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The Empirical Test of Fama-French Five-Factor Model: Evidence from Pakistan Stock Exchange

Abstract   This study provides an empirical examination of the Fama and French five-factor asset pricing model (FF5FM) in the equity market of Pakistan. Using data from 2007 to 2017 of non-financial firms listed on PSX. The univariate approach is used to construct the dependent portfolios based on four firm's characteristics, while a 2x3 approach is used to construct size, value, profitability, and investment factors. Time series regression is used to analyze the data to obtained results. The empirical evidence demonstrates that FF5FM performs better the three-factor model in the Pakistan stock market and the performance of the four-factor model that drops investment factor is similar to FF5FM except for portfolios constructed based on investment factor.

Key Words: PSX, Size, Value, Profitability, Investment, Five-Factor Model

Introduction

The equity market is supposed to contribute enormously because it gives a boost to savings. Besides, it gives rise to the investment in terms of quantity and quality (Singh, 1997) and it creates paths that encourage savings and equity financing which have a positive impact on the growth of the economy (Yartey & Adjasi, 2007). The investors use potential economic fundamentals for making investment decisions as well as other characteristics related to firms to figure out their expectations; however, the complexities of the stocks market make it difficult to take investment decision. The investment decisions have taken based on the reward or return against investment and the risk associated with return; however, the investment decision in the equity market remained a confusing task until the 1950s. The investment decisions had taken based on how much stocks can earn or the capacity of earning stocks. In other words, the key consideration of investment returned that by investing in a specific stock how much they would get. Even though they would implicitly realize the existence of risk, but they were unable to measure it due to which they did not put all their investment in one place and just like a financial remedy they used to invest in more than once, or it can be said that probably in multiple assets as like portfolio. But again, the lack of a specific model makes it difficult to assess' portfolios, or it was not possible to calculate the risk of the portfolio. So, there was a need for a model to assess the portfolio, through which they might be able to compute the risk that is connected with the investment (Iqbal, Khattak, Khattak, & Ullah, 2012). One of the initial efforts had been made in the 1960s by Sharpe (1964) which directed to the formation of the Capital Asset Pricing Model (CAPM) after which attempts are made by Linter (1965) and Mossin (1966). Latterly the model was empirically tested by various researchers in different advanced and emerging markets of the world to validate the main assumption of the model such as Black, Jensen, and Scholes (1972), Blum (1968), Fama and MacBeth (1973) and Gibbons (1982). Most of the empirical studies that tested CAPM recommended the significance of the CAPM; however, in some cases, CAPM failed in its application. Later, the model was questioned because of the basic assumptions of the model and also because of its empirical application by researchers like Merton (1973) and Fama and French (2004).

According to the previous literature that offers the empirical evidence that large portion of the variation occurs in returns on assets is left unexplained by CAPM has given a massive

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encouragement to scholars to track the exploration of other factors that cause systematic risk or a set of risk factors which could describe variation in the returns on asset better than a model that has a single factor. In this regards, the Fama and French (1993) conducted a study on the stocks market of the developed economy of US in which they have added two additional risk factors related to firm's characteristics one is the size of the firms, and another one is B/M equity that can capture the size premium and B/M premium to CAPM. Their study contributes in real means to the development of multi-factor models of asset pricing. In a recent study related to asset pricing that has done in the markets of a developed economy (US) by the Fama and French (2015), the two risk factors came to the surface as a crucial factor in asset pricing model the one is related to the profitability capacity of the firm, and the other one is related to the investment. They argue that these two factors should be considered as additional risk factors with the Fama-French three-factor model (FF3FM) for explaining variations in returns as they found them significant in their study which leads to the development of a new model that can price the assets known as Fama-French five-factor model (FF5FM). The FF5FM is tested empirically in numerous markets of the world regardless of whether the market is developed or emerging and in many of them, the model is proved as an enhanced description of the returns on stocks compared to earlier asset pricing models. As stated, before FF5FM has been tested in the markets of different economies; however, its implementation/ application is rare in the emerging equity markets of South-Asia like the equity market of Pakistan. There may be certain reasons which might be the small size of the market, and it is also possible that in earlier periods to assemble sufficient share to shape necessary portfolios might be difficult (Ali, He, & Jiang, 2018).

As mentioned above the FF5F model is rarely tested with the data of the equity market of Pakistan; thus a need has arisen to test the model empirically with the updated data to validate the applicability of the model for Pakistan Stock Exchange (PSX). This study tries to observe the performance of FF5FM and compare it with FF3FM.

