Examination of the Predictive Power of Fama-French Five-Factor Model by the Inclusion of Skewness Coefficient: Evidence of Iranian Stock Market

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ABSTRACT

Due to the complexity of financial markets and specialization of investment, the investors in financial markets need tools, methods and models by which they can choose the best investment and the most appropriate portfolios. Fama-French Five-Factor Model (FFFFM) is one of the newest methods among various methods for financial asset pricing and prediction of stock returns. The main aim of this research is to investigate the improved predictability of returns by inclusion of the skewness variable to FFFFM. The statistical population of this study consists of all manufacturing companies listed in Tehran Stock Exchange (TSE) during 2003-2014. 75 companies selected by random sampling method. The results of panel data test of FFFFM indicate the positive significant effects of book to market value ratio, size, growth opportunity, and profitability but a negative significant effect of the investment variable. By inclusion of the skewness variable in the FFFFM model, the negative effects of investment variable becomes positive. Also, skewness variable indicates a significant positive impact and that this inclusion improved the predictability of firm returns.

Keywords:

Stock return, Fama-French Five-Factor Model, skewness, Tehran Stock Exchange.

1. Introduction

People should invest their revenue surplus for obtaining the economic growth, so any investor needs information about stock in order to be able to obtain stock with more returns and less risk. The information about stock of each company is either based on internal information of that company or its external information. Internal information of a company is reflected in its financial statements. But, the external information of a company exists in stock market. Internal and external factors both affect the stock returns and determine the stock price in market. These two factors reflect the way of selecting optimal portfolios.

Return forecast accuracy for future investment decisions is always considered as the investors' concerns. They are always looking for models and methods which improve the accuracy of their forecast in future returns. Obviously, if the investors have appropriate techniques, models and tools for analysis, they can perform an efficient investment by investigating different industries and understanding different companies in stock exchange. Among various theories and methods for financial asset pricing and stock return forecast, Fama-French Five-Factor Model (FFFFM) is one of the newest methods which have been less used in internal studies. Therefore, this study is seeking to find answer to the question of whether adding the skewness coefficient to FFFFM increases the predictability of stock returns.

The main objectives of this study are as follows:

- Examining the predictive power of FFFFM in TSE;
- Explaining the predictive power of FFFFM by the inclusion of skewness coefficient;
- Comparing the results of two mentioned models and explaining the role of skewness coefficient in improving the predictive power of future returns in TSE.

2. Literature Review

Numerous studies conducted on different factors affecting the expected stock return and they have tried to examine one or more factors affecting the expected returns. Capital Asset Pricing Model (CAPM) by William Sharpe (1964) was the first model for estimating the stock return and he considered the systematic risk or its beta coefficient as the only factor explaining the stock return difference. The deviations and anomalies of CAPM were revealed during 1990 to 1975. According to researchers, these anomalies were as a challenge to validity of CAPM in explaining the expected returns by systematic risk factor (beta), and then the use of multi-factor models was gradually replaced by Single-factor CAPM in explaining the stock returns.

After the CAPM, Fama and French provided an evidence for empirical failures of CAPM. Fama and French (1993, 1996) studied the factors associated with enterprise features such as the size, book-to-market value, leverage, etc. on stock returns, and proposed a Three Factor Model to explain stock returns. According to Fama-French Three Factor Model (FFTFM), the stock return is affected by three factors namely beta factor, firm size and book to market value ratio and in order to predict stock returns we have consider three mentioned variables. Adding two new variables of profitability and investment to previous FFTFM, Fama and French (2015, 2016a) studied the explanatory power of their new FFFFM in New York, U.S and NASDAQ Stock Exchange during 1963-2013. According to important results of multivariate regression for FFFFM, different coefficients of determination (R^2) are obtained according to different categories of portfolios. According to the results, the power of FFFFM was 63% for explaining the stock return.

The value factor will not be significant in model by inclusion of two new variables namely the profitability and investment. In fact, the firms with high B/M have low tendency towards less investment and also low profitability and vice versa. Therefore, the value factor is affected by investment and profitability and excludes the value factor in model (insignificancy). However, Fama and French believe that the value factor should also exist in model because it may be different in different countries and time periods (Fama and French, 2016b). According to regression results in FFFFM during the target period and sample, the value of intercept (alpha) is very small and close to zero.

