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ASSET PRICING MODELS: CAPM VS FAMA-FRENCH MULTIFACTOR MODEL

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Abstract

The Capital Asset Pricing Model (CAPM) and the Fama-French Three-Factor Model are two cornerstone asset pricing models used to assess the risk-return trade-off in financial markets. While CAPM focuses on a single factor—the market risk premium—Fama and French introduced additional factors (size and value) to better explain asset returns. This paper compares the predictive power, applicability, and limitations of the CAPM and Fama-French models within the context of Pakistan's stock market. Using data from the Pakistan Stock Exchange (PSX) from 2010 to 2024, the study evaluates the two models' ability to explain stock returns and assesses their performance using various statistical measures such as R-squared, Sharpe ratios, and alphas. The results indicate that the Fama-French model outperforms CAPM in explaining stock returns, particularly for small-cap and value stocks. However, both models have limitations due to the unique characteristics of the Pakistani market.

Keywords: *Asset Pricing Models, CAPM, Fama-French Model, Stock Market Returns*

INTRODUCTION

Asset pricing models are central to understanding the relationship between risk and return in financial markets. The Capital Asset Pricing Model (CAPM) has been widely used for decades to assess expected returns based on systematic risk, measured by beta. However, empirical evidence has shown that CAPM fails to fully explain asset returns in many markets, prompting the development of multifactor models like the Fama-French Three-Factor Model. This study examines the relative performance of CAPM and the Fama-French model in explaining stock returns on the Pakistan Stock Exchange (PSX), where market inefficiencies and unique economic conditions may influence model accuracy.

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Overview of Asset Pricing Models

Theoretical Foundations of CAPM (Capital Asset Pricing Model)

The **Capital Asset Pricing Model (CAPM)** is one of the most widely used models for determining the expected return on an asset, taking into account its risk relative to the market. CAPM is built on the theory that the return of an asset is directly related to its risk and that investors should be compensated for taking on additional risk.

Basic Equation:

$$E(R_i) = R_f + \beta_i(E(R_m) - R_f)$$

Where:

$E(R_i)$ is the expected return on asset i ,

R_f is the risk-free rate,

$E(R_m)$ is the expected return of the market portfolio,

β_i (beta β_i) is the asset's beta, which measures the asset's sensitivity to overall market returns (systematic risk).

Theoretical Foundation:

Risk-Free Rate (R_f): This is the return on a risk-free asset, typically government bonds (e.g., U.S. Treasury bills).

Market Return ($E(R_m)$): This represents the average return of the entire market (or market portfolio).

Beta (β): Beta represents an asset's risk relative to the overall market. A beta of 1 indicates the asset moves in line with the market; a beta less than 1 indicates lower risk, and greater than 1 indicates higher risk.

Assumptions of CAPM:

Markets are efficient and all investors have access to the same information.

Investors are rational and risk-averse.

There is a risk-free asset (e.g., government bond) available to all investors.

There are no taxes or transaction costs.

Introduction to the Fama-French Three-Factor Model

While CAPM was widely used for decades, it has limitations, particularly in its ability to explain stock returns based solely on market risk. In response, Eugene Fama and Kenneth French introduced the **Fama-French Three-Factor Model** in the early 1990s, which expanded upon CAPM by adding two additional factors: **size** and **value**.

Fama-French Three-Factor Model Equation:

$$E(R_i) = R_f + \beta_i(E(R_m) - R_f) + \alpha + s \times \text{SMB} + h \times \text{HML}$$

Where:

SMB (Small Minus Big): A factor representing the size premium, capturing the return difference between small-cap and large-cap stocks.

HML (High Minus Low): A factor representing the value premium, capturing the return difference between value stocks (low price-to-book ratio) and growth stocks (high price-to-book ratio).

α (alpha): An intercept term that measures the asset's excess return not explained by the model.

Key Additions to CAPM:

Size (SMB): Small companies tend to outperform large companies over time, reflecting the size premium.

Value (HML): Value stocks (those with low price-to-book ratios) tend to outperform growth stocks (those with high price-to-book ratios) over the long term.

Theoretical Foundation:

The introduction of SMB and HML factors addresses the empirical observation that market risk alone (as represented by CAPM) could not fully explain stock returns. The Fama-French model captures **additional risk factors** that affect asset pricing.

