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TESTING FAMA-FRENCH FIVE-FACTOR MODEL: EMPIRICAL EVIDENCE FROM INDIA

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ABSTRACT
This study investigates the five-factor model proposed by Fama and French (2015) for the Indian stock market. The study utilizes data from all stocks listed on the S&P BSE 500 from October 1999 to September 2023. The time-series regression approach is used to test the significance of each factor in explaining the excess returns of 96 portfolios formed on different factors. We find that there are patterns in average returns related to size, value, and profitability factors. However, the investment factor is weak. The findings show that the five-factor model outperforms the traditional three-factor model in explaining stock returns. Unlike the findings of Fama and French (2015), the results show that the value factor is not redundant in India. The findings of our study are primarily useful for estimating expected stock return. The results can also be used to evaluate the performance of managed portfolios, especially in the mutual fund industry.
Keywords: *Asset pricing models, Five-Factor model, Profitability, Investment, Indian stock market*

1. INTRODUCTION

The inadequacy of the capital asset pricing model (CAPM) established by Sharpe (1964) in capturing patterns in stock returns underpins the emergence of multi-factor asset pricing models. Fama and French (1993) introduce a three-factor model (FF3F) by adding factors related to size and book-to-market equity ratio (B/M) variables to the CAPM. Several studies demonstrate that the FF3F model outperforms the CAPM in explaining stock returns (e.g., Sehgal and Balakrishnan, 2013; Cakici *et al*., 2013; Aziz and Ansari, 2014). Consequently, the FF3F model is acknowledged as the standard model in asset pricing literature. After over twenty years, Fama and French (2015) develop the five-factor model (FF5F) by incorporating the factors related to profitability and investment into their FF3F model. This idea is based on Miller and Modigliani (1961) and empirical findings regarding the significant impact of investment and profitability factors on stock returns. Fama and French (2017) report that the FF5F model is superior to the FF3F model in describing stock returns globally. Additionally, they empirically demonstrate that the B/M becomes redundant when the investment and profitability factors are incorporated in the FF3F model.

Many studies examine the FF5F model in both developed and emerging markets. However, there is limited literature on the implementation of the FF5F model in emerging markets compared to developed ones. For example, Guo *et al*. (2017) focus on China; Ekaputra and Sutrisno (2020) on Indonesia and Singapore; and Chiah *et al*. (2016) on Australia. This study is the latest contribution to emerging market research, providing evidence from India. This research is motivated by the fact that only a few studies have investigated the empirical validity of the FF5F model in India, and their findings remain inconclusive.

Given this background, the study aims to achieve two main objectives. The primary objective of this research is to assess the effectiveness of the FF5F model in India, an emerging market. The importance of the Indian stock market is underscored by the recent milestone of its entire market capitalization exceeding $5 trillion for BSE-listed stocks. Therefore, India has the fifth position among the world's largest stock markets, following the United States, China, Japan, and Hong Kong. Secondly, Fama and French (2015) demonstrate that average returns relate to B/M, profitability, and investment factors through the dividend discount model. They empirically discovered that the B/M becomes redundant in the presence of profitability and investment variables. They assert that this outcome may be specific to the sample period and the market they examine. Therefore, this study examines whether the B/M factor is redundant in India.

The findings indicate that size, value, and profitability determine average stock returns in India. However, there is no significant relation between investment and average returns. The results indicate that the FF5F model outperforms the FF3F model in describing average returns. Moreover, the findings suggest that the B/M factor is not redundant in India, contrary to the findings of Fama and French (2015).

The remainder of this study is as follows: Section 2 outlines the data and method. Section 3 discusses the results of this study, and Section 4 concludes the study.

