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Test of Multi-moment Capital Asset Pricing Model: Evidence from Karachi Stock Exchange

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ABSTRACT

This study examines the Capital Asset Pricing Model of Sharpe (1964) Lintner (1965) and Black (1972) as the benchmark model in the asset pricing theory. The empirical findings indicate that the Sharpe-Lintner-Black CAPM inadequately, particularly the explains Pakistan's equity market economically and statistically significant role of market risk for the determination of expected returns. Instead of identifying more risk factors, a detailed analysis of a single risk factor is undertaken. We have concentrated on two main extensions of the standard CAPM model. First, the standard model is extended by taking higher moments into account. Second, the risk factors are allowed to vary over time in the autoregressive process. The result of unconditional non-linear generalisation of the standard model reveals that in the higher-moment CAPM model the investors are rewarded for co-skewness risk. However, the test provides marginal support for rewards of the co-kurtosis risk. Finally, the empirical usefulness of conditional higher moments in explaining the cross-section of asset return is investigated. The results indicate that the conditional co-skewness is an important determinant of asset pricing, and the asset pricing relationship varies through time. The conditional covariance and the conditional co-kurtosis explain the asset price relationship in a limited way. It is concluded that Kraus and Litzenberger (1976) attempts to develop a modified form of the Sharpe-Lintner-Black CAPM and is more successful with KSE data.

JEL classification: C29, G12

Keywords: Covariance, Co-skewness, Co-kurtosis, Non-normal Return Distribution, Capital Asset Pricing Model, Time-varying Moments.

1. INTRODUCTION

The capital asset pricing model (CAPM) developed by Sharpe (1964) and Lintner (1965) is still the most widely used approach to relative asset evaluation. The theory predicts that the expected return on an asset above the risk-free rate is proportional to non-diversifiable risk, which is measured by the covariance of asset return with a portfolio composed of all existing assets, called the market portfolio. The theoretical and empirical attack on the traditional mean-variance model motivated researcher to investigate moments of higher order than the variance of the return. The standard CAPM applies when the restrictive condition are met that are investor care about the mean and variance of the return. However, when the returns are non-normal and investors have non-quadratic utility, implying that investors are concerned about all moments of the return, not just the mean and variance [Rubinstein (1973) and Scott and Phillip (1980)]. Furthermore, a quadratic utility function for an investor implies an increasing risk aversion; instead it is more reasonable to assume that risk aversion decreases with an increase in wealth. The skewness characterises the degree of asymmetry of a distribution among the mean. Positive (negative) skewness indicates a distribution with asymmetric tail extending towards more positive (negative) values. The kurtosis of a probability distribution refers to the extent to which the distribution tends to have relatively large frequencies around the centre and in the tail of distribution. Provided that the market has the positive skewness of returns, investors will prefer an asset with positive co-skewness. The co-kurtosis measures the likelihood the extreme returns jointly occur in a given asset and in the market, investors prefer small co-kurtosis.

The most popular asset pricing model is the three-moment CAPM model of Kraus and Litzenberger (1976), which provide preference over skewness. Hamaifar and Graddy (1988) derive a linear four-moment model by incorporating co-kurtosis along with covariance and co-skewness into the pricing equation. The theoretical justification for including higher moments, co-skewness and co-kurtosis in the asset pricing framework can be read from shape of return distribution. The positively skewed distribution tends to offer small probabilities of windfall gains while limit large downside losses. Thus all else equal, investors prefer positively skewed portfolio to negatively skewed portfolio [Harvey and Siddique (2000)] and they would be expecting a positive premium for assets that have positive co-skewness with the market if the market portfolio is negatively skewed [Friend and Westerfield (1980)]. The excess kurtosis reflects either large frequency around the centre (low probabilities of

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moderate loss) or in the tails of distribution (small probabilities of large losses). Thus kurtosis could be either risk reducing or risk enhancing depending on the trade-off between the fatness at the centre and tail of the return distribution. The skewness and kurtosis can not be diversified by increasing the size of portfolio [Arditti (1972), Gibbons, Ross and Shanken (1989)], thus the non-diversified skewness and kurtosis become important considerations in asset valuation.

The second track that has been followed in the literature in order to improve the standard CAPM is conditional tests of asset pricing models. The hypothesis that the risk associated with an asset does not vary over time seems to be inappropriate. Applying higher moment CAPM with constant risk parameters are over simplified. It has long been recognised that financial risk are time varying in nature. This stylised is first to the time varying behaviour of conditional covariances Engle, *et al.* (1987), Bollerslev, *et al.* (1988) and other studies. The conditioning information is very important in higher-moment-CAPM.[2] The covariance, co-skewness and co-kurtosis risks are time varying in nature, and so are their prices [Harvey and Siddique (2000a) and Dittmar (2000)], which indicates that relationship between co-skewness and co-kurtosis and asset returns is time dynamic in nature.

Emerging markets exhibit very different risk-return relationship. Studies on these markets have found the existence of highly autocorrelated returns, volatile prices and supernormal returns in most of the emerging markets [Harvey (1995)]. One of the main problems of portfolio managers investing in emerging markets is to quantify expected return and risk. Therefore the main objective of this study is to examine empirically how well the market equilibrium model of Sharpe (1964) Lintner (1965) can explain the risk return relationship in case of Pakistani market. The other most common observation of stock return in emerging markets is leptokurtosis, skewness and volatility clustering [Harvey (1995)]. Hussain and Uppal (1998) has confirmed this fact for Karachi Stock Exchange. After testing standard CAPM our objective is to test the non-linear generalisation of CAPM. An attempt is made to incorporate third and forth moments in the standard two moment model. Then these models are extended by incorporating conditional moments.

This study is organised as follows. The previous empirical findings are briefly reviewed in Section 2. Section 3 provides the methodological framework for empirical analysis. The empirical results are discussed in Section 4 and the Section 5 offers conclusion.

2. REVIEW OF PREVIOUS EMPIRICAL FINDINGS

The studies on higher moment model are done extensively after the early work of Arditti (1967, 1972) and Rubinstein (1973). A subsequent noteworthy

[2] This is due to the reason that returns distribution changes over time [Hansan (1994); Harvey and Siddique (1999)], and over differencing interval [Hawawini (1980)].

work by Krraus and Litzenberger (1976) test a linear three-moment pricing model pricing model that uses co-skewness as a supplement the co-variance risk to explain asset return on individual New York Stock Exchange (NYSE) stocks. They conclude that three-moment model explain the otherwise observed deficiency in the relationship which is not explained by standard model. The three-moment model is examined further by Friend and Westerfield (1980) but not come up with conclusive evidence of importance of skewness in pricing the assets. The study by Sears and Wei (1985) extended theoretically three-moment model further by finding that the economic price of risk and skewness contain two elements: the market risk premium and an elasticity coefficient that is proportional to the marginal rate of substitution of skewness for risk. Barone-Adesi (1985) proposed a quadratic model to test the three-moment CAPM. Harvey and Siddique (1999) present some extensive analysis of the effect of co-skewness on asset prices. They find both that co-skewness accounts for part of explanation power of size and value factors of Fama and French (1993), and that co-skewness can explain part of return to momentum trading strategies which are largely unexplained by these factors. Harvey and Siddique (2000b) presents some results of testing time variation in skewness and Harvey and Siddique (2000a) test whether in the context of three variable conditional model, the market risk premium changes over time. Harvey (2002) shows that skewness, and kurtosis priced in the individual emerging markets but not in the developed markets. He observes that volatility and returns in emerging markets are significantly positively related. But the significance of volatility coefficient disappears when co-skewness, skewness and kurtosis are considered. Harvey's explanation for this phenomenon is that low degree of integration of the emerging markets. Friend and Westerfield (1980) suggest that investors are willing to pay a premium for investors which have positive co-skewness with the market if market portfolio is positively skewed.

The third moment effect on asset pricing in unconditional setting has been explored by numerous studies [Arditti and Levy (1972); Jean (1971); Kane (1982); Lee (1977); Schweser (1978); Ingersoll (1975); Lim (1989) and Friend and Westerfield (1980)] and provides a mixed result of the effect of systematic skewness on asset pricing. In contrast the fourth moment (kurtosis) and its effect on asset pricing have received little attention. Homaifar and Graddy (1988) and Fang and Lai (1997) are among the studies that advocated co-kurtosis. But the results explaining asset pricing behaviour is not clear even in case of developed markets. Homaifar and Graddy (1988) drive a linear four moment pricing model by incorporating co-kurtosis along with covariance and co-skewness into the pricing equation. Cook and Rozeff (1984) find that co-skewness really describes the effect of the dividend yields on asset pricing. Messis, *et al*. (2007) have shown that in Athens Stock market investors have preferences for positive skewness in their portfolios; however, investor seems to be not compensated for variance and kurtosis risks. Skewness and kurtosis are also found to be non-diversifiable simply by increasing the size of the portfolio [Arditti (1972))]. On the whole, evidence far and against skewness preference is inconclusive, and that for kurtosis preference the evidence is limited and awaits verification.