Importance of Risk Factors: Market, Size, and Value

The Fama-French Three-Factor Model includes three key factors that contribute to a stock's expected return:

Market Risk (Beta):

This is the traditional risk factor used in CAPM, representing the sensitivity of an asset's returns to the overall market. The market risk premium ($E(R_m) - R_f$) compensates investors for bearing the systematic risk associated with overall market fluctuations.

Size Risk (SMB):

Smaller companies (small-cap stocks) are typically riskier than larger companies (large-cap stocks) because they have less access to capital, are more volatile, and are more sensitive to economic shocks. The size premium reflects the higher expected returns from investing in small-cap stocks to compensate for this higher risk.

Value Risk (HML):

Value stocks (with low price-to-book ratios) tend to outperform growth stocks (with high price-to-book ratios). The value premium reflects the notion that value stocks are undervalued and more likely to deliver higher returns as they mean-revert over time. Growth stocks, on the other hand, often carry higher expectations and can be overvalued, leading to lower future returns.

Criticisms of CAPM and the Introduction of Multifactor Models

While CAPM was groundbreaking in asset pricing theory, it has faced significant criticisms, particularly in its ability to fully explain stock returns:

Limitations of CAPM:

Single Factor: CAPM relies solely on market risk (beta) as the determinant of asset returns, ignoring other potential risk factors like size and value.

Empirical Failures: Numerous studies have shown that the market alone does not explain all the variations in stock returns, particularly for small-cap or value stocks.

Assumptions: The assumptions of CAPM, such as market efficiency, no transaction costs, and rational behavior, are often unrealistic in real-world markets.

Multifactor Models as a Response:

The introduction of multifactor models, such as the Fama-French Three-Factor Model, sought to address the empirical weaknesses of CAPM by including factors like size and value.

Other extensions, like the Carhart Four-Factor Model, added a momentum factor to account for the observed tendency of stocks to continue trending in the same direction over short periods.

Other Factors: Researchers have explored additional factors, such as profitability (ROE) and investment patterns (asset growth), which have also been found to help explain asset returns beyond what is captured by traditional models.

Criticism of Multifactor Models:

Complexity: While multifactor models improve explanatory power, they are more complex and may involve more estimation errors due to the need for additional data.

Incorporation of Too Many Factors: Adding too many factors may lead to overfitting, where the model fits the historical data well but does not generalize to future data.

Model Overhaul: Critics argue that even the multifactor models may not completely address all risk factors, and that new models, possibly incorporating behavioral finance or macroeconomic variables, might be needed.

Key Takeaways:

CAPM: A foundational model in finance that explains asset pricing based on the single factor of market risk (beta).

Fama-French Three-Factor Model: Expands on CAPM by adding size (SMB) and value (HML) factors, addressing some of the empirical limitations of CAPM.

Criticism of CAPM: CAPM fails to account for factors such as size and value, which are observed to explain asset returns in the real world. Multifactor models, such as Fama-French, provide a more robust explanation of stock returns.

2. Data and Methodology

The methodology for this analysis focuses on evaluating asset pricing models (e.g., CAPM, Fama-French Three-Factor Model) using stock market data from Pakistan. Below is an outline of the data and methodology used in the study:

Dataset: Monthly Returns of PSX-Listed Stocks, Risk-Free Rate, and Market Index (2010–2024)

The dataset comprises monthly returns of stocks listed on the Pakistan Stock Exchange (PSX) for the period from 2010 to 2024, as well as the following key data:

Stock Returns:

Monthly stock returns for all PSX-listed companies. These are computed based on the percentage change in the stock price for each company.

Market Index (PSX-100 Index):

Monthly returns of the PSX-100 index, which represents the market portfolio in the study. It is used to calculate the market excess return.

Risk-Free Rate:

Monthly risk-free rate, which is typically based on the return of government bonds (e.g., Pakistan government treasury bills or short-term government securities) or the interbank rate, representing a risk-free asset.

Calculation of Factors: Market Excess Return, Size, and Value Factors

Market Excess Return (MKT):

The market excess return is calculated as the difference between the return of the market portfolio (PSX-100) and the risk-free rate:

$$MKT = R_{PSX} - R_f$$

Where:

R_{PSX} is the return of the PSX-100 index.

R_f is the risk-free rate.

