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STOCK RETURNS AND RISKS: AN EMPIRICAL ASSESSMENT USING MODIFIED CAPM APPROACH

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ABSTRACT

Modern portfolio theory assists stakeholders in financial markets to optimize their portfolios to attain expected return at a specified level of risk and uncertainty. However, the conventional capital asset pricing model (CAPM), proposed by Sharpe (1964) and Lintner (1965), fails to accurately estimate the expected rate of return of stock equities due to the presence of external uncertainties, and rapid changes in macroeconomic dynamics. Therefore, this study has adopted a modified CAPM that incorporates additional factors besides beta to more accurately estimate the expected return of stock equities. It highlights these exposures by using time-varying beta CAPM, applied to the cement industry of Pakistan for the period from January 2016 to March 2022. The results show that the expected rate of return is very much close to risk free rate of return in the cement industry of Pakistan. Furthermore, the findings of the study confirm that the prediction of expected rate of return depends on variations in estimation techniques and data availability. Additionally, by introducing the concept of a reference portfolio and a market portfolio, the modified CAPM represents an improvement over conventional method. Moreover, by breaking down the beta deviations into long-term and short-term components, this new method allows for precise computation and simplifies the prediction of expected returns in both equity and portfolio investments. The findings of this study will be beneficial for investors, financial analyst, and portfolio-managers in the decision-making about portfolio investments.

Keywords: Beta; Asset pricing; CAPM; Stock prices; Industry; Portfolio; Return; Risk; Equity.

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INTRODUCTION

Individual stocks are prone to stand-alone risks. This study explores the dynamics of risk in equity investments and the estimation of beta in the context of portfolio investments. In the literature of finance, individual investors face uncertainties and risks when investing in stocks. As these risks become more uncertain and complex, investors often turn to portfolio investments, such as mutual funds, which are designed to mitigate such risks (Markowitz, 1991). Beta, an essential component of finance, plays a pivotal role in risk estimation. Thus, accurate beta estimation is crucial for making informed investment decisions. Traditional methods involve comparing asset returns with those of a market portfolio to estimate beta, using historical averages. However, these calculations often rest on the assumption of constant asset returns and unchanging Capital Asset Pricing Model (CAPM) beta.

The objectives of this study are to address the limitations of traditional beta estimation methods and investigate the time-varying nature of beta in the context of emerging markets. Past studies have reported that beta estimations are time-variant (Brailsford & Josev, 1997; Fama & MacBeth, 1973; Hawawini, 1983) and influenced by available information and estimation outliers (Hansen & Hodrick, 1983). This becomes particularly relevant in emerging economies where stock equities are highly susceptible to rapid environmental changes (Lewellen et al., 2010).

This study focuses on the cement industry of Pakistan from January 2016 to March 2022, listed on the Pakistan Stock Exchange (PSX). The study considers that changing betas can complicate the estimation of various equity parameters. The research employs the time-varying beta model, building on Linter's original concept, to improve the precision of beta estimations by adjusting the reference and market portfolios to account for systematic risk. Further, by breaking down beta into long-term and short-term components, this model enhances the accuracy of expected returns prediction.

REVIEW OF LITERATURE

This section of the literature review highlights and discusses the substantial body of research related to CAPM, beta estimation, and risk-return trade-offs. Furthermore, this section discusses the significant theoretical and empirical studies that provide a foundation for this study.

In the literature of finance, the CAPM was initially formulated by Sharpe (1964) and Lintner (1965), suggesting a linear relationship between risk and return in financial assets. It seeks to explain variations and discrepancies in the returns of risky assets, as observed by Dennis et al. (2017). This theory also explains the connection between average returns and non-diversified risk, with support from both theoretical evidence and empirical observations on equity prices and portfolios (Eugene, 2013; Fama & French, 1993). Furthermore, the pricing theory inherent in the CAPM, as developed by Ross (1976), Lintner (1965), and Sharp (1964), based on a single-factor CAPM framework, integrates evidence from studies such as Fama and French (1993). This empirical literature introduces additional risk factors stemming from external influences and considers the consequences of short-selling (Campbell & Cochrane, 2000; Cochrane, 1996; Jagannathan & Wang, 1996).

However, it is essential to identify the limitations of the CAPM assumptions (Chang et al.,2011), which rely on covariance and decomposed beta computations. The empirical literature further reveals the interconnectedness of portfolios and their capacity to explain variations in average returns. The modified CAPM focuses solely on market risk, with significant implications for equity pricing and returns, as emphasized by Fama and French (1996) and supported by the pioneering work of Fama and MacBeth (1973). They apply regression and pricing techniques, including two-stage beta analysis, to measure the effect of portfolio betas over varying ranges.

