Investigation the strength of Five-factor model of Fama and French (2015) in describing fluctuations in stock returns

Roya mirzaei[1]
Amir Abbas Sahebgharani[2]
Nazanin Hashemi[3]

Abstract

Prediction of stock returns is always one of the most important discussions of financial markets, which has led to introducing of various models to pricing financial assets, one of the most important of these models is to measure the surplus returns by Fama & French model was introduced in the form of a 5-factor model which, in spite of its satisfaction with the model, is still in conflict with many anomalies in the market, which the model can not explain, in the same way The purpose of this paper is to examine the strength of Five Factor Model of Fama & French (2015) for explaining volatility as a market anomaly.The sample consists of 168 companies listed in Tehran Stock Exchange. Portfolio Analysis is the approach of this paper for testing explanatory power of the Five Factor Model. Results show that profitability and investment factors couldn't explain excess returns. This conclusion contradicts the model of Fama and French (2016).

***Keywords**: excess return, anomaly, volatility, Five Factor model of Fama and French*

[1]. Master of financial Management from Shahid Beheshti University Royamirzaei13@gmail.com
[2]. Ph.D. Student in accountancy of Allame Tabatabaee University abbas_sahebgharani@yahoo.com
[3]. Faculty member in accountancy of Islamic Azad University- South Tehran Branch n.hashemi 72 @yahoo.com

Introduction

One of the most important criteria for investing is the return of equity, which most actual and potential investors are paying particular attention to it. Investors always attempt to invest their deposits somewhere to achieve the highest return in line with the investment risk. With the growth of financial markets, investors need models and methods that help them choose the best and most suitable investment portfolio; in the other hand, fluctuations in stock returns has a special role in the decision making of investors and corporate executives. Therefore, the relationship between stock return volatility and return on investment in the capital market is important. The benefits of studying the stock return volatility and returns of investment are investors' consider stock return volatility as proxy of risk. And it can also be used as criteria of efficiency of the market. On the other hand, prediction of stock returns are always one of the main issues in financial markets, because stock returns are a key element of the decisions of market participants; investors are always trying to invest their deposit somewhat in line with their investment risk, to earn the most return.

Theoretical fundamentals and research background

With developing of financial markets, investors need models and methods that help them choose the best and the most suitable portfolio; this has led to various models for pricing financial assets, which are changing every day. The most important and the most well-known models for explaining the relationship between risk and expected return on risky assets is the Capital Asset Pricing Model (CAPM) presented by Sharp (1964), Linner (1965) and Black (1972). Empirical evidence has been presented in CAPM approval, including the Black, Scholes and Jensen (1972), and Fama and Macbeth (1973) models. But researchers have tried to test the relationship between non-beta variables and stock returns since the 1980s. One of them can be the Earning per share (Basu, 1977), the size of the company (Banz, 1981), the book value to market value (Rosenberg et al., 1985), the past stock returns (De Bont and

Thaler, 1985) the leverage (1998), profitability (Hugen Webber, 1997). These empirical studies showed that, in addition to the systematic risk of market, these variables are also of high strength for explaining the return. Bale (1978) believed that the E/P ratio was representative of the unrecognized factors in the expected return. In other words, stocks with high expected risk and returns may have a high E/P ratio(Ball, 1978). Statman (1980), Rosenberg, Reed, and Lustin (1985) showed that there is a direct relationship between risk and BV/MV (Rosenberg et al., 1985) by examining the relationship between average returns and the ratio of book value to market value of equity (B/M) in New York Stock Exchange. Chan, Hamao, and Laconishuk (1993) examined the stock market relationship with four variables: E/P ratio, size, book value to market value (B / M), and cash flow in Tokyo Stock Exchange. The results of their research showed that the relative of returns to book value to market value (B/M) was statistically more significant compared to the other three variables. Also, the relation between returns to the ratio of cash flow to share price waspositive and the company size was negative The results of the relationship between returns and earnings are also unclear at the price (E/P) (Chan et al., 1991). Banz (1981) added the company's market value factor (ME) to New York Stock Exchange. The small ones, on the average, are more productive than large companies, which are known to be effective. In other words, it receives a reciprocal relationship between size of the company and stock returns. Reed (Banz, 1981) Basu (1983), unlike Chan et al. (1991), finds the average return on equity with a ratio of earnings per share to the price (E/P) and market value of the company, which showed that the return on equity with a per-unit income (E/P) has a direct relationship and, on average, companies with a high profit margin (E/P) have higher returns than E/P companies with earnings per head. Like Banz (1981), his research also showed an inverse relationship between the average return on equity and the market value of the firm (Basu, 1983). Bondari (1988) examined the relationship between stock returns and the ratio of debt to equity. His research with control of beta and size of the company showed that the company with high debt-to-equity ratio, has higher yields. In other words, between the two factors of the stock return and debt-to-equity ratio there is a direct connection (Bandary, 1988). Fama and French (1993) presented their three-factor model that could explain the changes in returns and describe almost all of the known anomalies such as profit to price, cash flow return and sales growth. The anomaly that the three-factor

