An Empirical Analysis of the Capital Asset Pricing Model and Beta In Istanbul Stock Exchange. Is Beta Still Allive?

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Abstract

Risk and return is one of the cornerstones of modern finance theory. Most of the previous studies that have analysed the unconditional relationship between beta (systematic risk) and returns find weak and inconsistent results. However, this paper extends this approach by focusing on the conditional relationship between beta and return in the up (market risk premium is positive) and down markets (market risk premium is negative) in ISE using the approach of Pettengill (1995). Consistent with findings for other countries; there is no unconditonal evidence. However, in a regression conditioned on the occurrence of up and down markets, beta factor turns out to be a strong indicator of both in upward and downward markets. This is a substantial result for investors and portfolio managers in an emerging market. Nevertheless, only the evidence for the conditional relation between beta and returns is not sufficient to support the CAPM hypothesis. It is observed statistical evidence for conditional CAPM, that is, CAPM is valid when market excess return is positive on ISE-100 index stocks over the sample period.

Key words

Beta, Risk, CAPM, Conditional Relationship

1 INTRODUCTION

The Capital Asset Pricing Model (CAPM) developed by Sharpe (1964) and Lintner (1965) is one of the cornerstones of modern finance theory. It is dominating capital markets and it is subject to discussions whether it is valid or not since its inception. Although there are a lot of criticisms about CAPM, it continues to be widely used in cost of capital estimation, in portfolio management and in academic research.

The CAPM posits a simple and stable linear relationship between an asset's systematic risk and its expected return. Friend and Blume (1970), Black, Jensen and Scholes (1972), Fama and MacBeth (1973) found support for CAPM and their evidence showed a significant positive relationship between realized returns and systematic risk (as measured by beta). However, the estimation values γ_0 (the risk free rate) and γ_1 (the slope of the regression) were not equal to $\overline{R_f}$ and ($\overline{R_m - R_f}$) as predicted by CAPM. In the study of Friend and Blume, for NYSE, the values obtained of γ_0 and γ_1 are not in line with the CAPM's predictions. In periods 1955-1959 and 1960-1964, γ_0 is substantially greater than the true value but in 1965-1968 period γ_0 is substantially less than the true value. γ_1 is less than predicted level in the first two periods and greater in the third. The results of Black, Jensen, and Scholes (1972) study showed that the relationship between beta and returns is significantly positive over long periods of time but the slope of the regression γ_1 in most periods is less than ($\overline{R_m - R_f}$)

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nevertheless with the correct sign while γ_0 is greater than $\overline{R_f}$. Fama and MacBeth (1973) could not reject the hypothesis that the relation between risk and return is linear and on average there seemed a positive tradeoff between return and risk.

On the other hand, from the 1980's, Banz (1981), Basu (1983), Bhandari (1988), and Fama and French (1992) have found weak or no statistical evidence in support of this relationship.[2] Fama and French (1992) documented that average stock returns are not positively related to beta. They concluded that variables like firm's size, E/P (earnings per share/price per share), financial leverage and book to market equity were associated with average stock returns.[3]

Substantial criticism of CAPM is brought forward by Roll (1977). Roll claimed that no correct test of the theory had been presented and there was practically no possibility that a correct test of the CAPM would ever be achieved in the future because of the fact that the true market portfolio is mean variance efficient. The true market portfolio is a global portfolio, which must contain all worldwide assets. In empirical studies, the index is used as a proxy for global market portfolio, which is a paradox for the theory of CAPM.

Pettengill, Sundaram, and Mathur (1995) developed a conditional relationship between beta and returns, which depends on whether the market excess return (market risk premium) is positive or negative. When the excess return on the market index is positive (negative), we should definitely observe a positive (negative) relationship between beta and returns. In this conditonal study of Pettengill, Sundaram, and Mathur, the empirical results supported the conclusion that there is a positive and statistically significant relationship between beta and realized returns.