Fan and Yu (2013) compared Fama and French model with model by Chen et al in 12 big industries in the world. Chen et al's model includes the market investment and return on assets factors and it is inspired by Q Theory. The results also indicate that Chen et al's model has higher explanatory power.

Furthermore, despite the fact that alpha coefficient is also significant in Chen et al's model, its value is less than Fama and French model.

Maxim (2015) compared the predictive power of 6 models namely the CAPM, DCAPM, two-factor, APT, and three and five-factor Fama and French models in Bucharest Stock Exchange (BVB) during 2006-2013. According to results of this study, the explanatory power of stock return in FFFFM is higher than other studied models, so that the highest and lowest coefficients of determination (R^2) are related to FFFFM and DCAPM, respectively.

Racicot and Theoret (2015) tested the FFFFM for hedge funds during 1995-2012. According to results of this study and unlike the findings of FFFFM, the value factor is significant in most of the hedge fund strategies. In Fama and French's findings, the intercept (alpha) converges to zero by addition of two new variables, the investment and profitability, but the mystery of alpha remains unsolved in this study and alpha is robust.

Nusret Cakici (2015) examined the three and five-factor Fama and French models in 23 advanced stock markets during 1992 to 2014. The obtained results indicate strong evidence in North American, European and global markets similar to results of U.S stock market. However, the impact of profitability and investment factors is very low on portfolios of Japan, Asia, and Oceania. The inclusion of profitability and investment factors indicates insignificant value factor in North American, European and global markets similar to findings by Fama and French (2015), but significant value factor in Japan, Asia and Oceania markets. The results suggest that the regional models are better than the global models.

Investigating the FFFFM in Australian stock market during 1982-2013, Chiah et al (2015) have concluded that FFFFM has higher explanatory power than the three-factor model. Furthermore, the value factor is still significant despite the existence of profitability and investment factors.

Most of the Iranian studies investigate the stock return by examining the CAPM, Three-Factor Fama and French, and Carhart models and invesitgate other explanatory variables on stock returns, and have made less use of FFFFM.

Eshraghnia and Nashvadian (2008) examined Fama and French three-factor model in TSE. In this study, these two pricing models are compared according to portfolio method. According to results, Fama and French three-factor model has better performance than CAPM in TSE. A direct relationship between the book to market value ratio with stock return, and an indirect relationship between firm dimensions with stock returns indicate the similar impact of these two factors in TSE.

In a research entitled "Comparison of predictability for Fama and French model with beta value and expected stock return", Akbari-Moghaddam et al (2009) compare two methods of RBM and Fama-French three-factor model to predict the expected return in TSE. According to findings, Fama-French three-factor model has superiority to RBM model; there is a direct relationship between the firm size and expected return of company, but an inverse relationship between ratios of book-to-market value with expected return.

Pourzamani and Bashiri (2013) examined Carhart model to predict stock returns according to separation of growth and value stocks during 2006-2010. According to results, the growth stock has a greater return. Furthermore, the obtained return by Carhart is compared with actual data returns in order to increase the reliability of study, and it is found that the obtained returns of this model is not significantly different from actual data.

Salehi et al (2014) in a research entitled "Fama-French Five-Factor Model: A new model for measuring the expected stock return" introduced FFFFM. According to this study, there are a few empirical studies on the ability of this model to explain stock returns; and its evaluation will be subject to future studies.

Izadinia et al (2014) compared FFFFM with Carhart four-factor model in explaining stock returns of companies listed on TSE. This study is based on Fama-French four-factor model and momentum. This research investigates a period of 2007-2011, and the results indicate that the use of multi-factor models is more appropriate than the single-factor capital asset pricing model. Furthermore, it is found that Carhart four-factor model does not have any superiority to FFTFM because among four variables namely the market risk premium, size, value and tendency to past performance (momentum), only two variables- risk premium and size- affect the stock returns.