2. DATA & METHODOLOGY

2.1 Data

This study utilizes data from all stocks listed on the S&P BSE 500. The data is collected from the Prowess database from October 1999 to September 2023. We gather data on the monthly adjusted closing prices of all stocks throughout the specified timeframe. The risk-free rate (R_f) is approximated by the rate of 91-day Treasury bills for computing the portfolio's excess return. The treasury bill rate is collected from the RBI website. A company must possess accounting data for the preceding year to become part of the sample. The company with a negative book value of equity is excluded from the sample. The measure of profitability is determined by scaling the operating profit by the book value of equity. Using the approach of Fama and French (2015), we employ asset growth to approximate investment. To determine asset growth, we subtract the total assets in year (t-1) from the total assets in year (t). Consistent with Fama and French (1993, 2015), a six-month gap is maintained from the end of the financial year (March in India) to ensure the data is readily available for portfolio formation purposes.

2.2 Factor construction and models

This sub-section discusses the creation of factor portfolios that will be used in the RHS of the regression equation. The market factor (R_m-R_f) is calculated as the return on the market index minus the risk-free rate (R_f). The stocks characterizing size are allocated into two portfolios based on median value – small-size and big-size portfolios. Then, we compute the 30^{th} and 70^{th} percentiles of the B/M among the sample stocks. The stocks with a B/M falling in the 30th percentile are grouped as low B/M or growth stocks, and those with a B/M greater than the 70th percentile are considered high B/M or value stocks. The remaining stocks are considered medium stocks. Similarly, we categorize stocks into three groups based on profitability and investment factors.

The combination of two size-based portfolios and three B/M-based portfolios yields a total of six portfolios (2 × 3). Then, we compute monthly returns on these six portfolios using an equally weighted approach from October to September of the following year, t+1. The portfolios are then reformed each year in October. Then, we create two factors, SMB and HML, that replicate the return premium related to size and B/M ratio. SMB is calculated as the mean returns on portfolios characterized by small size, less the mean returns on portfolios characterized by large size. Similarly, HML is determined as the mean returns on portfolios characterized by high B/M minus the mean returns on portfolios characterized by low B/M. Following the same procedure used to obtain the HML factor, we form two additional factors, RMW and CMA, which capture the return premium related to profitability and investment. RMW is computed as the mean return on portfolios characterized by robust profitability minus the mean return on portfolios characterized by weak profitability. Similarly, CMA is computed by deducting the mean returns of aggressive portfolios from the mean returns of conservative portfolios. Accordingly, we get the three size values – SMB_{BM}, $SMB_{OP,}$ and SMB_{INV}. The average of these three size values will give the size factor (SMB).

Fama and French (2015) incorporate profitability and investment factors into their FF3F model, leading to the development of the FF5F model. The time-series regression equations of these models are given below:

$$R_{it} - R_{Ft} = a_i + b_i\,(R_{Mt} - R_{Ft}) + s_i SMB_t + h_i HML_t + e_{it} \qquad (1)$$

$$R_{it} - R_{Ft} = a_i + b_i\,(R_{Mt} - R_{Ft}) + s_i SMB_t + h_i HML_t + r_i RMW_t + c_i CMA_t + e_{it} \qquad (2)$$

where R_{it} is the return on portfolio i for the period t, R_{Ft} denotes the risk-free rate for period t, a_i is the intercept term, b_i is the beta for portfolio i, R_{Mt} denotes the return on the market portfolio, SMB_t denotes the size premium, HML_t indicates the value premium, $RMW_{t,}$ and CMA_t denote the return premium related to profitability and investment factors, and e_{it} is the error term.

2.3 Portfolio Formation

This sub-section deals with the construction of test portfolios. We apply the triple-sorting (2x4x4) methodology to form these portfolios. The stocks based on market capitalization are classified into two portfolios. The stocks with B/M are divided into four portfolios in increasing order. Similarly, the stocks based on profitability and investment are also classified into four portfolios. The combination of two size-based portfolios with four B/M-based portfolios and four profitability-based portfolios produces 32 Size-BM-OP portfolios. Following a similar procedure, we obtain 32 portfolios characterizing Size-BM-INV and another 32 portfolios characterizing Size-OP-INV. Accordingly, we get a total of 96 portfolios by combining these three sets of 32 portfolios. Finally, after calculating portfolio returns for each of them, we deduct the risk-free rate to get the excess portfolio return (R_i-R_f), which will be used in the LHS of the regression equation. This process is repeated each year for the sample period.

