Does Fama-French three factor model outweigh the CAPM model? Evidence from the Dhaka Stock Exchange

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Abstract

In this paper we compare the explanatory power of a single index model with the multifactor asset-pricing model of Fama and French (1996) for Dhaka stock exchange for the period of January 1, 2010 to December 31, 2012. We find that all the three factors have significant determining impact on stock returns. Moreover, the three factor model has higher explanatory power than the CAPM to account for time series variation of stock returns. Our findings show that firm size and book-to-market equity helps to explain the variation in average stock returns in a meaningful manner. In summary, our findings suggest that CAPM beta is not alone sufficient to explain the average expected stock returns in Bangladesh.

JEL classification: **G110, G120, G150**

Keywords

Portfolio theory, capital asset pricing model, multifactor model, size, book-to-market equity.

1. Introduction

A fundamental question in finance is how the risk of an investment should affect its expected return. The capital asset pricing model (CAPM) provided the first coherent framework for answering this question. The CAPM was developed in the early 1960s by Sharpe (1964) and Lintner (1965).

The CAPM is based on the idea that not all risks should affect asset prices. According to the CPAM, every investment carries two distinct risk. One is systematic risk measured by beta and the other the unsystematic risks. Sharpe (1964) suggests that in a diversified portfolio, unsystematic risk can be diversified away when held with other investments in a portfolio. As investors are capable of eliminating unsystematic risks, it has no bearing on a stock's return. Since investor cannot eliminate systematic risk merely by diversifying, CAPM focuses on the relationship between systematic risk and the expected return of either a stock or a portfolio.

Ever since the Sharpe and Linter CAPM was developed, it has received a great deal of attention in the finance world. The CAPM has been extensively tested throughout the world equity markets, and its validity has often been questioned. The results indicate that the CAPM, with only one explanatory variable, the market risk factor, fails to explain all the patterns of realized average stock return.

Fama and French (1992) re-ignited the validity of CAPM. Adopting the Fama and Macbeth (1973) approach to CAPM testing, on examining the US market they failed to find any relationship between average returns and beta, though showed that size and book-to-market equity are significant in explaining the cross-sectional variation in average returns and thus are significant risk measure. They argued that both these variables are proxy for risk.

Consequently, the Fama and French three factor model was developed over capital asset pricing model (CAPM) in explaining the excess return of stock portfolios by adding two more variables, namely size risk premium and value-vs-growth risk premium.

In this paper we advance the asset pricing debate, by comparing the explanatory power of s single index model with the multifactor asset-pricing model of Fama and French (hereafter FF) for Bangladesh. Particularly we ask: (I) Is the beta risk the only risk needed to explain the variation in stock returns? (II) Does the multifactor model of FF explain the variation in average stock returns in a meaningful manner?

We examine the beta and return relationship for the constituent stock of the Dhaka stock exchange for the period of 2010-2012. We chose the Bangladeshi market for several reasons. First, earlier studies (see, for example, Fama and French, 1996; Hung et al., 2004; Isakov 1999; Faff, 2001) are mainly conducted in the western markets including the US, the UK, the Australia and Europe, with the presence of efficient market. However, whether the results for the western markets can be applied to other markets is an open question given that the intuitional settings and the market mechanisms are quite different in developing countries, like Bangladesh. Second, Bangladeshi market is particularly suitable for our purpose of investigating how a stock's price of a company behaves in different economic settings with relatively poor financial transparency. Third, we conduct our study on the capital market of Bangladesh where stock market may not be as efficient as in the developed countries.

We use daily prices of 50 stocks listed in Dhaka Stock Exchange over period of January 2010 to December 2012. We form four portfolios and regress the portfolio excess returns on the market risk premium in the CAPM model and market risk premium, size risk premium and value-vs-growth risk premium in the three factor model. We develop an equally weighted

index to represent the Bangladeshi capital market. Alternatively, we use the DSE20 stock market index for the same purpose. Our results by using both market indexes confirm that variables of CAPM and the three factor model have statistically significant impact on the excess portfolio returns in Bangladesh. However, the higher R-squared values of the three factor model exhibit its superiority over the CAPM model.

The rest of the paper is divided into 5 sections. Section 2 discusses the literature and background of the study. The data and variables and the models are described in section 3. We present the results along with a discussion in section 4 and section 5 concludes the study.

