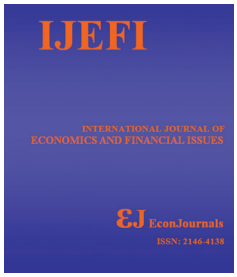

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Fama-French Five Factor Model: Evidence from Turkey*

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ABSTRACT

The aim of this study is to test the validity of the Fama-French five factor model (FF5F) in Borsa Istanbul (BIST) during the 132-month period between July 2005 and June 2016. Therefore, the excess returns of 14 different intersection portfolios constructed on the basis of size, market to book ratio, profitability and investment factors have been used during period between July 2005 and June 2016. Our results show that there is no pricing error according to result of Gibbons et al. (1989) GRS-F test of FF5F. Hence, FF5F seems to be valid in the BIST. In addition, FF5F appear to explain variations on excess portfolio returns.

Keywords: Capital Asset Pricing Model, Fama-French Five Factor Model, Asset Pricing Models, Time Series
JEL Classifications: C19, D53, G14

1. INTRODUCTION

The goal of portfolio management is to assemble various securities. In investments made to financial assets, determination of the level of risk taken against the level of expected return is a great of importance in terms of investment decision. The investor's needs are defined in terms of risk, and the portfolio manager maximizes return for investment risk undertaken. Measuring the relationship between risk and expected return has been a problem in the field of finance. In the 1960s, investigating the relationship between a financial asset's risk and expected return was firstly introduced by Harry Markowitz on Modern Portfolio theory. In 1964, Sharpe and Lintner have been proposed the capital asset pricing model (CAPM). It is known as the continuation of Markowitz's modern portfolio theory. The CAPM attempts to capture the risk and return relationship and use the market risk factor as the only explanatory factor in explaining stock returns. This model has been a research topic for many researchers. In several empirical studies, it has been used. Although it is generally used both of academic and empirical studies, it has been criticized by many researchers because it is completely inadequate to explaining stock returns. According to the empirical results of Banz (1981), Bhandari (1983), Stattman (1980), Basu (1983) and Rosenberg et al. (1985), it was emphasized that the CAPM was mostly inadequate in explaining the changes in stock returns and the validity of the model was seriously questioned. The majority of these criticisms have been to take into consideration the market risk factor in explaining stock returns. Morever, it has been stated that variation in stock returns are not only dependent on the market risk factor but also these variations may be the effects of various variables.

The Fama and French (1992) investigated the effects of factors such as market factor, size, leverage, price to earnings (P/E) and book to market equity (BE/ME) on stock return. According to findings, they found that the beta was insufficient to explain the stock return. Then, Fama and French (1993, 1995 and 1996) presented an empirical three-factor model (FF3F) which includes size and BE/ME factors in addition to the market factor. As a result, they found that FF3F explained the variations in the stock returns better than CAPM. Hence, this model has attracted the attention of many researchers and academicians in the field of finance. Ajili (2002) investigated these factors from July 1976 to June 2001 periods for France, Charitou and Constantinidis (2003) investigated these factors from 1992 to 2001 periods for Japan. Drew et al. (2004) investigated these factors from 1993 to 2000 periods for China. Gaunt (2004) investigated these factors from 1991 to 2000 periods for Australia. Rahman and Baten (2006) investigated these factors from 1993 to 2003 periods for

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Bangladesh. Gharghori et al. (2007) investigated these factors from 1995 to 2004 periods for Australia. Almwalla and Karasneh (2011) investigated these factors from 1999 to 2010 periods for Jordan. According to the analysis results, it was found that FF3F performed better than CAPM in explaining average stock returns. Similarly, in Turkey several studies have been tested the FF3F of Fama and French (1993). Samiloglu (2006), Kandir and Inan (2011), Guzeldere and Sarioglu (2012), Yalcin (2012), Eraslan (2013), Yuksel (2013), Coskun and Cinar (2014), Goren and Umutlu (2015), Ayturk et al. (2016) found that the FF3F Model is valid in Turkey and FF3F performed better than CAPM in explaining average stock returns.

