A TEST OF THE VALIDITY OF THE CAPM IN PAKISTANI EQUITY MARKET

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ABSTRACT

We investigate the validity of the Sharpe-Lintner (traditional) capital asset pricing model (CAPM) and the higher moments CAPM using a sample 34 companies listed on the Karachi Stock Exchange (KSE) over sample period January 2004 to March 2007. The end of month stock prices of all the 34 firms and the end of month values of the KSE100 index are utilized to obtain monthly stock returns and market returns respectively. We used the standard two-step procedure to test the validity of the CAPM. Our results suggest no statistically significant support for both the traditional and the higher moments CAPM. We, however, found that the intercept term mostly remained to be significant in the tests of both the Sharpe-Lintner CAPM and the higher moments CAPM. We found positive risk premiums for both covariance and coskewness in the higher moments CAPM. Positive risk premium for covariance and/or coskewness is in line with the theory of the CAPM. The cokurtosis risk was found to be statistically insignificant. Further the introduction of high moments in the CAPM improved the results. This shows that investors are positively rewarded for coskewness risk in the KSE.

Key Words: Capital Asset Pricing Model, Coskewness, Cokurtosis.

1. INTRODUCTION

Sharpe (1964) and Lintner (1965) developed the capital asset pricing model (CAPM) as by extending the earlier work of Markowitz (1952). Following Markowitz theory, the Sharpe-Lintner CAPM assumes that investors only consider the mean and variance of the returns of any asset. Their model, following Markowitz theory, assumes that the relevant risk of any asset is the non-diversifiable risk that can not be eliminated or reduced in a portfolio. Hence it postulates a linear relationship between the returns and risk of an asset. It measures the risk of an asset as the variability of asset returns relative to the returns of a well diversified portfolio i.e. market portfolio. One of the advantageous of the CAPM is that it can be applied to portfolio of assets in the same manner is it can be to individual assets.

Black, Jensen and Scholes (1972) were the first to report substantial empirical support for the validity of CAPM in equity markets. Their sample consisted of all stocks that traded on the New York Stock Exchange (NYSE) over sample period 1931 to 1965. Rather than using individual stocks, they formed 10 portfolios and used monthly returns data to test the linear relationship between portfolio returns and portfolio betas. Forming portfolios results in reduction of diversifiable risk and hence improves the estimation of beta which is based on non-diversifiable risk only. Their Findings were consistent with the theory of the CAPM as they reported a near linear relationship between returns and betas. This relationship was also confirmed by Fama and McBeth (1973). However, Roll (1977) and Ross (1977) proved that the Sharpe-Lintner CAPM does not hold in presence of inefficient proxy market portfolio. The argument is that the proxy portfolio does not include all assets and hence under-represents the true market portfolio which is mean-variance efficient.

Efforts, however, continued on both theoretical and empirical level to find support for the CAPM. Breeden (1979) developed the intertemporal capital asset pricing model (ICAPM) as he relaxed the assumption of one period investment horizon. Bollevslev, Chou and Kroner (1992) also developed their version of the CAPM relaxing the assumption that investors have identical expected distributions of asset returns. Another aspect where the CAPM theory extensively developed comprises of the development of multifactor models. For example, Banz (1981) included size as an explanatory variable in the CAPM. The findings of his study suggest that size measured as market capitalization is better measure than beta for explaining the cross-sectional variations in security returns. Specifically the findings suggest size of the firm (market capitalization) is inversely related with average returns. However, Banz's findings must be considered cautiously; the findings do not reject the CAPM theory rather extends it.

