Journal of Critical Reviews
ISSN- 2394-5125 Vol 7, Issue 16, 2020

Indian Equity Market: Investigation Using FAMA French and CAPM Models

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Abstract

For the purpose of this research, the CAPM and Fama-French Models of asset pricing were examined to see if they are accurate. As part of the initiative, researchers are looking to use the models of Macbeth (1973) and compare them with those of other institutional investors' results in the Indian equities market. Assuming the SENSEX is representative of Indian stock markets, this analysis concludes that the FF and CAPM models beat passive investment on the index, but only by a small margin. As a result of these findings, it appears that the Indian market exhibits illogical or inexplicable behaviour, which necessitates more focused research of the market in order to understand its behaviour.

Keywords: FAMA French, CAPM model, Indian equity markets

Introduction

Markowitz proposed that the universal answer to the problem of portfolio selection is based on anticipated utility theory, and the asset pricing models were created by this simple idea of the mean-variance efficient portfolio. Based on the assumption that investors are risk averse, the Portfolio theory is used to determine the link between expected return and risk. For a given amount of risk, an investor can either maximise the return or minimise the risk. Following this, three Nobel laureates, William F. Sharpe, Linter, and Mossin, established the Capital Asset Pricing Model (CAPM), which became the standard model for asset pricing, establishing a linear link between anticipated return and market beta. Excess returns were explained only by market beta, it was said. According to CAPM, investors are utility maximisers of terminal wealth who choose portfolios solely based on mean and variance, absence of taxes and transaction costs, homogeneous behaviour of all investors with regard tothe joint probability distribution of returns, and the ability to risk-free lending and borrowing. There are several ways in which the CAPM impacts corporate finance, particularly in the areas of capital allocation and portfolio selection, as well as cost-benefit analysis.

The efficient Market Hypothesis (EMH) shattered investors' aspirations of making money in emerging markets like India by asserting that market prices take into account all available information and are only impacted by unforeseen events. If markets are efficient, the CAPM stated that the only way to outperform the market was to take on more risk. Numerous research, on the other hand, showed that taking advantage of anomalies at the correct moment might provide better profits.

The CAPM and EMH's predictions were all wrong because of the size, value, leverage, liquidity, and price-earning effects. This led to a two-pronged attack on the CAPM assumption: one, that CAPM was mis-specified, suggesting the presence of a component other than market beta; the other, that investors' irrational actions were a threat to its assumptions. The Fama-French N-Factor model and Behavioural Finance, both of which studied irrational exuberance and studied investor behaviour, were the result of the first argument.

The differences outlined above, even though they are not supported by a well-formed theory, prove to be vital for making decisions and building a strong stock market. Studying CAPM and Fama-French Three-Factor Models in India's equities market, our study aims at examining the impact of firm fundamentals in explaining average returns. An effort has been made to compare the models and investigate the potential of additional factors behind the variance in results. Using market data and the regression coefficients established from the literature review, we were able to model average returns and then forecast average returns. Predicted returns were then compared to the actual returns of the same time. Lastly, we evaluated the accuracy of the CAPM model with the Fama model in order to determine which model is more suited to the Indian markets. Specifically, this study proposes the following research questions:

1. To evaluate the Capital Asset Pricing Model (CAPM) in Indian markets.
2. To evaluate the Fama- French Four-factor model (FFTFM) in Indian markets.
3. To examine which is the better model between CAPM and FFTFM in predicting average daily returns

Theoretical Background of the study

Financial academics have always had a hard time figuring out how to explain market returns, and many models have been presented to do so. Graham and Dodd's books, "Security Analysis," which outlined a quantitative and probability-based definition of "investment," and the "Intelligent Investor," encouraged a new generation of investors to study to better understand market returns.Harry Markowitz's Nobel Prize-winning work on the Modern Portfolio Theory in 1952 had the greatest influence on explaining returns. The model was hailed as a game changer, igniting a wave of new ideas that sought to build an equilibrium theory of asset pricing under a range of variables, including risk. In their publications, William (1964) and Mossin (1966) reaffirmed the hypothesis of systematic vs. unsystematic risk as a factor in equity returns. The CAPM was developed by Markowitz, Sharpe, and Miller in conjunction with Fisher, based on their earlier work (1972).

