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Empirical Testing of Capital Asset Pricing Model on Bahrain Bourse

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Abstract

The study is undertaken to find out the relationship between portfolio returns and market returns and test the empirical validity of the standard CAPM model on Bahrain Bourse. The study is based on 39 companies listed in the Bahrain Bourse, Bahrain All Share Index as market proxy and yield of Government of Bahrain securities as risk free rate of return. The study covers period from January 1, 2011 to December 31, 2014. The analysis of the results of the study revealed that many of the independent variables together with beta can explain the portfolio returns. However, the intercept test reveals that the portfolio returns are equal to the risk-free rate of return. Therefore, we can conclude that the results of intercept test of standard CAPM proves the theory and the beta test results goes against the standard theory.

Keywords: Capital Asset Pricing Model, Risk, Portfolio, Return, Beta.

JEL: G13; G14; G 15; G18; C32; F30

1. Introduction

Rational investors are assessing the risk-return profiles of securities before investing. Therefore, it is important to understand the rate of returns and the degree of risks to be assumed. Different measures have been used for assessing risks of securities. After Sharpe-Lintner-Mossin proposed the standard form of CAPM, many studies have been conducted by the researchers to test the validity of capital asset pricing model. Even though there are many research studies on the developed and developing countries stock market, there are no research studies on the Bahrain Bourse. Therefore, the researcher attempted to test the validity of capital asset pricing model in the Bahrain Bourse.

There are 47 companies listed in Bahrain Bourse and out of these 47 companies, for 8 companies share prices are not available. Therefore, 39 companies are selected and the study is based on 39 companies, Bahrain All Share Index as market proxy and yield of Government of Bahrain securities as risk free rate of return. The study covers period from January 1, 2011 to December 31, 2014. The daily closing share prices of the sample companies and Bahrain All Share Index data were collected and used in this study. The share price and index price series have been used to construct daily return series.

2. Review of Literature

The portfolio theory developed by Markowitz (1952, 1959) provided the basis for CAPM. He suggested that rational investor to optimize risk and return should choose portfolio rather than individual stock. Therefore, rational investor uses diversification of portfolio to optimize risk and return. According to Sharpe (1964), "in equilibrium there would be a simple linear relationship between the expected returns and standard deviation of returns for efficient combination of risky assets. In effect, market presents two types of prices: the price of time or the pure interest rate and the price of risk, the additional expected returns per unit of risk. Diversification enables the investor to escape from all except the risk that results from the swings in economic activity- this type of risk persists even in efficient combinations". Black et al. (1972) used regression equation to estimate alpha (α) and beta (β) for the monthly share price data of NYSE from 1926 to 1964. The estimated beta was used to divide stocks into 10 portfolios. The parameters for each 5-year period were calculated and used to test the realized returns for subsequent 12 months. Time series method was used to estimate α and β for 420 months data and 4 sub-periods data. They found that α and β are inversely related for all sub-periods except for the first sub-period.

Fama and French (1992) tested CAPM using stock returns data between 1941and 1990 from NYSE, AMEXA and NASDAQ. They discuss the combination of size and book-to-market equity to capture the cross-sectional variation in average stock returns associated with market beta. They concluded that the variation in beta is not related to the size and there is a flat relation between market beta and average return, even though beta is the only explanatory variable. The results do not support the Sharpe-Lintner-Black CAPM model's positive relation between average stock return and beta. They report that beta does not completely explain "Cross-Sectional" variation in the average returns of stocks during the study period. Fama and

French observe that a firms size, book-to-market ratio (BE/ME) absorb the role of leverage and E/P factors in stock returns.

Black (1993) rejected that "beta as the sole variable explaining returns on stock is dead", and argues that this is a misstatement of the results of Fama and French (1992). He argues that the result of Fama and French (1992) is the effect of data mining and the announcement of death of beta seems to be premature. Fama and French (1993) suggest that a firm's book-to- market ratio and size are in fact proxies for the firm's loading on priced risk factors. Fama and French (1996a) questioned the validity of the results of Kothari *et al*. (1995) and argued against beta. They also showed that annual and monthly betas produce the same inferences about the beta premium. They argued that beta premium is more and cannot save the CAPM even though there are evidences to support that the beta alone cannot explain expected return.

