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Full Length Research Paper

Fama and French three factor model: Empirical evidence from financial market of Pakistan

Zeeshan Hamid[1], Ch Asad Hanif[1], Shehzada Saif ul Malook[1] and Wasimullah[2]*

Management Sciences Department, Air University, Islamabad, Pakistan.
Learning Resource Centre, National Bank of Pakistan, Islamabad, Pakistan.

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The purpose of this research is to empirically evaluate the efficacy of Fama and French three factor model with respect to asset pricing and expected portfolio returns for stock in financial sector in Pakistan (listed on Karachi Stock Exchange (KSE)). Multivariate regression analysis is applied on the six portfolios made on the basis of size and book to market value. Monthly data of 20 banks were taken for the period of five years starting from January 2006 to December 2010. Results showed that for most of the portfolios the Fama and French three factor model explained the variations in returns.

Key words: Size premium, value premium, market premium, three factor model.

INTRODUCTION

Capital asset pricing model (CAPM) says that the expected return on an asset above the risk-free rate is proportional to systematic risk, which is calculated by the covariance of portfolio containing all existing securities (market portfolio) with the asset return (Sharp and Lintner). CAPM states that there should be a relationship between the market portfolio's beta and the cross section of average returns but empirical result of the data taken form Pakistani stock exchange does not show strong relationship (Eatzaz and Attiya, 2008).

A strong negative relationship was found between firm size and average returns by Banz (1981). Another variable which makes a significant impact in explaining average return is the ratio of book-to-market (B/M) which was documented by Chan et al. (1991). In 1992, Fama and French (FF) presented three factor model that explained most of the return of a stock which states that value stocks (with high B/M ratio) provide better returns as compared to growth stock (with low B/M ratio) and small firms provide better returns as compared to big firms.

The objective of this study is to empirically analyze how well Fama–French three factor asset pricing model explains the cross-sectional deviations in expected stock returns in Pakistani market.

This study will help local and foreign individual investors, institutional investors and policy makers to better understand the risk/reward characteristics of Pakistani market. This might also be useful to construct a portfolio to capture future performance (maximum return on a given level of risk).

LITERATURE REVIEW

CAPM is one of the fundamental concepts which explain the expected return on a stock based on the systematic risk. This model predicts the expected return on a stock given the risk free rate, expected return on the market and the stock's beta coefficient. The assumptions of CAPM include:

1. The ability of investors to borrow and lend unlimited amount at risk free rate,
2. No transaction costs,
3. Homogenous expectations and holding periods,
4. No taxes,
5. All securities are perfectly liquid and divisible,

*Corresponding author. E-mail: Zeeshan.hamid83@gmail.com.

6. For selecting securities all investors use Markowitz mean-variance framework,
7. Divisible assets,
8. There is no inflation and constant interest rate,
9. The capital markets are in equilibrium (Sharpe, 1964).

The CAPM equation is:

$$E(Ri) = Rf + [E(Rm) - Rf] \beta i + \varepsilon i$$

Where expected return on any asset i is E (Ri), the risk free rate is Rf, the expected return of market is E(RM), βi measures the sensitivity of security's return to change in market return. Beta measures the systematic risk; the residual term of any asset is εi.

Ross (1976) presented arbitrage pricing theory (APT) which explains the multifaceted relationship between risk and return. It explicate that the expected return of any security can be molded as a linear function of a variety of macro-economic factors, where factor-specific beta coefficients correspond to sensitivity to change in each factor.

Fama and French (1992) studied that the CAPM does able to fully explain the cross sectional average returns of US stocks for the period 1963 to 1990. CAPM beta does not explain stock's multi dimensional risks. Fama and French in 1993 examined that other factors also have impact on asset's return. They presented additional factors value premium and size premium other than market beta which explain average return on a security. The Fama and French three factors model equation is:

$$E(Ri) = Rf + [E(Rm) - Rf] bi + siE(SMB) + hiE(HML) + \varepsilon i$$

Where E(Ri) = Expected return on any asset
Rf = Risk free rate,
E(Rm) = Expected return on market,
Bi = sensitivity of the asset returns to market returns,
Si = sensitivity of the asset returns to return of small size minus big size,
E(SMB) = expected return of small size minus return of big size,
hi = the sensitivity of the asset returns to return of HML,
E(HML) = the expected return of high BE/ME ratio minus return of low BE/ME ratio,
εi = the residual term of any asset i.