Dusan Isakov (1999) found that beta is strongly related to the cross-section of realized returns in Swiss Stock Market over the period 1983-1991 when the sample is seperated according to whether the excess market return is positive or negative. Similarly, Jonathan Fletcher(1997) claimed that there was no evidence of significant relationship between beta and returns in UK Stock Market when unconditonal relationship between beta and returns was examined. There was a significant positive relationship between beta and returns in periods of positive market risk premium and vice verse. Also Ralf Elsas, Mahmoud El-Shaer and Erik Theissen (2003) found conditonal significant relationship between beta and returns in German Stock Market. Gordon Y. N. Tang and Wai C. Shum (2003) examined the conditonal relationship between beta and returns in international stock marktes between 1991 and 2000. They found significant positive relationship between beta and returns in up markets (positive market excess returns) and a significant negative relationsip in down markets (negative market excess returns).

The previous studies that test a relationship between beta and returns find weak and inconsistent results because the tests are unconditional. Some previous studies failed to identify this unconditional relationship because the average market risk premium in the sample period was close to zero.[4] In the CAPM framework, it is assumed a positive risk-return relationship and the expected market return must be greater than risk free rate that is market risk premium must be positive. In reality, the realized market return can be lower than

[2] Banz (1981) shows average returns are better explained by size (value of market equity) than by beta over the period 1936-1975. Basu (1983) finds a positive relation between average return and E/P. Bhandari (1988) documents that average return is positively related to company leverage.

[3] Since all these variables are scaled versions of price, it is reasonable to expect that some of them are unnecessary for explaining average returns. The main result of Fama and French (1992) was that for the 1963-1990 period in NYSE, AMEX, and NASDAQ; size and book to market equity capture the cross-sectional variation in average stock returns.

[4] Ralf Elsas, Mahmoud El-Sharer, Erik Theissen (2003) states that if the average market risk premium in the sample period is close to zero, unconditional relationship between beta and returns is not statistically significant. In ISE between 1998-2008/06 the average excess return on market is -0.806.

the riskless rate of interest. If the market risk premium is close to zero in the sample period, we could not observe a significant relationship between beta and returns. Also, Dusan Isakov (1999) indicates that the tests which show that betas and returns are not related empirically are often performed in periods where the average realised market excess return is not significantly different from zero.

Only the evidence for conditonal relation between beta and returns is not sufficent to support the CAPM hypothesis. In the CAPM framework; all the estimation values γ_0 and γ_1 should be statistically in the intervals of true values and non-systematic risk does not have any effect on the return of a well-diversified portfolio, and the relation between beta and returns should be linear.

This paper generally builds on the work of Pettengill, Sundaram, and Mathur. (1995)[5]. The paper focuses on the conditional relation between beta and returns in ISE between 1998 and 2008/06 and also investigates if CAPM is statistically valid or not over the same sample period. The object of this paper is twofold. First I analyze the relation between beta and returns using data from the Turkish Stock Market that might be interesting because Turkish Stock Market is an emerging market and one of the most volatile markets in the world. Second, the validity of CAPM is investigated in the sample period. It is important for an emerging market whether the results are consistent or not with developed markets.

2 DATA AND THE METHODOLOGY

The unconditional and conditional relationship between beta and returns is tested for ISE-100 index stocks over the period 1998-2008/06 and the evidence for CAPM is sought in the same period. To test the relation between beta and returns and the validity of CAPM, cross-sectional regression analysis is used.

After estimation of betas using a standard time series regression for each month, the cross-sectional regression analysis is applied to ISE-100 index (a value-weighted index of 100 stocks) securities. ISE-100 index contains 100 blue-chip Turkish companies with the highest market capitalization, highest trading volume and highest liquidity respect to other stocks.

Reference for ISE-100 index securities is the listing published by ISE between the period January 1998 - June 30 2008. To be included in the sample stocks must have a continuous listing on the ISE-100 index and be actively traded over the period January 1998 to June 2008. The 86 stocks that nearly fulfill this requirement represent approximately 85% of total market capitalization.6 I obtained monthly returns for domestic stocks, adjusted for dividends and equity offerings, using Istanbul Stock Exchange databank. The weighted averages of one-month time deposits, which are a proxy for riskless rate of return, are obtained using the Central Bank of Turkey databank.

