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2008

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Abstract

The analysis of this study explores a set of macroeconomic variables along with market return as the systematic sources of risks explaining variations in expected stock returns for 49 stocks traded at Karachi Stock Exchange for the period 1993-2004. Some of these economic variables are found to be significant in explaining expected stock returns. The test of conditional multifactor CAPM is carried out by specifying conditional variance as a GARCH (1,1)-M process. The results of the conditional multifactor CAPM-with-GARCH-M model reveal that conditional model shows very marginal improvement in explaining risk-return relationship in Pakistani Market during the sample period. As regards the risk premium for variance risk, the results are not so supportive, only for a few stocks significant compensation for variance risk to investors is observed. The model is then extended to allow variability in economic risk variables and conditioning information is taken as lagged macroeconomic variables that influence business conditions in Pakistan. The results show evidence in support of conditional multifactor CAPM. The economic variables that are observed to perform relatively well in explaining variations in assets' returns include consumption growth, inflation risk, call money rate, term structure. However, the market return, foreign exchange risk and oil price risk, which explain a significant portion of the time series variability of stock returns, have limited influence on the asset pricing. Therefore we can conclude that expected returns variation could be explained by macroeconomic variations and this variability has some business cycle correlations.

JEL Classification: C53 E44 G11
Keywords: Multifactor capital asset pricing model, information set, business-cycle variables, time varying risk, time varying risk premium, GARCH-M model and market efficiency.

1. Introduction

The asset returns and macroeconomic events are connected as the marginal value of wealth that derives the asset market is also important for macroeconomic analysis. In dynamic macroeconomics theory the most important relationships are the equality of saving and investment, the equality of marginal rate of substitution with marginal rate of transformation and the factors that determine the allocation of consumption and investment across time and states of nature. The asset markets provide mechanism that performs all these equilibrating processes. Asset returns underlie the price line that draws together marginal rates of substitution and marginal rates of transformation. The asset market gives the marginal value of wealth, and measurement of important variables depends on modern and dynamic macroeconomics (Cochrane, 2005).

The multifactor asset pricing model implies that the expected returns of assets are related to their sensitivity to change in state of the economy.[1] The first empirical research connecting financial market

[1] The expected returns vary over time and are correlated with business cycles. For example, Fama and Schwert (1977) find

to real economy is the study of Chen, *et al.* (1986). The study uses a set of economic variables as proxies for economic risks and investigates that these risks are rewarded in the stock market.

Many researchers find the evidence of time varying behavior of risks and risk premiums associated with these economic variables (Ferson and Harvey, 1991; 1993 and 1999). The conditional multifactor model provides the specification of information environment that investors use to form their expectations. Therefore, in this study the multifactor model is extended to include conditional information set consist of business-cycle variables, which generate time-varying risks and premiums associated with these risks.

The conditional multifactor CAPM implies that the expected returns of an asset is related to its sensitivity of changes in the state of the economy; therefore we can estimate a time series of betas for the change in the state of economy. For each relevant state there is market price or premium per unit of beta. So the multifactor model is extended in such a way that the expected returns are generated by change in betas and change in compensation of betas over time (Ferson and Harvey, 1993).

The research on linking macroeconomic variables to asset returns are extensively done for developed markets. It is relatively new area for developing markets. Although it is commonly believed that macroeconomic factors affect stock returns, the nature and direction of influence on stock prices is not so clear in case of Pakistani market. The linkage of asset prices and macro-economy is investigated for Pakistan in statistic and dynamic settings. The main purpose of this study is to explain the sources and nature of macroeconomic risks that drive risk premiums in Pakistani Stock Market. The emerging markets have special characteristics, which make them different from developed markets. This study contributes to existing literature by choosing the economic variables and information variables according to the business conditions of Pakistan. These two sets are selected following two criteria. First, the economic variables should be representative of pervasive source of risk for investor in Pakistan and second, they are extensively used in empirical literature. The instrument variables in information set are standard and commonly used in literature and they drive the business conditions in Pakistan. Another contribution of this study is that the firm level analysis of multifactor model for different time intervals provides more insight in the issue. In addition in exploring the time variability of the risk-return relationship in the information set both past variances (GARCH-M specification) and business-cycle variables are used.

The plan of this study is as follows. Section 2 briefly reviews the previous empirical findings. The macroeconomic risk factors which are expected to be priced in the stock market and their data sources are discussed in section 3. In section 4, the empirical methodology is outlined. The analytical framework of unconditional multifactor model is presented using observed economic variables as suggested by Chen, *et al.* (1986). Then the multifactor model is extended by including conditional moments and, finally, the behavior of time varying risks and risk premiums associated with economic variables are incorporated into the model. Section 5 discusses the results and last section concludes the study.

2. Review of Previous Empirical Findings

The Intertemporal Capital Asset Pricing Model introduce by Merton (1973, 1980) and Arbitrage Pricing Theory propose by Ross (1976) provide the theoretical foundation that in order to explain the cross-section variation in expected returns, we need state variable or sources of risk factors in addition to market portfolio. In empirical literature two basic approaches are used to test the Arbitrage Pricing

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that expected returns are related with inflation. Fama and French (1989) show that prices that forecast returns are correlated with business cycles. A number of authors including Estrella and Harddouvelis (1991) and Ang and Piazzesi (2004) have also documented those price variables that forecast returns also forecast economic activity. Most importantly the term premium (long term bond yield minus short term bond yield) is high in the bottom of recessions, forecasts large stocks and bond returns, and also forecasts that GDP growth is large as we emerge from recession.

Theory (APT); statistical and theoretical. The statistical approaches use factor analysis to extract the common factors and then test whether the expected returns are explained by the cross-sectional loadings of asset returns on the factors. In estimating unspecified factors through factor analysis approach one only knows that there are risk factors other than those explained by CAPM that might affect the asset returns, but one does not know what exactly are these other factors. So it is intellectually more satisfying and practically beneficent, if observed economic variables are used as the specified factors because measured economic factors introduce potentially rich additional information, thereby linking asset prices behavior to economic events.

The theoretical approaches specify variables that are correlated with asset returns and test whether the loadings of returns on these economic factors explain the cross-section of expected returns. In turn, the theoretical approaches are of two main types. The first, initiated by Chen, *et al.* (1986), specifies macroeconomic and financial market variables that are thought to capture the systematic risks of the economy. A second method is to specify characteristics of the firm, which are likely to explain the anomalies in asset returns. Some of such anomalies documented in literature are small firm effect, January effect, earning-to-price ratio, book-to-market value, leverage, etc. The most prominent work in this regard is the series of papers by Fama and French (1992, 1993, 1995, 1996, 1998 and 2004) constructing hedge portfolios with long/short positions in firms with attributes known to be associated with mean returns. For instance, the small minus big stocks (SMB) differential returns and the high book-value minus low book-value stocks (HML) differential returns affect the differences in returns on hedge portfolios associated with firm size and book-to-market equity ratios, respectively. In case of Pakistani market Iqbal and Brooks (2007) and Javid (2008) show that Fama-French variables have some role in explaining the beta-return relationship in Pakistani Market.

In their noteworthy study Chen, *et al.* (1986) test whether macroeconomic variables can represent the risks that are rewarded in the stock market. The variables Chen, *et al.* include are the growth rate of industrial production, the difference between the returns on high and low-grade bonds, the difference between the returns on long and short-term bonds and unexpected inflation. The study finds that these sources of risk, especially the industrial production, yield-spread and term-structure are significantly priced. They find that compared to the economic state variables, market and consumption betas have less influence on pricing and the index of oil prices do not have any compensation. There are a number of studies which use macro-economic variables as factors in order to examine the stock performance during good or bad macroeconomic times determining average returns. These variables include investment-capital ratio and consumption-wealth ratio (Lettan and Ludnigon, 2000). Other variables influencing excess returns include term-structure, spread between long-term and short-term bonds, the default spread, treasury-bill rate and earning-dividend ratio. The relationship between inflation and common stock returns has also been studied extensively. In particular, Nelson (1976), Jaffee and Mandelleer (1976), Fama and Schwert (1977), Schwert (1981) and Gulltekin (1983) present evidence that stock returns are related to both expected and unexpected inflation.

The introduction of floating exchange rate regime in most of the countries during 1970s result in increase in exchange rate volatility and with it the level of foreign exchange risk increases. Joulion (1991) using the multifactor model of Chen, *et al.* (1986) report that exchange-rate risk is not priced in the US market. Dumas and Solnik (1995) and DeSanta and Gerard (1998) show that time varying exchange-rate risk receives statistically significant price in international capital market, consistent with International Capital Asset Pricing Model (ICAPM) of Solnik (1994) and Adler and Dumas (1983). These results imply that the investors are sometime subjected to currency risk exposures and therefore are expected to be compensated for bearing currency risk takers.

As regards the conditional multifactor model, Ferson and Harvey (1991) in their study of US stocks and bond returns, reveal that the time variation in the premium for beta-risk is more important than the changes in the betas themselves. This is because equity risk premiums are found to vary with market conditions and business cycles. Schwert (1989) attributes differential risk premiums between up and down markets due to varying systematic risk over the business cycle. Jagannathan and Wang

(1996) show that fifty percent cross-sectional variation in average returns are explained by conditional CAPM model; however, the firm size does not have any additional explanatory power. They find that when a proxy for return on human capital is also included in measuring aggregate wealth, the pricing errors are found to be statistically insignificant.