Ranaldo and Favre (2005), Christie-David and Chaudhary (2001), Chang, Johnson and Schill (2001), Hwang and Satchell (1999), Jurczenko and Maillet (2002), Galagedera, Henry and Silvapulle (2002) have proposed estimation technique that uses cubic model as a test of co-skewness and co-kurtosis. Ranaldo and Favre (2005) have applied the four-moment-CAPM to hedge fund data and show that the use solely of the two moment pricing model may be misleading and wrongly indicate insufficient compensation for the investment risk. Christie-David and Chaudhary (2001) investigate the four moment model to the future markets and find that systematic skewness increases the explanatory power of the return generating process of the future market. Hwang and Satchell (1990) examine co-skewness and co-kurtosis in emerging markets. Chang, Johnson and Schill (2001) compare the four-moment CAPM with the Fama and French (1993) three-factor model. The studies by Harvey and Siddique (1999 and 2000), Kraus and Litzenberger (1976), Friend and Westerfield (1978) have used alternative methodology and computed co-skewness out of the model.

There has been little work on testing the conditional higher-moment CAPM. Some research exists which estimates pricing kernels which are quadratic function of market returns and are therefore consistent with the three-moment CAPM [Dittimar (2002)]. He performs conditional tests allowing the coefficient in the polynomial expansion of the aggregate investor’s marginal rate of substitution to be sign-corrected function of lagged information variables. He concludes that the preference over the fourth moments of market returns and labour growth rates are required to adequately fit the data.

This paper is one of the first to study higher-moments in asset pricing behaviour for Pakistani equity market. We explore the empirical usefulness of conditional higher moments in explaining the cross-section of explaining equity returns.

3. EMPIRICAL METHODOLOGY AND DATA

The mean variance capital asset pricing model of Sharpe (1964) and Lintner (1965) model requires normality condition. The asset return distribution for Pakistani stock market is skewed and leptokurtic [Hussain and Uppal (1998)]. This suggests that higher moments should be taken account of while analysing asset pricing. This is especially true in case of emerging markets to hedge funds, since skewness and kurtosis are particularly significant in these contexts justifies the need of higher moment asset pricing model. The mean variance capital asset pricing model of Sharpe (1964) and Lintner (1965) is our benchmark model to compare the more general asset pricing framework represented by quadratic and cubic models. The standard CAPM is discussed in Section 3.1. In the section 3.2 standard CAPM is extended by incorporating higher moments in order to examine whether these variables can explain the portion of expected return, which can not be explained by CAPM. In section 3.3 the higher-moment CAPM model is transformed into time conditional model.

3.1. Two-moment Capital Asset Pricing Model

We start our analysis by empirical model developed by Sharpe (1964) and Lintner (1965) in which a relationship for expected return is written as:

$$E(R_{it}) = R_f + \beta_i \left[E(R_{mt}) - R_f \right] \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

where $E(R_{it})$ is the expected return on *i*th asset, R_f is risk-free rate, $E(R_{mt})$ is expected return on market portfolio and β_i is the measure of risk or market sensitivity parameter defined as $\beta_i = Cov(R_i - R_f, R_i - R_f) / Var(R_i - R_f)$. This equation measures the sensitivity of asset return to variation in market return. In excess return form CAPM Equation (1) is written as:

$$E(r_{it}) = \beta_i E(r_{mt}) \; \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

where r_{it} is the excess return on asset *i* and r_{mt} is the excess return on market portfolio over the risk-free rate. It is assumed that the ex-post distribution from which returns are drawn is ex-ante perceived by the investor. It follows from multivariate normality, that Equation (2) directly satisfies the Gauss-Markov regression assumptions. Therefore for empirical testing of CAPM is carried out on the basis of the equation:

$$r_{it} = \lambda_0 + \lambda_1 \beta_i + \varepsilon_{it} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

The coefficient λ_1 is the premium associated with beta risk and an intercept term λ_0 has been added in the equation. Further note that if $\lambda_0 = 0$ and $\lambda_1 > 0$, this implies that Sharpe-Lintner CAPM holds.

3.2. The Unconditional Higher-moment Capital Asset Pricing Model

Introducing the higher moments, such as systematic skewness and systematic kurtosis into the standard CAPM model, the validity of mean-variance-skewness and mean-variance-skewness-kurtosis is tested. The factor loadings on market premium squared and cubed can be obtained by taking the fourth order Taylor approximation as: [3]

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[3] The derivation of four-moment asset pricing is discussed in Appendix A following Fang and Lai (1997) and Scott and Horvath (1980).

$$E(r_{it}) = \beta_i E(r_{mt}) + \gamma_i E(r_{mt})^2 + \kappa_i E(r_{mt})^3 \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

Where the parameter β_i denotes the systematic beta is same as above in Equation (1), γ_i represents systematic skewness and κ_i is systematic kurtosis of asset *I* defined as:

$$\gamma_i = \text{cov}(r_{it}, r_{mt}^2) / E(r_{mt} - E(r_{mt}))^3 = \cos kew(r_{it}, r_{mt}) / skew(r_{mt}) \quad \ldots \quad (4)$$

$$\kappa_i = \text{cov}(r_{it}, r_{mt}^3) / E(r_{mt} - E(r_{mt}))^4 = cokurt(r_{it}, r_{mt}) / kurt(r_{mt}) \quad \ldots \quad (5)$$

The slope coefficient of the cubic CAPM model given in the above Equation (3) are used as explanatory variable in the following cross section Equations (6), (7) and (8):

$$r_{it} = \lambda_0 + \lambda_1 \beta_i + \lambda_2 \gamma_i + \varepsilon_{it} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (6)$$

$$r_{it} = \lambda_0 + \lambda_1 \beta_i + \lambda_3 \kappa_i + \varepsilon_{it} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (7)$$

$$r_{it} = \lambda_0 + \lambda_1 \beta_i + \lambda_2 \gamma_i + \lambda_3 \kappa_i + \varepsilon_{it} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (8)$$

The coefficient λ_0 is intercept term and λ_1, λ_2 and λ_3 are risk premium for covariance-risk, co-skewness risk and co-kurtosis risk respectively. In this equation the sign of beta is expected to be the same as already in the standard CAPM discussed section 3.1. The risk premium that is rewarded for beta is positive, that is higher market risk results in higher premium. A zero intercept is equivalent to risk free intercept as in the mean-variance CAPM model. Since investors have preference for high skewness, negative market skewness is considered as risk and is expected to be rewarded with a positive skewness premium. Therefore in our model given in Equations (6) and (8) λ_2 is positive if market is negatively skewed and takes a negative value if market is positively skewed. For kurtosis the same argument is applied as for the second moment, that is high kurtosis (or fat tails) is a negative investment incentive and the corresponding risk premium λ_3 is expected to be positive in our model given in Equations (7) and (8).

3.3. The Conditional Higher-moment Capital Asset Pricing Model

The conditioning information in higher-moment-CAPM is also important. The covariance, co-skewness and co-kurtosis are likely to be time varying in nature and so are their prices.[4] There are several econometric techniques to test

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[4]This is due to the reason that return distribution changes over time [Hansan (1994); Harvey and Siddique (1999)], and over differencing interval [Hawawini (1980)] also cast doubts on static skewness and kurtosis measures in the existing literature where the shape of the return distribution implicitly assumed to be constant.

conditional model. For example Bodartha and Mark (1991) and Ng explicitly model covariance and prices of risk, Ferson and Harvey (1999) model beta as linear function of conditioning variables, Harvey (1989) explicitly model the price of risk and leave the covariance dynamics unspecified by applying Generalised Method of Moment. Harvey and Siddique (1999, 2000a) used capture conditionality by modelling beta by autoregressive process. We follow their approach to test whether conditional co-skewness and conditional co-kurtosis supplement the two moment conditional model. The conditional version of higher-moment CAPM models are given by rewriting Equation (3) as:

$$E_{t-1}(r_{it}) = \beta_{it} E_{t-1}(r_{mt}) + \gamma_{it} E_{t-1}(r_{mt})^2 + \kappa_{it} E_{t-1}(r_{mt})^3 \quad \ldots \quad (9)$$