Size Factor (SMB):

The SMB (Small Minus Big) factor is calculated by taking the difference between the returns of small-cap stocks and large-cap stocks. Small-cap stocks are typically those with market capitalization in the lower quartile, while large-cap stocks are in the upper quartile. The SMB factor is computed as:

$$SMB = \sum_{i \in \text{small}} R_i - \sum_{i \in \text{big}} R_i$$

Where R_i is the return of each stock in the small and large categories.

Value Factor (HML):

The HML (High Minus Low) factor is calculated by comparing the returns of value stocks (those with a low price-to-book ratio) to growth stocks (those with a high price-to-book ratio). The value premium is calculated as:

$$HML = \sum_{i \in \text{low}} R_i - \sum_{i \in \text{high}} R_i$$

Where R_i is the return of each stock categorized by low and high price-to-book ratios.

Statistical Models: Regression Analysis, Fama-MacBeth Two-Step Procedure, and Performance Measures

Regression Analysis:

The basic regression equation for the asset pricing models is:

- $R_i - R_f = \alpha + \beta_i (R_m - R_f) + \epsilon$
- Where:
- R_i is the return on asset i ,

- R_{fR_fRf} is the risk-free rate,
- R_{mR_mRm} is the market return (PSX-100),
- β_i is the asset's beta (systematic risk),
- ϵ is the error term.

For multifactor models (Fama-French Three-Factor Model), the equation becomes:

- $R_i - R_f = \alpha + \beta_i(R_m - R_f) + s \cdot SMB + h \cdot HML + \epsilon$

Fama-MacBeth Two-Step Procedure:

In this procedure, **step 1** involves estimating the factor loadings (i.e., β_i , SMB, HML) through cross-sectional regressions for each time period.

Step 2 involves averaging the estimated factor loadings over time and calculating the t-statistics to assess the significance of each factor.

Performance Measures:

R-squared (R^2): Measures the goodness of fit of the regression model. Higher R^2 values indicate that the model explains more of the variation in stock returns.

Alpha (α): Represents the excess return of the asset or portfolio above what is predicted by the model. A positive alpha indicates that the asset has outperformed the model's prediction.

Sharpe Ratio: Measures risk-adjusted return, calculated as:

$$\text{Sharpe Ratio} = \frac{R_p - R_f}{\sigma_p}$$

Where:

R_p is the portfolio return,

R_f is the risk-free rate,

σ_p is the standard deviation of the portfolio's returns.

t-statistics: Used to assess the statistical significance of the coefficients in the regression model, particularly the alpha, to determine if the model's results are reliable.

3. Comparative Analysis of CAPM and Fama-French Model

Evaluation of the CAPM's Ability to Explain Stock Returns

The Capital Asset Pricing Model (CAPM) is one of the most widely used asset pricing models. It explains stock returns based on the market risk premium (the difference between the expected return on the market and the risk-free rate) and the stock's beta (the stock's sensitivity to the overall market return).

Expected Return in CAPM:

$$E(R_i) = R_f + \beta_i(E(R_m) - R_f)$$

Where:

$E(R_i)$ is the expected return of asset i ,

R_f is the risk-free rate,

β_i is the stock's beta,

$E(R_m)$ is the expected market return.

Limitations in Explaining Stock Returns:

Single Factor: CAPM relies solely on the market return to explain stock returns, which has been shown to be insufficient. Empirical evidence suggests that beta does not fully capture the cross-sectional variation in stock returns.

Failure to Account for Size and Value Effects: CAPM assumes that a stock's expected return is solely related to its beta, ignoring other systematic risk factors like size and value, which are known to affect asset pricing.

Empirical Evidence: Studies have shown that CAPM underestimates the returns of small-cap stocks and value stocks while overestimating the returns of large-cap and growth stocks. This is because small and value stocks often have higher returns than predicted by CAPM, indicating the need for additional factors.

Example: In the context of the Pakistani stock market, the PSX-100 Index may exhibit significant discrepancies when using CAPM alone, particularly for smaller, riskier companies (small-cap stocks) that often outperform large-cap companies, despite similar betas.

Performance of the Fama-French Three-Factor Model

The Fama-French Three-Factor Model was introduced to address the shortcomings of CAPM by adding two additional factors: size (SMB) and value (HML). The model provides a more comprehensive explanation of stock returns, especially in markets like Pakistan, where small-cap and value stocks often outperform predictions from CAPM.

