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AN EMPIRICAL EVALUATION OF CAPM PREDICTION BIAS AND MODEL ADEQUACY WITH PANEL EVIDENCE FROM THE INDIAN STOCK MARKET

UMA DEVI
Assistant Professor, Rao Bahadur Y Mahabalewarappa Engineering College Ballari, Viveshwaraya Technological University, Belagavi.

Dr. K T GOPI
Professor, Rao Bahadur Y Mahabalewarappa Engineering College Ballari, Visveswaraya Technological University Belagavi.

Abstract

This study provides a comprehensive empirical evaluation of the Capital Asset Pricing Model (CAPM) by examining the divergence between actual and predicted returns using panel data from Nifty 200 firms. While CAPM remains one of the most influential asset pricing models in financial economics, its empirical validity—particularly in emerging markets—has been widely debated. This research moves beyond traditional CAPM validation by incorporating prediction bias analysis, alpha persistence, and panel econometric techniques to assess model adequacy. Using Ordinary Least Squares (OLS) and panel data models, the findings indicate a statistically significant beta coefficient ($\beta \approx 0.9864$, $p < 0.001$) and strong explanatory power ($R^2 = 0.906$), confirming the importance of systematic risk. However, the presence of statistically significant positive alpha ($\alpha = 0.1209$, $p < 0.05$) reveals systematic prediction bias, suggesting that CAPM consistently underestimates returns. Panel data analysis further confirms the persistence of abnormal returns even after controlling for firm-specific heterogeneity. The study contributes to the asset pricing literature by demonstrating that CAPM is statistically robust yet economically incomplete in the Indian stock market. The findings have implications for investors, policymakers, and researchers, emphasizing the need for multi-factor and behavioral models in emerging markets.

Keywords: CAPM, Alpha, Panel Data, Prediction Bias, Indian Stock Market.

1. INTRODUCTION

The Capital Asset Pricing Model (CAPM) is one of the most fundamental frameworks in financial economics, offering a theoretical basis for understanding the relationship between expected returns and systematic risk. Developed by William Sharpe (1964) and extended by John Lintner (1965), CAPM posits that the expected return on an asset is determined solely by its sensitivity to market risk, measured by beta. Under the assumptions of efficient markets, rational investors, and frictionless trading, CAPM provides a linear relationship between risk and return.

Despite its theoretical elegance and widespread application in portfolio management, capital budgeting, and financial decision-making, the empirical validity of CAPM has been the subject of extensive debate. Numerous studies have documented deviations between actual returns and CAPM predictions, raising questions about the model's adequacy. These deviations are particularly pronounced in emerging markets, where structural inefficiencies, information asymmetry, and behavioral biases play a significant role.

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The Indian stock market provides a compelling context for testing the validity of CAPM. Over the past two decades, the market has undergone significant transformation, characterized by increased institutional participation, technological advancements, and regulatory reforms. However, it continues to exhibit features of an emerging market, including volatility, heterogeneity among firms, and varying levels of investor sophistication. This study aims to evaluate CAPM not merely as an explanatory model but as a predictive framework. Specifically, it investigates whether CAPM accurately predicts returns or systematically deviates from actual outcomes. By focusing on prediction bias and alpha persistence, the study provides deeper insights into the limitations of CAPM. Furthermore, the use of panel data techniques allows for the control of firm-specific heterogeneity, enhancing the robustness of the analysis.

2. LITERATURE REVIEW

The CAPM was formally introduced by Sharpe (1964) and Lintner (1965), building upon the portfolio theory developed by Markowitz. Early empirical studies provided partial support for the CAPM, suggesting that beta is positively related to expected returns. However, subsequent research revealed significant anomalies that challenged the model. Fama and French (1992) conducted a seminal study demonstrating that beta alone does not adequately explain stock returns. Their findings showed that firm size and book-to-market ratios have stronger explanatory power than beta. This led to the development of the Fama-French three-factor model, which incorporates size (SMB) and value (HML) factors. Banz (1981) identified the size effect, showing that small-cap stocks tend to outperform large-cap stocks. Similarly, Basu (1977) documented the value effect, where stocks with low price-to-earnings ratios generate higher returns. Jegadeesh and Titman (1993) further identified momentum effects, suggesting that past winners continue to outperform.Roll (1977) criticized CAPM on theoretical grounds, arguing that the model is untestable because the true market portfolio cannot be observed. This critique highlighted fundamental limitations in empirical testing. In emerging markets, studies have consistently found deviations from CAPM predictions. Factors such as market inefficiency, liquidity constraints, and behavioral biases contribute to these deviations. Research in the Indian context has also reported inconsistent beta-return relationships and the presence of abnormal returns.