Where the parameter β_{it} denotes the conditional covariance risk, γ_{it} represents conditional co-skewness risk and κ_{it} is conditional co-kurtosis risk of asset *i*.[5] The conditional covariance conditional co-skewness and conditional co-kurtosis are obtained by autoregressive process following Harvey and Siddique (1999). The unconditional co-skewness and co-kurtosis are central third and fourth moment about the mean are same as in section 3.2, which are calculated out of model and allow conditionality by autoregressive process. The time-variation in conditional covariance, co-skewness in this study is captured by autoregressive process as:

$$E(\varepsilon_{it}\varepsilon_{mt}) = \rho_0 + \rho_1\varepsilon_{it-1}\varepsilon_{mt-1} + \rho_2\varepsilon_{it-2}\varepsilon_{mt-2} \quad \ldots \quad \ldots \quad \ldots \quad (10)$$

$$E(\varepsilon_{it}\varepsilon_{mt}^2) = \rho_0 + \rho_1\varepsilon_{it-1}\varepsilon_{mt-1}^2 + \rho_2\varepsilon_{it-2}\varepsilon_{mt-2}^2 \quad \ldots \quad \ldots \quad \ldots \quad (11)$$

$$E(\varepsilon_{it}\varepsilon_{mt}^3) = \rho_0 + \rho_1\varepsilon_{it-1}\varepsilon_{mt-1}^3 + \rho_2\varepsilon_{it-2}\varepsilon_{mt-2}^3 \quad \ldots \quad \ldots \quad \ldots \quad (12)$$

The conditional covariance, conditional co-skewness and co-kurtosis are estimated for each stock estimating Equations (10), (11) and (12). Then the cross-section regression is estimated for each month to get the reward for these conditional risks. The average risk premium is calculated for the test period. To test if these risk factors significantly influence the cross-section of expected return the standard t-test and error adjusted t-test are applied. The cross-section regression equations are:

$$r_{it} = \lambda_{0t} + \lambda_{1t}\beta_{it} + \lambda_{2t}\gamma_{it} + \varepsilon_{it} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (13)$$

$$r_{it} = \lambda_{0t} + \lambda_{1t}\beta_{it} + \lambda_{2t}\kappa_{it} + \varepsilon_{it} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (14)$$

$$r_{it} = \lambda_{0t} + \lambda_{1t}\beta_{it} + \lambda_{2t}\gamma_{it} + \lambda_{3t}\kappa_{it} + \varepsilon_{it} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (15)$$

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[5] $\beta_{it} = \mathrm{cov}_{t-1}(r_{it}, r_{mt}) / \mathrm{var}_{t-1}(r_{mt})$; $\gamma_{it} = \cos kew_{t-1}(r_{it}, r_{mt}) / skew_{t-1}(r_{mt})$; $\kappa_{it} = cokurt_{t-1}(r_{it}, r_{mt}) / kurt_{t-1}(r_{mt})$.

The coefficient λ_{0t} is intercept term and $\lambda_{1t}, \lambda_{2t}$ and λ_{3t} are risk premium for conditional covariance-risk, co-skewness risk and co-kurtosis risk respectively.

3.4. Data and Sample

The econometric analysis to be performed in the study is based on the data of 49 firms listed on the Karachi Stock Market (KSE), the main equity market in the country for the period July 1993 to December 2004. These 49 firms were selected out of 779 firms, which contributed 90 percent to the total turnover of KSE in the year 2000. [6] In selecting the firms three criteria were used: (1) companies have continuous listing on exchange for the entire period of analysis; (2) almost all the important sectors are covered in data; (3) companies have high average turnover over the period of analysis.

From 1993 to 2000, the daily data on closing price turnover and KSE 100 index are collected from the Ready Board Quotations issued by KSE at the end of each trading day, which are also available in the files of Security and Exchange Commission of Pakistan (SECP). For the period 2000 to 2004 the data are taken from KSE website. Information on dividends, right issues and bonus share book value of stocks are obtained from the annual report of companies, which are submitted on regular basis to Securities and Exchange Commission of Pakistan (SECP). Using this information daily stock returns for each stock are calculated.[7] The six months treasury-bill rate is used as risk free rate and KSE 100 Index as the rate on market portfolio. The data on six-month treasury-bill rates are taken from *Monthly Bulletin* of State Bank of Pakistan.

4. EMPIRICAL FINDINGS

The empirical validity of CAPM model and higher-moment CAPM is examined by using daily as well as monthly data of 49 individual stocks traded at Karachi Stock Exchange during the period July 1993 to December 2004. The tests of these models are carried out in excess return form and the risk factor is excess market return above the treasury-bill rate. The sample period is divided into sub-period of three year: 1993-1995, 1996-1998, 1999-2001 and 2002-2004; two large sub-periods: 1993-1998 and 1999-2004; and for the whole sample period 1993- 2004.

Table 1 presents important summary statistics of daily returns of the 49 selected stocks. Three stocks out of five stocks selected from the textile sector (GULT, FTHM, and DWTM) have the smallest sample size. The firms from

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[6]Appendix Table B1 provides the list of companies included in the sample.

[7] $R_t = \ln P'_t - \ln P'_{t-1}$, where R_t is stock return and P'_t, the stock price is adjusted for capital changes that is dividend, bonus shares and rights issued.

Table 1

Summary Statistics of Daily Stock Returns

Company	No. of Obs.	Mean	St. Dev.	Skewness	Excess Kurtosis	Jarque-Bera
AABS	1990	0.13**	3.57*	0.65*	4.54*	1849.67*
ACBL	2697	0.10***	2.81*	–0.02	8.62*	8342.60*
AGTL	2094	0.21*	3.15*	0.40	11.48*	11556.03*
AICL	2681	0.08	3.54*	0.02	8.25*	7604.82*
ANSS	1544	0.00	7.75*	–0.61	11.34*	8364.52*
ASKL	2426	0.09	3.46*	0.22	8.32*	7016.92*
BWHL	1644	–0.01	4.61*	0.31	7.29*	3665.67*
CHCC	2491	0.07	3.42*	0.36**	4.36*	2023.86*
CRTM	2149	0.07	4.36*	0.20	11.14*	11127.45*
CSAP	1829	0.12	4.44*	0.49	12.77*	12504.90*
CULA	1664	0.06	4.31*	0.34	6.07*	2528.65*
DBYC	2166	0.00	6.57*	0.45	16.36*	24229.89*
DHAN	1489	–0.05	4.34*	1.37*	9.23*	5749.70*
DSFL	2707	0.02	3.25*	0.48**	4.85*	2753.04*
DWTM	385	–0.02	4.90*	0.68	11.43*	2125.84
ENGRO	2660	0.08	2.63*	0.11	8.55*	8107.69*
FASM	1405	0.18	2.96*	–1.28	23.45*	32574.22*
FFCJ	2080	0.03	3.26*	0.62**	7.23*	4656.48*
FFCL	2704	0.08	2.29*	–0.24	5.54*	3479.76*
FTHM	239	0.50	8.33*	0.39	5.63*	321.46*
GTYR	2192	0.08	3.51*	1.40*	13.89*	18339.20*
GULT	587	0.26	5.96*	0.43*	10.28*	2601.98*
HAAL	1863	0.20**	3.81*	0.45*	3.77*	1167.39*
HUBC	2380	0.08	3.13*	–0.81	17.86**	31877.97*
ICI	2667	0.03	2.90*	0.34	4.32*	2128.42*
INDU	2659	0.06	3.13*	0.59***	4.41*	2307.69*
JDWS	1716	0.14	5.74*	0.25*	8.01*	4607.77*
JPPO	1944	–0.02	4.10*	0.94*	8.13*	5637.21*
KESC	2702	–0.02	3.97*	0.69*	6.52*	5002.83*
LEVER	2429	0.06	2.35*	0.51**	8.54*	7491.23*
LUCK	2310	0.04	4.13*	0.47**	6.31*	3914.20*
MCB	2714	0.08	3.20*	–0.07	4.76*	2567.14*
MPLC	2430	–0.04	4.18*	0.54	3.75*	1540.80*
NATR	2391	0.09	3.19*	0.47***	6.14*	3850.41*
NESTLE	986	0.26**	4.18*	0.14	7.44*	2279.29*
PACK	1856	0.09	3.20*	–0.43	10.24*	8169.93*
PAEL	1933	0.02	5.79*	0.42	19.20*	29760.13*
PAKT	1862	0.01	3.97*	–0.02	9.26*	6654.47*
PKCL	1776	0.02	4.53*	0.21	5.57*	2307.90*
PSOC	2713	0.11***	2.71*	–0.28	11.19**	14189.96*
PTC	2402	0.03	2.80*	0.08	7.35*	5415.82*
SELP	2024	0.01	3.92*	–0.47	43.68*	161003.70*
SEMF	2598	0.10	3.14***	0.91***	9.67***	10486.12*
SITC	1807	0.09	3.24*	0.38	11.33*	9708.85*
SNGP	2711	0.08	3.13*	0.29	4.59*	2418.05*
SSGC	2706	0.05	3.25*	0.56	10.77*	13220.94*
TSPI	1833	–0.05	11.32*	0.12	7.71*	4542.77*
TSSL	1304	–0.11	8.79*	–0.34	18.43*	18478.51*
UNIM	1999	–0.04	10.35*	0.54	16.61*	23068.60*

Note: *Indicates significance at 1 percent. ** Indicates significance at 4 percent level.