2. Theoretical Framework

The CAPM of Sharpe (1964) and Lintner (1965) model shows that return of any asset or portfolio of assets is a linear combination of risk free asset and a risk premium of the asset. The risk premium in this model is described in this model as a product of market risk premium and the associated beta of the asset. The CAPM beta is defined as the covariance of asset return with the market return standardized by market variance. Subsequent empirical studies show mixed results on the effectiveness of beta in explaining stock returns.

Early tests of CAPM conducted by Black, Jensen and Scholes (1972), Blume and Friend (1973) and Fama and Macbeth (1973) find that the relationship between asset price and estimated beta is significant. However, the intercept is high indicating abnormal returns earned by assets and the slope of the linear function can marginally explain the cross sectional differences in stock returns. Studies find that few other variables not included in CAPM can explain the variability of stock price significantly. Two of such variables are size

of the firm (Basu, 1977; Banz, 1981; Reinganum, 1981) and book-to-market (BM) equity ratio of the firms (Rosenberg et al., 1985; Lakonishok at al. 1994). According to these studies, beta fails to capture the return premium received by small firms and high BM firms.

Motivated by these findings, Fama and French (1993) developed the three factor model which incorporates size factor and BM equity ratio factor with the CAPM usual beta or market risk factor to predict the return of a risky asset such as stock. They provide evidence that the three factor model has better explanatory power than CAPM. They used 342 monthly observations of US stock market in testing their model. Subsequently this model has been applied in different markets by different authors. However, we have not found that there is a dearth of study in any published paper that applied this model in Bangladeshi capital market.

A number of studies examine the validity of CAPM in Bangladeshi Market. Ali, Islam and Chowdhury (2010) do not find evidence that CAPM hypothesis work in this market with 160 firms from Dhaka stock Exchange. They conduct cross sectional regression of the excess stock return on their calculated betas and find the constant value significantly different than zero. If CAPM is valid, that is, excess stock returns are fully explained by beta then the constant value or the intercept should be zero.

Hasan et al. (2011) report similar findings with a study with 80 companies listed in Dhaka Stock Exchange. However, they report a positive relationship between CAPM beta and stock return and unlike Ali, Islam and Chowdhury (2010) found the linearity of security market line.

Another branch of studies such as Mobarek and Mollah (2005) Rahman and Baten (2006), Uddin (2009) and Chowdhury and Sharmin (2013) explore the determinants of Bangladeshi stock returns by using a number of variables including CAPM beta. These studies use the

firm size and firm book to market ratio variables to represent the other two Fama-French model variables. The study of Mobarek and Mollah (2005) with 123 non-banking firms listed in DSE do not support of the CAPM hypothesis. However, the other variables such as firm size, book to market ratio, volume of share traded, earning yield and cash-flow yield have significant impacts on these stock returns. Rahman and Baten (2006) study the impact of excess market return, size and book-to-market (BM) ratio on excess return of stocks and find all these variables are significant. However, these studies did not use exact variables used in Fama-French model as this model uses the size risk (difference in stock return between small and large firms) and BM risk (difference in stock returns between high BM firms and low BM firms) rather than firm size and firm BM ratio as determinants of stock returns. Chowdhury and Sharmin (2013) include the Fama-French size risk factor in their study but do not include the BM risk factor and apply the Fama-MacBeth (1973) cross-sectional regression methodology instead of Fama-French time series regression methodology. Our study, to the best of our knowledge, is the first study to apply the Fama-French three factor model in Bangladeshi stock market. We also make a comparative analysis with CAPM model in terms explaining the returns of Bangladeshi stocks.

