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Original Paper

Does Momentum Matter? Modeling Stock Returns through Fama-French and Carhart Model for Pakistan Stock Exchange

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Abstract Asset pricing models are widely applied for explaining variations in stock returns. The applicability of these models is tested on different markets for assessing different stock price anomalies. In this paper, Fama and French three factor model and Carhart Model were applied on the KSE-100 Index, over the period of 2004 to 2019. Following the FF 3 factor methodology, we create a relatively large number of portfolios based on size, value and momentum, whereas the existence of momentum factor was checked through Carhart model. The results indicates that, out of 25 portfolios, 15 were able to explain the variations in stock returns, which shows 60% efficiency of the Carhart model compared to the FF 3 factor model with 56% efficiency whereby only 14 portfolios were able to explain the variations in the stock returns. The momentum factor is thus evident from the results, whereas the value factor is found to be redundant. Our findings suggest that while projecting stock prices, financial experts and analysts should not ignore the momentum factor as by doing so there may be chances of underpricing or over-pricing of stock returns.

Keywords Market Risk, SMB: Small minus Big (Size), HML: High minus Low (Value), WML: Winners minus Losers (Momentum), FF 3 Factor: Fama & French Three Factor Model

1 Introduction

There are numerous approaches for pricing assets and determining stock returns. The Capital Asset Pricing Model (CAPM) developed by Lintner (1965) is a famous example. However, this approach only handles unavoidable risks, using the parameter to represent systematic risk. This is calculated using regressions, with stock returns serving as the independent variable (X) and market returns

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serving as the dependent variable (Y). Because of its single-factor nature, the CAPM frequently produces unsatisfactory results when applied. Notably, it fails to account for major inconsistencies like size, value, momentum, profitability, and investment. Given, the multi-dimensionality of the risk, there exists several multi-factor models such as (Carhart 1997; Fama and French 1993) three factor model and the Fama and French (2015), five factor model. The 3 factor model adds two new factors to the CAPM model, which are size and value. There are well rooted theoretical foundations for these extended models in the economic literature. Set as a standard, these models are basically applied to compare portfolio returns with the corresponding stocks attributes such as size, probability, book to market and aggregate returns. The portfolios can perform remarkably well than the market when their returns are over and above the projected benchmark.

As a use case, Nugraha and Susanti (2019) centered their research in Indonesia on the LQ 45 Index and only considered large and liquid firms. They used the Fama, French, and Carhart 3 Factor models for a sample of 20 entities and compare the predictive capacities of the two models. The results showed a small performance improvement in terms of predicting stock returns: 77% for the FF 3 Factor and 79% for the Carhart Model. However, there is a difference between the two models in terms of understanding stock.

Similalry, Momani (2021) checks for the robustness of both the FF3 Factor and the Carhart model, on the stock exchange of Amman in Jordan. The study takes data of all the companies from 2002 to 2018. Utilizing the OLS method, the study reports similar findings whereby the value factor becomes redundant as soon as there is an introduction of the new factor, i.e. the momentum factor, which better describes the results as depicted by Gumanti et al (2017) among others.

Hossan et al (2019) also checks for the validity of the Carhart Model in Bangladesh by taking sample of 109 companies of Dhaka Stock Exchange, for the period from 2005 to 2014. They constructed ten portfolios, six of SMB and HML, and four of SMB and Momentum, all the excess returns are then regressed individually with all of these four factors. The findings were also consistent with Gumanti et al (2017), and indicated that the market risk, size and momentum were found to be significant whereas the value factor becomes redundant, and the Carhart model can predict the returns correctly if all the other factors are not playing an influential role. Similalry, Mahmud (2019) also tests the Carhart model on Kompas 100 i.e. Indonesia for a small period from 2014-2016, the regressions performed on the four factors were found to be consistent with the Gregoriou et al (2016) which confirms that the portfolio gives better returns and better results in the long run.

Owing to the above discussion and recent evidence, the current study emphasizes on testing these models in a developing market such as Pakistan. As noted by Shamim et al (2014), developing markets have the potential to validate the CAPM, FF3 and Carhart Model in extending investment choices for investors while improving profitability and risk reduction. However, the application of CAPM and other models have difficulties, especially in the context of the Pakistani market. This difficulty largely stems from market efficiency, a

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constraint that is not unique to Pakistan but is amplified in this context. Significant government participation, insider trading concerns, and capital outflows are some other issues which increase this challenge.

When focused on the Karachi Stock Exchange, depicting the behavior of stock returns becomes significantly more complicated due to its intrinsic asymmetry, as stated by Sajid and Qureshi (2017). During the years 1989 to 1993, the stock market was undisturbed by seasonal fluctuations. According to Ahmad and Zaman (2000), a small number of researches indicate that CAPM is highly effective at the Karachi Stock Exchange. Although investors earn favorable returns in this situation, these returns have an impact on stock prices. The display of returns, according to Sajid and Qureshi (2017), resists a symmetrical depiction due to the intricacies inherent in their nature.

