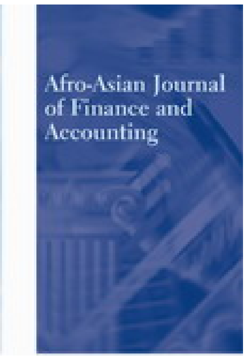

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Analysing asset pricing models in the Indian stock market: a comprehensive empirical study

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Abstract: This study aims to analyse the asset-pricing model in India by using a comprehensive database of companies listed in the BSE 500 Index. The study covers a 20-year period from July 2000 to June 2020 and focuses on the evaluating the Fama-French three-factor and Fama-French five-factor models. To examine these asset-pricing models, ordinary least-squares multivariate regression analysis is performed for both single-sorted and double-sorted portfolios. The market proxy is selected by assessing its robustness among three potential proxies. The results suggest that return patterns are influenced by firm characteristics, specifically size, as well as fundamentals such as profitability and investments. These factors play a significant role in shaping portfolio returns. The empirical results suggest that both the Fama-French three-factor model and the Fama-French five-factor model are statistically suitable for capturing portfolio returns. However, the Fama-French five-factor model shows better performance compared to the three-factor model. Notably, the factors of size, profitability, and investment have an impact on most portfolios. These results support the adoption of Fama-French multifactor models to determine the cost of capital in the Indian stock market and emphasise the factors that fund managers, asset managers and investors should consider when constructing portfolios.

Keywords: five-factor model; three-factor model; efficient market hypothesis; market anomalies; investments; portfolio.

JEL codes: G11; G12.

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1 Introduction

One of the most important hypotheses in the study of financial economics is the efficient market hypothesis (EMH). The inventor of the EMH, Fama (1970), discovered that stock prices accurately reflect information assimilation in an efficient market. No market participant can therefore achieve abnormal profits. Although developed markets have long embraced this theory, there is some evidence to the contrary. Anomalies are the collective term for these deviations. EMH behavioural economists have uncovered significant anomalies over the past few decades that have enabled investors to achieve exceptional returns. Risk-based theories asset pricing theories have been disproved, and Warren Buffett has been cited by scholars such as Price and Kelly (2004) as concrete evidence of continued market outperformance. As a result, a number of strategies have emerged that identify elements of risk responsible for stock returns and subvert the single-factor capital asset pricing model (CAPM). This has therefore led to the development of other models, the Fama-French model (1992) being the most popular and widely used.

To explain portfolio stock returns, Fama and French (1992) point to size (SMB) and value (HML) characteristics that contribute to excess market returns. Two risky factors, small minus big (SMB) and high minus low (HML), were included as additional variables in the CAPM on the grounds that beta is not the only factor affecting stock returns. Thus, SMB-based portfolios represent small-cap company returns versus large-cap company returns while adjusting the book-to-market (BM) ratio. Adjusted for market capitalisation, portfolios with a low book-to-market ratio outperform portfolios with a high book-to-market ratio in terms of returns. Dubbed the Fama and French three-factor model (FF3FM), the portfolio produces positive returns and can account for over 90% of returns, as opposed to 70% for the CAPM. The Fama-French five-factor model (FF5FM) is an extension of their 2015 study and now includes two additional components of profitability (RMW) and investment (CMA). They acknowledged that two significant studies contributed to the creation of their five-factor model. First, Novy-Marx (2013) reported that profitability has the ability to predictably explain asset returns, noting that portfolios based on profitability yield much higher returns than portfolios of unprofitable enterprises. To further clarify the relationship between BM, projected returns, profitability, and investment, Aharoni et al. (2013) measured investment at the firm level. Aharoni and his collaborators discovered a strong, albeit weak, relationship between investment and expected stock returns. This prompted Fama and French to describe US stock returns from 1963 to 2013 using their five-factor model, which included profitability and investment variables as risk indicators. Since then, the FF5FM has been subject to extensive research in stock markets around the world.

Cakici (2015) tested the FF5FM from 1992 to 2014 on 23 established stock markets for each of the four regions of North America, Europe, Japan and Asia Pacific. The study found minimal evidence for Japan and Asia but supported the model's applicability in North America and Europe. Cakici discovered that localised rather than global issues offer a more compelling explanation. Fama and French (2017) conducted an international analysis of the FF5FM and found that it has the ability to predict asset returns in North America, Europe, and Asia-Pacific. However, the model was unable to account for returns on Japanese assets. Racicot and Rentz (2016) in Ottawa, Huang (2018) in Macau, Lin (2017) in China, Cox and Britten (2019) in Johannesburg, Ozkan (2020) in Turkey and Mosoeu and Kodongo (2020) in China, Egypt, India, Malaysia, South Africa and South Korea are just some of the published studies on emerging markets. There is still little research on emerging markets, so thorough assessments and testing in developing countries like India are needed.

Studies on the five-factor model have been conducted in India, including those by Connor and Sehgal (2001), Dash and Mahakud (2013), Balakrishnan (2014), Harshita and Yadav (2015), Kewei et al. (2015), Balakrishnan and Maiti (2017), Nenavath (2018), Anwar and Kumar (2018), Arora and Gakhar (2019), Shaun and James (2019), Khurshid (2020), Chaudhary et al. (2020) and Lalwani and Chakraborty (2020). These studies are limited by dates and time periods, leading to mixed results. This motivates us to explore its applicability in India on a larger sample over a longer period of time.