Sauer and Murphy (1992) investigated the validity of CAPM for the German Stock market and concluded that it effectively explained the variations in stock returns in the German Stock Market. Jagannathan and Wang (1993) in response to Fama and French (1992) argued that the proxy portfolio of all stocks as a reasonable substitute for the market portfolio and constant be-

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tas over time are unreasonable assumptions. They used human capital as an additional explanatory variable in the CAPM and reported that the model explained 28% of the variations in returns of the 100 portfolios studied by Fama and French (1992) who failed to provide empirical support for the CAPM. They reported that CAPM explained 57% of the variations in returns when betas were allowed to vary over business cycles. However, relative size was not found to be statistically significant in explaining variations in returns after accounting for sampling error. However, Fama and French (1992), Davis (1994), and Miles and Temmermann (1996) failed to empirically find support for the CAPM.

Chen (2003) investigated the applicability of CAPM and consumption CAPM in the stock market of Taiwan and found encouraging results for the CAPM. Matteev (2004) found support for the CAPM in the Bulgarian stock market. He found that the beta and average stock returns were significantly related whereas size and book-to-market equity anomalies were relatively insignificant. Michailidis et al (2006) reported mixed findings to support the CAPM in the Greek stock exchange. Gursoy and Rejepova (2007) investigated the validity of the CAPM in the Turkish equity market. They failed to find support for the CAPM using Fama & Macbeth (1973) methodology. However, they found strong support for the CAPM following the Pettengil (1995) methodology.

Since the earlier experimentation of Rubenstein (1973) with higher order CAPM, theoretical and empirical development on the theory of CAPM continued. Kraus and Litzenberger (1976) proposed a three-movement CAPM which includes coskewness to explain the variations in stock returns. It is proposed that positive coskewness will require negative market risk premium and negative coskewness will require positive market risk premium (Lim, 1989). Harvey (1999) and Harvey and Siddique (2000) have extendedly investigated the inclusion of coskewness as an explanatory variable and reported support for the three-movement CAPM. Hamaifar and Graddy (1988) developed a four-movement CAPM which includes cokurtosis in addition to covariance and coskewness to explain the variations stock returns. Iqbal and Brooks (2007) reported that beta and coskewness are positively priced in the Karachi Stock Exchange (KSE). They found the risk-return relationship to be non-linear in the KSE and that the relationship was strong only in the recent past as the KSE became more liquid and the trading activity increased. Harvey (1995) and Hussain and Uppal (1998) investigated the distribution of stock returns in Pakistan and found that stock returns in the KSE are not normally distributed. Javid and Ahmed (2008) in a recent study failed to empirically support the Sharpe-Lintner CAPM. However, they found support for conditional CAPM. Ahmad and Rosser (1995), Ahmad and Zaman (2000) also investigated the risk and return relationship in the equity market of Pakistan.

This study aims contributing to the literature on the CAPM in Pakistani equity market. In the second section we describe the methodology of the study, the third section contains the data analysis and discussions and the fourth section consists of conclusions from the data analysis.

2. Methodology & Data

2.1 Empirical Models

Sharpe (1964) and Lintner (1965) assume a linear relationship between the average security return and the beta of that security as:

$$E(\widehat{R}_{it}) = R_{fr} + [E(\widehat{R}_{mt}) - R_{fr}]\beta_i \quad (1)$$

where is the expected return on asset (security) *i* in period *t*, is the risk free rate, $E(\widehat{R}_{mt})$ is the expected market return in period *t* and is Cov$(\widehat{R}_{it}, \widehat{R}_{mt}) / \mathrm{var}(\widehat{R}_m)$. The validity of the CAPM is investigated by running a cross sectional regression of the average stock returns on β_i. Following Fama and MacBeth (1973), first we estimate the following regression model to estimate the β_i of each security in the sample.

