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An Empirical Evaluation of the Fama-French Five-Factor Model in the Indian Equity Market: Evidence from NSE-Listed Stocks

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ABSTRACT: This study evaluates the performance of Fama-French three- and five-factor models, emphasizing profitability (RMW) and investment (INV) factors in explaining stock returns. By examining these frameworks, this study seeks to enhance the understanding of market behavior and return determinants. The analysis uses NSE 500 constituents from October 1995 to September 2022, employing time-series regression to assess model efficacy through statistical measures, including intercept terms (alpha) and goodness-of-fit metrics (adjusted R^2). The results show the Five-Factor Model's superior explanatory power compared to the CAPM and Three-Factor specification, validating the value of profitability and investment factors in asset pricing. This study reveals the limitations of single-factor approaches while highlighting the advantages of multifactor frameworks for return prediction, portfolio optimization, and risk assessment. The 27-year dataset provides more robust insights than those of previous studies with restricted parameters, enabling the identification of market patterns across varying economic conditions. These findings advance the empirical asset pricing literature through a comparative analysis of competing models in the Indian equity context, with implications for investment strategies and financial decision-making.

KEYWORDS: Asset pricing, Factor investing, multi-factor models, Risk premium, Profitability

I. INTRODUCTION

Asset pricing models play a crucial role in financial economics by explaining the cross section of expected stock returns. The Capital Asset Pricing Model (CAPM) (Sharpe, 1964; Lintner, 1965; Mossin, 1966) laid the foundation by linking returns to market risk, while the Fama-French three-factor model (Fama & French, 1993) expanded this framework by incorporating size (SMB) and value (HML) factors. Despite their widespread use, empirical evidence suggests that these models fail to capture return variations fully, prompting further refinement.

The Fama-French five-factor model (2015) enhances asset pricing frameworks by incorporating profitability (RMW) and investment (CMA) factors based on the dividend discount model. These additions address anomalies related to firm profitability, investment behavior, and value premiums. In India, profitability, particularly operating profitability, has emerged as a strong return predictor, with Gupta and Banga (2016) documenting significant differences between high- and low-profitability firms. While consistent with Novy-Marx's (2013) global findings, the profitability effect appears stronger in India because of concentrated ownership and capital constraints. The model's investment factor (CMA) shows varied performance across markets, reflecting differences in corporate governance and growth dynamics. Despite improved explanatory power, the five-factor model's universality remains debated, particularly regarding consistency across economic cycles and the potential omissions of factors such as momentum or liquidity, especially in emerging markets such as India, where institutional and market microstructural factors are significant.

This study examines the five-factor model in pricing assets, compares its performance with earlier models, and explores its applicability across financial markets. We analyze empirical evidence, test robustness in various economic environments, and discuss potential extensions to enhance predictive accuracy. Our findings contribute to the asset-pricing discourse by evaluating whether the five-factor model represents a sufficient paradigm or requires further refinement. The structure of this paper is organized as follows: Section 2 provides a comprehensive review of the existing literature relevant to the study. Section 3 outlines the research methodology employed in the investigation. Section 4 details the findings of the study and offers a thorough discussion of the results. Finally, Section 5 concludes the paper by summarizing the key insights and presenting implications based on the findings.

II. LITERATURE REVIEW

The Capital Asset Pricing Model (CAPM) has served as a foundational tool in finance, yet it faces significant theoretical and empirical challenges. Roll's (1977) critique questioned the testability of the model, noting that the true market portfolio was unobservable. Empirical evidence eroded the CAPM's dominance; notably, Fama and French (1992) demonstrated that beta alone fails to explain cross-sectional returns, with firm size and book-to-market (B/M) ratios offering stronger predictive power.