Review of Literature

The dominant modern investment theories are originated from two early concepts, one is the work of Markowitz (1952), who developed portfolios selection theory that argues that if the financial market is efficient then higher return has expected due to higher risk exposure and the other one concept is known as CAPM presented by Sharpe (1964), argued that if the portfolios are diversified, the unsystematic risk that is linked with individual assets have a tendency to offset each other, only the systematic risk is the relevant factor. Thus, investors rewarded just for bearing greater "systematic" risk. However, it is not possible to fully diversify away the systematic risk. According to CAPM, there is one factors that is market (beta) factor which is enough for the describing the variations occurs in returns on stocks.

The CAPM stated that the expected market risk premium could explain an asset or portfolio's expected returns. If paraphrased, the stock returns are only sensitive to market factor, and the sensitivity had been defined as a beta. But because of the failure of the CAPM in some economies, it was realized that the equity market is very intricate and cannot be fully explained by only one factor there might be some other risk factors that can describe the returns variations or fluctuations on the assets that lead to the development of multifactor asset pricing model. For instance, intertemporal CAPM which was developed by Merton (1973) and Arbitrage Pricing Theory (APT) that was presented by Ross (1976) which provides the base to determine that how much return should be expected from an asset. APT stated that expected returns of assets are sensitive to macroeconomic variables. However, the number and identification of macroeconomic variables are not given by the model.

The patterns in returns on assets are known as anomalies, and CAPM is unable to explain them. Such as side effect is found by Banz (1981), the size effect is that firms that have small market capitalization have a tendency to earn returns than the firms have big market capitalization. Parallel anomalous patterns with respect to book-to-market (BE/ME) equity were founded by Rosenberg, Reid, and Lanstein (1985). In the same line, Fama and French (1992) used firm-specific characteristics with the market beta of CAPM as they perceived that firm-specific characteristics are the variables that cause risk. Their study finds a lack of support for the central assumption of the CAPM as returns on stocks have a positive relationship with market beta. In search of identification of most relevant factors, the work related to the asset pricing by Fama and French (1992) was extended by Fama and French (1993) expand the list of factors that are used to define returns on asset, and an altered approach is adopted to test that how to price the asset. The main findings are obvious: the inability of CAPM to describe the variations occurs in the returns, as the market factor is weighted towards big firms. While the other two factors known as size and value premia capture strong regular variation occurring in equity returns when using a time-series

regression for testing, which are typically obscured within the market factor. However, these two risk factors in isolation are not enough to explain returns and must be modelled in conjunction with the factor related to the market. In this regard, the study conducted by Fama and French (1993) concludes that the market risk factor and two firm's characteristics a total of three risk factors related to the market, the firm's size, its B/M value are appropriate to explain returns of equity. In search of an appropriate model of asset pricing and identification of the relevant factors another empirical study conducted by Baker and Haugen (1996) and Cohen, Gompers, and Vuolteenaho (2002) found the proof that average stock returns of comparative more profitable firms are abnormally high, while, Fairfield, Whisenant and Yohn (2003) and Titman, Wei and Xie (2004) observed that the average returns (ARs) of a firm are also influenced by its pattern of investment because they found the lower investment firms have low average returns on stocks. Similarly, Novy-marx (2013) observed that in explaining the variations in ARs on security, the gross profitability has the same power as the B/M ratio. Similarly, Hou et al. (2015) contributed to the literature by conducted an empirical study and found that the risk factors profitability and investment also have significant roles in the description of fluctuations occurs in stocks returns. Motivated by past literature and their empirical findings and q theory, Fama and French (2015) augment two additional factors profitability premia and investment premia to their FF3FM and proposed FF5FM that capture the effect related to profitability and investment pattern of the firm.

Data Sources

The sample of this study is constructed using listed firms on PSX over the period 2007 to 2017 a total of 120 months. Following the previous literature, the financial firms, the firms that have negative B/M, and firms that are not actively traded are excluded from the sample of this study. Monthly prices of the sample stocks are sourced from the business recorder. The six-month T-bills rate is used as the risk-free rate (RFR) and data taken from State Bank of Pakistan (SBP) and converted to a monthly rate as the rates are annual. The data of the accounting variables are taken from the annual reports of the companies.

