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Title: Conditional CAPM and Cross sectional returns– A study on Indian Securities Market

Introduction:

A substantial portion of research in financial economics is devoted to understand how investors evaluate the riskiness of financial assets and the premium attached to the risk. Though it is common knowledge that higher the risk higher would be the returns, the question that remains are, what type of risks are rewarded and what is the price of the risk i.e the risk premium per unit risk. Several equilibrium asset pricing models viz., Capital Asset Pricing Model (CAPM) (Sharpe, Lintner and Mossin, 1961) later modified by Black (1972), Arbitrage Pricing Theory (APT) (Ross, 1976), Intertemporal capital asset pricing model (ICAPM) of (Merton, 1973) and Consumption based capital asset pricing model (breedin) attempt to answer the questions. Despite the anomalies found in the CAPM (discussed below), it still remains the most favourite asset-pricing model for researchers as well as industry practitioners. The success owes partly to the simplicity and intuitive appeal of the model and mainly to the lack of better alternative models (Fama, 1991).

Early cross-sectional tests on CAPM:

The CAPM postulates that the return on any asset is linearly related to its market beta, with beta being defined as the ratio of the covariance of the asset with the market portfolio to the variance of the market portfolio. In other words, cross sectionally only the market beta shall be priced. The early empirical tests of CAPM by Black, Jensen and Scholes (1973) and Fama and Macbeth (1973) found support for CAPM because higher returns were associated with higher betas. Although the security market line obtained from the studies was more flat than what is prescribed by CAPM, it was considered to be supporting the zero-beta CAPM of Black.

CAPM anomalies:

The problems for CAPM started with the findings of anomalies in early 80s. The most important of them is 'size effect' (Banz, 1981) i.e. small stocks in terms of market capitalization earn more returns than what is prescribed by CAPM. The 'value effect' (Basu, 1983) says that the high BV/MV earn higher returns than the low BV/MV stocks. Another important anomaly that is to be explained is the 'momentum effect' (Jagadeesh and Titman, 1993). Momentum effect says that there is momentum in stock returns and the stocks that have done well in the past tend to do well in the future and the losers of the past tend to be lose in the future too. Fama and French (1992) in their most cited article find that when size and BV/MV factors are considered the CAPM ? has no marginal explanatory power for cross sectional returns.

Explanation for CAPM anomalies:

Various explanations are offered to explain the CAPM anomalies. The explanations range from data snooping (Lo and Mckinlay, 1990) to investors' over-reaction (Lakhonishok et. al, 1997) or under-reaction. Fama and French (1993) offers an empirical three-factor model with size and BV/MV considered explicitly apart from the market beta of CAPM. Though the three-factor model have better explanatory power than the original CAPM the economic reason for size and BV/MV to be priced is not known. Fama and French (1993,1996), in their later article says that the small stocks with high BV/MV ratio are firms that have performed poorly and are vulnerable to financial distress and command a premium which they call as 'distress premium'. But why distress risk should be priced and why it should command more price than the market beta remain to be answered (Campbell, 2000).

Another explanation could be that the CAPM might not be able to explain the cross sectional returns unconditionally but conditionally it might perform well. The assumptions on the estimation of original CAPM, following two pass regression methods of Fama and Macbeth (1973), like constant expected returns, risk premium and market betas are not valid. Risk premiums vary over time (Ferson and Harvey, 1991) and will be higher during the recessionary period. Also during a recession the financial leverage of firms in relative poor shape may increase relative to other firms causing their stock betas to rise (Jagannathan and Wang, 1996). So by allowing the expected returns, betas and risk premiums in the CAPM to vary explicitly, it might be possible to improve the cross-sectional explanatory power of CAPM. Or in other words, the CAPM holds conditionally at any given point in time. In this proposed paper, we attempt to test whether testing CAPM conditionally improves the explanatory power.

Conditional CAPM:

The conditional CAPM in excess form can be written as follows:

$$E[r_{it} / Z_{t-1}] = \frac{Cov[r_{it}, r_{mt}] / z_{t?1}}{Var[r_{mt}] / z_{t?1}} E[r_{mt} / Z_{t?1}]$$

Z_{t-1} is the information available with the investors at time t-1. These information variables have predictive ability for expected returns and hence used by the investors. By defining the dynamics of the expected returns, covariance and the variance over time the model can be estimated.