3. DISCUSSION OF RESULTS

The primary objective of our study is to investigate how well the FF5F model performs in India. This section presents a comprehensive analysis of time-series regressions conducted on 96 portfolios-32 portfolios characterized by Size-BM-OP, 32 portfolios characterized by Size-BM-INV, and 32 portfolios based on Size-

OP-INV. The FF3F and FF5F models, which are given in equations (1) and (2), are used to regress the excess returns of these 96 portfolios.

3.1 Summary statistics for factors

Table 1 presents the descriptive statistics of the factor returns, including the mean, standard deviation, t-statistics for the mean, and correlation between them. Panel A demonstrates that the average excess return on R_m-R_f is 0.62% per month, with an SD of 4.96%, the highest among factors. This implies that the Indian stock market exhibits low risk aversion due to its low mean and high standard deviation of the market variable. The mean excess return on SMB is 1.35% per month, the highest among all factors, and is significant at the 1% level. Singh et al. (2023) also find similar results for the SMB factor in India. The HML factor generates a significant monthly return premium of 0.41%, on average. The mean returns for RMW and CMA are 0.13% per month and 0.29% per month, respectively, and both are statistically insignificant. Overall, we find robust size and value effects in the Indian stock market.

Table 1: Descriptive Statistics of Factor Returns: Oct 1999 to Sept 2023, 288 months

Panel A: Means and SD for monthly returns					
	Rm-Rf	SMB	HML	RMW	CMA
Mean (%)	0.62	1.35	0.41	0.13	0.29
SD (%)	4.96	2.73	3.99	2.30	2.13
t-statistics	1.49	5.91	1.24	0.66	1.61
Panel B: Correlation between different factors					
	Rm-Rf	SMB	HML	RMW	CMA
Rm-Rf	1.00				
SMB	0.39	1.00			
HML	0.48	0.37	1.00		
RMW	-0.38	-0.13	-0.64	1.00	
CMA	0.04	-0.03	0.44	-0.41	1.00

Panel B shows the correlation among five factors. The correlation between SMB and the market factor is positive, suggesting that small stocks tend to have higher betas, which is a reasonable finding. There is an unexpectedly positive correlation between SMB and HML, which aligns with the findings of Singh et al. (2023) in the Indian context but contradicts those of Fama and French (2015). HML shows a negative correlation with RMW and a positive correlation with CMA. This indicates that a value firm is more likely to have lower profitability and investment. RMW is negatively correlated with CMA, indicating that profitable firms are likely to invest more, which is logical.

The monthly return premiums for the three sets of triple-sorted test portfolios are reported in Table 2. Panel A shows the return premium of 32 portfolios characterized by Size-BM-OP. For both small and big stocks, the average return increases with B/M and OP. Panel B displays the return premium of 32 portfolios characterized by Size-BM-INV. Similar to Panel A, high B/M portfolios earn higher returns than low B/M portfolios. However, the pattern of returns for portfolios related to investment is not clear.

Table 2: Average monthly excess returns for 25 portfolios: Oct 1999 to Sept 2023, 288 months

	Small				Big			
Panel A: 32 Size-BM-OP portfolios								
BM→	Low	2	3	High	Low	2	3	High
Low OP	1.57	1.72	2.20	2.20	0.16	1.06	1.20	1.29
2	1.66	1.47	2.36	2.79	0.75	0.93	1.64	1.06
3	1.41	2.00	2.42	2.10	0.98	1.24	1.69	1.62
High OP	2.26	2.47	2.61	3.14	0.87	0.85	0.87	1.67
Panel B: 32 Size-BM-INV portfolios								
BM→	Low	2	3	High	Low	2	3	High
Low INV	1.68	2.20	2.32	2.51	0.67	0.95	1.82	1.37
2	1.97	1.43	1.92	2.53	1.15	0.92	1.33	1.10
3	1.88	1.73	2.24	1.89	0.99	0.99	1.03	1.20
High INV	1.96	2.52	2.49	2.86	1.63	0.99	1.01	1.62
Panel C: 32 Size-OP-INV portfolios								