model Fama and French (1993) could not explain, it was volatility (Jagadish and Titan, 1993). To consider the effect of the momentum effect, Carhrat (1997) added the Momentum Factor (WML) to the Fama and French three-factor model(1993). The Carhart's four-factor model (1997) comparing with the three-factor model, Fama and French (1993), had more potential to explain the surplus return. Fama and French (2014) put Carharet's model as the base model and added profitability to this model to test the increasing or non-profitability factor. The results of this study showed that there was a significant relationship between the stock return and profitability. Hence, they inferred that the explanatory power of the five-factor model is more than the explanation of the Carhart's model. A lot of research has also shown that the average return on equity is related to the ratio of the book value of equity to its market value. There was also evidence that profitability and investing could increase the explanatory power of stock returns created by the ratio of the book value of equity to the market value. Therefore, Fama-French (2015), with the argument that the five-factor model has a higher explanatory capability, improved its three-factor model (1993) and their model by adding two factors of investment and profitability. This researchers (2016) again tried to complete their model, anomalies that the three-factor model Fama and French (1993) were unable to explain them, and those variables which were not included in the five-factor model; one of this anomalies is a stock fluctuation factor that is not included in 2015 Fama and French's model. So Fama and French tested it with their five-factor model (2015). In fact, this model complements the studies of the Fama and French five-factor model (2015), which has not been empirically investigated in the Iranian capital market; this present research attempts to add volatility of stock returns as one of the market anomalies to Fama and French (2015) model and investigation of the ability of this model to explain Tehran Stock Exchange's surplus returns.

Kang's (2012) study on fluctuations in securities showed that stock fluctuations are negative relationship with the stock return, so securities have higher returns when they have the lower risk. The Martin study (2012) showed that the companies with low fluctuation is able to perform better than market expectations.

Baker et al. (2011) also investigated the volatility of stocks with returns. Their findings indicated that in the United States, stocks that are in the

category of the least volatility are, on average, of higher returns than those in the others. They will get the category of volatility (Bikro et al., 2011).

Bohl et al. (2009) research on the relationship between investment and the volatility of stock returns showed that the increase in the ownership of institutional investors has a staggering effect on the fluctuation of stock returns because they quickly stock up with the new information and make the stock market more efficient.

Research by Crow et al. (2006) showed that stocks with low volatility are more robust because of the low volatility improvement of the company's access to capital.

Fakhari and Taheri (2010) investigated the relationship between institutional investors and the volatility of stock returns of companies listed in the stock exchange. Their research indicates that the presence of institutional investors increases the monitoring of the performance of managers, reduces information asymmetry, and ultimately decreases the stock return volatility by increasing the ownership of this group of shareholders.

Research question

This research seeks to answer the question of "whether the five-factor model of Fama and French (2015) is capable of explaining the volatility of stocks as anomaly of the market?"

Methodology

The statistical population of the study consisted of all listed companies in Tehran Stock Exchange. The research sample includes all companies in the community that have the following conditions:

1.Their fiscal year ends on March 20th each year.
2. During the research period, they did not change their fiscal year.
3. They are not active in the financial intermediation industry, banks, leasing and investment.
4. They have a positive book value.