(2)

In the above equation (2) R_{it} and R_{mt} are the realized stock and market returns respectively. These returns are calculated as:

$$R_{it} = 100 * SUM(\ln(P_t) - \ln(P_{t-1})) \quad (3)$$

$$R_{mt} = 100 * SUM(\ln(KSE100_t) - \ln(KSE100_{t-1})) \quad (4)$$

We then run a cross sectional regression of $\overline{R}_i$ i.e. mean returns of the securities on β_i i.e. betas of the securities calculated in equation (2) as:

(5)

The validity of the CAPM is subjected to two null hypotheses. These are:

$H0_a$: $\gamma_0 \neq 0$

$H0_b$: $\gamma_1 = [R_m - R_{fr}] > 0$

These hypotheses suggest that the risk premium for market risk (beta) is positive and that the risk free equals the mean return of the security that is uncorrelated with the market. We also include the standard deviation of the residuals of each security from the time series regression for the estimation of beta as additional explanatory variable of the variations in stock return. This modification is reflected in equation (6) as:

$$R_{it} = \gamma_0 + \gamma_1\beta_i + \gamma_2\sigma(\mu_i) + \mu_i \quad (6)$$

The term $\sigma(\mu_i)$ is the standard deviation of the residuals from the beta regression model for security *i* and γ_2 measures the risk premium associated with the

Table 3.1 Descriptive Statistics

	N	Min	Max	Mean	S.D	Skew	Kurtosis
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic
AICL	39	-34.2825	37.0434	2.7400	16.3311	0.0582	-0.1724
AKBL	39	-44.2948	19.9074	1.1912	14.2897	-1.8070	3.3302
ANL	39	-27.3423	38.5662	0.7751	15.7955	0.5268	0.4384
AGIL	39	-23.0555	34.0151	2.5346	11.5142	0.3227	0.8809
ACPL	39	-21.8944	22.7827	3.1329	11.0053	-0.2099	-0.3407
ABOT	39	-33.0502	27.0637	0.9128	10.8705	-0.4646	1.9858
AGTL	39	-16.8066	16.7723	0.9744	7.1866	-0.0105	0.7303
BAFL	39	-26.6804	27.9537	0.0340	14.3492	-0.2781	-0.5874
BOP	39	-31.5006	31.8454	3.2524	12.9454	-0.0189	0.8212
CCBL	39	-26.9129	28.2644	0.6455	13.9378	-0.0050	-0.3599
DGKC	39	-28.9227	19.8735	1.6904	12.7162	-0.6715	-0.2649
DAWH	39	-27.5554	51.6397	0.8638	13.2465	1.2144	5.2578
ENGRO	39	-14.7523	16.2795	1.7718	6.5554	0.2363	0.3336
FFBL	39	-20.5812	19.2684	1.3724	9.6002	-0.2050	-0.5143
FCCL	39	-41.2685	42.7938	1.1093	16.3141	-0.0651	0.4938
FFC	39	-22.2751	13.4467	0.1835	7.5086	-0.6436	0.8444
FABL	39	-25.4326	21.5497	1.5227	10.6321	-0.1538	-0.0389
HMB	39	-42.2790	28.2325	1.7707	14.0298	-1.4414	2.9990
ICI	39	-24.7704	21.3412	1.0951	9.3387	-0.1473	0.7779
INDU	39	-17.9910	24.5863	1.9077	10.1816	0.3525	-0.1013
IBFL	39	-8.3881	25.1471	1.1195	6.7292	1.7085	4.1065
JSCL	39	-30.4797	47.7179	3.4483	15.7234	0.7137	1.1517
KESC	39	-26.0164	41.1196	0.0564	13.4733	0.6492	1.5881
KOHE	39	-13.2172	27.7632	0.3058	7.5028	1.3625	3.6280
LUCK	39	-34.6326	29.2287	2.9671	13.8199	-0.4929	0.5447
MCB	39	-48.3552	28.2674	4.3154	14.5264	-1.1420	3.2691
MARI	39	-23.2299	37.6580	1.1828	11.9563	0.7892	2.1538
MEBL	39	-35.3110	46.3011	0.6184	12.6720	0.5116	4.6349
MYBL	39	-16.2260	32.1397	1.3408	11.3958	0.5434	0.3568
NBP	39	-23.1196	28.7445	3.8083	12.0557	-0.2277	0.0204
NML	39	-28.6529	39.9683	2.9337	14.0834	0.4089	1.0281
PNSC	39	-37.6816	63.1231	1.6827	20.2474	0.7913	1.7133
PICT	39	-17.8879	37.1440	2.3310	12.7382	0.8023	0.2422
SNGP	39	-28.8115	30.2470	1.0241	12.7824	0.2511	0.2070
MR	39	-14.6075	20.2276	2.3693	6.6671	-0.0235	0.6215