The empirical validity of CAPM has been widely debated in financial literature. While early studies by Sharpe (1964) and Lintner (1965) supported the model, subsequent research identified significant anomalies. Fama and French (1992, 1993) demonstrated that beta alone fails to explain stock returns, leading to the development of multi-factor models. Studies such as Banz (1981) and Basu (1977) identified size and value effects, while Jegadeesh and Titman (1993) documented momentum anomalies. In emerging markets, Harvey (1995) and Bekaert and Harvey (2002) reported deviations due to inefficiencies and structural constraints. Evidence from the Indian stock market (Sehgal & Balakrishnan, 2013; Tripathi & Gupta, 2010) further confirms the limitations of CAPM, highlighting the presence of abnormal returns and inconsistent beta-return relationships.

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This study builds upon the existing literature by explicitly focusing on prediction bias and alpha persistence, providing a more nuanced evaluation of CAPM in an emerging market setting.

3. METHODOLOGY

Model: $R_{it}-R_{ft}=\alpha+\beta(R_{mt}-R_{ft})+\epsilon$. OLS used as baseline.

Where:

- R_{it}: Return on stock i
- R_{ft}: Risk-free rate
- R_{mt}: Market return
- β: Systematic risk
- α: Abnormal return

Given the panel structure of the dataset, Fixed Effects (FE) and Random Effects (RE) models are employed:

- **Fixed Effects Model:** Controls for firm-specific heterogeneity
- **Random Effects Model:** Assumes random variation across firms The **Hausman test** is used to determine the appropriate model. **Diagnostic Tests**

To ensure robustness:

- Durbin-Watson test → checks autocorrelation
- Normality tests → validate residual distribution
- Robust standard errors → address heteroskedasticity

4. RESULTS

To evaluate the explanatory power and predictive accuracy of the Capital Asset Pricing Model (CAPM), an Ordinary Least Squares (OLS) regression was conducted using excess stock returns as the dependent variable and market risk premium as the independent variable. The results, reported in Table X, provide estimates of the intercept (α) and slope coefficient (β), along with their respective standard errors, t-statistics, and p-values. While β reflects the extent to which systematic risk influences stock returns, α serves as an indicator of prediction bias and abnormal returns. The statistical significance of these parameters enables a rigorous assessment of CAPM validity in the Indian stock market.

Table 1: CAPM Regression Results

Variable	Coefficient	Std Error	t-Stat	p-value
Alpha	0.1209	0.048	2.523	0.012
Beta	0.9864	0.008	129.810	0.000

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The empirical results indicate that the beta coefficient is approximately **0.9864**, which is highly significant ($p < 0.001$). This confirms that market risk plays a dominant role in determining stock returns. The R^2 value of **0.906** indicates that CAPM explains a substantial portion of return variation. This suggests that CAPM remains a strong explanatory model. However, the alpha coefficient is **0.1209** and statistically significant ($p < 0.05$), indicating systematic deviation between actual and predicted returns. This implies that CAPM consistently underestimates returns.

4.1 Panel Data Estimation Results

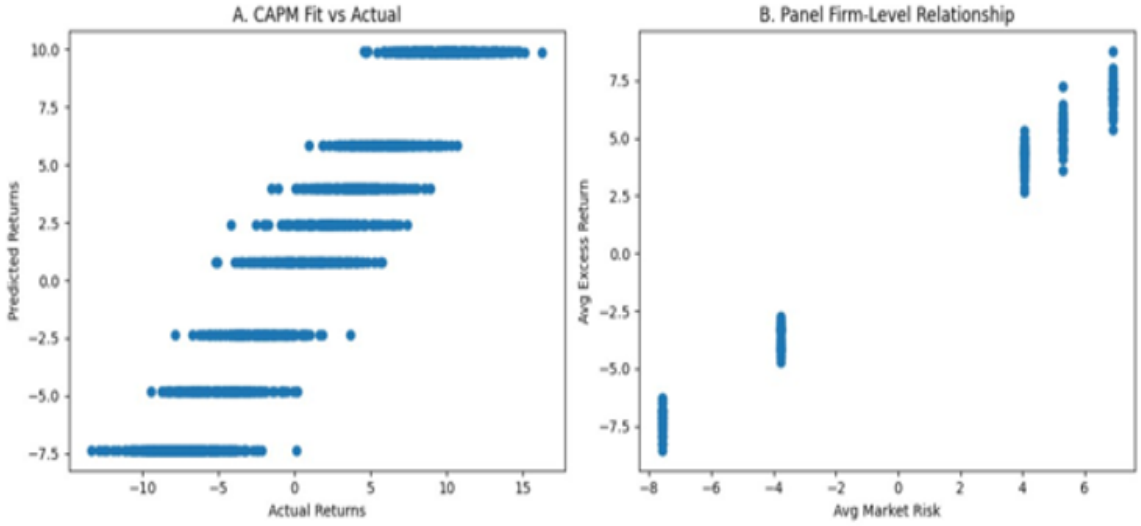
Panel data models (FE and RE) were estimated. FE controls firm-specific effects, RE assumes randomness. Hausman test favors FE, indicating correlation between firm effects and regressors.

Beta remains stable (0.98) and significant. Alpha persists, confirming prediction bias. This suggests CAPM inadequacy is structural.