The introduction of ARCH type processes by Engle (1982) and others, motivate the testing for time-varying volatility of stock market returns (and hence the time-varying betas) is given considerable attention in the literature (Bollerslev *et al.,* 1988; Ng, 1991 and Bollerslev *et al,*. 1994). The ARCH-based empirical models appear to provide stronger evidence, of the risk-return relationship than do the unconditional models (Morgan and Morgan, 1987). However, very little work has been done on multifactor model-with GARCH specification (Soufian, 2004).

As regards the Pakistani market, Ahmed and Zaman (1999) investigate the risk-return relationship applying the GARCH-M model and show the presence of strong volatility clusters implying that the time path of stock returns follows a cyclical trend. Hussain and Mahmood (2001) estimate the causal relationship between stock market and consumption expenditure, investment expenditure and economic activity. Their analysis indicates the presence of a one-way causation from macro-variables to stock returns, implying that in Pakistani market fluctuations in macroeconomic variables cause changes in stock prices. Iqbal *et al.* (2008) document that conditional standard and Fama-French model scaled by trading volume and dividend yield result in smaller prediction error but conditioning information do not improve the explanatory power of models. They conclude that unconditional Fama-French model augmented with a cubic market factor perform better in case of Pakistani market. Javid (2008a) find that conditional Fama-French CAPM and conditional consumption CAPM perform relatively well in explaining risk-return relationship in Pakistan. Javid (2008b) documents that in evaluating the forecasting ability of the conditional asset pricing models, the forecasting power of conditional multifactor CAPM is relatively better compared to conditional CAPM model and conditional consumption CAPM model. The conditioning information set is taken as lagged macroeconomic variables that influence business conditions in Pakistan.

It is well documented that macroeconomic variables influence the asset returns in developed markets.[2] There is a surge of interest to uncover the relationship of macroeconomic variables with stock prices among financial economist in Pakistan. Since, economists have started taking interest in this issue only recently, many areas on research are still not covered. In this perspective the present study aims to make a contribution to the literature by investigating the firm level multifactor price behavior with reference to Karachi Stock Exchange, the main equity market in Pakistan.

3. Macroeconomic Risk Variables

The idea of using macroeconomic variables as proxies for pervasive risk factors is very intuitive, as some co-movement is commonly observed between asset returns and economy-wide factors such as inflation, interest rate and changes in industrial production etc. In order to specify ex-ante the economic factors that have some relationship with asset returns, the motivation comes from the rational valuation formula (RVF), which sets the current price as a function of all expected dividends and expectation of discount rate. Poterba and Summers (1988) linearize the rational valuation formula to the following approximation,

$$P_{it} = E_t(\delta_{t+1} D_{t+1}) + E_t(\delta_{t+1}\delta_{t+2} D_{t+2}) + E_t(\delta_{t+1}\delta_{t+2}\delta_{t+3} D_{t+3} + ... \quad (1)$$

[2] Lintner (1975), Modigliani and Cohn (1979), Chen, *et al.* (1986), Fama (1981), Chen (1991), Antoniou *et al.* (1998), Kaoutoulas and Kryzanowski (1998), Ferson and Harvey (1991, 1993, 1999) and other studies.

Here P_{it} is the price of asset i , E_t denotes conditional expectations based on the information available at time t, D_t is dividend, $\delta_t = 1/(1+r_f+r_p)$, r_f is risk free rate and r_p is risk premium. According to this representation, stock prices change if the future expected dividends are revised or if discount factor changes. It follows that systematic economic factors, that influence stock prices are those that changes expected cash flow and the discount rate. The choice of these macroeconomic variables is guided by general economic theory, but in practice the identification of economic variables is provided by empirical literature.

In this study a set of macroeconomic variables are considered that investors are likely to count as risk factors for investment and need compensation in the emerging market of Pakistan. The standard CAPM indicates a role of market portfolio of aggregate wealth, and a proxy for the market return is used as KSE 100 index in excess of the weighted average of treasury-bill return.

In economic literature interest rate is commonly used for capturing the state of economic opportunities. Merton (1973), Cox, *et al.* (1985), Chen, *et al.* (1986) and Ferson (1989) and many recent studies have used interest rate as state variable. In this study, call money rate is used as proxy for the short-term interest rate. The short-term interest rates also affect economic conditions and stock prices. Fama and French (1989) observed that treasury-bill rate tend to be low in business contraction, especially in the low turning points of business cycle. The term structure between long-term government bonds and treasury-bill rates is used as proxy for difference between long-term interest rate and short-term interest rate. The term structure of interest rate is related to expected growth rate of GDP and consumption and serves as an indicator of economic activity (Chen, 1991 and Campbell, 1987). The intuition behind is that if future output is expected to be high, individuals have greater desire to smooth consumption by attempting to borrow against future expected production, thereby bidding-up interest rate. In inter-temporal setting assets are priced according to their covariance with aggregate marginal utility of consumption (Lucas, 1978; Breeden, 1980 and Cox *et al*., 1985). The intuition is that individual will adjust their inter-temporal consumption streams so as to hedge against changes in opportunity set. The changes in the expected growth rate of GDP affect term structure, which in turn influence the discount rate and hence pricing. Although term structure and call rate generally are not mean zero, since the term structure is usually upward sloping, most of the studies have used them directly as innovations (Chen, *et al*., 1986). But in some studies the innovation of these variables is used to ensure that they are both zero mean and serially uncorrelated (Kaoutoulas and Kryzanowski, 1998 and other studies).

The inflation could be the source of economic risk because this variable affect expected aggregate marginal utility. If firms also differ in their exposure to changes in inflation, there may be an inflation risk premium in multiple-factor model. Thus in this study the unanticipated inflation is also used as a measure of risk following Chen, *et al.* (1986). The unanticipated inflation rate is the difference between actual and expected inflation rate; the latter measured by forecasted inflation rate based on the best-fitted ARMA process. Inflation rate is based on wholesale price index.

The influence of macro-economy such as the level of aggregate economic activity measured by private consumption and the level of aggregate industrial production also affects the flows of corporate sector. The level of activity, as measured by growth in industrial sector captures real sector of the economy. They serve as indicators of current health of the economy and hence influence the earning expectations of the investors. Both the real-sector variables are taken in terms of growth rates.

The exchange rate, which is defined as domestic currency price of foreign currency is one of the factors that captures the effect of foreign sector on the asset returns. It is well known that investment decision in the foreign asset is dependent on investment performance of foreign asset and performance of domestic currency relative to foreign currency (De Santis and Gerard, 1998). Thus variation in exchange rate effects cash flows because when purchasing power parity is violated, this variation in exchange rate reflects currency risk to shareholders who want to maximize returns and minimize risk. Another economic risk factor that influences assets prices is the oil prices and Chen, *et al.,* 1986) and other studies used this risk factor for testing multifactor model.

The macroeconomic variables that are found to influence the stock returns in the empirical literature, the general economic and financial theoretical give guidance. Finally those variables are selected which derive business conditions in Pakistan and explain the pricing behavior significantly. Following the standard practice, lagged values of macroeconomic variables are selected as instruments. This set includes market return (RM), call money rate (CR), term structure (TS) defined as difference between ten-year government bond rate and treasury bill rate, unanticipated inflation (UI), industrial production growth rate (IP), unanticipated change in foreign exchange rate (EU), consumption growth rate (CG) and the growth rate of world crude oil prices (OG).

Table1. Economic Variables

Definition	Data Source
Market Return defined as KSE 100 Index (RM)	Ready Board Quotations of KSE and KSE website
Manufacturing Output Index (IP)	Monthly Statistical Bullion, SBP
Per Capita Real Consumption (C)	Economic Survey
Call Money Rate (CR)	Monthly Statistical Bullion, SBP
Term Structure: Difference b/w 10-year government bond yield and 6-month treasury bills rate (TR)	Monthly Statistical Bullion, SBP
Whole Sale Price Index (WPI)	Monthly Statistical Bullion, SBP
Oil Price Index (O)	OPEC Website
Foreign Exchange rate (E)	Monthly Statistical Bullion, SBP

Data and Sample

The test of adequacy of multifactor CAPM models is performed on the data of 49 firms[3] (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 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 as log first difference of closing prices after adjusting for dividends, bonus shares and right issues. The six months treasury-bill rate is used as risk free rate and KSE 100 Index as the rate on market portfolio. The economic variables such as treasury-bill rate, call rate, long-term government bond rate, wholesale price index, crude oil prices index, and index of manufacturing output and foreign exchange rate are available on monthly frequencies and are obtained from Monthly Statistical Bullion of State Bank of Pakistan.

4. Empirical Methodology

In linking macroeconomic variables with expected returns, we start our analysis with the unconditional multifactor CAPM. The multifactor asset-pricing model implies that the expected returns of assets are related to their sensitivity to change in the state of the economy. Following Chen, *et al.*

[3] The list of companies is provided in appendix Table A1.