3. Data and Methodology

3.1. Data

The study uses a time series data set consisting of daily data of three years covering a period of January 1, 2010 to December 31, 2012. Total number of time series observation is 718. We have collected randomly chosen 50 stocks whose full three years data for our study period are available in the Thomson Reuters Tick History (TRTH) database. We use this 50 stocks firstly to form a portfolio that represent the market in our study and secondly to form four

portfolios whose returns are used as to compute the dependent variable here. The dependent variable in our study is excess average return over risk-free return of the four portfolios. Four different portfolios have been formed by different combinations of size of firms and book-to-market equity ratios. The portfolios are divided into two size categories and two book-to-market equity ratio categories and combining the two size categories with two book-to-market value ratio categories generate 4 portfolios which are constructed at the end of each December. The stocks are arranged in an ascending order in terms of both size of firms and *BM* ratio. Then portfolios are formed by combining (1) the largest ten firms and the highest ten *BM* firms, (2) the smallest ten firms and the highest ten *BM* firms (3) the largest ten firms and the lowest ten *BM* firms, and (4) the smallest ten firms and the lowest ten *BM* firms. However, number of stocks in all portfolios is not 20 as we have cases where the same firms qualify in both the categories relevant to a particular portfolio.

The average returns are equally weighted average return of each of the portfolios described above. We have taken the excess return of the portfolios by deducting the risk free rate from the average portfolio returns. The bank rate has been used as the proxy of the risk free return as we do not find data of any other reliable rate to represent the risk free rate for the Bangladeshi market. The Independent variable for the CAPM is only market risk premium, while the three factor model adds two more independent variables which are size risk premium and book-to-market *(BM)* risk premium.

The excess return of the market, $R_{mt} - R_{ft}$, is the return of the market over the risk free return. We have formed an equally weighted portfolio of 50 stocks and computed the daily log return of the portfolio. For an alternative proxy of the market we have taken DSE20 stock price index which is a value weighted index calculated by the Dhaka Stock Exchange. The size risk premium is represented by *SMB* (small minus big) which is calculated by taking the

difference in average return between the portfolio formed with the smallest ten firms and portfolio of ten biggest firms with our sample of 50 stocks. *HML* is used to represent the book-to-market value risk premium and calculated by subtracting the daily returns of the portfolio of ten highest *BM* firms (value firms) from daily return of the portfolio with lowest ten *BM* firms (growth firms).

SMB = Return of the portfolio of largest firms – return of the portfolio with the smallest firms

HML=Return of portfolio of highest BM firms – return of the portfolio with lowest BM firms.

The summary statistics of the dependent variables that is excess return of four portfolios and the independent variables are shown in Table 1. From the table it is clear that only portfolio 1 comprising of largest firms and highest *BM* firms earns a positive average excess return during our sample period. That indicates that in contrast to general findings in literature, earnings from the stocks of larger firms are higher than the stock of smaller firms. The negative mean value of *SMB* also supports this point. In the same token, the negative mean *HML* value implies that the stock returns of growth firms outweigh that of value firms defying the general findings in opposite direction in literature based of developed markets.

Table 1: Descriptive statistics of excess returns of portfolios and the market indexes, *SMB* and *HML*

	Excess Return							
	PF-1	**PF-2**	**PF-3**	**PF-4**	**EWI**	**DSE20**	**SMB**	**HML**
Mean	0.0002	-0.0005	-0.0004	-0.0003	-0.0006	-0.0005	-0.0018	-0.0007
Med	0.0002	0.0004	0.0001	0.0004	-0.0012	-0.0004	-0.0018	-0.0014
Max	0.3766	0.1362	0.1525	0.1497	0.1333	0.1326	0.0505	0.1106
Min	-0.3537	-0.0976	-0.0945	-0.0990	-0.0848	-0.0915	-0.0426	-0.1065
Std. Dev.	0.0409	0.0231	0.0220	0.0224	0.0240	0.0254	0.0127	0.0205
Skewness	0.3597	-0.0501	0.3016	0.2243	0.1244	0.0124	0.0266	0.3096
Kurtosis	48.5143	6.4178	8.5624	7.8094	5.7034	5.2654	3.8835	5.8433

3.2. The Model

Our paper aims to explore the superiority of Fama and French three factor model over capital asset pricing model (CAPM) in explaining the excess return of stock portfolios. Based on daily data of Bangladeshi stocks covering the time period of January 1, 2010 to December 31, 2012. Our basic time-series model is:

$$R_{pt} - R_{ft} = \alpha_{pt} + \beta_p[R_{mt} - R_{ft}] + e_{pt} \quad (1)$$

If the single index model describes expected returns, the regression coefficient α_i should be equal to zero and β_i greater than zero. In addition, we investigate the relation between the expected return of a certain portfolio, and the overall market factor, firm size *(ME)* and book-to-market ratio *(BE/ME)* by using the following model:

$$R_{pt} - R_{ft} = \alpha_{pt} + b_p[R_{mt} - R_{ft}] + s_p SMB_t + h_p HML_t + e_{pt} \quad (2)$$