Table 2: Panel Model Comparison

Model	Beta	Alpha	Inference
Fixed Effects	0.98	Varies	Significant
Random Effects	0.9864	0.1209	Significant

The panel data results reveal that the market risk coefficient (β) remains stable and statistically significant across both Fixed Effects and Random Effects models, indicating the robustness of CAPM in explaining return variation. However, the persistence of positive and significant alpha suggests that CAPM systematically underestimates returns. The variation of alpha in the Fixed Effects model further highlights firm-specific heterogeneity, while the Random Effects model confirms the presence of average abnormal returns. These findings indicate that CAPM inadequacy is structural rather than a consequence of omitted firm-level effects.



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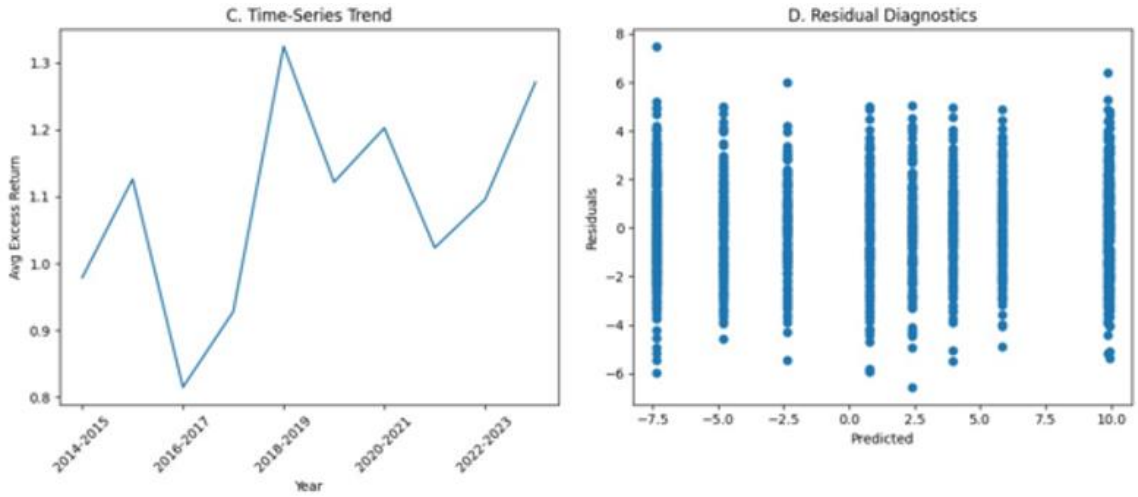

Figure 1: Actual vs CAPM Predicted Returns

This figure presents a comprehensive visualization of CAPM performance using panel data. Panel A illustrates the relationship between actual and CAPM-predicted returns, highlighting deviations from the theoretical line. Panel B shows firm-level average relationships, capturing cross- sectional heterogeneity. Panel C presents the time-series trend of excess returns, reflecting temporal dynamics. Panel D displays residual diagnostics, indicating potential model misspecification and supporting the presence of systematic prediction bias.

5. DISCUSSION

The results confirm that the market risk factor (β) is highly significant and consistent across OLS and panel estimations, indicating that systematic risk remains a key determinant of stock returns. The high explanatory power of the model suggests that CAPM effectively captures the general relationship between risk and return. However, the presence of a positive and statistically significant alpha (α) indicates that the model systematically underestimates actual returns, highlighting a clear prediction bias.

The persistence of alpha, even after controlling for firm-specific heterogeneity through panel data techniques, suggests that the limitation of CAPM is structural rather than due to omitted firm- level variables. This finding aligns with the multi-factor asset pricing literature, particularly the Fama-French models, which emphasize that additional factors such as size, value, and other systematic risks influence returns beyond the market factor. The inability of CAPM to incorporate these dimensions explains its incomplete predictive performance.

In the Indian market context, factors such as liquidity constraints, investor sentiment, and macroeconomic volatility further contribute to deviations from CAPM predictions. The observed abnormal returns and residual dispersion indicate potential market inefficiencies, challenging the core assumptions of CAPM. Overall, while CAPM remains

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statistically valid as a baseline model, it is economically insufficient, reinforcing the need for more comprehensive multi-factor and behavioral models to explain return dynamics effectively.

6. CONCLUSION

This study examined the predictive performance and adequacy of the Capital Asset Pricing Model (CAPM) in the Indian stock market using both OLS and panel data techniques. The results indicate that while the market risk factor (β) is highly significant and explains a substantial portion of return variation, the presence of a positive and statistically significant alpha (α) reveals systematic prediction bias. This suggests that CAPM consistently underestimates actual returns, thereby limiting its effectiveness as a predictive model.

The persistence of abnormal returns, even after controlling for firm-specific heterogeneity through panel analysis, indicates that CAPM is structurally incomplete. The findings highlight the influence of additional factors such as liquidity, investor behavior, and macroeconomic conditions, which are not captured within the CAPM framework. Therefore, while CAPM remains a useful benchmark for understanding risk-return relationships, the study supports the adoption of multi-factor and behavioral models for more accurate estimation of stock returns, particularly in emerging markets like India.

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