standard deviation of the residuals. We test the null hypothesis that the residual's risk remains unrewarded in the market. In addition we also test the classical assumption of the CAPM which suggests that there is a linear relationship between risk and return by estimating the following model in equation (7).

$$R_i = \gamma_0 + \gamma_1 \beta_i + \gamma_3 \beta^2{}_i + \mu_i \quad (7)$$

In the above model (7), $\beta^2{}_i$ is the square root of the β_i to test the linearity between risk and return. Finally we estimate the following model in equation (8):

$$R_{it} = \gamma_0 + \gamma_1 \beta_i + \gamma_2 \sigma(\mu_i) + \gamma_3 \beta^2 + \mu_i \quad (8)$$

The model in equation (8) enables to test the hypothesis that variation in market betas is entirely explains the variation in returns across stocks. This implies that the other two variables do not explain the variation in returns across stocks.

Finally we introduce higher moments in the conventional Sharpe-Lintner CAPM to establish the validity of higher moments CAPM. We then estimate the following models:

$$R_{it} = \gamma_0 + \gamma_1 \beta_i + \gamma_4 \psi_i + \mu_i \quad (9)$$

$$R_{it} = \gamma_0 + \gamma_1 \beta_i + \gamma_5 \vartheta_i + \mu_i \quad (10)$$

$$R_{it} = \gamma_0 + \gamma_1 \beta_i + \gamma_4 \psi_i + \gamma_5 \vartheta_i + \mu_i \quad (11)$$

where γ_4 measure the risk premium associated with coskewness ψ_i and γ_5 measures the risk premium associated with cokurtosis ϑ_i where the coefficients of coskewness () and cokurtosis for all the sample stocks are calculated from the following model:

$$R_{it} = \gamma_0 + \beta_i (R_m - R_{fr}) + \psi_i (R_m - R_{fr})^2 + \upsilon_i (R_m - R_{fr})^2 + \mu_i \quad (12)$$

2.2 Sample & Data

We employ a sample of 34 companies listed on KSE to investigate the validity of the CAPM in the Pakistani equity market. Monthly observations of all the sample companies over sample period from January 2004 to March 2007 are obtained from the website of the KSE (www.kse.com.pk). The monthly observations of the KSE100 index were also obtained from the website of the KSE to proxy for the market portfolio. We use the 6 months' treasury bills rate as a proxy for the risk free rate and data on the risk free rate was obtained from the different reports of the State Bank of Pakistan.

3. EMPIRICAL RESULTS

We estimate the basic Sharpe-Lintner Model in equation (5) and report the results in Table 3.2. It reveals that the beta coefficient is significant at the 10 percent. However, the intercept term is statistically significant at one percent. This evidence does not support the basic Sharpe-Lintner CAPM as the intercept term is statistically significant and exceeds the average risk free rate when annualized. However, Fama and Macbeth (1973) also reported the same finding. The estimated market risk premium is positive and confirms the CAPM theory which predicts a positive relationship between stock returns and market risk.

Table 3.2 also reports the estimated coefficients from model (6), (7) and (8). It reveals that the market risk premium is positive in all the three estimated models. The intercept term, however, is statistically significant only in model (6). The estimated risk premiums for the standard deviation of residuals (SDResd) and the squared-beta are statistically insignificant.

