Asian Journal of Finance & Accounting
ISSN 1946-052X
2014, Vol. 6, No. 1

Multifactor Explanations of CAPM Anomalies: An Evidence for Indian Stock Market

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Received: March 5, 2014 Accepted: May 28, 2014 Published: June 1, 2014

doi:10.5296/ajfa.v6i1.5241 URL: http://dx.doi.org/10.5296/ajfa.v6i1.5241

Abstract

We evaluate the ability of alternative asset pricing models in explaining returns on various characteristic (company size and value) sorted and prior return ranked portfolios. Data is employed from January, 1997 to June, 2012 for 488 companies listed on BSE-500 index. We find that Fama-French three factor model performs better than one factor capital asset pricing model in explaining mean excess returns on characteristic sorted portfolios. We also observe that Fama-French model partly explains long term, reversal, and momentum profits. Asset pricing results are found to be vibrant to the alternate versions of company size and value factors and choice of different market proxies as the FF model (in all its versions) outperforms CAPM. We further show that the Carhart four factor model involving an additional momentum factor, does not significantly perform better than FF model for different portfolios except short term momentum profits.

Keywords: CAPM, Asset pricing, Momentum effect, Reversal effect and company size

JEL CODES: C12, C31, G12, and G14

1. Introduction

CAPITAL ASSET PRICING MODEL (in short CAPM) developed by Sharpe (1964) has laid empirical foundation that securities returns have linear relationship with their market betas and returns are adequately explained by market betas. The above arguments have been violated for US stock market due to the empirical evidences against the core predictions of the CAPM. One of the most important arguments posing challenge to CAPM is firm size-return relationship. Banz (1981) documents size effect[1] in which company size measured by market capitalization (market price of stocks times number of shares outstanding in the market) is related with stock returns. It means the companies with small size capitalization (small stocks) provide higher returns vis-à-vis the companies of big size capitalization (big stocks). Chan (1985) shows that small firms provide higher returns than big firms as the small firms are likely to be exposed to economic fluctuations such as boom and depression. Keim (1982) records size related anomaly and he finds that the abnormal returns are negatively related to size i.e., big size firms provide abnormal returns than small size firms. He also tests the seasonal effect in stock returns and finds that there is January effect in stock returns and abnormal returns are heavily registered in January. Friend and Lang (1988) experiment the size effect and also state that size is predominantly a risk effect which is not captured by beta. Chan and Chen (1991) express that small size firms provide better returns than big firms as the former tend to be having less operational efficiency, higher financial leverage, and weak ability to access for external financing etc,. Another challenge the one factor CAPM confronts is the company value effect[2] which is documented by different researchers for several stock markets of which some of the main studies are highlighted here. Basu (1977) documents that stocks with low P/E ratios (an indicator of company value) provide superior returns than stocks with high P/E ratios. His arguments to this include non-reflection of P/E ratio information in securities prices, market disequilibrium, and entry of tax-paying investors in to capital market to rebalance their portfolios through buying low P/E stocks. Bhandari (1988) observes a linear relation between stock returns and firm's debt-equity ratio. Chan, Hamao, and Lakonishok (1991) demonstrate that there is a positive relation between stock returns and corporate fundamentals such as size, book equity to market equity, earnings yield, and cash flow yield. They find a significant impact in stock returns and book equity to market equity and cash flow yield. Chan, Karceski, and Lakonishok (1998) take on an empirical work which examines the stock returns' relation with fundamental factors, technical factors, and macroeconomic factors and they find a significant influence of fundamental factors (accounting based variables) and technical factors (prior returns) in stock returns while poor relation is observed between stocks returns and macroeconomic factors.

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[1] Size effect means small stocks (small size companies) outperform big stocks (big size companies) by providing extra-normal returns. See Banz (1981).

[2] Value effect means low value stocks provide higher returns vis-à-vis high value stocks. See Fama-French (1993), Basu (1977), Bhandari (1988), and Chan, Hamao, and Lakonishok (1991).

Chui and Wei (1998) test the relationship between stock returns and market beta, size, and book equity to market equity for the stock markets of Hong Kong, Korea, Malaysia, Taiwan, and Thailand. They find a positive relation between beta and stock returns is weak while size effect is strongly pronounced across the markets. Book to market equity explains the stock returns in all the markets with exception of Taiwan and Thailand. Stattman (1980) shows that stock returns have negative relation with book equity to market equity. Another challenge of CAPM is prior return effect[3] which means past returns on stock attract the investors. Debondt and Thaler (1985, 1987) find new evidence that most of the investors overreact to certain unexpected news released by corporate and events happening in the company. They further show that portfolios provided higher returns in the past starts giving lower returns in the future. Chan, Jegadeesh and Lakonishok (1996) reveal that prior returns and past earnings surprise predict large variations in stock returns and these variations are not explained by market beta, size, and book equity to market equity. Barberis, Shliefer and Vishny (1998) find that value stocks or out of favour stocks outperform the glamour stocks by providing higher returns. Moreover, they see a little evidence in favour of an argument that value stocks are fundamentally risky. Daniel, Hirshleifer and Subrahmanyam (1998) develop a theory which proves that the investors overreact to information which are of private in nature while underreact to public information being released corporate. Hence, size, value, and prior returns are typically called as asset pricing anomalies. Fama-French [(FF model) (1993)] propose a model which consists of three stock market related factors such as market, company size and value. The company size is represented by market capitalization while value is quantified by price-to-book ratio. Fama-French (1996) develop a multifactor model which explains most of the CAPM anomalies excepting momentum pattern which is outlined later. They also show that their multifactor model can also explain stock returns when alternative measures of size and value factors are used. Hence, the model has piqued the interest of the researchers and practitioners. Jegadeesh and Titman (1993) document of short term momentum effects in stock returns which could be achieved through buying stocks that provided better returns in the past and selling stocks that fetched poor returns in the past. This strategy is described as momentum strategy. Jegadeesh and Titman (2001) uphold the robustness of their previous findings. However FF multifactor model (1996) fails to explain this momentum pattern in stock returns. This led to the genesis of four factor model by Carhart (1997) which includes a one year momentum factor recorded by (Jegadeesh and Titman) in addition to the already specified Fama-French factors. The four factor model suggests that common factors associated with stock returns as well as investment expenses can explain returns on mutual funds.

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[3] For prior returns effect see De Bondt and Thaler (1985, 1987) and (Jegadeesh and Titman, 1993, 2001), Fama-French (1966)

Lui and Zhang (2008) find that substantial part of momentum profits are explained by industrial production which is one of the macroeconomic variables. They also perceive that expected growth in industrial production is a kind of risk which can be priced by the investors. Fama-French (2008) re-examine and find the emergence of new stock return anomalies such as profitability, growth, accruals, net stock issues etc., besides size, value, and momentum. They further document that these anomalies are integrated with stock returns. Fama-French (2012) test the integration between stock returns and size, value, and momentum for four regions namely North America, Europe, Japan, and Asia Pacific. They conclude that there is premium for value, size, and momentum in all regions with the exception of Japan.

Three factor Fama-French model has widely been accepted by stock markets across the world. [See Fama-French (1998) and Chui-Wei (1998)]. In Indian environment, Connon G and Sehgal S, (2003) reveal that their findings are benign to the FF model. Sehgal S and Balakrishnan I (2002) find that long term returns pattern reverts after short term momentum effect is controlled. Sehgal S and Balakrishnan I, (2008) also find that a major part of momentum profits on Indian equities are explained by Fama-French model. Sehgal, S, and Jain, S, (2009) document a strong short term momentum pattern in stock returns in Indian stock market and they also find that momentum profits could not be explained by CAPM and FF model. Sehgal, S, and Jain, S, Laurence, (2013) observe a weak momentum profits on portfolios formed using long term past returns. They further show that CAPM and FF model do not capture the long term momentum profits. Sehgal S, and Balakrishnan A, (2013) reconfirm the presence of strong size and value effects. They also find that FF model is stronger than CAPM in explaining stock returns.