Fama and French (2012) developed Fama-French Four Factor Model (FF4F) which includes momentum in addition to the FF3F. Most recently, Fama and French (2014) introduce a Fama-French five factor model (FF5F) by augmenting the FF3F with two mimicking factors that capture the return premiums associated with profitability and investment. Fama and French (2015) tested the performance of FF5F for the U.S. market using the data from July 1963 to December 2013. Their results suggest that FF5F performs better than FF3F of Fama and French (1993). FF5F has been tested many researchers and academicians in the field of finance. Abbas et al. (2015) tested FF5F from 2004 to 2014 periods for Pakistan. Clarice and William (2015) tested FF5F from 2002 to 2014 periods for Brazil. Nguyen et al. (2015) tested FF5F from 2008 to 2015 periods for Vietnam. Chiah et al. (2016), Heaney et al. (2016) tested FF5F from 1982 to 2013 and 1993-2015 periods for Australia. According to the results of the analysis, it was generally found that FF5F performed better than FF3F in explaining average stock returns.

This paper investigates the FF5F for Borsa Istanbul (BIST) during the 132-month period between July 2005 and June 2016. The excess returns of the risk-free interest rate of 14 different intersection portfolios constructed on the basis of size factor, value factor, profitability and investment factor used in BIST during period between July 2005 and June 2016.

The sequence of the study is as follows: In Section 2, we present data, variables, and methodology relevant for this paper; in Section 3 we present our empirical results; and in Section 4, we make some closing remarks.

2. DATA, VARIABLES AND METHODOLOGY

Our sample comprises all firms (excluding firms in finacial sector) which traded in BIST during the periods between July 2005 and June 2016. We use monthly data on July 2005 to June 2016 as the sample period. The reason that we do not analyze the period before 2005 is the change in the accounting standards in 2004. Fama and French (1992) use only the all non-financial firms because the high leverage that is normal for these firms probably does not have the same meaning as for nonfinancial firms, where high leverage more likely indicates distress. (Fama and French, 1992. p. 429). We don't include our sample them because financial firms have high leverage than non-financial firms. In selection of firms included in the sample group, we complied with constructing criteria Fama and French (1993, 2015). In addition to our sample excludes; (i) firms missing data necessary for the analysis, (ii) firms that were removed from BIST quotation, (iii) and firms with more than one share Class (A-C). Following Fama and French, firms with negative BE/ME for December of year "t-1," were excluded from the sample for the period between July of year "t" and June of year "t+1." When BE/ME turned positive in the following years, the firms were again included in the sample (Fama and French, 1993).

In this respect, firms which is subject of the research differ in years. Thus, the number of firms included in the sample group during the period between July 2005 and June 2016; it is observed that there are 174 firms in 2005 and 281 firms in 2015. The number of firms included in the sample group over the years is shown in Table 1.

In the study, for the period between July 2005 and June 2016 were used monthly data. Descriptive information on the required data for each company included in the study is presented in Table 2.

To ensure that accounting variables were known before the returns they were used to explain, Fama and French (1992) match the accounting data for all fiscal year ends in calendar year t−1 with the returns for July of year t to June of t+1. Firms with fiscal year ends other than December were excluded from the sample. Firms are required to file their accounting reports to BIST within 6 months of their fiscal year ends. So we do not use that accounting variables are known before the returns they are used to explain, firms with fiscal year ends for portfolio construction. Portfolio construction periods have begun at the end of July of each year "t" and end in June of each year "t+1." Thus, in calendar year "t−1" are matched with the returns for July of year "t" to June of year "t+1" for the portfolio construction.

In order to include in a firms in portfolio, it must be traded both December of year "t−1" and in June of each year "t." Besides, it must be able to maintain its existence at end of fiscal year. Value-weighted method is used to calculate the monthly returns for each portfolio. When the monthly returns are calculated, the data belonging to period from July of each year "t" to June of each year "t+1" are taken as basis (Erismis, 2007. p. 47).

We construct portfolios following the portfolio construction methodologies of Fama and French for construct the factors and the monthly returns (Fama and French, 1993, 2015).