In this study, companies listed in the BSE 500 Index are the main subject of an investigation into the feasibility of applying the FF3FM and FF5FM to the Indian stock markets. The aim of the study is to identify excess returns from portfolios classified by market returns, market capitalisation, book-market ratio, profitability, and investment. This study advances knowledge of asset pricing and offers insightful information on the various elements that go into determining the cost of capital. The study also identifies portfolio premiums based on the existence of these variables and may offer advice to investors, asset managers, and portfolio managers in creating successful investment plans. The remainder of this paper is divided into four sections: an in-depth analysis of the relevant literature, a description of the study's methodology, a presentation and analysis of the empirical results, and a conclusion.

2 Review of the literature

Sharpe's CAPM (1964) is the asset pricing topic that has received the most attention and is used by practitioners in the capital markets. Similarly, Fama's (1970) EMH theory paved the way for the strengthening of capital markets, since efficiency depends on accurate asset pricing and rational behaviour by market participants. However, research has raised doubts about the EMH and revealed that there are anomalies in the stock market. Reinganum (1981) also disputed Basu's (1977) claim that value-based variables are incompatible with CAPM when explaining returns in US markets. According to Stattman (1980), firms experiencing severe distress performed better than better-performing firms. Both Banz (1981) and Basu (1983) accepted that markets were inefficient and that some assets were mispriced. Banz (1981) noted the size premium of 0.40% each month for NYSE stocks from 1926 to 1975 as evidence of the size impact in the USA. In his study of anomalies, Schwert (1983) found that downside risk assessments and average returns of small stocks were skewed upwards. Examining the time-series behaviour of the size effect, Keim (1983) and Brown et al. (1983) discovered that the size effect was predominantly evident in January. When Roll (1983) and Reinganum (1983) tried to explain the January size effect using the tax-loss selling theory, they concluded that it could not be properly explained. Based on the results, Fama and French (1992) examined the combined effects of market beta, size, earnings per share, financial leverage, and book-to-market ratio on average returns on the NYSE, AMEX, and NASDAQ. All of these variables turned out to be significant and exhibited the expected returns. Fama and French (1993) then hypothesised that, in a time-series test, the three variables market, company size, and book-to-value would have better explanatory power than the CAPM. The premiums related to value, size and market are the three dimensions of market risk. In contrast, Berk (1995) extended the CAPM to include the E/P ratio, dividend yield ratio, book-to-market ratio, leverage and firm size.

According to Fama and French (1995), who examined whether earnings are related to size and B/M, they showed that stocks with low B/M produce significant returns, whereas stocks with large B/M produce weak returns. It is evident that when attempting to explain returns, there is a strong correlation between market and size components in earnings. However, the B/M variables and earnings do not correlate in a way that could explain the returns. The relationship between returns and portfolios based on B/M, size, earnings/price, cash flow/price, past sales growth, long-term past returns, and short-term past returns was presented by Fama and French (1996). The FF3FM has been shown to be applicable to developed stock markets and to be more accurate than the CAPM in capturing cross-sectional asset returns (Liew and Vassalou, 2000; Griffin and Lemmon, 2002). Using different variables (B/M, expected profitability, and investment) of the valuation model, Fama and French (2006) confirmed that increased expected investments decrease expected returns when B/M and expected profitability are controlled. Fama and French (2012) tested the integration of stock returns using size, B/M, and momentum factors in four regions; North America, Europe, Japan, and Asia Pacific found that all countries except Japan had a strong value premium with a momentum factor explaining returns.

Several of the research reviewed in the study also examined additional factors affecting asset returns. For instance, Novy-Marx (2013) determined profitability using the ratio of gross profit to assets and found that profitable companies significantly outperformed unprofitable companies. Similar to the BM ratio, Profitability was found to have excellent predictive power. In addition, Aharoni et al. (2013) found anomalous results with a clear negative relationship between expected returns and expected investments, which seems to be positive but trivial, following Fama and French (2006). Their research suggested that the valuation model, which considers company level rather than per-share level, should be validated. In contrast, Hou et al. (2015) proposed a q-factor model, superior to the FF3FM and Carhart's (1997) four-factor model, consisting of market, size, investment, and profitability components. This model has proven effective in describing the cross-section of stock returns. The above insights led the Fama and French (2015) to extend the FF5FM to include market size, investment, and profitability by including two additional components, namely investment and profitability. The applicability of the five-factor model was subsequently explored globally by Fama and French (2017), who found that stock returns are positively associated with BM and profitability is adversely associated with investments in North America, Europe, and the Asia-Pacific (excluding Japan).