Operational definition and how to calculate the variables of research

The variables of the present research are as follows:

- Return shares R_i (t): Based on changes at the beginning and end of each month, considering the increase in the capital and the dividend.

Stock returns will be calculated using the relationship (1-1)

$$R_{it} = \frac{D_{it} + P_{it}(1 + X_{it} + C_{it}) - (P_{it-1} + M_{it} * X_{it})}{P_{it-1} + M_{it} * X_{it}}$$ relationship1-1

R_{it} is the returni at time t, P_{it} is thee stock price i at the end of period t, P_{it-1} stock price i at the beginning of period t, D_{it} share dividend i at the end of period t, X_{it} is percentage increase in the capital from the place of demand and cash flow of stock i in period t, C_{il} equals percentage increase of the capital from the stock i in period t, M_{it} is the amount paid by the capital transition for increasing capital from cash and demand for share i;

- R_f (t) is the risk-free return rate that is obtained from the interest rate on public-interest bonds.
- Size: The stock market value of companies on 31st of September each year.
- Value: The ratio of the carrying amount of the end of the financial year to the market value of the equity of companies on March 20th each year.
- Market risk: The difference of the average market rate and the risk-free rate.

In this research, the market returns R_{mt} are calculated monthly using the relationship (1-2):

$$R_{mt} = \frac{I_t - I_{t-1}}{I_{t-1}}$$ Relationship1-2

I_t The return on Tehran Stock Exchange Index, is the total index of Tehran Stock Exchange at the end of the period, I_{t-1} I the total value of Tehran Stock Exchange in the beginning of the period.

Profitability factor (RMW): is income minus the cost of good sold, general administrative costs and sales, and interest expense divided book value of equity.

Robust Minus Weak (RMW)= (sales-of-sale of all-price public and administrative costs-cost of interest) / (shares of book value holders) Relationship1-3

Investment factor (CMA): is calculated from the relationship (1-4):

Conservative Minus Aggressive (CMA)= (Total value at end of year in assets) (Total value of assets in the beginning of the year) Relationship1-4

Calculating Dependent variable

In order to calculate the dependent variable (portfolio surplus return) R_p (t) -R_f (t), companies' stocks are divided into two large and small portfolios, based on the size and weight of the stock market value each year. Then, independent of the prior session, the total sample stocks are classified according to stock fluctuations into three large, medium and small groups. The combination of these two groups consists of six portfolios. Since the volatility factor on the right of the equation does not play any role in the formation of portfolios, by introducing this variable in the formation of dependent variables portfolios and by examining the average monthly returns of these portfolios and comparing their changes in portfolios of different sizes can investigate the effect of volatility as an anomaly

Table1.1.Classificationofportfoliosbasedonsize,dependentvariableandvolatilityfactor

(H) High Risk	(M) Medium	(L) Low Risk	Risk / Size
SH	SM	SL	(S)Small

BH	BM	BL	(B)Big

CalculatingIndependentVariables

1. Value Factor (HML): Companies are categorized into two large groups (B) and small (S) each year based on the mid-market value. Then, independent of the classification of the previous step, total companies are classified according to the ratio of B / M to 3 large groups (B), medium (N) and small (S). This division is carried out in the form of 30%, 40% and 30%, so that 30% above it, as value companies (H), 40% of the middle as medium-value companies (M), 30% of the lower values are defined as growth companies (L). The HML activity is calculated by the relationship (1-5).

HML = (SH + BH)/2 – (SL + BL)/2 Relationship1-5

2. Profitability factor (RMW): To calculate RMW, companies are categorized on a per-year basis on the basis of the mid-market value divided into two large (B) and small (S) groups. Then, independent of the classification of the previous stage, the stock is based on the profitability of op.) To three large groups (B), medium (N) and small (S). As 30% above it, as a company High profitability (R), 40% middle, as middle-income companies (N), are defined as 30% low as low-profit companies (W). The profitability factor is calculated on the basis of the relationship (1-6).