2.1. Portfolios Based on Size

Market equity (ME) was used as size factor. ME is the market value of the firm's equity at the end of June of year "t." It is calculated by multiplying the share price of the firm by the number of shares outstanding of the firm. Market value belonging to each year "t" for each share was obtained by calculating the market value at the end of June of relavent year. After the market value for June was calculated, all firms in the sample were, firstly, sorted from small to large according to the June market value of year "t." Later on, the firms sorted were grouped into two groups based on market value, small and large. Firms with a market value over the median market value of the sample at the end of June of year "t" were

Table 1: Capitalization of all firms and chosen firms treated in BIST

Year	Chosen firms traded on BIST		All firms traded on BIST		Rate % (a/b)
	Number	Market capitalization (TL) (a)	Number	Market capitalization (TL) (b)	
2005	174	63,195,717,123.13	306	317,775,826.08	198.8
2006	184	87,523,142,075.55	322	246,375,185.35	355.2
2007	187	122,091,063,449.27	327	653,480,442.66	186.8
2008	188	122,818,532,948.27	326	541,800,863.42	226.6
2009	189	112,320,371,426.63	325	576,933,468.82	194.6
2010	193	166,399,473,897.48	350	883,851,714.22	188.2
2011	209	218,594,859,576.91	373	1,073,061,463.81	203.7
2012	227	217,899,172,905.91	422	1,062,380,205.10	205.1
2013	255	263,379,174,883.19	438	1.281,995,975.37	205.4
2014	277	282,155,212,493.21	437	1.354,976,262.02	208.2
2015	281	315,184,919,730.71	429	1,470,211,055.72	214.3

Market capitalization, is calculated by multiplying the total number of shares per year and the closing price at the end of July. BIST: Borsa Istanbul

Table 2: Descriptive information relating on used data

Panel A: Monthly return data		
Data	**Definition**	**Explanation**
R_i	Share's return	Share's return: It was gathered from data in which finnet information news network
R_m	Market's return	Market's return: BIST national-100 indices was used. It was gathered from data in which finnet information news network
R_f	Risk-free interest rate	Risk-free interest rate: Monthly interest rates derived from the annual interest rates of central government domestic debt stock, it was gathered from republic of turkey prime ministry undersecretariat of treasury (www.hazine.gov.tr)
Panel B: Firms factors relaiting data		
Data	**Definition**	**Explanation**
ME	Market equity	It was gathered from firms data in which finnet information news network
ME/BE	Market equity/book equity	It was gathered from firms data in which finnet information news network
O_p.	Operating profitability	It was gathered from firms data in which finnet information news network
Invs.	Invesment	It was gathered from firms data in which finnet information news network

included in the "Big (B)" size portfolio and firms with a market value under the median market value of the sample at the end of June of year "t" were included in the "Small (S)" size portfolio. Lastly, these firms were included in the relevant market value portfolios through July of year "t" to June of year "t+1." At the end of June of year "t+1," the portfolios are updated based on the market value at that time.

2.2. Portfolios Based on ME/BE

Market to book equity (ME/BE) ratio was used as value factor. ME is the market value of equity at the end of December of year "t−1," whereas BE used in June of year t is the book value of equity for the last fiscal year end in "t−1." Firstly firms included in the sample sorted from small to large according to the ME/BE. Then the firms were sorted in ascending order into three groups (high, medium, or low; H, M or L) based on the breakpoints for the bottom 30%, middle 40%, and top 30% of the values of ME/BE. Firms that have ME/BE values above 30% of the values of ME/BE values are included in the "High" (H) ME/BE portfolio. Firms that have ME/BE values below 30% of the values of ME/BE values are included in the "low" (H) ME/BE portfolio and the remaining firms are included in the "medium" (M) ME/BE portfolio. Lastly, at the end of June of year "t+1," the portfolios are updated based on the ME/BE at that time.

