3. Materials and Methods

This research uses time-series methodology to analyze if market, size, value, investment, profitability and momentum have an impact on returns and to measure the extent of such an impact.

3.1 *Objectives of the study*

This work is aimed at fulfilling the following:

1. Testing the relevance of the Fama-French Five Factor model in the Indian stock market.
2. Comparing the CAPM, the Fama-French three-factor model, the Carhart four-factor model, the Fama-French five-factor model, an altered five-factor model which includes momentum factor but excludes the value; and a six-factor model arrived at by adding a momentum factor to the Fama-French five factors.
3. To explore the persistence of investment and profitability effects in the domestic stock market.
4. To investigate the persistence of momentum effect in the domestic stock market.

3.2 *Hypotheses*

Driven by the aforementioned objectives, we propose the following hypotheses:

- Momentum has significant explanatory power in stock returns.
- The Fama-French Five-Factor model sufficiently explains portfolio returns.
- A Five-Factor model as proposed in this study, which excludes the Value factor and assimilates a Momentum factor, is better at explaining portfolio returns than the Fama French Three-Factor and Five-Factor model.

- The Six-Factor model, comprising of the Fama-French five factors plus momentum, better explains portfolio returns.

3.3 *Design of the Study*

The study will be descriptive in nature and econometric modeling will be used to establish the dynamics of the relationship sought to be defined. The study will compare the following models:

1. Single-Index Capital Asset Pricing Model

The CAPM was the first model to establish a relationship among excess returns and market risk. The mathematical equation to describe the model is shown in equation (i) below.

$R_{pt} - R_{ft} = \alpha_{it} + \beta_1(R_{mt} - R_{ft}) + \varepsilon_{it}$--------**eq. (i)**

Where $R_{pt} - R_{ft}$ gives the excess returns generated by the portfolio.

$R_{mt} - R_{ft}$is the premium for market risk.

$\alpha_{it}$is the intercept that measures abnormal returns for the portfolio.

$\beta_1$is the Beta coefficient or slope coefficient of the market risk premium which is measured as follows:

$\beta_1 = \frac{Cov\ (R_{mt,}R_{pt})}{Var\ (R_{mt,})}$

$\varepsilon_{it}$is the error term.

2. The Fama-French Three-Factor model

This model aims at improving upon the shortcomings of the CAPM, as detailed in the introduction of this study, by including two more variables, market size and firm value.

Empirical studies conducted by Fama and French found strong evidence that suggests that the two recently added variables, namely size and value, have significant explanatory power as far as variations in excess returns are concerned.

Equation (ii) is the mathematical representation of the model.

$R_{pt} - R_{ft} = \alpha_{it} + \beta_1(R_{mt} - R_{ft}) + \beta_2 SMB_t + \beta_3 HML_t + \varepsilon_{it}$---------**eq (ii)**

3. Carhart Four-Factor model

Carhart found statistically significant evidence which showed that the model proposed by the Eugene Fama and Kenneth French could be made more robust by adding a fourth factor, momentum, to it.

Equation (iii) is the Mathematical expression of the model.

$R_{pt} - R_{ft} = \alpha_{it} + \beta_1(R_{mt} - R_{ft}) + \beta_2 SMB_t + \beta_5 MOM_{it} + \varepsilon_{it}$----------**eq (iii)**

4. Fama-French Five-Factor model

Fama and French (2015) later added two more variables, profitability and investment, to the three factors from their previous model to come up with a Five-Factor model, in order to address the shortcomings of the model that were exposed in recent literature.

Equation (iv) given below is a mathematical representation of the aforementioned model as we know it.

$R_{pt} - R_{ft} = \alpha_{it} + \beta_1(R_{mt} - R_{ft}) + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 RMW_t + \beta_5 CMA_t + \varepsilon_{it}$------**eq. (iv)**

5. The improvised models

Equation (v) represents an improvised Five-Factor model arrived at by adding a Momentum factor to and removing Value factor from the existing Fama-French Five-Factor model.

$R_{pt} - R_{ft} = \alpha_{it} + \beta_1(R_{mt} - R_{ft}) + \beta_2 SMB_t + \beta_3 RMW_t + \beta_4 CMA_t + \beta_5 MOM_{it} + \varepsilon_{it}$ ------**eq. (v)**

Equation (vi) is the Six-Factor model that is proposed by adding Momentum to the Fama-French Five-Factor model.