Fama and French (1996) explained the pattern of average returns which CAPM was unable to capture. According to them average return is related to firms characteristics like cash flow/price, past sales growth, size, long term past returns, earnings/price, book-to-market equity and short term past returns. In this study they concluded that three factors model explain average returns better than CAPM and capture average-return anomalies except for continuation of short-term returns.

Chawarit (1996) compared CAPM to APT model to explain the predictability of return of stocks listed on stock exchange of Thailand for the period 1990 to 2000. The study was further divided in to two parts of times that is, before economic crises and after it. The research found that in comparison with CAPM model, APT model is better while explaining the return of stock for Thailand Stock Exchange.

Later on, Fama and French in (1998) examined the value and growth stocks for the period 1975 to 1990 in international market and concluded that value stocks have better returns as compared to growth stocks around the world. Global portfolios of high book-to-market value outperformed low book-to-market value portfolios. In twelve out of thirteen major markets value stocks provided better returns as compared to growth stocks.

Chanthirakul (1998) found out two factors that explain stock return's in the stock exchange by applying arbitrage pricing theory but these factors are not helpful in finding the reason for the return furthermore, the quantity of factors explaining returns on stocks will vary if the sample changes. Fama and French model replicated on stock market of Australia by Halliwell et al. (1999) concluded that F and F three factor model captures some of the stock returns and some premium was observed on small minus big (SMB) capitalization and high minus low (HML) book to market value (factors but the model did not explain the market returns as strongly as it did in US market.

For the period 1929 to 1997, Davis et al. (2000) comprehensively examined the covariance and average returns. They divided the data in two phases first from July 1929 to June 1963 and second from July 1963 to June 1997 and found out that value premium was higher than size premium and was statistically significant for the first phase.

Aleati et al. (2000) studied the effect of risk on return for Italian stocks. Time series regressions were used to examine the data from 1981 to 1993 for stocks listed on Italian Stock Exchange. Instead of portfolio returns they used the individual stocks returns in contrary of most of researcher. They found empirical evidence that default premium, changes in market index, changes in interest rates, changes in oil prices and SMB and HML and factors which determine assets returns. Connor and Sehgal (2001) tested F and F three factor model on stock returns in Indian market and concluded that over the period of time mean returns were not only explained by the market factor but also by the market, size and book-to-market factors.

Drew and Veeraraghavan (2002) tested the existence of size and value premium in Malaysian market from December 1991 to December 1999. There research found out the effect of size and value premium in stock returns which was not explained by the CAPM. Drew and Veeraraghavan (2003) applied Fama and French three

factor model to examine the explanatory power of a single index. The studies were done on Hong Kong, Korea, Malaysia and Philippine markets and found out that F and F three factor model better explains the stock returns.

Bundoo (2006) applied Fama and French model (1993) on Stock Exchange of Mauritius. The empirical evidences confirmed that Fama and French model holds for Stock Exchange of Mauritius. This study also found that F and F three factor model is vigorous in consideration of time-varying betas.

For the period of September 1992 to April 2006, Iqbal and Brooks (2007) tested CAPM on the Karachi Stock exchange using two step Fama-Macbeth procedure. They tested it with both with and without riskless assets. In this study beta explained the Cross sectional variation in expected returns. Uzair and Hanif (2010) applied CAPM on Karachi Stock Exchange covering period of 6 years (2003 to 2008) selecting 60 companies from KSE-100 Index. Results showed that CAPM does not provide accurate results.

Homsud et al. (2009) replicated the F and F three factor model over the period July 2002 to May 2007 to Stock Exchange of Thailand. They found that Fama and French model is better model to describe Thailand Stock Exchange as compared to CAPM Bahtnagar and Ramlogan (2010) used multiple regression approach to compare CAPM, split CAPM and the three factor model to explain the Average return in the United Kingdom Market for period April 2000 to June 2007. Results indicated that three factor models provided better results as compared to CAPM and Split CAPM in explaining UK market returns.

THEORETICAL FRAMEWORK AND HYPOTHESIS GENERATION

Keeping in view the purpose of this research that is testing of FF three factor model in Pakistani scenario , the following hypotheses (alternative will be the focus of testing):-

H_1: $\alpha_P = 0$
H_2: $\beta_{1t} = 0$
H_3: $\beta_2 = 0$
H_4: $\beta_3 = 0$

Where αP is regression intercept and β1, β2 and β3 are risk sensitivities of portfolio returns. If three slope coefficients are significant and intercept is not significant then three factor model will be valid in Pakistani scenario.