Banking and Energy sector (ACBL, MCB, PSOC, SNGC, and KESC) have the most frequently traded stocks. The results reported in column 3 shows that only 6 out of 47 have significant positive mean return. Among these 6 stocks NESTLE has the maximum, positive and significant mean value (0.26 percent). However, no firm has significantly negative mean return. The estimates of standard deviation are significant at 1 percent for all the firms except for the SEMF. The most frequently traded stocks have smaller values of standard deviation for most of the cases. The results reported in column 4 show that the negative value of skewness is not significant for any stock. There are 16 stocks out of 49 with significant positive value of skewness. The values of excess kurtosis presented in column 6 indicate very clearly that all the stocks are leptokurtic behaviour which is described as fat tails in the literature. The estimates of the J. B. Test given in the last column are consistent with the results of excess kurtosis that is all stocks deviate from normality. Thus the main features of data are that returns are positive, volatile, and asymmetry and have fat tails.

The Table 2 reports two sets of results to test the adequacy of unconditional mean-variance CAPM, mean-variance-skewness CAPM and mean-variance-kurtosis CAPM. To test validity of CAPM model, two-step estimation procedure, that is time series and cross-sectional estimation procedure, is used as proposed by Fama and McBeth (1973). In step one the risk factors β_i covariance risk, γ_i co-skewness risk and κ_i co-kurtosis risk of asset i are computed out of model as in [Kraus and Litzenberger (1976) and Harvey and Siddique (2000a)].[8] The Appendix Table B2 provides the results of out-of-model calculations of covariance, co-skewness and co-kurtosis based on daily and monthly data. The risk premium associated with these risk factors are estimated by cross-section regression Equations (6), (7) and (8) by *Generalised Least Square.*[9] The standard deviations of residuals from the beta estimation equation are used for the estimation of error covariance matrix involved in the *GLS* estimation procedure. Finally, the parameter estimates obtained for all the months in the test period are averaged out. The mean risk premium so obtained

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[8] $$\beta_i = \frac{E_{t-1}(r_{it} - E(r_{it})(r_{mt} - E(r_{mt})}{E_{t-1}(r_{mt} - E(r_{mt}))^2}$$

$$\gamma_i = \frac{E_{t-1}(r_{it} - E(r_{it})(r_{mt} - E(r_{mt})^2}{E_{t-1}(r_{mt} - E(r_{mt}))^3}$$

$$\kappa_i = \frac{E_{t-1}(r_{it} - E(r_{it})(r_{mt} - E(r_{mt})^3}{E_{t-1}(r_{mt} - E(r_{mt}))^4}$$

[9]The cross-section regression have problem because the returns are correlated and heteroskedastic. The standard deviations of residuals from the beta estimation equation are used for the estimation of error covariance matrix involved in the *GLS* estimation procedure.

Table 2

Average Risk Premium for the Unconditional Multi-moment CAPM

	$\beta_{i,}$ γ_i, and κ_i Computed on Daily Data					$\beta_{i,}$ γ_i, and κ_i Computed on Monthly Data				
	A $r_i = \lambda_0 + \lambda_1\beta_{it} + \varepsilon_{it}$									
	λ_0	λ_1	λ_2	λ_3	R^2	λ_0	λ_1	λ_2	λ_3	R^2
1993–1995	–0.01	0.01			0.12	0.00	0.01***			0.09
	(–0.76)	(0.54)				(–0.250)	(1.57)			
	[–0.64]	[0.48]				[–0.24]	[1.54]			
1996–1998	–0.01	–0.01			0.16	–0.02	–0.01			0.13
	(–0.66)	(–1.07)				(–1.34)	(–1.44)			
	[–0.62]	[–1.00]				[–1.31]	[–1.38]			
1999–2001	0.003	0.002			0.15	0.01	0.00			0.11
	(0.04)	(0.05)				(0.51)	(0.09)			
	[0.04]	[0.05]				[0.50]	[0.09]			
2002–2004	0.04*	0.003			0.14	0.03*	0.00			0.08
	(3.49)	(–0.42)				(3.43)	(0.08)			
	[1.41]	[–0.40]				[3.42]	[0.07]			
1993–1998	–0.01	0.002			0.14	–0.01	0.00			0.14
	(–0.97)	(–0.36)				(–0.97)	(–0.36)			
	[–0.89]	[–0.36]				[–0.96]	[–0.35]			
1999–2004	0.02*	0.002			0.15	0.02*	0.00			0.15
	(2.19)	(–0.24)				(2.23)	(–0.34)			
	[1.54]	[–0.24]				[2.22]	[–0.33]			
1993–2004	0.01	0.00			0.15	0.01	0.00			0.15
	(0.89)	(–0.44)				(0.90)	(–0.50)			
	[0.84]	[–0.43]				[0.89]	[–0.49]			

Continued—

Table 2—*(Continued)*

	B $r_i = \lambda_0 + \lambda_1\beta_{it} + \lambda_5\kappa_{it} + \varepsilon_{it}$									
	λ_0	λ_1	λ_2	λ_3	R^2	λ_0	λ_1	λ_2	λ_3	R^2
1993–1995	–0.01	0.01	0.003**		0.14	0.003	0.001	0.01*		0.20
	(–1.01)	(0.64)	(1.76)			(–0.35)	(0.71)	(2.85)		
	[–0.73]	[0.55]	[1.68]			[–0.35]	[0.71]	[2.75]		
1996–1998	–0.02	–0.01	0.01**		0.18	–0.02**	–0.01**	0.01**		0.27
	(–1.20)	(–0.91)	(1.75)			(–1.77)	(–1.93)	(1.81)		
	[–0.97]	[–0.87]	[1.62]			[–1.74]	[–1.84]	[1.71]		
1999–2001	0.001	0.002	0.001		0.16	0.004	0.001	0.01		0.16
	(0.05)	(0.05)	(–0.02)			(0.00)	(0.00)	(0.01)		
	[0.05]	[0.05]	[–0.02]			[0.37]	[–0.16]	[0.81]		
2002–2004	0.04*	0.003	0.001		0.17	0.02*	0.001	0.003		0.12
	(3.30)	(–0.45)	(–0.43)			(2.59)	(–0.02)	(–0.24)		
	[1.30]	[–0.44]	[–0.43]			[2.59]	[–0.02]	[–0.23]		
1993–1998	–0.01**	0.001	0.01*		0.16	–0.01*	0.001	0.01*		0.14
	(–1.58)	(–0.16)	(2.35)			(–1.62)	(–1.16)	(2.19)		
	[–1.25]	[–0.16]	[2.21]			[–1.61]	[–1.12]	[2.12]		
1999–2004	0.02*	0.001	0.001		0.17	0.01*	0.003	0.001		0.14
	(2.15)	(–0.27)	(–0.37)			(2.09)	(–0.14)	(0.56)		
	[1.49]	[–0.27]	[–0.37]			[2.09]	[–0.14]	[0.55]		
1993–2004	0.003	0.001	0.002**		0.17	0.00	0.001	0.004**		0.14
	(0.53)	(–0.30)	(1.60)			(0.22)	(–0.81)	(1.86)		
	[0.52]	[–0.30]	[1.59]			[0.22]	[–0.81]	[1.85]		

