Test of Higher Moment Capital Asset Pricing Model in Case of Pakistani Equity Market

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Abstract
In this study we test the mean-variance capital asset pricing model (CAPM) developed by Sharpe (1965) Lintner (1966) on individual stocks traded at Karachi Stock Exchange (KSE), the main equity market in Pakistan for the period 1993-2004 using daily and monthly data. The empirical findings do not support standard CAPM as a model to explain assets pricing in Pakistani equity market. In response to this finding first, we have extended the model to mean-variance-skewness and mean-variance-skewness-kurtosis model following Kraus and Litzenberger (1976). In the second step we allow the covariance, coskewness and cokurtosis to vary over time in autoregressive context leading to conditional three-moment CAPM and conditional four-moment CAPM. The results of unconditional and conditional higher-moments CAPM reveal that three-moment CAPM performed relatively well in explaining risk-return relationship in Pakistan during the sample period However, the results of higher-moment model indicate that systematic covariance and systematic cokurtosis have marginal role in explaining the asset price behavior in Pakistan.

JEL Classification: C29, G12
Keywords: Covariance, coskewness, cokurtosis, non-normal return distribution, capital asset pricing model, time-varying moments.

1 Introduction

The capital asset pricing model (CAPM) developed by Sharpe (1965) and Lintner (1966) 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 researchers 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 consider only the mean and variance of the return. However, when the returns are non-normal[1] and investors have non-quadratic utility, it implies that investors are concerned about all moments of the return, not just the mean and variance (Rubinstein, 1973 and Scott and Horvath, 1980). The quadratic utility function for an investor implies an increasing risk aversion; whereas it is more appropriate to assume that risk aversion decreases with an increase in wealth.

The most extensively tested asset pricing model is the three-moment CAPM model of Kraus and Litzenberger (1976), which provides preference over skewness. Hamaifar and Graddy (1988) derive a linear four-moment model by incorporating cokurtosis along with covariance and coskewness into the pricing equation. The skewness and kurtosis can not be diversified by increasing the size of portfolio (Gibbons, Ross and Shanken, 1989), thus the non-diversified skewness and kurtosis become important considerations in asset valuation. 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 is over simplified. The conditioning information is very important in higher-moment-CAPM as well[2]. The covariance, coskewness and cokurtosis risks are time varying in nature, and so are

[1] French et al (1987), Akgiray and Booth (1988), Jensen and de Varies (1991), McCulloch (1997) and Hussain and Uppal (1998) and numerous other studies have shown non-normality in stock returns.
[2] This is due to the reason that returns distribution changes over time (Hansan, 1994 and Harvey and Siddique, 1999) and over differencing interval Hawawini, 1980).

their prices (Harvey and Siddique, 2000a and Dittmar, 2000), which indicates that relationship between coskewness and cokurtosis and asset returns is time varying in nature.

Pakistani market like other emerging markets reveal very different risk-return relationship and the 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 (1965) Lintner (1966) 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[3]. After testing standard CAPM our objective is to test the non-linear generalization of CAPM using daily as well as monthly data following the utility based methodology of Kraus and Litzenberger (1976). Then the conditional CAPM model is extended by incorporating conditional third and fourth moments. The present study adds to the existing literature by testing unconditional and conditional higher moment CAPM for the firm level daily as well as monthly data. Second, for more insight the investigation is done for different time intervals as the market have different sentiment at different periods and third two alternative estimation techniques are used to test the models.

This study is organized 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 Sharpe-Lintner CAPM has been subjected to extensive empirical testing in the past and various researchers come up with mixed findings. Fama and McBeth (1973) perform the classical test and validate the CAPM on all stocks listed on New York Stock Exchange (NYSE) during 1935-1968, while Tinic and West (1984) who use same NYSE data find contrary evidence. Black *et al*. (1972) test CAPM by using time series regression analysis. Greene (1990) investigates the CAPM on UK private sector data and shows that CAPM does not hold. Sauer and Murphy (1992) confirmed that CAPM is the best model for describing the German Stock Market data. In a more detailed study Hawawini (1993) could not confirm the validity of CAPM in equity markets in Belgium, Canada, France, Japan, Spain, UK and USA. The other studies which have tested CAPM for different countries include Lau *et al*. (1975), for Tokyo Stock Exchange, Sareewiwathana and Molone (1985) for Thailand Stock Exchange and Bark (1991) for Korean Stock Market.

The mixed empirical findings on the risk return relationship have motivated to extend the standard model and investigate the non-linear generalization of the model. The studies on higher-moment CAPM model are done extensively after the early work of Rubinstein (1973). A subsequent noteworthy work by Krraus and Litzenberger (1976) test a linear three-moment pricing model that uses coskewness as a supplement the covariance risk to explain asset return on individual and they come up with conclusion that three-moment model explain the observed deficiency in the relationship which is not explained by standard CAPM model. Friend and Westerfield (1980) however, do not arrive at conclusive evidence of importance of skewness in pricing the assets. The study by Sears and Wei (1985) extend theoretically three-moment CAPM 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

[3] The shape of return distribution gives justification for including higher moments, coskewness and cokurtosis in the asset pricing framework. The positively skewed distribution tends to offer small probabilities of windfall gains while limit large downside losses. Thus other things being equal, investors prefer positively skewed portfolio to negatively skewed portfolio (Harvey and Siddique, 2000a). They would be expecting a positive premium for assets that have positive coskewness with the market if the market portfolio is negatively skewed (Friend and Westerfield, 1980). The excess kurtosis reflects large frequency in the tails of distribution (small probabilities of large losses) and thus kurtosis is risk enhancing.