The review of literature shows that most of the tests of CAPM have been conducted on developed stock markets and are based on the basic methodology adopted by (Sharpe, 1964; Lintner, 1965; Mossin, 1968; Black et al., 1972; Fama and MacBeth, 1973; Ross, 1976). Besides testing for CAPM, many of the studies have firm size effect, P/E effect, dividend effect, and problems due to misspecification in the CAPM model. In spite of the criticism of (Roll, 1977, 1981; Fama and French, 1992, 1996; and Davis *et al.,* 2000) on the relevance of tests of CAPM, it is clear that the studies on CAPM have provided valuable insights to the stock returns behaviour in markets. If systematic risk and returns are linearly related and residual risk is unrelated to returns, it will have important implication for investors.

Iqbal (2011) reviewed 36 research articles on relevance of CAPM and found that there are different views on the relevance of CAPM. Many researchers believe that CAPM is relevant to measure risk and return and the argument on beta death is premature whereas there is another group of researchers who criticise CAPM and argue that the beta is dead.

Singla and Pastricha (2012) in their study did not find any positive relationship between the stocks' systematic risk, beta (β) and their expected returns. They found that the stocks' expected return is more closely related to their betas (β) in the negative return periods than in the positive return periods.

3. Objectives of the Study

The objectives of the study are:

To find out the relationship between market returns and returns on portfolio.

To determine the influence of unsystematic factors on portfolio.

To test the empirical validity of the standard CAPM model on Bahrain Bourse.

4. Hypotheses

The following hypotheses are developed based on Fama and French (1992) factors model:

Ho: Market betas are not the determinants of the cross-section of the expected portfolio returns.

Ho: The intercept (Alpha) in the CAPM is not significantly different from zero.

Ho: The cross section Regression is not a good fit in both univariate and multiple regression.

Ho: Excess market return over the risk free rate of return *(Rm-Rf)* does not explain the cross-section of portfolio returns.

The corresponding alternate hypotheses for the above null hypotheses are:

H1: Market betas are the determinants of the cross-section of the expected returns on portfolio.

H1: The intercept (Alpha) in the CAPM is significantly different from zero.

H1: The cross section Regression is a good fit in both univariate and multiple regression.

H1: *Rm-Rf* explains the cross-section of portfolio returns.

The intercept value is hypothesized to be zero in the CAPM because of the model used to test the dependent variable, excess of portfolio returns over the risk free returns *(Rp-Rf)*. In other cases, the intercept is expected to be equal to the risk-free rate of return**.** Because of the way researcher has defined the dependent variable in this study, alpha is equated to zero**.** This model also yields results similar to the Standard form where alpha is equated to the risk-free rate of return.

5. Research Methodology

Black et al. (1972) analysed the relationship between risk and return and verified whether the relationship is linear. They found that systematic risk or beta is an important determinant of security return.

5.1 Calculation of Percentage Returns, Beta, Alpha and Total Risk

The daily returns are calculated using the following models:

$$R_{it} = \frac{P_{it} - P_{it-1}}{P_{it-1}} \times 100, \quad R_{mit} = \frac{I_{it} - I_{it-1}}{I_{it-1}} \times 100 \tag{1}$$

Mean return of security is given by:

$$\overline{R_i} = \frac{\sum_{t=1}^{N} R_{it}}{N} \tag{2}$$

Mean return of market m is given by:

$$\overline{R_m} = \frac{\sum_{t=1}^{N} R_{mit}}{N} \tag{3}$$

Where,

R_{it} = Return on security i during time period t; R_{mit} = Return on market index during time period t; P_{it} = Adjusted closing price of security i for time t; P_{it-1} = Adjusted closing price of security i for time t-1; I_{it} = Adjusted closing value of market index corresponding to the period of security i for time t; I_{it-1} = Adjusted closing value of market index corresponding to the period of security i for time t-1; N = Number of observations (returns).

The following market model is used to represent expected returns on security. The realized returns are used as the measure in place of expected returns. The risk measures like beta, alpha are calculated using this model.

$$R_i = \alpha_i + \beta_i R_m + e_i, \quad for\; i = 1, \ldots N. \tag{4}$$

Mean of (e_i) = E (e_i) = 0; Variance of e_i = E (e_i^2) = $\sigma^2_{e_i}$;

$$\text{Variance of } R_m = E\,(R_m - R_m)^2 = \sigma_m^{\,2} \tag{5}$$

$$\text{Variance of security i is: } \sigma_i^2 = \beta_i^2\, \sigma_m^{\,2} + \sigma^2_{e_i} \tag{6}$$

Where, R_i = Expected return on Security 'i'; α_i = Intercept of a straight line or alpha coefficient of security i; β_i = Slope of a straight-line or beta coefficient of security i; R_m = Expected return on index m; e_i = Error term with mean zero and a Standard deviation which is constant. This term captures the variations in security i that are not captured by the market index m; σ_m = Standard deviation of market index m, $\sigma_m^{\,2}$ = Variance of market index m.