A 10.5 year observation period (1998-2008/06) is used to estimate one-month betas. Monthly betas are estimated using a time series regression as expressed in Equation (1).

$$R_i - R_f = \beta_i \left(R_m - R_f\right) + \varepsilon_i \quad (1)$$

where R_i is the monthly percentage return on security i including dividends and stock splits. R_f is the risk free rate for which the weighted averages of one-month time deposits is used. β_i is the covariance between the security's return and the market's return divided by the

[5] Pettengill, Sundaram, and Mathur (1995) do not look for the evidence if CAPM is valid or not, they just focus on the conditional relation between beta and returns.

[6] The 14 stocks out of 86 are listed in ISE100 index since 2000. Beta values of these stocks are estimated from the first month that they have begun to trade. Since there are enough data (nearly 100 months), no biases of beta estimation are expected.

variance of the market and it shows the systematic risk of the security i.[7] R_m is the monthly percentage return on ISE-100 index, which is used as a proxy for the global market portfolio like other studies. $(R_m - R_f)$ is called excess return on the market or market risk premium. ε_i is the error term. In CAPM hypothesis, the returns are expected returns. Like other empirical studies, realized returns are used. From Equation (1), I have 86 estimated betas of the 86 stocks in ISE-100 index.

In order to test the unconditional relationship between beta and returns and the validity of CAPM; a cross-sectional regression is estimated to see if the estimated betas are related to the average return in the way predicted by CAPM. The estimated equation is as follows:

$$R_i = \gamma_0 + \gamma_1 \beta_i + \gamma_2 \sigma^2(\varepsilon_i) + \text{ui} \quad (2)$$

In Equation (2), R_i is the average return of security i over the sample period. β_i is the estimated beta of security i from Equation (1)[8] and $\sigma^2(\varepsilon_i)$ is the variance of residuals of security i over the sample period. ui is the error term. This cross-sectional regression tests the unconditional relation between beta and returns and the validity of CAPM in the sample period.

In order to determine whether the unconditional relationship do exist or not between beta and returns, the value of γ_1 can be tested to see if it is significantly different from zero. If the coefficient of γ_1 is greater than zero, a positive risk-return tradeoff is supported. Pettengill (1995) states that this procedure might test the usefulness of beta as a measure of risk, but it does not directly test the validity of CAPM. Testing the statistically validity of CAPM is based on the coefficients of Equation (2). According to CAPM; the estimated value of γ_0 should be equal to $\overline{R_f}$ (the average value of 126 months of risk-free rate), and the value obtained for γ_1 should be equal to the average of 126 months of market excess returns $(\overline{R_m - R_f})$. γ_2 should not statistically deviate from zero. If this condition holds, it shows that unsystematic risk is not priced as expected.

The unconditional test to determine the relationship between beta and returns and the validity of CAPM is applied to ISE-100 index stocks.

The cross-sectional test in Equation (2) can be viewed, as a test of two joint hypotheses as mentioned in the study of Ralf Elsas, Mahmoud El-Sharer and Erik Theissen (2003). Namely, there is a statistically significant relation between systematic risk and realized returns, and the average market risk premium is positive.

On the assumption of a positive risk-return tradeoff, the expected return of the market must be greater than risk-free return or all investors will prefer the risk-free instrument. Since the term [$E(R_m) - R_f$] must be positive, the expected return of a security is a positive function of beta. If investors are certain that the market return is always greater than the risk-free rate, no investor would hold the risk-free instrument and investors would have an incentive to invest in stocks. However, in the case of using realized returns instead of expected returns, there are instances where realized return for the market is less than the risk-free instrument. If

[7] I use individual stocks in the estimation of betas instead of forming portfolios because of the sample size of ISE-100 index. In any case in the cross-sectional regression, the 86 stocks in ISE-100 index form a portfolio automatically, which is equal weighted.