2.3. Portfolios Based on Profitability

Fama and French use the operating profit which (measured with accounting data for the fiscal year ending in "t−1") is annual revenues minus cost of goods sold, interest expense, and selling, general, and administrative expenses, all divided by booke quity at the end of fiscal year "t−1" (Fama and French, 2015. p. 4). In this study, in spite of the fact that, Fama and French use the operating profit, we used another profitability measure, net income/book equity ratio was used because of reasons related to the data availability. Firstly firms included in the sample sorted from small to large according to the net income/book equity. Then the firms were sorted in ascending order into three groups (robust, medium, or weak; R, M or W) based on the breakpoints for the bottom 30%, middle 40%, and top 30% of the values of net income/book equity. Firms that have net income/book equity values above 30% of the values of net income/book equity values are included in the "robust" (R) profitability portfolio. Firms that have net income/book equity values below 30% of the values of net income/book equity values are included in the "weak" (W) profitability portfolio and the remaining firms are included in the "medium" (M) profitability portfolio. Lastly, at the end of June of year "t+1," the portfolios are updated based on the net income/book equity at that time.

2.4. Portfolios Based on Investment

Fama and French use the investment variable which is the growth of total assets for the fiscal year ending in "t−1" divided by total assets at the end of "t−2" (Fama and French, 2015. p. 4):

$$Invs. = \frac{(Total\ assets_{t-1} - Total\ assets_{t-1})}{Total\ assets_{t-2}}$$

Firstly firms included in the sample sorted from small to large according to investment ratio. Then the firms were sorted in ascending order into three groups (conservative, medium, or aggressive; C, M or A) based on the breakpoints for the bottom 30%, middle 40%, and top 30% of the values of investment. Firms that investment values above 30% of the values of investment are included in the "aggressive" (A) investment portfolio. Firms that have investment values below 30% of the values of investment values are included in the "conservative" (C) investment portfolio and the remaining firms are included in the "medium" (M) investment portfolio. Lastly, at the end of June of year "t+1," the portfolios are updated based on the investment at that time.

2.5. Size-ME/BE Portfolios

For size-ME/BE portfolio, we were constructed based on the intersections of independent ME and ME/BE portfolios. When size group firms into two groups based on ME, ME/BE group firms into three groups based on ME/BE. At the end of June of each year "t," according to size-ME/BE ratios six portfolios (SL, SM, SH, BL, BM, BH) were established as the intersections of the two size and the three ME/BE groups. In the end of the June each year, this formation process was repeated (Fama and French, 1995. p. 134-138).

2.6. Size-profitability (Size-Operating) Portfolios

For size-operating portfolio, we were constructed based on the intersections of independent ME and profitability portfolios. When size group firms into two groups based on ME, profitability group firms into three groups based on profitability ratio. At the end of June of each year "t," according to size-operating ratios six portfolios (SR, SM, SW, BR, BM, BW) were established as the intersections of the two size and the three profitability groups. In the end of the June each year, this formation process was repeated (Fama and French, 2015. p. 4-6).

2.7. Size-investment Portfolios

For size-investment portfolio, we were constructed based on the intersections of independent ME and investment portfolios. When size group firms into two groups based on ME, profitability group firms into three groups based on investment ratio. At the end of June of each year "t," according to size-investment ratios six portfolios (SC, SM, SA, BC, BM, BA) were established as the intersections of the two size and the three investment groups (see Table 3). In the end of the June each year, this formation process was repeated (Fama and French, 2015. p. 4-6).

Five risk factors have been identified to explain stock returns (see Table 4). These factors (Fama and French, 2015. p. 6):

- Market factor, is the difference between the market return and the risk-free interest rate (R_m-R_f).
- SMB factor, is the return difference between the average return of small (S) market value portfolios and the average return of big (B) market value portfolios.
- Value factor (HML), is the return difference between the average return of high (H) ME/BE ratio portfolios and the return of low (L) ME/BE between portfolio returns.
- RMW factor, is the return difference between the average return of robust (R) profitability portfolios and the average return of weak (W) profitability portfolios.
- CMA factor, is the return difference between the average return of conservative (C) investment portfolios and the average return of aggressive (A) investment portfolios.

In this part of study, we used the time series regression approach to test FF5F. The monthly returns of the 14 portfolios, which were created according to size, size-ME/BE, size-Op., and size-Invs., on the risk-free interets rate were used as dependent variables in time series regressions.

