Conditional Capital Asset Pricing Model: An Application to Pakistani Stock Market

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Introduction

- An efficient performance of pricing mechanism of stock market is a driving force for channeling saving into profitable investment and facilitating in the optimal allocation of capital and also attracting foreign investor in emerging market.
- The pricing mechanism by ensuring a suitable return for facing risk on investment expose viable investment opportunities to the potential investors.
- To find out how the risk of an asset be measured and what economic forces determine the price of the risk.

Mean-Variance Portfolio Theory

- The foundation for the development of CAPM is laid by Markowitz (1952) and Tobin (1958).
- The Mokowitz model assumes that investors are risk averse and when choosing among portfolio they only care about mean and variance of their one-period investment return. The result is that the investor will chose a mean-variance efficient portfolio

Standard Capital Asset Pricing Model

- Sharpe (1964) and Lintner (1965) extended it further by developing a relationship between risk and expected return by identifying a portfolio that must be efficient if asset prices are to clear the market.
- This theory predicts that the expected returns on an asset above the risk free rate is proportional to the non-diversifiable risk, which is measured by the covariance of the asset return with a portfolio composed of all the existing assets, called the market portfolio

Standard Capital Asset Pricing Model

- The CAPM model

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

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

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

$$E(R_{it}) = E(R_{zt}) + \beta_i (E(R_{mt}) - E(R_{zt}))$$

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

Implication of CAPM

- Three implications of the relationship between expected return and market beta are tested

$$r_i = \lambda_0 + \lambda_1 \beta_i + \lambda_{2t} SD(\varepsilon_i) + \varepsilon_i$$

$$r_{it} = \lambda_0 + \lambda_1 \beta_i + \lambda_2 \beta_i^2 + \varepsilon_{it}$$

$$r_i = \lambda_0 + \lambda_1 \beta_i + \lambda_2 SD(\varepsilon_i) + \lambda_3 \beta_i^2 + \varepsilon_i$$

Conditional CAPM

- Then assumption of one period model is relaxed. Return distribution is allowed to vary over time

$$E_{t-1}(r_{it} | Z_{t-1}) = \beta_i E_{t-1}(r_{mt} | Z_{t-1})$$

$$\beta_{it} = \mathrm{cov}(r_{it}, r_{mt} | Z_{t-1}) / \mathrm{var}(r_{mt} | Z_{t-1})$$

$$r_{it} = \lambda_{0t} + \lambda_{1t}\beta_{it} + \varepsilon_{it}$$

Conditional CAPM

- The conditional CAPM imply that expected return of an asset is related to their sensitivity of changes in the state of the economy, called the time series of betas for each state of economy. For each relevant state there is market price or premium per unit of beta.
- The major determinants of price movements of stocks are business cycle variables.
- The lagged business cycle variables are entered into model in linear form for estimating beta risk month by month.
- The cross-section regression is estimated for each month to find time varying risk premium

Conditional Variances

- Let σ_{it} is unconditional standard deviation

$$r_{it} = Z_{t-i}\delta + \varepsilon_{it}$$

$$\widehat{\varepsilon}_{it} = r_{it} - Z_{t-i}\widehat{\delta}_t$$

$$\left|\widehat{\varepsilon}_{it}\right| = \sigma(\theta, Z_{t-1}) + v_{it}$$

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

$$\varepsilon^*_{it} = r_{it} - Z_{t-1}\delta^*$$

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

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

Conditional Covariance

- Conditional covariance between market return and asset return

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

$$sign(Z_{t-1}\widehat{\psi})(Z_{t-1}\widehat{\psi})^{2}(\pi/2)$$

$$\operatorname{sgn}(x) = x/|x|$$

Conditional Beta

- 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 CAPM is estimated month by month and the slope coefficient gives risk premium for each month.

Data

- The data include 49 companies which contributed 90% to the total turnover of KSE in the year 2000. In selecting the firms three criteria were used.
- Companies have continuous listing on exchange for the entire period of analysis.
- Almost all the important sectors are covered in data.
- Companies have high average turnover over the period of analysis.

Data

- Information on dividends, right issues and bonus share book value of stocks are obtained from the annual report of companies.
- The sample is divided into sub-sample for three years, six yeaars.
- The data on macroeconomic variables are obtained from Monthly Statistical Bulletin and Economic Survey

The Instruments

- The intuition is that investors want to smooth their out their consumption. At business-cycle troughs, the equity risk premium is high because investors are short of cash and use all their cash to keep consumption a permanent level. They do not have much discretionary cash for investing in stocks. Therefore to make sure that investors hold their portfolio of stocks, the risk premium must be high in equilibrium. This line of argument also implies that proper instrument variables must be related to current and/or future macroeconomic environment.

Estimation Procedure

- Two-step estimation procedure time series cross-section regression.
- In using individual assets the large idiosyncratic variances are of concern GMM is used in time series.
- In cross-section regression the returns are correlated and heteroscedasticity, *Generalized Least Square (GLS)* is used in cross-section regression
- 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 premium is zero is calculated using the standard deviation of the time series of estimated risk premium which captures month by month variation following Fama and McBeth (1973).
- Alternative t-ratios using a correction for errors in beta suggested by Shanken (1992).

Empirical Findings

- Sharpe–Lintner CAPM is not adequate to KSE. The critical condition of CAPM, a positive trade off between market risk and return, is rejected.
- For the most period of the study, negative sign in the estimated market premium is observed.
- Secondly, the residual risk plays some role in pricing risky assets for the period 1998-2000, 1999-2001 and overall period 1993 to 2004

Empirical Findings

- The investors get positive compensation for market risk in sub-periods 1993-1995, 1993-1998, 1999-04 and the overall sample period 1993-2004. The results suggest that there is positive and significant compensation on average to bear conditional market risk.
- The results of conditional CAPM confirm the notion of time variation in market risk and risk premium is confirmed to some extent by the individual firms at KSE

Market Efficiency

- The joint hypothesis that market efficiency does not hold true, due to presence of significant mean pricing errors in all models

Conclusion

- The main conclusion emerges from the analysis is that the results confirms the time variations in economic risk and risk premium. The empirical evidence reveal that the model with time varying market beta and time-varying risk premium captures more support.