The methodology is based on determining the expected return on an asset based on its systematic risk concerning the market and the risk-free rate. For example, John Cochrane was able to get the result utilising the economic ideas of marginal utility and consumption-based models in his book, "Asset Pricing." The model was extremely intuitive, with several intuitions supplied for the same (2010, Chapter 1). Equity markets began to diverge in the early years, prompting experts to re-examine the model to explain results. It was Fama French (1996) who sought to explain returns using a multi-factored method, categorising businesses according to their Beta, Small Minus Big capitalization, and High minus Low book values (HML). The model was able to account for more than 90% of the diversified portfolio returns at the time of his research, compared to the CAPM, which was able to account for around 70% earlier. It was later enhanced to include a profitability element (RMW) and an investment factor (CMA) from the Fama and French 3-factor model.

The model, while widely accepted, received various critiques, such as failing the Gibbons, Ross, and Shanken test (1989), Griffin pointing out that the model was heavily impacted by country-specific characteristics, and other studies pointing out its poor performance in developing economies; Additionally, Roll (1977) points out that a genuine portfolio would comprise all investments in the market, and indexes such as the S&P500 are only able to present an aggregate image of the same, operating simply as a proxy. Chen, Nai-Fu, Roll, and Ross (1986, Economic Forces and the Stock Market) and A. Ilmanen's book "Expected Returns: An Investor's Guide to Harvesting Market Rewards" provide further details on economic forces and their influence on stock markets (2011, Chapter 12 and 14).

While Bartholdy and Peare's time series examination of both models (CAPM and the FF 3 factor) indicated that 5 years of monthly data and an equal-weighted index offered the most accurate estimations, they do query whether either model can be used to estimate returns. Recent studies in the context of developing markets have examined the Fama-French and CAPM models on the Brazilian equity market between 1999 and 2007. (Chague et al, 2007). The article, using the US equity markets as a benchmark, says that the estimation of the FF model matches the Brazilian data better than the CAPM, generating a premium of around 6.5 percent. However, as compared to the CAPM model, US data performs better in the context of the FF model but also introduces several discrepancies.

From 1994 to 2016, researchers at Huang, Tzu-Lun (2018) examined the Chinese market. An advantage of FF 3 over other standard models is that it takes into account Chinese characteristics, which may be more powerful in explaining known risk factors because of China's rigorous regulations and information asymmetry. The cement sector in Dhaka (Bangladesh) is studied in another research by Sattar (2017) using the CAPM and the FF 3-factor model. With each component coefficient statistically significant, the FF 3-factor model outperformed the CAPM. However, Sattar does warn that the added expenses may exceed the advantages of a model shift in an organisation due to the onerous aspects of the FF model that necessitate regular rebalancing.

Research Methodology and Hypotheses development

This study uses CAPM model and **Fama French N-Factor Model** to analyse the data. The Indian equity market when compared to the US or UK markets is still in its nascent state with over 12500 listings but only about 10% of them make up a majority of the market capitalization. Furthermore, unlike other developed markets, the Indian market sees a significant influence of retail investors (usually classified as amateur investors using their savings to bet on the market) compared to institutional investors (companies actively participating in the market using several proprietary strategies).

Looking at the data, we use a set of returns for the BSE SENSEX as a measure of market returns from 1st July 1997 to 31st December 2019. The data was obtained from Yahoo! Finance and is publicly available to download.

Using this as well as data posted on the Fama-French website we were able to draw returns for the factors for the same period over the expected world portfolio returns. These were then later adapted to the Indian equity markets using R Studio (publicly available data analysis software based on R language) – (the code for the same is provided as a subfile along with the project report). Please note that the data acquired was with survivorship-bias adjustment – i.e.

firms that dissolved during the period were kept out of the return calculations. This was done to keep the numbers consistent and without breaks which can hamper the quality of the research.

Furthermore, to test the data we also look at the MSCI INDA (based on Indian equity markets as a whole) and SMIN (based on small-cap Indian equities) ETFs as well as a passive investing scenario in SENSEX to compare our models. The data for these two ETFs is available from 9th February 2012 to 31st December 2019.

Thus, developing our CAPM and FF models, we train our models from 1st July 1997 to 8th February 2012 and then test them to see which models generate higher average daily returns from 9th February 2012 to 31st December 2019. The variables used are the ones described above in the model specifications. For the investigation, the following hypotheses were developed as part of the study.