[8] The assumption used in some other studies [Pettengill, Sundaram, and Mathur (1995), Fama and Macbeth (1973)] which states that the betas in the estimation period proxy betas in the test period is not valid in this study. The period in estimation of betas and the test period are the same. (1998-2008/06). So biases of betas in the test period are not point at issue.

$R_m < R_f$, then $\beta_i(R_m - R_f) < 0$. In this case the security return includes a negative risk premium and an inverse relationship exists between beta and returns, which is proportional to beta. The CAPM model asserts a systematic and positive tradeoff between beta and returns as mentioned before but the argument above suggests a segmented relationship between beta and returns, that is, a positive relation during positive market excess return periods and a negative relation during negative market excess return periods.9

A month-by-month comparison of the ISE-100 index (as the proxy for the market return) and the weighted averages of one-month time deposits (as the measure for the risk free return) over the period 1998 through 2008/06 shows that the weighted averages of one-month time deposits exceed the market return in 62 out of 126 total observations. The existence of a large number of negative market excess return periods suggests that an unconditional positive relation between beta and returns are biased against finding a systematic relationship.

Analyzing months with positive and negative market risk premium separately can solve this problem. This can be achieved by adding the cross-sectional regression Equation (2) a variable δ that takes on the value 1(0) if the market risk premium in the month under consideration is positive (negative). So the Equation (2) is modified as Equation (3).

$$R_i = \gamma_0 + \gamma_1 \delta \beta_i + \gamma_2 (1-\delta) \beta_i + \gamma_3 \sigma^2(\varepsilon_i) + ui \qquad (3)$$

where $\delta = 1$, if $(R_m - R_f) > 0$ (when market excess returns are positive) and $\delta = 0$, if $(R_m - R_f) < 0$ (when market excess returns are negative).

The above relationship in Equation (3) is investigated for each month in the sample period by estimating either γ_1 or γ_2, depending on the sign for market risk premium. Equation (3) implies: If $(R_m - R_f) > 0$ (when market excess returns are positive), $\delta = 1$, γ_1 is the relevant coefficient and it is expected to be positive. If the estimated γ_1 is statistically significant and bigger than 0, this proves that there is a positive relation between beta and returns when market excess return is positive. Looking for a statistically evidence for CAPM, γ_1 must be also equal to the monthly average of $(R_m - R_f)$ when $(R_m - R_f)$ is positive in each month. In that case γ_0 must be equal to the monthly average of risk-free rate when market excess returns are positive.

When $\delta = 0$, $(R_m - R_f) < 0$ (market excess returns are negative), γ_2 is the relevant coefficient and it is expected to be negative. If the sign of the estimated γ_2 is negative and it is statistically significant, this confirms that there is a negative relation between beta and returns when market excess return is negative. The value of estimated γ_2 is not important unless we examine the validity of CAPM. When we examine the statistically validity of CAPM, γ_2 must be also equal to the monthly average of $(R_m - R_f)$ when $(R_m - R_f)$ is negative in each month. In that case γ_0 must be equal to the monthly average of risk-free rate when market excess returns are negative. In both cases, γ_3 should not deviate from zero statistically.[10]

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[9] This conditional relationship between beta and returns is initially explained by Pettengill, Sundaram, and Mathur (1995). They state that why the sample period must be separated according to whether excess market return is negative or positive as mentioned above.

[10] In Equation (3), the average of R_i (the average monthly return of a security) and the variance of the residuals of that security $[\sigma^2(\varepsilon_i)]$ are taken into account when market excess returns are positive

3 EMPIRICAL RESULTS

The unconditional and conditional tests are applied for 86 securities from ISE-100 index to identify the relationship between beta and returns, and to test the validity of CAPM.

The empirical results will able to show whether the relation between beta and returns, and the validity of CAPM exists or not in ISE over the sample period.

I start by presenting the results of the traditional unconditional test, which neglects the conditional nature (depending on excess market returns positive or negative) of the relation between beta and returns.