Beta and Alpha are calculated by using the following formulae:

$$Beta = \beta_i = \frac{N\sum_{t=1}^{N} R_{mit} R_{it} - \sum_{t=1}^{N} R_{mit} \sum_{t=1}^{N} R_{it}}{N\sum_{t=1}^{N} R_{mit}^2 - \left(\sum_{t=1}^{N} R_{mit}\right)^2} \tag{7}$$

$$Alpha = \alpha_i = \left(\bar{R}_{it} - \beta_i \bar{R}_{mit}\right) \tag{8}$$

Total Risk of i is:

$$\sigma_i^2 = \beta_i^2 \sigma_m^2 + \sigma_{e_i}^2 \tag{9}$$

Total Risk = Systematic Risk + Unsystematic Risk

N = Number of pairs of observations.

If CAPM is valid, then the intercept (α_i) will not be significantly different from zero (as our dependent variable is Rp-Rf. Thus a direct test of the CAPM is by estimating equation (5) for a portfolio and testing to see if α_i is equal to zero. The CAPM assumes that there is a direct relationship between the security returns and their beta.

5.2 Steps to Calculate Regression of Portfolio

5.2.1 Regression Using Size (Year t-1)

The methodology used by (Fama and French, 1992; Mohanty, 2002; Connon and Sehgal, 2003) has been used in this study. Using size as independent variable and the difference between the individual portfolio returns and the risk-free rate of returns *(Rp-Rf)* as the dependent variable, a regression is run for the following:

$$\left(R_p - R_f\right) = \alpha + \beta_2 R_{ME_{P_{t-1}}} + e_{P_{t-1}} \tag{10}$$

If the factors model holds true then we expect αo to be closer to zero and size to capture the cross-sectional variation in average security returns.

5.2.2 Regression Using lnBE/ME (Year t-1)

The methodology used by (Fama and French, 1992; Connon and Sehgal, 2003) has been used in this study. Using BE/ME as independent variable and R_p-R_f as the dependent variable, a regression is run for the following:

5.2.3 Regression Using EPS/Price (Year t-1)

$$\left(R_p - R_f\right) = \alpha + \beta_3 R_{\left(\frac{BE}{ME}\right)_{P_{t-1}}} + e_{P_{t-1}} \tag{11}$$

If the factors model holds true, we expect αo to be closer to zero and book-to-market equity to capture the cross-sectional variation in portfolio returns.

The methodology used by (Fama and French, 1992; Mohanty, 2002) has been used in this study. Using price earning as an independent variable and *Rp-Rf* as the dependent variable, a regression is run for the following:

$$\left(R_p - R_f\right) = \alpha + \beta_4 R_{\left(\frac{E}{P}\right)_{P_{t-1}}} + e_{P_{t-1}} \tag{12}$$

If the factors model holds true then we expect α_o to be closer to zero and price earning to capture the cross-sectional variation in portfolio returns.

5.2.4 Regression Using Rm-Rf (Year t-1)

The methodology of Fama and French (1992) has been used. Using excess market returns over the risk free rate of return *(Rm-Rf)* as independent variable and R_p-R_f as the dependent variable, a regression is applied for the following:

$$\left(R_p - R_f\right) = \alpha + \beta_5 R_{\left(R_m - R_f\right)_{P_{t-1}}} + e_{P_{t-1}} \tag{13}$$

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If the factors model holds true then we expect α_o to be closer to zero and *Rm-Rf* to capture the cross-sectional variation in portfolio returns.

5.2.5 Multiple Regression Using $B_{p,}$ and Size (Year t-1)

The methodology used by (Banz, 1981; Fama and French, 1992; Connon and Sehgal, 2003) has been used. Using portfolio betas (Phase I multiple regression in Standard form of CAPM) and size as independent variables and R_p-R_f as the dependent variable, a multiple regression is applied for the following:

$$\left(R_p - R_f\right) = \alpha + \beta_1 \beta_p + \beta_2 R_{ME\,p_{t-1}} + e_{p_{t-1}} \tag{14}$$

If the factors model holds true then we expect α_o to be closer to zero and two variables, size and beta, combine to capture the cross-sectional variation in portfolio returns.