OP→	Low	2	3	High	Low	2	3	High
Low INV	2.30	2.16	2.92	2.50	1.14	0.92	1.27	0.84
2	1.93	2.41	2.18	1.80	0.94	0.69	1.48	1.43
3	1.96	1.77	1.64	2.42	0.60	1.22	1.17	0.81
High INV	1.67	2.09	2.53	2.95	0.90	0.89	1.11	0.62

Panel C shows the return premium of 32 portfolios characterized by Size-OP-INV. Similar to Panel A, the average excess returns exhibit an upward trend as the OP increases. However, the pattern of returns for portfolios related to investment is not clear. The results reveal strong patterns related to value and profitability in India. However, the investment factor is weak.

3.2 Time-series regressions details

3.2.1 32 Size-BM-OP portfolios

Table 3 displays the details of the time-series regression of 32 Size-BM-OP portfolios. Panel A demonstrates the intercepts of the FF3F model for small and large stocks. The three-factor intercepts are statistically significant for only 4 out of 32 cases. This result shows that the FF3F model can describe the returns of these portfolios. The intercepts, coefficients, and Adjusted-R2 for the FF5F model are reported in Panel B. The FF5F model performs similarly to the FF3F model, as only 4 out of 32 intercepts are significant. All portfolios exhibit a positive and significant association with Rm-Rf, the market factor.

Table 3: Regression for 32 portfolios based on Size, BM, and OP: Oct 1999 to Sept 2023, 288 months

	Small				Big			
BM→	Low	2	3	High	Low	2	3	High
Panel A: Three-factor intercepts: R_m-R_f, SMB, and HML								
OP ↓			$\alpha^{Three\text{-}factor}$				$\alpha^{three\text{-}factor}$	
Low OP	0.20	-0.69	0	-0.09	-0.93**	0.19	0.21	0.05
2	-0.10	-0.05	0.32	0.38	-0.05	0.16	0.61*	0.25
3	0.13	0.18	0.23	-0.42*	0.34	0.35	0.61*	0.27
High OP	0.44	0.44	0.34	0.44	0.18	-0.12	-0.12	0.36
Panel B: Five-factor intercepts and coefficients: R_m-R_f, SMB, HML, RMW and CMA								
			$\alpha^{Five\text{- }factor}$				$\alpha^{Five\text{- }factor}$	
Low OP	0.14	-0.66	-0.05	-0.04	-0.81**	0.21	0.23	0.06
2	-0.08	-0.14	0.30	0.32	-0.09	0.09	0.56*	0.27
3	0.10	0.20	0.16	-0.45*	0.29	0.28	0.56*	0.27
High OP	0.46	0.37	0.24	0.31	0.13	-0.23	-0.19	0.28
			$B^{Rm\text{-}Rf}$				$B^{Rm\text{-}Rf}$	
Low OP	1.01***	1.01***	0.94***	0.85***	0.98***	0.87***	0.89***	1.03***
2	1.12***	0.77***	0.89***	0.90***	0.90***	0.92***	0.93***	0.95***
3	0.75***	0.91***	0.93***	0.87***	0.75***	0.93***	0.98***	0.99***
High OP	0.95***	0.87***	0.94***	0.90***	0.81***	0.97***	0.87***	0.84***
			B^{SMB}				B^{SMB}	
Low OP	0.71***	1.45***	1.13***	1.11***	0.34***	0.12*	0.18**	-0.04
2	0.88***	0.72***	1.08***	1.22***	0.18**	0.09	0.14	-0.33**
3	0.68***	0.95***	1.11***	1.26***	0.17**	0.19**	0.09	0.12
High OP	1.10***	1.08***	1.14***	1.36***	0.13***	0.09	0.09	0.39***
			B^{HML}				B^{HML}	
Low OP	-0.41***	-0.18	0.30***	0.56***	-0.14	0.16***	0.23***	1.05***
2	-0.26*	0.13	0.12	0.51***	-0.15**	0.01	0.34***	0.97***
3	-0.16	-0.04	0.28***	0.62***	-0.21***	-0.03	0.51***	0.88***
High OP	-0.48***	0.15*	0.37***	0.69***	-0.17***	0.29***	0.45***	0.42***