R_{pt} is the average return of the selected portfolios at time *t*. R_{ft} is the risk free return. $R_{mt} - R_{ft}$ is the excess monthly returns earned the each of 25 portfolios at each time *t*. R_{mt} is the market return. SMB_t is the difference each month between the return on a portfolio of small stocks and the portfolio of big stocks ; HML_t is the difference each month between the return on a portfolio of high book-to-market equity stocks and the returns on a portfolio of low book-to-market stocks. The factor loadings b_p, s_p and h_p are the sensitivity of the excess returns of the portfolio towards excess return of the market, small firms and high book value to market value firms respectively. e_{pt} is the error term.

Model (1) represents the CAPM developed by Sharpe (1964) and Lintner (1965). The three factor model developed by Fama and French (1993) is examined by applying model (2). Fama and French (1993) argued that if assets are priced rationally, variables that are related to stock returns must proxy for sensitivity to common risk factors in returns. Therefore,

according to the three factors model two additional variables, *SMB* and *HML* increases the explanatory power of the model significantly.

4. Results

Here we compare the robustness of the single index model with the multifactor model of FF (1996). Particularly we ask: (a) whether the beta risk is the only risk need to explain the variation in average stock returns, and (b) whether an overall market factor, firm size and book-to-market equity value can explain the cross-sectional pattern of stock returns. We report the regression results for both CAPM and the three factor model on four portfolios in Table (2) to (5). The adjusted R squared (R^2) and Durbin Watson stats are also shown in the Tables. We apply both models by using equally weighted index and DSE20 index.

In Table 3 and 5, we report the results of using equally weighted index and In Table 2 and 4, we report the regression results of using the DSE20 index. We find that the beta coefficients are unrealistically low in the regressions with DSE20 index, whereas the beta coefficients are around the market beta of one in the regressions using the equally weighted index matching with findings in asset pricing literature. Hence we will concentrate our analysis on the results from the latter regressions. We use the Auto-regression AR(1) and in some cases AR(2) specifications where the residual values suffer from autocorrelation problem. We also find heteroskedasticity in the residuals; therefore report the heteroskedasticity robust White standard errors for all cases.

If the CAPM or three factor models can predict the excess returns of the portfolios correctly then the regressions should generate zero or insignificant intercepts. We find insignificant

intercepts in our regressions of both of the models indicating that none of the portfolios earn any abnormal return.

The coefficient of market risk premium or betas, as shown in Table 3, are positive for all of the portfolios in one factor CAPM model indicating the relevance of beta in determining the variability of portfolio returns in the Bangladeshi market context. The beta values ranges from 0.89 to 1.02. These values are hovering near one as we have used only 50 stocks to form the market index. However, we expect to get similar results with wider market index with only higher variability in beta values. The portfolio that combines the biggest firms with the value firms has lowest beta value. Consistently, the highest beta or market risk comes from the portfolio with the smallest firms and lowest BM firms (growth firms). This result is supported by the literature showing that small firms bear more systematic risk than the large firms and growth firms bear more market risks than value firms.

The beta coefficients in three factor Fama-French model are also positive and significant as the model predicts (Table 5). The value of the coefficients of the four portfolios varies from 0.82 to 1.00. Here we also find that portfolios with bigger firms (portfolio 1 and 3) have smaller betas (0.92 and 0.82 respectfully) than portfolios with smaller firms (portfolio 2 and 4 with beta coefficient of 1.00 and 0.93). The results are consistent with Fama and French (1993) that smaller firms are riskier than the bigger firms. On the other hand, we do not see any such generalization when we compare the high BM versus low BM firms in contrast to Fama and French (1993) findings.