RMW= (SR + BR)/2 – (SW + BW)/2 Relationship1-6

3. CMA factor: For CMA calculation, companies are categorized according to the market value into two large groups (B) and small (S) each year. Then, independently of the classification of the previous stage, the company investments are categorized into three large (B), medium (N) and small (S) groups based on the investment (Inv). As 30% above it, they are considered as firms with bold investment (A), 40% of the middle as middle-end companies (N), 30% of its lower values are defined as conservative investment firms (C). The investment operator from the relationship (1-7) is calculated.

CMA = (SC + BC)/2 – (SA + BA)/2 Relationship1-7

4. SMB factor: In this method, the SMB consists of three small components called SMB $_{(B / M)}$, SMB $_{OP}$ and SMB_{Inv}. In this way, the total SMB includes the difference in the average returns of 9 portfolios in the small group of the average returns of 9 portfolios in the large group. Each SMB component SMB $_{(B / M)}$, SMB $_{OP}$ and SMB_{Inv} are derived from the average fraction of small group portfolios from the mean of large group portfolios.

$= (SH + SN + SL)/3 – (BH + BN + BL)/3$ Relationship1-8 $SMB_{B/M}$

$SMB_{OF} = (SR + SN + SW)/3 – (BR + BN + BW)/3$ Relationship1-9

$SMB_{Inv} = (SA + SN + SC)/3 – (BA + BN + B)/3$ Relationship1-10

And the total SMB is derived from the average of 3 SMB components:

$SMB = (SMB_{B/M} + SMB_{OF} + SMB_{Inv})/3$ Relationship1-11

After the formation of portfolios, the time series regression model is compiled as follows: p denotes the number of the portfolio and the index t of the period.

Finally, the model is a factor that includes all factors.

$Ri(t)- Rf(t) = \alpha + \beta [Rm (t)- Rf(t)] + sSMB (t) + hHML(t)+ rRMW(t)+ cCMA(t) + \varepsilon(t)$ Relationship1-11

SMB (size factor) difference between stock returns with small size and stock size at large size (HML) book value to market value) difference between stock returns with a high ratio of book value to market and lower shares to market, RMW (Profitability factor) the difference between the returns of companies with high profitability and low profitability of companies is achieved. Finally, the CMA (investment factor), which distinguishes between the return on investment of companies with high (bold) investments and companies with capital down (conservative).

To test the volatility factor as one of the opposites of the market rules and one of the factors not considered in the Fama and French (2015) five-factor model, the mode of operation is initially based on the independent composition of the factor of magnitude and volatility of return. Portfolios are formed with a 3 * 2 reversal, and then the surplus returns of these six portfolios, which are

calculated by the independent combination of 3 * 2 based on the size factor and the computational value are investigated.

Data analysis and hypothesis test

In order to determine whether the Fama and French (2015) five-factor model is able to explain the surplus returns of structured portfolios based on the volatility factor (as one of the opposite of the market rules), by fitting the regression the time series for the six portfolios and obtaining the coefficients of risk factors and the analysis of the results of each time series regression can be concluded. In other words, if the five-factor model (2015) is capable of explaining additional yields, then the width from its source is expected to be zero. Therefore, by comparing the width of the model's origin, one can comment on that model of opinion made. Also, for the purpose of influencing and determining the type of relationship between risk factors on the excess returns, the variable coefficient sign is determined. The t-report also indicates the significance of the coefficients.
The portfolio's over capacity, which is based on the size and volatility factor.

Table2-1.Return on portfolios

Low volatility	Medium volatility	High volatility	
Section A: Average monthly surplus			
1/83	0/77	0/61	Small
1/02	0/84	0/35	Big
Section B: Standard deviation			
3/57	6/41	9/66	Small
2/22	6/6	3/93	Big

Table A (1) and (B) show, respectively, the excess returns of portfolios and their standard deviation, respectively. As can be seen, in small firms with high risk or low risk yield returns the surplus is higher than that of large corporations. Small companies also have higher volatility fluctuations. This research, like previous studies, suggests that stocks with low volatility have a

higher surplus return than high volatility stocks. Next, using a time series regression analysis, we will test the model.

Descriptive statistics

The descriptions of the variables are presented in the table (1-3).