Fama and French's (1993) Three-Factor Model (hereafter known as FF3F) incorporated market, size (SMB), and value (HML) factors. Carhart (1997) added a momentum factor () to create a Four-Factor Model with improved explanatory power. However, concerns regarding data mining (Black, 1993; Kothari et al., 1995) and theoretical foundations remain. These models show inconsistent performance in emerging economies (Griffin, 2002), in which factor behavior differs. Behavioral finance research (Lakonishok et al., 1994) suggests that anomalies may reflect investor bias rather than systematic risk. Fama and French (2015) proposed a Five-Factor Model (hereafter known as FF5F) by adding profitability (RMW) and investment (CMA) factors, supported by Novy-Marx's (2013) findings on profitability as a return predictor. Hou et al. (2015) proposed a similar Q-factor model. While FF5F shows strong performance in U.S. markets (Fama & French, 2017), the international results vary. Cakici and Fabozzi (2018) find significant value and profitability in emerging markets; however, investment factors lack robustness.

Emerging market studies have shown that the factor relevance varies. In Asia, value and profitability dominate, whereas investment effects are subdued in high-growth economies. Latin American markets reveal strong size and profitability premiums but show inverse investment-return relationships (Albuquerque et al., 2019). The African and Middle Eastern markets show significance mainly for the market factor, with other factors having limited explanatory power (Sensoy & Tabak, 2016). While FF5F explains about 60% of the return variation in emerging markets versus 80% in developed markets (Fama & French, 2017), momentum outperforms profitability and investment in these regions (Rouwenhorst, 1999), suggesting model modification benefits. Factor behavior shows distinctive characteristics in India. Studies by Sehgal and Jain (2011) and Gupta and Banga (2016) find that the Three-Factor Model is effective, with profitability as a key factor. Dash and Mahakud (2018) identified momentum (UMD) as a key return driver, advocating a hybrid model integrating FF5F with momentum for enhanced performance. Mishra and Rahman (2020) and Patel and Subrahmanyam (2022) observed that the investment factor differs in India, due to corporate governance practices and capital structures unique to the country.

These findings justify applying the FF5F model to the Indian equity market. With features such as high retail investor participation and distinct regulatory frameworks, India offers fertile grounds for reexamining global asset pricing models. Validating FF5F in this setting has implications for investors seeking portfolio strategies and policymakers assessing market efficiency. Comparing Indian results with global models can help determine the need for region-specific modifications, reinforcing the model's relevance while acknowledging limitations.

III. RESEARCH METHODOLOGY

This study uses the NSE 500 index as its sample, representing 91.8% of free-float market capitalization as of March 2024. This study includes firms ranked among the top 800 by market capitalization and trading volume, traded on at least 90% of trading days in the preceding six months. The dataset covers the NSE-listed common stocks from October 1995 to September 2022. Financial data, including stock returns, index returns, market capitalization, and risk-free rates (91-day treasury bills from RBI), were obtained from the CMIE Prowess IQ database to construct Fama-French factors and evaluate the test portfolios.

Financial firms and companies with incomplete data are excluded from the analysis. Fama-French factors are constructed using investment, profitability, and book-to-market (BM) ratios, with book equity adjusted for preference shares, minority interest, and deferred taxes; negative book equity firms are dropped. The extreme returns (top/bottom, 1%) were trimmed. Market values from Prowess IQ determine the BM ratios and size (market cap). Following established methods (Cooper et al., 2008; Fama & French, 2015), investment is proxied by asset growth, whereas profitability is operating income divided by book equity. To prevent look-ahead bias, portfolios are formed annually in September using March financials with a six-month lag. Only actively traded listed firms with complete data are included.

A. Factor Formation

Following Fama and French (1993, 2015), we construct size, value, profitability, and investment factors, without size bias. Using NSE 500 firms, we split stocks into two size groups (small/big) at the median market cap and then independently sorted them into three groups (30th/70th percentiles) by B/M, OP, or Inv, creating six portfolios per sort (e.g., SH/BH for small/big high-B/M). The value factor (HML) equals the high-minus-low B/M returns across size groups. Similarly, the RMW (profitability) and CMA (investment) factors subtract weak from robust OP and aggressive from conservative Inv portfolios. The size factor (SMB) averages

small and large returns across sorts. Market excess returns (Rm-Rf) use the NSE 500 returns minus the 91-day T-bill rate. This framework spans 1995-2022.