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 coskewness on asset prices. They find both that coskewness accounts for part of explanation power of size and value factors of Fama and French (1993) study, and that coskewness can explain part of return to momentum trading strategies which are largely unexplained by these factors. Harvey (2002) shows that skewness, and kurtosis is 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, however, the significance of volatility coefficient disappears when coskewness, skewness and kurtosis are considered. Harvey's explanation for this phenomenon is the low degree of integration of the emerging markets.

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), Harvey and Siddique (1999)] 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), Fang and Lai (1997) and Iqbal *et al* (2007) are among the studies that advocated cokurtosis, however, the results explaining asset pricing behavior are not clear even in case of developed markets. Cook and Rozeff (1984) find that coskewness really describes the effect of the dividend yields on asset pricing. On the whole, evidence for 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 Chaudhry (2001), Chang *et al.* (2001), Hwang and Satchell (1999), Jurczenko and Maillet (2002), Galagedera *et al.* (2002) suggest estimation technique that uses cubic model as a test of coskewness and cokurtosis. Ranaldo and Favre (2005) applies the four-moment-CAPM to hedge fund data and shows that the use of solely two moment pricing model may be misleading and wrongly indicate insufficient compensation for the investment risk. Christie-David and Chaudhry (2001) investigate the four moment CAPM 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 coskewness and cokurtosis in emerging markets. There has been few studies (Ang and Chen, 2002 and 2006; Dittmar (2002; Post *et al*., 2005; Poti, 2004 and 2005 and Smith, 2007) 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). Harvey and Siddique (2000b) present some results of testing time variation in skewness in explanting the cross-section variation in asset return.

In Pakistani market the returns distribution deviate from normality (Hussain and Uppal, 1998). Iqbal and Brook (2007) find evidence of non-linearity in the risk return relationship and come to the conclusion that for Pakistani market the unconditional version of the CAPM is rejected. Iqbal *et al (*2008) conclude that the unconditional Fama-French model augmented with a cubic market factor perform the best among the competing models. Javid and Ahmad (2008) show that standard CAPM do not explain the risk return relationship adequately, however the conditional model has better performance in explaining risk-return relationship. The empirical investigation of conditional higher moments in explaining the cross-section of asset return indicate that conditional coskewness is important determinant of asset pricing and conditional covariance and conditional cokurtosis explains the asset price relationship to a limited extent (Javid and Ahmad, 2008). Ahmed and Zaman (1999) attempt to investigate the risk-return relationship for Pakistani market and the results of GARCH-M model show the presence of strong volatility clusters implying that the time path of stock returns follows a cyclical trend. This study adds to the exiting literature for Pakistan equity market by testing the higher-moment CAPM model in conditional and unconditional context using daily as well as monthly firm-level data.

3. Empirical Methodology and Data

The mean variance Sharpe-Lintner CAPM is our benchmark model and this model is extended by allowing for higher moments to accommodate for more general type of preferences and account for distinct non-normality that is observed in stock returns data. We account for time–variation in risk and prices of risk because it appears necessary in the data.

We start our analysis by empirical model developed by Sharpe (1965) and Lintner (1966) in which a relationship for expected return is written as:

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

Or $E(r_{it}) = \beta_i E(r_{mt})$ (2)

$$\beta_i = \mathrm{cov}(r_{it}, r_{mt}) / \mathrm{var}(r_{mt}) \tag{3}$$

where $E(R_i)$ is the expected return on ith asset, R_f is risk-free rate, $E(R_m)$ is expected return on market portfolio and β_i is the measure of risk or market sensitivity parameter. In equation (2) r_i is the excess return on asset i and r_m is the excess return on market portfolio over the risk-free rate. The equations (1) and (2) measures the sensitivity of asset returns to variation in market return. The market beta is slope coefficient of time series regression of asset return on market portfolio given in the above equation (2) following Fama and McBeth (1973). It is used as explanatory variable in the following cross-section regression equation which is estimated by GLS to test the adequacy of the model:

$$r_{it} = \lambda_0 + \lambda_1 \beta_i + \varepsilon_{it} \tag{4}$$

The coefficient λ_1 is the premium associated with beta risk and an intercept term λ_0 has been added in the equation.

The validity of Sharpe-Lintner-Black CAPM is examined in this study by testing the implications of the relationship between expected return and market beta given in equation (4). To test the hypothesis that the risk associated with residuals has no effect on the expected asset return, residual risk, $SD(\varepsilon_{it})$ of each asset is added as an additional explanatory variable:

$$r_{it} = \lambda_0 + \lambda_1 \beta_i + \lambda_2 SD(\varepsilon_{it}) + \varepsilon_{it} \tag{5}$$

To test the linearity of the risk return relationship we include a quadratic term of β_i in the standard model given in equation (4), and the model takes the following form:

$$r_{it} = \lambda_0 + \lambda_1 \beta_i + \lambda_3 \beta_i^2 + \varepsilon_{it} \tag{6}$$

The joint hypothesis is that market portfolio is mean-variance efficient, this implies that difference in expected return across assets are entirely explained by difference in market betas, other variables should add nothing to the explanation of expected return. It is tested by adding predetermined explanatory variables in the form of beta-square to test linearity and residual standard deviation to test that beta is the only essential measure of risk. The model becomes:

$$r_{it} = \lambda_0 + \lambda_1 \beta_i + \lambda_2 SD(\varepsilon_{it}) + \lambda_3 \beta_i^2 + \varepsilon_{it} \tag{7}$$

If coefficients of the additional variables are not statistically different from zero, this implies that the market proxy is on minimum variance frontier.

