

# Comparing Factor Models in the Indian Stock Market

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## Abstract

Which factor model better explains portfolio return variation in India? This study compares the Fama French Three Factor Model, Carhart Four Factor Model & Fama French Five Factor Model in the Indian Stock Market. S&P BSE 100 index companies are studied over 16 years, i.e., April 2005 to June 2021. Four fundamentals & a momentum variable (Market Capitalization, P/B ratio, past performance, Profitability & Investment) based factor mimicking portfolios had been formed using the Fama French (1993, 2015) & Carhart (1997) Methodology. Portfolios for dependent variables were formulated using a double-sorting process keeping the Size factor conditional. The degree of multicollinearity is required to be checked & hence VIF test is conducted before regression analysis. It was found that the Carhart Four-factor model performs better compared to the other two models. Findings of the study can be useful to fund managers, managers, investors & traders in selecting stocks for portfolio management, trading & risk management.

**Keywords:** Size, Value, Momentum, Profitability, Investment.

## Introduction

Asset pricing models developed so far have aspired to explain the returns completely. However, various versions of asset pricing models have not been able to. The pioneering work in the same line is the capital asset pricing model by Mossin (1966), Sharpe (1964), & Lintner (1965) which is a single index model. Following the development of CAPM, many researchers & practitioners found that there are other factors beyond the market return which led to the development of multi-factor models. Fama & French (1993) developed the three-factor model adding size & book to market equity as explanatory variables which is the extension of CAPM. The Fama-French model aims to describe stock returns through three factors: (1) market risk, (2) the out-performance of small-cap companies relative to large-cap companies (size), and (3) the out-performance of high book-to-market companies versus low book-to-market companies (Value).

A few years later, Carhart (1997) put forth a momentum anomaly cum strategy which was later incorporated as the fourth factor in Fama French Three factor model. It is also known in the industry as the MOM factor (monthly momentum). Momentum in stock is described as the tendency for the stock price to continue rising if it is going up and to continue declining if it is going down. The MOM can be calculated by subtracting the equal-weighted average of the lowest-performing firms from the equal-weighted average of the highest-performing firms, lagged one month (Carhart, 1997).

In 2015, Fama French again extended the three-factor model by adding profitability & investment as two more explanatory variables. Similar to the Three-factor model, the Five-Factor model is an empirical asset pricing model. The empirical tests of the five-factor model aim to explain average returns on portfolios formed to produce large spreads in Size, B/M, profitability, and investment. (Fama and French, 2014).

This study compares the asset pricing models, namely, Fama French Three, Five-factor models & Carhart Four Factor model in the Indian Stock Market & will try to answer which model better

explains the security returns in the Indian stock market. Moreover, findings will be useful in making well thought out informed decisions to maximize return with minimum possible risk. Moreover, it is an effort to contribute to the body of knowledge of fundamental factor models for asset pricing.

## Literature review

There is dearth of research regarding comparison of Factor Models covered in the study. Majority of the studies compared Fama French Factor model with CAPM. Maheshwari & Dhankar (2014) supported the multi-dimensional nature of risk and suggested the application of multi-factor asset pricing models for consideration in investment decisions. Fama and French three-factor model was found superior to the traditional one-factor CAPM. Singh & Yadav (2015) found that the five-factor model performed better than the other models for the portfolios formed on investment. However, except for cases in which portfolios are formed on investment, the four-factor model (without an investment factor) is parsimonious. Arora & Gakhar (2019) found that the three-factor model performed better than the other models in elucidating average stock returns. The majority of the studies confirm size & value as significant factors in detecting expected returns variation.

## Methodology & Models

### Data

The study uses constituents of S&P BSE 100 as a sample, traded over the period 1st April 2005 to 31st June 2021. The monthly closing prices of stocks are converted into arithmetic returns & the closing value of the index into market return. The Bombay Stock Exchange (BSE) -100 index is used as the market proxy & 91-day Treasury bill yields are used as the proxy for the risk-free rate. Various company characteristics are used to form "stylized portfolios", stated below.

### Methodology

For creating portfolios and factors, the methodologies developed by Fama French (2015) and Carhart (1997) have been applied. Each company has been allocated to different portfolios by using five variables every year June end. These are:

- Size: Market capitalization at each 31st March.
- Value: Price to Book ratio (P/B ratio) on each 31st March.
- Momentum: Returns of the Past 12 months calculated at the end of June each year.
- Profitability: The ratio of pre-tax profit to total book equity on the 31st March of each year.
- Investment: Change in total asset, i.e.  $(A_t - A_{t-1}) / A_{t-1}$ . Where  $A_t$  is the total asset at 31<sup>st</sup> March of year t and  $A_{t-1}$  is the total asset at 31<sup>st</sup> March of year  $t-1$ .

Every year 30th of June, all companies are split into small (S) and big (B) size groups by taking market capitalization as a base and for which median breakpoint is used. Further, each group (small and big) gets subdivided into three subgroups: low (L), neutral (N), and high (H) by using the top 30th & bottom 30th percentile value of the P/B ratio for breakpoints. By doing 2\*3 Bivariate sorting on variables the size and the P/B ratio, six portfolios are formed, i.e., SL, SN, SH, BL, BN, and BH, Where L stands for low, N for neutral & H for High. Every year from July, the monthly equally weighted return for all these six portfolios has been calculated. The same process has been repeated each year by employing bivariate sorting. In this way, we can see the impact of second sorting variables on stock returns while keeping the first sorting variable conditional. The above process has been followed

to construct the portfolios based on size-momentum, size-profitability & size-investment return except the second variable sort has been done either on momentum or profitability or investment return. Portfolios based on size and momentum are SW, SN, SL, BW, BN, and BL, where W stands for the winner, N for neutral, and L for the loser. Portfolios on size and profitability are SR, SN, SW, BR, BN, and BW, where R stands for robust, N for neutral, and W for weak. Portfolios based on size and investment are SC, SN, SA, BC, BN, and BA, where C is conservative, N is neutral, and A is aggressive. Similarly, the equally weighted monthly returns for all categories of portfolios (as shown in the tables below) have been calculated.