B. Construction of Test Portfolios

In September 1995, our portfolio construction used sequential sorting. First, we classify firms into four size groups using 25th, 50th, and 75th percentile market capitalization cutoffs. Within each size group, we sort stocks into four portfolios based on book-to-market ratios (using quartile breakpoints), repeating this process for profitability and asset growth measures. This creates three sets of 16 portfolios: size-B/M, size profitability, and size investment. We computed the value-weighted monthly returns for these portfolios and held them for 12 months. The sorting and rebalancing procedure is repeated annually in September, yielding 324 monthly return observations per portfolio from October 1995 to September 2022.

C. The Empirical Methods

CAPM

$$R_i(t) - R_F(t) = \alpha_i + b_i[R_M(t) - R_F(t)] + \varepsilon_i(t) \quad \textbf{(3.1)}$$

Fama French three factor model

$$R_i(t) - R_F(t) = \alpha_i + b_i[R_M(t) - R_F(t)] + s_i SMB(t) + h_i HML(t) + \varepsilon_i(t) \quad \textbf{(3.2)}$$

Fama French five factor model

$$R_i(t) - R_F(t) = \alpha_i + b_i[R_M(t) - R_F(t)] + s_i SMB(t) + h_i HML(t) + r_i RMW(t) + c_i CMA(t) + \varepsilon_i(t) \quad \textbf{(3.3)}$$

$R_i(t)$Expected return on asset i, $R_F(t)$ $r$isk-free rate. b_i Beta of the asset. $R_M(t)$Expected returns of market portfolio. $R_M(t) - R_F(t)$ Market risk premium. SMB, size factor, returns of small-cap stocks minus large-cap stocks. HML; the value factor, the return of high book-to-market (value) stocks minus low book-to-market (growth) stocks. $RMW(t)$ represents the disparity in returns between the diversified portfolios of stocks with strong and weak profitability. $CMA(t)$ represents the difference in returns between diversified portfolios of stocks from low- and high-investment firms, categorized as conservative and aggressive, respectively.

IV. RESULTS AND DISCUSSION

A. Descriptive Statistics of factor returns

Table No I. ***R_m-R_f is the market portfolio return of sample stocks minus the 91 days Treasury bill rate. SMB, Small Minus Big, HML, High Minus Low, RMW, Robust Minus Weak and CMA, conservative minus aggressive. The table shows the monthly returns (Mean) and standard deviations (Std dev.) and t-statistics for the average returns.***

Averages, standard deviations, and t-statistics for monthly returns					
	R_m-R_f	SMB	HML	RMW	CMA
Mean	0.65	0.91	0.12	0.29	0.22
Std. Dev.	7.31	3.61	3.71	2.03	1.97
t-Statistic	1.6	4.53	0.57	2.58	1.99

Factor analysis using NSE 500 stocks reveals distinct return patterns. The market factor (R_m-R_f) shows a modest 0.65% return (t=1.60), indicating weak equity premium. Small caps significantly outperformed large caps (SMB: 0.91%, t=4.53), which strongly supports the size effect. Contrary to expectations, the value factor (HML) is insignificant (0.12%, t=0.57). Robust profitability generates higher returns (RMW: 0.29%, t=2.58), whereas conservative investment firms show borderline outperformance (CMA: 0.22%, t=1.99). These findings highlight the strong size and profitability effects, marginal investment impact, and negligible value premium in India's equity market during the study period.

Table No II. ***R_m-R_f is the return on the market portfolio of all sample stocks minus the 91 days Treasury bill rate. SMB, Small Minus Big, HML, High Minus Low, RMW, Robust Minus Weak and CMA, conservative minus aggressive. Table shows the correlations between these factors.***

Correlation between different factors					
Variables	R_m-R_f	SMB	HML	RMW	CMA
R_m-R_f	1	0.19	0.26	-0.22	0.03
SMB	0.19	1	0.27	-0.18	0.12
HML	0.26	0.27	1	-0.61	0.42

RMW	-0.22	-0.18	-0.61	1	-0.33
CMA	0.03	0.12	0.42	-0.33	1

Correlation analysis of Indian equity factors reveals distinct risk dimensions. The market factor (R_m-R_f) shows minimal correlation with the other factors, confirming its independence. The size factor (SMB) displays modest positive links with value (HML: 0.27) and conservative investment (CMA: 0.12) but a negative association with profitability (-0.18). Value and profitability factors show a strong negative correlation (-0.61), indicating that value stocks have lower profitability. The value-investment connection (HML-CMA: 0.42) suggests that value firms invest conservatively. Profitability is negatively related to value and investment factors, indicating that profitable firms tend toward growth and aggressive investment. While most factors maintain low-to-moderate correlations, the interplay between value, profitability, and investment dimensions highlights key considerations for multi-factor modeling in India's market.

