have an effect on the company's return, is expected to be in a positive relationship with the firm return, whereas investment factor is expected to have a negative relationship with the firm return. That is to say, firms with higher profitability will have higher returns, while firms with higher levels of investment are expected to have lower returns.

4. Empirical findings

In order to analyse the Five Factor Asset Pricing Model developed by Fama and French (2015), firstly the stasis in the series should be examined. However, unit root process in panel time series models is divided into two according to whether there is cross-section dependence in series. First-generation panel unit root models (Levin, Lin and Chu, 2002; Harris and Tzavalis, 1999; Breitung, 2000; Hadri, 2000; Im, Pesaran and Shin, 2003; Choi, 2001; Maddala and Wu, 1999) did not take into account the cross-section dependence. On the other hand, second generations of panel unit roots (Taylor and Sarno, 1998; O'Connel, 1998; Breuer, McNown and Wallace, 2002; Phillips and Sul, 2003; Moon and Perron, 2004; Bai and Ng, 2004; 2010; Pesaran, 2007) took into consideration the cross-section dependence. Hence, the cross-section dependence between the series in the model was first tested using the CD test recommended by Pesaran (2004).

The results of the cross-section dependence test are shown in Table 4.

Table 4

Cross-Section Dependence Tests

Variable	CD-Test Statistics	Probability Values
$R_{it} - R_{ft}$	62.36***	0.000
$R_{Mt} - R_{Ft}$	116.69***	0.000
LNSMB	105.80***	0.000
HML	66.24****	0.000

Variable	CD-Test Statistics	Probability Values
RMW	24.35***	0.000
CMA	59.58***	0.000

Note: *Probability values are asymptotic normal distribution values.H_0 hypothesis shows that there is no cross-section dependence and the alternative hypothesis shows that there is -section dependence. *** H_0 hypothesis is rejected at 1% significance level.*

Pesaran (2004) CD test results showed that there was cross-section dependence in series. For this reason, considering the cross-section dependence of the series for the stability of the series, second generation panel unit root test was used in our study. Pesaran (2007), Im, Pesaran and Shin (2003) expanded the panel unit root test taking into account the cross-section dependence. Pesaran (2007) included the delayed values and first differences of the cross-section averages of the series as a factor in the model, allowing the coefficient of the autoregressive variable of Dickey-Fuller regression to be heterogeneous. This test is also referred to as ADF (CADF) test, extended via cross-section dependence. While the null hypothesis of the model showed that all units forming the panel contained unit roots, the alternative hypothesis indicated that some units were stationary. In the unit root test, CADF t-statistics of each series could be compared with the critical values presented by Pesaran (2007).

For the stability of the whole panel, CADF t statistics of the units were averaged, and Im, Pesaran and Shin (2003) (CIPS) test statistics were presented by extending with cross-section dependence. The CIPS test statistics of the series are presented in Table 5. Because only the Market Risk Premium series did not change between the units, Extended Dickey-Fuller (Dickey and Fuller, 1981) and Phillips-Perron tests (Phillips and Perron, 1988) were applied and the stability results of the series were presented in Appendix 2 in order not to disturb the flow.

Table 5

CIPS Panel Unit Root Test Statistics

Variable	Delay Numbers			
	0	1	2	3
$R_{it} - R_{ft}$	-20.56***	-20.078***	-14.167***	-9.957***
LNSMB	-7.812***	-5.711***	-4.966***	-5.07***

HML	-7.725***	-3.876***	-2.477***	-1.818**
RMW	-14.143***	-11.267***	-8.066***	-4.71***
CMA	-13.329***	-11.593***	-11.181***	-11.816***

*Note: The model contains only the invariable. Test statistics show Zt-bar statistics. H_0 hypothesis shows that the series has unit roots. ***, ** and * indicate that H_0 hypothesis was rejected at 1%, 5% and 10% significance level (*** p <0.01, ** p <0.05, * p <0.1). Critical values are provided by Pesaran (2007).*

Pesaran (2007) CIPS test results showed that the series used in the study were stable in level values. The H_0 hypothesis which expressed the entire panel contained unit root (I (1)) was rejected. Series was stable at level values. Therefore, the study continued with the level values of the series.