			B^{OP}				B^{OP}	
Low OP	-0.02	-0.30*	-0.10	-0.18**	-0.39***	-0.10	-0.22**	-0.12
2	-0.14	0.34***	0.01	0.12	0.13*	0.10	0.11	-0.11
3	-0.07	-0.07	0.23**	0.17**	0.11*	0.21**	0.02	0.02
High OP	-0.05	0.24**	0.29***	0.57***	0.26***	0.36***	0.25**	0.29***
			B^{INV}				B^{INV}	
Low OP	0.55***	0.31*	0.57***	-0.06	-0.20	0	0.20**	0.21
2	0.07	0.06	0.15	0.25***	0.02	0.35***	0.21*	0.07
3	0.36***	0	0.20**	-0.08	0.20***	0.22**	0.44***	-0.06
High OP	-0.06	0.19	0.29***	-0.03	-0.05	0.25**	0.09	0.14
Small								
	Adj. $R^{2\ (Three\text{-}factor)}$				*Adj.* $R^{2\ (Five\text{-}factor)}$			
Low OP	0.36	0.54	0.72	0.85	0.37	0.56	0.74	0.85
2	0.49	0.59	0.75	0.81	0.49	0.61	0.75	0.82
3	0.44	0.63	0.77	0.85	0.45	0.63	0.78	0.86
High OP	0.73	0.68	0.78	0.73	0.73	0.68	0.79	0.76
Big								
	Adj. $R^{2\ (Three\text{-}factor)}$				*Adj.* $R^{2\ (Five\text{-}factor)}$			
Low OP	0.55	0.77	0.69	0.71	0.57	0.78	0.70	0.71
2	0.73	0.74	0.66	0.60	0.73	0.76	0.67	0.60
3	0.69	0.70	0.69	0.58	0.70	0.71	0.70	0.58
High OP	0.82	0.65	0.59	0.66	0.83	0.67	0.60	0.68

Note(s): Asterisks ***,** and * denote the significance level at 1%, 5%, and 10%.

Source(s): Authors' own work

The SMB slopes exhibit a declining trend as the size increases, showing the size effect. As expected, the HML factor is positively (negatively) loaded on value (growth) portfolios. The RMW slopes increase with profitability across the portfolios. The slopes of CMA do not exhibit a clear pattern. The mean adjusted R^2 for the FF5F and FF3F models is 0.68 and 0.67, respectively. This shows that the FF5F model performs slightly better in describing the stock returns of 32 portfolios characterized by Size-BM-OP in the Indian stock market.

3.2.2 32 Size-BM-INV portfolios

Table 4 reports the regression estimates for 32 portfolios related to Size-BM-INV. In Panel A, the regression intercepts of the FF3F model are shown. The regression intercepts of the FF3F model are statistically significant for only 5 out of 32 cases, suggesting that the FF3F model can explain the returns of 32 portfolios based on Size-BM-INV portfolios. In Panel B, the intercepts, slopes, and Adjusted-R2 for the FF5F model are reported. The FF5F model provides a better explanation for the stock returns of 32 Size-BM-INV portfolios, as only 4 out of 32 intercepts are significant. All these 32 portfolios exhibit a significantly positive relation with the market factor. As expected, the slopes of SMB decrease as the size increases across the rows. The slopes of HML are significantly negative (positive) for growth (value) portfolios, showing the value effect in the Indian market. The RMW slopes exhibit no clear pattern. The slopes of CMA are decreasing as the investment increases in each column.