Table No III. ***Average monthly percent excess returns for 16 (4× 4) EW portfolios formed on Size and B/M, Size and OP, Size and Inv: 10/1995–09/2022, 324 months. ***, **, * represents 1%, 5% & 10% level of significance and the t-statistics are in parentheses.***

BM→	Low	2	3	High
Panel A: Size-B/M Portfolios				
Size↓	C			
Low	2.62***	2.13***	2.24***	2.41***
	(3.65)	(3.21)	(3.52)	(3.56)
2	1.66***	1.39***	1.61**	1.12*
	(3.06)	(2.46)	(2.41)	(1.75)
3	1.45***	1*	0.94	1.16*
	(2.94)	(1.78)	(1.59)	(1.86)
High	0.77*	0.67	1.08*	1.03*
	(1.91)	(1.36)	(1.94)	(1.69)
Panel B: Size-OP Portfolios				
Size↓	Low	2	3	High
Low	1.89***	2.67***	2.5***	2.46***
	(3.05)	(3.99)	(3.76)	(3.47)
2	1.25*	1.57***	1.39**	1.57**
	(1.91)	(2.75)	(2.52)	(2.48)
3	1.02*	0.61	1.65***	1.23**
	(1.85)	(1.19)	(3.14)	(2.28)
High	0.35	0.91**	1.01**	0.85**
	(0.66)	(1.99)	(2.24)	(2.14)
Panel C: Size-Inv Portfolios				
Size↓	Low	2	3	High
Low	2.46***	2.46***	2.34***	2.3***
	(3.77)	(3.77)	(3.48)	(3.45)
2	1.65***	1.57***	1.1**	1.42**
	(2.72)	(2.69)	(1.94)	(2.18)
3	1.19**	1.23**	1.16**	1.16**
	(2.15)	(2.41)	(2.42)	(1.98)
High	0.83**	0.79**	0.77**	0.63
	(1.82)	(1.79)	(1.67)	(1.29)

B Summary Statistics of Portfolios

Table 03 reports the excess returns across the 4×4 size-sorted portfolios, revealing key patterns in Indian equity returns. For Size-B/M portfolios (Panel A), we observe a strong size effect, with small stocks generating higher excess returns (2.13-2.62%) compared to large stocks (0.67-1.08%), consistent with Banz (1981) and Fama-French (1992). The value premium appears weaker and less monotonic than in developed markets, with high B/M stocks underperforming medium B/M in some size quartiles, aligning with the emerging market evidence from Cakici et al. (2013), which shows attenuated value effects.

Panel B's Size-OP portfolios show a strong profitability premium, particularly in small stocks, where high OP firms earn 2.46% versus 1.89% for low OP, supporting Novy-Marx's (2013) findings. The premium persists but decreases among larger stocks (0.85% for big/high-OP vs. 0.35% for big/low-OP), suggesting greater mispricing or risk in small profitable firms. This pattern mirrors Hou et al.'s (2015) q-factor results, which show stronger effects in developed markets.

The size–Inv results (Panel C) show that conservative investment firms (low Inv) outperform aggressive investors across size quartiles, with the highest spread in small stocks (2.46% vs. 2.30%). This investment effect is weaker than the profitability premium, consistent with Fama-French (2015), but contrasts with the stronger investment effects in Hou et al.'s (2015) q-theory predictions. T-statistics indicate that the size, profitability, and investment effects remain significant in India, albeit with varying magnitudes versus developed markets.