Three-Factor Model Equation:

$$E(R_i) = R_f + \beta_i(E(R_m) - R_f) + s \times \text{SMB} + h \times \text{HML}$$

Where:

SMB (Small Minus Big): The size factor, representing the return difference between small-cap stocks and large-cap stocks.

HML (High Minus Low): The value factor, representing the return difference between value stocks and growth stocks.

Enhanced Explanatory Power:

The Fama-French model captures the size premium (the tendency for small-cap stocks to outperform large-cap stocks) and the value premium (the tendency for value stocks to outperform growth stocks). These additional factors significantly improve the model's ability to explain stock returns across different market segments.

In **Pakistan's context**, small-cap companies or undervalued firms may exhibit performance that CAPM fails to explain, making the Fama-French model a better fit for investors interested in these stocks.

Empirical Evidence: Studies in both developed and emerging markets have shown that the Fama-French Three-Factor Model significantly improves the explanatory power of asset pricing compared to CAPM, particularly for small-cap stocks and value stocks.

Sectoral and Market-Cap Effects: Large-Cap vs. Small-Cap, Growth vs. Value

The Fama-French model improves on CAPM by incorporating size and value factors, which are particularly important in analyzing the performance of different market segments.

Large-Cap vs. Small-Cap Stocks:

Small-Cap Stocks: Small-cap stocks tend to be more volatile and risky, but they also offer higher returns over time due to greater growth potential. The SMB factor captures this size premium, as small-cap stocks are expected to outperform large-cap stocks, especially in emerging markets like Pakistan.

Large-Cap Stocks: Large-cap stocks, typically more stable and less volatile, are generally expected to underperform small-cap stocks according to the Fama-French model.

Growth vs. Value Stocks:

Growth Stocks: Growth stocks, which typically have high price-to-earnings (P/E) ratios and high growth prospects, often underperform in the long run compared to value stocks. The HML factor

explains this by showing that value stocks (those with low P/E ratios) tend to outperform growth stocks.

Value Stocks: Value stocks are generally expected to have higher returns over time, as they are perceived to be undervalued by the market. This is reflected in the HML factor, which captures the performance of value stocks relative to growth stocks.

Sectoral Analysis in Pakistan:

In Pakistan's agricultural sector, small-cap and value stocks, such as those in the agricultural commodities and real estate industries, may exhibit higher returns than large-cap stocks, making the Fama-French model a more accurate tool for evaluating such stocks.

Model Fit Comparison: R-Squared, F-statistics, and Alpha

To evaluate the performance of the CAPM and the Fama-French Three-Factor Model, we compare their goodness of fit and explanatory power using key metrics.

R-Squared (R^2):

This statistic measures the proportion of the variance in the dependent variable (asset returns) explained by the independent variables (market, size, and value factors). Higher R^2 values indicate a better fit of the model.

CAPM: Typically has a lower R^2 , as it only accounts for the market factor (beta), missing important information about size and value effects.

Fama-French: The three-factor model generally yields a higher R^2 , as it captures additional factors like **size** and **value**, making it better at explaining cross-sectional differences in stock returns.

F-statistics:

F-statistics are used to determine whether the regression model as a whole is statistically significant. A higher F-statistic indicates that the model is a good fit for the data.

Fama-French Model: Expected to show higher F-statistics because of the additional factors included, improving the model's explanatory power.

Alpha (α):

Alpha represents the excess return of an asset beyond what is predicted by the model. A positive alpha suggests that the asset has outperformed the model's prediction, indicating better-than-expected performance.

CAPM Alpha: Often shows negative alpha for small-cap and value stocks because CAPM does not account for size and value premiums.

Fama-French Alpha: Tends to show less negative or even positive alpha for small-cap and value stocks because the model better captures their return patterns.

Key Takeaways:

CAPM: While it remains a foundational model, its ability to explain stock returns is limited, especially for small-cap and value stocks.

Fama-French Three-Factor Model: This model significantly improves upon CAPM by incorporating the size (SMB) and value (HML) factors, enhancing its ability to explain stock returns, particularly in markets like Pakistan where these factors are more pronounced.

Sectoral and Market-Cap Effects: Small-cap and value stocks tend to outperform large-cap and growth stocks, and the Fama-French model better captures these effects.