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 by the following model as suggested by Kraus and Litzenberger (1976), Homaifar and Graddy (1988) and Fang and Lai (1997)[4] as follows:

$$r_{it} = \lambda_0 + \lambda_1 \beta_i + \lambda_4 \gamma_i + \lambda_5 \kappa_i + \varepsilon_{it} \tag{8}$$

Where the parameter β_i denotes the systematic covariance, γ_i represents systematic coskewness and κ_i is systematic cokurtosis of asset i which are time series regression coefficients of cubic model given in equation (4):

[4] The derivation of higher moment model is presented in Appendix B.

$$E(r_{it}) = \alpha_i + \beta_i E(r_{mt}) + \gamma_i E(r_{mt}^2) + \kappa_i E(r_{mt}^3) \tag{9}$$

The slope coefficients of the cubic CAPM model given in the above equation (9) are used as explanatory variable in the cross section equation (8) to estimate the corresponding risk premium: The coefficient λ_0 is intercept term and λ_1, λ_4 and λ_5 are risk premium for covariance risk, coskewness risk and cokurtosis risk respectively. 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 equation (8), λ_4 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_5 is expected to be positive in our model.

The conditional information in higher-moment-CAPM is also important. The covariance, coskewness and cokurtosis are likely to be time varying in nature and so are their prices. We follow Harvey and Siddique (1999) approach to test whether conditional coskewness and conditional cokurtosis supplement the two moment conditional model. The conditional version of higher-moment CAPM models are given by rewriting equation (9) as:

$$E_{t-1}(r_{it}) = \alpha_i + \beta_{it} E_{t-1}(r_{mt}) + \gamma_{it} E_{t-1}(r_{mt}^2) + \kappa_{it} E_{t-1}(r_{mt}^3) \tag{10}$$

Where the parameter β_{it} denotes the conditional covariance risk, γ_{it} represents conditional coskewness risk and κ_{it} is conditional cokurtosis risk of asset i [5]. The conditional covariance, conditional coskewness and conditional cokurtosis are obtained by autoregressive process following Harvey and Siddique (1999)[6]:

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

$$E(\varepsilon_{it}\varepsilon_{mt}^2) = \rho_0 + \rho_3 \varepsilon_{it-1}\varepsilon_{mt-1}^2 + \rho_4 \varepsilon_{it-2}\varepsilon_{mt-2}^2 \tag{12}$$

$$E(\varepsilon_{it}\varepsilon_{mt}^3) = \rho_0 + \rho_5 \varepsilon_{it-1}\varepsilon_{mt-1}^3 + \rho_6 \varepsilon_{it-2}\varepsilon_{mt-2}^3 \tag{13}$$

The conditional covariance, conditional coskewness and cokurtosis are estimated for each stock estimating equation (11), (12) and (13). 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 with error adjustment as suggested by Shanken (1992) is applied. The cross-section regression equation is:

$$r_{it} = \lambda_{0t} + \lambda_{1t}\beta_{it} + \lambda_{4t}\gamma_{it} + \lambda_{5t}\kappa_{it} + \varepsilon_{it} \tag{14}$$

The coefficient λ_{0t} is intercept term and λ_{1t}, λ_{4t} and λ_{5t} are risk premium for conditional covariance-risk, coskewness risk and cokurtosis risk respectively.

Data and Sample

The econometric analysis is performed on the data of 50 firms (which contributed 90% to the total turnover of KSE in the year 2000 listed on the Karachi Stock Market (KSE), the main equity market in the Pakistan for the period January 1993 to December 2004. In selecting the firms three criteria are used: (1) continuous listing on exchange for the entire period of analysis; (2) representative of all the important sectors and (3) 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

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

[6] Harvey and Siddique (1999) use a non-central t-distribution for the marginal distribution of returns which is extended for multivariate case. Butharda and Mark (1991) allow conditionality by GMM method, however the result are same by applying both methods.

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 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 market portfolio. The data on six-month treasury-bill rates are taken from Monthly Bullion of State Bank of Pakistan.

4. Empirical Results

The empirical validity of static version of standard CAPM is examined in this study by using daily as well as monthly data of 50 stocks traded at Karachi Stock Exchange during the period July 1993 to December 2004. The standard CAPM is our benchmark model and our study is based on the extension of this model in non-linear generalization in unconditional and conditional context. The test is carried out in excess return form above the risk free rate. 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). 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.

The Table 1 presents important summary statistics of daily returns of the 50 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 Banking and Energy sector (ACBL, MCB, PSOC, SNGC, KESC) have the most frequently traded stocks. The results reported in column 3 shows that only 6 out of 50 have significant positive mean return. Among these 6 stocks NESTLE has the maximum, positive and significant mean value (0.26%). The estimates of standard deviation are significant at 1% 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 50 with significant positive value of skewness. The values of excess kurtosis presented in column 6 indicate very clearly that all the stocks have leptokurtic behavior which is described as fat tails in the literature. The estimates of the JB (Jarque-Bara) 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 on average positive, volatile, asymmetry and have fat tails.

To test appropriateness of CAPM model, in the first step betas are estimated in time series regression framework using *Generalized Method of Moment approach (GMM.* Lagged market return and lagged asset returns are used as instruments. In the second step a cross section regression of actual returns on betas is estimated for each month in the test period by applying *Generalized Least Square (GLS)*. 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.[8] Finally, the parameter estimates obtained for all the months in the test periods by taking the average. 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 t-ratio for testing the hypothesis that average risk premium is zero is calculated using the standard deviation of the time series of estimated risk

[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.

[8] The empirical analysis of individual assets returns have always doubts because of possible non-synchronous returns (Harvey and Siddique, 1999). To reduce such concerns the betas are estimated by following Scholes and William (1977) suggestion that instrument variable is a better choice. Thus *GMM* is used for the time series estimation. The cross-section regression have problem because the returns are correlated and heteroskedastic, therefore *GLS* is used in cross-section regression analysis.

premium which captures month by month variation following Fama and McBeth (1973) and adjusted for errors in beta as suggested by Shanken (1992). The $R^2$is average of month by month coefficient of determination.