Table 1-3. Descriptive statistics of independent variables

	CMA	RMW	HML	SMB	RM -RF
Average	**-1/04**	**1/10**	**-0/55**	**0/9**	**0/61**
Standard Deviation	**4/88**	**7/22**	**2/27**	**5/36**	**6/35**

According to table (1-3), the average market factor is 61% and the standard deviation is 6.35% per month, which is similar to that of the Fama and French (2016) study. In the same range, the average size of (0.95 percent) and standard deviation (36.5 percent). The mean of HML was also negative (0.55 percent), which was found in most previous studies, such as Fama and French (2016), Liu Valsalu (2000) And Copoule et al. (1993). The sign of this variable was positive. The highest positive mean is the profitability factor, which is equal to 1.10%. While this factor in the Fama and French (2016) research is equal to 25.05 and the investment factor has a negative average of 1.4%, the investment factor in Fama and French (2016) Is positive.

Regression test

Table (1-4) shows the results of fitting the Fama and French five-factor model for the six portfolios based on the volatility factor as opposite to the rule and size.

Table 1-4 Time series regression results

(H)High Risk	(M)Medium Risk	(L)Low Risk

(H)High Risk	(M)Medium Risk	(L)Low Risk	
	α		
0/022	0/011	0/01	(S)Small
(2/37)	(1/43)	(1/88)	
0/011	0/015	0/018	(B)Big
(1/29)	(1/61)	(2/17)	
	b		
0/63	0/55	0/49	(S)Small
(4/49)	(4/63)	(2/88)	
0/53	0/49	0/78	(B)Big
(4/01)	(3/33)	(6/17)	
	s		
0/29	0/23	0/13	(S)Small
(2/32)	(2/74)	(2/18)	
-0/046	-0/049	-0/26	(B)Big
(-1/88)	(-2/35)	(-4/35)	
	h		
0/037	-0/55	-0/16	(S)Small
(0/09)	(-2/68)	(-0/041)	
0/127	-0/16	-0/29	(B)Big
(0/34)	(-0/38)	(-0/85)	
	r		
-0/014	-0/18	-0/12	(S)Small
(-0/82)	(-1/69)	(-0/85)	
-0/193	-0/15	0/027	(B)Big
(-1/61)	(-1/13)	(0/23)	
	c		

(H)High Risk	(M)Medium Risk	(L)Low Risk	
-0/02	**0/01**	**0/08**	**(S)Small**
(-0/29)	**(0/13)**	**(0/79)**	
-0/03	**0/054**	**-0/03**	**(B)Big**
(-0/37)	**(0/52)**	**(-0/38)**	

The regression results indicate that the width of the source is in six portfolios formed in the range of 0.01 to 0.022, which means that most of the widths of the sources are not significant at 5% level.

The range obtained for the SMB regression coefficient is negative from 0.049 to 0.29, with all coefficients at 5% for companies meaningful. The factor is the same as the Fama and French (2016) test for positive small portfolios and for large negative portfolios. In general, it can be concluded that this model is similar to the results of previous studies on the effect of size factor on Tehran Stock Exchange.

In the case of HML, it can be said that in high risk portfolios with low risk or high risk, the factor is not at the 5th percentile level, as a result of the HML factor. There is no ability to explain the surplus returns for a large corporation portfolio, while this factor has the ability to explain the surplus returns is for the portfolio of small and medium-sized firms. The profitability factor also has a negative range of 0.55-0.127, which is not all profitable factors at the 5th level, and it can be said that the factor profitability does not have the ability to explain the surplus return in portfolios (formed on the basis of volatility and size). The risk factor for capital may also get involved not significantly at the 5% level. Based on the obtained coefficients and the significance level of each of them, it can be concluded that Fama and French (2015) model has no ability to explain the surplus returns of portfolios based on the volatility factor as opposed to the rule and size, and regarding the significance level of the factors, market risk, SMB, and HML, it can be seen that the three-factor model, Fama and French (1993) is more capable of explaining the surplus return on portfolios formed on the basis of volatility, as opposed to the base of the market.