F-test and Breusch-Pagan LM test were used to determine the appropriate estimation of the model. The F test result showed that the most consistent estimator against the fixed effects estimator was the pooled Pooled Ordinary Least Squares estimator. In addition, the result of the Breusch-Pagan LM test demonstrated that the most consistent estimator against random effects estimator was the POLS estimator. Heteroscedasticity related to the model, autocorrelation and cross-section dependence tests were performed. According to the results of the Wooldridge autocorrelation test, the H_0, hypothesis suggesting that there was no first-degree autocorrelation in the model, was rejected. The findings showed that the autocorrelation problem in the model was important. According to Breusch-Pagan / Cook-Weisberg and White test for heteroscedasticity, H_0 hypothesis, suggesting that error terms had equivalent variance, was rejected. The findings showed that there was a problem of heteroscedasticity in the model. In addition, cross-section dependence of the model was examined by Pesaran test. According to the results of the Pesaran CD test, the H_0 hypothesis, suggesting that there was no cross-section dependence in the model, was rejected. As the model had cross-section dependence, it is important to use estimators that take cross-section dependence into account. Accordingly, the results of the specification tests, there were dependence problems between autocorrelation, heteroscedasticity and cross-section units in the model. For this reason, Driscoll-Kraay estimator developed by Driscoll and Kraay (1998) and producing standard errors resistant to these three problems was used in the study. The results are presented in Table 6. In addition to the estimation results of Equity (1), the effect of the market value variable

representing the size of the companies on the company risk premium was positive and statistically significant at 1% significance level. This result showed that as the market value of the companies increased, their returns also increased, and they obtained more than the risk-free interest rate. This result was not compatible with the expectations of the Five Factor Asset Pricing Model.

The estimated coefficient of the B/M ratio calculated by the proportion of the book value to the market value was found to be negative and significant at 5% significance level. As the B/M ratio of companies increased, their returns decreased. Enterprises with a higher B/M ratio offered lower returns to their investors. The findings obtained for the B/M variable which included the size variable also contradicted the expectations of the FF5 model.

The effect of profitability variable calculated as EBIT / Total Assets on company returns was positive and significant at 10% significance level. As expected, the return of the enterprises working with high profitability was also high. This result was compatible with the findings of Lin (2017).

Although the effect of the asset growth rate which refers to investment on the return of the companies was positive, it was not statistically significant. The findings for the investment, the fifth and last factor, also did not meet the expectations in the model.

Lastly, the fixed term is significant in model. This means that these factors did not explained the variations in excess returns of observed companies. This is meant that other variables can be added to further improve the model established for the turkey.

However, these results were similar to those of Guo et al. (2017) and Lin (2017).

Table 6

Analysis of the Results

Explanatory Variables	Coefficients	Driscoll / Kraay Standard Errors	Probability
$R_{Mt} - R_{ft}$	0.955358***	0.0558	0.000
LNSMB	0.012934***	0.0042	0.003
HML	-0.03959**	0.0165	0.019
RMW	0.006561*	0.0035	0.070
CMA	0.042305	0.0260	0.108
Fixed term	-0.23581**	0.0919	0.012

Diagnostic Tests	Results
F-test statistics	1.20
Breusch-Pagan LM test statistics	0.03
Autocorrelation Test	
Wooldridge Autocorrelation Test	15.47***
Heteroscedasticity Tests	
Breusch-Pagan / Cook-Weisberg test	194.5***
White test	189.13***
Cross-section Dependence	
Pesaran CD test statistics	10.686***
R^2-value	0.48
F- value	74.24***
Number of Observations	1576
Number of Companies	18

*Note: *, **, *** represent the level of significance at 10%, 5% and 1% significance levels.*

5. Concluding remarks

The data belonging to the period of 1995Q1-2017Q3 was used in the study investigating whether Five - Factor Asset Pricing Model of Fama and French (2015) is valid for the companies in the Istanbul Stock Market Sustainability Index. Driscoll-Kraay estimator, developed by Driscoll and Kraay (1998), and producing resistant standard errors was utilized.