**Table 1: Size & P/B (Value)**

Size	P/B Ratio (Value)		
	Low(L)	Neutral (N)	High (H)
Small (S)	SL(16) <sup>1</sup>	SN(18)	SH(13)
Big (B)	BL(12)	BN(18)	BH(15)

**Source:** Compiled by Author

**Table 2: Size & Momentum**

Size	Momentum		
	Winner(W)	Neutral (N)	Loser (L)
Small (S)	SW(15)	SN(17)	SL(14)
Big (B)	BW(12)	BN(20)	BL(14)

**Source:** Compiled by Author

**Table 3: Size & Profitability**

Size	Profitability		
	Robust(R)	Neutral (N)	Weak(W)
Small (S)	SR(6)	SN(19)	SW(22)
Big (B)	BR(22)	BN(18)	BW(6)

**Source:** Compiled by Author

**Table 4: Size & Investment**

Size	Investment		
	Conservative(C)	Neutral (N)	Aggressive (A)
Small (S)	SC(15)	SN(18)	SA(14)
Big (B)	BC(13)	BN(19)	BA(14)

**Source:** Compiled by Author

<sup>1</sup> Average number of firms during the entire study period.

### Explanatory variables:

- Market premium (Rm-Rf): the monthly excess return of the market portfolio.
- Small minus Big (SMB): is the monthly premium of the size factor that is the average of SMBP/B, SMBM, SMBP, and SMBI. SMBP/B is the difference between the average return of SL, SN, and SH and the average return of BL, BN, and BH. SMBM is the difference between the average return of SW, SN, and SL and the average return of BW, BN, and BL. SMBP is the difference between the average return of SR, SN, and SW and the average return of BR, BN, and BW. Similarly, SMBI is the difference between the average return of SC, SN, and SA and the average return of BC, BN, and BA.
- Low minus High (LMH): is the monthly premium of price to book factor that is the difference between the average return of SL and BL & average return of SH and BH.
- Winner minus loser (WML): is the monthly premium of the momentum factor which is the difference between the average return of SW and BW and the average return of SL and BL.
- Robust minus Weak (RMW): is a monthly premium of the profitability factor that is the difference between the average return of SR and BR and the average return of SW and BW.
- Conservative minus Aggressive (CMA): is the monthly premium of the investment factor that is the difference between the average return of SC and BC and the average return of SA and BA.

SMB, LMH, RMW, CMA, and WML (calculated as shown in Table 5) are returns of zero investment or mimicking portfolios of size, Price to book, momentum, investment, and profitability.

**Table 5:** Factors' Description

Factor	Formula
$SMB_{P/B}$	$(SL + SN + SH)/3 - (BL + BN + BH)/3$
$SMB_M$	$(SW + SN + SL)/3 - (BW + BN + BL)/3$
$SMB_P$	$(SR + SN + SW)/3 - (BR + BN + BW)/3$
$SMB_I$	$(SC + SN + SA)/3 - (BC + BN + BA)/3$
$SMB_{P/B\&M}$	$(SMB_{P/B} + SMB_M)/2$
$SMB_{P/B\&P}$	$(SMB_{P/B} + SMB_P)/2$
$SMB_{P/B\&I}$	$(SMB_{P/B} + SMB_I)/2$
SMB	$(SMB_{P/B} + SMB_{P+} + SMB_I)/3$
LMH	$(SL+BL)/2 - (SH+BH)/2$
WML	$(SW+BW)/2 - (SL+BL)/2$
RMW	$(SR+BR)/2 - (SW+BW)/2$
CMA	$(SC + BC)/2 - (SA + BA)/2$

**Source:** Compiled by Author

**Note:** SMB - Small minus big; LMH - Low minus high; WML - Winner Minus Loser; RMW - Robust minus weak; CMA - Conservative minus aggressive.

### Fama French & Carhart Models

The study has used time series regression modeling. The models have been explained in Table 6 & explanations of variables are in Table 7.

**Table 6: Equations of the Asset Pricing Models**

Model	Regression Equation
Three – Factor Model	$R_{it} - R_{ft} = \alpha_i + \beta_i (R_{mt} - R_{ft}) + s_i \text{SMB}_t + l_i \text{LMH}_t + e_{it}$
Four -Factor Model	$R_{it} - R_{ft} = \alpha_i + \beta_i (R_{mt} - R_{ft}) + s_i \text{SMB}_t + l_i \text{LMH}_t + w_i \text{WML}_t + e_{it}$
Five – Factor Model	$R_{it} - R_{ft} = \alpha_i + \beta_i (R_{mt} - R_{ft}) + s_i \text{SMB}_t + l_i \text{LMH}_t + r_i \text{RMW}_t + c_i \text{CMA}_t + e_{it}$

**Source:** Compiled by Author

**Table 7: Explanation of Variables of the Asset Pricing Models**

Variables	Explanation
$R_{it}$	Portfolio (i) return for period t.
$R_{ft}$	Risk-free rate of return for period t.
$R_{mt}$	Market return for period t.
$\alpha_i$	Intercept
$\beta_i, s_i, l_i, w_i, r_i, c_i$	Coefficients
$e_{it}$	Residual term
$\text{SMB}_t$	Returns on portfolios of small market capitalization securities minus big market capitalization securities for period t
$\text{LMH}_t$	Returns on portfolios of low P/B ratio securities minus high P/B ratio securities for period t.
$\text{WML}_t$	Returns on portfolios of winner securities minus loser securities for period t.
$\text{RMW}_t$	Returns on portfolios of robust profitability securities minus weak profitability securities for period t.
$\text{CMA}_t$	Returns on portfolios of conservative investment securities minus aggressive investment securities for period t.