To test their FF5F, we used excess returns on 14 portfolios as dependent variables, and returns on mimicking portfolios, SMB, HML, RMW and CMA excess returns on the market proxy as explanatory variables in our regressions. The model can be represented by the following equation:

$$R_{it}-R_{ft} = \alpha_i+\beta_i(R_{mt}-R_{ft})+s_i(SMB_t)+h_i(HML_t)+r_i(RMW_t)+c_i(CMA_t)+\varepsilon_{it}$$

Where;

- R_{it} is the return on security or portfolio i for period t,
- R_{mt} is the return on the value-weight (VW) market portfolio for period t,
- R_{ft} is the risk-free return for period t,
- SMB_t is the return on a diversified portfolio of small stocks minus the return on a diversified portfolio of big stocks for period t,
- HML_t is the difference between the returns on diversified portfolios of high and low B/M stocks for period t,
- RMW_t is the difference between the returns on diversified portfolios of stocks with robust and weak profitability for period t,
- CMA_t is the difference between the returns on diversified portfolios of the stocks of low and high investment firms, which we call conservative and aggressive for period t,
- ε_{it} is a zero-mean residual for period t.

The "β_i, s_i, h_i, r_i, c_i" (beta coefficients) mentioned in the equation represent sensitivity coefficients that express the slope of the multiple regressions that is made between R_i-R_f, R_m-R_f, SMB, HML, RMW and CMA.

If an asset pricing model completely captures expected returns, the intercept is indistinguishable from zero in a regression of an asset's excess returns on the model's factor returns (Fama and French, 2015. p. 9).

In addition to the significance of regression alpha coefficient in financial literature, some statistical tests are used. The GRS-F test of Gibbons et al. (1989) is generally recommended in studies to determine whether the alpha coefficient values are significantly different from zero. To save space, the probability, or p-value, of getting significance level of GRS-F statistic larger than the one observed if the true intercepts are all zero, is not shown (Gibbons et al., 1989. p. 1124):

- H_0: For FF5F, all α_i coefficients obtained from multiple factor models are equivalent to zero (α_i=0).
- H_1: For FF5F, not all α_i coefficients obtained from multiple factor models are equivalent to zero ($\alpha_i \neq 0$).

3. EMPIRICAL RESULTS

Before starting the empirical analysis, we should test whether our explanatory variables are stationary. Therefore, we used Augmented Dickey and Fuller (ADF) (1979) and Philips and Perron (PP) (1988) test statistics. Since Dickey and Fuller (ADF) and Philips and Perron (PP) (1988) test statistics are less than the test critical values, we reject the null hypotheses that our explanatory variables (have a unit root) are not stationary at any level of significance. Moreover Durbin Watson test statistic was used to determine autocorrelation in regression models. The results relating to the variables are shown in Table 5.

As seen in Table 5, Since the ADF and PP test values are larger than the absolute value of the MacKinnon table critical value, the series do not contain the unit root and the series are constant at the level.

Table 6 shows descriptive statistics related to monthly factor premiums based on intersection portfolio. If we compare the mean returns (Panel A), The value weighted returns of the monthly factor portfolios for Rm-Rf (market factor), SMB, HML, RMW and CMA in BIST are as follows; 0.014%, 0.003%, −0.008%, 0.004% and 0.000%, respectively. When portfolio value-weighted returns are ordered from large to small:

R_m-R_f>RMW>SMB>CMA>HML

We can state that the average excess return of market portfolios over risk free rate is larger than the average excess return of robust over

Table 3: Groups formed by classifying firms into size-ME/BE, size-Op. and size-investment portfolios

Size	ME/BE			Investment			Profitability		
	High (H)	Medium (M)	Low (L)	Conservative (C)	Medium (M)	Aggressive (A)	Robust (R)	Medium (M)	Weak (W)
Small (S)	SH	SM	SL	SC	SM	SA	SR	SM	SW
Big (B)	BH	BM	BL	BC	BA	BA	BR	BM	BW