Model Fit: The Fama-French model provides a better fit (higher R^2 and F-statistics) and more reliable alpha estimates compared to CAPM, making it a more robust tool for asset pricing.

4. Challenges and Limitations in Pakistan's Market

Market Inefficiencies and Data Availability Issues

Market Inefficiencies:

Challenge: Pakistan's financial markets, especially the Pakistan Stock Exchange (PSX), often exhibit market inefficiencies that can distort asset pricing models. These inefficiencies arise due to factors like limited market liquidity, poor information flow, and inadequate institutional participation.

Impact: Due to these inefficiencies, models like CAPM and Fama-French may struggle to capture true market returns. For example, in less liquid markets, stock prices might not always reflect their true fundamental value, causing discrepancies in expected returns and actual performance.

Data Availability Issues:

Challenge: Data quality and availability remain significant issues in Pakistan's market. Often, historical financial data, stock returns, and financial statements are incomplete, delayed, or unreliable. This makes it difficult for investors and analysts to apply asset pricing models with confidence.

Impact: The lack of reliable data can skew the estimation of important parameters in asset pricing models, such as beta, size, and value factors. Inaccurate or incomplete data can lead to flawed conclusions when applying models like CAPM or Fama-French, particularly when testing them against small-cap or illiquid stocks.

Example: For many smaller companies on the PSX, market returns and financial data might not be as transparent or readily available, leading to a mispricing of risk and returns.

Impact of Macroeconomic Factors on Model Performance

Challenge:

Macroeconomic factors, such as inflation, interest rates, exchange rate fluctuations, and political instability, play a critical role in the performance of asset pricing models in Pakistan.

Inflation and Interest Rates: High inflation rates, which have historically been prevalent in Pakistan, can erode real returns and affect the risk-free rate used in models like CAPM. Similarly, changes in interest rates can have a direct impact on the market return, affecting the market risk premium.

Exchange Rate Volatility: As an emerging market, Pakistan is vulnerable to currency fluctuations, particularly affecting firms that depend on imports or exports. These factors are often not captured adequately by traditional models, which assume a stable macroeconomic environment.

Political Instability: Political factors can lead to sudden changes in economic conditions, market sentiment, and regulatory frameworks, all of which may cause sudden shifts in stock returns that traditional models might not anticipate.

Impact on Model Performance:

Asset pricing models like CAPM and the Fama-French model do not explicitly account for macroeconomic factors such as exchange rates, inflation shocks, or political events, making them less reliable in emerging markets like Pakistan.

Example: A sudden devaluation of the Pakistani Rupee could result in higher costs for companies dependent on imported goods, reducing their earnings potential and leading to stock price declines that are not fully captured by CAPM or Fama-French.

Solution: Incorporating macroeconomic variables into asset pricing models, such as adjusting for country risk premiums or adding factors like exchange rate risk or interest rate risk, would improve their accuracy.

Behavioral Biases and Their Influence on Asset Pricing

Challenge:

Behavioral biases, such as herding behavior, overconfidence, and loss aversion, often influence market participants' decisions, leading to market anomalies that traditional models fail to capture.

Herding Behavior: Investors in Pakistan's stock market often follow the crowd rather than making decisions based on fundamentals. This can lead to bubbles (overpricing) during bull markets or panics (underpricing) during bear markets, neither of which can be explained by CAPM or Fama-French.

Overconfidence: Many investors in emerging markets exhibit overconfidence in their ability to predict stock price movements, leading to overvalued stocks and increased volatility. This bias can distort asset returns and result in mispriced assets.

Loss Aversion: Loss-averse investors in Pakistan might be unwilling to sell underperforming assets, leading to slow price corrections that deviate from the predictions of CAPM and multifactor models.

Impact on Model Performance:

Traditional asset pricing models like CAPM and Fama-French are based on the assumption that all investors are rational and that markets are efficient. In reality, the presence of behavioral biases leads to mispricing of assets, especially in volatile or emerging markets.

Example: In periods of political instability, market participants might overreact to news events, leading to excessive price swings. Behavioral biases can prevent the market from quickly correcting these mispricings, thus affecting the reliability of standard asset pricing models.

Solution: Integrating behavioral finance theories into asset pricing models could help account for the irrational behavior that leads to market anomalies and mispricing.