METHODOLOGY

Standard multivariate regression framework method is used to apply Fama and French three factors model on financial sector of Pakistan. Return above risk free rate on each portfolio were regressed on three factors namely value premium, size premium and market risk premium. The model equation is:

$$EPR = \alpha i + (Rm-rf)\ \beta 1 + SMB\beta 2 + HML\beta 3 + et$$

Five years monthly data of 20 banks listed on KSE is used in this research. Data of 20 banks were sorted according to their capitalization which is determined by multiplying the total number of shares times the price per share. Then the top 8 banks were grouped as high market value (big) and other 8 were grouped as low market value (small) stocks.

After that grouping securities are divided into three groups based on their book to market ratio. First group consist of securities having high B/M ratios, second group has securities having medium B/M ratios and last group consist of securities having low B/M ratios.

Types and sources of data

The secondary data from KSE is used for this study for which monthly closing prices are taken from BR website (brecorder.com) to calculate monthly returns and annual T bill yield are used for a risk free proxy.

Dependent variable

Excess portfolio return represented by EPR is the dependent variable. It shows the return over risk free rate. To calculate the return of market and the return of portfolio logarithmic return Rt = ln (Pt/Pt-1) is used and yield of government bond for 1 year is taken as a risk free rate (converted into monthly return). Average of all stocks is taken to find portfolio return.

Independent variables

Market risk premium and size factor and value premium are three independent variables in this research.

First independent variable is market risk premium which is difference between the market return and risk free rate. Second independent variable is size premium that is small minus big (SMB). This factor reflects the excess return offered by small size companies as compared to big size companies because small size companies have relatively high risk due to less financial flexibility and lower diversified nature than bigger firm which forces investor to ask for risk premium when they invest in firms having small capitalization. The third independent variable is the value premium high minus low (HML) that captures additional return offered by companies whose book value (BV) to market value (MV) ratio is high. If the book to market ratio is high it shows that the difference in book value of the firm and the value of its stock is large which may be because of investor's low expectation resulting in making such firms more sensitive to financial and business risk because of which investor could ask for premium.

Monthly portfolio and market return

The portfolio returns are the average returns of individual stock calculated as Rt = ln (Pt/Pt-1) where Pt and Pt-1 are closing prices on day t and t-1.

Similarly the return on market portfolio are calculated by using KSE 100 Index Rt = ln (KSE(100) t/ KSE(100)t-1) where KSE (100)t

Table 1. Descriptive statistics of monthly returns (2006 to 2010).

Statistics	BL	BM	BH	SL	SM	SH
Mean	-0.002421	-0.007666	-0.0118	-0.011206	-0.00020235	-0.022555
Median	-0.00607	0.000929	-0.0065	-0.001858	-0.001248	-0.000521
Maximum	0.601546	0.417526	0.4789	0.414633	0.183779	0.182681
Minimum	-0.502806	-0.464023	-0.5311	-0.465354	-0.496759	-0.502716
Std. dev.	0.144185	0.121949	0.13882	0.126101	0.114108	0.117889

Table 2. Descriptive statistics of KSE 100 daily returns (2006 to 2010).

	Mean	Median	Maximum	Minimum	Std. dev.
KSE 100 index	0.00383	0.012865	0.202797	-0.4198	0.093652

Table 3. Factor statistics (2006 to 2010).

Statistics	MRP	SMB	HML
Mean	-0.005287	-0.001205	-0.0103
Median	0.003393	-0.000946	-0.0053
Maximum	0.192339	0.06554	0.0276
Minimum	-0.429303	-0.265455	-0.1918
Std. dev.	0.093645	0.048204	0.03159

and KSE(100)t-1 are closing index value on day t and t-1

Market risk premium small minus big (SMB) and high minus low (HML) factor

Market risk premium is estimated by deducting the monthly T-Bill yield from monthly KSE 100 index yield. SMB is calculated by deducting the average return of big capitalization portfolios from average return of small capitalization portfolios.

HML is calculated as the difference between the return of high B/M value portfolio and the small B/M value portfolio. In order to find the market ratio book value of equity is divided to the market value of equity. Based on size and book to market value ratios six portfolios were made that is B/L, B/M, B/H, S/L, S/M and S/H.