1. There is a statistically significant relationship between excess returns and market beta.
2. Stocks of small companies outperform the stocks of large companies
3. High BE/ME stocks perform better than low BE/ME stocks.
4. Persistence of a momentum factor in the Indian equity markets
5. FAMA French Factor model is better than the CAPM in the Indian equity markets
6. Comparison of the above models vs ETFs used by large institutional investors

ANALYSIS AND DISCUSSIONS

Model Specifications

Capital Asset Pricing Model

Several initial research used a Mean-Variance (MV) technique to compute and optimise portfolios, but Sharpe and Litner (1964) broke through with the CAPM. While the MV analysis produced optimum portfolios based on inputs like anticipated returns, variances, and covariances, the CAPM was developed expressly to address the issue of expected returns and shed light on the reasons for the discrepancy between the expected returns of various assets. The diagram below illustrates this point. Depending on the level of risk, each asset produces a varying return (as measured by Mean) (as measured by Standard Deviation).

As a result, the CAPM clearly defines a trade-off between risk and return for investors, suggesting that investors demand various expected returns for different assets as compensation for risk..

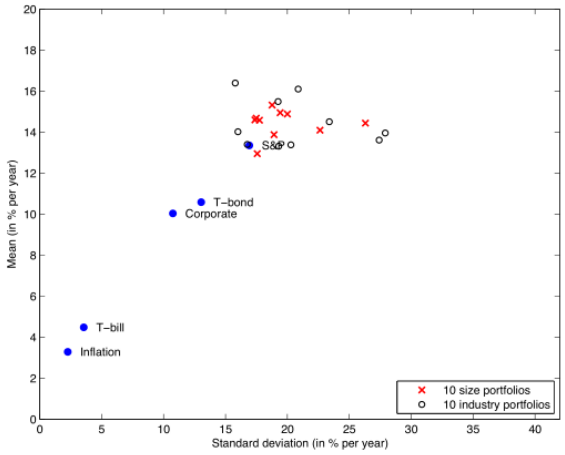
Given the ease of availability of derivations for the same, we jump to the final CAPM equation as proposed by Sharpe et al. (1964)

$$E(R_i) - R_f = \alpha + \beta_i * [E(R_M) - R_f]$$

Where,

$$\beta_i = \frac{Cov(R_i, R_M)}{Var(R_{M)}}$$

And



$E(R_i)$ = Expected Return on Asset i

R_f = Risk-Free Rate (Usually a 10-year government bond)

α = Alpha or the intercept term, which is a measure of abnormal returns and when used in a portfolio is often an indicator of the portfolio manager's skill.

β_i = Beta of the asset which measures the volatility of the asset concerning the market volatility. In essence, it shows how the asset returns move following the market. By definition, a market beta has a value of 1. Assets that have betas greater than 1 move more than the market and with negative betas move in the opposite direction of the market (these are usually used for hedging against the market)

Fama French N-Factor Models

For its side, the Fama-French model tried to break down security returns and risks into their many components on the idea that returns are driven by a small number of common sources of risk factors, each of which is distinct in its own right. It is possible to break down the returns, variances, and covariances of an investment portfolio into common and unique components to determine the sensitivity of an asset to a particular risk factor. A well-diversified portfolio contains only common risks (since the unique or the idiosyncratic ones can theoretically be diversified away). Our data allowed for a 4-factor iteration of the same model, based on market returns, SMB, HML, and WML, while the original model was a 3-factor model with other iterations to follow that took different factor loadings into account. For example, the model is as follows

$$E(R_i) - R_f = \alpha + \beta_{i,M} * \left[E(R_M) - R_f\right] + \beta_{i,SMB} * E(SMB_t) + \beta_{i,HML} * E(HML_t) + \beta_{i,WML} * E(WML_t)$$

Where

β_M = Market beta

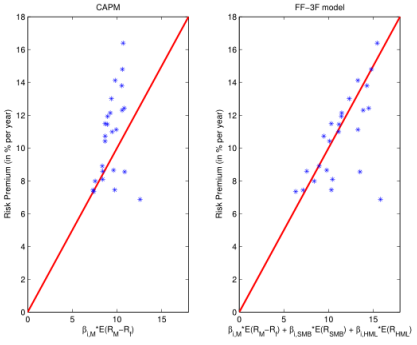
β_{SMB}, β_{HML} , β_{WML}= Respective betas for each of the goven strategy

SMB_t= Small minus Big. Measures the "Size" of the stocks in accordance with their market capitalization. The portfolios are formed as a zero cost portfolio such that

$R_{SMB,t} = R_{S,t} - R_{B,t}$

Where $R_{S,t}$ and $R_{B,t}$ are returns on small and big stocks respectively. This is based on the evidence that small stocks have historically outperformed big stocks – thus we go "long" on small stocks and "short" on large stocks.