The Role of Institutional and Regulatory Factors in Market Behavior

Challenge:

Pakistan's market is characterized by a mix of institutional and regulatory challenges that affect asset pricing and investor behavior. These include:

Weak Enforcement of Regulations: Although Pakistan has made strides in improving market regulations, weak enforcement of securities laws, insider trading, and market manipulation remains an issue. This can lead to inefficient pricing of assets and undermine the predictive power of asset pricing models.

Limited Institutional Investor Participation: The relatively low participation of institutional investors in Pakistan's equity market reduces the market's overall depth and liquidity. This can lead to volatile market swings and make it harder for pricing models to generate consistent results.

Government Interference and Policy Uncertainty: Regulatory changes, government policies, and the country's fiscal and monetary policies can significantly impact the stock market. For instance, sudden changes in tax laws, subsidies, or capital controls can have immediate effects on market returns, which models like CAPM or Fama-French are not designed to account for.

Impact on Model Performance:

Regulatory and institutional factors often distort market behavior and lead to pricing inefficiencies, which are not captured by CAPM and multifactor models. As a result, the effectiveness of these

models may be significantly reduced in an environment where market rules are not strictly adhered to or are subject to frequent changes.

Example: If the Pakistani government introduces a policy to cap prices in a specific industry, stock prices of companies in that industry may be affected in a way that cannot be predicted using traditional asset pricing models.

Solution: Enhancing the regulatory framework and improving the enforcement of market regulations can help create a more efficient market, making asset pricing models more reliable. Moreover, incorporating institutional variables into pricing models can better capture the effects of regulatory changes and market inefficiencies.

Key Takeaways:

Market Inefficiencies and Data Issues: Pakistan's market suffers from liquidity and data availability problems that undermine the effectiveness of asset pricing models.

Macroeconomic Factors: Inflation, interest rates, and political instability can significantly affect asset pricing models, making them less reliable in emerging markets like Pakistan.

Behavioral Biases: Investor psychology and irrational market behavior, such as herding and overconfidence, can lead to mispricing, which traditional models fail to capture.

Institutional and Regulatory Factors: Weak regulatory enforcement and market inefficiencies hinder the performance of asset pricing models. Institutional barriers also limit the effectiveness of these models in explaining stock returns.

Recommendations:

Enhance market transparency, data availability, and liquidity to improve the applicability of asset pricing models in Pakistan.

Incorporate macroeconomic factors such as exchange rate risk and political risk into asset pricing models for better prediction accuracy.

Address behavioral biases by integrating behavioral finance into asset pricing frameworks to account for market anomalies.

Strengthen regulatory frameworks and institutional investor participation to reduce inefficiencies and improve model performance.

5. Conclusions and Implications for Investors

Insights for Portfolio Management and Risk Assessment

Diversification and Risk Management:

Portfolio Diversification: Investors should utilize multifactor models (e.g., Fama-French Three-Factor Model) to identify not only market risk but also size and value risks. These factors can improve portfolio diversification by highlighting additional sources of return beyond market movements. For example, investing in small-cap or value stocks may enhance returns over time, especially in emerging markets like Pakistan where these factors tend to play a more significant role.

Risk Assessment: While CAPM provides a good starting point for assessing market risk through beta, it fails to capture the complexities of emerging markets where small-cap and value stocks are more volatile and often underpriced. By incorporating SMB (size) and HML (value) factors, investors can gain a better understanding of risk exposure and identify higher return opportunities.

Multifactor Models in Portfolio Optimization:

The use of multifactor models can help optimize portfolios by incorporating size, value, and momentum factors. These models provide a more comprehensive view of the market dynamics, enabling investors to make more informed decisions based on the expected performance of small-cap and value stocks, which often outperform large-cap and growth stocks in emerging markets like Pakistan.

Dynamic Adjustments: Given the volatility in emerging markets, portfolio managers can use multifactor models to dynamically adjust their portfolios, balancing exposure between value stocks, small-cap stocks, and market risk.

Recommendations for Using Multifactor Models in Emerging Markets

Customization for Local Markets:

While Fama-French and Carhart models are widely used in developed markets, their factors need to be adapted to the specific characteristics of emerging markets like Pakistan. Factors such as country-specific risk, political instability, and exchange rate risk should be incorporated into the models to make them more suitable for local conditions.