Econometric specifications:

The econometric specifications shall follow Harvey (1991) to impose additional structures on the first and second moments of equation (2) to test. Three variants conditional CAPM shall be tested viz., conditional CAPM with time varying moments (the means, variances and covariances are allowed to vary over time), conditional CAPM with constant betas (betas are restricted to be

constant) and conditional CAPM with constant price of risk (the reward to volatility is restricted to be constant).

In all the three forms of conditional CAPM, the return on portfolios as well as the return on market portfolio is defined as

$u_{jt} = r_{jt} - Z_{t-1}?_j$

$u_{mt} = r_{mt} - Z_{t-1}?_m$

Z_{t-1} is the information set which investors use to forecast the expected returns. The assumption here is that the expected returns on the assets and market proxy are linear with the information variables. The information set would contain variables (macro economic and financial variables of the firm) that are found to have ability to predict equity returns in short term.

1. **Conditional CAPM with time varying moments**: In this model, the expected returns, the risk premium and the betas of the portfolios are allowed to vary over time. In this case we have to define the dynamics of the variance and the covariance over time. The equation for this version would be:

   $E[r_{it} / Z_{t-1}] = \frac{Cov[r_{it}, r_{mt}] / z_{t?1}}{Var[r_{mt}] / z_{t?1}} E[r_{mt} / Z_{t?1}]$

2. **Conditional CAPM with constant betas:** In this version, the betas of the portfolios (the ratio of the covariance of the portfolio with the market to the variance of the market) is restricted to be time invariant. With this restrictions the model reduces to the standard CAPM model. The only difference is that the expected returns of the portfolio and the market portfolio are allowed to vary over time. This enables us to test whether the restriction of constant betas is correct or not. The testable equation in excess return form can be written as follows:

   $E[r_{it} / Z_{t-1}] = ?_{im} E[r_{mt} / Z_{t-1}]$

3. **Conditional CAPM with constant price of covariance risk**

   In this case we restrict the price of covariance risk to be constant or in other words the reward to volatility ratio is kept constant. This restrictions allow us to test whether the price of covariance risk changes over time. Also this CAPM being a domestic CAPM, the price of covariance risk should be the same for all the portfolios. But that restriction is not imposed on the model. This allows the data to speak whether the price of covariance risk is indeed the same across the portfolios or not. The equation for this shall be:

   $E[rit / Zt-1] ? ?_i Cov[r_{it}, r_{mt}] / Z_{t?1}$

Estimation methods:

The models mentioned above shall be tested using Hansen's (1982) Generalized method of moments. A vector of orthogonality conditions (g) shall be formed and the parameters shall be chosen to make the orthogonality conditions as close to zero as possible by minimizing a quadratic form (g'wg) where w is symmetric weighting matrix. The minimized value of the quadratic form shall be distributed $?^2$ under the null hypothesis with degrees of freedom equal to the number of orthogonality conditions minus the number of parameters. The $?^2$ statistic, which is called the test of the overidentifying restrictions, shall provide the goodness of fit of the model. The reason for choosing Generalized method of moments (GMM) over maximum likelihood restriction is because in GMM needs less restrictive assumptions.

Sources of Data:

We shall use monthly data from 1990:01 - 2001:07 for all the firms listed in Bombay Stock Exchange during the period 1990-2001. Five value-weighted portfolios shall be created by value ranking the companies on the basis of market capitalization every month and splitting these companies into value-ranked quintiles, and then forming five portfolios based on value weights within a quintile.

The monthly closing price data for the stocks required for this study shall be collected from the data published by the 'Centre for Monitoring Indian Economy' (CMIE). The returns of 91-day Treasury bill of the Government of India shall be used as the risk free rate. For the bench mark or market return, we shall use the value-weighted return on the Bombay stock exchange index BSE-National index.

The selection of instrumental variables for conditioning information is borrowed from previous studies done on developed markets (please refer Harvey, 1991 pg no 120 &121 for detailed references and discussion). The instrumental variables considered are the lagged market return, foreign exchange rate (Rs/USD) changes, difference between the redemption yield on 10 year T-bonds and 91 day Treasury bill of Government of India and finally the ratio of the market proxy (BSE-National index) to the index for domestic industrial production. The monthly data for the above instrumental variables are collected from ISI-Emerging markets database (lagged market return), RBI bulletins (91 day treasury bill returns and returns on 10 year T-bonds) and "International Financial Statistics" released by International Monetary fund and the monthly bulletins of the Reserve Bank of India.

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