Estimation results show that: (i) firms with higher market value offer higher returns to their investors. (ii) On the other hand, as B/M of the enterprises increases, their returns lower. (iii) Finally, enterprises with high profitability provide higher returns to their investors. These effects can be compared with the original article in which the Five Factor Asset Pricing Model was introduced by Fama and French (2015) which stated that enterprises with high market value offer lower returns, and as B/M of the enterprises increases, their returns also increase. They also expressed that when the profitability of the companies increases, their returns also increase, and if investments of the companies increase, their returns decrease. In the study, the size

and value factors were in contrast to the expected results. In the profitability factor, the results were compatible with the Fama-French model. The results of the investment variable were not statistically significant.

As a result, there is not enough evidence regarding whether the Five Factor Asset Pricing Model of Fama and French (2015) is valid on the companies listed on the Borsa Istanbul Sustainability Index. The results of this study are similar in many studies such as Çakıcı (2015), Guo et al. (2017) and Lin (2017) in literature review.

In future studies, the validity of the FF5 model for other indices of the Istanbul Stock Market should also be investigated to reach a more general judgments about market opportunities in Turkey. In addition, analyses were carried out using a model that did not take into account structural breaks. In further studies, the findings that will be obtained by using methods that take into account the structural breaks to consider the political and economic events may lead to more accurate results.

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APPENDIX 1

Literature Review

Author	Data (Frequency)	Sample	Econometric Methodology	Empirical Findings
Nguyen et al. (2015)	Aug 2007 to July 2015 (daily and monthly)	Vietnam	Regression	It is explained that the new asset pricing model had a greater clarity of explanation for anomalies than traditional CAPM and three-factor model.
Chiah and et al. (2016)	Jan 1982- Dec 2013 (monthly)	Australia	Regression, GMM	Five factor models could explain the asset pricing anomalies more strongly than the three-factor model.
Çakıcı (2015)	July 1992 - Dec 2014 (monthly)	North America, Europe, USA	Regression	Five factor model for North America, Europe and other global markets were similar to the five factor model results for US stock markets.
Mustafa and Ali (2016)	2002-2011 (monthly)	Norway	Regression	FF5 was better in explaining volatility than previous pricing models.
Dhaoui and Bensalah (2016)	July 1965 to Sep 2015 (monthly)	New York	Regression	FF5 model has a standard validity.
Chen and et al. (2017)	Different market sentiment periods	China	traditional covariance matrix	FF5 model was found to be more sensitive to fluctuations in stock prices than FF3 model.
Guo et al. (2017)	July 1995 – Dec 2013. (monthly)	China	GRS Tests	Investment factor was not statistically significant between July-1995 and June-2015 and between July-1997 and December-2013.
Lin (2017)	1997 to 2015 (monthly)	China	Regression	Found that the profitability factor was statistically valid but the investment factor was not.
Racicot and Rentz (2017)	Data of Fama and French	12 different sectors	GMM	They found that each variable was of high importance.
Huynh (2017)	1990–2013 (monthly)	Australia	Regression, GMM	The findings indicated that investment and profitability variables played an important role, but a better asset pricing model should also be investigated.
Jiao and Lilti (2017)	July 2010 to May 2015 (monthly)	China and America	Regression	It is found that profitability and investment factors in China did not have a very high explanatory power compared to American markets.
Yang et al. (2017)	Jul. 1990 - Feb. 2017 (monthly)	North America and USA	EGARCH	The FF5 model has been proven to be valid.
Acaravcı and Karaömer (2017)	July 2005 - June 2016 (monthly)	Turkey	Regression	They found that the FF5 model was valid for Borsa İstanbul.
Mosoeu and Kodongo (2017)	01 Jan 2010 - 25 Nov 2016 (monthly)	Developing countries	GMM	FF5 model could explain the portfolio returns in emerging markets, but it was not sufficient to explain the average returns of the global portfolio.
Zhang et. al. (2018)	May 2005 - April 2015 (monthly)	Chinese A-share Market	Regression	FF5 model has explanation ability less than three-factor model
Dirxy and Peter (2018)	2002-2017 (monthly)	Germany	Regression	New factors have add significant explanatory power to the analysis.

APPENDIX 2

Unit Root Test Results of Market Risk Premium

	ADF		PP	
	Fixed	**Fixed and Trend**	**Fixed**	**Fixed and Trend**
Market Risk Premium	-10.16927 (0.00)	10.55336 (0.00)	-10.15834 (0.00)	-10.54292 (0.00)

Note: Values in parentheses show significance.