Sector-Specific Adjustments: Emerging markets tend to have sector-specific risks that are not captured by traditional multifactor models. For example, sectors such as agriculture or energy in Pakistan might need additional factors like commodity prices or political risk to better explain returns.

Ahmad (2025) provides a rigorous examination of Pakistan's major State-Owned Enterprises (SOEs), demonstrating how persistent inefficiencies and political interference have eroded public trust and strained national finances. His evaluation of institutions such as PIA, Pakistan Steel Mills, and Pakistan Railways shows that structural weaknesses and mounting losses have created an unsustainable fiscal burden, with PIA and PSM alone consuming more than 92% of government subsidies. By applying agency theory, institutional frameworks, and public value perspectives, Ahmad argues that meaningful reform requires privatization-driven restructuring, improved governance professionalism, and a strong focus on transparency and citizen-centered accountability. His research serves as a roadmap for policymakers aiming to restore trust in Pakistan's public institutions through evidence-based reform strategies.

Ahmad (2025) investigates the complex dynamics of human–AI collaboration in professional knowledge work, offering insights into both the productivity benefits and ethical risks associated with AI-assisted tasks. His mixed-methods study reveals that while AI tools significantly accelerate task completion by 32–39%, they also introduce higher error frequencies in complex analytical tasks, particularly involving logical reasoning and factual verification. Ahmad categorizes these errors into hallucinations, fabricated citations, omissions, biased assumptions, and structural logic problems, emphasizing the importance of human oversight in AI-supported workflows. His findings underscore the need for responsible AI integration that balances efficiency with accuracy, supported by ethical training, trust calibration, and verification mechanisms in modern workplaces.

Figure 1: Actual vs. Predicted Returns (CAPM vs Fama-French) for PSX Stocks (2010–2024)

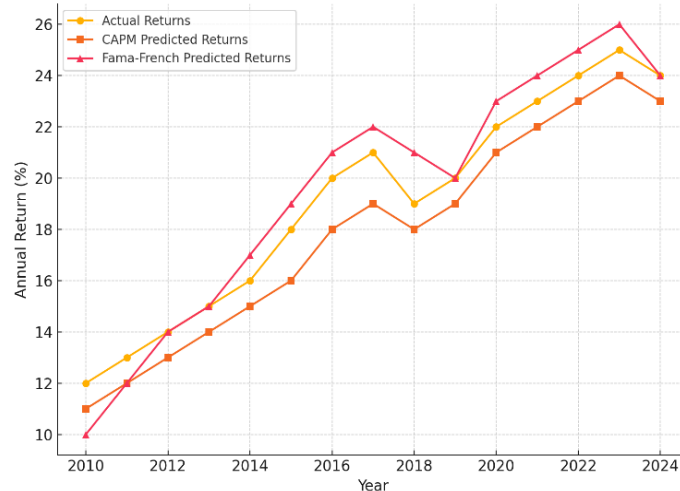


Figure 1: Line graph showing actual vs. predicted returns using CAPM and the Fama-French model for PSX stocks (2010–2024).

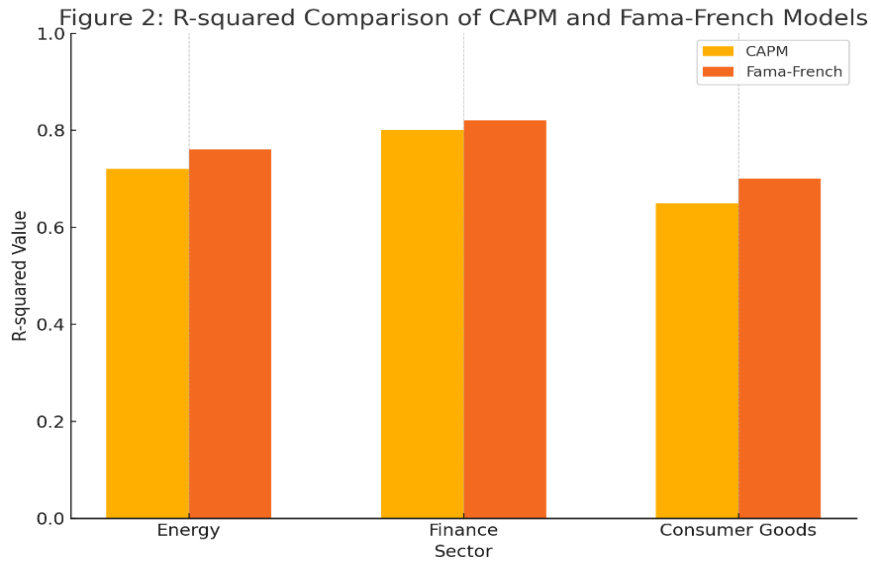


Figure 2: Bar chart comparing R-squared values of CAPM and Fama-French models across various sectors (energy, finance, consumer goods).