Portfolios and Variables Construction

Two approaches are used to construct the portfolios, univariate portfolios, and double sorting portfolios in order to test the asset pricing models of this study. The univariate portfolios approach is used to shape the LHS portfolios, and the excess returns of each portfolio are treated as the dependent variable of the current study used for the purpose to test the models. The process results in four sets of portfolios, a total of 16 portfolios, and a set of four univariate portfolios based on each characteristic. Such as four portfolios P1, P2, P3, and P4 (from low to high) are determined for size, value, profitability, and investment effect. These portfolios formed with the following criteria: the whole sample stocks are allocated into four portfolios (P1, P2, P3, and P4) using market capitalization quartiles as breakpoints at the end of each year-t. The other portfolios formed on the same method except the sorting variable is B/M equity, Profitability, or investment in place of size of the firms.

The explanatory variables comprise five risk exposures in which one is a market factor, and the other four are firm's characteristics. The market factor is defined as the market excess return or equity premium that is the market return on the excess of RFR. While for the other exploratory four factors, the double sorting approach (2x3) is used to construct portfolios. The sample stocks are allocated into two size portfolios (small and big), and then each size portfolio is divided into three portfolios based on B/M (growth, medium, and value). The same approach has been used to shape the six portfolios for each of the other two factors profitability and investment; however, the only difference is the second sorting variable is profitability (weak, medium, and robust) or investment (conservative, medium and aggressive) respectively have been used. The value factor, profitability, and investment factor generally denoted as HML, RMW, and CMA, while the size factor denoted as SMB is the average of $SMB_{B/M}$, SMB_{OP}, and SMB_{Inv}.

Models

This study employs time series regression with the aim to test the presence and significance of the various factors on asset pricing in the PSX. The study follows a stepwise approach; the models and description are as follows:

$$ER_{i,t} = \alpha + \beta_i ER_{m,t} + s_i SMB_t + h_i HML_t + e_{i,t} \quad (1)$$

$$ER_{i,t} = \alpha + \beta_i ER_{m,t} + s_i SMB_t + h_i HML_t + r_i RMW_t + e_{i,t} \quad (2)$$

$$ER_{i,t} = \alpha + \beta_i ER_{m,t} + s_i SMB_t + h_i HML_t + c_i CMA_t + e_{i,t} \quad (3)$$

$$ER_{i,t} = \alpha + \beta_i ER_{m,t} + s_i SMB_t + r_i RMW_t + c_i CMA_t + e_{i,t} \quad (4)$$
$$ER_{i,t} = \alpha + \beta_i ER_{m,t} + s_i SMB_t + h_i HML_t + r_i RMW_t + c_i CMA_t + e_{i,t} \quad (5)$$

Where ER_t is the excess return ($R_i – R_f$) on portfolio at time t, α is the regression intercept, ER_m is the excess market return ($R_m – R_f$), SMB, HML, RMW and CMA is size premium, value premium, profitability premium and investment premium, respectively and β, s, h, r, and c are the coefficients of expected risk premium to market, size, value, profitability and investment respectively, in the regression model, e_i is the residual term.

Results and Interpretation

Table 1 displays the patterns in monthly returns on portfolios in excess of six-month T-bill rates used as RFR. The set of four univariate portfolios is shaped based on each one of the four characteristics of the firms such as size or B/M or profitability or investment take into consideration for this study. The portfolio denoted as P1 contains stocks that have the lowest market capitalization, B/M, Profitability and investment, and highest values of respective factors are contained by portfolio P4.

Table 1. Average Percent Excess Returns of Portfolios – June 2007 to July 2017

	P1	P2	P3	P4
Size	1.159	1.027	0.899	0.585
B/M ratio	0.594	0.884	0.930	1.239
Profitability	0.766	0.945	0.956	1.162
Investment	0.966	0.875	0.951	0.994

The results show that for size portfolios, the monthly average excess returns drop when moving from P1 towards P4, which suggests a negative or inverse relationship amid the firm's excess returns and size of the firms. For instance, P1 has a 1.159% monthly average excess return while for P4, the monthly return is 0.966% shows return moves downward when the size of the firm upward (increase). The past literature available on the relationship between size and asset return also shows a similar pattern for developed as well as emerging markets such as Fama and French (1993, 2015) for the US, Lin (2017) for China and Ali et al., (2018) for Pakistan. The results of B/M and profitability sorted portfolios show returns rise monotonically with the rise in B/M and profitability which supported by the previous literature evident as the prior empirical studies evident that high B/M value and robust profitability stocks earn more than that low B/M growth and weak profitability firms, respectively. The result shows that the pattern of excess returns does not seems to be very clear for the investment portfolios. The returns fall from P1 to P2 and increase when turning to P3 and P4. The returns increase with an increase in investment evident from Table 2 show that the return on stocks is positively related to investment. The result of investment portfolios is contradicted with the famous findings of Fama and French (2015) for the US stock market who observed the existence of an inverse relationship between the investment pattern of the firm and its return. However, they observed that the relationship between returns and the explanatory variable B/M, OP or investment is conditional to controlling for other two risk factors, though, the controlling for other variables is not permitted in univariate sorting that may be probable reason due to which the pattern is not clear in returns on investment.