I have 86 estimated betas from Equation (1). By regressing the cross-sectional regression (Equation 2), Table (1) gives the regression results. Following the standard procedure, t-test is used to determine whether the coefficients are significantly different from zero.

Variable	Coefficient	Std. Error	t-Stat.	Prob.	$\bar{R}^2 = 0.11$
γ_0	2.87	0.58	4.98	0.00	
γ_1	0.39	0.57	0.69	0.49	
γ_2	0.00	0.00	3.52	0.00	d Stat. = 1.93*

Table 1: Unconditional Test Results of ISE-100 Index Securities

**D statistic (Durbin-Watson) is 1.93. From the Durbin-Watson tables, we find that for 85 obsevations and two explanatory variables, d_L = 1.6 and d_U = 1.696 at the 5 percent level. Since the computed d of 1.93 lies between 1.696 and 2.304 [$d_U < d < 4 - d_U$] there is statistically no evidence of autocorrelation.*

Table (1) has the cross-sectional regression results of the unconditional relationship between beta and returns in ISE-100 index securities. The null hypothesis of no relation between beta and realized returns (i.e., $H_0 : \gamma_1 = 0$) cannot be rejected. γ_1 is insignificant statistically. So the existence of a positive overall relationship between beta and return must be rejected for ISE-100 index securities over the period 1998-2008/06.

To find evidence for CAPM, the other regression coefficients in Table (1) such as, γ_0 which stands for R_f, and γ_2 which stands for the variance of the error terms, do not have to be analyzed unless $R_m - R_f$ (γ_1) is significantly greater than zero. Because of the statistical insignificance of γ_1, it is obvious that unconditional CAPM does not hold in ISE-100 index securities over the period 1998-2008/06.

When the conditional relationship between beta and returns is examined by classifying the market excess return as either positive or negative [$(R_m - R_f) > 0$ or $(R_m - R_f) < 0$], this conditionality produces 64 positive market returns, and 62 negative market returns out of 126 months during the period 1998-2008/06 . I therefore re-estimated the model using the cross-sectional regression (Equation 3).

Table (2) shows the results when $\delta = 1$. When $\delta = 1$, market excess returns are positive [$(R_m - R_f) > 0$] and γ_0, γ_1, and γ_3 are the relevant coefficients.

Variable	Coefficient	Std. Error	t-Stat.	Prob.	$\bar{R}^2 = 0.59$

[$(R_m - R_f)$>0] in a condition $\delta = 1$. However, in a condition $\delta = 0$, the average of R_i and the variance of the residuals [$\sigma^2(\varepsilon_i)$] when market excess returns are negative [$(R_m - R_f)$<0] are taken into account.

γ_0	3.48	0.93	3.74	0.00	
γ_1	10.19	0.93	11.01	0.00	
γ_3	0.00	0.00	2.38	0.02	d Stat. =2.14*

Table 2: Conditional Test Results When Market Risk Premium Is Positive

**The computed d of 2.14 lies between 1.696 and 2.304 [$d_U < d < 4 - d_U$] at the 5 percent level. So there is statistically no evidence of autocorrelation*

The results in Table (2) show that the relation between beta and returns is statistically significant when the market excess return is positive. The hypothesis that $H_0 : \gamma_1 = 0$ is rejected, we accept $H_1 : \gamma_1 \neq 0$. γ_1 is positive and it is 10.19, which is significantly different from zero at the 0.05 level (t value for γ_1 is 11.01). The results of the conditional test when market excess return is positive thus support the conclusion that the betas are related to realized returns in the way predicted by the theory. When market excess return is positive, there is a positive significant relation between beta and returns.