Table No IV. ***This table reports the regression analysis of 16 Size-OP portfolios from October 1995 to September 2022 (324 months) using the CAPM, FF3F and FF5 Factor models. The results are risk-adjusted based on HAC correction; ***, **, and * represent 1%, 5%, and 10% levels of significance, respectively. The regression equation for the five-factor model is*** $\boldsymbol{R(t) - R_M(t) = \alpha + b[R_M(t) - R_F(t)] + sSMB(t) + hHML(t) + rRMW(t) + cCMA(t) + \varepsilon_i(t)}$.

BM→	Low	2	3	High		Low	2	3	High
	Size-B/M	Portfolios							
Size↓	*Panel A:*	*CAPM alpha*				*Fama French three factor alpha*			
Low	1.93***	1.48***	1.56***	1.7***		0.77**	0.39	0.51	0.57***
2	1.04***	0.75**	0.93**	0.37		0.23	-0.05	0.08	-0.33
3	0.87***	0.38	0.26	0.41		0.55**	0.09	-0.05	0.16
High	0.25**	0.06	0.44	0.32		0.23	0.27	0.72	0.49*
Panel B: F&F five factor alpha and factor coefficients									
Size↓	*Fama French five factor alpha*					R_m-R_f			
Low	0.68*	0.22	0.49**	0.55***		1***	0.91***	0.86***	0.87***
2	0.26	-0.08	0.04	-0.3		0.93***	0.92***	0.87***	0.95***
3	0.51**	0.06***	-0.01***	0.21		0.89***	0.9***	0.92***	0.96***
High	0.22	0.22	0.64**	0.37		0.81***	0.92***	0.89***	0.96***
Size↓	*SMB*					*HML*			
Low	1.37***	1.3***	1.23***	1.29***		-0.49**	-0.14	0.49***	0.76***
2	0.96***	0.95***	0.98***	0.8***		-0.57***	-0.2*	0.59***	0.78***
3	0.39***	0.33***	0.34***	0.24**		-0.28***	0.25**	0.67***	1.1***
High	0.03	-0.25***	-0.37***	-0.25***		-0.17***	0.25***	0.92***	1.14***
	RMW					*CMA*			
Low	0.1	0.35*	0.16	-0.02		0.26	0.24	-0.21	0.12
2	-0.16	-0.06	0.11	-0.2		0.15	0.24	0.01	0.2
3	0.09	0.13	-0.09	-0.18		0.02	-0.11	-0.01	0.09
High	0.02	0.01	0.1	0.07		0	0.19*	0.25	0.49***
Panel C:	*F&F three factor Adj R^2*					*F&F five factor Adj R^2*			
Low	0.70	0.75	0.85	0.91		0.70	0.75	0.85	0.91
2	0.75	0.79	0.83	0.84		0.75	0.79	0.83	0.84
3	0.77	0.74	0.76	0.79		0.76	0.74	0.76	0.79
High	0.85	0.84	0.77	0.78		0.84	0.84	0.78	0.79

C Size- BM portfolios

Table 04 presents the regression results for 16 size–B/M portfolios, revealing insights about factor model performance in India's equity market. The CAPM generates significant alphas across portfolios (0.25% to 1.93% monthly), with large magnitudes for small-cap and high book-to-market (B/M) stocks, consistent with CAPM anomalies in developed (Fama & French, 1992) and emerging markets (Cakici et al., 2013). The Fama-French three-factor model (FF3F) reduces these alphas, particularly for small-cap portfolios (small/low-B/M alpha drops from 1.93% to 0.77%), showing the importance of size (SMB) and value (HML) factors. However, significant residual alphas remain for small/high-B/M stocks (0.57% monthly), suggesting that additional factors may be required to capture return patterns.

The FF5F model shows improved performance, with most alphas becoming insignificant, particularly in the large-cap portfolios. The market factor (R_m-R_f) remains significant (0.81–1.00), whereas small-cap stocks show strong SMB loadings (1.23–1.37). Value stocks display increasing HML exposure with rising book-to-market ratios, from –0.49 to 1.14. The profitability (RMW) and investment (CMA) factors have weaker loadings but remain meaningful, especially for small-cap and value portfolios. These patterns support Fama and French's (2015) claim that the RMW and CMA capture additional risk dimensions beyond the three-factor model. The adjusted R^2 values show that the FF3F and FF5F models explain 70–91% of returns, with higher accuracy for small-cap and value portfolios. The RMW and CMA factors contribute marginally (0–2%). These findings, consistent with those of Fama and French (2015), reveal stronger FF3F performance and weaker RMW and CMA roles in India.