This paper attempts to examine the efficiency of three factor Fama-French model (FF model), and four factor Carhart model for Indian stock market in explaining stock returns. To evaluate the above, we perform out of sample test using data for a longer time period (1997 - 2012). The sample covers more recent period. Hence, this study will be a useful one to check if the Fama-French factors continue to be valid over time. Hence one does not infer that FF factors are not the outcome of investor fancies towards company characteristics which may be defunct in due course. We also test the efficacy of FF model using its alternative construction/selection of risk factors. We also evaluate the robustness of Carhart four factor model in explaining the cross sectional average stock returns.

The structure of the paper is as follows. Section II presents data and their sources. Section III examines if the Fama-French three factor model is superior to one factor CAPM in terms of explaining stock returns. Section IV verifies if FF model is robust to explain the average stock returns when Fama-French alternative versions/risk factors are employed. Section V tests the relative strength of Carhart model vis-à-vis FF model in explaining stock returns. Last section sheds light summary and conclusion of the study.

2. Data

The sample size of the study is 488 companies which are listed on a recognized stock exchange i.e., Bombay Stock Exchange (BSE) 500. The index is broad based one. The data consists of month end adjusted share prices[4] from January, 1997 to June, 2012. The data source for share

Asian Journal of Finance & Accounting
ISSN 1946-052X
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price is CMIE Prowess. We form stylized portfolios based on company size and value which are described as company characteristics. The size of the company is measured using three variables such as market capitalization (MC), total assets (TA), and enterprise value (EV). EV is the total book value of debt plus market capitalization. Value of the company is determined by using two measures such as price-to-book (P/B) and price-to-earning (P/E) ratios.

Fama-French (1993, 1995) find a relative distress/value effect for the companies. The premise of relative distress (value) factor is such that the companies which have low P/B and P/E ratios are expected by the investors to provide them higher returns as these companies are characterized as low earning companies while companies of high P/B and P/E ratios are potentially high earnings making companies which tend to provide lowerr returns to the investors as these companies are possibly less risky. In line with prior research, we also use P/B and P/E ratios as the measures of company value. We again collect the data for company characteristics from CMIE Prowess.

Treasury bill (T-Bill) is one of the money market instruments being issued by Government. Return on T-Bill has zero covariance with return on market portfolio and other risk factors. The implicit yields on t-bills are the risk free returns. Moreover, it is a general practice in asset pricing research in India of using implicit yields on 91 day t-bills as risk free rate in order to compute excess returns on portfolio and excess returns on market. Hence, we use implicit yields on 91-day treasury bills as risk free proxy. The implicit yields on 91 day T-bills are collected from Reserve Bank of India's website. The Bombay stock exchange (1983-84) and National stock exchange (NSE-50) popularly known as NIFTY are used as market proxies.

3. Explanation on The Cross Section of Average Stock Returns: Capm Versus Fama-French Model

Connon G and Sehgal S (2003) perform maiden experimentation of the FF model for Indian stock market and find that FF model captures the mean excess returns on portfolios which is missed out by one factor CAPM. We examine whether FF model continues to be a successful asset pricing tool in a longer and more recent time period i.e. 1997-2012 for Indian stock market.

In order to execute this, we construct portfolios based on company characteristics using single and double sort criterion, also form the portfolios based on prior returns of the sample companies.

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[4] The study uses only adjusted share price for estimation purpose. It means the share prices are adjusted for capitalization changes such as stock split, stock dividends, and right issues.

3.1 Single Sorted Portfolios

We start the analysis by ranking sample securities on a single criterion (Company characteristic) i.e. measure of company size/value and form portfolios termed as single sorted portfolios. The portfolio construction procedure is as follows. First, we rank the companies at the end of June, 1997 (period t) on the basis of market capitalization (MC). Then the companies are categorized in to five portfolios, P_1 (Portfolio one) contains 20% of the sample stocks with smallest MC while, P_5 (Portfolio five) comprises of 20% of the sample stocks with largest MC. Then equally weighted returns on these five portfolios from July, 1997 (t) to June, 1998 (t+1) are calculated. Then ranking is revised in June, 1998 and this process is repeated till end of the study period. Next we estimate the mean excess return[5] on each portfolio from July, 1997 to June, 2012. The similar procedure is adopted for alternative measures of company size i.e., TA and EV. Since TA is fully accounting based information while EV happens to be partly accounting based data, they are made available to the public in the month of March of every year. Unlike other countries, India has financial year in which March is the closing month. Hence, some companies release the financial statement and other finance related information to the investors with some delay. This may trigger a lag between financial closing date and availability of financial information so as to be used by investors for their decision making purpose. Hence, the portfolios are formed with a time gap of three months from financial closing date to overcome this problem. Thus portfolios are formed based on these size measures in March of year (t), while the holding period starts from July of year (t) unlike market capitalization where portfolio ranking is done in June of (period t) as information is regularly available.

Next the sample stocks are sorted on the basis of relative distress measures (value factor) i.e. P/B and P/E ratios. While ranking is done based upon these financial ratios in March of year (t), portfolio is constructed from July to June (t) as P/B and P/E ratios are accounting based information and therefore the time gap for portfolio formation is necessary for reason stated above. Then, we run CAPM regressions on returns on portfolios using prominent excess return version of the market model specification.

$$R_{Pt} - R_{Ft} = a + b\,(R_{Mt} - R_{Ft}) + e_t \qquad (1)$$

where

$R_{Pt} - R_{Ft}$ = Excess returns (stock return minus risk free return) on portfolio,

$R_{Mt} - R_{Ft}$ = Excess returns on the market factor (excess of market returns over risk free return)

a = Measure of abnormal returns and

b = Sensitivity coefficient.

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[5] The excess return is the security return minus risk free return for corresponding time period

Equation (1) is the CAPM specification which is estimated to verify whether returns on portfolio are fully explained by excess returns on market portfolio. This can be decided on the basis of 'a' (intercept) value. If the value of 'a' (intercept) is indistinguishable from 0, it implies that CAPM explains returns on portfolio otherwise one can presume that it fails to do so.

Equation (2) represents three market related anomalies such as market, size, and value, proposed by Fama-French (1993). Equation (2) is estimated to evaluate if FF three factors have the explanatory power of returns on portfolio as CAPM fails to explain the portfolio return. Hence, we regress the excess returns on portfolios for Fama-French factors being expressed in the way of:

$$R_{Pt} - R_{Ft} = a + b\,(R_{Mt} - R_{Ft}) + sSMB_t + lLMH_t + e_t \tag{2}$$

Where,

SMB and LMH are the risk proxies of company size and value respectively and

S and l represent the sensitivity coefficients of SMB and LMH factors.

SMB and LMH factors are constructed by performing double sorted criterion. Next we rank the sample stocks on the basis of size and value of companies. The ranking procedure follows. In the month of June of year (t), we rank the sample stocks by taking market capitalization as a measure of size. Then the stocks are categorized in to two groups namely small and big. Bottom 50% of the stocks are named as small (S) and top 50% of the securities are called as big (B). Then the sample stocks are again classified in to three groups namely low (L), medium (M), and high (H) based on P/B ratio which is a value measure. To the above classification based on P/B ratio, we use the following breakpoints. First 33.33% of stocks from bottom are falling in the low group, next 33.33% of stocks are in the bracket of medium group, and above 66.66% of the stocks are in the high group. Then from the intersection of two size and three value groups, six portfolios consisting of S/L, S/M, S/H, B/L, B/M and B/H are constructed. The S/L portfolio contains small size and low value stocks, while B/H comprises of big size and high value stocks.