Notably, research on numerous stock markets has produced ambiguous results. According to Hou et al. (2015), profitability and investment are more accurate risk indicators affecting risk and returns, making the five-factor model one of the finest asset pricing models. Using a joint econometric estimator (OLS), Racicot and Rentz (2016) suggested a five-factor model with explanatory power to characterise returns in 12 industries. However, when using the GMM technique, all variables seemed irreverent except for the market. The inclusion of the liquidity element weakens the model. In Chinese markets, Lin (2017) discovered that an FF5FM consistently outperformed the FF3FM, while Huang (2018) found that the FF5FM outperformed other asset pricing models. Using a sample from 18 different countries, Foye (2018) found that the FF5FM performs better than the FF3FM in Eastern Europe and Latin America, while achieving the same profitability and investment premium in Asian countries. The five-factor model has been praised by Cox and Britten (2019) as the best way to explain the cross-sectional returns at the Johannesburg Securities Exchange. They claimed that profitability and investment factors help explain returns by identifying large value premiums and inverse size premiums. Testing the FF5FM for particular stock markets, Mosoeu and Kodongo (2020) used the GMM regression approach and found that the profitability factor performed better than other components. For country-specific and geographically diversified portfolios, the model performed poorly on the GRS test, consistent with previous research for the Australian, Chinese, and South African markets but not for the American and Japanese markets. Ozkan (2020) analysed all the Fama-French factor models in the Turkish stock market using Sharpe's maximum squared ratio and concluded that the FF5FM is the model that is most similar to the q-factor model.

It is crucial to assess five-factor models in the context of developing countries like India, although most international studies on this tend to focus on established markets. According to Dash and Mahakud (2013), the FF5FM is able to anticipate BM, liquidity, and the short-term momentum effect in both conditional and unconditional forms, According to Harshita and Yadav (2015), a four-factor model (excluding the investment component) is a finicky model and the Fama-French five-factor model outperforms the CAPM and FF3FM in Indian stock markets. FF5FM's ability to explain stock returns for portfolios in terms of size, value, profitability, and investment has been highlighted by Balakrishnan and Maiti (2017). For the Indian stock markets, Khurshid (2020) assessed CAPM, FF3FM, and FF5FM using factors such as profitability, size, value, investment, and market to explain asset returns. For the CNX 500 index for 1999 to 2014, Harshita and Yadav (2015) examined the five-factor model. They discovered an inverse relationship between return and market capitalisation, profitability, and investment, but a direct relationship between returns and the BM ratio. Furthermore, they indicated that the FF3FM asset-pricing model outperforms a five-factor model where the portfolio is sorted by investment and has the maximum explanatory power of the FF5FM model. According to Tripathi and Singh's (2020), the five-factor model explains the asset returns more effectively than the single-index model and is more applicable to the Indian stock market. However, the adjusted R^2 remains noticeably unchanged.

A thorough analysis of the FF5FM's applicability in the context of developed and developing markets yields contradictory findings. Indian stock markets have encompassed several global markets since their deregulation. The components based on firm characteristics would undoubtedly be supported by testing asset pricing models that explain asset returns, but there is also a requirement to assess their explanatory power in explaining the returns. Systematic risk (beta) often assesses how well a security has performed relative to the market. Using a multi-factor assessment of each investment risk, managers could use to make ethical investment decisions with the aid of. This study compares the performance of the FF3FM and FF5FM to determine which model better captures asset returns.

3 Research methodology

Our choice of research methodology was based on a review of a broad literature. Singh and Yadav (2015) used three asset pricing models; the CAPM, the FF3FM and the FF5FM and found that the Fama and French models were superior to the CAPM. Moreover, Chung et al. (2006) and Nguyen and Puri (2009) suggested that the Fama and French factors could be explained by co-skewness and co-kurtosis, supporting the covariance-risk-based approach over the conditional models.

The study initially considers 500 sample firms from the BSE 500 index, of which 240 are included in the final sample for the period June 2000 to July 2020 (Chaudhary and Bakhshi, 2021). The analysis excludes companies with insufficient data for any of the four factors. The four variables are identified and denoted by the acronyms MC (market capitalisation), which measure size; BV (book value), which assesses value stocks (book-to-price ratio); ROE (return on equity), which assesses profitability (net profit/equity); and INV (investment), which assesses investment (annual growth in total assets). The CMIE Prowess database is used to obtain accounting data for the companies, monthly closing prices, and BSE 100 index data. Information on 91-day government bond yields is obtained from the Reserve Bank of India (http://www.rbi.org). The definition of the variables, the creation of the portfolio, and the calculations are carried out according to the methods of Fama and French (1993, 2015). Using a single ranking method, sample companies are sorted and ranked into five equally weighted portfolios: P1, P2, P3, P4 and P5. These portfolios are based on four separate factors: MC, BV, ROE, and INV. Specifically, P1 is the smallest portfolio while P5 is the largest. For Indian companies, March marks the end of the financial year and the book prices for shares from the previous year are available until the end of June. As a result, the portfolio is built at the end of June each year and each factor is ranked on 31 March, monthly natural logarithmic returns (ln) are computed for each sample company using adjusted monthly closing prices. Then the mean excess returns of the five portfolios from July 1999 to June 2000 are calculated.

Subsequently, the approaches of Harshita and Yadav (2015) and Balakrishnan and Maiti (2017) are then used to build portfolios. As a result, the companies are rated according to MC and divided into three equal (33.33%) portfolios for each of the other variables, and two equal (33.33%) portfolios for small (S) and big (B) companies. Depending on the BV ratio, portfolios are categorised as high (H), neutral (N), and low (L); robust (R), neutral (N), and weak (W); and conservative (C), neutral (N), and aggressive (A); all dependent on profitability. To reduce the influence of the size component on other factors, this classification generates a 2 × 3 bivariate matrix for each controllable factor.