Clarice and William, 2015. p. 5

Table 4: Construction of size, ME/BE, profitability and investment factors

Sort	Breakpoints	Factors and their components
2×3 sort on; -Size-ME/BE, -Size-Op., -Size-Invs.	-Size; median value ME/BE, Op. Invs.; 30%, 40%, and 30%.	-$SMB_{ME/BE}$=(SH+SM+SL)/3–(BH+BM+BL)/3 -SMB_{Op}=(SR+SM+SW)/3–(BR+BM+BW)/3 -SMB_{Invs}=(SC+SM+SA)/3–(BC+BM+BA)/3 -SMB=($SMB_{ME/BE}$+SMB_{Op}+$SMB_{invs.}$)/3 -HML=(SH–SL)/2+(BH–BL)/2 -RMW=(SR–SW)/2+(BR–BW)/2 -CMA=(SC–SA)/2+(BC–BA)/2

Fama and French, 2015. p. 6

Table 5: Stationarity test results regarding level values of variables

Variable	ADF (level)		Phillips Perron (level)		Durbin Watson
	Test statistics	Probability	Test statistics	Probability	
ESL	−9.628	0.000	−9.608	0.000	1.985
ESM	−9.924	0.000	−9.924	0.000	1.997
ESH	−9.771	0.000	−9.703	0.000	1.985
EBL	−9.774	0.000	−9.868	0.000	2.010
EBM	−10,109	0.000	−10.104	0.000	1.988
EBH	−9.844	0.000	−9.856	0.000	2.000
ESR	−10.241	0.000	−10.235	0.000	1.969
ESW	−9.721	0.000	−9.703	0.000	1.979
EBR	−9.991	0.000	−9.991	0.000	1.988
EBW	−11.748	0.000	−11.742	0.000	1.966
ESC	−9.974	0.000	−9.980	0.000	1.979
ESA	−10.380	0.000	−10.440	0.000	2.007
EBC	−10.259	0.000	−10.262	0.000	1.985
EBA	−9.569	0.000	−9.569	0.000	1.987
R_m-R_f	−11.115	0.000	−11.118	0.000	2.002
SMB	−11.530	0.000	−11.528	0.000	2.005
HML	−10.142	0.000	−10.078	0.000	1.997
RMW	−12.948	0.000	−12.948	0.000	2.043
CMA	−10.513	0.000	−10.550	0.000	2.017
MacKinnon critical values					
1% level	−3.435		−3.435		
5% level	−2.863		−2.863		
10% level	−2.567		−2.567		

-E: Return of excess of risk-free interest rate, S//B: Small and big portfolio, M: Medium portfolio, H//L: High and low portfolio, R//W: Robust and weak portfolio, C//A: Conservative and aggressive portfolio, -R_m-R_f: Market factor, SMB: Size factor, HML: Value factor, RMW: Profitability factor, CMA: Investment factor

Table 6: Descriptive statistics related to monthly factor premiums based on intersection portfolio

Panel A: July 2005 - June 2016							
Variable	**Mean**	**Median**	**Maximum**	**Minimum**	**SD**	**Skewness**	**Kurtosis**
R_m-R_f	0.014	0.007	0.910	−0.448	0.142	2.576	17.984
S	0.016	0.014	0.240	−0.262	0.080	−0.196	4.345
B	0.013	0.016	0.167	−0.255	0.070	−0.611	4.239
SMB	0.003	0.000	0.124	−0.068	0.032	0.807	4.820
H	0.012	0.010	0.356	−0.260	0.079	0.204	5.789
L	0.020	0.015	0.166	−0.230	0.072	−0.530	4.073
HML	−0.008	−0.011	0.251	−0.106	0.039	1.977	15.496
R	0.014	0.015	0.173	−0.249	0.069	−0.546	4.281
W	0.010	0.008	0.237	−0.259	0.082	−0.152	4.251
RMW	0.004	0.004	0.069	−0.134	0.033	−1.291	6.811
C	0.014	0.013	0.177	−0.227	0.073	−0.513	3.765
A	0.014	0.011	0.195	−0.300	0.078	−0.490	4.843
CMA	0.000	−0.001	0.106	−0.103	0.026	0.086	6.296