(1986), a set of economic variables is specified as proxies for economic risks in section 3 and it is investigated whether or not these risk factors are rewarded in the stock market. For the analysis a modified version of standard Fama and MacBeth (1973) two-step estimation procedure is used. This technique is also used in Chen *et al.* (1986), Ferson and Harvey (1991, 1993 and 1999) and several other studies.

The set of macroeconomic variables is included in the test of CAPM with the perspective to see whether these factors have pricing significance as against the market index. First, the changes in asset returns are linked to the changes in economic variables, therefore, the step one is time series regression of the excess returns of each asset on the economic variables and market return. The Generalized Method of Moments (GMM) method is applied as estimation method and lag explanatory variables are used as instruments. The slope coefficients in these time-series regressions give estimates of assets' sensitivity to economic state variables, called betas. The estimated sensitivity or betas are used as independent variables in cross-sectional regressions with average asset's excess returns of a particular month being the dependent variable. The step two is cross-sectional regression estimation done month by month. Each set of coefficients of cross section for any particular month gives estimate of risk premiums associated with the economic variables for that month. Then these two steps are repeated for each month and as a result time series of these estimated risk premiums are obtained. Then time series means of these estimates are tested for statistical significance under the null hypotheses that the means of risk premiums are equal to zero. The t-ratio for testing the hypothesis that the average premium is zero is calculated using the standard deviation of the time series of estimated risk premiums, as Fama and McBeth (1973). Since estimated betas are used in second stage regressions, the regression involves error-in-variables problem. These t-ratios are adjusted for correction as suggested by Shanken (1992).

It is assumed that the stock returns of asset i follows a linear factor model with j economic variables. Therefore following Chen *et al.* (1986):

$$E(r_{it}) = E(\sum_{j=1}^{J} \beta_{jt} f_j) \tag{2}$$

Or,

$$r_{it} = \beta_{0t} + \sum_{j=1}^{J} \beta_{jt} f_j + \varepsilon_{it} \tag{3}$$

Where β_{0t} are the constants, $\beta_{itj}s$ are factor sensitivities on the macroeconomic variables and ε_{it} is idiosyncratic error term. The market beta and macroeconomic betas are estimated simultaneously and then risk premiums are estimated by cross-sectional regression equation (4) which is estimated by GLS for each month:

$$r_{it} = \lambda_0 + \sum_{j=1}^{J} \lambda_j \beta_{ijt} + \varepsilon_{it} \tag{4}$$

Where λ_0 is the intercept and λ_j is the slope coefficients using economic variables, and β_{ij} are time series estimated factor sensitivities estimated by equation (3).

The multifactor model is extended to allow investors to have conditional as against unconditional expectations and there are several approaches to deal with this. The GARCH-M model has the capacity to describe direct relationship between conditional first and second moment. Therefore multifactor CAPM-plus-GARCH-M asserts that inventors revise their estimation of mean and variance of asset returns each period to reflect expansion of information set upon which expected returns are based. The multifactor regression model becomes:

$$r_{it} = \beta_{0t} + \sum_{j=1}^{J} \beta_{ijt} f_j + \sum_{i=1}^{p} \alpha_i r_{t-i} + \sum_{s=0}^{q} \beta_j \varepsilon_{t-j} + \theta_i f(h_t^{1/2}) + \varepsilon_{it} \quad (5)$$

$$\varepsilon_t = v_t \sqrt{h_t} \quad (6)$$

$$h_t = \phi_0 + \sum_{k=1}^{l} \phi_k \varepsilon_{t-k}^2 + \sum_{m=1}^{s} \lambda_m h_{t-m} \quad (7)$$

In equation (5) β_{0t} is the constant, β_{jt} are factor sensitivities on the economic variables and ε_{it} is idiosyncratic error term. In equation (6) the random error term is decomposed into v_t, which is homoscedastic with $\sigma_{v_t}^2 = 1$ and h_t which is hetroskedastic with ARMA process given by (7). The coefficient ϕ_k is called ARCH coefficient of order k and λ_m the GARCH coefficient of order m. Further, in equation (5) $f(h_t^{1/2})$ the conditional variance function is used as an explanatory variable in addition to excess market return. The coefficient of $f(h_t^{1/2})$ measures the premium for variance risk, as opposed to covariance risk. Since the covariance risk is a more relevant risk measure, the cross-section regression is estimated on betas acquired from the time series regression applying GARCH (1,1)-M. The premium for covariance risk is estimated by the following cross-section regression equation using these betas as explanatory variables:

$$r_{it} = \lambda_{0t} + \sum_{j=1}^{J} \lambda_{jt} \beta_{ijt} + \varepsilon_{it} \quad (8)$$

The λ_{0t} is the intercept and λ_{jt} is the slope coefficient measuring the risk premiums associated with each economic variable and these estimates are tested for significance by t-test.

The time variation is allowed in the model and conditional variances and covariance of economic risks are estimated month by month. Then cross-section model is used to examine how betas or exposures of economic factor influence expected returns when risk premiums associated with these risks are time varying in nature. The estimation technique is a refined version of the standard Fama-McBeth (1973) approach. The following time series multifactor regression model is estimated in the first stage:

$$r_{it} = E_{t-1}(r_{it} | Z_{t-1}) + \varepsilon_{it} \quad (9)$$

$$E_{t-1}(r_{it} | Z_{t-1}) = E_{t-1} \left\langle \sum_{j=1}^{J} \beta_{jt} f_j \middle| Z_{t-1} \right\rangle \quad (10)$$

Or

$$r_{it} = \beta_{0t} + \left\langle \sum_{j=1}^{J} \beta_{jt} f_j \middle| Z_{t-1} \right\rangle + \varepsilon_{it} \quad (11)$$

$E_{t-1}(.)$ indicates the conditional expectation, given public information set Z_{t-1} at time t-1, $\beta_{ij}s$ are conditional betas or the regression coefficients on j economic variables and ε_{it} is idiosyncratic error term. The betas are allowed for time variation depending on Z_{t-1} by making them linear functions of predetermined instruments following Shanken (1990), Ferson and Harvey (1991, 1993, 1999), Ferson and Schadt (1996) and other studies. The information set includes lagged predetermined macroeconomic variables (market return, call money rate, term structure, industrial production growth, inflation rate, exchange rate, consumption growth and the growth rate of oil prices) and a constant.

In conditional multifactor model, the relevant conditional betas are estimated as inverse of conditional variance-covariance matrix, multiplied by a vector of conditional covariance of an asset's returns with the economic variables.[4] First of all conditional variances are estimated by Davidian-Carroll (1987) method, which form the diagonal of variance-covariance matrix. Next, covariance terms are estimated to complete the variance-covariance matrix. Then for each month the vector of conditional betas is computed by inverting the 8×8 conditional variance-covariance matrix of the economic variables and post-multiplying the result with the vector multiplied by 8×1 vector of conditional covariance of economic variables with an asset's return. This process is repeated for each of the chosen assets. By using these vectors of conditional betas, the cross section equation (8) is estimated month by month and slope coefficients measure risk premiums for each month. The average of economic risk premiums are then tested for the significance of their difference from zero.

5. Empirical Results

The unconditional multifactor model is estimated by using modified version of Fama and McBeth (1973) estimation procedure. The estimation procedure composed of two steps. In the step one time series regression of excess return is done on all economic variables and those economic variables that significantly influence the asset pricing are used to estimate factor sensitivities or beta coefficient associated to those factors. The results of this time series are given in Table A3 of the appendix. In the step two these factor sensitivities are used as variables in cross section regression estimated to find risk premiums associated with these risk factors. The results of cross section analysis of risk premiums based on unconditional multifactor model are presented in Table 1. For conditional model when information set is past variances then first step is done on chosen economic variables by multifactor CAPM-with-GARCH-M model. In the second step betas acquired from first step are used as explanatory variables to find compensation for these economic risks. The results of average risk premiums based on conditional multifactor CAPM-plus-GARCH (1,1)-M are presented in Table 2. Finally, all lagged macro-economic variables are considered in the information set that drive asset prices and conditional betas are estimated in step one. Then cross-section regression is done on these betas to obtain conditional risk premiums in second stage and Table 3 documents these results.

The results reported in Table A3 in appendix are based on time series regressions using GMM estimation technique where lag asset returns and lag macroeconomic variables are used as instruments. The results indicate that market risk β_{RM} is positive, that is, the rates of return on the individual stocks rise and fall with the market return and, hence, the individual assets are exposed to covariance risk. The results show that in most cases the asset returns are inversely related to consumption growth, showing that as the rate of growth of consumption increases, the rates of returns on assets tend to decline. The reason is as follows. For the given GDP growth rate, the increase in consumption growth indicates greater desire for savings, which in turn increases the supply of loan-able funds. This in turn is likely to reduce the rates of returns on assets.