**Source:** Compiled by Author

Correlation analysis has been used to know the association among the explanatory variables. Gujarati (2009) stated that multicollinearity is associated with degree & the assumptions of the classical linear regression model for no- multicollinearity must be tested before running regression models. The variance inflating factor (VIF) test checks the degree of multicollinearity. If  $VIF = 1$ , it implies the absence of multicollinearity & the acceptable limit is  $< 10$ . Corrective action needs to be taken if  $VIF > 20$  (St – Pierre & Glamocic, 2000).

$$VIF_{k=}$$

Where,

$VIF_k$  – Variance inflating factor k,

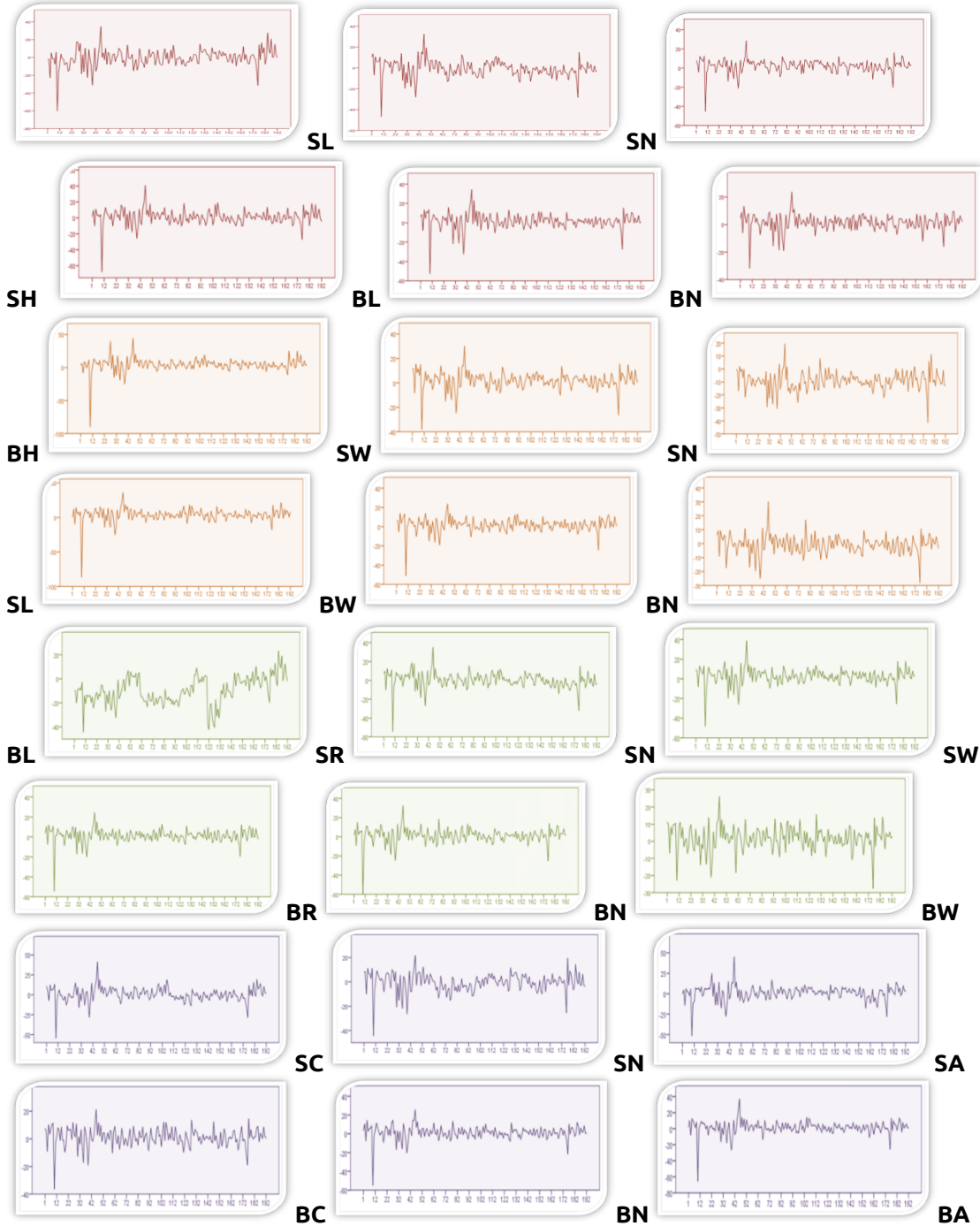
$r_{12}$  - correlation coefficient between factors  $f_1$  &  $f_2$ .

All statistical tools were employed through MS Excel and SPSS using 1% & 5% levels of significance.

### Analysis & Discussion

#### Graphical Representation of Portfolio Returns

In this section, all portfolio returns are plotted on a graph to check the returns' pattern of various factors covered in this study.



**Figure 1:** Graphical Representation of Portfolio Returns

The Figure 1 depicts the graphical representation of unadjusted returns on the bivariate portfolios formed based on five variables using Fama French (2015) & Carhart's (1997) methodology. The volatility in returns can be seen clearly.

### Descriptive Statistics

In this section, we provided descriptive statistics of designed portfolios & all explanatory variables.

**Table 8:** Summary statistics on the portfolio Unadjusted Returns (Size & Value Sorted)

(July 2005 – June 2021, 192 observations)

	Min.	Max.	Mean	Std.Dev.	Skewness	Kurtosis
S/L	-0.6015	3.935	0.0153	0.3012	11.59	151.91
S/N	-0.4683	2.6714	0.0058	0.2104	10.67	136.29
S/H	-0.4534	3.8085	0.0415	0.2818	12.59	169.43
B/L	-0.6771	3.6999	0.0294	0.2829	11.46	150.17
B/N	-0.5254	2.7836	0.0300	0.2168	10.70	137.82
B/H	-0.3175	1.1334	0.0194	0.1000	6.98	81.22
Mkt	-0.2596	0.3129	0.0126	0.0670	-0.266	3.702
SMB	-0.0698	0.9327	-0.0053	0.0716	11.87	156.09
LMH	-0.2539	1.3465	-0.0081	0.1112	9.49	115.92