The SMB (small minus big) portfolio means mimicking the risk factor in returns associated with MC (measure of size of the company). SMB is the average returns on small stock portfolios (S/L, S/M, and S/H) reduced by average returns on big-stock (B/L, B/M, and B/H) portfolios. SMB is expressed as follows:

$$SMB = (((S/L) + (S/M) + (S/H)) - ((B/L) + (B/M) + (B/H)))/3 \tag{3}$$

LMH (low minus big) portfolio means mimicking the risk factor associated with returns related to P/B ratio (measure of value of the company). LMH is the average of the returns on high – P/B portfolios (S/H and B/H) minus average returns on low P/B portfolios (S/L and B/L). LMH is shown as under:

$$LMH = (((S/L) + (B/L) - ((S/H) + (B/H)))/2 \tag{4}$$

The estimation of the LMH differs from FF model (1993) which uses HML, meant to mimick the risk factor in returns relating to value factor. HML is constructed using book equity to market equity (BE/ME). We estimate LMH using price-to-book ratio (P/B) which is the mirror image of BE/ME. Hence, the interpretation of the results of value factor will be inverse to those of FF model (1993).

Table 1 (A) presents means excess returns on size/value based portfolios. The mean return on P_1 exceeds that of P_5 by about 43% on annualized basis using alternative size definitions except total assets whose mean return differential is 40%. Hence at prima facie, a strong size effect is observed. The company value is defined using two measures namely P/B and P/E ratios. P_1 is the portfolio with the highest relative distress firms (firms having weak fundamentals) and P_5 is the portfolio with lowest relative distress firms (firms with strong fundamentals). The results for two relative distress proxies are also provided in table 1 (A). The mean return differentials between portfolios P_1 and P_5 are 24% and 14% for P/B and P/E respectively. This reveals a strong value effect. Further, we observe the relationship between company size/value and return is monotonic in nature. The return differentials between P_1 and P_5 are high, thus, indicating returns could be influenced by risk factors. Hence, it is imperative to check if excess returns on size and value based portfolios are captured by risk models.

In table 1 (B), regression results for one factor CAPM are presented. It is seen that CAPM does not explain the excess returns on portfolios. This is confirmed from the fact that alphas (intercepts) of all P_1 are distinguishable from zero. It means abnormal returns on portfolios seem bigger. Further, the inability of CAPM to the above is also witnessed from the t-statistics of alphas which are significant at 5% level. Similar results are found for alternative size/value measures. Further, betas differentials between P_1 and P_5 seem to be little which also indicates the failure of CAPM to explain extra normal returns.

Table 1 (C) documents regression results for size/ value sorted portfolios using FF model are reported. It can be noted that small stock portfolios load heavily on size factor, while strong size effect is countered by inverse value effect thus reducing the power of FF model in explaining abnormal returns on size sorted portfolios. There is an inverse value effect found with the exception of market capitalization based classification. Low P/B and P/E stocks are highly sensitive to both size and value factors compared to high P/B and P/E stocks resulting in low alpha. FF model alphas are however smaller than CAPM alphas. Our results show that FF model explains major part of extra normal returns on single sorted portfolios compared to CAPM.

3.2 Double Sorted Portfolios

Next we form portfolios based on two company characteristics by adopting double sorted criterion which has already been discussed in the previous sub-section. Then, we construct six sets of portfolios using the standard FF model definition i.e., MC-PB as well as alternative versions of FF model (MC-PE, TA-PB, TA-PE, EV-PB, and EV-PE). These six sets are made by combining size and value measures.

The mean excess returns on portfolios formed using double sort are given in table 2 (A). It is clear that the returns on all small size and value (S/L) stocks are more than that of big and growth (B/H) stocks. This indicates that Indian stock market has strong influence of company size and value effects. However, these findings are not consistent with Berk's empirical findings which prove that size effect is an outcome of endogenous identity.

Moreover, it is noting worth that size effect is pervasive for all three size measures (MC, TA, and EV). MC is a market based measure while latter two are non-market based measures. Berk does not find size effect for non-market measures[6]. Next, we verify if size and value effects in stock returns could be explained by asset pricing models.

The regression results of CAPM are shown in table 2 (B). It is clearly understood that the model fails to explain average returns on S/L stocks. This is substantiated with alphas of all S/L stocks are not close to zero and t alphas are statistically significant at 5% level. Table 2(C) presents the regression results of FF model. The results clearly express that FF model captures the average returns on S/L portfolio. The explanation for this is S/L portfolios load heavily on size and value factors. It is also noticed that alphas of all S/L portfolios are almost decimated. This again confirms that the FF model is a better descriptor.

3.3 Prior Return Portfolios

3.3.1 Portfolios based on long term past returns

We form the portfolios based on long-term prior returns as has been done by De Bondt and Thaler (1985) and Fama-French (1996). In the month of June of each year t, we rank the sample stocks in ascending order on the basis of their average returns during last three years (36 months) then we form five portfolios. The bottom 20% of the sample stocks are called portfolio one (P_1) whereas top 20% of the sample stocks are clubbed in portfolio five (P_5). P_1 is found to be the loser portfolio as it provided the lowest past returns while P_5 is the taken as the winner portfolio as it yielded the highest returns. Then equally weighted returns on monthly basis on these five portfolios from July of year t to June of year t+1 are calculated. The portfolios are reformed in June of year t+1, on the assumption that portfolio holding period is 12 months. Thus, we adopt i months/j months trading strategy, where i is the portfolio formation period and j is the portfolio holding period.

Table 3 (A) shows the mean returns on loser (P_1) and winner (P_5) portfolios. The mean excess returns on P_1 and P_5 are 29% and 35% respectively on annualized basis. The results suggest the presence of long term momentum pattern in stock returns. Table 3 (A) also reveals of regression results for long term prior return portfolios regressed on the market factor as per CAPM model. The CAPM does not have explanatory power as alphas for P_1 and P_5 are statistically significant. The regression results of FF model are also reported in table 3 (A). The FF model partly captures the abnormal returns.

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[6] Book value of assets, book value of all un-depreciated assets including plant and equipments, total annual sales, total number of employees

It is also important to check that if average returns tend to reverse when the portfolios are formed using returns for three years prior to portfolio formation. International evidence points out reversals in long term returns while a momentum pattern for such data is observed in the case of India. Our long term results may be distorted due to the fact that there is a strong short term momentum in stock returns shown later where this short term (12 months) is forming part of long term data. To correct this, one year is skipped between portfolio formation and holding periods as suggested by Fama-French (1996). In the month of June of year (t), we rank the sample stocks in ascending order on the basis of their average returns during last three years (36 months) then we form five portfolios. P_1 and P_5 are termed as loser and winner portfolio respectively. Then equally weighted returns on monthly basis on these five portfolios from July of year t to June of year t+1 are calculated. The portfolios are reformed in June of year t+1, on the assumption that portfolio holding period is 12 months. We thus adopt 36 month 12 month trading strategy skipping one year between portfolio formation period and portfolio holding period.

The results for these portfolios are shown in table 3 (B). One can observe that there is a weak reversal pattern in stock return after controlling the momentum effect. CAPM again fails to explain returns on corner[7] portfolios and FF model is able to capture the abnormal returns partly. This is predominantly due to the fact that loser portfolio loads heavily on the value factor compared to winner portfolio. This supports the risk argument as the loser seems to be fundamentally weak as it contains mainly low P/B stocks.