Recognizing this research vacuum, the study seeks to explore the dependability and validity of CAPM on the Pakistan Stock Exchange. The research will use data from the Karachi Stock Exchange, with a focus on the entire shares index. Notably, both in theory and in practice, the various characteristics of emerging and developed markets underline their disparities.

The continual evolution of stock markets emphasizes the need for increased effectiveness and efficiency in order to maximize productivity for investors in these early market environments therefore the objective of this study is to check whether the momentum plays an important role in forecasting the stock return or not. To solve the above-mentioned issue, Fama French 3 model and Carhart model has been included in the study for the analysis.

2 Literature Review

Cakici and Tan (2014) investigates the effect of size, value and momentum over a period from 1990 to 2012, keeping UK and other 22 stock exchanges from the developed markets. The portfolios thus constructed were for the 23 markets in our sample, i.e. β, SMB, HML and WML, to act as a proxy market risk, size, value and momentum. The study does not find any significance of size on the 23 markets, meaning that variations in the returns of the stock are inadvertently explained by the size portfolio during the period of study. The study however does find significance and positive connection between the returns of the stock and HML in the 23 markets and were found non-negligible in 9 EU markets, Canada, Japan and Asia Pacific stock exchanges. The study also finds that the momentum is also significant in UK, 8 EU Markets, 2 markets from Japan and Asia Pacific. The momentum of Canadian market is also found to be in an upward trend and having significant relationship.

Cakici and Tan (2014), following the application of the Carhart model, Nwani (2015) also tested for the international evidence of the 5-factor model, on the data over the period of 1992 to 2014 in 23 stock markets of the developed countries. The findings show similarities between US, Europe North America, & Global Exchanges, the profitability & the investment variables are very much fragile in the Asia & Japan markets. It also identifies that since the markets are still desegregated the regional or local models can perform outstandingly as compared to Global models. However as identified by the pioneers of the model, about the size variable being insignificant here in their data sample, the

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size factor still has its significance across all the regions. Nwani (2015), in his research, deployed the Carhart model for the exploration of the importance of SMB (size), HML(value) & WML (momentum), in describing the fluctuations in returns from the shares listed on UK Market. They draw a sample of around 100 stocks over a period from 1996 to 2013, keeping in mind the simple random sampling. OLS technique was used to test the model, but they found that the size of the firm was completely irrelevant for the 50% of the portfolios that were formed, the value effect was completely significant with all the 6 portfolios, the momentum effect was there but only visible in the high value stocks, the results summarily explains that irrespective of the momentum & size, the value effect does exists in all the 6 portfolios, while momentum effect was present only in the high value stocks, the size effect was here completely negligible as it failed to explain the variations in the returns of the stocks listed of FTSE-Index.

Balakrishnan and Barik (2021), in their paper examines the existence of long-term & short-term momentum in the Indian Stock market by taking data from Bombay Stock Exchange (BSE-500) due to large market capitalization. From their sample they took 482 companies from July 2002 to November 2018 & their data frequency was monthly. They used 6 mimicking portfolios, over different trading strategies, they also used OLS for their results. They also used 3 macroeconomic variables, i.e. dividend yield, term spread, and 91-day T-bill yield. They confirm the existence of long-term and short-term momentum, however all the 3 models tried, only Carhart model was able to capture the momentum, but still there are some winner portfolios' returns which are not being captured by the Carhart Model.

Lalwani and Chakraborty (2020) compares the performance of these asset pricing models taking 5 developed & 5 emerging markets. Developed markets contains USA, UK, Canada, Japan & Australia, whereas emerging markets contains Malaysia, China, India, Taiwan & South Korea. They also introduced a new factor i.e. quality. These models were tested through GRS, R-Square & average absolute intercepts. FF 5 factor model explains the variations better in 3 of the developed markets i.e. Canada, Australia & USA. & only one of the emerging markets i.e. China. It is mainly because the pricing mechanism in these countries is integrated. For the rest of the other markets the FF 3 factor & the Carhart model is suitable.

Azam et al (2021), used monthly data of 521 companies of PSX from Jan-2002 to Dec-2020, they proposed a seven-factor model adding liquidity & momentum as the new factors, however they tested the CAPM, FF 3, Carhart, FF 5 factor models along with the new model. They used 6 portfolios for their analysis. As pertinent with the Fama and French (2015) the value factor also loses its significance in the market. The newly introduced factors are found to be significant, also the newly introduced model performs way better than the rest of the models.