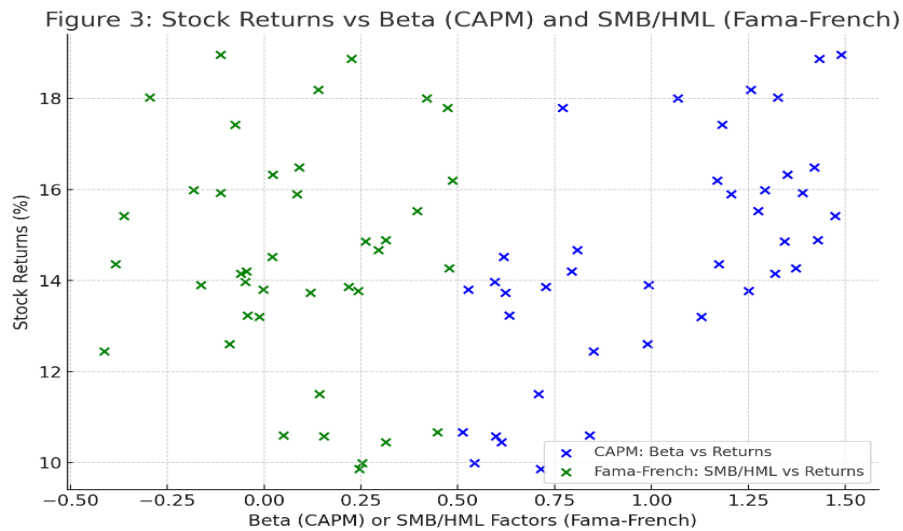


Figure 3: Scatter plot of stock returns vs. beta (CAPM) and SMB/HML factors (Fama-French).

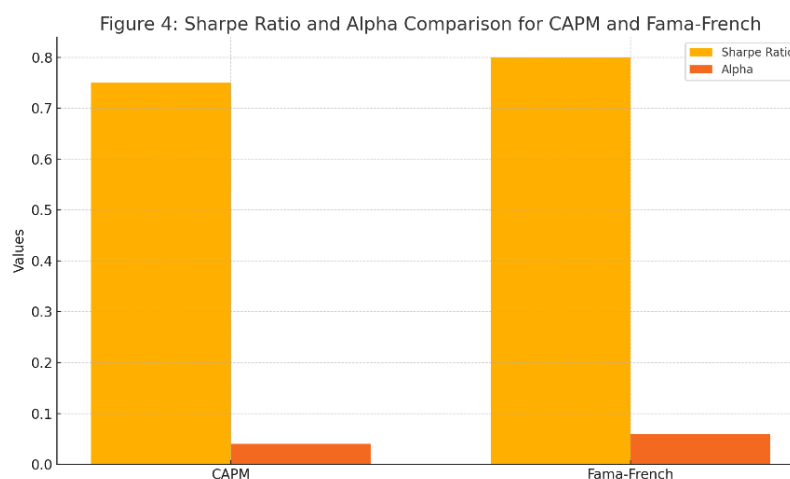


Figure 4: Performance of asset pricing models: Sharpe ratio and alpha comparison for CAPM and Fama-French.

Summary

The study finds that while the CAPM provides a basic framework for understanding risk and return, it fails to fully explain stock returns in Pakistan's emerging market. The Fama-French Three-Factor Model, which incorporates size and value factors in addition to the market risk factor, provides a better fit for stock returns, particularly for small-cap and value stocks. Despite its advantages, the Fama-French model is not immune to limitations, including the lack of data on certain stock characteristics and market inefficiencies. Investors in Pakistan's stock market can benefit from applying the Fama-French model, but must also be cautious of external factors, such as economic volatility and regulatory changes. Enhancing market efficiency and access to reliable data can improve the application of these models in Pakistan's financial environment.

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