Continued—

Table 2—*(Continued)*

	C $r_i = \lambda_0 + \lambda_1\beta_{it} + \lambda_5\kappa_{it} + \varepsilon_{it}$									
	λ_0	λ_1	λ_2	λ_3	R^2	λ_0	λ_1	λ_2	λ_3	R^2
1993–1995	–0.02***	0.01		0.01*	0.15	–0.01	0.004**		0.01*	0.12
	(–1.55)	(0.60)		(2.34)		(–0.48)	(1.60)		(2.26)	
	[–0.76]	[0.52]		[1.49]		[–0.48]	[1.58]		[2.22]	
1996–1998	–0.01	–0.01		0.002	0.23	–0.02**	–0.01**		0.001	0.18
	(–1.11)	(–1.06)		(0.20)		(–1.79)	(–1.87)		(–0.07)	
	[–0.98]	[–0.99]		[0.20]		[–1.76]	[–1.79]		[–0.07]	
1999–2001	0.01	0.001		–0.01***	0.20	0.00	0.001		0.004	0.17
	(1.30)	(–0.02)		(–1.43)		(0.46)	(0.03)		(0.39)	
	[1.07]	[–0.02]		[–1.20]		[0.41]	[0.03]		[0.31]	
2002–2004	0.04*	0.003		0.004	0.17	0.02*	0.001		0.01	0.13
	(4.45)	(–0.44)		(–0.58)		(2.75)	(–0.53)		(0.91)	
	[1.66]	[–0.42]		[–0.55]		[2.75]	[–0.51]		[0.89]	
1993–1998	–0.02**	0.002		0.01	0.19	–0.01***	0.001		0.003	0.15
	(–1.91)	(–0.31)		(1.09)		(–1.74)	(–0.71)		(0.42)	
	[–1.41]	[–0.31]		[0.95]		[–1.72]	[–0.68]		[0.40]	
1999–2004	0.03***	0.002		–0.01	0.19	0.01*	0.001		0.01	0.15
	(1.37)	(–0.11)		(–0.50)		(2.37)	(–0.28)		(0.85)	
	[0.77]	[–0.11]		[–0.45]		[2.37]	[–0.28]		[0.85]	
1993–2004	0.01	0.002		0.001	0.19	0.00	0.001		0.004	0.15
	(1.09)	(–0.44)		(–0.16)		(0.00)	(–0.65)		(0.89)	
	[1.02]	[–0.44]		[–0.16]		[0.00]	[–0.65]		[0.89]	

Continued—

Table 2—*(Continued)*

	D $r_{it} = \lambda_0 + \lambda_1\beta_{it} + \lambda_4\gamma_{it} + \lambda_5\kappa_{it} + \varepsilon_{it}$									
	λ_0	λ_1	λ_2	λ_3	R^2	λ_0	λ_1	λ_2	λ_3	R^2
1993–1995	–0.02***	0.01	0.002	0.01*	0.16	0.00	0.002	0.02*	0.01*	0.14
	(–1.57)	(0.65)	(1.04)	(2.13)		(0.04)	(0.82)	(2.55)	(1.98)	
	[–0.76]	[0.56]	[1.03]	[1.45]		[0.04]	[0.81]	[2.40]	[1.98]	
1996–1998	–0.01	–0.01	0.01*	0.003	0.25	–0.02**	–0.01	0.01*	–0.01	0.20
	(–1.28)	(–0.91)	(1.94)	(–0.22)		(–1.67)	(–1.93)	(1.91)	(–0.54)	
	[–1.09]	[–0.87]	[1.79]	[–0.22]		[–1.64]	[–1.84]	[1.85]	[–0.52]	
1999–2001	0.01	0.003	0.003	–0.01	0.22	0.002	0.001	0.01	0.004	0.20
	(1.24)	(0.04)	(0.81)	(–1.43)		(0.80)	(–0.14)	(1.06)	(–0.34)	
	[1.04]	[0.04]	[0.81]	[–1.16]		[0.79]	[–0.14]	[1.05]	[–0.34]	
2002–2004	0.04*	0.003	0.001	0.003	0.20	0.02*	0.002	–0.01*	0.02**	0.15
	(4.26)	(–0.45)	(0.27)	(–0.49)		(2.53)	(–0.10)	(–1.92)	(1.78)	
	[1.58]	[–0.44]	[0.27]	[–0.47]		[2.53]	[–0.10]	[–1.80]	[1.78]	
1993–1998	–0.02	0.001	0.004*	0.004	0.21	–0.01***	0.00	0.01*	–0.01	0.18
	(–2.03)	(–0.16)	(2.19)	(0.59)		(–1.39)	(–1.13)	(2.08)	(–1.03)	
	[–1.44]	[–0.16]	[2.09]	[0.56]		[–1.37]	[–1.09]	[1.94]	[–1.01]	
1999–2004	0.03*	0.001	0.001	–0.01	0.21	0.01*	0.004	0.002	0.01	0.18
	(3.72)	(–0.28)	(0.33)	(–1.47)		(2.34)	(–0.18)	(–0.41)	(0.88)	
	[2.11]	[–0.28]	[0.33]	[–1.30]		[2.34]	[–0.18]	[–0.41]	[0.88]	
1993–2004	0.01	0.001	0.002**	0.003	0.21	0.001	0.001	0.004**	0.001	0.18
	(0.96)	(–0.30)	(1.84)	(–0.56)		(0.26)	(–0.83)	(1.99)	(0.02)	
	[0.91]	[–0.30]	[1.82]	[–0.56]		[0.26]	[–0.83]	[1.97]	[0.02]	

Note: The *t*-values below the coefficient in round brackets are Fama-McBeth *t*-values and in square brackets the *t*-values are error adjusted Shanken *t*-values. The market Skewness for 1993-1995 is –0.05, for 1996–1998 it is –0.25, for 1999–2001 it is –0.08 , for 2002–2004 it is –0.24, for 1993–1998 it is –0.27 , for 1999–2004 it is –0.17 and for 1993–2004 it is –0.24. The expected sign of the premium for co-skewness-risk according to Kraus and Litzenberger (1976) would be opposite the sign of market skewness. The * shows significant at 1 percent, ** is significant at 5 percent and *** is significant at 10 percent.

is used to test, applying t-statistics, the null hypothesis that the risk premium is equal to zero. Since betas are generated in the first stage and then used as explanatory variables in the second stage, the regressions involve error-in-variables problem. Therefore tests based on usual standard errors are unreliable. The t-ratio for testing the hypothesis that average premium is zero is calculated using the standard deviation of the time series of estimated risk premium which captures month by month variation following Fama and McBeth (1973). We also calculated alternative t-ratios using a correction for errors in beta suggested by Shanken (1992).[10] The R^2 is average of month by month coefficient of determination.

The results of testing the standard model in panel A show that there is no positive and significant compensation on average to bear market risk. The finding that in several cases the market premium is estimated to be negative is contrary to the main hypothesis of CAPM, because critical condition of CAPM is that there is on average a positive trade off between market risk and return. The intercept terms λ_0 are not significantly different from zero in almost all sub-periods with the exception only in period 2001-2003 and 2002-2004 sub-periods. This result is in line with Sharpe-Lintner model to some extent.

The third and fourth moments are incorporated in standard CAPM in order to examine the effect of higher moment on asset pricing with daily as well as monthly data. In the higher moment CAPM model, co-skewness and co-kurtosis are estimated out of the model in the first stage based on daily data as well as monthly data. In the second stage the cross-section regression is estimated by using these calculated variables as explanatory variables. The results of the three-moment-CAPM presented for individual stocks based on daily data and monthly data in Table 2 show that the introduction of co-skewness risk as additional explanatory variable with beta, the intercept term λ_0 are significantly different from zero in 2002-2004, 1993-1998 and 1999-2004 in three-moment CAPM as shown by the results reported in section B of Table 2. The risk premium for co-skewness λ_2 is positive for the sub-periods 1993-1995, 1996-1998, 1993-1998, and for overall period 1993-2004. Since the investors have preference for positive skewness, negative market skewness, which we have observed in all sub-periods and overall sample period is considered as risk and investor is rewarded with positive premium for co-skewness risk for some sub-periods. These results indicate that systematic co-skewness-risk is compensated in the Karachi stock market in some sub-periods and overall period, this result is in conformity with Kraus and Litzenberger

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[10]Shanken (1992) suggests multiplying $\hat{\sigma}^2(\hat{\lambda}_{it})^2$ by the adjustment factor $[1+(\mu_m-\hat{\lambda}_{it})^2]/\sigma_m^2$, where μ_m is mean of market return and σ_m is standard deviation of market return.

(1976) extended CAPM findings. This result is consistent with the studies for developed market like Fang and Lai (1998), Friend and Westerfield and Sears and Wei (1985). In the model when co-kurtosis risk is combined with beta the risk premium for co-kurtosis-risk in section C of the Table 2, λ_3 is positive and insignificant for most of the sub-periods only sub-period 1993-1995 the compensation for co-kurtosis risk is positive and significant. When the beta risk is supplemented by both co-skewness risk and co-kurtosis risk in the section D of the Table 2, the results are improved to some extent as coefficient of determination increases. However, the risk premium for covariance risk remains inconclusive and insignificant. The co-skewness-risk is priced for sub-periods 1993-1995, 1996-1998, 1993-1998 and for overall period 1993-2004, whereas the co-kurtosis-risk is compensated only in sub-period 1993-1995 and in 2002-2004 (with monthly data).

