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Simplicity Vs Accuracy: The Case Of Capm And Fama And French Model

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Abstract: Practitioners prefer to use capital assets pricing model (CAPM) owing to its simplicity and conveniences to estimate expected return on risky financial assets whereas academics like to use Fama and French three factors model due to its ability to accurately predict expected returns. The objective this paper is to test the predictive power of both of these models in accurately estimating the expected returns. Since many previous studies have suggested the development of portfolios instead of using individual stocks returns for comparing the performance of assets pricing models, this paper develops five portfolios from the combinations of size and value stocks over a five years period from 2003-2007. In time series regressions, results of both the CAPM and the Fama and French model indicate that intercept values are either insignificant or close to zero. However, the slope coefficients of SMB and HML (proxies for size and value premiums in Fama and French model) are insignificant in majority of portfolios. These results favor the use of the CAPM model to estimate expected returns. To check robustness of the results, excess returns of individual stocks were also regressed on risk factors. These set of regressions show almost similar results as results of the portfolio regressions. Finally, all firms were pooled and a single regression was estimated both for CAPM and Fama and French. The results are almost unchanged.

Key words:

INTRODUCTION

(Markowitz, 1952, 1958) laid the foundation of the Modern Portfolio Theory (MPT). He proved that portfolio return is equal to weighted average return of the assets in portfolio, but portfolio risk is not the weighted average risk of the assets. Rather the portfolio risk is a function of weights assigned to the assets, the variances in returns of the assets, and the covariance matrices among the assets returns. The Markowitz Framework was also called 'mean-variance framework because rational investor would choose only those portfolios that maximize return for a given level of variance or minimize variance for a given level of return.

The Markowitz framework was considered practically too difficult while handling a portfolio with large number of assets because of the large number of covariance terms. To simplify the process of choosing stocks, (Sharp, 1964; Lintner, 1965) introduced single factor model which was very simple and intuitively appealing. The model was the 'Capital Asset Pricing Model' or the CAPM. The model remained popular for almost 4 decades. Owing to its simplicity and attraction, it is still the most extensively applied and taught asset pricing model. The idea of CAPM is that all investors will invest in one efficient portfolio, called the market portfolio or Portfolio M. Portfolio M includes all risky assets and hence it is a completely diversified portfolio. Investors would require risk premium on a given assets based on the asset's contribution to the portfolio M risk. The asset's input to the portfolio risk is measured by the ratio of assets covariance with the portfolio M to the variance of the portfolio M. In CAPM terminology, this ratio is called 'beta'. The higher the beta of an asset, the higher is the required rate of return on that asset. With this simple approach, investment decision is based on whether a given asset offers as much return as its required rate of return or not.

Despite the apparent simplicity and intuitively appealing theory, CAPM has not stood firm to empirical tests. Researchers like (Douglas, 1968; Black, Jensen and Scholes, 1972; Miller and Scholes, 1972; Fama and MacBeth, 1973) find that CAPM underestimate the true risk premium on securities. In a more recent study, Fama and French (1992) use a very large data set of US firms over a period of 1963-1990 to estimate risk premiums on securities. They found that there are three common risk factors in stock returns. The implication of their study is that CAPM understate risk premium on small firms and firms with high book-to-market ratio in cross-section returns. This finding puts question mark on the accuracy of expected returns calculated with the CAPM.

Till date, CAPM is the most widely taught asset pricing model in finance courses and widely used model among practitioners because of its simplicity. Does the simplicity of CAPM come at the cost inaccuracy? Does Fama and French model give consistently better results even outside developed economies? These empirical questions need to be tested in different time periods and in different markets like emerging economies. The objective of this paper is to investigate these questions in Pakistani capital market.

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The rest of the paper is organized as follows. In the next section, theory and assumptions of CAPM. Section 3 discusses the methodology and data of the study. Section 4 presents results of both CAPM and Fama and French model. And the section 5 concludes the paper.

Literature Review:

A. The Capital Asset Pricing Model:

The foundation of CAPM is based on the work done by (Harry Markowitz, 1959) where an investor is assumed to be risk averse. The investor opts for a portfolio based on the mean-variance criterion to choose "mean-variance efficient" portfolios. The CAPM converts the algebraic condition on asset weights in mean-variance model into testable prophecy of relation between expected return and risk by recognizing an efficient portfolio if asset prices are to clear the market of all assets.