Babalouyan and Mozaffari (2016) in a research entitled "Comparison of predictive power in FFFFM with Carhart four- factor and HXZ q-factor models in explaining stock return", used the monthly data of companies listed on TSE during 2010 to 2014 and found that FFFFM has a higher explanation power than Carhart and HXZ models. Contrary to findings by Fama and French in U.S stock exchanges, the value factor (HML) in TSE has been significant and not considered as a redundancy. According to the results, among the factors namely beta, size, value, tendency to past performance (momentum), profitability and investment, the momentum and investment do not affect the stock returns on TSE.

3. Methodology

This research is a fundamental semi-experimental study and data analysis method is Panel Data method. Therefore, F Limer and Hausman tests are used in this regard. The content related to research literature is collected from library studies such as books, scientific journals, proceedings, doctoral theses, reviewed documents, and electronic research resources such as the Internet, etc. The data directly obtained from official reports, documents, financial statements and notes issued by companies in TSE and E-views software is used to fit the model.

According to research objectives, the hypothess of this study is as follows;

H1: Inclusion of the skewness coefficient to FFFFM significantly improves the predictability of firms' returns in TSE.

The statistical population of this study consists of companies listed on TSE and the sample consists of companies on TSE. This is done by systematic screening sampling by taking into account several criteria as follows:

- They should be accepted by TSE since 2003.
- To enhance the comparability, the fiscal period of samples should end in March.
- They should not have any changed activities or financial year during the study period.
- They should be manufacturing (not financial) companies.

Finally, it should be noted that the dismissed companies, companies transferred to subsidiary panels and those, which do not have the minimum sessions at desired date according to acceptance time, have been excluded from statistical population

In this study, the following model is used to test FFFFM and explain the role of skewness coefficient in improving the predictive power of FFFFM:

$$\mathrm{R_{it}} - \mathrm{R_{Ft}} = \mathrm{a_t} + \beta_1 \mathrm{BM} + \beta_2 \mathrm{Size} + \beta_3 \mathrm{growth} + \beta_4 \mathrm{Profit} + \beta_5 \mathrm{invest} + \varepsilon_{\mathrm{it}}$$

Where $R_{it} - R_{Ft}$ refers to stock return; BM: the ratio of book to market value; Size: firm size; growth: growth opportunity; Profit: profitability factor; and invest: investment factor.

The following model is used to test the research hypothesis and the role of skewness. SK refers to skewness of stock return.

$$\mathrm{R_{it}} - \mathrm{R_{Ft}} = \mathrm{a_t} + \beta_1 \mathrm{BM} + \beta_2 \mathrm{Size} + \beta_3 \mathrm{growth} + \beta_4 \mathrm{Profit} + \beta_5 \mathrm{invest} + \beta_6 \mathrm{SK} + \varepsilon_{\mathrm{it}}$$

The variables are calculated as follows:

- **Annual stock return:**

The annual stock return is defined as follows:

$$K_t = \frac{(P_t - P_{t-1}) + D_t + \frac{(P_t - P_n) * N_c}{N_t} + \frac{N_e * P_1}{N_t}}{P_{t-1}}$$

where:

K_t = Total stock return

P_t = Stock price at the end of fiscal year

P_{t-1} = Stock price at the beginning of fiscal year

P_n = Nominal value of share

D_t = Gross dividend per share

Ne = Number of increased shares by reserves or retained earnings

Nc = Number of shares increased by cash

N_t = Number of shares before capital increase

The variables of FFFFM and skewness coefficient are calculated as follows:

- **Firm size (SIZE):**

It refers to a two-dimensional variable which receives value of 1 if the firm size is lower than the median of sample firms and those with financial limitations, otherwise it giants value of zero and is measured by logarithm of firm assets.

SIZE it = $\log_{10}$(TAit)

TA_{it}: Book value of total assets of company *i* at the end of year *t*

- **Book to market value (BV/MV):**

The book value refers to the value of each asset in balance sheet of company. Since the assets of every year are depreciated, the book value is also reduced every year. To calculate book value per share first the entire debt is subtracted from total assets, and the remainder is divided by number of shares issued by company. BV/MV obtains by dividing book value of all shares to market value of the shares.