Discussion and conclusion

Results of the research show that the factors of profitability and capitalization do not have the ability to explain this surplus return, contrary to the results of the research by Fama and French (2016). In other words, it can be said that the three-factor probability of Fama and French (1993) is a useful model for explaining surplus returns based on the magnitude and the opposite of the oscillation rate of stock returns. Although there has been no research on the power of Fama and French (2015) model in the contradiction of the basics, it can be said that the results of the research are consistent with the results of the Kakis research (2015). He examined the five-factor Fama and French (2015) model in 23 advanced stock markets, whose results showed that the impact of profitability and investment factors on the explanatory power of Japan, Asia, and Pacific portfolio overcapacity was very weak.

Resource

1. Artmann, S., Finter, P., & Kempf, A. (2012)Determinants of expected stock returns large sample evidence from the German market. *Journal of Business Finance & Accounting*, 39(5-6), 758-784
2. Baker, M., Bradley, B., Wurgler, J., (2011). "Benchmarks as limits to arbitrage: understanding the low volatility
3. anomaly". Financial Analysts Journal 67, 40–54.
4. Bohl,M., Brzezcynski,J., Wilfling,B,(2009). "Institutional investors and stock returns Volatility": Empirical
5. evidence from a natural experiment Journal of Banking & Finance, 33,pp. 627-639
6. Core, J.E., Guay, W.R., Rusticus, T.O., (2006). Does weak governance cause weak stock returns? An
7. examination of firm operating performance and investor's expectations. Journal of Finance 61, 655–687.
8. -Davis, James L., Eugene F. Fama and Kenneth R. French, (2000) "Characteristics, CoVariances, and Average Returns: 1929 to 1997" -, *Journal of Finance*, 55, p. 392.
9. Eoghan Nichol, M.D. (2014)."Profitability and investment factors for UK asset pricing models".
10. Fama, E. F., & French, K. R. (1993) "Common risk factors in the returns on stocks and bonds. *Journal of financial economics*, 33(1), 3-56
11. Fama, Eugene F., and Kenneth R. French, 1992a*:* "The Cross-Section of Expected Stock Returns": *Journal of Finance*, 47, pp. 427-465
12. Fama, E. F., & French, K. R. (1997)."Industry costs of equity":. J*ournal of financial economics*, 43(2), 153-193
13. Fama, E. F., & French, K. R. (2012) "Luck versus Skill in the Cross Section of Mutual Fund Returns":.*The Journal of Finance*, 65(5), 1915-1947
14. Fama, E. F., & French, K. R. (2014)"Size, value, and momentum in international stock returns":.*Journal of Financial Economics*, 105(3), 457-472
15. Fama, E.F., & French, K. R. (2015)."a five factor asset pricing model ": *The Journal of Financial Economics*, 65(5), 1-22.
16. Hajiannejad, A. & Izadinia, N. (2014). A Comparison between basic Fama and French three Factor model and basic Carhart four factors Model in Explaining the Stock return on Tehran Stock Exchange":, *Journal of Asset Management and Financing*, 2(3), 18-27
17. Hou, H., Xue, C. and Zhang, L. (2014). "A Comparison of New Factor Models":, *National Bureau of Economic Research*.
18. Kang, X., (2012). "Evaluating Alternative Beta Strategies". S&P Dow Jones Indices Research Paper.
19. -. Martin, I., (2012). "On the valuation of long-dated assets". Journal of Political Economy 120, 346–358.
20. Parikakis,G & Syriopoulos (2008), "Contrarian strategy and overreaction in foreign exchange markets",
21. Research in International Business and Finance, PP. 319-324.
22. Petersen, M.A., (2009). Estimating standard errors in finance panel data sets: comparing approaches. Reviewof Financial Studies 22, 435–480.

23.Rajgopal, S., M. Venkatachalam,(2011). "Financial reporting quality and
24.idiosyncratic return volatility". Jaournal of Accounting and Economics 51: pp 1–20.
25.Zhu, J, (2009). "Pricing volatility of stock returns with volatile and persistent components" Financ Mark Portf
26.Manag 23: 243–269
27.Zafar., N. Urooj, S.F.,Durrani, T.K.,(2008). "Interest rate volatility and stock return and volatility". European
28.journal of economic, issue 14