The parameters of sensitivity of stock returns to unanticipated inflation risk, that is β_{UI}, have a mix signs but for most of the stocks it is negative. This results show that stock returns decrease as inflation rate increases and such investment become less attractive for most of the cases. The effect of increase in call money rate on asset returns is not conclusive as indicated by β_{CR}, but for most of the stocks it is positive. Only for few stock returns are negatively related to call money rate. As interest rate rises, asset become more competitive compared with other assets on which the rates of return are closely tied with call money rate, therefore assets in stock market become more attractive. Term structure factor

[4] The procedure is discussed in more detail in Appendix B.

loading β_{TS} is negative showing inverse relationship between asset returns and returns on government bonds above the treasury-bill rate. The sensitivity of asset returns to growth of industrial production is negative for most of the stocks as represented by β_{IP}. This implies that instability in real sector of the economy has adverse effect on asset returns in stock market. The association of stock returns with oil prices risk is mixed but negative for most of the stocks. The exposure of asset returns to exchange rate risk β_{EU} is negative for most of the stocks, because exchange rate instability adversely affects stock returns.

Table 2 reports the average risk premiums associated with the economic variables for unconditional multifactor CAPM and t-ratios in the parenthesis are reported for the hypothesis that mean premium is equal to zero. The results show that average premium associated with market risk is positive and significant only for sub-periods 2002-2004 and for other sub-periods and for entire sample period it is inconclusive and insignificant. The CAPM theory suggests that there is positive compensation of facing market risk. The results show that the including economic variables as risk factors in the standard model has enhanced the impact of market return in limited way (only for one sub-period), which shows still negative risk premium for other sub-periods and overall period. This finding suggests that if market is not efficient, other macroeconomic risk factors also fail to improve the pricing significance of market risk in unconditional multifactor model. This result is consistent with the findings by Chen, *et al.* (1986) and they argue that other economic variables largely subsume the market premium, but opposite result are found by Ferson and Harvey (1991). The average premium associated with call money rate is negative for the sub-period 1999-2001, 2002-2004 and 1999-2004 and in longer sub-period 1993-1998. The term structure risk has negative compensation in the market only for the period 1993-1995 and positive and significant in the period 2002-2004 and 1993-1998 and 1999-2004. The inflation risk has no significant influence on asset prices behavior. The risk premium associated with industrial growth has no impact on the cross-section variation of asset returns, reflecting stock market provides no assurance against real systematic production risks. The foreign exchange rate risk and oil price shocks also have not shown any conclusive and significant pricing behavior. However, market reward negative risk premium only in 1996-1998 for foreign exchange risk and oil price growth is negatively compensated in 1993-1995. The market also rewards the consumption risk positively and significantly for most of the sub-periods 1993-1995, 2002-2004, 1993-1998, 1999-2004 and overall sample period 1999-2004. The intercept terms are also significantly different from zero for most of the sub-periods and overall sample period.

The test of multifactor in conditional setting multifactor CAPM-with-GARCH-M is carried out on monthly and daily data. Table A4 in appendix reports the estimates of beta, ARMA parameters, the parameter of conditional variance, and GARCH equation parameters and R^2 for all 49 stocks based on monthly data. The autoregressive of order one, two and three and moving average of order one are significantly different from zero. The coefficient of market beta is positive and significant at 1% level for almost all the stocks. The sensitivity of other economic variables has mixed sign; these factor sensitivity parameters are inconclusive but significant for most stocks. The GARCH estimates provide large R^2 than unconditional estimates. More specifically the results of multifactor CAPM-plus-GARCH (1, 1)-M show a strong support for positive relation market return and individual stock returns. However, significant risk premium for variance risk is observed only for a few stocks (11 stocks out of 49 stocks). The results suggest that there is some evidence of relation between the conditional mean and conditional variance of excess returns of the stocks however, covariance risks are more relevant risk measure. Therefore, the premiums for covariance risks are estimated by cross-section regression using these betas as explanatory variables and the average of these economic risk premiums are reported in Table 3.

Table: 2: Average Risk Premium Associated with Unconditional Multifactor CAPM

	λ_{0t}	λ_{RM}	λ_{CR}	λ_{TS}	λ_{IP}	λ_{UI}	λ_{EU}	λ_{CG}	λ_{OG}	R^2
1993-95	0.01*	-0.01	0.002*	-0.001*	0.003	0.003	0.005	0.002*	-0.01***	0.34
	(1.51)	(-1.04)	(3.48)	(-2.77)	(0.36)	(1.10)	(1.11)	(2.58)	(-1.13)	
	[1.48]	[-1.03]	[3.46]	[-2.76]	[0.37]	[1.10]	[1.10)	[2.57]	[-1.12]	
1996-98	-0.02*	(0.01	0.004	0.003	-0.002	0.001	-0.01*	0.004	-0.01*	0.39
	(-4.66)	[-0.86]	(0.32)	(-0.18)	(-0.19)	(0.54)	(-1.88)	(0.94)	(-1.29)	
	[-4.62]	[-0.86]	[0.31]	[-0.17]	[-0.19]	[0.54]	[-1.88]	[0.94]	[-1.29]	
1999-01	0.008	-0.003	-0.001***	0.004	-0.004	-0.002	0.007	0.002	0.01	0.30
	(0.85)	(-0.21)	(-1.28)	(0.78)	(-0.31)	(-0.62	(0.95)	(0.07)	(0.61)	
	[0.85]	[-0.21]	[-1.27]	[0.78]	[-0.31]	[-0.62]	[0.94]	[0.07]	[0.60]	
2002-04	0.02*	0.02*	-0.002*	0.001*	0.01	0.001	0.004	0.002*	0.01	0.33
	(3.30)	(1.77)	(-3.21)	(2.67)	(0.45)	(0.35)	(-0.03)	(2.80)	(0.73)	
	[3.19]	[1.70]	[-3.20]	[2.66]	[0.44]	[0.35]	[-0.03]	[2.80]	[0.72]	
1993-98	0.004	0.01	-0.001*	0.001*	0.003	0.004	-0.001	0.001*	0.001	0.36
	(0.03)	(0.48)	(-2.46)	(2.12)	(0.28)	(0.20)	(-0.33)	(2.44)	(0.09)	
	[0.03]	[0.47]	[-2.45]	[2.12]	[0.28]	[0.20]	[-0.33]	[2.43]	[0.09]	
1999-04	0.01*	0.01	-0.001*	0.001*	0.004	-0.001	0.003	0.001*	0.01	0.36
	(2.52)	(0.95)	(-3.32)	(2.54)	(0.03)	(-0.27)	(0.85)	(2.04)	(0.94)	
	[2.47]	[0.93]	[-3.31]	[2.54]	[0.03]	[-0.27]	[0.84]	[2.03]	[0.93]	
1993-04	0.003	0.003	0.004	0.003	0.003	0.001	0.001	0.004***	-0.001*	0.37
	(0.73)	(0.02)	(-0.75)	(0.44)	(0.07)	(0.44)	(0.53)	(1.66)	(-0.19)	
	[0.72]	[0.02]	[-0.75]	[0.44]	[0.07]	[0.44]	[0.53]	[1.66]	[-0.19]	

Note: The t-values reported below the coefficients in round bracket are Fama-McBeth t-values and in square brackets the t-values are error adjusted Shanken t-values. The * indicates significant at 1% level, ** indicates significant at 5% level and *** indicates 10% significant rate.

From the results reported in Table 3, it is evident that there is limited improvement in the estimated risk premiums using GARCH (1,1)-M betas over the unconditional multifactor CAPM model. The results show that the incorporation of other economic variables as risk factors in the standard CAPM model have improved the results and market risk has positive and significant compensation in the sub-periods 2002-2004 and 1999-2004. The average premium associated with call money rate is negative and significant in 2002-2004 and 1999-2004. However, this risk is positively associated with expected returns in the sub-period 1996-1998 and 1993-1998. The term structure risk has negative compensation in the market for the sub-period 1993-1995, 1996-1998 and 1993-1998 and positive in the sub-period 1999-2001, 2002-2004 and 1999-2004. The interesting thing about these results is that the premiums of call money rate and term structure have opposite signs for both unconditional and conditional multifactor CAPM models as shown by the results reported in Table 1 and Table 2. The average monthly premium associated with inflation risk is negative and significant for the sub-period 1993-1995, 2002-2004 and 1993-1998. However, this risk has no clear and significant compensation other periods. The unanticipated change in prices has the general effect of redistributing wealth among investors; there is no clear presumption about what would be the sign of this risk premium. The negative premium for this risk means that stock market assets are generally perceived to be hedged against the adverse influence of this risk. The risk premium associated with industrial growth is positive and significant for sub-periods 1999-2001, 1999-2004 and overall period 1993-2004. This finding reflects that stock market provides compensation against real systematic production risks, indicating that real sector risk have compensations. The exchange rate risk also has not shown any conclusive and significant pricing behavior. The oil prices shock has negative and significant influence on expected returns for the period 1993-1995 and 1993-1998 but does not affect the expected returns in other periods. The market also rewards the consumption risk positively and significantly for the sub-periods 1999-2001, 2002-2004, 1999-2004 and overall period 1993-2004. This results show that variation in expected returns across assets is explained by consumption growth for the period under study. These results indicate that employing multifactor CAPM-with-GARCH-M gives limited improvement over unconditional estimation. This suggests that GARCH-M model is not sufficient to lead satisfactory results for conditional multifactor CAPM.