Table 1 Bivariate sorting of factors

	BV ratio		
Size	*High (H)*	*Medium (M)*	*Low (L)*
Small (S)	SH	SM	SL
Big (B)	BH	BM	Bl
	Profitability		
Size	*Robust (R)*	*Neutral (N)*	*Weak (W)*
Small (S)	SR	SN	SW
Big (B)	BR	BN	BW
	Investment		
Size	*Conservative (C)*	*Neutral (N)*	*Aggressive (A)*
Small (S)	SC	SN	SA
Big (B)	BC	BN	BA

Note: Bivariate sorting of size with BV, profitability and investment independently.

Table 2 Factor calculation

Factor	*Formula*
SMB_{BV}	(SH + SN + SL)/3 – (BH + BN + BL)/3
SMB_{OP}	(SR + SN + SW)/3 – (BR + BN + BW)/3
SMB_{INV}	(SC + SN + SA)/3 – (BC + BN + BA)/3
SMB	SMBBV + SMBOP + SMBINV
HML	(SH + BH)/2 – (SL + BL)/2
RMW	(SR + BR)/2 – (SW + BW)/2
CMA	(SC + BC)/2 – (SA + BA)/2

Note: Formulas used for factor calculation.

According to Table 1, 18 portfolios are created based on size-BV, size-profitability and size-investment. The factors, that represent size, value, profitability, and investment, are small minus large (SMB), high minus low (HML), robust minus weak (RMW), and conservative minus aggressive (CMA). The factor calculation formulas from Fama and French (2015) are shown in Table 2.

The BSE 100 index is used as a market proxy to determine the mean excess returns for single-sorted portfolios (P1, P2, P3, P4 and P5) and double-sorted portfolios, size-value (SH, SN, SL, BH, BN, BL), size-profitability (SR, SN, SW, BR, BN, BW), and size-investment (SC, SN, SA, BC, BN, BA).

For the FF3FM, the regression formula is:

$$\text{Rit} - \text{RFt} = \text{ai} + \text{bi}\left(\text{RMt} - \text{RFt}\right) + \text{siSMBt} + \text{hiHMLt} + \text{eit}. \quad (1)$$

For the FF35M, the regression formula is:

$$\text{Rit} - \text{RFt} = \text{ai} + \text{bi}(\text{RMt} - \text{RFt}) + \text{siSMBt} + \text{hiHMLt} + \text{riRMWt} + \text{ciCMAt} + \text{eit} \quad (2)$$

4 Empirical tests and results

Table 3 shows the excess mean returns and risks for the five portfolios based on MC, BV, ROE, INV, and factor returns [equation (2)]. The findings imply that P1 outperforms large portfolios overall, with the exception of ROE, showing the impact of market size and investments in Indian stock markets. For MC, P1 (0.023) delivers 2% better returns than P5 (0.003). The standard deviation for all portfolios shows that P1 may represent greater risk than P5, which may be the case. In terms of MC and ROE, P1 is 2% more at risk than P5. Among them the SMB and BSE 100 indices yield the highest average returns (0.006), while HML and RMW yield negative average returns. In summary, the higher performance of the P1 and SMB factors highlights the size effect in the Indian stock market.

Table 4 shows the relationship between factor returns (RM, SMB, HML, RMW, and CMA), that are independent of one another. Small companies typically have a larger market beta than large companies, which explains why SMB (0.259) have the highest association with RM. The second-highest positive correlation (0.257) shows a fundamental similarity in profitability and company size between SMB and RMW. SMB shows a positive correlation with each of the variables. With the exception of CMA, which has a negative correlation with RM and HML, other components are favorably related. It is evident that companies with low beta values invest cautiously. However, this is unexpected since conservative investments are negatively correlated with high book-value returns. Overall, the correlation matrix reveals a weak but positive correlation between the variables, indicating that joint control of the variables was not established.

The results of the regression equations for the FF3FM of the P1, P2, P3, and P5 portfolios are shown in Table 5a, for various versions of the factors (MC, BM, ROE, and INV). With the exception of P1, which is sorted by MC, the regression results seem to suggest that FF3FM perfectly explains the asset returns of single-sorted portfolios. There is no return pattern that would cause anomalies in the Indian equity market as the intercept terms for each portfolio are all zero and statistically insignificant (alpha value). However, the MC alpha value of P1 (0.007), which is significant at 5%, indicates that there may be a size effect. Last but not least, the adjusted R^2 for each portfolio is greater than 84%, demonstrating a high degree of goodness of fit. This shows that the model most effectively articulates the three components responsible for the variability of returns.

Table 3 Descriptive statistics for single sorted portfolio and factor returns

Portfolios	*P1*	*P2*	*P3*	*P4*	*P5*
			MC		
Returns	0.023	0.007	0.006	0.006	0.003
Risk	0.097	0.094	0.085	0.078	0.074
			BV		
Returns	0.016	0.011	0.009	0.004	0.003
Risk	0.093	0.084	0.082	0.087	0.080
			ROE		
Returns	0.008	0.008	0.010	0.010	0.009
Risk	0.100	0.087	0.083	0.076	0.078
			INV		
Returns	0.012	0.008	0.009	0.008	0.008
Risk	0.093	0.088	0.082	0.079	0.088
			Factors		
	BSE 100 Index	*SMB*	*HML*	*RMW*	*CMA*
Returns	0.006	0.006	–0.005	–0.002	0.001
Risk	0.069	0.034	0.041	0.021	0.027

Note: This table reports the summary statistics of portfolios and factor returns based on returns and standard deviation.