Table No V. ***This table reports the regression analysis of 16 Size-OP portfolios from October 1995 to September 2022 (324 months) using the CAPM, FF3F and FF5 Factor models. The results are risk-adjusted based on HAC correction; ***, **, and * represent 1%, 5%, and 10% levels of significance, respectively. The regression equation for the five-factor model is*** $\boldsymbol{R(t) - R_M(t) = \alpha + b[R_M(t) - R_F(t)] + sSMB(t) + hHML(t) + rRMW(t) + cCMA(t) + \varepsilon_i(t)}$.

OP→	Low	2	3	High		Low	2	3	High
Size-OP Portfolios									
Size↓	*Panel A:*	*CAPM alpha*				*Fama French three factor alpha*			
Low	1.22***	2.01***	1.79***	1.75***		0.08	0.92***	0.69***	0.73***
2	0.49	0.92***	0.76***	0.9***		-0.38	0.13	0.02	0.15
3	0.32	-0.02	1.03***	0.6**		-0.03	-0.19	0.72***	0.27
High	-0.32	0.33*	0.46**	0.33**		-0.24	0.49**	0.54***	0.35**
Panel B: F&F five factor alpha and factor coefficients									
Size↓	*Fama French five factor alpha*					R_m-R_f			
Low	0.34	1.1***	0.47**	0.33		0.81***	0.8***	0.89***	0.97***
2	-0.15	0.22	-0.21	-0.02		1***	0.88***	0.87***	0.92***
3	0.14	-0.13	0.55**	0.18		0.94***	0.9***	0.9***	0.92***
High	-0.15	0.5***	0.42**	0.18		0.98***	0.86***	0.85***	0.81***
Size↓	*SMB*					*HML*			
Low	1.31***	1.27***	1.28***	1.19***		0.39***	0.48***	0.74***	0.59***
2	1.01***	0.91***	0.86***	0.87***		0.2***	0.09	0.33***	0.51***
3	0.39***	0.19**	0.36***	0.38***		0.47***	0.35***	0.22*	0.1
High	-0.11**	-0.2***	-0.1**	-0.02		0.26**	0.28***	0.11	0.06
	RMW					*CMA*			
Low	-0.81***	-0.48***	0.55***	1.06***		0.07	-0.09	0.13	0.14
2	-0.78***	-0.38*	0.55***	0.57***		0.18	0.22	0.23	-0.08
3	-0.47***	-0.15	0.46***	0.25		-0.08	-0.05	0.08	0.05
High	-0.46***	-0.15	0.24	0.45***		0.36**	0.22*	0.19	0.1
Panel C:	*F&F three factor Adj R^2*					*F&F five factor Adj R^2*			
Low	0.84	0.85	0.86	0.79		0.86	0.85	0.86	0.82
2	0.82	0.81	0.80	0.80		0.84	0.81	0.81	0.80
3	0.81	0.76	0.74	0.76		0.81	0.76	0.75	0.76
High	0.81	0.82	0.81	0.81		0.83	0.82	0.82	0.83

D Size- OP portfolios

Table 05 shows the regression results for the Size-OP portfolios. CAPM generates significant alphas, particularly for small and low-OP firms. The smallest size and lowest OP portfolio yield an alpha of 1.22%, while small high-OP firms show significant alphas (1.75%). These findings align with those of previous studies (Fama & French, 1993; 2015) that document the CAPM's failure to explain size and profitability anomalies. The FF3F model reduces these alphas; for example, the smallest and lowest OP portfolio's alpha drops to 0.08% (insignificant), while high-OP small firms retain a significant but smaller alpha (0.73%). This suggests that SMB and HML absorb much mispricing, although profitability-related anomalies persist, consistent with Novy-Marx (2013), who finds profitability to be a distinct risk factor.