Two important assumptions are added to the Markowitz model to recognize the mean-variance efficient portfolio by (Sharpe, 1964; Lintner, 1965). One assumption is the borrowing and lending at a risk free rate independent of the amount borrowed and lent and the second assumption is the complete agreement of investors about the assets returns from previous period to the current period. With the complete agreement about the distribution of returns and risk-free borrowing or lending, all investors see the same investment opportunity set and invest in available risky portfolios. Investors choose either to lend or borrow at risk-free rate (known as separation theorem of (Tobin, 1958)) and invest in a portfolio that lies at the point of tangency of a line from risk-free rate to the risky portfolio opportunity set.

Since all investors are in agreement about the joint distribution of returns and they invest in the tangency portfolio (portfolio M), the risk premium that an investor will require on a risky assets depends on how much an asset adds to the risk of the portfolio. If return on an asset has smaller covariance or zero covariance with return of the portfolio M, the risk-premium on that asset will be smaller even if the asset's standard deviation (a measure of total risk of the asset) is greater. In pure mathematical terms, risk premium on the asset will depend on the ratio of the covariance of the asset's and the portfolio M's returns to the variance of the portfolio M's return. This ratio is called beta (β);

$$\beta = \frac{Cov(Ri, R_m)}{Var(R_m)}$$

CAPM assumes linear and positive relationship between an asset's beta and the risk premium on the asset. Beta is the single factor in estimating risk-premium on risky assets. This also suggests that beta captures all elements of the asset's systematic risk. The risky asset must compensate investors for the opportunity cost of funds and the elements of its systematic risk. The opportunity cost of funds is equal to the return on risk-free assets or return on an asset that has zero covariance with the portfolio M. the equation of CAPM is derived in the following manner.

$$E(R_i) = R_f + \beta_i[(E(R_m) - R_f] \tag{1}$$

Where E(Ri) is the expected return based on risk-free rate and the assets systematic risk R_f is the risk-free interest rate, $E(R_m)$ is the expected return on the market portfolio, and β_i is the beta of asset i, which is also the slope in regressing an asset's excess return on the market's excess return.

It was noticed by Jensen (1968) that the Sharpe-Lintner version of CAPM which relates the expected return and market beta also implies a time series regression test. As per Sharpe and Lintner version of CAPM, the expected risk premium on M (its beta times the expected value of (R_{mt} - R_{ft}) completely explains the expected value of the asset's excess return. In reality if it is so, the intercept term in the time series regression "Jenson's Alpha" must be zero for each asset.

In cross section regressions, empirical studies suggest a positive relation between beta and average return but it is too flat where intercept is the risk free rate and co-efficient on beta is the expected market return in excess of the risk free rate (Jensen, 1968; Douglas, 1968; Black, *et al.,* 1972. Similar empirical finding were confirmed in the time series studies by (Black, *et al*., 1972; Friend and Blume, 1970; Stanbaugh, 1982).

The failure of CAPM to predict near-to-real world risk premium on stocks may be because of theoretical failings and many simplifying assumptions. (Ross, 1978) rightly pointed out that the theoretical portfolio M, which is central to the theory of CAPM, can never be observed in real world and hence (Ross, 1978) says that CAPM is unstable.

In many empirical studies, CAPM understated risk-premium on the stock of small firms and firms with high book-to-market ratio. These two features might be proxies for additional systematic risk factors which the CAPM fails to capture. To help predict risk premiums on such firms accurately, (Fama and French, 1993) suggested addition of two more risk premiums to the CAPM equation. Fama and French model is discussed next.

B. The Fama and French Model:

(Fama and French, 1993) suggested an alternative to the CAPM that included two additional factors which helped explain the excess returns on a stocks or a portfolio . In addition to the market factor, or ($R_m - R_f$), Fama and French added SMB (Small minus Big) and HML (High minus Low). The factor SMB represented the average return on small portfolios (small cap portfolios), less the average return on big portfolios (large cap portfolios). The HML factor represented the average return on value portfolios less the average return on two growth portfolios. The value portfolios represented stocks with a high Book Equity (BE) to Market Equity (ME) ratio and the growth portfolios represented the complete opposite with low BE/ME ratios. Fama and French found that the addition of these two factors enabled a more robust explanation of the variability in portfolio returns. The three-factor model is described by equation (3) where the expected excess return on portfolio i is

$$E(R_i) = R_f + \beta_i[E(R_m) - R_f] + S_i E(SMB) + h_i E(HML) \tag{3}$$

Where $(E(R_m)\text{-}R_f)$, *E(SMB)* and *E(HML)* are expected premiums, and the factor sensitivities or loadings β_i, S_i and H_i are the slopes in the time series regression,

$$R_i - R_f = \alpha_i + \beta_i(R_m - R_f) + S_i SMB + h_i HML + \mathrm{E}_i \tag{4}$$