Table 4 Correlation between factor returns

	RM	*SMB*	*HML*	*RMW*	*CMA*
RM	1.000				
SMB	0.259	1.000			
HML	0.021	0.217	1.000		
RMW	0.175	0.257	0.201	1.000	
CMA	–0.004	0.236	–0.011	0.196	1.000

Note: This table reports the correlation between the factors.

Table 5b, on the other hand, demonstrates that the regression results of the three-factor model and the five-factor model are very similar for single-sorted portfolios. With the exception of P1 on MC, all alpha values of the portfolios are zero and not statistically significant. The size effect is shown by the statistically significant alpha value of 5% for very small-cap companies, while the improved dispersion indicated by the model is supported by the expanded range of R^2 from 84% to over 87% for each portfolio. Therefore, with a slight improvement in adj. R^2, both models are equivalent in the way they capture the asset returns of single-sorted portfolios.

The summary statistics (risks and returns) of the excess mean returns on double-sorted portfolios are shown in Table 6. Surprisingly, in each panel, the large stock portfolios outnumber the small stocks, demonstrating the existence of size, profitability, and investment effect. The modest pattern of portfolio returns associated with value, profitability, and investment is clearly demonstrated by the fact that the mean excess returns of SL, SR, and SC are each 1% higher than those of BL, BR, and BC. Based on size neutrality in terms of profitability and investments, similar return patterns emerge for SN (1% of the market) and BN. SC (0.016) had the highest returns of any portfolio, supporting the idea that small companies and conservative investing are the best combination.

Table 5a Regression results of the three-factor model on single sorted portfolio

MC	*Coefficients*				*p-value*				*Adj. R^2*
	α	β	*s*	*l*	α	β	*s*	*l*	
P1	0.007	0.954	1.498	–0.265	0.000*	0.000	5E-65	2E-07	0.913
P2	–0.006	1.020	1.191	–0.099	0.004	0.000	6E-49	0.051	0.904
P3	–0.004	0.978	0.748	0.018	0.114	0.000	7E-22	0.759	0.849
P4	–0.001	1.003	0.341	–0.016	0.457	0.000	4E-09	0.728	0.885
P5	–0.003	1.013	0.093	0.060	0.045	0.000	0.024	0.075	0.931
BM	*Coefficients*				*p-value*				*Adj. R^2*
	α	β	*s*	*l*	α	β	*s*	*l*	
P1	0.002	0.916	1.319	–0.185	0.333	3E-69	4E-46	0.002	0.865
P2	0.000	0.906	0.956	–0.063	0.868	8E-74	2E-33	0.244	0.858
P3	–0.001	0.960	0.770	–0.080	0.530	8E-89	5E-30	0.089	0.888
P4	–0.006	1.079	0.640	–0.054	0.003	3E-97	1E-22	0.262	0.900
P5	–0.003	1.098	0.148	0.046	0.019	2E-122	0.001	0.199	0.933
ROE	*Coefficients*				*p-value*				*Adj. R^2*
	α	β	*s*	*l*	α	β	*s*	*l*	
P1	–0.006	1.110	1.165	–0.101	0.007	4E-88	1E-42	0.068	0.898
P2	–0.004	1.018	0.911	–0.108	0.020	3E-106	3E-46	0.008	0.928
P3	0.000	0.992	0.728	–0.046	0.804	9E-96	6E-30	0.307	0.902
P4	0.001	0.925	0.600	–0.081	0.529	1E-92	1E-23	0.062	0.891
P5	0.001	0.937	0.501	0.010	0.708	3E-78	3E-13	0.846	0.843
INV	*Coefficients*				*p-value*				*Adj. R^2*
	α	β	*s*	*l*	α	β	*s*	*l*	
P1	–0.001	1.012	1.088	–0.206	0.659	7E-78	8E-37	0.000	0.872
P2	–0.003	0.997	0.899	–0.012	0.229	3E-80	3E-30	0.828	0.870
P3	–0.001	0.977	0.725	–0.041	0.477	1E-90	9E-28	0.379	0.890
P4	–0.001	0.994	0.554	–0.013	0.577	2E-108	3E-25	0.736	0.921
P5	–0.002	1.049	0.673	–0.059	0.325	2E-82	4E-19	0.293	0.863

Notes: This table reports the regression results of the three-factor model on single sorted portfolios; α denotes the alpha, β the beta, *s* the size factor, and *l* the value factor.
*Rejection of null hypothesis at 5% significance level.