**Source:** Compiled by Author

Table 8 includes the results of unadjusted returns on Size & value sorted portfolios, Market, SMB & LMH for the entire period. Portfolio annual unadjusted returns range from 6.96% to 49.8%. Among three small-sized portfolios, only S/H outperformed the B/H portfolio. However, big-sized portfolios, viz. (B/L & B/N) outperformed small-sized portfolios on similar double sorting. B/H portfolio depicts the lowest Standard deviation with moderately high average monthly returns. S/L portfolio accounts for the highest standard deviation among all portfolios as smaller-size portfolios sorted on low Price to Book ratio inherently cover the higher risk but should provide the maximum return. Instead small sized high price-to-book value sorted portfolio could fetch the highest return. Small-sized portfolios have higher average returns than big-sized portfolios (Fama and French, 1995; Connor and Sehgal 2001; and Gupta and Kumar, 2007) could not be confirmed for this study. However, Portfolio returns fared well compared to market returns except the S/N portfolio. Moreover, SMB & LMH factors are providing very low negative returns with comparatively lower standard deviation. Thus, the strategy of going long on small & short on big-sized stock didn't perform as expected. The same is the case with the Value factor, i.e., buying value stocks & selling growth stocks also didn't perform as anticipated. A very high value of Skewness & Kurtosis confirms fat right skewed tail.

**Table 9:** Summary statistics on the portfolio Unadjusted Returns (Size & Momentum Sorted)

(July 2005 – June 2021, 192 observations)

	Min.	Max.	Mean	Std.Dev.	Skewness	Kurtosis
S/W	-0.4308	4.0073	0.0451	0.2988	12.31	164.06
S/N	-0.5448	3.3069	0.0386	0.2494	11.83	156.51
S/L	-0.5527	2.6889	-0.0385	0.2175	10.33	130.71
B/W	-0.6833	5.0158	0.0380	0.3726	12.84	173.99

	Min.	Max.	Mean	Std.Dev.	Skewness	Kurtosis
B/N	-0.3751	1.7039	0.0218	0.1397	9.08	110.98
B/L	-0.5495	2.0494	0.0222	0.1698	8.75	107.57
SMB	-0.0749	0.3993	-0.0123	0.0384	6.48	68.84
WML	-0.1307	2.1604	0.0497	0.1592	12.30	163.83

**Source:** Compiled by Author

Table 9 covers the results of unadjusted returns on Size & Momentum sorted portfolios, SMB & WML for the entire period. Portfolios' annual unadjusted returns ranged from (46.2) % to 54.12 %. S/W outperformed all other portfolios followed by S/N & B/W portfolios. The S/L portfolio depicts the worst result followed by the B/N portfolio. Thus, Winner portfolios carry quite better returns than loser portfolios. Stocks that have performed well in the past will generate significant positive returns over 3 to 12-month holding periods & vice versa (Jegadeesh & Titman,1993; Dr. A Balakrishnan, 2015) can be confirmed in this study. B/N portfolio depicts the lowest Standard deviation with comparatively low average monthly returns. S/W portfolio accounts for the highest standard deviation among all portfolios, providing the highest returns too. Except for the S/L portfolio, Portfolio returns are moderately higher than the market returns. Moreover, the WML factor can also fetch moderately higher returns with a comparatively lower standard deviation than the S/W portfolio. The portfolio of past winners (losers) outperformed (underperformed) the market over the sample period, and the strategy of buying recent winners and selling losers (WML) has outperformed both the strategy of buying small and selling big stocks (SMB), as well as buying low and selling high P/E stocks (LMH). A strategy that buys stocks that have performed well in the past and sells stocks that have performed poorly in the past generates significant positive returns (Jegadeesh & Titman,1993; Dr. A Balakrishnan, 2015) get verified. A very high value of Skewness & Kurtosis confirms fat right skewed tail for all the portfolios.

**Table 10:** Summary statistics on the portfolio Unadjusted Returns (Size & Profitability Sorted)

(July 2005 – June 2021, 192 observations)

	Min.	Max.	Mean	Std.Dev.	Skewness	Kurtosis
S/R	-0.4439	1.6911	-0.0860	0.1723	5.66	58.70
S/N	-0.5453	3.7858	0.0220	0.2859	12.01	159.28
S/W	-0.4809	3.6725	0.0441	0.2758	11.98	158.74
B/R	-0.5457	2.5802	0.0248	0.1984	11.15	146
B/N	-0.5975	3.6257	0.0308	0.2732	11.96	158.88
B/W	-0.2762	0.2823	0.0172	0.0723	-0.355	2.81
SMB	-0.1399	0.8870	-0.0309	0.0756	9.449	114.49
RMW	-0.2127	0.1582	-0.0613	0.0606	0.112	0.322

**Source:** Compiled by Author

Table 10 uncovers the results of unadjusted returns on Size & profitability sorted portfolios, SMB & RMW for the entire period. Portfolios annual unadjusted returns ranged from (103.2) % to 52.92%. S/W outperformed all other portfolios followed by the B/N portfolio. S/R portfolio depicts the worst result despite covering small-sized profitable companies. Small-sized profitable firms earned negative returns, whereas loss-making firms earned the highest. Big-sized profitable as well as loss-making firms produced positive returns, though the former fetched more. Moreover, the RMW factor also depicts high negative returns. Thus, the strategy of going long on robust & short on weak stock didn't perform as projected. Similar patterns have been documented in the past for the Indian

stock market (Singh & Yadav,2015; Sehgal et al.,2014; Sehgal and Balakrishnan, 2013). However, a positive profitability return relationship, conditioned on the size factor, cannot be established, similar to Fama & French (2008 & 2015) & Subramaniam (2016). B/W portfolio depicts the lowest Standard deviation with low positive average monthly returns. S/N portfolio accounts for the highest standard deviation among all portfolios, though providing moderate returns only. Except for the S/R portfolio, returns are moderately higher than the market returns. A very high value of Skewness & Kurtosis confirms fat right skewed tail for all portfolios except B/W (Light left skewed tail) & RMW (light right skewed tail).