The FF5F model reduces abnormal returns, particularly for high-OP small firms, where the alpha declines to 0.33%. However, some portfolios show significant alphas (1.10% for small- and medium-OP firms), indicating that while RMW and CMA improve pricing efficiency, they do not fully capture return variations, which is consistent with Hou et al. (2015), who argue for additional factors such as investment and quality. The factor loadings reveal meaningful patterns across the portfolios. All portfolios load positively on the market factor (R_m-R_f), ranging from 0.81 to 1.00, with small firms showing lower betas. The size factor (SMB) is positive for small firms (up to 1.31) and negative for large firms (–0.11 to –0.20), reinforcing Banz's (1981) size effect. Value factor (HML) loadings are higher for low-operating-profitability (OP) firms (0.39 to 0.74), whereas high-OP firms show weaker HML exposure (Fama & French, 2015). Profitability (RMW) loadings are negative for low-OP firms (–0.81) and positive for high-OP firms (1.06), consistent with the results of Novy-Marx (2013). The investment factor (CMA) coefficients are mostly insignificant, except for large firms (0.36), suggesting that profitability is a stronger return driver than investment (Hou et al., 2015).

The FF3F model explains 74–86% of return variation, while FF5F marginally improves explanatory power (from 0.84 to 0.86 for small, low-OP firms). This suggests diminishing gains from adding RMW and CMA, similar to the findings in emerging markets (Ali et al., 2020).

Table No VI. ***This table reports the regression analysis of 15 Size-Inv portfolios from October 1995 to September 2022 (324 months), using the CAPM, FF3F and FF5 Factor models. The results are risk-adjusted based on HAC correction; ***, **, and * represent 1%, 5%, and 10% levels of significance, respectively. The regression equation for the five-factor model is*** $\boldsymbol{R(t) - R_M(t) = \alpha + b[R_M(t) - R_F(t)] + sSMB(t) + hHML(t) + rRMW(t) + cCMA(t) + \varepsilon_i(t)}$.

Inv→	Low	2	3	High		Low	2	3	High
Size-Inv Portfolios									
Size↓	*Panel A:*	*CAPM alpha*				*Fama French three factor alpha*			
Low	1.78***	1.64***	1.64***	1.62***		0.59**	0.66***	0.55**	0.59**
2	0.95***	0.9***	0.47	0.69**		0.14	0.11	-0.2	-0.25
3	0.52**	0.6**	0.58***	0.46*		0.16	0.3	0.38	0.13
High	0.25	0.24	0.23	0.03		0.32	0.35	0.32	0.02
Panel B: F&F five factor alpha and factor coefficients									
Size↓	*Fama French five factor alpha*					*R_m-R_f*			
Low	0.48	0.47**	0.54**	0.8***		0.84***	0.88***	0.88***	0.84***
2	0	0.03	-0.14	-0.08		0.94***	0.91***	0.85***	0.98***
3	0.09	0.19	0.4	0.3		0.95***	0.88***	0.83***	1.02***
High	0.16	0.27	0.28	0.07		0.86***	0.83***	0.81***	0.92***
Size↓	*SMB*					*HML*			
Low	1.37***	1.13***	1.28***	1.21***		0.38***	0.51***	0.63***	0.63***
2	0.92***	0.91***	0.78***	1.13***		0.34***	0.08	0.31***	0.07
3	0.39***	0.32***	0.22***	0.39***		0.29**	0.43***	0.28***	0.17*
High	-0.12**	-0.15***	-0.11***	0.01		0.26**	0.17***	0.36***	0.09
	RMW					*CMA*			
Low	-0.09	0.3**	0.23	-0.09		0.7***	0.38***	-0.38**	-0.92***
2	0.04	-0.08	-0.08	-0.19		0.67***	0.54***	-0.13	-0.53***
3	-0.1	0.13	0	-0.07		0.56***	0.34*	-0.1	-0.74***
High	-0.06	-0.11	0.18	0.06		0.96***	0.62***	-0.13	-0.4***
Panel C:	*F&F three factor Adj R^2*					*F&F five factor Adj R^2*			