Panel B: Cross-correlations					
	R_m-R_f	SMB	HML	RMW	CMA
R_m-R_f	1				
SMB	−0.031	1			
HML	0.059	0.348	1		
RMW	−0.178	−0.268	0.068	1	
CMA	−0.084	0.067	0.029	0.116	1

Table 7: FF5F Model regression results (July 2005-June 2016)

FF5F model: $R_{it}-R_{ft}=\alpha_i+\beta_i(R_{mt}-R_{ft})+s_i(SMB_t)+h_i(HML_t)+r_i(RMW_t)+c_i(CMA_t)+\varepsilon_{it}$

R_i-R_f	α	B	s	h	r	c	DW	F-ist.	Adj.R
ESH	0.007	0.195	1.274	0.894	−0.432	−0.304	1.91	31.75	0.540
	(1.103)	(1.964)**	(6.264)*	(4.311)*	(−2.524)**	(−1.256)		[0.000]	
ESM	0.001	0.204	1.030	−0.019	−0.385	−0.226	1.90	15.07	0.349
	(0.221)	(1.941)***	(5.753)*	(−0.143)	(−2.314)**	(−0.760)		[0.000]	
ESL	0.003	0.202	1.138	−0.358	−0.427	−0.417	1.86	19.33	0.411
	(0.559)	(2.284)*	(6.653)*	(−3.019)*	(−3.365)*	(−1.814)***		[0.000]	
EBH	0.001	0.189	0.074	0.380	−0.322	−0.340	1.79	10.30	0.262
	(0.241)	(2.202)*	(0.499)	(3.689)*	(−2.332)**	(−1.299)		[0.000]	
EBM	0.003	0.219	0.159	0.038	−0.324	−0.390	1.94	8.33	0.218
	(0.556)	(1.986)*	(0.724)	(0.289)	(−1.784)***	(−1.495)		[0.000]	
EBL	−0.005	0.182	0.210	−0.366	−0.327	−0.227	1.83	7.35	0.195
	(0.817)	(1.881)**	(1.178)	(−2.336)**	(−2.043)**	(−0.847)		[0.000]	
ESR	−0.002	0.198	1.021	−0.095	0.081	−0.278	1.85	9.22	0.238
	(−0.334)	(1.865)**	(4.848)*	(−0.689)	(0.378)	(−0.913)		[0.000]	
ESW	0.001	0.176	1.127	−0.123	−0.823	−0.209	1.80	24.66	0.476
	(0.283)	(1.836)**	(6.771)*	(−1.284)	(−6.101)*	(−0.941)		[0.000]	
EBR	0.004	0.181	0.097	0.108	−0.094	−0.367	1.88	6.96	0.185
	(0.756)	(1.972)**	(0.624)	(1.133)	(−0.745)	(−1.762)***		[0.000]	
EBW	0.000	0.203	−0.008	0.136	−1.189	−0.437	1.94	17.37	0.384
	(0.021)	(1.984)**	(−0.036)	(0.922)	(−4.841)*	(−1.440)		[0.000]	
ESC	0.002	0.184	1.067	−0.068	−0.493	0.234	1.75	18.41	0.399
	(0.404)	(1.948)***	(5.856)*	(−0.611)	(−3.258)*	(0.929)		[0.000]	
ESA	−0.000	0.209	1.200	−0.160	−0.519	−0.919	1.89	23.04	0.456
	(−0.102)	(2.029)**	(7.638)*	(−1.546)	(−3.544)*	(−3.866)*		[0.000]	
EBC	0.001	0.218	0.153	0.011	−0.465	0.052	1.91	8.40	0.220
	(0.212)	(2.137)**	(0.956)	(0.102)	(−2.797)*	(0.210)		[0.000]	
EBA	0.004	0.194	0.019	0.104	−0.438	−0.794	1.77	11.83	0.292
	(0.694)	(2.072)**	(0.102)	(0.842)	(−2.667)*	(−2.945)*		[0.000]	
Observation number	132	132	132	132	132	132	132	132	132

-E: Excess return of risk-free interest rate, S//B: Small and big portfolios, M: Medium portfolios, H//L: High and low portfolios, R//W: Robust and weak portfolios, C//A: Conservative and agressive portfolios, -values in parentheses are t statistics, values in brackets are P values, (***), (**), (*) coefficient is significance at 10%, 5%, 1% significant level, -the values in parentheses are the corrected resistive t statistic according to Newey-West method for the heteroscedasticity problem

weak profitability portfolios, small size over big size portfolios, conservative over aggressive portfolios and high ME/BE over low ME/BE portfolios. Thus, this result shows that the maximum return premium can be obtained from the market portfolio.