(Fama and French, 1992; 1995; 1996 and 2004) share one consistent theme, in that the CAPM with its single beta factor fails to price other risks which contribute to the explanation of a portfolio's expected returns.

Fama and French model suffers from two problems which are the absence of proper theory and the models failure in some empirical tests. The Fama and French three factor model is ad hoc in nature. The model happens to give better results on a given date set, but the theoretical underpinnings are not strong as they are in case of CAPM. Though some supportive theories are being sought now in academic literature. Second problem is that estimates based on Fama and French show serious consistency issue when based on different data sets or time horizons.

Method:

A. Data:

The study tests the CAPM and Fama and French three factor model using monthly data of KSE stocks selected from different sectors over the period of January 2003 to December 2007. All KSE 100-index companies were initially selected from which 5-portfolio were to be made at the intersection of Size and B/M factors. Only those firms were included for which monthly share price data were available in the said period. Firms with negative equity were excluded from the analysis. Closing share prices of the selected firms were taken at the end of each month. KSE 100 index was taken as the proxy for the market portfolio. The proxy for risk free rate was the rate on Pakistan’s t-bills in respective periods.

B. Portfolio Development:

Earlier studies on CAPM used cross-sectional regressions which suffered from several estimation issues of which two widely recognized are (i) errors in the residuals because of positive correlation (ii) betas of individual assets in cross-sectional regressions were imprecise. To overcome these problems, (Blume, 1970; Friend and Blume, 1970; Black, *et al*., 1972) believe that diversified portfolios give better estimates of betas as compared to individual assets. Following these researchers and (Fama and French, 1993), we work with portfolios as wells as individual stocks to test CAPM and Fama and French model. From the sample, two groups of firms on the basis of size were made. The first group, called “BIG” included twenty largest firms of KSE-100 Index and the second group, called “SMALL” contained twenty smallest firms. Using B/M ratio criterion, the firms were classified into three groups. “High B/M” group had twenty firms with highest B/M ratio; “Medium B/M” and “Low B/M” groups included 20 firms each with medium and low B/M ratios respectively.

To ensure variation in the data set, all possible portfolio sets at the intersection points of the above 5 groups were made. The intersection points are 6, however, there was no intersection point in one case which left us with only 5 portfolios. These portfolios are labeled as B/L (big size with low B/M ratio), B/M (Big size and middle B/M), B/H (Big size and high B/M ratio), S/L (Small size with low B/M ratio), S/M (Small size with Middle B/M ratio), and S/H (Small size with high B/M ratio).

Model Specification:

For cross-sectional regression, the following model as is specified.

$$E(R_i) = R_f + \beta_i[E(R_m) - R_f]$$

Where $E(R_i)$ is the expected return on stock. R_f is the risk-free interest rate, $E(R_m)$ is the expected return on the market portfolio, β_i is beta of stock i or the slope coefficient in the CAPM regression equation.

The equation for the time series regression suggested by Jensen (1958) is given below. The excess return on asset i the explained variable and the excess return on the market variable is the explanatory variable:

$$R_i - R_f = \alpha + \beta_i[R_m - R_f] + \varepsilon_i$$

Where d $(R_i - R_f)$ is the excessive return for the stock i, of $(R_m - R_f)$ represent market premium, alpha (α) value, if different from zero, would indicate additional risk premium above or below what the CAPM suggest.