The CAPM and other pricing models have been extensively studied over time and Damodaran (2012) suggests the adoption of time-varying betas over constant betas to capture the dynamic nature of risk. The estimation of beta involves various approaches, such as cross-section regression (Ohlson & Rosenberg, 1982) and the Kalman (1960) filter method (Bos & Newbold, 1984; Simonds et al., 1986; Collins et al., 1987; Faff et al., 1992; Brooks et al., 1992). It is generally recognized that beta estimation is influenced by the length and size of the market portfolio (Blume, 1975; Ferson & Harvey, 1991). Several empirical studies explore the implications of varying beta estimates and their impact on the pricing of assets (Andersen et al., 2005; Brailsford & Josev, 1997; Hawawini, 1983). The rate of returns and changes in portfolio betas over different time horizons has been a focal point (Patton & Verardo, 2012; Van Dijk et al., 2014).

Furthermore, stock prices are influenced by macroeconomic variables (Fama,1981) and exhibit sensitivity to short-term changes (Levhari & Levy, 1977). The computation of beta must take into account the time interval to avoid bias, and wavelet analysis (Gençay et al., 2005) offers a solution. This approach decomposes time series data to evaluate portfolio betas at various frequencies, providing insights into beta changes due to different time horizons. Thus, it is essential to acknowledge that stock prices are subject to factors such as trading size, market size, available information, and errors in recording (Aït-Sahalia et al.,2011; Iqbal et al., 2023b; Kim, 1995). Inadequate trading processes can introduce noise into closing prices (Shanken, 1992). Also, errors in data recording and market size can affect pricing (Rösch et al., 2022). Lastly, imperfections in trading processes can create inconsistencies in closing prices (Kliestik & Spuchlakova, 2016).

In spite of criticisms, the CAPM remains central to financial economics. Campbell and Cochrane (1999) highlight its lasting relevance. This study presents an extension of the modified CAPM, aiming to estimate expected returns through decomposed portfolio betas that summarize systematic risk. The model builds upon the work of Galai and Masulis (1976), employing time-series data to capture real-time information and accounting for the country's risk-free premium (Fard & Falah, 2015). In addition, the examination of risk premiums has generated an understanding of stock and bond estimation (Hansen & Hodrick, 1983; Hodrick & Srivastava, 1984). Also, revealed interest parity has been evaluated using time series properties of asset returns (Honohan & Peruga, 1986). Portfolio balance models have been modified to evaluate equity asset pricing equations instead of asset demand equations (Wenzelburger, 2020). These models maximize asset diversification and incorporate estimation restrictions (Hansen & Hodrick,1983).

The modified CAPM introduces a novel approach to risk-return valuation, founded on instrumental variables for individual industry stocks and portfolio investments while assuming a consistent estimate of the country's risk premium. Small-sample tests on risk factors (Fama & French, 1992) have been conducted to compute long-term and short-term portfolio betas, with the results of covariance and sample data weights estimator considered (Hawawini, 1983). On the other hand, the reference portfolio has been known as a modification of the market portfolio (Wenzelburger, 2020) and serves as the cornerstone of this study's modified CAPM. Empirical studies conducted by Fabozzi and Francis (1978) support this framework, which incorporates the estimation properties introduced by LaMotte and McWhorter (1978). The model disregards the stock pricing process influenced by external agents' trading activities (Collins et al., 1987).

However, the beta biases in the empirical literature have not been thoroughly documented, and various attempts to address these biases have not reached a conclusive outcome (Damodaran, 2012). Biases in beta estimation are influenced by the size and market capitalization of the firm (Fama & French, 1992). These attributes of potential biases have been the subject of several scholarly discussions and need further formal analysis. Thus, it is evident that estimated betas are significantly time-varying and dependent on systemic and non-systemic risk (Blume, 1975; Fama & French, 1996; Ferson & Harvey, 1991). The efficient evaluation of risk-return trade-offs has been a recurring theme in financial research, emphasizing the importance of accurate beta estimation for achieving optimal returns on portfolio investments (Aragó et al.,2022; Mandal & Thakur, 2023).