The Table 2 reports two sets of results based on daily data and monthly data to test the adequacy of CAPM model. The results 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. When the other measure of risk that is residual risk is incorporated in the equation, the average of monthly estimated coefficient of residual risk λ_2 is positive and statistically significant in 1993-1995, 1993-1998 and overall period 1993-2004 and also the average of the monthly coefficient of determination becomes better. According to CAPM since the investors holds efficient market portfolio and diversify in many assets residual risk (i.e. nonsystematic risk) should have no impact on the risk return relationship. Therefore the findings contradict the CAPM indicating that residual risk play some role in price determination in some sub-period. The results also show no non-linearity in the relationship between average return and market risk. When both residual risk and non-linear beta is added in standard model the results remain the same that residual risk plays some role in price determination in few sub-periods. The intercept term is significantly different from zero for most of the sub-period in all models. These results show no support of fundamental hypothesis that on average there is a positive trade off between risk and return. However, results show some improvement in terms of higher coefficient of determination, when other measure of risk such as residual risk and nonlinear beta are added. This leads to the conclusion that other risk factors also affect average asset return.

The empirical validity of CAPM model and higher-moment CAPM is examined by using the same data set by applying Fama-McBeth method. Two sets of results are presented by Table 3 to test the adequacy of unconditional mean-variance CAPM, mean-variance-skewness CAPM and mean-variance-kurtosis CAPM. In step one the risk factors β_i covariance risk, γ_i coskewness risk and κ_i cokurtosis risk of asset *i* are computed out of model as proposed by Kraus and Litzenberger (1976). Alternatively these risk factors are estimated as time series regression coefficient of cubic market model (Fang and Lai, 1999 and Iqbal *et al*, 2007) in the first step following the equation (9). The GMM is used as estimation technique and lag asset returns and lag market return as used as instrument variables. The risk premium associated with these risk factors are estimated by cross-section regression equation (8) by GLS. Then time series means of these estimates are tested for significance. To test whether the incorporating third and fourth moments have some role in addition to market return in explaining cross-section of expected return, Fama-McBeth (1973) t-values are calculated and adjusted for Shanken (1992) adjustment factor.

The results of testing the standard model in Table 3 show that when 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 with monthly data. The introduction of coskewness risk as additional variable along with beta variable, the intercept term λ_0 become significantly different from zero in 2002-2004, 1993-1998 and 1999-2004. The risk premium for coskewness 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 coskewness risk for some sub-periods. These results indicate that systematic coskewness risk is compensated in the Karachi Stock Market in some sub-periods and overall period; this result is conformed by Kraus and Litzenberger (1976) findings. The investors are found to have aversion for to variance and preference for positive skewness. In the model when cokurtosis risk is combined with beta risk in the standard model the results reported in Table 3 indicate that the compensation for cokurtosis risk is positive and significant only for sub-period 1993-1995, otherwise this compensation is not significant for most of the sub-periods. When the beta risk is supplemented by both coskewness risk and cokurtosis risk in the model the result are improved to some extent as coefficient of determination increases. However, the risk premium for covariance risk remains inconclusive and insignificant. The coskewness risk is priced for sub-periods 1993-1995, 1996-1998, 1993-1998 and for overall period 1993-2004, whereas the cokurtosis-risk is compensated only in sub-period 1993-1995 and in 2002-2004. The additional evidence on relative explanatory power of covariance-risk relative to coskewness risk and cokurtosis risk in determining asset prices is where β_i, γ_i and κ_i are estimated by cubic model in the first stage and lag asset return are instruments. These estimated parameters of sensitivity β_i, γ_i and κ_i are used as explanatory variables to find premium for these risk factors in the second stage. The results presented in appendix Table A1 are almost identical to those reported in Table 3. There is evidence for three sub-periods that investors get reward for skewness as predicted by Kraus-Litzenberger theory. On other hand cokurtosis seems to affect expected return in limited way. The pattern of covariance-risk premium remains strange and insignificantly different from zero. The empirical tests made for Brazilian market by Attayde and Flores Jr (2000) and for Athens stock market by Messis *et al* (2007) come up with same conclusion as shown by our results, that the skewness play the most important role, while the gain of adding kurtosis is negligible. Hung and Xu (2003) on the contrary find limited evidence for the existence of higher order pricing factor for UK.

The results of conditional two moment, three moment and four moment models are presented in Table 4. It is apparent from the results that the extension of standard CAPM by incorporating conditional coskewness has improved the results. The intercept term is significantly different from zero in sub-periods 1993-1995, 1993-1998 and 1999-2004. The premium for beta risk is also positive and significant for the period 1993-1995 and inconclusive and insignificant otherwise. The price of conditional coskewness risk is significantly different from zero in sub periods 1993-1995, 1996-1998 and 1993-1998 and the overall sample period. 1993-2004. The risk premium for conditional cokurtosis risk when it is taken as an additional explanatory variable with covariance risk is positive and significant in sub-periods 1993-1995 and 1993-1998 (with monthly data). 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 model. The beta risk is positively and significantly compensated only for the period 1993-1995. These results indicate that covariance and cokurtosis risk have limited compensation only for few periods, but investors get reward for conditional coskewness risk in the Karachi stock Market. The evidence on conditional higher moment asset pricing model by alternative methodology where the risk parameters β_i, γ_i and κ_i are estimated by cubic model in the first stage by GMM procedure and the findings reported in appendix Table A2 are similar to those reported in Table 4. Our results are consistent with the evidence of developed market US market by Harvey and Siddique (2000a and 2000b) which shows that conditional skewness helps to explain the cross-section variation in expected returns across assets. They find coskewness is significant in the model when factor based on size and book-to-market are included in the model. They suggest that momentum effect is related to systematic skewness. Harvey (2002) also shows that skewness and kurtosis is priced in the individual emerging markets but not in the developed markets.