Coefficients of SMB or size factor are significant in all 4 cases in the three factor model shown in Table (5). The first two portfolios which have high BM ratios, thus are value firms, have negative SMB coefficients while the last two portfolios with low BM ratios exhibit

positive SBM coefficients suggesting that investors receive size risk premium only for low BM or growth firms in Bangladesh. In terms firm size, we cannot make such generalization as portfolios of large firms (portfolio 1 and 3) and of small firms (portfolio 2 and 4) show mixed sign of positive and negative size risk coefficients. These results are not consistent with Fama and French (1993) who showed that biggest firms have negative SMB coefficients while smallest firms have positive coefficients. Another notable point of the results is that magnitude of the SMB coefficient is bigger for low BM firms than the high BM firms. The regressions using DSE20 index, however, show positive coefficient results for the size risk factor (Table 4).

Our results indicate that HML (the BM factor) plays an important role in determining the excess portfolio returns in the three factor model shown in Table 5. For this variable, the coefficients of large firm portfolios (portfolio 1 and 3) and are negative and of small firm portfolios (portfolio 2 and 4) are positive indicating that it is the large firm investors that receive value-vs-growth risk premium. Again we cannot make such generalization for high or low BM firms as the coefficients are mixed for respective portfolios. Fama and French (1993) report negative coefficients for all five low BM firms. The coefficient of HML variable for all the portfolios shown in Table 4 are positive and significant bolstering the application of Fama-French three factor model in Bangladeshi capital market.

If we compare the degree of explanatory power (i.e. adjusted R squared) of three factor model over the CAPM then we observe a higher explanatory power of the three factor model. The adjusted R squared values ranges from 85.21% to 89.81% in CAPM model with the equally weighted index. This value can be increased to around 92% by applying the Fama-French three factor model indicating that the beta variable explains 92 per cent of the variation in the cross-section average stock returns. While using the DSE20 index we find the

adjusted R squared value from 14.06% to 21.31%, whereas for the three factor model this value is around 29.88% to 55.36%. Clearly the three factor model can explain more the excess return variability of the portfolios in Bangladeshi capital market. Besides, all three factors of the model are found statistically significant in our regression results. The results indicate that by using Fama-French three factor model over the one factor CAPM model can improve the portfolio formation and forecasting practises in this market. However, the high explanatory power of the one factor, the market risk premium of CAPM model holds the key of the explanatory powers of the three factor model.

Table 2: CAPM with DSE-20

Regressions of excess stock portfolio returns on excess market return (MKT-RF) by using CAPM: January 1, 2010 to December 31, 2012, 718 observations. DES-20 index is used as a proxy of the market. Dependent variables: Excess returns on four portfolios formed by intersecting two size and two book-to-market equity ratio portfolios. The upper values of each of the cells show the coefficients and the lower values show the corresponding standard error.

Variables	PF-1	PF-2	PF-3	PF-4
Constant	-0.0004	-0.0004	-0.0007	-0.0006
	(0.0006)	(0.0007)	(0.0008)	(0.0008)
Market risk	0.2631***	0.2663***	0.2179***	0.2339***
	(0.0188)	(0.0189)	(0.0204)	(0.0623)
AR(1)	-0.1484***	-0.0960***		
	(0.0374)	(0.0376)		
R-squared	0.21	0.21	0.14	0.14
Durbin-Watson stat	2.01	2.00	2.00	1.95
N	718	718	718	718

Table 3: CAPM with equally weighted index

Regressions of excess stock portfolio returns on excess market return (MKT-RF) by using CAPM: January 1, 2010 to December 31, 2012, 718 observations. The equally weighted index is used as a proxy of the market. Dependent variables: Excess returns on four portfolios formed by intersecting two size and two book-to-market equity ratio portfolios. The upper values of each of the cells show the coefficients and the lower values show the corresponding standard error.

Variables	PF-1	PF-2	PF-3	PF-4
Constant	0.00004	0.00014	-0.00015	-0.00002
	(0.00031)	(0.00030)	(0.00045)	(0.00042)
Market risk	0.89526***	0.92308***	0.96299***	1.01951***
	(0.01795)	(0.01531)	(0.01472)	(0.01493)
AR(1)		0.10929**	0.22890***	0.16423***
		(0.04349)	(0.03636)	(0.03682)
R-squared	0.89	0.90	0.85	0.87
Durbin-Watson stat	1.88	1.98	1.99	2.00
N	718	718	718	718

Table 4: Fama-French Model with DSE-20

Regressions of excess stock portfolio returns on excess market return (MKT-RF) and on excess return for size (SMB) and book-to-market equity (HML) in addition to (MKT-RF) by using the three factor model: January 1, 2010 to December 31, 2012, 718 observations. DSE-20 index is used as a proxy of the market. Dependent variables: Excess returns on four portfolios formed by intersecting two size and two book-to-market equity ratio portfolios. The upper values of each of the cells show the coefficients and the lower values show the corresponding standard error.