- **Growth opportunity:**

$$GROWTHit = \frac{(TAit\ + MVEit\ ) - BVEit}{TAit}$$

where:
BVE_{it} = Book value of equity in company *i* at the end of year *t*
MVE_{it} = Market value of equity in company *i* at the end of year *t* and it is equal to number of stock issued by company at the last traded price of stock at the end of year *t*
TA_{it} = Book value of total assets of company *i* at the end of year *t*

- **Profitability factor:**

It is the difference between stock returns of companies with high profitability and stock returns of companies with low profitability.

- **Investment factor:**

It is the difference between stock returns of companied with high investment (venture) and stock returns of companied with low investment (conservative).

- **Skewness:**

The skewness is in fact a criterion for asymmetry of distribution function and is equal to normalized third momentum. Skewness is zero for a perfectly symmetrical distribution; it is positive for an asymmetric distribution with kurtosis towards the higher values of positive skewness; and it is negative for asymmetric distribution with kurtosis towards the smaller values (Johnson et al, 2001). The deviation from symmetry of a distribution is called the skewness, and this amount of deviation is measured by normal distribution which is symmetrical. Several formulas have been proposed for the calculation of skewness coefficient. The following formula is used to calculate skewness coefficient and it is known as skewness coefficient calculation by momentum:

$$ske = \frac{r_3}{\sigma_p^3} = \frac{\frac{\sum(r_{pi} - \bar{r}_p)^3}{N}}{\left(\frac{\sum(r_{pi} - \bar{r}_p)^2}{N}\right)^3}$$

$$\frac{n}{(n-1)\ (n-2)} \sum \left(\frac{(r_{pi} - \bar{r}_p)^2}{S}\right)^3$$

4. Results

Table 1 represents the descriptive statistics for research variables. It should be noted that these results are related to all research data of studied period and for all sample companies.

Table 1: Descriptive statistics of research variables

Variable	Mean	Standard deviation	Median
$R_{it} - R_{Ft}$	0.17417	68.3493	61.63167
Size	26.15334	2.45623	15.65821
BV/MV	0.564269	0.452589	0.628641
Growth	15.71505	2.402602	15.73486
Profit	102.3452	45.67129	121.67536
Invest	87.10818	57.56879	90.7642
Sk	1.0876	0.876	1.4536

The first, second, third and fourth columns indicate variable names, the mean values, standard deviation values, and median values of the variables for the period of 2003-2014 and for the whole studied companies, respectively.

In studies of time-series data, the stability (fixed variable distribution over time) of variables should be studied before estimating a model because if the variables be unstable, the regression will become false. This study uses Levin, Lin & Chu test for examining the stability of variables. Since the obtained significance level for Levin, Lin & Chu test is less than 0.05 for all variables, it can be concluded that the research variables are significantly stable, and thus there will not be the problem of false regression in regression analysis (Table 2).

Table 2: Stability test of research variables

Variable	Levin, Lin and Chu test	
	Statistic value	Significance level
$R_{it} - R_{Ft}$	-52.75	0.000
Size	-45.32	0.000
BV/MV	-20.31	0.000
Growth	-26.03	0.000
Profit	-32.72	0.000
Invest	-24.39	0.000
Sk	-33.28	0.000
FCFF	-43.19	0.000
DPS	-32.27	0.000
EPS	-45.13	0.000

F limer test is used to study which one of the pooled or panel models are appropriate for estimating the regression models of research. The results of F limer test presented in Table 3. Since the significance level of F limer test is lower than 0.05 for model, the null hypothesis of this test will be rejected. Therefore, this test indicates that the panel model is appropriate for estimation of FFFFM. According to F limer test, which indicates the model of estimation by panel data, there are two methods of estimation with fixed or randomized effects models for estimation with panel data. Hausman test is used to determine whether the fixed or randomized-effects models should be used for estimating the parameters of model. The null hypothesis of Hausman test indicates the appropriate randomized-effects model for estimating the regression models of panel data. The results of Hausman test are presented in Table 3. Since significance level of Hausman test is less than 0.05 for model, so the null hypothesis based on appropriate randomized effects is rejected in model; and the panel method with fixed effects is used to estimate the regression model.