As regards the market efficiency hypothesis, it is rejected due to presence of significant mean pricing errors in all the models. Overall, the results support the hypothesis in favor of time variation in expected return of assets. The market risk and compensation of taking risk depend on economic environment of Pakistan; however, market risk clearly cannot explain all the variations in assets returns, as indicated by substantial pricing errors in our models.

To sum up in testing the validity of standard model, the estimates of covariance risk premium for the most part is insignificant with inconclusive signs. This motivated to supplement the standard model with higher moments both in conditional and unconditional context. The estimates of coskewness risk premium are positive and significant for most of the sub-periods and overall period. The cokurtosis risk premium is positive and significant only for few sub-periods. The skewness significance is found positive and significant indicating that coskewness is considered as important risk factor by the investor in his decision making process and it is positively associated with the return of the asset. The covariance risk premium and cokurtosis risk premium are significant only few sub-periods. This indicates that coskewness dominates over covariance and cokurtosis as risk factor. These results suggest that investor dislikes those assets distributed with more return on the extreme tails and negatively skewed and prefer those with positive skewness and relatively more peakedness around the centre. The skewness and kurtosis in return distribution may be seen as statistical expression of market inefficiency and market friction, specifically non-normal return distribution may be due to illiquidity and low information transparency which are common features of Pakistani market. This suggests the relevance of existence of coskewness and cokurtosis in modeling asset pricing behavior of Pakistani market, therefore non-linear asset pricing model are superior to the standard model in explaining risk return relationship.

5. **Conclusion**

This study examines the capital asset pricing model developed by Sharpe (1965) Lintner (1966) 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 also 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. The asset returns in Pakistan equity market deviate from normality indicating 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 an attempt to demonstrate the benefits of conditional non-linear pricing behavior and results have shown some evidence of higher order pricing factors associated with coskewness and cokurtosis. The result of unconditional non-linear generalization of the model and the results demonstrate that in higher moment model the investor is rewarded for coskewness risk. However, the test provides marginal support for reward of cokurtosis risk. It is concluded that the modified form of Sharpe-Lintner CAPM used by Kraus and Litenberger (1976) 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 coskewness is important determinant of asset pricing and the asset pricing relationship varies through time. The conditional cokurtosis explains the asset price relationship in limited way. However we 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 other risk factors and information variables that are able to explain expected return more adequately.

Table 1. Summary Statistics of Daily Stock Returns listed on KSE

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%, ** indicates significance at 5% level and *** indicates 10% significance level.*

Table 2: Average Risk Premium for Unconditional CAPM

	λ_0	λ_1	λ_2	λ_3	R^2	λ_0	λ_1	λ_2	λ_3	R^2
	$r_{it} = \lambda_0 + \lambda_1\beta_i + \varepsilon_{it}$									
1993-95	-0.31	0.11			0.15	0.12	0.15***			0.16
1996-98	-0.27	-0.14			0.16	-0.20	-0.12			0.16
1999-01	0.30	0.20			0.15	0.31	0.21			0.17
2002-04	0.24*	0.13			0.14	0.33*	0.20			0.15
1993-98	-0.31	0.22			0.17	-0.22	0.19			0.17
1999-04	0.22*	0.23			0.15	0.24*	0.20			0.16
1993-04	0.33	0.18			0.15	0.41	0.20			0.15
	$r_{it} = \lambda_0 + \lambda_1\beta_i + \lambda_2 SD(\varepsilon_{it}) + \varepsilon_{it}$									
1993-95	0.22	0.17	0.45*		0.18	0.23**	0.21**	0.36*		0.17
1996-98	0.21	0.24	-0.43		0.20	0.30	-0.18**	-0.39*		0.19
1999-01	0.30	0.15	0.37		0.19	0.32	0.17	-0.21		0.19
2002-04	0.34	0.20	-0.26		0.17	0.32	0.19	0.27		0.18
1993-98	0.33	0.23	0.44**		0.17	0.31	0.18	0.22*		0.17
1999-04	0.42*	0.28	-0.40		0.18	0.41**	0.21	0.43		0.19
1993-04	0.35	0.24	0.26*		0.21	0.35**	0.23	0.34*		0.20
	$r_{it} = \lambda_0 + \lambda_1\beta_i + \lambda_3\beta_i^2 + \varepsilon_{it}$									
1993-95	-0.33**	0.25**		-0.12	0.19	0.40	0.21*		-0.21	0.17
1996-98	-0.31	-0.21		0.20	0.18	-0.32	0.20		0.20	0.19
1999-01	0.40	0.20		0.11	0.17	0.30	0.15		0.17	0.17
2002-04	0.34*	-0.21		0.21	0.18	0.23*	0.20		0.20	0.19
1993-98	-0.32**	0.24		-0.15	0.19	-0.31	0.19		0.16*	0.19
1999-04	0.29**	0.26		0.20	0.19	0.29	0.11		0.10	0.21
1993-04	0.42	0.21		0.14	0.20	0.31	0.22		0.14	0.21
	$r_{it} = \lambda_0 + \lambda_1\beta_i + \lambda_2 SD(\varepsilon_{it}) + \lambda_3\beta_i^2 + \varepsilon_{it}$									
1993-95	-0.41	0.23	0.40**	-0.21	0.23	0.22**	0.21	0.22*	0.17	0.23
1996-98	0.31	-0.26	-0.39	0.19	0.24	0.30	-0.24*	-0.43	0.14	0.25
1999-01	-0.32	0.21	0.29	0.20	0.21	-0.31	0.22	0.38***	0.12*	0.23
2002-04	0.35*	-0.22	-0.31	0.21	0.26	0.32*	0.20	0.35	0.20	0.25
1993-98	0.40	0.23	0.45*	0.12	0.25	0.41	-0.11**	0.27*	0.21**	0.24
1999-04	0.42**	-0.21	-0.31	0.13	0.27	0.30	0.20	0.26*	0.20	0.25
1993-04	0.41	0.22	-0.27*	0.20	0.29	0.31***	0.16	-0.35	0.20	0.28

Note: The * indicates significant at 1%, ** indicates significant at 5% and *** indicates significant at 10%.