To examine the time varying behavior of risk factors and the time-varying risk premiums, the conditional betas for risk factors are estimated for each month by Davidian-Carroll (1987) method. The information set consists of lags of business-cycle variables. Table 4 reports the average of the conditional risk premiums estimates over sub-periods and the overall sample period. The t-ratios for the test of hypothesis that mean premium is zero are presented in the parenthesis.

Table 3: Average Risk Premium Associated with Conditional Multifactor CAPM-with-GARCH (1, 1)-M Model

	λ_{0t}	λ_{RM}	λ_{CR}	λ_{TS}	λ_{IP}	λ_{UI}	λ_{EU}	λ_{CG}	λ_{OG}	R^2
1993-95	-0.02	0.003	0.001	0.001*	0.02	-0.01*	0.003	0.003*	-0.06*	0.51
	(-1.16)	(-1.10)	(-0.99)	(-4.17)	(0.68)	(-2.34)	(0.97)	(-2.92)	(-4.01)	
	[-1.15]	[-1.10]	[-0.99]	[-4.16]	[0.66]	[-2.32]	[0.97]	[-2.91]	[-3.60]	
1996-98	0.03	-0.03*	0.002*	0.001*	0.003	0.001	0.001	0.001	-0.02	0.38
	(1.09)	(-8.69)	(2.65)	(-2.85)	(0.08)	(0.11)	(-0.27)	(0.31)	(-0.83)	
	[1.02]	[-8.43]	[2.64]	[-2.84]	[0.08]	[0.11]	[-0.27]	[0.31]	[-0.83]	
1999-01	0.02	0.002	0.001	0.001*	0.05***	0.003	0.004	0.003***	-0.01	0.32
	(0.82)	(1.25)	(-0.50)	(2.67)	(1.48)	(-0.78)	(0.91)	(1.78)	(-0.76)	
	[0.78]	[1.24]	[-0.49]	[2.66]	[1.28]	[-0.78]	[0.90]	[1.77]	[-0.76]	
2002-04	0.00	0.04*	0.004*	0.002*	0.04	-0.01**	0.001	0.004*	0.01	0.33
	(-0.07)	(11.06)	(-4.62)	(4.77)	(1.07)	(-1.62)	(0.01)	(2.19)	(0.68)	
	[-0.07]	[9.93]	[-4.61]	[4.74]	[0.98]	[-1.61]	[0.01]	[2.18]	[0.67]	
1993-98	0.01	-0.02	0.001***	-0.001*	0.01	-0.003	0.001	0.001	-0.03*	0.33
	(0.31)	(-7.46)	(1.64)	(-4.28)	(0.39)	(-1.42)	(0.25)	(-1.16)	(-2.60)	
	[0.31]	[-7.41]	[1.63]	[-4.27]	[0.38]	[-1.42]	[0.25]	[-1.16]	[-2.51]	
1999-04	0.01	0.02*	-0.002*	0.001*	0.04**	0.002	0.002	0.003*	-0.001	0.36
	(0.49)	(8.12)	(-3.37)	(4.89)	(1.68)	(0.56)	(0.60)	(2.62)	(-0.05)	
	[0.48]	[7.76]	[-3.36]	[4.87]	[1.50]	[0.56]	[0.60]	[2.60]	[-0.05]	
1993-04	0.01	0.003	-0.001***	0.001	0.03***	0.003	0.002	0.001***	-0.02***	0.39
	(0.53)	(1.29)	(-1.41)	(0.91)	(1.42)	(1.12)	(0.57)	(1.35)	(-1.58)	
	[0.52]	[1.29]	[-1.40]	[0.90]	[1.34]	[1.12]	[0.57]	[1.35]	[-1.57]	

Note: The t-values reported below the coefficients in round bracket are Fama-McBeth t-values and in square brackets the t-values are error adjusted Shanken t-values. The * indicates significant at 1%, ** indicates significant at 5% and *** indicates significant at 10% level.

The results indicate that there is improvement in the results compared to unconditional multifactor CAPM and conditional multifactor CAPM-with-GARCH-M specification. The intercept terms are significantly different from zero for all the sub-periods except for the overall period. The results show that average premium for market risk is positive and significant for the sub-period 1999-2004, 2002-2004 and overall period 1993-2004 and inconclusive and insignificant otherwise. The premium for consumption growth is positive and significant in the period 1999-2001, 2002-2004, 1999-2004 and overall period 1993-2004. The foreign exchange rate risk is positively compensated in the market for the period 1993-1995, 1996-1998, 1993-1998 and overall period 1993-2004. The unanticipated inflation, term structure and call money rate have negative compensation. The inflation risk is significantly negatively rewarded in the periods 1993-1995, 1996-1998, 2002-2004 and 1993-1998. The average premium for term structure is negative and significant for the period 1993-1995, 1996-1998, 1993-1998 and overall period 1993-2004. The call money rate risk has negative and significant compensation in the market for the period 1993-1995, 1999-2001 and 1993-1998. The industrial production risk has mixed but insignificant premium showing that the risk associated with industrial production is not priced during the period under study. The oil price risk is significantly and negatively compensated for the periods 1993-1995 and 1996-1998.

We have developed the connection of stock returns to changes in economic risks. Business cycle variables are included as information set to explain asset prices dynamics. The core finding is that expected returns vary overtime and are correlated with business cycles, that is, returns are high in bad times when investors are not much willing to hold risky assets and, hence, low in good times. The results show that average time varying premium associated with market risk is positive and significant for a few sub-periods. This finding suggests that if market is not efficient other macroeconomic risk factors improve the pricing significance of market risk in conditional model. The negative risk premium for unanticipated inflation risk and term structure risk seem plausible. The expected returns are higher in bad times, since agents are less willing to hold risky assets, and lower in good times. Inflation is lower in bad times and higher in good times, so this explains why investors get negative compensation for facing inflation risk. Fama and Schwert (1977) have also come up with the same conclusion. Another explanation is that if investors prefer stocks whose returns are positively correlated with inflation and if this is the determining factor then risk premium for inflation risk variable would be negative. The unanticipated changes in inflation have the general effect of redistributing wealth among investors. The negative sign of these variables means that stock market asset is hedged against the adverse influence on other assets that are relatively more fixed in nominal terms. The term structure risk is negatively compensated, which shows that stocks whose returns are inversely related to increase in long-term over short-term rates are more valuable. One way to explain this result is that term structure measures change in the long-term real rates of interest (inflation effects are included in other variables as well). After long term interest rate decreases, there is subsequently a lower real returns on any form of capital. Investors who want protection against this possibility place a relatively higher value on assets whose returns increase when the long-term real rates decline and such risk will carry negative risk premiums. Thus stocks whose returns are correlated with the long term bond returns, holding other things equal, are more valuable than stocks that are uncorrelated or negatively correlated with the long term bonds returns. The consumption growth risk is intuitively important to link asset returns to macroeconomics, because consumption reveals all information about wealth and income prospects. The results reveal that investor gets positive premium for consumption risk and. Ferson (1990) also comes up with same conclusion.

The results of conditional multifactor model show that production risk has no significant premium. Therefore one can say that instability in real sector of the economy does not have much role in explaining the variation in the expected returns of stocks at KSE. The reason may be that in Pakistani market the information about production changes is not assessable to investor. As regards the foreign exchange risk and oil price risks, these have weak effects, that is, negative premium for few sub-periods. This suggests that instability of foreign exchange rate or in oil prices affects the stock returns adversely only in a few sub-periods. The oil prices risks are considered important economic variable, impact of oil price shock is insignificant for explaining the asset prices behavior for most of the sub-periods and overall period.

The joint hypothesis that market is efficient does not hold true due to presence of significant mean pricing errors in all models. The standard asset pricing theory says that that beta on market portfolio is sufficient to capture the pricing impact of macroeconomic state variables. The results of unconditional and conditional multifactor model have shown that market index fails to have a statistically significant effect in most of the sub-periods. The insignificance of market index in pricing the stocks is opposite with its significance in time series regression with good t-values. This suggests that although market index explains much of the inter-temporal movement but market beta could not explain the cross-sectional differences in average returns even after the betas of economic state variables have been included. On the other hand, macroeconomic variables have some significant effects on asset pricing. Overall, the results suggest that time variation in economic risks and their rewards provide some explanation of variation in expected returns across assets.

6. Conclusions

The analysis of this study investigates a set of macroeconomic variables in addition to market return as the systematic sources of explaining variations in stock returns. Some of these economic variables are found to be significant in explaining expected stock returns. The test of conditional multifactor CAPM is carried out by specifying conditional variance as a GARCH(1,1)-M process The result of the model reveal that conditional CAPM performs relatively well in explaining risk-return relationship in Pakistan during 1993-2004. As regards the risk premium for variance risk, the results are not so convincing, only for a few stocks significant compensation for this risk by investors is observed. The model is then extended to allow variability in economic risk variables and their rewards. The empirical results show evidence in support of conditional multifactor CAPM. The conditioning information is taken as lagged macroeconomic variables that influence business conditions in Pakistan. The economic variables that are observed to perform relatively well in explaining variations in assets' returns include consumption growth, inflation risk, call money rate and term structure. However, the market return, exchange risk and oil prices risk, which explain a significant portion of the time series variability of stock returns, have limited influence on the asset pricing.