Table 2. Regression Intercepts and their T-statistics for Asset Pricing Models

	α				t(α)			
	P1	P2	P3	P4	P1	P2	P3	P4
Panel A: FF3F model								
Size	0.14	0.03	-0.15	0.05	1.88	1.77	2.14	1.17
B/M ratio	-0.17	-0.12	-0.02	0.19	-1.55	-1.69	-1.28	1.24
Profitability	-0.13	0.17	0.18	0.24	-0.85	1.91	2.02	2.52
Investment	0.29	0.04	0.11	0.07	2.03	0.76	1.498	1.28
Panel B: FF5F model								
Size	0.09	0.05	-0.17	0.08	0.97	0.99	2.37	0.56
B/M ratio	-0.11	0.16	0.03	0.12	-1.53	1.94	1.28	1.66
Profitability	-0.06	0.10	0.05	0.14	-1.08	1.29	1.3	1.16
Investment	0.21	0.01	0.09	0.06	1.23	0.75	1.09	1.11

The main objective of this study is to test the capability of the contemporary model of asset pricing, which is FF5FM to completely describe the fluctuations occur in returns on stocks. Table 2

shows the regression intercepts from two models of asset pricing, the first one is FF3FM, and the second one is FF5FM. The regression alpha should not be different from zero if the variation in the portfolio's return on excess is fully described by the explanatory variables (Fama & French, 1993, 2015). Panel A of Table 2 displays the intercepts and their t-statistics from regression model when the returns are described using FF3FM, and it can be observed that the model describes the returns on the stocks in two sets of univariate portfolios, one set shaped on size and the other shaped on B/M, however, the results show the inability of the model while fully capturing fluctuations occurring in the returns on three of the total portfolios which are the highest and second-highest profitability and lowest investment portfolio. For these portfolios, the FF3F model produces the highest intercepts, and their t-statistics demonstrate that they are significantly not equal to zero. For the univariate portfolios that are specifically shaped on the B/M factor and investment, the returns are captured and described by the FF3F model as the regression intercepts are insignificant for all these portfolios except the extremely conservative portfolio. Panel B of Table 2 displays the alphas from the regression model and their t-statistics for the second model under consideration for this study, the FF5F model. Based on the results reported in Panel B it can be noticed that the performance of FF5F model is mostly similar to the performance of FF3F model for two out of four sets of univariate portfolios, one set is formed on size of the firms and the second set is formed on B/M factor. These two sets of univariate portfolios have insignificant intercepts evident by the t-statistics of the coefficients; the only exception is the second-highest size portfolio. However, for the portfolios in the other two sets, one set is formed on profitability and the other constructed on investment, the FF5FM showed improved performance. The results show that the two highest profitability and lowest investment portfolios offer more returns on excess that is estimated by the FF3FM. In other words, the FF3FM is failed to fully describe the variations in returns on these portfolios.

Table 3. Average Absolute Alpha and Average Adjusted R2

Model	A $|\alpha|$	Adjusted R^2
Panel A: Size portfolios		
FF3F	0.08	0.85
FF3F + RMW	0.07	0.90
FF3F + CMA	0.08	0.85
ER_m, SMB, RMW, CMA	0.11	0.78
FF5F	0.07	0.88
Panel B : B/M portfolios		
FF3F	0.13	0.87
FF3F + RMW	0.08	0.89
FF3F + CMA	0.13	0.87
ER_m, SMB, RMW, CMA	0.15	0.79
FF5F	0.08	0.88
Panel C : Profitability portfolios		
FF3F	0.16	0.78
FF3F + RMW	0.08	0.86
FF3F + CMA	0.17	0.77
ER_m, SMB, RMW, CMA	0.11	0.85
FF5F	0.09	0.85
Panel D : Investment portfolios		
FF3F	0.13	0.81
FF3F + RMW	0.11	0.85
FF3F + CMA	0.09	0.88
ER_m, SMB, RMW, CMA	0.12	0.83
FF5F	0.09	0.88