Table 5b Regression results of the five-factor model on single sorted portfolio

MC	*Coefficients*						*p-value*						*Adj.* R^2
	α	β	*s*	*l*	*r*	*c*	α	β	*s*	*l*	*r*	*c*	
P1	0.008	0.949	1.450	–0.277	0.214	0.111	0.000*	0.000	0.000	0.000	0.029	0.144	0.916
P2	0.908	–0.204	–0.125	–0.006	1.209	0.203	1.006	0.009	0.014	0.007	0.000	0.042	0.000
P3	–0.003	0.958	0.786	–0.020	0.275	–0.342	0.164	0.000	0.000	0.718	0.013	0.000	0.860
P4	–0.001	1.000	0.298	–0.023	0.154	0.117	0.588	0.000	0.000	0.613	0.089	0.098	0.887
P5	–0.003	1.006	0.135	0.049	0.019	–0.215	0.038	0.000	0.001	0.140	0.766	0.000	0.936
BM	*Coefficients*						*p-value*						*Adj.* R^2
	α	β	*s*	*l*	*r*	*c*	α	β	*s*	*l*	*r*	*c*	
P1	0.003	0.896	1.412	–0.223	0.165	–0.544	0.247	0.000	0.000	0.000	0.126	0.000	0.887
P2	0.000	0.884	1.002	–0.106	0.305	–0.400	0.913	0.000	0.000	0.042	0.003	0.000	0.875
P3	–0.001	0.961	0.720	–0.080	0.099	0.187	0.623	0.000	0.000	0.091	0.289	0.011	0.892
P4	–0.005	1.069	0.638	–0.075	0.202	–0.106	0.007	0.000	0.000	0.121	0.034	0.152	0.902
P5	–0.003	1.104	0.085	0.056	0.038	0.279	0.018	0.000	0.049	0.106	0.576	0.000	0.941
ROE	*Coefficients*						*p-value*						*Adj.* R^2
	α	β	*s*	*l*	*r*	*c*	α	β	*s*	*l*	*r*	*c*	
P1	–0.005	1.102	1.031	–0.125	0.492	0.365	0.015	0.000	0.000	0.013	0.000	0.000	0.919
P2	–0.003	1.009	0.847	–0.128	0.321	0.125	0.050	0.000	0.000	0.001	0.000	0.038	0.935
P3	0.000	0.977	0.760	–0.074	0.199	–0.273	0.971	0.000	0.000	0.091	0.022	0.000	0.909
P4	0.001	0.924	0.655	–0.080	–0.119	–0.199	0.648	0.000	0.000	0.063	0.160	0.003	0.897
P5	0.001	0.925	0.615	–0.008	–0.056	–0.517	0.777	0.000	0.000	0.865	0.560	0.000	0.873
INV	*Coefficients*						*p-value*						*Adj.* R^2
	α	β	*s*	*l*	*r*	*c*	α	β	*s*	*l*	*r*	*c*	
P1	0.000	1.029	0.902	–0.183	0.154	0.809	0.789	0.000	0.000	0.000	0.082	0.000	0.925
P2	–0.002	0.985	0.895	–0.036	0.233	–0.113	0.327	0.000	0.000	0.515	0.033	0.186	0.873
P3	–0.001	0.968	0.741	–0.059	0.134	–0.153	0.567	0.000	0.000	0.213	0.153	0.036	0.892
P4	–0.001	0.984	0.601	–0.032	0.086	–0.273	0.620	0.000	0.000	0.389	0.241	0.000	0.928
P5	–0.002	1.019	0.805	–0.112	0.231	–0.767	0.299	0.000	0.000	0.015	0.011	0.000	0.912

Notes: This table reports the regression results of the five-factor model on single sorted portfolios; α denotes the alpha, β the beta, *s* the size factor, *l* the value factor, *r* the profitability factor, and *c* the investment factor. *Rejection of null hypothesis at 5% significance level.

Table 6 Descriptive statistics for double sorted portfolio and factor returns

	Size/book-to-market portfolios					
	SL	*SM*	*SH*	*BL*	*BM*	*BH*
Returns	0.015	0.010	0.003	0.006	0.007	0.008
Risk	0.093	0.094	0.116	0.079	0.074	0.074
	Size/profitability portfolios					
	SR	*SN*	*SW*	*BR*	*BN*	*BW*
Returns	0.011	0.014	0.014	0.005	0.006	0.006
Risk	0.098	0.092	0.091	0.081	0.078	0.076
	Size/investment portfolios					
	SC	*SN*	*SA*	*BC*	*BN*	*BA*
Returns	0.016	0.011	0.011	0.004	0.004	0.007
Risk	0.096	0.094	0.095	0.079	0.075	0.077

Note: This table reports the summary statistics of double-sorted portfolios based on returns and standard deviation.

The results of the regression equation for double-sorted portfolios based on MC/BM, MC/ROE, and MC/INV are presented in Table 7a. The alpha values of all portfolios are equal to zero and have no statistical significance. They verify the three-factor model that accounts for the return of each double-sorted portfolio. The presence of a size effect is supported by the statistical significance of the SMB(s) factor and the heavy loading of SL, SR, and SC. For all portfolios, the SMB component is statistically significant and shows its superiority due to its explanatory power. For all portfolios except SH (1.214), the negative-poor loading of the HML(l) factor is evident. There is no value effect, as shown by the statistical significance of 12 out of 18 portfolios. For all portfolios, the beta assessment of market returns (BSE 100 Index) is statistically significant, demonstrating its reliability as a return-explanation tool. The adjusted R^2 values of all portfolios range from 84% to 93%, showing the ability of the three-factor models to explain asset returns.