HML_t = High Minus Low. Forms portfolios of value stocks (stocks with high fundamentals relative to market value, such as high book-to-market ratios) and growth stocks (low ratios). Value stocks have historically outperformed growth stocks.



WML_t = Winners minus Losers. Form portfolios by "long-ing" winner stocks and "short-ing"loser stocks (based on their performance over the past month up to 6 months - a constant rebalancing is done at the end of each period to make sure the strategy stays following the market movements). Winner stocks have dramatically outperformed loser stocks (This is oneof the "hottest" anomalies right now and it has become common amongmoney managers – and is also referred to as the momentum strategy).

The following figure shows a comparison of the CAPM and Fama French model based on 25 random portfolios generated over the period 1927-2015.

To initially train the models, we trained them against the SENSEX returns to obtain coefficients i.e. betas for each of the factors using which we continued to the testing phase. Let us first look at the results for the CAPM.

CAPM

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.070237555
R Square	0.004933314
Adjusted R Square	0.004656983
Standard Error	0.017146216
Observations	3603

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.005248634	0.005248634	17.85293828	2.44565E-05
Residual	3601	1.058667781	0.000293993		
Total	3602	1.063916415			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.000378914	0.000285725	1.816134549	0.069432853	-4.12839E-05	0.001079113
Rm-Rf %	0.00074386	0.00017605	4.225273752	2.44565E-05	0.000398692	0.001089029

As we can see, the adjusted R Square term posts a very low value. This is consistent with most regressions done in the field given the difficulty in explaining returns in the market. As an argument for the same, if models could predict the returns on equity indices with a high goodness of fit, it would theoretically mean that the market is a predictable entity and given that everyone would likely adapt to the same (efficient market hypothesis), the net returns would tantamount to zero, which is not the case.

Furthermore, we observe that both the intercept terms and the market coefficient post a significant value at the 90% confidence level. The significance of the intercept however fails at the 95% confidence level indicating that the market returns are an important factor to be considered while explaining the market returns. However, it cannot account fully explain the returns and thus would require us to consider several other factors.

Moving on to the Fama French Four factor model, we have the following results:

FAMA FRENCH 4 FACTORS

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.075673024
R Square	0.005726407
Adjusted R Square	0.009521044
Standard Error	0.017146525
Observations	3603

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	0.006092418	0.001523104	5.180568728	0.000368359
Residual	3598	1.057823997	0.000294003		
Total	3602	1.063916415			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.00040748	0.000286808	1.908871283	0.056358179	-1.4843E-05	0.001109803
SMB %	8.26357E-05	0.000330466	0.25005789	0.802556857	-0.000565284	0.000730556
HML %	-0.0004567	0.000275812	-1.655838075	0.097841818	-0.000997464	8.40635E-05
WML %	3.46694E-05	0.000237344	0.146072382	0.883872432	-0.000430673	0.000500011
Rm-Rf %	0.000739617	0.000189481	3.903382969	9.65951E-05	0.000368116	0.001111118

The adjusted R square term is larger than the one observed in the CAPM thereby implying that the model has better goodness of fit in comparison to the CAPM. When looking at the factors, we see some interesting results. The intercept term, HML factor, and Market factor, each post a significance at the 90% confidence level, while the SMB and the WML factors are insignificant. This is both in line with and contrarian to several studies. Dijk (2011) and Tripathi (2003) for example argue that the book value (HML – high book value minus low book value) posits a bias in the Indian investors' mind and thus plays an important role in the Indian equity markets with the size factor losing its importance over time with the ease of access to information to investors. Sobti (2016) on the other hand argues against the same and counters with a higher dependence on the size factor while stating that the value factor seems to be insignificant. We do however note that the returns used by Sobti (2016) were based on monthly returns over 5 years from 2010-2016 and were directly after the global recession of 2008, which would likely have implied certain biases in her data owing to the recovery period wherein many stocks would likely have been mispriced.