**Table 11:** Summary statistics on the portfolio Unadjusted Returns (Size & Investment Sorted)

(July 2005 – June 2021, 192 observations)

	Min.	Max.	Mean	Std.Dev.	Skewness	Kurtosis
S/C	-0.5459	4.3827	0.0292	0.3283	12.29	163.90
S/N	-0.4430	2.7831	0.0090	0.2157	11.15	144.71
S/A	-0.5156	3.1636	0.0263	0.2446	11.09	143.36
B/C	-0.3644	1.0980	0.0174	0.1029	5.75	64.18
B/N	-0.5486	3.3305	0.0287	0.2504	12.04	160.31
B/A	-0.6561	3.1831	0.0295	0.2439	11.30	148.30
SMB	-0.0692	0.9059	-0.0037	0.0707	11.29	144.27
CMA	-0.4329	0.1306	-0.0046	0.0487	-3.369	30.42

**Source:** Compiled by Author

Table 11 uncovers the results of unadjusted returns on Size & Investment sorted portfolios, SMB & RMW for the entire period. Portfolios' annual unadjusted returns range from 10.8 % to 35.4%. The B/A portfolio outperformed all other portfolios followed by S/C portfolio. B/C portfolio earned the lowest return despite covering small conservative companies. There is not much difference in small-sized conservative & aggressive company's portfolio returns. In contrast, Big-sized aggressive companies depict much better returns than conservative companies in the same size grouping. Portfolios of small stocks have higher average returns than big stocks as company investment increases. This is not the same for companies that invest aggressively. Negative returns on CMA factor signify that returns typically fall as we move from higher to lower investment sorts, showing an inverse relationship between returns and investment. A similar pattern is reported in Fama and French (2015) and Singh & Yadav (2015). Thus, the strategy of going long on conservative & short on aggressive stocks didn't perform as estimated. The B/C portfolio depicts a low standard deviation with a low positive average monthly return. S/C portfolio accounts for the highest standard deviation with the highest returns among all portfolios. All portfolio returns are higher than the market returns. The very high value of Skewness & Kurtosis confirms fat right skewed tail for all portfolios except CMA (Fat left skewed tail).

## Correlation Analysis

**Table 12:** Correlations between the factor portfolios

	Mkt	SMB	LMH	WML	RMW	CMA
Mkt	-	0.126	0.094	0.096	-0.005	-0.064
SMB	-	-	0.849**	0.913**	0.245**	-0.617**
LMH	-	-	-	0.811**	0.246**	-0.601**
WML	-	-	-	-	0.222**	-0.650**

	Mkt	SMB	LMH	WML	RMW	CMA
RMW	-	-	-	-	-	-0.062
CMA	-	-	-	-	-	-

**Note** \*\* indicates significance at a 1% level of confidence.

**Source:** Compiled by Author

Table 12 shows the Correlation coefficients between the Mkt, SMB, LMH, WML, and RMW CMA factors, which serve as the independent variables in the main regression model. The correlation is significant between SMB-LMH, SMB-WML, SMB-RMW, SMB-CMA, LMH-WML, LMH-RMW, LMH-CMA, and WML-RMW&WML-CMA suggesting some overlapping amongst factors. The mkt factor is not correlated to any of the factors. RMW & CMA factors are also not correlated, which suggests that market, Profitability & Investment independently contribute to explaining the returns of portfolios.

### Variance Inflating Factor

**Table 13:** VIF of the factor portfolios

	Mkt	SMB	LMH	WML	RMW	CMA
Mkt	-	1.01	1	1.01	1	1
SMB	-	-	3.58	6	1.06	1.61
LMH	-	-	-	2.92	1.06	1.57
WML	-	-	-	-	1.05	1.73
RMW	-	-	-	-	-	1
CMA	-	-	-	-	-	-

**Source:** Compiled by Author

A VIF value of 1 indicates the absence of multicollinearity. VIF value corresponding to market factor (f1) & all other factors (f2) is very close to 1. Factor combinations, except SMB & WML factors, have values less than or around 5. Hence, the rest of the factors are proving the absence of multicollinearity even at the limit of 5. SMB & WML factors have the highest VIF value. Though below the acceptable limit of 10, the applicability of these factors as independent factors simultaneously for explaining the returns of portfolios can be questionable.

### Regression Analysis

This section aims to test whether hierarchical regression models can explain the wide variations in the returns of the test portfolios. We covered individual regression alphas, the coefficients, and Adjusted R-squared values to provide a more detailed picture of model performance. Several points should be highlighted when analyzing the results of the time-series regression. First, the intercepts of the time-series regressions should be indistinguishable from zero, if the asset pricing model is well-specified. Second, the slopes of the risk factors employed in the time-series regression provide direct evidence on whether they can capture common variation in stock returns. The model comparison relies on Merton's (1973) zero-intercept criterion. We employ the F-statistic of Gibbons et al. (1989), the average adjusted R<sup>2</sup>.

**Table 14:** Regression Results of Fama French Three Factor Model for Double sorted portfolios' excess returns

$$R_{it} - R_{ft} = \alpha_i + \beta_i (R_{mt} - R_{ft}) + \beta_{si} \text{SMB}_t + \beta_{li} \text{LMH}_t + e_{it}$$