Table 3.2 Sharpe-Lintner CAPM Results

γ_0	γ_1	γ_2	γ_3	R^2
$R_{ti} = \gamma_0 + \gamma_1 \beta_i + \mu_i$				
1.1809	0.6717			0.1015
3.7572	1.9018			
0.0007	0.0662			
$R_{ti} = \gamma_0 + \gamma_1 \beta_i + \gamma_2 \sigma_i (\mu_i) + \mu_i$				
1.0839	1.2844		-0.4352	0.1226
3.2359	1.6188		-0.8632	
0.0029	0.1156		-0.3947	
$R_i = \gamma_0 + \gamma_1 \beta_i + \gamma_3 \beta^2{}_i + \mu_i$				
0.7837	0.6262		0.0395	0.1096
0.9600	1.7038		0.5284	
0.3445	0.0984		0.6010	
$R_{it} = \gamma_0 + \gamma_1 \beta_i + \gamma_2 \sigma (\mu_i) + \gamma_3 \beta^2 + \mu_i$				
0.4364 0.1412	1.3821		0.0627	-0.5560
0.4830	1.7124		0.8057	-1.0515
0.6326	0.0971		0.4268	0.3014

(Note: The t-values & p-values are given in italics respectively)

The results from the higher moments CAPM are presented in table 3.3. It reveals that the intercept term is statistically significant in all three models in presence of high moments. It reveals that except for the intercept term no other factor i.e. beta, coskewness and cokurtosis are significantly priced except for covariance (at 10 percent) in model (6) when coskewness is introduced as an additional variable in the CAPM. However, coskewness risk is found to be positively priced though statistically insignificant. A positive sign with the coskewness risk is consistent with Kraus and Litzenberger (1976) and Javid (2009). The cokurtosis risk is found to be insignificant and has a negative sign in model (7) and model (8). This is consistent with Javid (2009) who found cokurtosis to be insignificantly priced in the equity market of Pakistan. However, compared to the coefficients of determination in Table 3.2 the coefficients of determination in Table 3.3 show improvement as higher moments are introduced in the CAPM.

Table 3.3 Higher Moments CAPM Results

γ_0	γ_1	γ_4	γ_5	R^2
$R_{ti} = \gamma_0 + \gamma_1\beta_i + \gamma_4\psi_i + \mu_i$				
1.0234	0.5388		13.0679	0.1953
3.3540	*2.0255*		*1.5880*	
0.0021	*0.0515*		*0.1224*	
$R_{ti} = \gamma_0 + \gamma_1\beta_i + \gamma_5\upsilon_i + \mu_i$				
1.1510	0.5095		-37.1626	0.1329
3.6504	*1.3797*		*-0.3274*	
0.0010	*0.1776*		*0.7455*	
$R_{it} = \gamma_0 + \gamma_1\beta_i + \psi_i\gamma_5\upsilon_i + \mu_i$				
1.0439	0.4588	13.0611	-36.7317	0.1982
3.3062	*1.2658*	*1.5642*	*-0.3311*	
0.0025	*0.2153*	*0.1283*	*0.7429*	

(Note: The t-values & p-values are given in italics respectively)

4. CONCLUSIONS

We investigated the conventional CAPM and the higher moments CAPM in the Pakistani equity market through a sample of 34 firms listed on the KSE. We used monthly observations of stock prices and the KSE100 index over sample period January 2004 to March 2007. We employed Fama and MacBeth methodology to test both the Sharpe-Lintner CAPM and the higher moments CAPM. We found no statistically significant evidence to support the CAPM in any form. However, we found that the intercept term mostly remained to be significant in the tests of both the Sharpe-Lintner CAPM and the higher moments CAPM. Further we found that though the covariance and coskewness are insignificantly priced however they have positive signs which confirms the CAPM theory. However, further research is required to investigate the behavior of stock returns and discover factors that can explain the variation in stock returns in the equity market of Pakistan.

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