Table 3: Average Risk Premium for Unconditional Higher Moment CAPM

	β_i, γ_i and κ_i computed on daily data					β_i, γ_i and κ_i computed on monthly data				
	λ_0	λ_1	λ_4	λ_5	R^2	λ_0	λ_1	λ_4	λ_5	R^2
	$r_{it} = \lambda_0 + \lambda_1\beta_i + \lambda_4\gamma_i + \varepsilon_{it}$									
1993-95	-0.20	0.20	0.23**		0.20	0.20	0.13	0.12*		0.21
1996-98	-0.21	-0.20	0.21**		0.23	-0.21**	-0.12**	0.19**		0.24
1999-01	0.23	0.15	0.26		0.26	0.31	0.12	0.13		0.26
2002-04	0.31*	0.12	0.20		0.24	0.22*	0.12	0.13		025
1993-98	-0.11*	0.18	0.14*		0.23	0.21*	0.13	0.21*		0.24
1999-04	0.22*	0.21	0.13		0.22	0.14*	0.12	0.11		0.24
1993-04	0.23	0.17	0.12**		0.25	0.27	0.18	0.14**		0.26
	$r_{it} = \lambda_0 + \lambda_1\beta_i + \lambda_5\kappa_i + \varepsilon_{it}$									

1993-95	-0.22***	0.21		0.12*	0.24	-0.31	0.14**		0.21*	0.25
1996-98	-0.22	-0.21		0.12	0.25	-0.32**	-0.21**		0.18	0.25
1999-01	0.16	0.17		-0.21***	0.25	0.30	0.15		0.14	0.26
2002-04	0.40*	0.22		0.14	0.24	0.22*	0.20		0.17	0.24
1993-98	-0.22**	0.12		0.13	0.23	-0.31***	0.11		0.13	0.25
1999-04	0.28***	0.13		-0.11	0.25	0.21*	0.13		0.21	0.26
1993-04	0.21	0.16		0.21	0.27	0.30	0.11		0.14	0.27
	$r_{it} = \lambda_0 + \lambda_1\beta_i + \lambda_4\gamma_i + \lambda_5\kappa_i + \varepsilon_{it}$									
1993-95	-0.24***	0.15	0.12	0.11*	0.31	0.41	0.12	0.22*	0.21*	0.31
1996-98	-0.18	-0.11	0.15*	0.13	0.29	-0.24**	-0.11	0.17*	-0.11	0.30
1999-01	0.16	0.12	0.13	-0.21	0.30	0.22	0.12	0.21	0.14	0.31
2002-04	0.24*	0.13	0.11	0.13	0.29	0.23*	0.12	-0.18*	0.12**	0.29
1993-98	-0.22	0.16	0.13*	0.14	0.29	-0.31***	0.14	0.16*	-0.21	0.30
1999-04	0.33*	0.21	0.11	-0.12	0.30	0.21*	0.14	0.22	0.11	0.31
1993-2004	0.31	0.19	0.12**	0.13	0.32	0.32	0.11	0.14**	0.21	0.34

Table 4: Average Risk Premium for Higher-Moment Conditional CAPM

	β_i, γ_i and κ_i computed out of model by daily data					β_i, γ_i and κ_i computed out by monthly data				
	λ_{0t}	λ_{1t}	λ_{4t}	λ_{5t}	R^2	λ_{0t}	λ_{1t}	λ_{4t}	λ_{5t}	R^2
	$r_{it} = \lambda_{0t} + \lambda_{1t}\beta_{it} + \varepsilon_{it}$									
1993-95	-0.15	0.16**			0.35	-0.32	0.11**			0.37
1996-98	-0.22	-0.12			0.35	-0.20	-0.13			0.36
1999-01	0.01	-0.13			0.38	0.19	0.13			0.38
2002-04	0.31	0.13			0.37	0.03	0.10			0.38
1993-98	-0.01	0.14			0.35	-0.02	0.12			0.35
1999-04	0.22	-0.13			0.35	0.34	0.11			0.36
1993-04	0.40	0.14			0.37	0.27	0.16			0.37
	$r_{it} = \lambda_{0t} + \lambda_{1t}\beta_{it} + \lambda_{4t}\gamma_{it} + \varepsilon_{it}$									
1993-95	-0.41*	0.22***	0.11***		0.38	-0.22	0.12*	0.21*		0.39
1996-98	-0.22	-0.11	0.12***		0.37	-0.31	-0.11	0.14***		0.38
1999-01	0.004	-0.13	0.13		0.39	0.004	-0.13	0.17		0.39
2002-04	0.25*	-0.11	0.12		0.37	0.33*	0.11	0.12		0.38
1993-98	-0.33*	0.21	0.11*		0.39	-0.21	-0.13	0.15*		0.39
1999-04	0.23*	-0.15	0.13		0.36	0.22*	-0.14	0.18		0.37
1993-04	0.21	0.11	0.11*		0.39	0.41	-0.12	0.13*		0.39
	$r_{it} = \lambda_{0t} + \lambda_{1t}\beta_{it} + \lambda_{5t}\kappa_{it} + \varepsilon_{it}$									
1993-95	-0.22**	0.12		0.11*	0.37	-0.01	0.14		0.12*	0.38
1996-98	-0.31	-0.11		0.11	0.38	-0.25	0.15		0.12	0.39
1999-01	0.23	-0.13		0.22	0.37	0.33	-0.12		-0.14	0.37
2002-04	0.13*	-0.14		0.21	0.34	0.33*	0.11		-0.12	0.35
1993-98	-0.21***	0.13		0.11	0.35	-0.32	-0.12		0.11***	0.37
1999-04	0.3	-0.12		0.11	0.36	0.22	0.12		0.11	0.37
1993-04	0.30	0.21		0.21	0.38	0.31	-0.11		0.14	0.38
	$r_{it} = \lambda_{0t} + \lambda_{1t}\beta_{it} + \lambda_{4t}\gamma_{it} + \lambda_{5t}\kappa_{it} + \varepsilon_{it}$									
1996-98	-0.33	-0.11	0.12***	0.11	0.37	-0.32	-0.11	0.12**	-0.12*	0.38
1999-01	0.21	-0.11	0.12	-0.13	0.37	0.30	-0.21	0.11	-0.11	0.39
2002-04	0.25*	[-0.11]	0.21	-0.21	0.36	0.43*	0.17	0.22	-0.11	0.37
1993-98	-0.33*	0.11	0.11*	0.21	0.38	-0.31	-0.12	0.21*	-0.11***	0.38
1999-04	0.34*	-0.11	0.14	-0.14	0.39	0.22*	0.21	0.21	-0.13	0.40
1993-04	0.31	-0.21	0.21**	-0.11	0.41	0.40	-0.11	0.31*	-0.11	0.40