Portfolios	$\alpha$	$\beta$	S	L	R2	AIC
Value						
SL	0.032**	-0.003	1.521**	1.767**	0.955**	-507.25
SN	0.015*	0.091	1.470**	0.859**	0.846**	-406.61
SH	0.057**	-0.002	2.405**	0.966**	0.912**	-402.04
BL	0.044**	0.029	1.145**	1.784**	0.921**	-420.33
BN	0.040**	0.027	0.988**	1.223**	0.846**	-399.56
BH	0.020**	0.029	0.262*	0.585**	0.662**	-540.6
Momentum						
SW	0.061**	0.086	2.296**	1.185**	0.912**	-379.45
SN	0.052**	-0.026	1.694**	1.150**	0.920**	-467.53
SL	-0.029**	0.084	0.997**	1.258**	0.883**	-445.98
BW	0.060**	-0.061	2.658**	1.617**	0.909**	-287.30
BN	0.025**	0.048	0.392**	0.901**	0.799**	-512.67
BL	0.028**	0.007	0.372**	1.177**	0.821**	-460.36
Profitability						
SR	-0.082**	0.112	0.761**	0.765**	0.609**	-303.48
SN	0.038**	0.006	1.954**	1.298**	0.913**	-399.78
SW	0.059**	0.042	1.901**	1.249**	0.92**	-429.06
BR	0.034**	-0.023	0.926**	1.135**	0.873**	-466.32
BN	0.045**	-0.007	1.575**	1.404**	0.895**	-380.02
BW	0.013**	0.109	-0.445**	0.505**	0.217**	-503.52
Investment						
SC	0.048**	0.081	2.336**	1.444**	0.924**	-372.27
SN	0.019**	0.009	1.356**	1.031**	0.890**	-460.92
SA	0.038**	0.076	1.548**	1.163**	0.896**	-423.47
BC	0.018**	0.025	-0.025	0.778**	0.678**	-539.79
BN	0.042**	-0.019	1.444**	1.288**	0.896**	-414.61
BA	0.042**	0.017	1.287**	1.3**	0.873**	-386.64

**Note** \*\*, \* indicates significance at 1% & 5% level of confidence.

**Source:** Compiled by Author

According to Adrian, Etula, and Muri (2014), a good pricing model features an economically small and statistically insignificant intercept. If the null hypothesis is not rejected, the model seems to include all priced risk factors, as the intercept is not significantly different from zero. However, if the null is rejected, the model has an unexplained return, which implies that the model does not include all the priced risk factors. If all intercepts are significantly different from zero, we favor a small intercept.

From Table 14, it is clear that not a single model has an insignificant value of alpha. Thus, no model covers all priced risk factors & therefore, there is unexplained return variation in all portfolio return cases. Winner portfolios depict the highest unexplained variation, whereas size (Big) - OP (weak) sorted portfolios represent the lowest unexplained variation. Few portfolios viz. looser and Size (small) & OP (Robust), contain negative alphas indicating overestimation of returns by that model.

It is somewhat unusual that none of the coefficients of  $R_m - R_f$  in Table 14 regressions are significant at even a 5% level of significance. However, this may be because the S & P BSE 100 Index is heavily financial sector stocks Weighted. SMB representing size factor has three (Momentum neutral Portfolios & Big Conservative) insignificant coefficients out of twenty-four models. For the Size (big) Value (high) sorted portfolio, the Size coefficient is significant at a 5% level of significance. Moreover, All LMH coefficients representing the Value factor are significant too, at a 1 % level of significance. Thus, Value is the dominant explanatory variable.

Adjusted  $R^2$  values covered in Table 14 ranged from 22% (Big/Weak) to 95% (Small/Low). Value, Investment & Momentum sorted portfolio returns are explained better by the three-factor model. The adjusted  $R^2$  values are similar to those reported in A. Balakrishnan et al. (2018), Singh & Yadav (2015), Arora & Gakhar (2019) & other international studies (for example, Fama and French ,1993; Halliwell et al., 1999; Gaunt,2004). However, the pattern we document with small stock portfolios exhibiting higher adjusted  $R^2$  than big stock portfolios is inconsistent with international evidence.

This finding reinforces the findings of literature by Connor and Sehgal (2001), Bahl (2006), Taneja (2010), Mehta and Chander (2010), Sehgal et al. (2012), Sehgal and Balakrishnan (2013), Balakrishnan (2016), Das (2015), Singh & Yadav (2015) & Sobti (2016) i.e., the three-factor model better explains the variation in returns than the single market factor CAPM in Indian stock market. Moreover, the three-factor model performs well even when the underlying portfolios are formed on variables not considered in the three-factor model.

**Table 15:** Regression Results of Carhart Four factor model for Double sorted Portfolios' excess returns

$$R_{it} - R_{ft} = \alpha_i + \beta_i (R_{mt} - R_{ft}) + s_i \text{SMB}_t + l_i \text{LMH}_t + w_i \text{WML}_t + e_{it}$$

Portfolios	A	$\beta$	S	l	W	R2	AIC
<b>Value</b>							
SL	0.010	-0.010	0.920**	1.722**	0.438**	0.961**	-530.57
SN	-0.007	0.081	0.941**	0.786**	0.431**	0.861**	-425.62
SH	0.013	-0.001	1.155**	0.881**	0.807**	0.934**	-456.69
BL	0.008	0.048	0.066	1.675**	0.609**	0.939**	-470.47
BN	0.005	0.046	-0.017	1.122**	0.557**	0.873**	-431.15
BH	0.004	0.039	-0.169	0.516**	0.241**	0.689**	-556.11
<b>Momentum</b>							
SW	0.013	0.089	0.991**	1.028**	0.874**	0.945**	-468.74
SN	0.022**	-0.029	0.902**	1.069**	0.556**	0.936**	-510.60
SL	-0.029**	0.058	1.117**	1.259**	0.085	0.884**	-446.81
BW	-0.021**	-0.017	0.195	1.417**	1.354**	0.958**	-434.48

Portfolios	A	$\beta$	S	l	W	R2	AIC
BN	0.007	0.058	-0.119	0.829**	0.287**	0.819**	-531.19
BL	0.020**	0.013	0.070	1.186**	0.143*	0.821**	-459.10
<b>Profitability</b>							
SR	-0.078**	0.092	0.915**	0.801**	0.013	0.606**	-300.86
SN	0	0.008	0.897**	1.204**	0.692**	0.932**	-445.49
SW	0.028**	0.034	1.096**	1.162**	0.593**	0.936**	-469.12
BR	0.002	-0.004	-0.041	1.053**	0.520**	0.899**	-510.17
BN	-0.001	0.016	0.185	1.286**	0.778**	0.925**	-443.51
BW	0.017*	0.112	-0.327	0.499**	-0.092	0.210**	-500.97
<b>Investment</b>							
SC	0.009	0.078	1.252**	1.371**	0.732**	0.937**	-406.28
SN	-0.001	0.001	0.838**	0.966**	0.406**	0.902**	-482.80
SA	0.014	0.068	0.921**	1.085**	0.479**	0.909**	-449.29
BC	0.008	0.037	-0.322	0.742**	0.129*	0.686**	-543.29
BN	-0.004	0.007	0.073	1.179**	0.748**	0.929**	-486.64
BA	0.003	0.035	0.160	1.192**	0.642**	0.899**	-430.69