3.3.2 Portfolios based on short-term past returns

We finally form portfolios based on short term past returns as suggested by Jegadeesh and Titman (1993). For this purpose stocks are sorted on the basis of their average excess returns in the past one year (12 months). Then five portfolios are formed that equally weight the securities composition. The bottom 20% of the securities are termed as portfolio one (P_1) whereas top 20% of the securities are called portfolio five (P_5). According to this classification again P_1 and P_5 are the loser and winner portfolios respectively. Then equally weighted returns on monthly basis on these five portfolios from July of year t to June of year t+1 are calculated. The portfolios are reformed in June of year t+1, on the assumption that portfolio holding period is 12 months. Thus we adopt 12 month/12 month trading strategy. The results for short term past return portfolios are reported in table 3 (C). One can observe a strong momentum pattern in stock returns. CAPM as expected does not explain momentum returns. Interestingly, the FF model partly explains abnormal returns on the winner portfolio. This is owing to the fact that P_5 loads heavily on size factor. However it does not happen with value factor as P_5 fails to load on value factor. Thus, implying it comprises of small stocks.

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[7] Empirical results in all tables except (table 2) are shown only for the corner portfolios. The results for intermediate portfolios though estimated, are not shown due to the paucity of space. In the case of double sorted portfolios, results are shown for all the portfolios as they are not formed on a single criterion. Hence, corner portfolios do not exist.

4. Fama-French Alternative Definitions/Versions

Section 3 of this paper discusses the ability of FF model with its standard version i.e., MC_PB in explaining returns on portfolios based on characteristic and prior return sorted portfolios. We find that substantial part of returns on portfolios based on company characteristics and half of the returns on portfolios based on prior returns are explained by standard version of the FF model (MC-PB). It tempts us to verify if FF model with its alternative versions such as MC-PE, TA-PB, TA-PE, EV-PB, and EV-PE can extend its explanatory power on portfolio returns. The erstwhile six versions/definitions including MC-PB have been constructed using three size measures (MC, TA and EV) and two value measures (P/B and P/E). We also check the robustness of our asset pricing results to the selection of market proxy by using another stock market index namely NSE-50 in place of the BSE-200 which has been used initially. NSE-50, like BSE-200 is a popular value weighted index but is comparatively narrow based. The theoretical arguments suggest that broad based index should be a better proxy for market portfolio (which is value weighted and all-inclusive). Hence, we expect stronger results for BSE-200 compared to NSE-50 index.

Table 4 (A) provides the results for single sorted, double sorted, and prior return portfolios using BSE-200 as a market surrogate while table 4 (B) provides similar results for NSE-50. It is observed that FF model shows stronger results across the versions. The values of mean absolute alphas and adjusted R^2 showing the measure of abnormal returns and goodness of fit respectively appear to be similar in all six versions. At the same time it is noting worth that CAPM has substantially high mean absolute alpha and significantly lower adjusted R^2. Hence, one can suggest that the FF model is undoubtedly superior to CAPM. Further, these results are robust to irrespective of the market proxy used by us. Therefore, the FF model is also robust to its alternative versions/risk factors and, in general, does much better job in explaining average returns compared to one factor CAPM.

5. Carhart Four Factor Model

In the previous section we find that the FF model is not able to fully explain returns on size and value sorted portfolios. We now verify if the Carhart (1997) four factor model does a better job than FF model in explaining prominent asset pricing anomalies, especially momentum. Carhart’s model includes the three factors specified by FF (1993) and an additional momentum which is constructed by taking the difference between the returns on winner and loser portfolios based on short term (12 months) past returns on period to period basis. The Carhart’s specification is:

$$R_{Pt} - R_{Ft} = a + b\,(R_{Mt} - R_{Ft}) + s\,SMB_t + l\,LMH_t + w\,WML_t + e_t \qquad (5)$$

where

WML is mimicking portfolio that proxies for momentum factor in returns.

w is the sensitivity coefficient. All other terms in equation have been described earlier.

We repeat our experiments for characteristic sorted as well as prior return ranked portfolios. The results for Carhart model are provided in table 5. We observe that four factor model does not significantly perform better than the three factor model in explaining the abnormal returns (alphas) on size and value sorted portfolios. The four factor model also fails to explain long term momentum profits (Reversals) as winner portfolio does not load on momentum factor. However, Carhart model does explain one year momentum profits that are partly left unexplained by the FF model owing to the fact that winner portfolio (P_5) loads heavily on the momentum factor. One possible explanation for the success of stock momentum factor could be that it proxies for industry momentum. This implies that winning stocks come from industries which perform well in the recent past while losing stocks belong to poor performing industry. To the extent differences in industry performance is a reflection of differences in industry growth potentials, industry momentum factor is fundamental in nature and its impact is felt through the stock momentum factor (See Liu and Zhang (2008). This may lend support to the behavioral argument that momentum profits result owing to investor under reaction to past information.

6. Conclusions

In this paper we experiment the established asset pricing models' ability to explain cross section of average stock returns. Sample size is 488 Indian companies from 1997 to 2012. The sample companies are actively trading in the market. We perform our tests using three experimental portfolios: 1. Single sort based on size and value 2. Double sort based on size/value 3. Prior return portfolios based on long term (36 months), reversal, and short term (12 months) momentum effects. MC, TA, and EV are used as the measures of company size while P/B and PE ratios are used as the measures of company value.

Empirical results confirm that stock returns are strongly influenced by size and value factors in Indian stock market. It is also documented that FF model continues to be a better asset pricing tool as it explains the returns on portfolios formed on the basis of company characteristics. However, the FF model is not able to explain abnormal returns fully that is missed out by CAPM. These results are echoing the previous findings for the Indian stock market shown by Sehgal S and Balakrishnan A (2013). Our study covers longer time period including more recent years and suggest that the FF size and value factors have become relatively less important. More appropriately, it may imply that size and value do not proxy for any risk factors but perhaps represent investor fancy for certain firm characteristics as suggested by Daniel and Titman (1997) that are fading overtime

The FF model is able to partly capture contrarian and momentum patterns in stock returns that are missed by CAPM. The results contradict with previous findings documented by Sehgal and Sakshi Jain (2009 and 2011). We also evaluate the robustness of asset pricing results to alternative constructions/selection of the risk factors. We find that the FF model outperforms CAPM in all its versions involving alternative proxies of size and value factors and use of different market proxies.

Finally, we evaluate if the Carhart four factor model which includes an additional momentum factor besides the FF factors, does a better job than FF model in explaining returns. It is shown that the Carhart model does not perform significantly better than the FF model for characteristics sorted portfolios as well as long term momentum profits. However, the four factor model does explain the momentum profits this is owing to the fact that the winner portfolio loads on the momentum factor. Momentum profits do survive even in a four factor framework thus implying that continuation patterns may partly have their source in non rational investor behavior which cannot be explained by any systematic risk factor.

The study contributes to the asset pricing literature especially for Indian market, one of the emerging markets. It has strong implications for global fund managers who are designing portfolio strategies based on investment styles. Our findings cast shadow on the efficacy of multifactor models in explaining prominent asset pricing anomalies as these models have weak economic foundation and their empirical appeal will seem to be fading over time across global markets.

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Table 1. Empirical Results for Single Sorted Portfolios

For size sorted portfolios P1 represents small size stocks while P5 indicates big stock portfolios (Based on market capitalization, total assets and enterprise value). For value sorted portfolios (Based on price to book and price to earning ratios) P1 represents value stocks while P5 denotes growth stocks.