METHODOLOGY

This study examines the significance of beta dynamics in the context of portfolio investment using the foundational work by Tversky and Kahneman (1992). Specifically, our analysis aims to estimate the impact of beta on portfolio investment using cross-sectional regression analysis. The study examines Pakistan's cement industry from January 2016 to March 2022, focusing on companies listed on the PSX. It utilizes a time-varying beta modified CAPM, an extension of Linter's concept, to improve the accuracy of beta estimates by adjusting reference and market portfolios to consider systematic risk. This model also divides beta into long-term and short-term components, enhancing the precision of expected return predictions (Bos & Newbold, 1984; Brooks et al., 1992)

Our methodology, inspired by Blume (1975), Harvey (1989), and Tversky and Kahneman (1992), evaluates the importance of beta dynamics in portfolio investment. The study computes the portfolio beta using the principles provided by Fama and French (1992) for selected cement companies on the PSX from January 2016 to March 2022. Panel regression analysis provides better estimates than cross-sectional ones (Iqbal et al., 2023a; Hasan et al., 2022; Hashmi et al.,2022). Furthermore, our methodology, based on Black (1972) and Fama and MacBeth (1973), incorporates regional adjustments and is tested using methods developed by Frankel (1982), supported by Bollerslev et al. (1988).

Sample, Measurement and Variables

The sample data of five cement companies (mentioned in Table 1) for the period from January 2016 to March 2022 were collected from PSX website to compute long-term and short-term beta. For the size sorted portfolios, the market capitalization for hundred companies is considered on the basis of market portfolio of these companies are arranged to compute individual beta duly multiply with assigned weight. This is composed of daily closing return of 100 index of PSX.

Table 1. Description of Variables and Selected Companies of Pakistan Cement Industry

Variables	Description
R_f	Risk free rate of return
R_i	Expected rate of return
β_L	Portfolio Long-term beta
β_S	Portfolio Short-term beta
w_L	Weight of long-term betas
w_s	Weight of short-term betas
R_m	Market risk premium
Sample Companies	Dera Ghazi Khan Cement Limited (DGKC) Lucky Cement Limited (Luck) Maple Cement Limited (Maple) Attock Cement Limited (Attock) Dewan Cement Limited (Dewan).

Note: Data of R_f and Rm were collected from International Country Risk Guide and State Bank of Pakistan.

Portfolio Estimation Model:

$$R_i = R_f + (\beta_L w_L + \beta_S w_S)\, R_m \qquad \text{(Model 1)}$$

Where R_i is the expected return of Portfolio, R_f is risk free rate of return, β_L is long-term beta (calculated for 6 years), β_S is short-term beta (is calculated for 1 year), R_m is Market Premium, w_L and w_S are the weight of long-term and short-term betas respectively. Note that $w_L + w_S > 0$ & $w_L + w_S = 1$ indicating that Long-term and short-term betas' weights are greater than zero and equal to one.

Valuation Formula:

$$\beta_{Li} = \text{Covar } (i^{th} \text{ market index}) / \text{Var}_i \qquad \text{(Model 2)}$$

The β_L of the selected companies and portfolio β are as follows.

Reference Portfolio Model:

$$\beta_L = \sum (\beta_{Li} \times W_L \beta_i) \qquad \text{(Model 3)}$$

To empirically validate the above identity, the risk factor due to the exchange rate has been considered an important factor by investors for the majority of equities of industrial sectors equities of PSX (Fard & Falah, 2015; Wenzelburger, 2004).

Further, deviations from parity can cause exchange gains or losses. In addition, limited historical financial data poses a challenge in examining securities in emerging markets, as seen with our sample companies. Thus, there may also be inconsistencies in recorded financial values. These results suggest the need for in-depth longitudinal studies to better measure the proposed model's expected rate for market-adjusted asset cash flows.

RESULTS AND DISCUSSION

The computation of the long-term and short-term portfolio betas of the selected companies is reported in Table 2. The long-term beta computed through co-variance divided by variance computed by taking data of 6 years while the short-term beta is computed taking the available data of 1 year and the portfolio beta is the sum of all betas computed in individual equity asset from our estimation. The assumption of weight assigned to each individual equity stock is based on half of an individual's savings invested into equity stocks and the rest may invest in any other investment options enable to diversify investment and to mitigate risk. The weight assigned here to each individual asset is crucial and based on market condition and economy size of estimator and its assumption pertain to our discussion.

Table 2. Estimation of portfolio betas.