Table 4: Average Time-varying Risk Premium in Conditional Multifactor CAPM

	λ_{0t}	λ_{RM}	λ_{CR}	λ_{TS}	λ_{IP}	λ_{UI}	λ_{EU}	λ_{CG}	λ_{OG}	R^2
1993-95	-0.01***	0.03	-1.75**	-16.92***	-0.03	-0.77***	1.37***	-0.26	-0.08***	0.35
	(-0.71)	(1.03)	(-1.72)	(-1.64)	(-0.72)	(-1.60)	(1.67)	(-0.10)	(-1.68)	
	[-0.71]	[.98]	[-1.06]	[-0.01]	[-0.70]	[-0.21]	[1.12]	[-0.04]	[1-.29]	
1996-98	-0.02*	-0.01	0.33	-8.50***	-0.06	-0.70*	1.79*	1.10	-0.12***	0.36
	(-3.48)	(-0.46)	(0.24)	(-1.61)	(-1.15)	(-2.80)	(2.45)	(0.43)	(-1.29)	
	[-3.46]	[-0.46]	[0.07]	[-0.02]	[-1.03]	[-2.40]	[2.14]	[0.04]	[-0.85]	
1999-01	0.01***	-0.01	-2.04***	-5.59	-0.05	-0.06	0.74	7.97*	-0.02	0.37
	(1.53)	(-0.36)	(-1.56)	(-0.35)	(-0.73)	(-0.10)	(0.77)	(1.69)	(-0.18)	
	[1.50]	[-0.36]	[-1.03]	[-0.01]	[-0.67]	[-0.09]	[0.10]	[1.62]	[-0.18]	
2002-04	0.02*	0.03***	3.23	0.19	0.04	-0.96***	0.20	9.71**	-0.12	0.33
	(2.86)	(1.65)	(0.66)	(0.02)	(1.00)	(-1.44)	(0.34)	(1.86)	(-1.00)	
	[2.72]	[1.57]	[0.02]	[0.01]	[0.89]	[-1.15]	[0.14]	[1.72]	[-0.67]	
1993-98	-0.01**	0.01	-0.61***	-12.33**	-0.04	-0.73*	1.60**	0.49	-0.03	0.36
	(-1.95)	(0.44)	(-1.39)	(-1.74)	(-0.83)	(-2.21)	(1.96)	(0.17)	(-0.33)	
	[-1.95]	[0.44]	[-1.06]	[-1.01]	[-0.78]	[-1.30]	[1.22]	[0.03]	[-0.32]	
1999-04	0.02*	0.01**	0.60	-2.70	0.00	0.45	0.47	8.84*	-0.07	0.31
	(3.08)	(1.80)	(0.20)	(-0.28)	(-0.11)	(0.99)	(0.84)	(2.53)	(-0.86)	
	[2.97]	[1.79]	[0.03]	[-0.01]	[-0.11]	[0.21]	[0.17]	[2.03]	[-0.73]	
1993-04	0.002	0.01**	0.02	-7.30**	-0.02	-0.12	1.01*	4.85*	-0.05	0.40
	(0.78)	(1.88)	(0.01)	(-1.62)	(-0.70)	(-0.40)	(2.06)	(2.12)	(-0.82)	
	[0.78]	[1.86]	[0.01]	[-1.23]	[-0.69]	[-0.27]	[1.20]	[2.04]	[-0.75]	

Note: The t-values are reported below the average premium, Fama-McBeth t-values and Shanken error adjusted t-values .to test that the premium is different from zero. The * indicates significant at 1%, ** indicates significant at 5% and *** indicates 10% significant rate.

Therefore we can conclude that expected returns variation could be explained by macroeconomic variations that are real risks facing investors. Then expected returns vary over time and this variability has some business cycle correlations. This is the reason that expected returns are high in bad economic times because investors are less willing to hold risky assets and lower in good times.

Acknowledgment

The study is based on Ph D dissertation of Attiya Y. Javid. The authors wish to thank Dr Rashid Amjad, Dr Abdul Qayyum, Dr Fazal Hussain and Tariq Mahmood for their valuable comments. They are grateful to Muhammad Ali Bhatti for providing assistance in compiling data. The usual disclaimer applies.

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Appendix A
Table A1: 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 A2. 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%, ** indicates*

Table A3: The Coefficient of Economic Factors Sensitivity

	β_0	β_{RM}	β_{CR}	β_{TS}	β_{IP}	β_{UI}	β_{EU}	β_{CG}	β_{OG}	R^2
AABS	0.40*	0.27*	-5.32*	25.69*	-0.06***	-0.86*	0.20	-11.56*	-0.11**	0.31
ACBL	0.42*	0.71*	-18.71*	-16.89	-0.69*	1.67***	-0.13	-6.40	-0.40**	0.26
AGTL	-0.16***	0.57*	1.87	13.66**	0.27*	1.30*	0.52***	3.25***	0.11	0.42
AICL	-0.10	1.20*	18.03*	14.97***	0.07	-3.68*	-1.21*	-1.51	0.23	0.41
ANSS	0.23	0.86*	15.65***	12.52	1.14*	-3.12*	-2.01**	-10.4**	1.58*	0.87
ASKL	-0.28*	0.91*	15.85*	23.38*	0.39*	-1.16**	-0.54*	3.47	0.37**	0.39
BWHL	-0.28*	0.45*	5.94***	-0.16	-0.15	2.86**	-0.43**	6.89*	0.51*	0.37
CHCC	0.48*	1.03**	-11.40**	8.78	-0.68*	-1.87*	1.12*	-11.33*	-0.53*	0.40
CRTM	-0.31*	0.99*	11.14*	11.85**	0.37*	-1.10**	1.61*	6.23**	-0.15	0.29
CSAP	0.40*	0.56*	8.04**	25.64*	-0.38*	-2.98*	0.86*	-13.53*	-0.56*	0.32
CULA	-0.47*	0.35*	-3.73	-13.83*	-0.26*	1.23**	0.02	14.51*	-0.45*	0.34
DBYC	0.11	0.61*	9.59*	48.45*	0.11	2.19*	-1.00*	-7.40**	-0.38**	0.36
DHAN	0.17	1.11*	3.06	12.12**	-0.25*	-1.77**	0.99*	-6.59**	-0.80*	0.41
DSFL	0.22*	0.96*	3.10	13.11*	0.11	0.92***	-0.67*	-7.62*	0.25**	0.52
DWTM	0.20*	0.16*	-4.93*	-16.62*	-0.24*	-0.47	-0.39**	-3.30**	-0.12	0.32
ENGRO	0.00	0.56*	7.00*	12.90*	0.22*	-0.85	-0.83*	-1.83	-0.22**	0.35
FASM	0.33**	0.93*	-7.22***	6.28	-0.57*	-1.93**	2.35*	-7.56**	-0.77*	0.35
FFCJ	-0.21**	0.34*	-4.68**	-22.97*	0.28*	1.39*	-3.62*	7.62*	0.20**	0.42
FFCL	-0.48*	0.70*	4.62	-7.28*	-0.22*	0.65	-1.50*	12.49*	0.12	0.36
FTHM	0.09*	0.04***	-4.64*	-4.26*	-0.06*	-0.20**	0.10***	-1.40*	-0.06*	0.36
GTYR	0.49*	0.44*	-5.80**	19.64*	-0.24	-1.85*	0.54	-13.65*	-0.50*	0.31
GULT	0.44*	0.27*	-16.48*	-3.39	-0.10*	-0.48	0.07	-8.34*	-0.20*	0.43
HAAL	0.19*	0.28*	-12.25*	12.24*	-0.19*	0.20	-0.49**	-3.47**	-0.06	0.35
HUBC	-0.39*	1.59*	-3.01	-42.68*	0.06	1.05*	-0.20	13.82*	0.36*	0.56
ICI	0.04	1.25*	-5.51*	-5.32***	-0.06	-0.08	-0.55**	-0.16	0.13	0.54
INDU	ICP	0.26*	1.10*	-5.63*	-7.23***	0.75**	0.25***	-5.59*	0.12	0.41
JDWS	INDU	0.17*	1.12*	-4.63*	-2.30	1.00*	-0.97*	-3.21**	-0.18**	0.31
JPPO	JDWS	0.02	0.65*	-42.31*	-49.30*	0.32	0.49	9.39**	0.25	0.43
KESC	JPPO	-0.03	0.51*	-9.91*	-15.88*	-0.25	0.23	3.36	-0.31*	0.26
LEVER	KESC	0.23*	1.63*	-10.58*	-11.66*	1.34**	0.58*	-3.62	-0.39*	0.63
LUCK	LUCK	-0.54*	0.97*	10.55*	-3.30	2.07*	0.95*	13.59*	0.35**	0.37
MCB	LEVER	-0.06	0.64*	-5.00*	-10.14*	-0.63*	-0.25**	3.05**	0.21*	0.32
MPLC	MCB	-0.22*	1.12*	1.45	-8.59*	1.01*	0.54**	6.44*	0.08	0.59
NATR	-0.38*	0.72*	7.26*	-26.51*	0.14*	0.77	0.74**	9.84*	0.20**	0.42
NESTLE	0.14**	0.83*	-8.85*	5.25***	-0.26*	-1.40*	-0.34**	-2.21	0.12***	0.39
PACK	-0.10*	0.11*	-4.24*	-3.91	-0.16*	0.98*	0.26	3.80*	-0.19*	0.40
PAEL	0.07	0.38*	-1.45	6.97*	-0.18*	-2.23*	0.27**	-2.02	-0.13	0.37
PAKT	0.35	0.75*	-13.80*	15.29*	-0.44*	-1.02**	-0.95*	-8.54*	-0.03	0.29
PKCL	0.09	1.14*	3.79**	8.47	-0.12	-2.71*	-0.84*	-3.60	0.13	0.34
PSOC	0.49*	0.36*	-2.74	-9.25	0.47*	-3.93*	-4.32*	-11.84*	1.36*	0.38
PTC	0.03	1.32*	-7.76*	-15.12*	-0.14*	2.38*	1.87*	1.64	-0.13*	0.65
SELP	0.06	1.35*	-4.89*	-11.73*	0.05	-0.61*	-0.20	-0.11	0.09	0.67
SEMF	-0.07	1.16*	-12.67	-19.04*	-0.16*	0.62	0.79*	5.36*	-0.22*	0.39
SITC	0.22*	0.13*	-4.98*	13.24*	-0.06	-1.78*	1.14*	-5.73*	-0.16*	0.38
SNGP	-0.08***	1.46*	2.89*	-8.93*	-0.11*	-0.21	0.75*	2.83**	-0.28*	0.67
SSGC	-0.20*	1.00*	11.21*	10.75*	0.32*	2.97*	-1.13*	3.26*	0.14***	0.61
TSPI	-1.30*	0.49*	43.28*	28.33*	0.71*	3.62*	-3.17*	25.84*	0.76*	0.42
TSSL	-0.04	0.22*	14.53*	17.89*	0.10	-0.27	0.31	-3.25	0.34*	0.50
UNIM	0.63*	0.58*	0.11	10.73***	0.56*	-2.49*	0.09	-18.41*	0.36**	0.42