Variables	PF-1	PF-2	PF-3	PF-4
Constant	0.0009	0.0006	0.0007	0.0007
	(0.0006)	(0.0007)	(0.0005)	(0.0007)
Market risk	0.2229***	0.2288***	0.1980***	0.2011***
	(0.0167)	(0.0172)	(0.0157)	(0.0167)
SMB	0.2806***	0.2433***	0.7290***	0.7253***
	(0.0313)	(0.0344)	(0.0284)	(0.0333)
HML	0.6055***	0.4222***	0.4715***	0.4066***
	(0.0518)	(0.0557)	(0.0472)	(0.0540)
AR(1)	-0.0870**		-0.1240***	
	(0.0380)		(0.0381)	
AR(2)			-0.0673*	
			(0.0375)	
R-squared	0.38	0.30	0.55	0.49
Durbin-Watson stat	2.01	2.09	2.01	2.08
N	718	718	718	718

Table 5: Fama French Model with equally weighted index

Regressions of excess stock portfolio returns on excess market return (MKT-RF) and on excess return for size (SMB) and book-to-market equity (HML) in addition to (MKT-RF) by using the three factor model: January 1, 2010 to December 31, 2012, 718 observations. The equally weighted index is used as a proxy of the market. Dependent variables: Excess returns on four portfolios formed by intersecting two size and two book-to-market equity ratio portfolios. The upper values of each of the cells show the coefficients and the lower values show the corresponding standard error.

Variables	**PF-1**	**PF-2**	**PF-3**	**PF-4**
Constant	0.0003	-0.0001	0.0002	0.0001
	(0.0003)	(0.0002)	(0.0003)	(0.0003)
Market risk	0.9204***	1.0028***	0.8249***	0.9291***
	(0.0215)	(0.0141)	(0.0215)	(0.0197)
SMB	-0.1326***	-0.2092***	0.3518***	0.3039***
	(0.0190)	(0.0211)	(0.0192)	(0.0198)
HML	0.1817***	-0.0751***	0.0935***	-0.0604**
	(0.0257)	(0.0281)	(0.0274)	(0.0286)
AR(1)	0.0857*	0.0816*	0.0668*	0.0893*
	(0.0497)	(0.0448)	(0.0393)	(0.0485)
R-squared	0.92	0.93	0.92	0.92
Durbin-Watson stat	2.00	1.99	2.00	2.01
N	718	718	718	718

5. Summary and Conclusion

This paper contributes to an understating of the role of beta, size and book-to-market equity are relevant risk variables in explaining realised returns on Bangladeshi securities. Our findings suggests that Fama and French (1993) is outperform over the single factor CAPM model in explaining the excess return of stock portfolios. We use a dataset from a developing economy, Bangladesh to examine applicability of the model in a different market set up. Our daily stock price data covers a period of three years from January 2010 to December 2012, whereas Fama and French (1993) used monthly data in their empirical analysis.

The three factor model includes two additional risk factors – size effect and book-to-market equity with the CAPM sole factor (market beta) in explaining the excess asset returns over

the risk free return. By using a time series regression we check the significance of key parameters of the two models. We find that the size and book-to-market factors combined with the market factor can explain the differences in average return across portfolio of stocks. However, the market factor plays a vital role in both CAPM and the Fama French three-factor model.

The adjusted R squared values are higher for three factor model regressions than that of CAPM regressions. Overall, the result suggests that the three factor model has greater explanatory power in justifying the changes in excess return of stocks in Bangladeshi capital market. Institutional and individual investors of this market may improve their investment, forecasting and portfolio formation decisions by applying the Fama-French three factor model over the CAPM model.

This paper provides important insights into the behaviour of the Bangladeshi stock market. Given the numerous studies that have questioned the role of beta as a significant and sole risk measure, this study supports the role of beta in explains the cross-section of returns, however, beta is not alone for size and book-to-market equity is also useful in explaining the cross-section of stock returns.

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