Table 4: Regression for 32 portfolios based on Size, BM, and INV: Oct 1999 to Sept 2023, 288 months

Small					Big			
BM→	Low	2	3	High	Low	2	3	High
Panel A: Three-factor intercepts: R_m-R_f, SMB, and HML								
INV↓			$\alpha^{Three\text{-}factor}$				$\alpha^{three\text{-}factor}$	
Low INV	-0.21	0.40	0.26	0.27	0.15	0.04	0.79**	0.20

2	0.66	-0.40	-0.06	0.25	0.46*	-0.03	0.63**	0.16
3	0.24	0.16	0.21	-0.58**	0.38*	0.18	0.24	0.17
High INV	0.20	0.41	0.48	0.18	-0.23	0.10	-0.30	0.14
Panel B: Five-factor intercepts and coefficients: R_m-R_f, SMB, HML, RMW, and CMA								
			$\alpha^{Five\text{- }factor}$				$\alpha^{Five\text{- }factor}$	
Low INV	-0.28	0.25	0.17	0.18	0.09	-0.05	0.76**	0.20
2	0.58	-0.43	-0.12	0.19	0.37	-0.12	0.61**	0.12
3	0.31	0.13	0.17	-0.56*	0.32*	0.14	0.19	0.08
High INV	0.30	0.50	0.52	0.29	-0.17	0.12	-0.32	0.23
			$B^{Rm\text{-}Rf}$				$B^{Rm\text{-}Rf}$	
Low INV	1.09***	0.90***	0.98***	0.87***	0.77***	1.04***	1.01***	0.89***
2	0.96***	0.78***	0.86***	0.90***	0.79***	0.91***	0.88***	0.98***
3	0.98***	0.86***	0.87***	0.89***	0.80***	0.88***	0.92***	1.02***
High INV	0.94***	0.86***	0.99***	0.88***	1.00***	0.95***	0.91***	0.98***
			B^{SMB}				B^{SMB}	
Low INV	1.01***	0.95***	1.04***	1.17***	0.11	0.17**	0.12	0.10
2	0.69***	0.97***	1.03***	1.11***	0.19**	0.25***	-0.12	-0.14
3	0.85***	0.82***	0.99***	1.21***	0.06	0.16**	0.02	-0.05
High INV	1.06***	1.09***	0.97***	1.29***	0.12	0	0.23**	0.22
			B^{HML}				B^{HML}	
Low INV	-0.22*	0.03	0.19***	0.36***	-0.31***	-0.03	0.29***	0.79***
2	-0.44***	0.13	0.23***	0.51***	-0.18***	-0.01	0.41***	0.79***
3	-0.32***	-0.13	0.31***	0.60***	-0.11**	-0.03	0.22**	0.69***
High INV	-0.52***	0.14	0.12	0.72***	-0.14**	0.27***	0.61***	0.82***
			B^{OP}				B^{OP}	
Low INV	0.04	0.29**	0.05	0.16**	0.09	0.09	-0.09	-0.18
2	0.12	0.09	0.03	0.15*	0.14*	0.16**	-0.07	0.05
3	-0.12	0.08	0.23**	-0.02	0.22***	0.07	0	0.17
High INV	-0.24*	0	-0.07	-0.03	0.03	0.28***	0.29**	-0.06
			B^{INV}				B^{INV}	
Low INV	0.50***	0.70***	0.59***	0.43***	0.36***	0.56***	0.39***	0.34***
2	0.47**	0.08	0.44***	0.23**	0.48***	0.42***	0.27***	0.19
3	-0.33**	0.13	-0.07	-0.12	0.05	0.17**	0.36**	0.42***
High INV	-0.34**	-0.74***	-0.18	-0.83***	-0.57***	-0.63***	-0.34***	-0.56***
Small								
	$Adj.\ R^{2\ (Three\text{-}factor)}$				$Adj.\ R^{2\ (Five\text{-}factor)}$			
Low INV	0.51	0.56	0.79	0.81	0.53	0.6	0.82	0.83
2	0.37	0.64	0.69	0.81	0.38	0.64	0.70	0.81
3	0.55	0.56	0.72	0.81	0.56	0.56	0.72	0.81
High INV	0.54	0.59	0.68	0.77	0.55	0.62	0.68	0.81