5.2.6 Multiple Regression Using $B_{p,}$ and BE/ME (Year t-1)

The methodology of Fama and French (1992) has been used. Using portfolio betas and BE/ME as independent variables and R_p-R_f as the dependent variable, a multiple regression is applied for the following:

$$\left(R_p - R_f\right) = \alpha + \beta_1 \beta_p + \beta_3 R_{\left(\frac{BE}{ME}\right)_{p_{t-1}}} + e_{p_{t-1}} \tag{15}$$

If the factors model holds true then we expect α to be closer to zero and two variables BE/ME, and beta, combine to capture the cross-sectional variation in portfolio returns.

5.2.7 Multiple Regression Using $B_{p,}$ and EPS/Price (Year t-1)

The methodology of Fama and French (1992) has been used. Using portfolio betas $\frac{E}{P}$ as independent variables and $\left(R_p - R_f\right)$ as the dependent variable, a multiple regression is applied for the following:

$$\left(R_p - R_f\right) = \alpha + \beta_1 \beta_p + \beta_4 R_{\left(\frac{E}{P}\right)_{p_{t-1}}} + e_{p_{t-1}} \tag{16}$$

If the factors model holds true, then we expect α_o to be closer to zero and the two variables, EPS/Price and beta, combine to capture the cross-sectional variation in portfolio returns.

5.2.8 Multiple Regression Using $B_{p,}$ and Rm-Rf (Year t-1)

The methodology of Fama and French (1992) has been used. Using portfolio beta and excess market returns over the risk free rate of return *(Rm-Rf)* as independent variables and *Rp-Rf* as the dependent variable, a multiple regression is run for the following:

$$\left(R_p - R_f\right) = \alpha + \beta_1\beta_p + \beta_5 R_{\left(R_m - R_f\right)_{P_{t-1}}} + e_{p_{t-1}} \tag{17}$$

If the factors model holds true then we expect α to be closer to zero and two variables, $\left(R_m - R_f\right)$ and beta combine to capture the cross-sectional variation in portfolio returns.

5.2.9 Multiple Regression Using $B_{p,\ Size}$ and EPS /Price (Year t-1)

The methodology of Fama and French (1992) has been used. Using portfolio betas, size and E/P as independent variables and R_p-R_f as the dependent variable, a multiple regression is applied for the following:

$$\left(R_p - R_f\right) = \alpha + \beta_1\beta_p + \beta_2 R_{ME_{P_{t-1}}} + \beta_4 R_{\left(\frac{E}{P}\right)_{P_{t-1}}} + e_{p_{t-1}} \tag{18}$$

If the factors model holds true then we expect α_o to be closer to zero and the three variables, beta, size and price earnings, combine to explain the cross-sectional variation in portfolio returns.

6. Empirical results of the study

The empirical results of the study are discussed in this section.

6.1 Test for Alpha and the Slope Co-efficient of Independent Variables Based on the Results of Cross-Section Regression

The intercept and slope co-efficient values of the independent variables are tested using the t-test, and adjusted R^2 values are tested using F-test at 5 percent level of significance. If the CAPM holds, the alpha value should not be significantly different from zero since Ri-R_f has been used as the dependent variable. It is expected that the α value of the regression based on these independent variables should be equal to zero and the slope co-efficient of independent variables should be equal to zero if they are not the determinants of security returns. In other way if the value of alpha is significantly different from zero it implies that the hypothesis regarding the risk-free rate of return does not hold and if the values of the slope co-efficient of the independent variables are significantly different from zero it implies that the independent variables chosen for the study determine the security returns in a significant way.

The independent variable, security beta (βi), is expected to explain the variation in security returns. If the independent variable, βi, explains the variance of the dependent variable, then the slope co-efficient of βi should be significantly different from zero. Therefore, the hypotheses relating to the slope co-efficient are that they are equal to zero, while the alternate hypotheses are that the slope co-efficient are significantly different from zero.

The F-test significance *F* indicates whether the regression of null independent variable/s with the dependent variable is a good fit. If the independent variable/s cause /s the variation in the dependent variable, the regression should be a good fit and therefore the computed values of significance *F* should be less than the level of significance chosen in most of the period.