1993-04	0.17	-0.21	0.13**	-0.21	0.43	0.24	-0.12	0.21*	-0.11	0.44

Note: For Table 3 and 4 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 * indicates significant at 1%, ** indicates significant at 5% and *** indicates significant at 10%.

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Appendix A

Table A1: Average Risk Premium for Unconditional Higher Moment CAPM

	β_i , γ_i and κ_i estimated by Cubic Model on daily data					β_i , γ_i and κ_i estimated on monthly data				
	λ_0	λ_1	λ_4	λ_5	R^2	λ_0	λ_1	λ_4	λ_5	R^2
	$r_{it} = \lambda_0 + \lambda_1 \beta_i + \lambda_4 \gamma_i + \varepsilon_{it}$									
1993-95	-0.21	-0.14	0.24		0.21	0.22	0.21	0.14*		0.23
1996-98	0.14	0.23	0.16***		0.24	-0.14	-0.22*	0.15**		0.24
1999-01	0.41*	0.19	-0.14		0.25	0.40	0.17	0.19**		0.26
2002-04	-0.16**	0.17	0.15**		0.24	0.22*	0.24*	-0.17		0.26
1993-98	0.23*	0.15	0.13***		0.26	-0.42	-0.15*	0.22		0.26
1999-04	0.30	0.14	0.21		0.27	0.32*	0.18*	0.20		0.26
1993-04	0.21	-0.15*	0.22**		0.28	0.41	-0.18	0.23**		0.28
	$r_{it} = \lambda_0 + \lambda_1 \beta_i + \lambda_5 \kappa_i + \varepsilon_{it}$									
1993-95	-0.33	0.17		0.21*	0.24	0.32	-0.17		0.18**	0.25
1996-98	-0.21	-0.21*		0.14	0.28	-0.41	0.18***		-0.11	0.28
1999-01	0.13*	0.14		-0.22	0.29	0.41	-0.22		-0.21	0.28
2002-04	0.41	-0.15		0.21	0.30	0.12*	0.21*		-0.14	0.29
1993-98	-0.45	-0.14		0.14*	0.29	-0.11	-0.21*		0.22	0.25
1999-04	0.31*	-0.22*		0.15	0.29	0.21*	0.21		-0.13	0.28
1993-04	0.20*	-0.21*		0.22**	0.30	0.30***	-0.31		-0.17	0.31
	$r_{it} = \lambda_0 + \lambda_1 \beta_i + \lambda_4 \gamma_i + \lambda_5 \kappa_i + \varepsilon_{it}$									
1993-95	-0.32	0.15	0.22	0.21*	0.30	0.25	-0.17	0.14**	0.21**	0.30
1996-98	-0.42	-0.22*	0.14**	0.22**	0.29	-0.41***	-0.22*	0.12**	-0.23	0.30
1999-01	0.37*	-0.24	0.31	-0.16	0.32	0.32	-0.15	0.22	-023	0.32
2002-04	0.41*	-0.23	0.15	0.14	0.31	0.32***	0.22*	-0.14	-0.15	0.32
1993-98	0.17	-0.21	0.17*	0.21*	0.30	-0.43	-0.15*	0.21**	0.25	0.31
1999-04	0.33*	-0.15*	0.22	-0.11	0.33	0.31*	0.14	0.22	0.21	0.33
1993-04	0.31*	-0.20*	0.19**	0.21*	0.34	0.34***	-0.24	0.24**	-0.25	0.35