Panel A: Mean Excess Returns

MC

	P_1	P_5
Mean	0.045	0.009
Standard Deviation	0.121	0.088

TA

	P_1	P_5
Mean	0.047	0.014
Standard Deviation	0.114	0.100

EV

	P_1	P_5
Mean	0.046	0.010
Standard Deviation	0.111	0.093

PB

	P_1	P_5
Mean	0.034	0.014
Standard Deviation	0.121	0.090

PE

	P_1	P_5
Mean	0.029	0.017
Standard Deviation	0.109	0.105

Panel B: CAPM Results

MC

	a	b	t(a)	t(b)	R^2
P_1	0.037	1.101	6.339	15.834	0.585
P_5	0.001	1.002	0.697	42.685	0.911

TA

	a	b	t(a)	t(b)	R^2
P_1	0.040	1.067	7.586	17.162	0.623
P_5	0.007	1.082	2.114	29.481	0.830

EV

	a	b	t(a)	t(b)	R^2
P_1	0.038	1.068	7.700	18.139	0.649
P_5	0.003	1.038	1.110	36.604	0.883

PB

	a	b	t(a)	t(b)	R^2
P_1	0.026	1.126	4.612	16.848	0.615
P_5	0.007	0.979	2.411	29.758	0.833

PE

	a	b	t(a)	t(b)	R^2
P_1	0.022	1.059	4.535	18.764	0.664
P_5	0.009	1.141	2.794	29.768	0.833

Fama-French Model Results

MC

	a	b	s	l	t(a)	t(b)	t(s)	t(l)	R^2
P_1	0.006	0.981	1.595	0.300	2.035	31.854	23.048	5.108	0.921
P_5	0.002	0.984	-0.131	0.233	1.127	44.339	-2.637	5.524	0.923

TA

	a	b	s	l	t(a)	t(b)	t(s)	t(l)	R^2
P_1	0.013	1.008	1.496	-0.211	3.966	26.994	17.839	-2.974	0.869
P_5	0.004	1.015	-0.080	0.667	1.570	39.857	-1.391	13.765	0.921

EV

	a	b	s	l	t(a)	t(b)	t(s)	t(l)	R^2
P_1	0.012	0.983	1.402	0.073	4.333	32.818	20.826	1.275	0.912
P_5	0.001	1.002	-0.044	0.358	0.491	40.104	-0.779	7.528	0.912

PB

	a	b	s	l	t(a)	t(b)	t(s)	t(l)	R^2
P_1	0.001	0.982	1.054	0.800	0.438	31.057	14.837	13.285	0.916
P_5	0.001	0.990	0.424	-0.316	0.336	33.403	6.375	-5.593	0.869

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PE

	a	b	s	l	t(a)	t(b)	t(s)	t(l)	R^2
P_1	0.000	0.946	0.943	0.578	0.136	31.816	14.127	10.205	0.910
P_5	0.001	1.127	0.480	-0.118	0.283	31.501	5.975	-1.731	0.859

Table 2. Empirical Results for Double Sorted Portfolios Formed on Alternative Measures of Company Size and Value

Panel A: Mean Excess Returns

MC_PB

	S/L	S/M	S/H	B/L	B/M	B/H
Mean	0.037	0.028	0.028	0.016	0.011	0.011
Standard Deviation	0.123	0.107	0.107	0.106	0.097	0.085

MC_PE

	S/L	S/M	S/H	B/L	B/M	B/H
Mean	0.034	0.029	0.032	0.017	0.012	0.009
Standard Deviation	0.112	0.103	0.113	0.101	0.090	0.095

TA_PB

	S/L	S/M	S/H	B/L	B/M	B/H
Mean	0.040	0.027	0.018	0.024	0.015	0.011
Standard Deviation	0.118	0.103	0.095	0.114	0.104	0.095

TA_PE

	S/L	S/M	S/H	B/L	B/M	B/H
Mean	0.039	0.025	0.022	0.020	0.017	0.011
Standard Deviation	0.110	0.097	0.101	0.105	0.100	0.103

EV_PB

	S/L	S/M	S/H	B/L	B/M	B/H
Mean	0.038	0.029	0.024	0.019	0.011	0.010
Standard Deviation	0.118	0.106	0.101	0.116	0.103	0.088

EV_PE

	S/L	S/M	S/H	B/L	B/M	B/H
Mean	0.035	0.029	0.028	0.017	0.013	0.009
Standard Deviation	0.111	0.100	0.105	0.105	0.095	0.098

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Panel B: CAPM Results for Double Sorted Portfolios

MC_PB

	a	b	t(a)	t(b)	R^2
S/L	0.029	1.146	5.074	16.742	0.612
S/M	0.021	1.049	4.511	19.260	0.676
S/H	0.021	1.103	5.014	22.665	0.743
B/L	0.008	1.111	2.161	24.722	0.774
B/M	0.003	1.083	1.192	35.010	0.873
B/H	0.004	0.940	1.554	32.219	0.854

MC_PE

	a	b	t(a)	t(b)	R^2
S/L	0.026	1.057	5.091	17.166	0.623
S/M	0.022	0.995	4.891	18.517	0.658
S/H	0.023	1.169	5.586	23.603	0.758
B/L	0.009	1.085	2.686	28.213	0.817
B/M	0.005	0.998	1.896	34.399	0.869
B/H	0.001	1.041	0.498	30.459	0.839

TA_PB

	a	b	t(a)	t(b)	R^2
S/L	0.032	1.082	5.748	16.230	0.597
S/M	0.019	1.015	4.441	19.605	0.683
S/H	0.011	0.995	3.206	24.648	0.773
B/L	0.016	1.127	3.379	19.865	0.689
B/M	0.007	1.125	2.196	28.338	0.819
B/H	0.003	1.069	1.262	37.668	0.889

TA_PE

	a	b	t(a)	t(b)	R^2
S/L	0.031	1.020	6.064	16.674	0.610
S/M	0.018	0.980	4.704	21.086	0.714
S/H	0.014	1.047	3.806	23.865	0.762
B/L	0.012	1.070	2.946	22.100	0.733
B/M	0.009	1.088	2.938	29.569	0.831
B/H	0.003	1.131	1.065	31.878	0.851

EV_PB

	a	b	t(a)	t(b)	R^2
S/L	0.030	1.080	5.336	16.109	0.593
S/M	0.021	1.034	4.692	19.242	0.675
S/H	0.017	1.038	4.458	23.142	0.751
B/L	0.011	1.178	2.408	21.714	0.726
B/M	0.003	1.136	1.093	32.809	0.858
B/H	0.003	0.965	1.349	32.654	0.857

EV_PE

	a	b	t(a)	t(b)	R^2
S/L	0.027	1.046	5.336	17.146	0.623
S/M	0.022	0.972	5.149	18.988	0.669
S/H	0.020	1.088	5.088	23.580	0.758
B/L	0.009	1.116	2.495	26.820	0.802
B/M	0.006	1.047	2.036	32.386	0.855
B/H	0.002	1.070	0.508	30.338	0.838

Panel C: Fama-French Model Results

MC_PB

	a	b	s	l	t(a)	t(b)	t(s)	t(l)	R^2
S/L	0.002	1.002	1.217	0.718	0.750	32.805	17.734	12.336	0.925
S/M	-0.002	0.962	1.160	0.216	-0.768	31.451	16.882	3.705	0.901
S/H	0.002	1.074	1.102	-0.296	0.704	32.212	14.709	-4.666	0.883
B/L	0.001	1.025	0.109	0.742	0.457	32.635	1.547	12.411	0.893
B/M	0.000	1.060	0.145	0.139	-0.175	35.008	2.133	2.407	0.882
B/H	0.001	0.954	0.225	-0.244	0.493	34.058	3.576	-4.570	0.869