**Note** \*\*, \* indicates significance at 1% & 5% level of confidence.

**Source:** Compiled by Author

From Table 15, it is evident that 17 out of 24 models have insignificant values of alpha & hence, these models cover all priced risk factors & therefore, there is unexplained return variation in the remaining portfolios. However, 4 out of 17 intercepts are negative indicating an overestimation of returns by the model. Moreover, 3 out of 7 models with significant alpha values also encompass negative intercept values pointing out the overestimation of returns by the model. Small Winner portfolio depicts the highest unexplained variation (lower than the highest intercept value of the Fama French Three Factor Model) whereas, the Big Winner portfolio represents the lowest unexplained variation.

None of the coefficients of  $R_m - R_f$  in Table 15 regressions are significant at even a 5% level of significance. SMB representing size factor cover 12 insignificant coefficients (Big) out of twenty-four models. Hence, the size factor in the Carhart Four Factor model cannot explain return variations of big-sized portfolios. Moreover, All LMH coefficients representing the Value factor are significant, that too at a 1% level of significance. 3 out of 24 WML coefficients are insignificant. For Big Loser & Big Conservative portfolios, the WML coefficient is significant at a 5% level of confidence. Thus, Value is the dominant explanatory variable.

Adjusted R2 values ranged from 21% (Big/Weak) to 96% (Small/Low). Value, Momentum & Investment sorted portfolio returns are explained better by the four-factor model. Moreover, the Four-factor model performs well even when the underlying portfolios are formed on variables not considered in the Four-factor model. The studies carried out by Gumanti et al. (2015), Bello (2008), Awwaliyah & Husodo (2017), Artmann et al. (2011), Ondieki (2011), Evbayiro-Osagie & Osamwonyi (2017), Zarembe et al. (2019) concluded the similar finding that Carhart Four Factor model outperforms the Fama & French Three Factor Model. However, Tzakov et al. (2017) concluded that the four-factor model is not significantly better than Three Factor Model.

**Table 16:** Regression Results of Fama French Five Factor model for Double sorted portfolios' excess returns

$$R_{it} - R_{ft} = \alpha_i + \beta_i (R_{mt} - R_{ft}) + s_i \text{SMB}_t + l_i \text{LMH}_t + r_i \text{RMW}_t + c_i \text{CMA}_t + e_{it}$$

Portfolios	A	β	S	l	R	C	R2	AIC
Value								
SL	0.025**	-0.045	1.547**	1.675**	-0.285**	-0.408**	0.958**	-514.54
SN	0.003	0.039	1.619**	0.702**	-0.358**	-0.436**	0.864**	-428.12
SH	0.051**	-0.064	2.419**	0.853**	-0.366**	-0.534**	0.911**	-397.96
BL	0.038**	0	1.116**	1.681**	-0.203*	-0.530**	0.926**	-430.89
BN	0.029**	-0.003	0.997**	1.121**	-0.260*	-0.480**	0.856**	-406.32
BH	0.012*	0.019	0.243*	0.504**	-0.123	-0.403**	0.692**	-556.58
Momentum								
SW	0.047**	0.018	2.379**	1.021**	-0.481**	-0.647**	0.922**	-399.84
SN	0.046**	-0.072	1.727**	1.016**	-0.265**	-0.539**	0.928**	-485.47
SL	-0.037**	0.048	1.111**	1.173**	-0.258**	-0.195	0.887**	-451.57
BW	0.055**	-0.118	2.535**	1.524**	-0.344*	-0.731**	0.905**	-277.87
BN	0.017**	0.034	0.383**	0.822**	-0.143	-0.385**	0.814**	-525.42
BL	0.019**	-0.006	0.368*	1.109**	-0.158	-0.340*	0.829**	-467.15
Profitability								
SR	0	0.123	0.829**	0.543**	1.254**	-0.044	0.836**	-468.58
SN	0.013	-0.057	2.018**	1.191**	-0.627**	-0.557**	0.925**	-424.4
SW	0.045**	-0.018	2.015**	1.107**	-0.452**	-0.494**	0.93**	-451.5
BR	0.032**	-0.042	0.852**	1.056**	-0.087	-0.478**	0.879**	-473.4
BN	0.037**	-0.044	1.501**	1.307**	-0.274*	-0.629**	0.900**	-386.61
BW	-0.013*	0.1	-0.335*	0.492**	-0.382**	-0.028	0.310**	-525.79
Investment								
SC	0.043**	0.007	2.584**	1.359**	-0.426**	0.026	0.923	-367.71
SN	0.014	-0.031	1.417**	0.902**	-0.233**	-0.454**	0.900**	-477.61
SA	0.018**	0.032	1.491**	0.970**	-0.424**	-1.038**	0.931**	-502.12
BC	0.008	0.016	0.056	0.775**	-0.189*	0.061	0.686**	-542.3
BN	0.036**	-0.05	1.360**	1.202**	-0.207*	-0.575**	0.899**	-419.02
BA	0.033**	-0.009	1.148**	1.164**	-0.192	-0.876**	0.890**	-413.17

**Note** \*\*, \* indicates significance at 1% & 5% level of confidence.

**Source:** Compiled by Author

From Table 16, it is evident that 5 out of 24 models have insignificant values of alpha & hence, these models explain variations in returns completely. 2 out of the remaining regression alphas are significant at a 5% level of confidence. Small Loser as well as Big Weak portfolios boast negative alphas indicating overestimation of returns by that model. The Big Winner portfolio depicts the highest unexplained variation, whereas the Big High portfolio represents the lowest unexplained variation.