Table A2: Average Risk Premium for Conditional Higher Moment CAPM

	β_i , γ_i and κ_i estimated by Cubic Model on daily data					β_i , γ_i and κ_i estimated on monthly data				
	λ_{0t}	λ_{1t}	λ_{4t}	λ_{5t}	R^2	λ_{0t}	λ_{1t}	λ_{4t}	λ_{5t}	R^2
	$r_{it} = \lambda_{0t} + \lambda_{1t} \beta_{it} + \varepsilon_{it}$									
1993-1995	-0.41	-0.15			0.36	0.01	0.19			0.36
1996-1998	-0.42	-0.14			0.35	-0.43	-0.21			0.36
1999-2001	0.35	0.19			0.37	0.001	0.21			0.38
2002-2004	0.34	0.16			0.37	0.23*	0.15***			0.37
1993-1998	-0.42	-0.12			0.36	-0.01	-0.17			0.37
1999-2004	0.20	0.16			0.34	0.52	0.21			0.36
1993-2004	0.33	0.14			0.37	0.32	0.14			0.38
	$r_{it} = \lambda_{0t} + \lambda_{1t} \beta_{it} + \lambda_{4t} \gamma_{it} + \varepsilon_{it}$									
1993-95	0.41	0.15	0.17*		0.36	-0.41	0.16	0.15*		0.381
1996-98	-0.30	-0.22	0.12		0.37	-0.43	-0.19	0.15**		0.37
1999-01	0.31	0.11	0.21		0.37	0.33	0.21	0.17		0.38
2002-04	0.42*	0.13	0.14*		0.38	0.23*	0.12	0.16*		0.38
1993-98	-0.31	0.14	0.21		0.37	-0.31	0.20	0.17		0.38
1999-04	0.31*	0.21	0.12		0.37	0.41*	0.12	0.21		0.37
1993-04	0.24	0.20	0.31**		0.38	0.21	0.14	0.21**		0.39

	$r_{it} = \lambda_{0t} + \lambda_{1t}\beta_{it} + \lambda_{5t}\kappa_{it} + \varepsilon_{it}$									
1993-95	-0.41	0.21**		0.11**	0.36	-0.41	0.22***		0.13**	0.37
1996-98	-0.32	-0.21		0.12	0.38	-0.22	-0.16		0.14	0.39
1999-01	0.20	0.15		0.14	0.37	0.10	0.14		0.11	0.36
2002-04	0.32	0.14		0.21	0.36	0.22*	0.14		0.21	0.39
1993-98	-0.17	0.21		0.12	0.37	-0.32	0.21		0.18	0.37
1999-04	0.21	0.12		0.11	0.36	0.21	0.13		0.25	0.38
1993-04	0.14	0.21		0.14**	0.37	0.23	0.22		0.12**	0.38
	$r_{it} = \lambda_{0t} + \lambda_{1t}\beta_{it} + \lambda_{4t}\gamma_{it} + \lambda_{5t}\kappa_{it} + \varepsilon_{it}$									
1993-95	0.21	0.14	0.12*	0.21**	0.38	0.31	0.12	0.21**	-0.21**	0.39
1996-98	-0.32	-0.21	0.13**	-0.14	0.39	-0.41	-0.12	0.15***	-0.21	0.41
1999-01	0.32	0.13	0.14	0.14	0.38	0.23	0.12	0.21	0.26	0.39
2002-04	0.27**	0.15	-0.11	0.12	0.39	0.42*	0.14	-0.13	0.22	0.40
1993-98	-0.33***	0.12	0.16*	0.21**	0.40	-0.41	0.30	0.17*	-0.15**	0.40
1999-04	0.21**	0.20	0.15	0.11	0.40	0.21*	0.13	0.22	0.14	0.42
1993-04	0. 40	0.11	0.20**	0.21**	0.44	0.12	0.1 2	0.21	0.17	0.44

Note: For Table A2 and A3 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 * indicates significant at 1%, ** indicates significant at 5% and *** indicates significant at 10%.

Appendix B:

The Model [9]

We assume that 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 maximize his expected utility, which can be represented by mean, variances, skewness and kurtosis of terminal wealth subject to the budget constraint. Let there are n risky assets and one risk free asset with parameters. Let R is rate of return of i risky assets, E is expectation operator, V is variance co-variance matrix of n risky assets and R_f is the rate of return on the risk free assets. Let the investor invests x_i of his wealth on risky assets and $1-\Sigma x_i$ in the risk free asset. The mean, variance, skewness and kurtosis of his portfolio excess return are $X(R-R_f)$, $X'VX$ $E[X'(R-\bar{R})/(X'VX)^{1/2}]^3$ and $E[X'(R-\bar{R})/(X'VX)^{1/2}]^4$ respectively.

Let the portfolio can be rescaled and the standard deviation of portfolio return is used to rescale the portfolio, then variance of portfolio return is unit that is, $X'VX = 1$. 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 maximize the investors expected utility of terminal wealth subject to the budget and unit variance constraints:

$$MaxU\{X'(\bar{R}-R_f), E[X'(R-\bar{R})]^3, E[X''(R-\bar{R})]^4\} - \lambda(X'VX - 1) \quad \text{(B1)}$$

[9] The model is developed following Fang and Lai (1997)

where λ is the Langrangian 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

$$\overline{R}-R_f=\phi_1 VX+\phi_2 \operatorname{cov}[X'(R-\overline{R})]^2,R]+\phi_3 \operatorname{cov}[X'(R-\overline{R})]^3,R] \quad \text{(B2)}$$

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

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

Where U_i the partial derivative with respect to ith 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. The separation theorem suggests that the portfolio 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 (B2) as,

$$\overline{R}-R_f=\phi_1 \operatorname{cov}(R_m,R)+\phi_2 \operatorname{cov}(R_m^2,R)+\phi_3 \operatorname{cov}(R_m^3,R) \quad \text{(B3)}$$

where $R_m^2(R_m^3)$ is the square (cube) of the standardized 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 (B3) 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 (B3) collapses to the CAPM. In the three-moment CAPM, systematic kurtosis is not priced and equation (B3) is reduced to Kraus and Litzenberger's three-moment CAPM.

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