Note: The t-values are presented in the parenthesis below the coefficient. The * indicates significant at 1%, **indicates significant at 5% and *** indicates significant at 10%.

Table A4: Multifactor CAPM-with GARCH-M Specification

	AABS	ACBL	AGTL	AICL	ANSS	ASKL	BWHL	CHCC	CRTM	CSAP	CULA	DBYC	DHAN
β_0	0.12	0.20***	-0.12	-0.26*	-0.39*	-0.10	-0.11	0.09	-0.03	0.03	0.03	0.66*	-0.01
β_{rm}	0.38*	1.00*	0.33*	1.30*	0.48*	0.59*	0.27**	0.98*	1.08*	0.74*	0.18*	1.35*	0.70**
β_{cr}	-0.61	-2.61	9.35***	5.88**	3.18*	-7.88*	1.52	-0.47	0.91	2.76	-4.40*	2.57	-7.29**
β_{ts}	12.61*	1.17	21.85**	-4.74	-1.94	9.26**	6.40	7.48	4.92	6.42	5.10***	27.55*	5.35
β_{ip}	-0.12***	-0.03	0.01	-0.07	0.07**	-0.07**	0.01	-0.01	0.03	-0.01	0.03	-0.02	-0.09
β_{ui}	-0.51	-0.67	0.91	0.19	0.89**	-0.74*	-0.70	0.61	-1.28**	0.24	0.62*	-2.17**	1.10***
β_{eu}	0.34	0.23	1.03	-0.26	0.42	-0.17	0.11	0.49	1.26*	0.56	0.28***	0.15	-0.60
β_{cg}	-3.61	-2.74	-4.65	6.69**	-0.41	-1.33	1.51	-2.31	0.82	-1.26	0.46	-11.35*	1.31
β_{og}	-0.12	-0.28*	-0.30***	-0.03	0.16*	0.08	0.18	-0.22**	-0.12	-0.20	0.05	-0.51*	0.03
α_1	-0.30*	-0.21*	0.15*						-0.19*	-0.13**		-0.35*	
α_2		-0.10	0.01	-0.31*	-0.24*					0.04			
α_3		-0.16**	0.13***		-0.18*						-0.29*		
α_4													
β_1							-0.22**						
β_2												-0.20**	
β_3												-0.16**	0.25*
β_4		0.25*	0.14***									-0.13	
θ_i		-0.72	1.63**		2.79*	1.69*	0.22				-0.25**	-2.01**	
ϕ_0	0.00*	0.00*	0.001*	0.002	0.01*	0.01*	0.00	0.00	0.01	0.001*	0.00	0.002	0.001*
ϕ_1	-0.08*	-0.08*	-0.04*	0.08	0.50*	0.76*	0.16**	0.04	-0.10*	-0.06*	0.91*	0.07	-0.04*
λ_1	0.82*	0.79*	1.03*	0.93*	-0.38*	-0.04	0.74*	0.90*	0.72*	1.03*	0.43*	0.73*	1.05*
R^2	0.30	0.58	0.37	0.54	0.33	0.36	0.35	0.52	0.41	0.36	0.38	0.49	0.42

(continued) **Table A4: Multifactor CAPM-with GARCH-M Specification Based**

	DSFL	DWTM	ENGRO	FASM	FFCJ	FFCL	FTHM	GTYR	GULT	HAAL	HUBC	ICI	ICPSEMF
β_0	0.22	-0.04	0.17	-0.05	0.02	0.004	-0.03	-0.19	-0.06	0.01	0.27*	0.004	-0.10
β_{rm}	1.38*	0.15*	0.80*	0.76*	0.01	0.80*	0.01	0.78*	-0.19*	0.54*	1.25*	1.29*	1.17*
β_{cr}	-3.04	0.85	-0.58	8.85*	-9.76*	0.12	3.10**	9.14*	-1.05	0.75	1.29	6.41*	0.40
β_{ts}	-3.19	-13.93**	2.24	18.44*	-19.92*	-6.47**	11.12*	10.24	7.38	15.84**	-16.50*	13.18*	-6.71**
β_{ip}	0.09	0.02	0.09	0.04	0.14**	-0.02	0.05**	-0.13	-0.14**	-0.08	0.00	-0.02	-0.07
β_{ui}	-0.10	0.72*	-0.06	0.07	-0.16	-0.24	-0.20	1.69*	0.90***	-0.59	-0.64**	1.41*	-0.01
β_{eu}	-0.09	-0.08	-0.74**	0.77	-2.34*	-0.19	-0.55**	-0.34	0.01	-0.90*	0.02	0.21	0.19
β_{cg}	-5.63	1.89	-4.07	0.60	1.68	2.99**	-0.37	4.38	1.48***	-1.35	-4.83*	-3.94**	-0.46
β_{og}	0.17***	-0.06	-0.25*	-0.09	-0.07	-0.01	-0.25*	0.13	-0.13	-0.15***	0.11**	-0.04	0.04
α_1				-0.40*	-0.27**	-0.22**		-0.19**					-0.29*
α_2				-0.32*									-0.30*
α_3											0.27*		-0.33*
α_4		0.23*											
β_1											0.09		
β_2						-0.08							
β_3		0.31*		-0.21*		-0.43	0.10**						
β_4								-0.31					
θ_i	0.25		-0.03	-0.38	0.24	-1.21	0.23*	0.004**	0.05	0.18	-0.57*	0.84**	1.52**
ϕ_0	0.01*	0.002**	0.01*	0.01**	0.003**	0.002	0.003*	0.23**	0.004*	0.00***	0.00*	0.01*	0.01*
ϕ_1	0.26*	0.34*	0.12**	-0.11**	0.55	0.14	1.12*	0.67*	0.69*	0.35**	0.93*	0.57*	0.20*
λ_1	-0.25	0.39	-0.39	0.70	0.37	0.31	-0.10*	0.23	0.41*	0.59*	0.01	-0.11	-0.09**
R^2	0.58	0.28	0.42	0.35	0.40	0.61	0.46	0.42	0.43	0.38	0.65	0.63	0.55