MC_PE

	a	b	s	l	t(a)	t(b)	t(s)	t(l)	R^2
S/L	0.001	0.939	1.237	0.459	0.205	31.997	18.758	8.212	0.917
S/M	0.001	0.921	1.087	0.127	0.378	25.924	13.617	1.870	0.855
S/H	0.004	1.120	1.073	-0.092	1.322	32.986	14.067	-1.417	0.890
B/L	0.002	1.021	0.151	0.523	0.899	33.642	2.222	9.056	0.890
B/M	0.001	0.977	0.144	0.122	0.457	34.371	2.252	2.245	0.878
B/H	-0.001	1.041	0.150	-0.076	-0.269	30.044	1.933	-1.151	0.840

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TA_PB

	a	b	s	l	t(a)	t(b)	t(s)	t(l)	R^2
S/L	0.003	0.961	1.422	0.404	1.187	30.654	20.188	6.766	0.914
S/M	0.000	0.968	1.110	-0.131	-0.082	26.589	13.570	-1.891	0.848
S/H	0.002	1.000	0.607	-0.364	0.642	28.330	7.653	-5.411	0.832
B/L	0.000	1.006	0.598	0.821	-0.091	30.924	8.185	13.252	0.901
B/M	0.000	1.062	0.260	0.459	-0.153	33.046	3.597	7.494	0.885
B/H	0.000	1.062	0.172	-0.029	0.016	37.305	2.681	-0.542	0.891

TA_PE

	a	b	s	l	t(a)	t(b)	t(s)	t(l)	R^2
S/L	0.005	0.922	1.313	0.243	1.758	27.260	17.275	3.776	0.885
S/M	0.002	0.939	0.934	-0.098	0.572	27.057	11.976	-1.488	0.846
S/H	0.002	1.036	0.755	-0.279	0.574	27.887	9.051	-3.942	0.835
B/L	-0.002	0.974	0.539	0.618	-0.703	31.413	7.743	10.469	0.894
B/M	0.003	1.034	0.212	0.401	0.910	33.319	3.042	6.784	0.884
B/H	-0.001	1.113	0.193	0.070	-0.263	31.514	2.437	1.042	0.857

EV_PB

	a	b	s	l	t(a)	t(b)	t(s)	t(l)	R^2
S/L	0.003	0.950	1.280	0.557	0.944	28.656	17.190	8.824	0.904
S/M	0.000	0.966	1.145	0.040	-0.056	27.551	14.533	0.596	0.866
S/H	0.002	1.023	0.913	-0.333	0.691	29.881	11.865	-5.101	0.859
B/L	-0.002	1.066	0.435	0.820	-0.773	31.306	5.690	12.647	0.895
B/M	-0.001	1.103	0.160	0.228	-0.419	33.481	2.163	3.632	0.876
B/H	0.001	0.978	0.236	-0.241	0.223	34.455	3.703	-4.463	0.872

EV_PE

	a	b	s	l	t(a)	t(b)	t(s)	t(l)	R^2
S/L	0.002	0.937	1.229	0.383	0.747	28.867	16.856	6.189	0.897
S/M	0.003	0.914	1.042	0.007	0.883	25.351	12.871	0.104	0.841
S/H	0.003	1.057	0.952	-0.194	1.104	30.627	12.278	-2.948	0.869
B/L	-0.002	1.037	0.411	0.527	-0.878	36.292	6.402	9.685	0.909
B/M	0.001	1.021	0.176	0.157	0.446	32.640	2.504	2.636	0.869
B/H	-0.001	1.067	0.156	-0.050	-0.323	29.826	1.945	-0.732	0.839

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Table 3. Empirical Results for Prior Returns Portfolios formed on long term prior returns

We adopt a 36/12 strategy. While 36 month is portfolio formation period while 12 month is the portfolio holding period. P1 includes past loser and P5 includes past winner.

Panel A: Mean excess returns

	P_1	P_5
Mean	0.024	0.029
Standard Deviation	0.104	0.122

CAPM RESULTS

	a	b	t(a)	t(b)	R^2
P_1	0.015	1.103	3.624	21.894	0.771
P_5	0.018	1.344	4.289	26.583	0.833

FF MODEL RESULTS

	a	b	s	l	t(a)	t(b)	t(s)	t(l)	R^2
P_1	-0.002	1.012	0.720	0.304	-0.471	25.958	7.955	3.580	0.874
P_5	0.004	1.321	0.893	-0.229	1.132	31.490	9.169	-2.498	0.894

We adopt a 36/12/12 strategy. The portfolio formation period is 36 month. We skip 12 months between portfolio formation and holding periods. The portfolio holding period is 12 month. P1 contains past loser and P5 comprises of past winners.

Panel A: Mean Excess returns

	P_1	P_5
Mean	0.031	0.030
Standard Deviation	0.102	0.123

CAPM RESULTS

	a	b	t(a)	t(b)	R^2
P_1	0.017	1.121	4.298	22.571	0.797
P_5	0.014	1.399	3.277	27.414	0.853

FF MODEL RESULTS

	a	b	s	l	t(a)	t(b)	t(s)	t(l)	R^2
P_1	0.002	0.995	0.691	0.397	0.704	29.849	9.389	5.475	0.920
P_5	0.001	1.365	0.762	-0.132	0.345	30.348	7.676	-1.351	0.899

Panel B: Portfolios formed on Short-term past returns.

We adopt a 12/12 strategy. Portfolio formations as well as portfolio holding period are of 12 month each. P_1 consists of past loser and P_5 contain past winner.

Mean excess returns

	P_1	P_5
Mean	0.022	0.033
Standard Deviation	0.111	0.118

CAPM RESULTS

	a	b	t(a)	t(b)	R^2
P_1	0.012	1.120	2.595	20.754	0.722
P_5	0.021	1.247	4.998	24.762	0.787

FF MODEL RESULTS

	a	b	s	l	t(a)	t(b)	t(s)	t(l)	R^2
P_1	-0.004	1.044	0.698	0.336	-0.886	23.892	7.004	4.087	0.823
P_5	0.006	1.213	0.901	-0.190	1.624	29.414	9.580	-2.443	0.862

Table 4. Empirical Results for alternative construction/selection of Fama-French factors

In this table we show how CAPM and alternative versions of the Fama-French model is explaining cross-section of returns on various characteristic sorted and prior returns portfolios. Panel A shows the results for BSE-200 when BSE-200 is used as a market proxy for estimating models while panel B provides results using NSE-50 as market proxy.

Single sorted Portfolios formed on Company Size: Comparative Results for CAPM and Alternative Versions of Fama-French Model.

Panel A: Market ProxyBSE-200 is used as a market proxy for estimating CAPM as well as Fama-French model

Model	Mean/Alpha	R^2
Market (CAPM)	0.015	0.755
Market,SMB_1,LMH_1(Standard Fama-French model – (Version1)	0.004	0.880
Market,SMB_2,LMH_2 (Version-2)	0.004	0.861
Market,SMB_3,LMH_3 (Version-3)	0.004	0.866
Market,SMB_4,LMH_4 (Version-4)	0.005	0.833
Market,SMB_5,LMH_5 (Version-5)	0.004	0.874
Market,SMB_6,LMH_6 (Version-6)	0.004	0.851

Single sorted Portfolios formed on Company Value: Comparative Results for CAPM and Alternative Versions of Fama-French Model.

Model	Mean/Alpha	R^2
Market (CAPM)	0.014	0.771
Market,SMB_1,LMH_1(Standard Fama-French model – (Version1)	0.002	0.882
Market,SMB_2,LMH_2 (Version-2)	0.001	0.868
Market,SMB_3,LMH_3 (Version-3)	0.003	0.869
Market,SMB_4,LMH_4 (Version-4)	0.005	0.841
Market,SMB_5,LMH_5 (Version-5)	0.002	0.877
Market,SMB_6,LMH_6 (Version-6)	0.002	0.856

Double sorted Portfolios formed on different Measures of Company Size and Value: Comparative Results of CAPM and Fama-French Model.