Low	0.84	0.83	0.80	0.78		0.85	0.84	0.81	0.80
2	0.83	0.81	0.78	0.82		0.84	0.82	0.78	0.83
3	0.77	0.76	0.74	0.79		0.79	0.77	0.74	0.81
High	0.73	0.76	0.80	0.83		0.77	0.79	0.80	0.83

E Size-Inv portfolios

Table 06 presents the regression results for 15 size investment portfolios from October 1995 to September 2022. The CAPM produces significant alphas for small, low-investment firms, with the smallest portfolio showing a 1.78% alpha (Fama & French, 1993, 2015). The FF3F model reduces these alphas—the smallest portfolio's alpha falls to 0.59%, as SMB and HML capture many unexplained returns. Some mid- and large-cap portfolios show insignificant alphas, suggesting a partial resolution of investment anomalies, consistent with Novy-Marx (2013).

The FF5F model reduces abnormal returns, particularly for small firms, with alphas of 0.48–0.80% (varying significance). Some portfolios still show significant alphas (0.80%*), indicating that RMW and CMA factors improve pricing, but do not fully capture investment anomalies. This aligns with Hou et al. (2015), who suggest that investment factors require additional quality or momentum control.

Factor loadings reveal the relationships between investment-based portfolios. All portfolios show positive market factor exposure (0.81–1.02), with higher betas for high-investment firms (Fama and French, 2015). The size factor (SMB) is positive for small, low-investment firms (1.37) and negative for large firms (–0.15), confirming the size effect (Banz, 1981). Value factor loadings are higher for high-investment firms (0.63) than for low-investment firms (0.38). Profitability (RMW) loadings vary, with some low-investment firms showing a positive exposure (0.30). The investment factor (CMA) shows strong negative loadings for low-investment firms (–0.92), consistent with Hou et al. (2015), indicating higher returns from conservative strategies. The FF3F model explains 73–84% of return variation, while FF5F provides marginal improvements (e.g., 0.85 vs. 0.84 for small, low-investment firms). This indicates that CMA and RMW enhance explanatory power modestly, which is consistent with studies in emerging markets (Ali et al., 2020).

V. CONCLUSION

The analysis of Size-BM, size–OP, and size–Inv portfolios in Indian equity markets provides insights into asset pricing, showing alignments and deviations from global patterns. The CAPM fails to explain cross-sectional returns, particularly for small firms and those with extreme OP or Inv characteristics, supporting the findings of its limitations in developed and emerging markets. The FF3F model enhances explanatory power by capturing size and value effects, although anomalies persist, especially among small firms with high OP and low investments. The FF5F model, which includes profitability and investment factors, provided the best fit. Investment shows stronger explanatory power than profitability, aligning with conservative capital allocation strategies that yield return premiums. The weaker profitability premium may reflect investors' focus on capital efficiency rather than on earnings strength. The high explanatory power across the models confirms their applicability, although the benefits of adding profitability and investment factors remain modest. Persistent mispricing in certain portfolios suggests possible omitted variables such as momentum or behavioral influences, consistent with global asset pricing research.

Implications of the Study

These findings have significant theoretical and practical implications for emerging markets, particularly India. The results confirm that the size and value effects remain meaningful, although the five-factor model's improvement over the three-factor version appears more modest than in developed markets. Persistent alphas in small-cap and value portfolios suggest either market inefficiencies or omitted risk factors unique to emerging economies, which is consistent with prior research (Cakici et al., 2013; Rouwenhorst, 1998). The stronger profitability effects and distinct behavior of investment factors in India highlight the need for localized model adjustments through modified factor weightings or variables such as momentum and liquidity.

This study highlights the incorporation of investment efficiency alongside traditional factors in portfolio construction. The findings show that while global factor models provide a framework, emerging markets need adaptations for local characteristicssuch as ownership structures, analyst coverage gaps, and market microstructure differences. Future research should explore behavioral explanations for residual mispricing and test hybrid models with region-specific factors. These insights help us understand how asset pricing theories apply to India's financial ecosystem, bridging global models and local market realities.

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