	Big							
	Adj. $R^{2\ (Three\text{-}factor)}$				*Adj.* $R^{2\ (Five\text{-}factor)}$			
Low INV	0.57	0.73	0.64	0.66	0.59	0.77	0.66	0.67
2	0.60	0.70	0.68	0.67	0.64	0.73	0.69	0.67
3	0.77	0.71	0.49	0.58	0.78	0.71	0.51	0.59
High INV	0.75	0.69	0.64	0.59	0.79	0.75	0.66	0.61
Note(s): Asterisks ***,** and * denote the significance level at 1%, 5%, and 10%. Source(s): Authors' own work								

The mean adjusted R^2 for the FF5F model is 0.67, while it is 0.65 for the FF3F model. This indicates that the FF5F model outperforms the FF3F model in terms of its ability to describe the stock returns of 32 portfolios characterized by Size-BM-INV in the Indian market.

3.2.3 32 Size-OP-INV portfolios

Table 5 displays the regression estimates of 32 portfolios related to Size-OP-INV. In Panel A, the regression intercepts of the FF3F model are reported. The FF3F model can describe the stock returns of 32 portfolios, as only 6 intercepts out of 32 are significant. Panel B reports the intercepts, coefficients, and Adj-R2 for the FF5F model. The five-factor intercepts are statistically significant in 4 out of 32 cases, indicating that the FF5F model provides a better explanation for the stock returns of the 32 Size-OP-INV portfolios. All 32 portfolios exhibit a positive and significant association with Rm-Rf. The slopes of SMB consistently decline as the size increases across the rows. There is no clear pattern in the coefficients of the HML factor. The slopes of RMW exhibit a positive relation between the profitability factor and stock returns, demonstrating the profitability effect. The slopes of CMA are significantly positive for portfolios with low asset growth and negative for portfolios with the highest asset growth. This suggests that this factor can account for the variation in stock returns associated with asset growth.

Table 5: Regression for 32 portfolios based on Size, OP, and INV: Oct 1999 to Sept 2023, 288 months

	Small				**Big**			
OP→	Low	2	3	High	Low	2	3	High
Panel A: Three-factor intercepts: R_m-R_f, SMB, and HML								
INV ↓			$\alpha^{Three\text{-}\ factor}$			$\alpha^{three\text{-}factor}$		
Low INV	0.11	0.23	0.84*	0.16	0.20	-0.01	0.37	0.04
2	-0.17	0.39	0.24	-0.29	0.05	-0.12	0.83**	0.70**
3	-0.68	-0.16	-0.30	0.30	-0.22	0.57*	0.49**	0.07
High INV	-0.60	0.07	-0.04	1.01***	-0.44	-0.05	0.24	-0.25
Panel B: Five-factor intercepts and coefficients: R_m-R_f, SMB, HML, RMW, and CMA								
			$\alpha^{Five\text{-}\ factor}$				$\alpha^{Five\text{-}\ factor}$	
Low INV	0.10	0.11	0.72	-0.01	0.23	-0.05	0.28	-0.10
2	-0.15	0.31	0.15	-0.41	0.08	-0.18	0.75**	0.57*
3	-0.69	-0.18	-0.27	0.28	-0.17	0.48	0.47**	0
High INV	-0.58	0.10	0.20	1.03***	-0.26	0.01	0.23	-0.28
			$B^{Rm\text{-}Rf}$				$B^{Rm\text{-}Rf}$	
Low INV	0.93***	0.85***	0.92***	0.98***	0.84***	1.10***	0.86***	0.96***
2	0.87***	0.84***	0.86***	0.97***	0.97***	0.80***	0.85***	0.87***
3	0.98***	0.80***	0.90***	0.87***	0.88***	0.85***	0.83***	0.92***
High INV	0.87***	0.87***	0.97***	0.90***	1.01***	1.02***	0.88***	0.92***