Table 4. According to Table 4, the significance of F-statistic for relevant model is less than 0.05, then we can conclude that there is a linear relationship between dependent and independent variables in this model. Therefore, it is concluded that the whole model is significant. Durbin-Watson test is utilized to investigate the independence of errors from each other. The lack of correlation between errors will be accepted if Durbin-Watson statistic is close to 2. According to Table 4, Durbin-Watson statistic has proper value for this model. Therefore, all studied variables have significant relationships according to results of estimated FFFFM. Among the studied variables, only the capital factor (investment) has a negative relationship, but the other variables have positive relationships.

First the FFFFM is examined to achieve the first research objective. The results FFFFM presented in

Table 3: F Limer and Hausman tests on primary FFFFM

	F Statistic	Significance level	The result
F Limer test	4.35	0.000	Null hypothesis of F Limer test rejected
Hausman test	Chi-square statistic	0.0027	Null hypothesis of Hausman test rejected
	13.56		

Table 4: Estimated FFFFM

Method	Regression panel with fixed effects	
Dependent variable	$R_{it} - R_{Ft}$	
Independent variables	Coefficient	Significance level
BM	0.165	0.0034
SIZE	0.126	0.00761
Growth	0.0549	0.0012
Profit	0.106	0.004
Invest	-0.132	0.027
c	5.41	0.000
F Statistic	4.25	
Significance level	0.0000	
Durbin-Watson statistic	1.70	
Coefficient of determination	0.7726	

In order to test the main research hypothesis, F Limer and Hausman test (1978)are also carried out and the results are presented in Table 5. Since the significance level of F Limer test is less than 0.05 for model, the null hypothesis of this test is rejected. Therefore, this test indicates that the panel model is appropriate for estimation of model. Hausman test is used to determine whether the fixed or random effects models should be applied to estimate parameters of model. Result of Hausman test for selection between fixed and random effects model are presented in second row of Table 5. Since the significance level of Hausman test is less than 0.05, the null hypothesis indicating the appropriate random effects is rejected in target model; and the panel method with fixed effects is utilized to estimate the regression model.

Table 6 indicates F statistic and its significance level for testing the linear relationship (significance test of total regression) between dependent and independent variables. Since the significance level of this test is less than 0.05 for target model, there is a linear relationship between dependent and independent variables in target model. Therefore, it is concluded that the whole model is significant. Durbin-Watson is obtained equal to 1.78, which is an appropriate value, in order to investigate the independence of errors from each other; and since the obtained coefficient of determination has higher value than the primary model, the first hypothesis is accepted according to obtained results. Other results also indicate a positive significant relationship between the book to market value ratio, firm size, growth opportunities, profitability, and investment with returns of firms.

Table 5: F Limer and Hausman tests on FFFFM by adding the skewness coefficient

	F Statistic	Significance level	Test result
F Limer test	3.21	0.000	Null hypothesis of F Limer test rejected
Hausman test	Chi-square statistic		Null hypothesis of Hausman test rejected
	14.35		

Table 6: Estimated FFFFM by the inclusion of skewness coefficient

Method	Regression panel with fixed effects	
Dependent variable	$R_{it} - R_{Ft}$	
Independent variables	Coefficient	Significance level
BM	0.172	0.0022
SIZE	0.076	0.00678
Growth	0.0471	0.0023
Profit	0.071	0.003
Invest	0.105	0.0491
SK	0.004	0.0056
C	5.41	0.000
F Statistic	7.31	
Significance level	0.0000	
Durbin-Watson statistic	1.78	
Coefficient of determination	0.8426	

5. Discussion and Conclusions

Given the impact of stock returns on potential and active shareholders' decisions, the researchers need to examine factors influencing the stock returns. This research first investigates the predictive power of FFFFM in TSE and then explains the role of skewness coefficient in improving the predictive power of FFFFM. The target models are estimated through panel data regression with fixed effects.

According to the results, all variables of FFFFM (book to market value ratios, firm size, growth opportunity, profitability, and investment) have positive and significant impact. Furthermore, based on inclusion of skewness of stock return variable to

FFFFM, the skewness and all variables of FFFFM have a positive significant impact on predictability of firm returns, so the research hypothesis confirmed. The positive impact of skewness on stock return is consistent with the result of research conducted by Barberis and Huang (2008), but inconsistent with research of Boyer et al (2010).

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