The results of conditional two-moment, three moment and four moment models are presented in Table 3. It is apparent from the results that the extension of standard CAPM by incorporating conditional co-skewness has improved the results. The premium for beta risk is positive and significant for the period 1993-1995 and inconclusive and insignificant otherwise. The results reported in panel B of the table reveal that the price of conditional co-skewness risk is significantly different from zero in sub periods 1993-1995, 1996-1998 and 1993-1998 and the overall sample period. 1993-2004. The intercept term is significantly different from zero in sub-periods 1993-1995, 1993-1998 and 1999-2004. The risk premium for conditional co-kurtosis when it is taken as an additional explanatory variable with covariance risk is positive and significant in sub-periods 1993-1995 and 1993-1998. It is inconclusive and insignificant in other sub-periods and overall period. The intercept term remain significantly different from zero for most of the sub-periods and overall sample period except for the sub-period 1993-1995 and 1993-1998. The results remain the same for four-moment-CAPM. The beta risk is positively and significantly compensated only for the period 1993-1995.

These results indicate that covariance and co-kurtosis risk have limited compensation only for few periods, but investors get reward for conditional co-skewness risk in the Karachi stock Market. This result is consistent with the evidence of developed market USA by Harvey and Siddique (1999, 2000).[11] As regards the market efficiency hypothesis, it is rejected due to presence of significant of variation mean pricing errors in all the models. Overall, the results support the hypothesis in favour of time in expected return of assets.

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[11]In their extensive analysis Harvey and Siddique (1999, 2000a and 2000b) they find that co-skewness account part of the explanatory power of size and book-to-market factor (which are discussed in next chapter) of Fama and French (1993). They also explain part of return momentum trading strategies which are largely unexplained by any factor [Jagadesh and Titmann (1999)].

Table 3

Average Risk Premium for the Conditional Multi-moment CAPM

	β_i , γ_i and κ_i Computed out of Model by Daily Data					β_i , γ_i and κ_i Computed out of Model by Monthly Data				
	A $r_{it} = \lambda_{0t} + \lambda_{1t}\beta_{it} + \varepsilon_{it}$									
	λ_{0t}	λ_{1t}	λ_{2t}	λ_{3t}	R^2	λ_{0t}	λ_{1t}	λ_{2t}	λ_{3t}	R^2
1993-1995	–0.01	0.06**			0.10	–0.003	0.01**			0.11
	(–0.37)	(1.66)				(–0.25)	(1.54)			
	[–0.35]	[1.03]				[–0.24]	[1.50]			
1996–1998	–0.02	–0.01			0.20	–0.02	–0.001			0.17
	(–1.30)	(–0.29)				(–1.64)	(–0.06)			
	[–0.98]	[–0.29]				[1.62]	[–0.05]			
1999–2001	0.01	–0.01			0.20	0.002	0.003			0.18
	(0.49)	(–0.51)				(0.06)	(1.01)			
	[0.46]	[–0.47]				[0.16]	[0.22]			
2002–2004	0.03	0.003			0.16	0.03	0.01			0.14
	(3.30)	(0.32)				(3.08)	(0.86)			
	[1.49]	[0.31]				[3.06]	[0.84]			
1993–1998	–0.01	0.004			0.15	–0.02	0.002			0.14
	(–1.26)	(0.40)				(–1.46)	(0.22)			
	[–1.05]	[0.38]				[–1.45]	[0.21]			
1999–2004	0.02	–0.003			0.18	0.02	0.01			0.15
	(2.46)	(0.25)				(2.05)	(0.71)			
	[1.71]	[–0.24]				[20.03]	[0.71]			
1993–2004	0.004	0.001			0.17	0.002	0.01			0.15
	(0.66)	(0.09)				(0.35)	(0.65)			
	[0.63]	[0.09]				[0.35]	[0.65]			

Continued—

Table 3—(*Continued*)

	B $r_{it} = \lambda_{0t} + \lambda_{1t}\beta_{it} + \lambda_{2t}\gamma_{it} + \varepsilon_{it}$									
	λ_{0t}	λ_{1t}	λ_{2t}	λ_{3t}	R^2	λ_{0t}	λ_{1t}	λ_{2t}	λ_{3t}	R^2
1993–1995	–0.04*	0.02***	0.01***		0.18	–0.02	0.01*	0.01*		0.15
	(–2.48)	(1.41)	(1.86)			(–1.57)	(1.68)	(3.90)		
	[–0.77]	[0.65]	[1.36]			[–1.57]	[1.66]	(3.75)		
1996–1998	–0.02	–0.01	0.02***		0.25	–0.01	–0.01	0.01***		0.21
	(–1.11)	(–0.78)	(1.65)			(–0.41)	(–1.23)	(1.69)		
	[–0.87]	[–0.72}	[1.17]			[–0.40]	[–1.19]	[1.53]		
1999–2001	0.004	–0.003	0.003		0.22	0.004	–0.003	0.001		0.21
	(0.35)	(–0.28)	(0.46)			(0.28)	(–0.29)	(0.21)		
	[0.34]	[–0.27]	[0.45]			[0.27]	[–0.28]	[0.21]		
2002–2004	0.05*	–0.01	0.002		0.21	0.03*	0.001	0.002		0.17
	(3.16)	(–0.54)	(0.41)			(3.16)	(0.05)	(0.44)		
	[1.04]	[–0.49]	[0.40]			[3.14]	[0.05]	[0.43]		
1993–1998	–0.03*	0.01	0.01*		0.22	–0.01	–0.003	0.01*		0.13
	(–2.46)	(0.50)	[2.30]			(–1.14)	(–0.34)	(3.06)		
	[–1.36]	[0.47]	(1.68)			[–1.11]	[–0.33]	[2.84]		
1999–2004	0.03*	–0.005	0.003		0.22	0.02*	–0.001	0.001		0.19
	(2.54)	(–0.57)	(0.62)			(2.19)	(–0.18)	(0.44)		
	[1.49]	[–0.55]	[0.61]			[2.18]	[–0.17]	[0.44]		
1993–2004	0.001	0.001	0.01*		0.17	0.01	–0.002	0.01*		0.19
	(0.11)	(–0.03)	(2.22)			(0.80)	(–0.38)	(2.67)		
	[0.11]	[–0.01]	[1.99]			[0.80]	[–0.38]	[2.64]		

Continued—

Table 3—(*Continued*)

	C $r_{it} = \lambda_{0t} + \lambda_{1t}\beta_{it} + \lambda_{3t}\kappa_{it} + \varepsilon_{it}$									
	λ_{0t}	λ_{1t}	λ_{2t}	λ_{3t}	R^2	λ_{0t}	λ_{1t}	λ_{2t}	λ_{3t}	R^2
1993–1995	–0.02**	0.02		0.01*	0.19	–0.01	0.01		0.02*	0.15
	(–1.89)	(1.23)		(2.18)		(–1.28)	(0.59)		(5.04)	
	[–0.93]	[0.67]		[2.14]		[–1.28]	[0.58]		[4.76]	
1996–1998	–0.01	–0.01		0.01	0.21	–0.01	0.01		0.002	0.21
	(–0.57)	(–0.69)		(0.15)		(–0.51)	(–1.04)		(0.17)	
	[–0.55]	[–0.64]		[0.14]		[–0.49]	[–1.00]		[0.16]	
1999–2001	0.003	–0.003		0.02	0.21	0.003	–0.002		–0.001	0.19
	(0.25)	(–0.27)		(0.39)		(0.24)	(–0.22)		(–0.14)	
	0.250	[–0.27]		[0.30]		[0.23]	[–0.22]		[–0.14]	
2002–2004	0.04*	–0.001		0.01	0.20	0.03*	0.001		–0.001	0.17
	(2.92)	(–0.11)		(0.16)		(3.04)	(0.13)		(–0.02)	
	[1.24]	[–0.11]		[0.16]		[3.02]	[0.12]		[–0.02]	
1993–1998	–0.01***	0.003		0.01	0.20	–0.01	–0.002		0.01***	0.17
	(–1.59)	(0.33)		(0.23)		(–1.06)	(–0.28)		(1.63)	
	[–1.26]	[0.31]		[0.21]		[–1.04]	[–0.27]		[1.53]	
1999–2004	0.02	–0.002		0.01	0.20	0.02	0.002		0.001	0.18
	(0.99)	(–0.13)		(0.36)		(1.09)	(–0.03)		(–0.03)	
	[0.69]	[–0.13]		[0.31]		[1.09]	[–0.03]		[–0.03]	
1993–2004	0.003	0.001		0.01	0.20	0.01	–0.001		0.004	0.17
	(0.52)	(0.07)		(0.45)		(0.77)	(–0.26)		(1.26)	
	[0.51]	[0.07]		[0.40]		[0.76]	[–0.26]		[1.25]	