Where,
S/M portfolio had stocks that have medium book to market ratio and small in size
B/H portfolio had stocks that have high book to market ratio and big in size

SMB is calculated as follows
SMB = Average return of (S/L, S/M, S/H) portfolio minus average return of (B/L, B/M, B/H) portfolio.

Similarly HML is calculated as follows:
HML = Average return of (S/H, B/H) portfolio minus average return of (S/L, B/L) portfolio.

EMPIRICAL RESULTS AND ANALYSIS

Descriptive statistics

The monthly returns between January 2006 and December 2010 were calculated for six sorted portfolios. Table 1, 2 and 3 represents the descriptive statistics of these portfolios.

For the sample period all portfolios return is in negative, highest return was offered by S/M portfolio followed by the B/L portfolio. The minimum monthly return was provided by big stocks having low book to market ratio and maximum return was offered by small stocks having medium book to market ratio. The highest monthly standard deviation was of B/L portfolio and lowest was of S/M portfolio. The maximum return on index portfolio was 20.2 % with mean of 0.38 %, minimum return of –41.93% and standard deviation of 9.36 %.

For the sample period average market risk premium, size premium and value premium all were in negative. The negative signs with value and size premium were due to negative mean return on all portfolios. Negative mean return for SMB factor means that on average big stocks outperformed small stocks in terms of returns and negative mean return for HML factor mean that on average growth stocks provided better returns as compared to

Table 4. Correlations between independent variables (2006 to 2010).

Variable	MRP	HML
HML	-0.051165	
SMB	-0.108942	0.3071

MRP, Market risk premium; HML, high minus low factor; SMB, small minus big factor.

Table 5. Three factor regression on portfolios sorted for size and book to market.

Variable	α	β1	β2	β1	(α)	π(β1)	π(β2)	π(β3)	P2	Δ-Ω Στατ
B/H	0.00086	-0.00482	-0.013	0.0345	0.2157	0.9421	0.0821	0.023*	0.65098	1.92555
B/M	-2.4E-05	0.000927	-0.58987	0.79614	0.681	0.2013	0.0213*	0.0012*	0.619726	2.127331
B/L	-0.02441	0.072651	-0.18368	-0.4678	0.1182	0.178	0.0074*	0.0395*	0.703729	2.287809
S/H	0.00083	-0.0024	0.6712	0.345	0.1257	0.7221	0.00341*	0.00012*	0.578	1.87325
S/M	0.00926	-0.432	0.234	0.532	0.1652	0.3421	0.00233*	0.02156*	0.5086	1.92555
S/L	0.00106	-0.0831	0.214	0.0564	0.1857	0.3421	0.000231*	0.079	0.432	1.92555

*Significant at 5%.

value stocks.

The correlations between the independent variables were negligible between value premium and Market risk premium and between size premium and market risk premium. On the other hand correlation between size premium and value premium is weak positive. SMB provide a logical rationale as size premium is not dependent on market risk premium and also value premium is relatively free from market risk premium.

Regression analysis

Table 4 and 5 summaries the results of regression for six constructed portfolios. The coefficients estimated in this study were encouraging for existence of value and size premium but contradict the market risk premium. For all six portfolios results were insignificant for the intercept. The existence of size and value premium was found in B/L portfolio but no support for market risk premium. Market risk premium is insignificant in all six portfolios. Existence of size premium is found in each portfolio except in B/H portfolio. The sign of size coefficients were consistent with FF model in all six portfolios. SMB coefficient was positive for small portfolios and negative for large portfolios. Existence of value premium was found in each portfolio except in S/L portfolio. The sign of HML coefficient is incorrect in S/L portfolio other than that it was positive for high B/M ratio portfolios and negative for low B/M ratio portfolios. The overall performance of model was adequate shown by R2 value. The Durbin-Watson stats showed that there was no past error in the data for all portfolios.

Conclusion

Given these results, it can be deduced that majority of results favour the FF three factor model in case of financial sector of Pakistan's economy. Empirical evidence shows that FF three factor model is appropriate to describe financial sector of Pakistan's economy that is the banks listed in Karachi Stock Exchange (KSE). Results of this study negate the presence of market risk premium. This study provides empirical evidence of size and value premium in financial sector which confirms the study done by Connor and Sehgal (2001), Drew and Veeraraghavan (2002), and Bundoo (2006).

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