In the CAPM model β or beta is the single factor when it comes to pricing risk.
Fama and French three factor model adds SMB and HML to account for size and value premium. The Fama and French three factor model equation is:

$$E(R_i) = R_f + \beta_i[E(R_m) - R_f] + S_i E(SMB) + h_i E(HML)$$

Where $E(R_m) - R_f)$ represent market premium, $E(SMB)$ is the size premium, and $E(HML)$ represent value premium, and the factor sensitivities. βi, Si, Hi, represent slopes in the time series regression,

The time-series equation is given as:

$$R_i - R_f = \alpha_i + \beta_i(R_m - R_f) + S_i SMB + h_i HML + \varepsilon_i$$

Like in CAPM regressions, $(R_i - R_f)$ is the excessive return for the stock i, $(R_m - R_f)$ represent market premium is the risk premium on market portfolio; Alpha(α) is the intercept of regression equation; and εi represents unexplained part of excess return of asset i.

Both of the models, CAPM and Fama and French model shows expected returns for individual stocks. These models can be transformed to show expected returns for a portfolio by rearranging as
for CAPM,

$$ER(p) = \alpha_i + \beta(R_p) + \varepsilon_p$$

And for FF three factor model.

$$ER(p) = \alpha_i + \beta(R_p) + S_p(SMB) + h_p(HML) + \varepsilon_p$$

Where $ER(p) = R_P - R_f$ and R_p = average return of portfolio.

RESULTS AND DISCUSSION

In this section, we first present descriptive statistics of the selected portfolios and then present results of the regressions.

A. Descriptive statistics:

Monthly returns of the selected five portfolios were calculated between January 2003 and December 2007 as mentioned in previous section. descriptive statistics of the selected portfolios are given in Table 1.

Table 1: Descriptive Statistics of Selected Portfolios.

	Portfolios				
Parameters	A	B	C	D	E
Mean	3%	4%	0%	5%	2%
Median	3%	4%	-1%	5%	1%
Maximum	16%	31%	35%	28%	22%
Minimum	-10%	-26%	-28%	-15%	-18%
Std.Dev	6%	12%	11%	12%	9%

Table 1 presents descriptive statistics of five selected portfolio. The letters A, B, C, D and E represent various portfolios. These portfolios are A= Big size with low B/M portfolio, B= Big size with Medium B/M portfolio, C= Small Size with Low, B/M portfolio, D= Small Size with Medium B/M portfolio , E= small size with High B/M Portfolio.

Among the five portfolios, portfolio D offered the highest average monthly return of 5% followed by portfolio B offering 4% monthly return. The maximum monthly return was yielded by portfolio C having small size with medium book to market ratio (35%), and the minimum monthly return was yielded by portfolio C again. The standard deviations were on the higher side for both portfolios B and portfolio D having a 12% standard deviation. The minimum standard deviation was 6% for portfolio A.

Table 2 shows the correlation between the returns on portfolios. The highest correlation of 71% is between the stocks of portfolio E (small size with High B/M Portfolio) and portfolio A (Big size with low B/M portfolio), and between portfolio E (small size with High B/M Portfolio) and portfolio D (Small Size with Medium B/M portfolio). On the other hand the lowest level of correlation (41%) was between portfolio B (Big size with Medium B/M portfolio) and portfolio C (Small Size with Low B/M portfolio).

Table 2: Correlations between Portfolio Returns

	A	B	C	D	E
A	100%				
B	45%	100%			
C	59%	41%	100%		
D	63%	54%	66%	100%	
E	71%	51%	60%	71%	100%

Table 2 presents matrix of correlation among the returns of five selected portfolio over the period January 2003 to December 2007 with monthly frequency. The letters A, B, C, D and E represent various portfolios. These portfolios are A= Big size with low B/M portfolio, B= Big size with Medium B/M portfolio, C= Small Size with Low, B/M portfolio, D= Small Size with Medium B/M portfolio , E= small size with High B/M Portfolio.

B. Regression Result:

The analysis was based on single variate regression analysis for CAPM and multivariate regression analysis for Fama and French model. The dependent variable for both of the analysis was the excess return on five portfolios, while independent variable for CAPM was only market risk premium but for Fama and French model there were two additional independent variables which were size premium (SMB) and value premium (HML).

Table 3 and 4 summarizes the results of CAPM regressions. To be accurate predictor of risk premium, intercept in the CAPM regression should be either zero or statistically insignificant or both. At a significance level of 5% all the intercepts of the five portfolios were non-significant while the risk factors (β) were significant for the all portfolios.

Table 3: CAPM Regression on Portfolios.