Table 8: Statistics for model performance

Dependent variables	Model	Ave. R^2	GRS-F	P
ESH, EBH, ESR, EBR, ESC, EBC, ESM, EBM, ESW, EBW, ESA, EBA, ESL, EBL	FF5F	0.33	1.00	0.45

-E: Excess return of risk-free interest rate, S//B: Small and big portfolios, M: Medium portfolios, H//L: High and low portfolios, R//W: Robust and weak portfolios, C//A: Conservative and agressive portfolios

Panel B shows the correlation between the explanatory variables. The correlation between market portfolio and SMB, RMW, CMA factors is negative and close to zero, whereas the correlation between market portfolio and HML factor is positive and weak. In addition, it is seen that the correlation coefficients between the explanatory variables do not exceed 50% of all, and the strongest correlation is between SMB and HML factor, whereas the weakest correlation is between HML and CMA factor. Thus, it can be said that there are no multicollinearity between the explanatory variables to cause any problem.

When the F values and probability values relating to the FF5F regression results are investigated, the F values and probability values of 14 portfolios identified as dependent variables indicate that the established models are significant. When the Durbin-Watson values are examined, no autocorrelation is found among the error terms. When the alpha coefficients obtained as a result of the regression are investigated one by one, it is seen that the alpha coefficients are statistically equal to zero. Thus, it can be said that there is no pricing error in the regression models established for 14 portfolios (see Table 7).

Table 8 shows dependent variables, average R^2 values, GRS-F test statistics and P values. When the average R^2 value is investigated, average R^2 value of FF5F is 0.33. This result indicates that FF5F has power on explaining variations on excess portfolio returns. When the GRS-F test result is investigated, it is seen that the FF5F has a GRS-F test result of 1.00 (P = 0.45) and the null (H_0) hypothesis is accepted. Thus, it has been determined that there is no price error in the model and the FF5F is valid in BIST. It can be said that this result is consistent with the results of studies conducted by Fama and French (2015), Nguyen et al. (2015), Clarice and William (2015), Chiah et al. (2016), Heaney et al. (2016), not but Cakici (2015).

4. CONCLUSION

The aim of this study is to test the validity of the Fama-French five factor model in BIST during the 132-month period between July 2005 and June 2016. Therefore, the excess returns of the risk-free interest rate of 14 different intersection portfolios constructed on the basis of size, market to book ratio, profitability and investment factors have been used in the BIST during period between July 2005 and June 2016.

We investigate size, ME/BE, profitability and investment factors effects as well as the viability of FF5F for BIST. Time series regressions have been carried out to analyse the effectiveness of FF5F on the BIST. Whether or not there is a pricing error in the FF5F is investigated by considering the GRS-F test value. When GRS-F test result is examined, it is determined that there is no pricing error according to GRS-F test result of FF5F. Hence, it is consequentially established that FF5F is valid in the BIST. In addition, FF5F has power on explaining variations on excess portfolio returns.

The impact of factors affecting stock returns and the determination of their explanatory power and direction of stock return have become one of the most important and remarkable issues for academics and analysts in the financial world in recent years. In this respect, when studies on Turkey and international studies are investigated, it is seen that CAPM, FF3F, FF4F models are used in explaining the variations in the stock returns. However, when the studies relating to the FF5F are investigated, it is determined that the number of international studies is few and the study on Turkey has not been done yet. Since there are a limited number of studies on the FF5F, this study aims to fulfill this gap and contributes to empirical literature on this subject. It is also expected that this study will make a significant contribution to researchers and analysts.

Furthermore, for further empirical investigations, we propose that researchers will be able to contribute to finance literature by trying different measures and variables for other tests of the FF5F.

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