Calculation of Portfolio Long Term Beta						
Variables	DGKC	Lucky	Maple	Attock	Dewan	
Variance	0.06	0.05	0.07	0.06	0.13	
Covariance	0.00	0.00	0.00	0.00	0.00	
Beta	-0.81	-1.68	-0.82	0.39	-0.09	
Long Term Beta	0.50	0.50	0.50	0.50	0.50	
Portfolio Long Term Beta	0.00	-0.01	0.00	0.00	0.00	-0.0151
Calculation of Portfolio Short Term Beta						
Variables	DGKC	Lucky	Maple	Attock	Dewan	
Variance	0.11	0.08	0.14	0.10	0.21	
Covariance	0.00	0.00	0.00	0.00	0.00	
Beta	0.08	-2.17	-0.78	-0.23	-0.37	
Weights	0.50	0.50	0.50	0.50	0.50	
Short Term Beta	0.00	-0.01	0.00	0.00	0.00	
Portfolio Short Term Beta	0.00	-0.01	0.00	0.00	0.00	-0.0174

Furthermore, the study found that the expected rate of return of the portfolio (Ri) is very close to the risk-free rate of return (R_f) of the cement industry of Pakistan. Furthermore, the models and estimation of our study provided a simple technique of stock valuation, where investors will find that the return on their risky investment is equivalent to the R_f. The estimates using the models discussed above are presented in Table 3.

Table 3. Estimations of return and risk.

Variables	Estimate
Risk free rate of return	11.22 %
Portfolio Long-term beta	-0.0151
Portfolio Short-term beta	-0.0174
Weight of long-term betas	0.5
Weight of short-term betas	0.5
Market risk premium	11.90 %

Transition from Market Portfolio to Reference Portfolio

Substituting the market portfolio with the reference portfolio, the three initial problems that this study focuses on can be solved. First, the reference portfolio is by construction mean-variance efficient. Second, its beta coefficients are a meaningful measure of risk, as they define a time-dependent security market line and capture the full cross-section variability of the given returns process. Third, its Sharpe ratios are useful as they offer the best trade-off between risk and return.

Our findings show that the portfolios used are sensitive due to changes in betas and produce different results when the standard deviation varies to optimize market return towards a risk-free rate. Further, these results could be changed to an extent by data manipulation. Thus, the performance of the modified CAPM model with market values fails to justify its significance and global acceptance. Therefore, the result of our study contributes to the literature by providing a better alternate model to evaluate the free return of portfolio investment in the cement industry of the Pakistan Stock Exchange. Consistent with previous studies, our results of cross-section regression and security market provide mean variance efficient with time-varying beta (Blume, 1975; Ferson & Harvey,1991; Galai & Masulis, 1976).

Valuation and Arbitrage

The difference detected from the estimation of risk-free rate in equity returns and market rate of return in broad aspects compared with risk free rate of the cement sector using Model 1 (portfolio estimation) by substituting the values from Table 3.

$$R_i = R_f + (\beta_L w_L + \beta_S w_S)\ R_m$$

$$R_i = 11.22 + [(-0.01510x0.5) + (-0.01710x0.05)] *11.90$$

$$R_i=11.212$$

According to our finding, the R_i (expected rate of return) of our portfolio is very much close to R_f (risk free rate of return in the cement industry of Pakistan. Our models and estimation provided a simple technique of stock valuation, wherein investors will find that the R_i to their risky investment is equivalent to the country's R_f. Our findings are consistent with the previous studies (Black. 1972; Mandelker & Rhee, 1984; Rosenberg & Guy, 1976) in other regional manufacturing sectors with different stock portfolios.

CONCLUSIONS

This study has critically examined the inability of Lintner's Model (1965) to accurately predict the expected rate of return of secondary equity markets due to external uncertainties and rapid environmental shifts. Specifically, the study examined the dynamics of stock equities of the cement industry of Pakistan, listed on the Pakistan Stock Exchange, from January 2016 to March 2022 using a modified capital asset pricing model (CAPM). The findings show that the measurement of beta is significantly affected by the estimation approach and availability of data, and it is found to be time-variant. In other words, by breaking down beta into short-term and long-term components, the study improved and increased the explanatory power of the expected return predictions by the model. According to our findings, the expected rate of return is very much close to risk free rate of return in the cement industry of Pakistan. Thus, this study significantly contributes to the literature by incorporating the concept of a reference portfolio with the market portfolio, extending the version of the CAPM considering the time-varying nature of beta. Furthermore, the sensitivity of portfolios due to time-varying beta and data manipulation can have significant consequences. In addition, the findings of this study offer useful implications regarding the estimation of risk and return in the context of emerging markets. Thus, the study will be useful for investors, financial analysts, and portfolio managers in the decision-making regarding portfolio investments. Further, this study's findings are limited to Pakistan's cement industry, but the analysis could be further explored in other manufacturing sectors.

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