Portfolios	α	β1	t(α)	t(β1)	R-Square
Big Size and Low B/M	0.0094	0.7019*	1.8382	10.2222*	0.65713
Big Size and Medium B/M	0.0129	0.7819*	0.8617	3.9011*	0.20843
Small Size and Low B/M	-0.0331	1.0655*	-2.85	6.841*	0.45893
Small Size and Medium B/M	0.0194	1.0942*	1.6312	6.8605*	0.46037
Small Size and High B/M	-0.0048	0.8911*	-0.57	7.8310*	0.52766

* Significant at 1%   ** Significant at 5%

Table 4: Single Regression of all Portfolios Stacked In One Column

CAPM				
A	β1	t(α)	t(β1)	R-square
0.000	0.906*	0.150	13.537*	0.399

* Significant at 1%   ** Significant at 5%

Table 5: Fama and French Model Regressions of Portfolios.

Portfolios	α	β1	β2	β3	t(α)	t(β1)	t(β2)	t(β3)	R-Square
Big size and low B/M	0.003	0.770*	-0.536	0.328	0.484	11.401*	-2.507	1.574	0.702
Big size and Medium B/M	0.019	0.709**	0.313	0.050	1.135	3.350	0.467	0.077	0.208
Small Size and Low B/M	0.003	0.770*	3.461*	-3.172*	0.484	11.401*	16.207*	-15.224*	0.909
Small Size and Medium B/M	0.033	0.954*	0.995	-0.514	2.624	5.984**	1.970	-1.044	0.515
small size and High B/M	0.003	0.770*	0.036	0.827*	0.484	11.401*	0.167	3.973*	0.851

* Significant at 1%   ** Significant at 5%

The time series regressions of Fama and French model show that at a confidence interval of 99% in five size to value portfolios, the intercepts were insignificant for all the five portfolios (A, B, C, D and E). The market risk premium was significant in four portfolios (A, C, D and E) while in portfolio B it was insignificant. At a confidence interval of 99% most of the portfolios didn't show any signs of size and value premium. Only portfolio C (small size with low B/M) showed value and size premium. It should be noted in portfolio C that SMB coefficient was positive for small portfolio confirming a size premium. Similarly the HML factor was negative for low B/M stocks demonstrating existence of value premium. Except portfolio C and E, no other portfolio showed any signs of size or value premium. Portfolio C showed size premium whereas portfolio E shows some signs of value premium.

At a significance level of 5% almost same result can be seen with non-significant intercept and with a significant risk premium but for the size and value premium no conclusive evidence could be found.

Table 6: Fama and French Model single Regression in all Portfolios.

α	β1	β2	β3	t(α)	t(β1)	t(β2)	t(β3)	R-Square
0.012	0.7947*	0.8543*	-0.496	2.239	11.759*	3.9928*	-2.378	0.451

* Significant at 1% ** Significant at 5%

Conclusion:

Assets' pricing has historically been a frightening task for the investors and the academicians and a lot of efforts have been made to find out a universal model which can possibly predict the expected returns in an accurate manner. Assets'prcing models such as CAPM and FF three factor models give inconsistent results across markets, data sets and time horizons. Recently, the Fama and French model has performed relatively better than the CAPM in empirical tests. CAPM still maintain its charm due to its simplicity and convenience which is why practitioners want the CAPM dead or alive. The purpose of this study is to know whether simplicity comes at the cost of accuracy in the case of CAPM and Fama and French Model. The sample for this study was taken from firms included in the KSE 100 Index. Monthly returns were calculated for a period of five years from 2003 to 2007. KSE 100 index was used as a benchmark for the market return while Pakistani t-bill rates were used as a proxy for risk free rate. Five portfolios were made the intersection of size and B/M ratio. In separate regressions, the excessive returns of these portfolios were regressed on the relevant risk factors of CAPM and Fama and French model in time series regressions. The result showed that intercepts were insignificant for all the portfolios in both CAPM and Fama and French Model in the time series regressions. In the case of CAPM, both the intercept and beta coefficients were as expected (i.e the intercept was insignificant and the beta significant). However, Fama and French model did not give conclusive results about the size premium and B/M ratio premium. Only one portfolio out of five showed both size and value premium while another portfolio showed only value premium. The evidence in this paper goes in favor of CAPM.

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