$R_{pt} - R_{ft} = \alpha_{it} + \beta_1(R_{mt} - R_{ft}) + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 RMW_t + \beta_5 CMA_t + \beta_6 MOM_{it} + \varepsilon_{it}$ ---**eq. (vi)**

- *R* are returns that are calculated as **($P_1 - P_0$)/P_0** where
    - **P_1** is the ending adjusted closing price for the current month
    - **P_0** is is the ending adjusted closing price for the previous month
- R_{pt} Portfolio returns at time *t*
- R_{ft} Returns on risk-free securities at time *t,* for which 91-Day Treasury Bill yield has been used.
- R_{mt} Market returns at time *t,* wherein the NIFTY500 index has been used as a proxy.
- SMB_t Small minus Big, and is used as the proxy for Size.
- MOM_{it} Momentum.
- HML_t High minus Low is the proxy for value and is calculated as the ratio of the Book Equity to the Market Equity of a company.
- RMW_t Robust minus weak and a proxy for Profitability and is calculated as the ratio of Net profit to the book value of a company's equity.
- CMA_t Conservative minus Aggressive, is a proxy for Investment and is measured as the percentage change in assets between the previous year and the current year. It is

calculated as the ratio of the change in amount of assets to the total amount of assets in the previous year.

3.4 *Data*

The study utilizes the CMIE Prowess database to source data used in the analysis. The data contains monthly adjusted closing prices of 2816 companies on the NSE. Besides data for monthly adjusted closing prices, the database was also used to source various accounting data pertaining to company fundamentals like market capitalization, PB ratio, Profitability and Asset growth. We further clean the data by filtering illiquid stocks by only considering stocks that have a trading history for all twelve months for the year being studied. Furthermore, we also exclude stocks that would generally be termed as penny stocks, which are stocks trading at a price of below Rupees ten, as these are also found to have poor liquidity. We apply this filter to ensure that the portfolios being used for the purpose of estimation are actually investible. Additionally, since complete data was unavailable for all companies for each year of the period under study, the portfolios are rebalanced every year to include only companies having complete financial and accounting data for that particular year. This is done so as to avoid any survivorship bias. A similar approach has been found in the previous literature reviewed, such as Balakrishnan, Maiti & Panda (2018) being one amongst them. As a consequence of applying the filters mentioned, the number of companies being included in each year varies from 323 in the year 2000, to 1293 in the year 2018.The series for monthly closing figures for the NIFTY500 was taken from Yahoo Finance. In keeping with the approach adopted by Fama-French, we also exclude financial firms from our sample. Data pertaining to the 91-day Treasury-Bill rate is taken from RBI website and is used as the risk-free rate.

The period from December to November is used for the purpose of portfolio construction. Since companies in India usually end up releasing their annual reports around the period of July-

August, constructing portfolios using market data as on December prevents the sample from being affected by look-ahead bias and will be a better indication of investor disposition towards company fundamentals.

3.5 *Methodology*

The study first uses the single sorting technique and forms portfolios by ranking companies using their Market Capitalization. The market cap of a company is used as a proxy for company size. At every calendar year ending, the sample stocks are first ranked on the basis of market capitalization and then segregated into deciles or ten equally weighted portfolios, wherein the first portfolio (P_1) comprises of the stocks of the smallest companies in terms of market size whereas the tenth portfolio (P_{10}) comprises of the largest companies by way of market cap. Subsequently, returns for the ten equally weighted portfolios are first calculated from January 2000 (*year t*) to December 2000 (*year t+1*). Thereafter, the portfolios are revised in the month of December of each year of the study period. In this way, the portfolios are revised in the month of December, every year and this process of portfolio revision is carried on for the whole period of study. Finally, mean returns for each month of the study period are calculated for all the ten portfolios from January 2000 to December 2019. Thereafter, single-sorted portfolios that would mimic other factors being used to construct the different asset-pricing models being tested in this study are formulated using a similar methodology and are mentioned in greater detail in the Annexures section. The study also involves the formulation and testing of double-sorted portfolios. The section for annexures also contains the details of how the various factor-mimicking double-sorted portfolios have been formed.

The variations in returns among various portfolios allude to the influence of certain risk factors on the performance of these portfolios. To establish the veracity of this argument, excess returns on portfolios are regressed against certain statistical models which have been explained

in the previous sections of this study. The approach used to formulate the various factors such as Size, Value, Profitability, Investment and Momentum are also explained in great detail in the Annexures section.