Model	Mean/Alpha	R^2
Market (CAPM)	0.014	0.751
Market,SMB_1,LMH_1(Standard Fama-French model – (Version1)	0.002	0.878
Market,SMB_2,LMH_2 (Version-2)	0.002	0.862
Market,SMB_3,LMH_3 (Version-3)	0.003	0.865
Market,SMB_4,LMH_4 (Version-4)	0.005	0.837
Market,SMB_5,LMH_5 (Version-5)	0.001	0.874
Market,SMB_6,LMH_6 (Version-6)	0.002	0.854

Portfolios formed on Long Term Past Returns without skipping one year: Comparative Results for CAPM and Fama-French Model.

Model	Mean/Alpha	R^2
Market (CAPM)	0.015	0.820
Market,SMB_1,LMH_1(Standard Fama-French model – (Version1)	0.002	0.906
Market,SMB_2,LMH_2 (Version-2)	0.001	0.895
Market,SMB_3,LMH_3 (Version-3)	0.003	0.888
Market,SMB_4,LMH_4 (Version-4)	0.005	0.862
Market,SMB_5,LMH_5 (Version-5)	0.001	0.893
Market,SMB_6,LMH_6 (Version-6)	0.002	0.874

Portfolios formed on Long Term Past Returns skipping one year between Portfolio Formation and Holding Period: Comparative Results for CAPM and Fama-French Model.

Model	Mean/Alpha	R^2
Market (CAPM)	0.014	0.825
Market,SMB_1,LMH_1(Standard Fama-French model – (Version1)	0.001	0.917
Market,SMB_2,LMH_2 (Version-2)	0.001	0.909
Market,SMB_3,LMH_3 (Version-3)	0.002	0.897
Market,SMB_4,LMH_4 (Version-4)	0.004	0.871
Market,SMB_5,LMH_5 (Version-5)	0.002	0.902
Market,SMB_6,LMH_6 (Version-6)	0.002	0.884

Portfolios formed on Short term Past Returns: Comparative Results for CAPM and Fama-French Model.

Model	Mean/Alpha	R^2
Market (CAPM)	0.014	0.767
Market,SMB_1,LMH_1(Standard Fama-French model – (Version1)	0.003	0.861
Market,SMB_2,LMH_2 (Version-2)	0.003	0.840
Market,SMB_3,LMH_3 (Version-3)	0.004	0.846
Market,SMB_4,LMH_4 (Version-4)	0.005	0.815
Market,SMB_5,LMH_5 (Version-5)	0.003	0.857
Market,SMB_6,LMH_6 (Version-6)	0.003	0.831

Panel B: Market Proxy NSE-50

Single sorted Portfolios formed on Company Size: Comparative Results for CAPM and Alternative Versions of Fama-French Model.

Model	Mean/Alpha	R^2
Market (CAPM)	0.017	0.689
Market,SMB_1,LMH_1(Standard Fama-French model – (Version1)	0.004	0.840
Market,SMB_2,LMH_2 (Version-2)	0.004	0.822
Market,SMB_3,LMH_3 (Version-3)	0.004	0.821
Market,SMB_4,LMH_4 (Version-4)	0.005	0.779
Market,SMB_5,LMH_5 (Version-5)	0.004	0.829
Market,SMB_6,LMH_6 (Version-6)	0.004	0.808

Single sorted Portfolios formed on Company Value: Comparative Results for CAPM and Alternative Versions of Fama-French Model.

Model	Mean/Alpha	R^2
Market (CAPM)	0.016	0.705
Market,SMB_1,LMH_1(Standard Fama-French model – (Version1)	0.001	0.840
Market,SMB_2,LMH_2 (Version-2)	0.001	0.827
Market,SMB_3,LMH_3 (Version-3)	0.002	0.823
Market,SMB_4,LMH_4 (Version-4)	0.004	0.786
Market,SMB_5,LMH_5 (Version-5)	0.001	0.831
Market,SMB_6,LMH_6 (Version-6)	0.002	0.812

Double sorted Portfolios formed on different Measures of Company Size and Value: Comparative Results of CAPM and Fama-French Model.

Model	Mean/Alpha	R^2
Market (CAPM)	0.016	0.688
Market,SMB_1,LMH_1(Standard Fama-French model – (Version1)	0.002	0.838
Market,SMB_2,LMH_2 (Version-2)	0.002	0.823
Market,SMB_3,LMH_3 (Version-3)	0.002	0.821
Market,SMB_4,LMH_4 (Version-4)	0.004	0.785
Market,SMB_5,LMH_5 (Version-5)	0.001	0.829
Market,SMB_6,LMH_6 (Version-6)	0.001	0.811

Portfolios formed on Long Term Past Returns without skipping one year: Comparative Results for CAPM and Fama-French Model.

Model	Mean/Alpha	R^2
Market (CAPM)	0.017	0.736
Market,SMB_1,LMH_1(Standard Fama-French model – (Version1)	0.002	0.849
Market,SMB_2,LMH_2 (Version-2)	0.002	0.832
Market,SMB_3,LMH_3 (Version-3)	0.002	0.829
Market,SMB_4,LMH_4 (Version-4)	0.005	0.789
Market,SMB_5,LMH_5 (Version-5)	0.001	0.836
Market,SMB_6,LMH_6 (Version-6)	0.002	0.810

Portfolios formed on Long Term Past Returns skipping one year between Portfolio Formation and Holding Period: Comparative Results for CAPM and Fama-French Model.

Model	Mean/Alpha	R^2
Market (CAPM)	0.017	0.737
Market,SMB_1,LMH_1(Standard Fama-French model – (Version1)	0.001	0.862
Market,SMB_2,LMH_2 (Version-2)	0.001	0.847
Market,SMB_3,LMH_3 (Version-3)	0.003	0.839
Market,SMB_4,LMH_4 (Version-4)	0.006	0.796
Market,SMB_5,LMH_5 (Version-5)	0.002	0.847
Market,SMB_6,LMH_6 (Version-6)	**0.002**	**0.819**

Portfolios formed on Short term Past Returns: Comparative Results for CAPM and Fama-French Model.

Model	Mean/Alpha	R^2
Market (CAPM)	0.016	0.705
Market,SMB_1,LMH_1(Standard Fama-French model – (Version1)	0.003	0.822
Market,SMB_2,LMH_2 (Version-2)	0.003	0.802
Market,SMB_3,LMH_3 (Version-3)	0.003	0.805
Market,SMB_4,LMH_4 (Version-4)	0.005	0.764
Market,SMB_5,LMH_5 (Version-5)	0.003	0.815
Market,SMB_6,LMH_6 (Version-6)	0.002	0.791

Table 5. The Carhart four factor model comprises of three factor Fama-French risk factors i.e. market, size and value as well as an additional momentum factor

Panel A: Single Sorted Portfolios

MC

	a	b	s	l	w	t(a)	t(b)	t(s)	t(l)	t(w)	R^2
P_1	0.006	0.987	1.637	0.292	-0.004	1.861	30.041	22.337	4.505	-0.089	0.987
P_5	0.003	0.994	-0.111	0.207	-0.053	1.280	41.157	-2.055	4.342	-1.538	0.920

TA											
	a	b	s	l	w	t(a)	t(b)	t(s)	t(l)	t(w)	R^2
P_1	0.012	1.004	1.488	-0.177	0.083	3.449	25.183	16.731	-2.245	1.453	0.870
P_5	0.004	1.023	-0.071	0.657	-0.033	1.519	36.813	-1.150	11.980	-0.836	0.918