Table 7a Regression results of the three-factor model on double sorted portfolio

MC/BM	*Coefficients*				*p-value*				*Adj. R^2*
	α	β	*s*	*l*	α	β	*s*	*l*	
SL	8E–05	0.962	1.350	–0.327	0.961	6E-104*	8E-74*	8.4E-15*	0.939
BL	–0.003	0.980	0.330	–0.332	0.160	2E-81*	7E–07*	2E–09*	0.846
SM	–0.003	1.016	1.198	–0.087	0.094	3E-98*	4E-57*	5E–02*	0.924
SH	–0.005	0.972	1.498	1.214	0.017*	3E-82*	3E-61*	2E-60*	0.932
BM	–0.001	0.912	0.389	–0.017	0.594	7E-82*	6E-10*	7E–01*	0.850
BH	0.002	0.971	0.182	0.127	0.256	1E-92*	1E–03*	6E–03*	0.874

Notes: This table reports the regression results of the three-factor model on double sorted portfolios; α denotes the alpha, β the beta, *s* the size factor and *l* the value factor.
*Rejection of null hypothesis at 5% significance level.

Table 7a Regression results of the three-factor model on double sorted portfolio

MC/ROE	Coefficients				p-value				Adj. R^2
	α	β	s	l	α	β	s	l	
SR	–0.003	1.019	1.397	–0.091	0.088	2E-99*	2.7E-68*	0.039*	0.932
BR	–0.003	1.038	0.292	0.065	0.173	4E-90*	3.5E–06*	0.197	0.870
SN	0.000	0.985	1.235	–0.183	0.939	6E-102*	3.5E-64*	0.000*	0.932
SW	0.000	0.981	1.182	–0.187	0.974	3E-95*	4.2E-56*	0.000*	0.919
BN	–0.002	1.023	0.310	–0.003	0.193	0.000*	4.5E-10*	0.947	0.916
BW	0.939	0.000	0.000	0.000	0.384	0.000*	2.4E–08*	0.959	0.916
MC/INV	*Coefficients*				*p-value*				*Adj. R^2*
	α	β	s	l	α	β	s	l	
SC	0.001	0.986	1.403	–0.178	0.692	7E-96*	9E-68*	8E–05*	0.928
BC	–0.004	0.994	0.423	–0.029	0.035*	3E-92*	3E-12*	0.537	0.881
SN	–0.003	0.994	1.204	–0.124	0.187	9E-83*	1E-46*	0.019*	0.892
SA	–0.002	1.007	1.190	–0.156	0.287	7E-81*	7E-44*	0.005*	0.886
BN	–0.003	0.977	0.244	0.032	0.131	5E-96*	9E–06*	0.466	0.884
BA	0.000	1.026	0.221	0.038	0.775	2E-109*	6E–06*	0.328	0.913

Notes: This table reports the regression results of the three-factor model on double sorted portfolios; α denotes the alpha, β the beta, s the size factor and l the value factor.
*Rejection of null hypothesis at 5% significance level.

The regression results from FF5FM are shown in Table 7b, and they are comparable to those from FF3FM. This shows that, with the exception of the SH and BC portfolios, the intercept is zero and statistically insignificant. Market, SMB, and HML are relevant to all portfolios supporting parity of performance between three and five factor models. For maximal portfolios, it is noteworthy that the factor loadings for RMW are positive and significant, whereas the factor loadings for CMA are negative and significant. The adjusted R^2 of all portfolios vary between 84% to 93%, suggesting that the two asset pricing models are equally good at predicting asset returns. Furthermore, the size, profitability, and investment implications seen in the Indian stock market are amplified by the statistically significant positive-heavy factor loadings for the SMB(s), RMW(r), and CMA(c) factors on SL, SR and SC.

Finally, Table 8 highlights the significance of the other four variables in the model along with the regression results for each variable (explanatory) for those variables. While the intercept terms for the CMA and market factors are small, the intercept terms for the RMW and SMB are significant. Therefore, CMA and market factors are redundant when regressed on the other four factors.