6.1.1 Analysis of the Results Based on Percentage Returns

Regression line has been fit by considering the percentage stock returns of the companies taken for analysis. The regression results based on percentage stock returns are obtained by forming portfolios with equal weights and market stock capitalization weights.

Table 1. The test for alpha and the slope co-efficient of *(Rm-Rf)*

P-value α	P-value (Rm-Rf)	Sig F	Status of P values
23.0779233	0	0	Per N<0.05
76.9231767	100	100	Per N>0.05

In Table 1, the results indicate that in majority (76.96%) of the years, α value is not significantly different from zero and therefore, the null hypothesis is accepted. The *(Rm-Rf)* slope coefficients test shows that in all the years, the slope coefficient is not significantly different from zero. Therefore, we accept the null hypothesis that *(Rm-Rf)* is not a significant determinant of portfolio returns. The F-test results indicate that in all the years *P-values are* more than 0.05. This indicates that the regression is a not good fit for all the years. This concludes that the independent variable *(Rm-Rf)* does not explain the variation in the dependent variable.

Table 2. The test for alpha and the slope co-efficient of *(Rm-Rf)*

P-value α	P-value (Rm-Rf)	Sig F	Status of P values
76.9231779	91.666777	84.62539	Per N<0.05
23.0769332	8.3333443	15.39461	Per N>0.05

In Table 2, the results indicate that in majority (76.99%) of the years, α value is significantly different from zero and therefore, the null hypothesis is rejected. The *(Rm-Rf)* slope coefficient test shows that in majority (91.78%) of the years, the slope coefficient is significantly different from zero. Therefore, we accept the alternate hypothesis that *(Rm-Rf)* is a significant determinant of portfolio returns. The F-test results indicate that in majority (84.62%) of the years *P-values are* less than 0.05. This indicates that the regression is a good fit for majority of the years. This leads to conclusion that the *(Rm-Rf)* explains the variation in the portfolio returns.

6.2 Cross-Sectional Regression Results of Percentage Returns with Equally Weighted Portfolios: Year Wise Analysis Based on Year t-1 Weights

Table 3. The test for alpha and the slope co-efficient of beta

P-value α	P-value β_p	Sig F	Status of P values
53.8461648	7.6923237	7.692128	% N<0.05
46.1539262	92.365692	92.31869	% N>0.05

In Table 3, the results indicate that in majority (54.24%) of the years, α value is significantly different from zero and therefore, the null hypothesis is rejected. The βp slope coefficient test shows that in majority (93.22%) of the years, the slope coefficient is equal to zero. On basis of the results we accept the null hypothesis that beta of the portfolio is not a significant determinant of returns of the portfolio. The F-test results indicate that in majority (93.22%) of the years *P-values are* more than 0.05 and support the argument that the portfolio beta does not explain the variation in the portfolio returns.

Table 4. The test for alpha and the slope co-efficient of EPS/Price

P-value α	P-value EPS/Price	Sig F	Status of P values
53.8461478	7.6922137	7.6832308	% N<0.05
46.1865456	92.318692	92.29869	% N>0.05

The results presented in the Table 4 indicate that in majority (55.91%) of the years, α value is significantly different from zero and therefore, the null hypothesis is rejected. The p-values of *EPS/Price* slope coefficients are more than the level of significance in majority (91.11%) of the years. Therefore, we accept the null hypothesis that security *EPS/Price* ratio is not a significant determinant of security returns. The F-test results indicate that in majority (91.11%) of the years *P-values are* more than 0.05. This supports the argument that the *EPS/Price* ratio does not explain the variation in the portfolio returns.

Table 5. The test for alpha and the slope co-efficient of *(Rm-Rf)*

P-value α	P-value ((Rm-Rf))	Sig F	Status of P values
23.1669229	0	0	Per N<0.05
76.9229669	100	100	Per N>0.05

The results presented in the Table 5 indicate that in majority (77.96%) of the years, α value is not significantly different from zero and therefore, the null hypothesis is accepted. The *(Rm-Rf)* slope coefficient test shows that in all the years, the slope coefficient is not significantly different from zero. Therefore, we accept the null hypothesis that *(Rm-Rf)* is a significant determinant of portfolio returns.

7. Conclusion

The analysis of the results of the study revealed that many of the independent variables together with beta can explain the portfolio returns. However, the intercept test reveals that it is equal to the risk-free rate of returns. Therefore, we can conclude that while the intercept test of capital asset pricing model proves the theory, the beta test goes against the standard theory.

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