			B^{SMB}				B^{SMB}	
Low INV	1.18***	1.00***	1.02***	1.17***	0.13	0.07	0.27***	0.12
2	1.02***	1.02***	0.96***	1.10***	-0.03	0.16**	0.03	0.09
3	1.54***	0.97***	0.97***	1.13***	0.16	0	0.05	0.05
High INV	1.21***	1.04***	1.21***	.98***	0.17	0.09	0.13	0.11
			B^{HML}				B^{HML}	
Low INV	0.18***	0.19**	0.35***	0.39***	0.35***	0.10	-0.06	0
2	0.42***	0.31***	0.26***	0.07	0.41***	0.08	0.04	0.02
3	0.05	0.29***	0.16**	0.15	-0.02	0.08	0.01	-0.02
High INV	0.24**	0.15	0.44***	0.07	0.58***	0.06	0.11	0.04
			B^{OP}				B^{OP}	
Low INV	-0.26***	0.28***	0.27*	0.50***	-0.23***	-0.05	0.10	0.26**
2	-0.18*	0.20**	0.29**	0.39***	-0.20**	0.13*	0.11	0.33***
3	-0.02	0.08	-0.15	0.12	-0.31***	0.25***	0.06	0.35***
High INV	0.09	-0.01	-0.19	0.14	-0.24*	-0.01	0.10	0.40***
			B^{INV}				B^{INV}	
Low INV	0.55***	0.42***	0.51***	0.47***	0.24***	0.39***	0.58***	0.67***
2	0.21*	0.25***	0.25*	0.31**	0.13	0.26***	0.51***	0.41***
3	0.04	0.03	0.02	-0.10	0.14	0.31***	0.04	0
High INV	-0.38**	-0.21	-1.59***	-0.41***	-1.03***	-0.52***	-0.08	-0.50***
Small								
	Adj. $R^{2\ (Three\text{-}factor)}$				*Adj.* $R^{2\ (Five\text{-}factor)}$			
Low INV	0.80	0.70	0.59	0.69	0.83	0.73	0.61	0.72
2	0.72	0.75	0.62	0.60	0.73	0.76	0.64	0.62
3	0.59	0.66	0.73	0.67	0.59	0.66	0.73	0.67
High INV	0.58	0.55	0.55	0.67	0.59	0.55	0.65	0.69
Big								
	Adj. $R^{2\ (Three\text{-}factor)}$				*Adj.* $R^{2\ (Five\text{-}factor)}$			
Low INV	0.73	0.72	0.57	0.51	0.75	0.74	0.61	0.56
2	0.77	0.68	0.55	0.60	0.78	0.69	0.58	0.63
3	0.55	0.61	0.75	0.78	0.56	0.63	0.75	0.80
High INV	0.56	0.71	0.66	0.68	0.62	0.74	0.67	0.73
Note(s): Asterisks ***,** and * denote the significance level at 1%, 5%, and 10%. Source(s): Authors' own work								

The mean adjusted R^2 for the FF5F model is 0.68, and it is 0.65 for the FF3F model. This finding demonstrates that the FF5F model performs slightly better in describing stock returns of 32 portfolios characterized by Size-OP-INV in the Indian market.

6. CONCLUSION

The existing asset pricing models, especially the three-factor model, fail to adequately account for the significant patterns in average returns, necessitating the development of an improved asset pricing model.

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Building on the work of Miller and Modigliani (1961) and the empirical evidence presented by Titman *et al.* (2004) and Novy-Marx (2013), Fama and French (2015) introduce a five-factor model that incorporates profitability and investment variables into their original three-factor model. This development presents an opportunity to enhance the asset pricing literature in India by conducting an out-of-sample test of the FF5F model. This study aims to evaluate the effectiveness of the FF5F model in the Indian stock market. This study utilizes data from all firms listed on the S&P BSE 500 from October 1999 to September 2023.

The findings indicate that size, value, and profitability factors influence average returns in India. In contrast, the investment factor is found to be insignificant, supporting the findings of Fama and French (2017) and Singh et al. (2023). Moreover, the results suggest that the FF5F model is more effective than the FF3F model in describing stock returns in the Indian stock market. Contrary to Fama and French's (2015) finding, the results indicate that the B/M factor is not redundant in India. However, further improvement is needed, as the FF5F model is unable to provide a complete explanation for the time-series variation in average returns.

The findings of our study are primarily useful for estimating expected stock returns and, therefore, for pricing Indian equities. The results can also be applied to evaluate the performance of managed portfolios, especially in the mutual fund industry.

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