Now, to see how these models fare against the passive practices of investing directly in the index i.e. SENSEX in this case as well as against ETFs handled by institutional investors such as MSCI we run several tests on the same by running the numbers from 9th February to 31st December 2019.

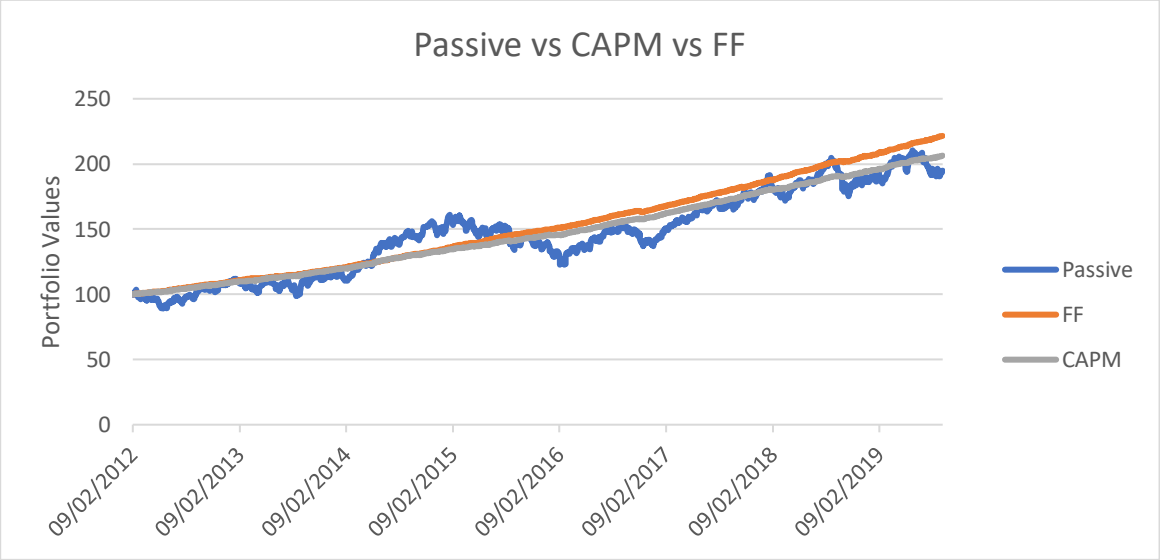
For the same, we start with $100 on the initial date and invest them as per the given strategies:

1. Passive – Invest directly in the SENSEX index on the initial date and compare the results to the final returns obtained on the end date.

2. CAPM and FF Model – We assume that the model represents the portfolios that generate returns according to the factors (as mentioned in the model) and allow for rebalancing measures. (*For ease of practice we do not account for transaction costs that would occur with each instance of rebalancing*) and compare the results for the same.

Comparing results for the passive strategy with the CAPM and FF Models we see the following results:

Values ($)	**09-02-2012**	**31-12-2019**	**Daily Log Returns**
Passive (SENSEX)	100	194.91	0.036%
CAPM	100	206.40	0.039%
FF Model	100	221.51	0.043%