Table 3 displays the average absolute alphas and average adjusted R square values for the asset pricing models take into consideration for this study that is FF3F model, FF5F model and four-factor model that drops B/M, profitability or investment factor which are used as performance measures, on the basis of which the performance of these models has been judged. Table 3 shows that adding RMW factor to the FF3F model reduces the average absolute intercept and in addition, the power of the model to explain variations and fluctuations occurs in return is improved for all the predicted portfolios under consideration as suggested by average absolute alpha and R-square. However, for portfolios formed on profitability, the improvement is comparatively more than the other two sets

of univariate portfolios formed on either firm's size or B/M factor. For instance, the average absolute alphas reduce from 0.08 for FF3F to 0.07 for FF5F and four-factor model for size portfolios, and average adjusted R^2 increase from 85% to 90%. While for profitability portfolios, the average absolute alpha drops from 0.16 for FF3F to 0.08 for the FF5F model and average adjusted R^2 increase from 0.78% to 86%. While adding investment factor, FF3FM, the improvement can be observed in only investment sorted portfolios. Overall, the results show that the FF5F model that augment two risk exposures into the FF3F model performs better than the FF3F model. Dropping investment factor, CMA from the FF5F model produce much similar results of the FF5F model suggest that CMA performs no role in describing the variations in returns on stocks listed on the equity market of Pakistan. While it can be noticed from the results that dropping HML from the FF5F model produce a large drop in the performance of the model as the rise in the average alphas and drop in R-square suggesting that HML play an important role to describe the returns variations of the firms listed on Pakistan stock market. These outcomes are inconsistent with the findings of Fama and French (2015) whose find CMA an important factor and HML as a redundant factor in describing returns, while in line with the findings of Lin (2017). One possible explanation for the redundancy of investment factor CMA is that the explaining power of investment factor is absorbed by the other four factors of the FF5F model except for portfolio formed on investment. To check whether the explanatory power of one factor is observed by other remaining four factors, each RHS factor of the FF5F model is regressed on the other four RHS factors. Table 4 displays the regression results of each RHS factor on other variables. The results for CMA shows that the regression intercept is -0.09 and its t-statistics is -0.56 which confirms its insignificance which suggests that average CMA returns are observed as described and captured by other RHS factors while the results show that the intercepts of other variables are positive and their t-statistics shows that they are statistically significant to suggest that average returns remain unexplained by exposures to other four explanatory factors. Similar results are found by Lin (2017) and Foye (2018) for CMA.

Table 4. Regression of Each Explanatory Variable on the other Four Variables

	α	ER$_m$	SMB	HML	RMW	CMA
ER$_m$						
Coe	0.71		-0.02	0.16	0.12	-0.30
t-statis	3.93		-0.16	1.47	1.25	-1.44
SMB						
Coe	0.67	-0.01		0.11	0.04	0.38
t-statis	4.21	-0.16		1.05	0.44	3.52
HML						
Coe	0.48	0.11	0.09		0.35	0.33
t-statis	2.84	1.47	1.05		4.61	3.33
RMW						
Coe	0.39	0.11	0.04	0.45		-0.32
t-statis	2.17	1.25	0.44	4.61		-2.82
CMA						
Coe	-0.09	-0.17	0.26	0.27	-0.20	
t-statis	-0.56	-1.44	3.52	3.33	-2.82	

Conclusion

An empirical investigation conducted to test the performance of FF3FM, FF5FM as well as three four-factor models that drop either HML, RMW, or CMA by using monthly data of PSX from 2007 to 2017. Two types of portfolios are constructed on four firm's characteristics (size, B/M ratio, profitability, and investment) to test the performance of asset pricing models in PSX. First, the LHS portfolios are the univariate portfolios that are constructed based on each one of the four firm's characteristics that are treated as the dependent variable. The univariate portfolios are shaped in a way that the whole sample is allocated to four groups such as P1, P2, P3, and P4 based on each characteristic using quartile breakpoints of each characteristic of the study taken. While the double sorting portfolios are shaped using a 2x3 approach for calculating RHS factors treated as exploratory variables. Further, to test the performance of the models of asset pricing, the time series regression is employed. The results of which show a negative relationship of return with one exploratory variable that is the size of the firm while the positive relationship of return with other exploratory variables like B/M, operating profitability, and investment. Besides, profitability and investment improve the performance of the model to describe the pattern in returns on stocks of equity market of Pakistan which is evident from the results of the reduction of intercept and rise of

R-square. Further, the FF5F model performs better than the FF3F model for profitability and investment sorted portfolios, and the four-factor model that drops the investment factor produces similar results as the FF5F model except for the portfolios that are formed on investment. To sum up, based on the results, the value and profitability factor is found as significant factors while investment is found to be redundant in explaining variations in returns on stocks of PSX.

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