Continued on next page

(continued) **Table A4: Multifactor CAPM-with GARCH-M Specification**

	INDU	JDWS	JPPO	KESC	LEVER	LUCK	MCB	MPLC	NATR	NESTLE	PACK	PAEL	PAKT
β_0	(-0.79)	(-0.63)	0.30*	0.07	-0.03	0.10	0.00	0.16	0.07	0.52*	(12.95)	-0.11	-0.13
β_{rm}	(14.57)	(10.16)	0.97*	1.56*	0.42*	1.03*	1.41*	1.23*	0.95*	0.16	(0.14)	0.66*	0.74*
β_{cr}	(0.16)	(-0.52)	-5.13**	2.99	-2.19	-2.82	-1.30	-1.56	-4.35**	-5.51	(-0.97)	2.39	-1.94
β_{ts}	(-1.50)	(-1.10)	-8.16***	-4.06	-4.04	7.50	-5.44*	15.97*	3.89	0.02	(0.01)	12.05*	20.29**
β_{ip}	(-0.89)	(0.48)	0.06	-0.13	-0.05	-0.13**	-0.02	-0.13*	-0.08	0.24	(0.35)	0.01	0.01
β_{ui}	(-0.01)	(-1.23)	-1.03***	0.65	0.09	-0.70	0.08	-1.77*	-0.76	-0.61	(-0.06)	-1.53*	0.48
β_{eu}	(0.36)	(-1.30)	-0.29	0.44	-0.05	-0.47	-0.20	-0.43	-0.40	-1.63	(-0.28)	-0.55	-0.39
β_{cg}	(-0.24)	(0.96)	-4.07***	-2.23	2.06	-1.78	-1.89	-4.53	-0.73	-3.53*	(-4.29)	2.16	2.70
β_{og}	(0.41)	(1.78)	0.17**	-0.07	0.09	0.02	0.06	0.02	0.01	0.37	(0.20)	-0.10	-0.07
α_1	(-2.44)		-0.29*						-0.29*	-0.34**	(-1.71)	-0.15**	
α_2	(-3.25)									-0.49*	(-51.25)		
α_3	(-3.63)	(-1.46)										-0.18*	
α_4			0.14**										
β_1		(1.51)					-0.32*						
β_2							-0.31*						
β_3							-0.34						
β_4												0.15	
θ_i	(1.51)	(0.41)	-0.88*		-0.20	-0.25	1.28*	-0.21	-0.08	-7.30*	(-27.02)	-0.09	0.02
ϕ_0	(3.96)	(5.76)	0.01*	0.004	0.00	0.003	0.00	0.02*	0.03*	0.004*	(-3.33)	0.002**	0.03*
ϕ_1	(2.15)	(-1.07)	0.52*	0.08**	0.21*	0.20***	0.17*	0.33*	-0.04**	0.17*	(13.39)	-0.08*	0.18***
λ_1	(-1.71)	(7.99)	0.07	0.82*	0.77*	0.64*	0.86*	-0.20*	-0.98*	0.74*	(48.15)	0.65	-0.17***
R^2			0.48	0.65	0.32	0.51	0.68	0.48	0.43	0.43		0.46	0.40

(continued) **Table A4: Multifactor CAPM-with GARCH-M Specification**

	PKCL	PSO	PTC	SELP	SITC	SNGP	SSGC	TSPI	TSSl	UNIM
β_0	(0.10)	0.35**	0.06	0.00	-0.08	-0.03	-0.02	-0.20	0.02	-0.12
β_{rm}	0.63*	0.60*	1.22*	0.78*	0.63	1.28*	1.26*	1.13*	0.46*	0.87*
β_{cr}	1.41	-9.62***	-4.19**	-6.10**	0.03	0.48	2.23	13.64*	5.88	-4.65
β_{ts}	3.43	-2.69	-8.89**	-14.92	2.53	-5.90	-1.42	13.23	1.82	-9.11
β_{ip}	0.05	0.06	0.02	0.06	-0.04	-0.05	0.01	-0.12	0.05	-0.38***
β_{ui}	0.26	-0.35	0.14	0.09	-0.56	0.89**	0.70**	-0.37	-0.96	0.62
β_{eu}	-0.95***	-0.67	0.25	-0.74***	0.04	-0.08	-0.33	-0.18	0.64	-0.77
β_{cg}	0.53	-2.71	-0.84	1.33	1.65	2.69	-0.70	2.30	-3.44	4.78
β_{og}	0.09	-0.09	0.21*	0.06	0.08	0.08	0.12***	-0.16	0.07	0.03
α_1						-0.18**		-0.24*		-0.33*
α_2			0.28*				-0.14**		-0.23**	
α_3							-0.19**		-0.22*	-0.23*
α_4										
β_1		-0.26*			-0.13					
β_2										
β_3										
β_4						-0.12		0.19*		-0.18***
θ_i	-1.04	-0.91***	0.43	0.24	0.31	5.36	0.68	-0.08	0.08	
ϕ_0	0.00	0.02*	0.01*	0.00	0.002	0.003	0.00	0.02*	0.00	0.02
ϕ_1	0.09	-0.12*	0.22*	0.13**	0.21**	-0.08*	0.07	0.82*	0.21**	-0.06*
λ_1	0.65*	0.44***	-0.54*	0.78*	0.78*	0.59**	0.75*	-0.04	0.68*	0.70*
R^2	0.39	0.35	0.76	0.42	0.38	0.73	0.75	0.13	0.39	0.41

Appendix B

Estimation of Conditional Betas

To estimate conditional betas, first of all conditional variances are estimated. Suppose r_{it} is actual return and let $E\langle r_{it} | Z_{t-1} \rangle$ denotes its conditional return on available information set at time t-1. Let σ_{it} be the unconditional standard deviation of return on asset i and let $E\langle r_{it} | Z_{t-1} \rangle$, denotes its conditional form. The conditional standard deviation of r_{it} conditional on a vector of lagged predetermined macro variables (marker return, growth in consumption per capita,, growth in industrial production, call money rate, term structure, inflation rate, exchange rate and oil price growth rate) and a constant. These variables are likely to be correlated with asset return and form a publicly available information set. The assumption is that the conditional mean of r_{it} is linear in Z_{t-1}. Then the following steps are estimated to transform residuals for estimation of conditional variance function:

$$r_{it} = Z_{t-i}\delta + \varepsilon_{it} \quad \text{(B1)}$$

$$\hat{\varepsilon}_{it} = r_{it} - Z_{t-i}\hat{\delta}_t \quad \text{(B2)}$$

Here $\hat{\delta}_i$ is the parameter estimate under OLS. The absolute values of residuals are used in the estimation of conditional standard deviation because it is a more robust choice [Davidian and Carroll (1987)]. Therefore a linear function for absolute residuals is estimated by OLS and $\hat{\theta}$ is obtained from the regression equation:

$$|\hat{\varepsilon}_{it}| = \sigma(\theta, Z_{t-1}) + v_{it} \quad \text{(B3)}$$

In next step the fitted $\sigma(\hat{\theta}, Z_{t-1})$ are used to estimate GLS estimates of δ^* given in the following regression equation:

$$r_{it} / \sigma(\hat{\theta}, Z_{t-1}) = \left[Z_{t-1} / \sigma(\hat{\theta}, Z_{t-1})\right]\delta^* + \varepsilon^*_{it} \quad \text{(B4)}$$

Then δ^* is used for Weighted Least Square to generate the final residuals, latter these residuals are used to estimate θ^*, that is:

$$\varepsilon^*_{it} = r_{it} - Z_{t-1}\delta^* \quad \text{(B5)}$$

$$|\varepsilon^*_{it}| = \sigma(\theta^*, Z_{t-1}) + v^*_{it} \quad \text{(B6)}$$

The function $\sigma(\theta^*, Z_{t-1})$ is the fitted conditional standard deviation function. Therefore the conditional standard deviation becomes:

$$\sigma^* = \sigma(\theta^*, Z_{t-1})\sqrt{\pi / 2} \quad \text{(B7)}$$

The term $\sqrt{\pi / 2}$ is a bias adjustment factor, which corrects for the fact that mean absolute deviation differs from standard deviation.[5]

[5] This adjustment is motivated by normal distribution, for which standard deviation is equals the mean absolute deviation multiplied by $\sqrt{\pi / 2}$. Schwert (1989) and Hsieh and Miller (1990) also use this adjustment.

The square of conditional standard deviations estimated by above method gives the conditional variance of market return. To estimate conditional covariance of asset return with the market return need some more manipulation. To estimate conditional covariance between two variables $i \neq j$, the residual from equation (B5) are taken for estimation of the following equation:

$$(\sqrt{\varepsilon_{it}^{*}})(\sqrt{\varepsilon_{jt}^{*}})s_{ijt} = Z_{t-1}\psi + \varepsilon_{ijt} \qquad \text{(B8)}$$

In this equation s_{ijt} is term that preserves the sign of the product of two residuals at each date. The fitted conditional covariances are:

$$sign(Z_{t-1}\hat{\psi})(Z_{t-1}\hat{\psi})^{2}(\pi/2) \qquad \text{(B9)}$$

Where $\text{sgn}(x) = x/|x|$.

In this way the above procedure forms fitted value to estimate conditional covariance of asset returns with the market return. The conditional betas are then estimated as inverse of conditional variance vector multiplied by estimate vector of conditional covariance of asset returns with the market return. By using this vector of conditional betas, the cross section equation of conditional multifactor CAPM given in equation (10) is estimated month by month and the slope coefficient gives risk premium for each month. In this way market risk and price of risk is allowed to vary over time. The average of these risk premiums is obtained and Fama-McBeth (1973) t-values are calculated to test that the premium is significantly different from zero. These t-values are also adjusted for Shanken (1992) adjustment.