Continued—

Table 3—(*Continued*)

D $r_{it} = \lambda_{0t} + \lambda_{1t}\beta_{it} + \lambda_{2t}\gamma_{it} + \lambda_{3t}\kappa_{it} + \varepsilon_{it}$

	λ_{0t}	λ_{1t}	λ_{2t}	λ_{3t}	R^2	λ_{0t}	λ_{1t}	λ_{2t}	λ_{3t}	R^2
1993–1995	–0.04*	0.03**	0.01*	0.04	0.22	–0.012	0.01**	0.01**	0.01	0.20
	(–2.59)	(1.58)	(2.29)	(0.65)		(–1.26)	(1.54)	(1.74)	(0.84)	
	[–0.75]	[0.67]	[1.54]	[0.20]		[–1.26]	[1.53]	[1.70]	[0.82]	
1996–1998	–0.02	–0.01	0.02***	0.01	0.27	–0.01	–0.01	0.02**	–0.02*	0.25
	(–1.10)	(–0.67)	(1.34)	(0.23)		(–0.66)	(–0.88)	(1.87)	(–2.05)	
	[–0.86]	[–0.63]	[1.02]	[0.20]		[–0.64]	[–0.85]	[1.68]	[–2.02]	
1999–2001	0.01	–0.01	0.002	–0.03	0.25	0.003	–0.002	0.01	–0.01	0.23
	(0.54)	(–0.45)	(0.34)	(–0.74)		(0.21)	(–0.17)	(1.11)	(–0.48)	
	[0.51]	[–0.44]	[0.33]	[–0.40]		[0.20]	[–0.17]	[1.10]	[–0.48]	
2002–2004	0.05*	[–0.01]	0.001	–0.040	0.23	0.03*	0.001	0.002	–0.001	0.19
	(3.29)	(–0.79)	(0.08)	(–1.28)		(3.00)	(0.08)	(0.42)	(–0.21)	
	[3.03]	[–0.67]	[0.08]	[–0.46]		[2.98]	[0.08]	[0.41]	[–0.20]	
1993–1998	–0.03*	0.01	0.01*	0.02	0.25	–0.01	–0.002	0.01*	–0.01***	0.21
	(–2.51)	(0.62)	(2.17)	(0.66)		(–1.22)	(–0.21)	(2.53)	(–1.36)	
	[–1.32]	[0.56]	[1.61]	[0.38]		[–1.20]	[–0.20]	[2.35]	[–1.34]	
1999–2004	0.03*	–0.01	0.001	–0.04	0.24	0.02*	0.001	0.01	–0.003	0.21
	(2.79)	(–0.87)	(0.30)	(–1.36)		(2.02)	(–0.07)	(1.14)	(–0.53)	
	[1.53]	[–0.80]	[0.30]	[–0.61]		[2.01]	[–0.07]	[1.14]	[–0.52]	
1993–2004	0.001	–0.001	0.01**	–0.01	0.24	0.004	–0.001	0.01*	–0.01	0.21
	(0.19)	(–0.09)	(1.93)	(–0.40)		(0.67)	(–0.20)	(2.54)	(–1.30)	
	[0.18]	[–0.08]	[1.77]	[–0.36]		[0.67]	[–0.20]	[2.51]	[–1.29]	

Note: The *t*-values below the coefficient in round brackets are Fama-McBeth *t*-values and in square brackets the *t*-values are error adjusted Shanken *t*-values. The market Skewness for 1993–1995 is –0.05, for 1996–1998 it is –0.25, for 1999–2001 it is –0.08 , for 2002–2004 it is –0.24, for 1993–1998 it is –0.27 , for 1999–2004 it is –0.17 and for 1993–2004 it is –0.24. The expected sign of the premium for co-skewness-risk according to Kraus and Litzenberger (1976) would be opposite the sign of market skewness. The * shows significant at 1 percent, ** is significant at 5 percent and *** is significant at 10 percent.

5. SUMMARY AND CONCLUSION

In this study examines the Capital Asset Pricing Model developed by Sharpe (1964) Lintner (1965) as the benchmark model in the asset pricing theory defining the first two moments as target variable. The empirical findings indicate that Sharpe-Lintner CAPM is inadequate for Pakistan's equity market in explaining economically and statistically significant role of market risk for the determination of expected return. In this study instead of identifying more risk factors a detail analysis of single risk factor is undertaken. We concentrated on two main criticisms on the CAPM, questioning the hypothesis of normal distribution of asset return and single period characteristic of standard model. The asset returns in Pakistan equity market deviates from normality indicates that investors are concerned about the higher moments of return distribution. First, the standard model is extended by taking higher moments into account. Second, the risk factors are allowed to vary over time in the autoregressive process. For Pakistani equity market this study is first attempt to demonstrate the benefits of non-linear pricing behaviour, has shown some evidence of higher order pricing factors associated with co-skewness and co-kurtosis. The result of unconditional non-linear generalisation of the model and the results demonstrate that in higher moment model the investors are rewarded for co-skewness risk. However the test provides marginal support for reward of co-kurtosis-risk. It is concluded that Kraus and Litenberger (1976) attempt to develop and substantiate a modified form of Sharpe-Lintner CAPM is successful to some extent with KSE data. Finally, the empirical usefulness of conditional higher moments in explaining the cross-section of asset return is investigated. The results indicate that conditional co-skewness is important determinant of asset pricing and the asset pricing relationship varies through time. The conditional covariance and conditional co-kurtosis explains the asset price relationship in limited way. However one can not really say that the role of market return is sufficient in explaining economically and statistically significant in explaining expected return. Intuitively the rapidly changing economic environment of emerging markets has strong impact on asset pricing [Harvey (1995)]. For more comprehensive analysis of asset pricing, it is needed to identify factors and information variables that are able to explain expected return more adequately

APPENDIX A

The Model

Assuming that there are n risky assets and one risk free asset with parameters $R = an \times 1$ vector of rate of return of i risky assets, $R = a\ n\times$ vector of expected return of risky assets; $V = a\ n\times n$ is variance co-variance matrix of n risky assets; and R_f is the rate of return on the risk free assets. The capital market is perfect and competitive with no taxes, transaction costs and indivisibility. All investors hold homogenous expectations about the return on the assets. Each investor seeks to maximise his expected utility, which can be represented by mean, variances, skewness and kurtosis of terminal wealth subject to the budget constraint.

Let the investor invests x_i of his wealth on risky assets and $1-\sum x_i$ in the risk free asset. The mean, variance, skewness and kurtosis of his portfolio excess return are $X(R-R_f)$, $X'VX$ $E[X'(R-\overline{R})/(X'VX)^{1/2}]^3$ and $E[X'(R-\overline{R})/(X'VX)^{1/2}]^4$ respectively, where $X' = (x_1, x_2 ....., x_n)$ is a $(n\times 1)$ vector of investor's holding of risky assets.

The portfolio can be rescaled since the relevant percentage invested in different assets is relevant. If the standard deviation of portfolio return is used to rescale the portfolio, then variance of portfolio return is unit (i.e., $X'VX = 1$) . The investors' preferences, which are a function of mean, variance, skewness and kurtosis of terminal wealth, thus can be defined over the mean, variance, skewness and kurtosis of the terminal wealth thus can be defined over the mean, skewness and kurtosis, subject to unit variance. The increase of the mean and skewness of terminal wealth is assumed to increase the investors' utility. In contrast the increase in kurtosis of terminal wealth increase the probability of extreme outcome of terminal wealth and will result in benefit and cost to investor. As a result the marginal utility of mean and skewness is assumed to be positive and kurtosis is assumed to be negative in the following derivations.