None of the coefficients of RM-Rf in Table 16 regressions are significant at even a 5% level of significance. SMB representing size factor cover 1 insignificant coefficient out of twenty-four models. For 3 out of 23 portfolios, the Size coefficient is significant at a 5% level of significance. A Big Weak portfolio is negatively related to the size factor. All the LMH coefficients representing the Value factor are significant too, at a 1 % level of significance. 5 out of 24 RMW coefficients are insignificant. 6 RMW coefficients out of the remaining are significant at a 5% level of confidence. Except for the Small Robust portfolio, the RMW factor is negatively related to portfolio returns. For 5 out of 24 portfolios, CMA coefficients are statistically insignificant. Big Looser portfolio is significant at a 5% level of confidence. The CMA factor depicts a negative relationship with portfolio returns except for Conservative portfolios. From the above discussion, it is clear that Value is the dominant explanatory variable. This finding is dissimilar to Fama & French (2015) as they found Value to be a redundant factor.

Adjusted R<sup>2</sup> values ranged from 31% (Big/Weak) to 96% (Small/Low). Value, Momentum & Investment sorted portfolio returns are explained better by the five-factor model. Moreover, the Five-factor model performs well even when the underlying portfolios are formed on variables not considered in the model.

The adjusted R<sup>2</sup> values are similar to those reported in A. Balakrishnan et al. (2018), Singh & Yadav (2015), Arora & Gakhar (2019) & Fama & French (2015). Moreover, the pattern we document with small stock portfolios exhibiting higher adjusted R<sup>2</sup> than big stock portfolios is consistent with international evidence. A. Balakrishnan (2018), Sutrisno & Ekaputra (2016), Wijaya et al. (2017), Djameluddin et al. (2017), Zaremba & Czapkiewicz (2016), Erdinç (2017), Chiah et al. (2016) & Chai et al. (2019) reported similar findings that Five Factor model performs superior to three-factor model. Whereas, Arora & Gakhar (2019) & Vakilifard et al. (2017) concluded three-factor model is better than the five-factor model in explaining portfolio returns. Zaremba & Czapkiewicz (2016), Chiah et al. (2016) & Chai et al. (2019) testify the superiority of Five Factor Model over the four-factor model in explaining portfolio returns. Whereas, Zaremba et al. (2019), Czapkiewicz et al. (2019) describe parallel results of the four-factor model better than the five-factor model in explaining portfolio returns.

### Comparing Models

Looking at the findings of intercept & adjusted R<sup>2</sup> values, it is clear that the Carhart Four Factor model is a better though not perfect model for explaining portfolio returns in the Indian Capital Market. Additionally, we tried to evaluate model performance by comparing the AIC values of all portfolios for three models, i.e., FF3F, C4FM & FF5F. Looking at the AIC values of each portfolio regression model (from tables 14,15 &16), it is evident that AIC values are lowest for only 7 models out of 24 viz. Small/Neutral (Value), Big/High, Small/Looser, Big/Looser, Small/Robust, Big/Weak & Small/Aggressive, pertaining to Fama French Five Factor Model. For the rest 17 models, the Carhart Four Factor Model performed well as supported by the Lowest AIC values.

### Conclusion

This study aimed to compare factor models viz., Fama French Three Factor Model, Carhart Four Factor Model & Fama French Five-Factor Model, of its ability to capture returns on portfolios formed on many corporate fundamentals such as size, value, profitability & investments. We examine whether average returns on portfolios based on size, value, momentum, profitability & investment exhibit any patterns. We employ data for companies listed on BSE-100. The study period is April 2005 to June 2021. The average return pattern shows that the Indian stock market is influenced by certain firm fundamentals, such as size, value, investment, and profitability & momentum factors, except

the fact that a small robust profitability sorted portfolio depicts abnormally high negative returns & Big Looser portfolio depicts positive returns. Moreover, there subsists a direct relationship between returns & size, returns & value, and returns & momentum, though the returns & size pattern is not very clear. At the same time, there exists an inverse relationship between returns & profitability, and returns & investment. The goodness of fit test (adjusted R<sup>2</sup> values), the feasibility of the model (intercept values) & AIC values clearly emphasize that the Carhart Four Factor model (1997) of asset pricing performs better than other asset pricing models covered in the study for the Indian Stock Market. This study has some limitations in not including a key CAPM anomaly as the scope of this study covers multi-factor models. Further, the study does not incorporate other corporate fundamentals, such as leverage, liquidity, working capital, and human capital.

Value & Momentum proved to be major factors in Portfolio return determination. One can invest in low price-to-earnings ratio stocks to earn higher returns. One can even design a strategy of taking a long position in low P/E stocks & short in high P/E stocks at the same time. Momentum factor mimicking portfolio turned out to be performing best among all the portfolios. One can choose to frame 3-3, 6-6, 12-12 months' momentum strategy. Taking a long position in past winners & short in past losers can fetch the highest returns.

No single factor seems to be significant alone to explain the variation in returns, but jointly size, value & momentum explain the maximum variation. This lends support to Carhart's four-factor as well as the Fama French models. Market beta alone is not statistically significant dissolving the predictions of CAPM. It also implies that firm-specific variables are gaining importance in explaining the variation.

The future perspectives of such research can be on exploring whether firm-specific factors explain risk in broad asset classes, such as industry-sorted portfolios, examining the role of business cycles on the asset pricing and company fundamentals, testing whether size, value, momentum, profitability & investment effects are found only in emerging markets or developed markets or both. In addition, the robustness of the Fama French model can be checked through alternative size & value measures & by dividing the total period into sub-periods. Fundamental factors, other than those considered in the study, can be explored to design a factor model. Residual diagnostics can also be performed for similar studies. Feasibility checks can be conducted through GRS statistics. In addition, Explanatory power can be checked other than through F statistics.

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