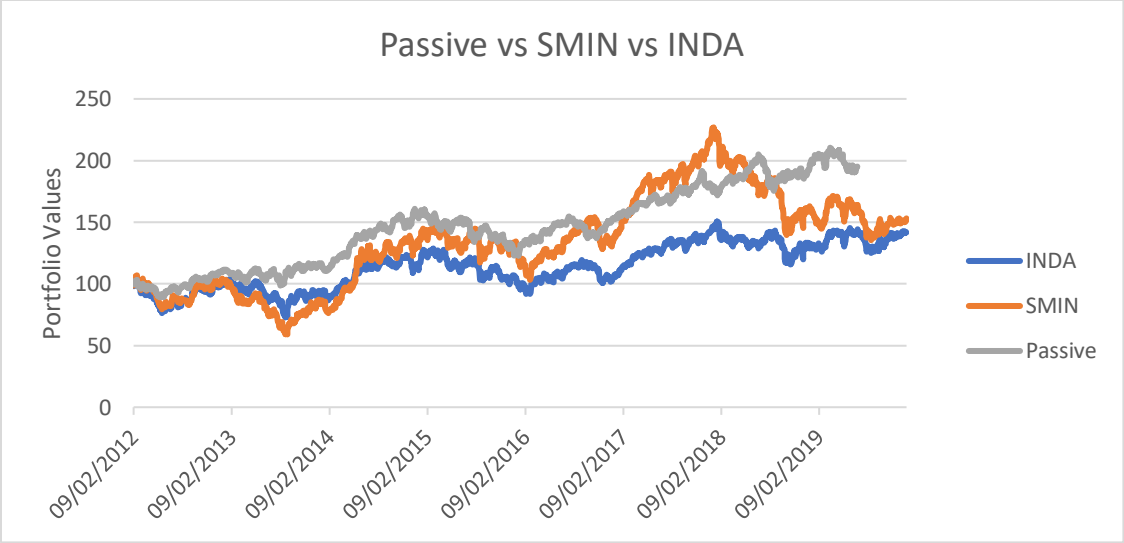
This indicates that the FF and the CAPM model outperform the passive strategy. For ease of comparison, we can also see a graph of the developments over the years.Besides a period from the middle of 2014-2015, where the passive strategy gained a lead, the models were able to outperform the passive strategy. Daily average log returns for the same have also been provided in the table above.

Furthermore, the results also articulate that the FF model outperforms the CAPM model in the long run.

Similarly, when we see the daily log returns for the MSCI ETFs, we have the following results:

Values ($)	**09-02-2012**	**31-12-2019**	**Daily Log Returns**
INDA	100	141.74	0.0176%
SMIN	100	152.86	0.021%

As we can see, the ETFs underperform all the 3 strategies mentioned above, providing lower average daily log returns. However, we do need to note that there is considerable volatility in the SMIN portfolio which had been overperforming the passive strategy but lost a chunk of its gain due to a slow 2019 which had been seeing a lower than usual demand, especially in the manufacturing industry which constitutes over 40% of the small-cap stocks listed in the Indian equities.



Now, let us look at each of the above-mentioned hypothesises and check them with the results:

1. *There is a statistically significant relationship between excess returns and market beta.*

Referring to the results provided in the CAPM regression, with a t value of 4.2 and p-value of $2.44*10^{-5}$, we cannot reject the null hypothesis.

2. *Stocks of small companies outperform the stocks of large companies*

There are two parts to this discussion. If we look at the factor returns, the SMB factor is deemed to be insignificant owing to its very high p-value. This is in line with the finding of Dijk (2011) as mentioned above – thereby rejecting the null hypothesis. However, if we look at the SMIN ETF (which comprises small-cap equities) vs the INDA ETF (which is majorly made of large caps), the SMIN posts a higher return. This may be accounted for by higher average volatility in the stocks.

3. *High BE/ME stocks perform better than low BE/ME stocks.*

This is statistically significant at the 10% confidence level and is again in line with the studies by Dijk (2011) and Tripathi (2003).

4. *Persistence of a momentum factor in the Indian equity markets*

The results indicate that we reject the null hypothesis in this case. This was surprising given the results of Sehgal (2012), who is a big advocate of the momentum factor as well as

looking at the results of Cliff Assness in his fund AQR which has constantly been applying and generating extra-normal returns using the momentum factor on developing countries stocks.

5. *Fama French Factor model is better than the CAPM in the Indian equity markets*

We cannot reject the null hypothesis in this case, with the average daily log returns in the FF model giving 0.043% compared to 0.039% in the CAPM model.

6. *Comparison of the passivemodels vs ETFs used by large institutional investors*

Results suggest that the passive strategy provides a greater average daily log returns 0.036% compared to 0.018% and 0.021% obtained by the ETFs.

Conclusion

The goal of this research is to examine the Indian equities markets and the effectiveness of various asset pricing models in estimating future returns. There are several additional aspects to take into account while analyzing the Indian market as its whole, as evidenced by the high and substantial values of alpha found in the data. Research by Rakyan and Facius (2017) looks at the skewness in SP500 options (US equities) to predict future pricing and Wendel and Mann (2017) look at fundamental and existential factors (such as company perception) for asset pricing under various scenarios are two examples of this type of research.) Findings show that the Equity Premium Puzzle is present in the Indian market. As we can see, the FF Model outperforms the CAPM and passive investment models, as well as the ETFs utilised by some institutional investors,in pricing return expectations.

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