Table 7b Regression results of the five-factor model on double sorted portfolio

MC/BM	*Coefficients*						*p-Value*						*Adj.* R^2
	α	β	*s*	*l*	*r*	*c*	α	β	*s*	*l*	*r*	*c*	
SL	0.000	0.960	1.327	–0.333	0.094	0.057	0.849	0.000*	0.000*	0.000*	0.232	0.351	0.940
BL	–0.003	0.973	0.364	–0.345	0.058	–0.194	0.171	0.000*	0.000*	0.000*	0.582	0.019*	0.848
SM	–0.002	1.004	1.163	–0.112	0.306	–0.004	0.188	0.000*	0.000*	0.011*	0.000*	0.950	0.928
SH	–0.005	0.976	1.512	1.223	–0.108	–0.005	0.013*	0.000*	0.000*	0.000*	0.301	0.950	0.932
BM	–0.001	0.909	0.392	–0.023	0.046	–0.044	0.630	0.000*	0.000*	0.009*	0.643	0.569	0.849
BH	0.003	0.957	0.179	0.099	0.260	–0.132	0.145	0.000*	0.002*	0.029*	0.004*	0.060	0.879
MC/ROE	*Coefficients*						*p-Value*						*Adj.* R^2
	α	β	*s*	*l*	*r*	*c*	α	β	*s*	*l*	*r*	*c*	
SR	–0.002	0.996	1.345	–0.140	0.564	–0.076	0.271	0.000*	0.000*	0.001*	0.000*	0.218	0.945
BR	–0.001	1.004	0.208	–0.008	0.848	–0.084	0.602	0.000*	0.000*	0.848	0.000*	0.194	0.913
SN	0.000	0.976	1.258	–0.199	0.103	–0.170	0.847	0.000*	0.000*	0.000*	0.206	0.008*	0.934
SW	–0.001	0.988	1.235	–0.169	–0.272	–0.095	0.742	0.000*	0.000*	0.000*	0.002*	0.162	0.923
BN	–0.002	1.018	0.328	–0.011	0.040	–0.111	0.208	0.000*	0.000*	0.784	0.604	0.069	0.916
BW	–0.002	1.011	0.318	0.021	–0.315	–0.065	0.161	0.000*	0.000*	0.570	0.000*	0.250	0.923
MC/INV	*Coefficients*						*p-Value*						*Adj.* R^2
	α	β	*s*	*l*	*r*	*c*	α	β	*s*	*l*	*r*	*c*	
SC	0.001	0.990	1.278	–0.177	0.237	0.466	0.375	0.000*	0.000*	0.000*	0.002*	0.000*	0.948
BC	–0.004	1.001	0.331	–0.018	0.078	0.398	0.034*	0.000*	0.000*	0.690	0.369	0.000*	0.898
SN	–0.003	0.981	1.235	–0.148	0.161	–0.241	0.233	0.000*	0.000*	0.005*	0.123	0.003*	0.896
SA	–0.002	0.980	1.313	–0.205	0.210	–0.713	0.263	0.000*	0.000*	0.000*	0.021*	0.000*	0.923
BN	–0.002	0.967	0.249	0.012	0.175	–0.126	0.189	0.000*	0.000*	0.784	0.045*	0.063	0.887
BA	0.000	1.011	0.296	0.011	0.105	–0.423	0.820	0.000*	0.000*	0.758	0.131	0.000*	0.932

Notes: This table reports the regression results of the five-factor model on double sorted portfolios; α denotes the alpha, β the beta, *s* the size factor, *l* the value factor, *r* the profitability factor, and *c* the investment factor. *Rejection of null hypothesis at 5% significance level.

Table 8 Regression of each explanatory variable on other four variables

	Intercept	*Rm-Rf*	*SMB*	*HML*	*RMW*	*CMA*
Rm-Rf						
Coefficient	0.003		0.505	–0.107	0.462	–0.239
p value	0.489		0.000	0.359	0.045	0.183
SMB						
Coefficient	0.006	0.111		0.158	0.229	0.274
p value	0.005*	0.000		0.004	0.034	0.001
HML						
Coefficient	–0.005	–0.037	0.248		0.339	–0.146
p value	0.049*	0.359	0.00S4		0.012	0.166
RMW						
Coefficient	–0.002	0.041	0.093	0.087		0.129
p value	0.110	0.045	0.034	0.012		0.015
CMA						
Coefficient	0.000	–0.035	0.182	–0.062	0.213	
p value	0.896	0.183	0.001	0.166	0.015	

Notes: This table reports the regression result of each factor on the other factors.
*Rejection of null hypothesis at 5% significance level.

5 Conclusions and implications

This study answers the question of whether fund managers should use equilibrium asset pricing models, such as CAPM or conventional models, as a one-size-fits-all strategy when attempting to diversify their holdings. Instead, the aim is to assess applicability of the FF3FM and the FF5FM in the Indian stock market using a different database than that of Khurshid (2020). The study also examines whether the Indian stock market has size, value, profitability, and investment effects. The study spans a 20-year period from 2000 to 2020 using a time-series multiple regression on the BSE 500 index dataset using the BSE 100 index as a market proxy. The findings show that company characteristics (size) and fundamentals (profitability and investments) have an impact on return patterns. Empirically, the FF5FM outperforms the FF3FM in terms of statistical suitability for capturing portfolio returns. Most portfolios are significantly impacted by size, profitability and investment characteristics. Our findings are broadly consistent with those of Khurshid (2020), except for the value effect.

The results of this study provide useful insights into the use of asset pricing models in the Indian market for practitioners such as fund managers, asset management firms and investors. Empirical evidence suggests that both the three and five-factor Fama-French models are statistically appropriate for capturing portfolio returns. Therefore, practitioners might consider using these models to calculate the cost of capital and make wise investment decisions. According to the study, the Fama-French five-factor model outperforms the three-factor model in capturing portfolio returns. This suggests that including additional variables beyond market returns can increase the explanatory power of the model and provide more accurate forecasts of returns in the Indian environment. The results suggest that portfolios are significantly affected by variables such as size, profitability, and investments. To achieve the best risk/reward trade-off, diversification strategies should take these elements into account. These insights can be used by fund managers and investors to construct well-diversified portfolios that consider the fundamentals and characteristics of individual companies. The inclusion of new risk proxies for companies in the models, such as liquidity and human capital, can expand future research in the Indian market. Additionally, analysing the application of asset pricing models to cross-sectional data would help determine how useful these models are for emerging equity markets.

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