Asian Journal of Finance & Accounting
ISSN 1946-052X
2014, Vol. 6, No. 1

EV

	a	b	s	l	w	t(a)	t(b)	t(s)	t(l)	t(w)	R^2
P_1	0.011	0.980	1.376	0.098	0.056	3.927	30.553	19.228	1.553	1.227	0.911
P_5	0.002	1.013	-0.025	0.327	-0.056	0.705	37.278	-0.418	6.093	-1.452	0.909

PB

	a	b	s	l	w	t(a)	t(b)	t(s)	t(l)	t(w)	R^2
P_1	0.001	0.993	1.016	0.789	-0.009	0.284	29.178	13.388	11.749	-0.176	0.913
P_5	0.001	0.992	0.420	-0.323	0.003	0.222	30.658	5.815	-5.053	0.067	0.864

PE

	a	b	s	l	w	t(a)	t(b)	t(s)	t(l)	t(w)	R^2
P_1	0.000	0.949	0.890	0.578	0.016	0.103	29.966	12.608	9.245	0.345	0.908
P_5	0.001	1.149	0.454	-0.172	-0.077	0.419	30.364	5.381	-2.306	-1.429	0.862

Panel B: Double Sorted Portfolios

MC_PB

	a	b	s	l	w	t(a)	t(b)	t(s)	t(l)	t(w)	R^2
S/L	0.002	1.008	1.211	0.694	-0.030	0.685	30.459	16.400	10.621	-0.626	0.921
S/M	-0.002	0.968	1.131	0.195	-0.021	-0.587	29.374	15.384	2.996	-0.447	0.897
S/H	0.003	1.084	1.103	-0.343	-0.084	1.002	30.858	14.082	-4.952	-1.673	0.885
B/L	0.002	1.030	0.101	0.708	-0.057	0.669	30.886	1.356	10.755	-1.199	0.892
B/M	0.001	1.076	0.136	0.092	-0.075	0.200	33.146	1.875	1.434	-1.613	0.881
B/H	0.001	0.954	0.208	-0.254	-0.003	0.322	31.489	3.083	-4.251	-0.063	0.866

MC_PE

	a	b	s	l	w	t(a)	t(b)	t(s)	t(l)	t(w)	R^2
S/L	0.000	0.943	1.220	0.451	0.002	0.172	29.743	17.251	7.195	0.040	0.913
S/M	0.002	0.923	1.080	0.094	-0.047	0.590	23.917	12.540	1.233	-0.857	0.847
S/H	0.006	1.138	1.066	-0.157	-0.104	1.706	31.666	13.295	-2.212	-2.028	0.890
B/L	0.003	1.038	0.135	0.489	-0.069	0.980	32.323	1.891	7.714	-1.498	0.892
B/M	0.002	0.975	0.160	0.092	-0.058	0.694	31.737	2.330	1.519	-1.331	0.873
B/H	0.000	1.052	0.121	-0.119	-0.030	-0.054	28.338	1.462	-1.621	-0.559	0.839

TA_PB

	a	b	s	l	w	t(a)	t(b)	t(s)	t(l)	t(w)	R^2
S/L	0.002	0.968	1.403	0.416	0.007	0.722	28.552	18.557	6.217	0.137	0.911
S/M	0.000	0.968	1.081	-0.160	-0.039	0.083	25.031	12.531	-2.102	-0.703	0.846
S/H	0.002	1.007	0.601	-0.392	-0.023	0.662	26.418	7.066	-5.216	-0.421	0.830
B/L	0.000	1.017	0.579	0.781	-0.051	0.052	29.112	7.439	11.328	-1.032	0.898
B/M	0.001	1.078	0.254	0.394	-0.107	0.432	31.778	3.357	5.890	-2.202	0.886

B/H	0.000	1.073	0.180	-0.054	-0.045	0.161	34.511	2.601	-0.886	-1.022	0.887

TA_PE

	a	b	s	l	w	t(a)	t(b)	t(s)	t(l)	t(w)	R^2
S/L	0.006	0.925	1.300	0.233	-0.005	1.666	25.160	15.860	3.212	-0.097	0.879
S/M	0.002	0.946	0.945	-0.116	-0.041	0.670	25.641	11.485	-1.591	-0.770	0.847
S/H	0.002	1.042	0.718	-0.307	-0.028	0.438	26.668	8.237	-3.981	-0.494	0.838
B/L	-0.002	0.981	0.505	0.609	-0.008	-0.608	29.415	6.785	9.254	-0.167	0.891
B/M	0.004	1.049	0.212	0.341	-0.104	1.291	31.528	2.861	5.193	-2.186	0.881
B/H	0.001	1.132	0.207	-0.002	-0.109	0.245	29.909	2.449	-0.032	-2.017	0.856

EV_PB

	a	b	s	l	w	t(a)	t(b)	t(s)	t(l)	t(w)	R^2
S/L	0.002	0.967	1.270	0.544	-0.031	0.613	27.086	15.944	7.722	-0.608	0.901
S/M	0.001	0.974	1.117	0.002	-0.058	0.321	25.811	13.271	0.027	-1.071	0.861
S/H	0.002	1.023	0.916	-0.360	-0.024	0.733	28.630	11.490	-5.103	-0.466	0.864
B/L	-0.001	1.076	0.414	0.761	-0.082	-0.415	29.988	5.170	10.744	-1.606	0.895
B/M	0.000	1.131	0.166	0.166	-0.129	-0.085	32.441	2.133	2.405	-2.588	0.879
B/H	0.001	0.981	0.222	-0.257	-0.014	0.250	31.721	3.221	-4.206	-0.323	0.868

EV_PE

	a	b	s	l	w	t(a)	t(b)	t(s)	t(l)	t(w)	R^2
S/L	0.002	0.946	1.205	0.369	-0.019	0.744	26.870	15.356	5.303	-0.369	0.891
S/M	0.004	0.930	1.052	-0.033	-0.087	1.015	23.952	12.141	-0.429	-1.566	0.838
S/H	0.004	1.061	0.936	-0.227	-0.022	1.181	29.283	11.582	-3.180	-0.416	0.871
B/L	-0.001	1.055	0.393	0.470	-0.089	-0.498	35.091	5.862	7.914	-2.075	0.911
B/M	0.003	1.027	0.185	0.103	-0.100	0.879	30.830	2.491	1.559	-2.111	0.867
B/H	-0.001	1.086	0.130	-0.092	-0.057	-0.145	28.092	1.512	-1.204	-1.040	0.837

Panel C: Prior Return Portfolios:
Portfolios formed on Long term Past returns (36/12 Strategy)

	a	b	s	l	w	t(a)	t(b)	t(s)	t(l)	t(w)	R^2
P_1	0.004	0.913	0.540	0.415	-0.325	0.685	14.229	4.391	3.714	-4.098	0.849
P_5	0.002	1.292	0.865	-0.178	0.244	0.619	32.141	9.390	-2.044	4.278	0.906

Asian Journal of Finance & Accounting
ISSN 1946-052X
2014, Vol. 6, No. 1

Portfolios formed on long-term past returns skipping one year between portfolio formation and portfolio holding periods (36/12/12 Strategy)

	a	b	s	l	w	t(a)	t(b)	t(s)	t(l)	t(w)	R^2
P_1	0.002	0.997	0.692	0.396	-0.024	0.782	29.703	9.373	5.441	-0.522	0.919
P_5	0.002	1.369	0.765	-0.136	-0.071	0.537	30.371	7.712	-1.387	-1.134	0.900

Portfolios formed on Short-term past returns (12/12 Strategy).

	a	b	s	l	w	t(a)	t(b)	t(s)	t(l)	t(w)	R^2
P_1	0.002	1.135	0.807	0.054	-0.537	0.537	33.124	10.555	0.795	-10.970	0.898
P_5	0.002	1.135	0.807	0.054	0.463	0.537	33.124	10.555	0.795	9.459	0.910