To maximise the investors expected utility of terminal wealth subject to the budget and unit variance constraints, lagrangian is formed.

$$MaxU\{X'(\overline{R}-R_f), E[X'(R-\overline{R})]^3, E[X''(R-\overline{R})]^4\} - \lambda(X'VX-1) \qquad \text{(A1)}$$

where λ is the lagrangian multiplier of the unit variances constraint. Taking the first order conditions for a maximum and solving for the investor's portfolio equilibrium conditions, it yields

$$\bar{R} - R_f = \phi_1 VX + \phi_2 \operatorname{cov}[X'(R-\bar{R})]^2, R] + \phi_3 \operatorname{cov}[X'(R-\bar{R})]^3, R] \qquad \text{(A2)}$$

where $\operatorname{cov}[X'(R-\bar{R})]^i$ is the $n \times 1$ covariance vector of asset return R with the portfolio return $X'(R-\bar{R})^i$ for i=1, 2,3.

$$\phi_1 = \frac{2\lambda}{U_1}, \ \phi_2 = \frac{-3U_2}{U_1} \ \text{ and } \ \phi_3 = \frac{-4U_3}{U_1}$$

U_i the partial derivative with respect to *i*th argument in order to move from the equilibrium conditions for individual investors to a model of market equilibrium, a separation theorem which assumes all investors hold the same probability believes and have identical wealth coefficients is employed. By the separation theorem, the port folio held by investors must be market port folio to clear the market. Let R_m be the market portfolio return with $R_m = X'_m(R - R_f)$ and $X'VX = 1$ is the budget constraint, the asset pricing model with skewness and kurtosis can thus be derived from Equation (A2) as,

$$\bar{R} - R_f = \phi_1 \operatorname{cov}(R_m, R) + \phi_2 \operatorname{cov}(R_m^2, R) + \phi_3 \operatorname{cov}(R_m^3, R) \quad \ldots \qquad \ldots \quad \text{(A3)}$$

where $R_m^2 (R_m^3)$ is the square (cube) of the standardised market portfolio return $R_{m,}$ ϕ_1, ϕ_2, ϕ_3 are the market price of systematic variance, systematic skewness and systematic kurtosis respectively. The Equation (A3) is the four-moment CAPM derived in this study. It shows that in the presence of kurtosis the expected excess rate of return is related not only to systematic variance and systematic skewness. The higher the systematic variance and systematic kurtosis, the higher is expected rate of return. The higher is systematic skewness, the lower is expected rate if return. In addition it is the systematic kurtosis and systematic skewness that rather than total kurtosis and total skewness that is relevant in the asset valuation. Investors are compensated in terms of expected excess rate of return for bearing the systematic variance and systematic kurtosis risks. Yet investors also forego the expected excess return for taking the benefit of increasing the systematic skewness. In the mean-variance framework, the systematic skewness and kurtosis would not be priced and equation (A3) collapses to the CAPM. In the three-moment CAPM, systematic kurtosis is not priced and Equation (A3) is reduced to Kraus and Litzenberger’s three-moment CAPM.

APPENDIX B

Table B1

List of Companies Included in the Sample

Name of Company	Symbol	Sector
Al-Abbas Sugar	AABS	Sugar and Allied
Askari Commercial Bank	ACBL	Insurance and Finance
Al-Ghazi Tractors	AGTL	Auto and Allied
Adamjee insurance Company	AICL	Insurance
Ansari Sugar	ANSS	Sugar and Allied
Askari Leasing	ASKL	Leasing Company
Bal Wheels	BWHL	Auto and Allied
Cherat Cement	CHCC	Cement
Crescent Textile Mills	CRTM	Textile Composite
Crescent Steel	CSAP	Engineering
Comm. Union Life Assurance	CULA	Insurance and Finance
Dadabhoy Cement	DBYC	Cement
Dhan Fibres	DHAN	Synthetic and Rayon
Dewan Salman Fibre	DSFL	Synthetic and Rayon
Dewan Textile	DWTM	Textile Composite
Engro Chemical Pakistan	ENGRO	Chemicals and Pharmaceuticals
Faisal Spinning.	FASM	Textile Spinning
FFCL Jordan	FFCJ	Chemicals and Pharmaceuticals
Fauji Fertilizer	FFCL	Fertilizer
Fateh Textile	FTHM	Textile Composite
General Tyre and Rubber Co.	GTYR	Auto and Allied
Gul Ahmed Textile	GULT	Textile Composite
Habib Arkady Sugar	HAAL	Sugar and Allied
Hub Power Co.	HUBC	Power Generation & Distribution
I.C.I. Pak	ICI	Chemicals and Pharmaceuticals
Indus Motors	INDU	Auto and Allied
J.D.W. Sugar	JDWS	Sugar and Allied
Japan Power	JPPO	Power Generation & Distribution
Karachi Electric Supply Co.	KESC	Power Generation & Distribution
Lever Brothers Pakistan	LEVER	Food and Allied
Lucky Cement	LUCK	Cement
Muslim Commercial Bank	MCB	Commercial Banks
Maple Leaf Cement	MPLC	Cement
National Refinery	NATR	Fuel and Energy
Nestle Milk Pak Ltd.	NESTLE	Food and Allied
Packages Ltd.	PACK	Paper and Board
Pak Electron	PAEL	Cables and Electric Goods
Pakistan Tobacco Company	PAKT	Tobacco
Pakland Cement	PKCL	Cement
Pakistan State Oil Company	PSOC	Fuel and Energy
PTCL (A)	PTC	Fuel and Energy
Southern Electric	SELP	Cables and Electric Goods
ICP SEMF Modarba	SEMF	Modarba
Sitara Chemical	SITC	Chemicals and Pharmaceuticals
Sui Southern Gas Company	SNGC	Fuel and Energy
Sui Northern Gas Company	SSGC	Fuel and Energy
Tri-Star Polyester Ltd.	TSPI	Synthetic and Rayon
Tri-Star Shipping Lines	TSSL	Transport and Communication
Unicap Modarba	UNIM	Modarba

Table B2

The Moments Calculated Out-of-Model

	Daily Data			Monthly Data		
	β_i	γ_i	κ_i	β_i	γ_i	κ_i
AABS	0.37	1.98	0.17	0.37	0.45	0.13
ACBL	0.98	0.90	1.00	1.02	0.89	0.82
AGTL	0.45	–0.41	0.10	0.56	–0.69	–0.64
AICL	1.07	2.05	1.01	1.56	–1.01	–1.08
ANSS	0.61	1.03	0.61	0.57	0.20	0.41
ASKL	0.77	0.39	0.82	0.92	0.80	0.85
BWHL	0.72	0.02	0.01	0.26	0.67	0.59
CHCC	0.85	–2.00	0.79	1.01	–2.00	0.79
CRTM	0.81	–1.64	0.06	1.04	–0.15	0.59
CSAP	0.72	0.84	0.59	0.72	–0.40	0.38
CULA	0.64	0.81	0.49	0.52	0.43	0.49
DBYC	1.23	–7.84	0.50	1.38	0.48	0.91
DHAN	0.81	–1.61	1.05	0.87	1.26	0.96
DSFL	1.20	0.34	1.07	1.41	0.89	1.12
DWTM	0.52	1.37	0.33	0.15	0.10	0.07
ENGRO	0.86	1.29	0.76	0.79	0.73	0.75
FASM	0.53	1.43	0.41	0.73	0.62	0.48
FFCJ	1.15	0.80	0.95	–0.03	0.22	0.81
FFCL	0.87	0.74	0.79	0.87	0.39	0.67
FTHM	–0.01	–0.87	–0.92	–0.07	–0.32	0.05
GTYR	0.61	0.83	0.43	0.71	1.16	0.73
GULT	0.31	2.87	0.07	0.09	0.75	0.50
HAAL	0.47	3.45	0.02	0.58	0.32	0.28
HUBC	1.30	2.61	1.44	1.23	2.17	1.65
ICI	1.13	0.44	1.04	1.32	0.57	1.10
ICPSEMF	1.00	0.04	0.84	1.10	0.69	0.72
INDU	0.77	0.15	0.63	0.94	–0.12	0.43
JDWS	0.31	–1.28	0.10	0.48	–0.06	0.24
JPPO	1.33	0.23	1.50	0.99	0.24	1.12
KESC	1.42	–0.06	1.47	1.61	1.29	1.69
LUCK	0.49	4.15	1.03	1.17	0.35	1.02
LEVER	1.20	0.90	0.45	0.52	0.62	0.48
MCB	1.17	1.25	1.11	1.25	0.80	1.05
MPLC	1.21	–0.02	1.08	1.30	–0.08	1.10
NATR	0.79	0.21	–0.29	0.86	0.21	0.63
NESTLE	0.54	–0.31	0.61	–0.03	0.09	0.15
PACK	0.52	0.93	0.73	0.68	0.45	0.64
PAEL	0.85	–0.54	0.85	0.85	0.23	0.37
PAKT	0.66	2.75	1.11	0.65	–0.20	0.36
PKCL	0.86	1.00	0.76	0.75	0.36	0.46
PSO	1.12	1.47	1.32	1.31	2.06	1.41
PTC	1.35	0.98	1.44	1.08	0.03	0.06
SELP	1.28	0.71	1.73	0.90	0.62	1.09
SITC	0.48	–1.02	0.43	0.57	–0.38	0.26
SNGP	1.25	1.43	1.08	1.37	1.07	1.19
SSGC	1.19	0.48	1.20	1.26	1.29	1.20
TSPI	0.73	0.58	0.52	0.81	0.58	0.52
TSSL	0.45	–1.78	0.14	0.38	0.56	0.40
UNIM	0.92	0.79	0.25	0.85	0.09	0.13

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