Now examining the other coefficients of the regression model, the CAPM hypothesis will be analyzed over the 1998-2008/06 period. Only, the existence of a relation between beta and returns is not sufficient to support the CAPM hypothesis. If CAPM is statistically valid; γ_0 must be equal to 3.29 [the average of the risk-free rate when $(R_m - R_f) > 0$ between the period 1998-2008/06]. In Table (2), we see that γ_0 is 3.48. The true value of γ_0 is 3.29. So the estimated value of γ_0 is definitely good.[11] In addition to this γ_1 must be equal to 10.48 [the average of market excess return when $(R_m - R_f) > 0$] and γ_3 must be equal to zero. The regression coefficients for γ_1 and γ_3 are satisfactory. The estimated coefficient for γ_1 is 10.19 and γ_3 is equal to zero statistically.[12]

The adjusted R^2 value of 0.59 indicates that the conditional estimations provide superior explanatory power. As a result, it is proven that conditional CAPM is statistically valid in ISE-100 index securities over the period 1998-2008/06 when the market excess return is positive.

Table 3 shows the results of when $\delta = 0$, market risk premium is negative $(R_m - R_f) < 0$.

Variable	Coefficient	Std. Error	t-Statistic	Prob.	$\overline{R}^2 = 0.67$
γ_0	1.63	0.84	1.95	0.055	
γ_2	-9.51	0.81	-11.76	0.00	
γ_3	0.00	0.00	4.64	0.00	d Stat.= 1.86*

Table 3: Conditional Test Results When Market Risk Premium Is Negative

**The computed d of 1.86 lies between 1.696 and 2.304 [$d_U < d < 4 - d_U$] at the 5 percent level. So there is statistically no evidence of autocorrelation*

The expected negative relationship between realized returns and betas should produce negative values for γ_2. The mean value of -9.51 is significantly different from zero (t = -11.76). This result shows that, when the market excess returns are negative, there is

[11] The %95 confidence interval of γ_0 is (1.63 to 5.34) which includes the true γ_0 (3.29).

[12] The %95 confidence interval of γ_1 is (8.35 to 12.03) which includes the true γ_1 (10.48). The t-value for γ_3 is 2.38, so it is significant at 0.05 level.

statistically strong evidence for the relationship between beta and returns over the 1998-2008/06 period. This means, when the market excess returns are negative, security betas and returns are inversely related.

Examining the other coefficients for the statistically validity of conditional CAPM shows that γ_0 is insignificant at 0.05 level (t value for γ_0 is 1.947). It should be equal to 4.27 [the average of the risk-free rate when $(R_m - R_f) < 0$ between the period 1998-2008/06].[13] So CAPM is not statistically valid when $(R_m - R_f) < 0$ between the periods 1998-2008/06.[14]

The overall result is that there is a strong evidence for the relationship between beta and returns in ISE-100 index securities over the period 1998-2008/06. When the excess return on the market index is positive (negative), a positive (negative) relationship between beta and returns is observed. The results support the hypothesis that the systematic risk of a stock as measured by beta is related to the return of the stock conditional on the sign of the market risk premium. However CAPM statistically holds when the market risk premium is positive over the same period.

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[13] γ_0 is significant at 0.10 level. However, the %95 confidence interval of γ_0 is (-0.03 to 3.29). This confidence interval does not include the true γ_0 (4.27).

[14] If CAPM statistically holds over the sample period, γ_2 should be equal to –12.45 [the average of market excess return when $(R_m - R_f) < 0$]. The estimated coefficient for γ_2 is –9.51 (t value is – 11.76). The %95 confidence interval of γ_2 is (-11.11 to -7.90). This confidence interval does not include the true γ_2 (-12.45).

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Summary

This paper analyses the traditional (unconditional) and the conditional relationship between returns and beta on ISE over the period 1998-2008/06 and then looks at the evidence for CAPM. Consistent with previous reseach, there is not any evidence of an unconditional relationship between beta and returns. However, when the sample is split into up and down market months (conditional relationship), the results support the relationship statistically. Stocks with higher beta have higher (lower) returns when the market risk premium is positive (negative). When the market is expected to rise, returns can be improved by investing in high beta stocks and vice verse. Overall the results support the continued use of beta as a measure of risk and betas are related to returns in ISE. Beta analysis is relevant and can be useful for investors and portfolio managers who might consider taking positions in emerging markets.