Aygoren and Balkan (2020) in their paper added a new factor to the FF 3 factor model, i.e. efficiency, they took the data of 147 companies of Nasdaq Exchange only of the technology related firms, over a period of ten years starting from July 2007 & ending at June 2017. Time series regression was used, & the model was tested through GRS, Adjusted R-Square & F-statistic. They also

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used 6 portfolios. They found that all these models are valid in their sample of study, however, the new proposed model performs better than the already introduced models. Also, the newly introduced factor, increases the prediction ability of the stocks' returns. This is because efficiency is considered to be a main factor in asset pricing by the investors.

The Prisma steps shown in Tabel: (1) were taken from Moher et al (2009)

Table 1: Prisma Protocol

PRISMA Steps		
Step1	Keywords	Asset Pricing, Carhart Model
Step2: Identification	Records Identified DB	200
	Records Identified other sources	86
Step3: Screening	Records Screened Included	286
	Records Screened Excluded	196
Step4: Eligibility	Accessed for eligibility	90
	Records excluded	62
Step5: Included	Included	28

Note: Authors own calculations.

and the databases were searched for the papers along with the keywords, the databases provides 200 papers and 86 papers were from the other sources, out these 286 papers, 196 records were excluded and 90 were eligible for the literature review, out of which owing to relevancy only 18 were found to be worthy of inclusion in our review, further the prime objective was to look for model so only 28 papers were included in this paper.

After incorporating only, the top cited 28 papers from the 90 papers from Harzing Publish & Perish, searched on Google Scholar & cross-ref, the models thus applied on the different markets are described in Table (2).

There are 8 papers in which the models were applied on the developed markets including Australia, USA, UK, China & Sweden. Whereas 17 papers were written on emerging markets, i.e. Indonesia, Iran, Pakistan, South Africa and Bangladesh, also there is also a paper which studies the models on emerging markets globally, whereas only 2 papers are evident which accounts for the global markets i.e. both emerging and developed. The samples of data used in this collection of papers are of the monthly frequency for the 28 papers.

Table 2: Application of Model on Markets

Markets	**No. of Papers**
Developed	8
Emerging	17
Global	1
Global-Emerging	1

Note: Authors own calculations.

There are studies which incorporates the momentum factor i.e. WML (Winners minus Losers), both the studies were done on the developed market of U.K and one study on US where the authors used Momentum along with another

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variable i.e. the sentiments index.

A study conducted on Australian market was also very much new in their methodology as they make all the factors orthogonalized for their market and make all the factors as it is for US market just to minus the impact of US stocks on the Australian market.

In our analysis, Australia, China, Sweden, USA, & UK are categorized into

Table 3: Abstraction from the Papers

Dependent Variable	Independent Variables	No. of Papers
	Beta	28
	HML	28
	SMB	28
	WML	28
	Orthogonalized Beta	1
Returns on Security	Orthogonalized SMB	1
	Orthogonalized HML	1
	Orthogonalized WML	1
	Orthogonalized RMW	1
	Orthogonalized CMA	1
	Sentiment Index	1

Note: Authors own calculations.

developed markets. On the other hand, Indonesia, Iran, Pakistan, South Africa and Bangladesh are categorized into emerging markets, as described below.

The following research hypotheses study were adapted from the Tee (2015)

Table 4: Region & Markets Wise Data

Region Wise	Markets	No. of Papers
Global	Global	1
Global-Developed	Emerging	1
Australia	Developed	1
China	Developed	1
Sweden	Developed	1
UK	Developed	2
USA	Developed	4
Bangladesh	Emerging	1
Indonesia	Emerging	5
Iran	Emerging	7
Pakistan	Emerging	2
South Africa	Emerging	2

Note: Authors own calculations.

Hypothesis 1:
HO: FF 3 factor model does explain the excess returns of KSE-100 Index
HA: FF 3 factor model does not explain the excess returns of KSE-100 Index
Hypothesis 2:
HO: Carhart model does explain the excess returns of KSE-100 Index
HA: Carhart Model does not explain the excess returns of KSE- 100 Index

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3 Research Methodology

Fama and French (1993); Carhart (1997) methodology is applied in this research, data collection, development of the portfolios & the construction of 25 mimicking portfolios as described below.

Quantitative analysis was used in this research, approach was deductive, & longitudinal time horizon has been selected. Fama and French (1993); Carhart (1997) is applied on KSE-100 Index from 2004-2019. According to Fama and French (1993) methodology, the KSE-100 Index has been divided into six portfolios, based on size, book-to-market & momentum factors, and 25 portfolios are based on these factors, which act as a proxy to the KSE- 100 INDEX excess returns.

3.1 Fama & French Model Extension

Fama and French proposed two new factors i.e. SMB (Small minus Big), HML (High minus Low). After the proposition of the Fama and French 3 factor model, in 1993, in which they extended the CAPM model proposed by William Sharpe, the FF 3 factor model was applied on many developed, developing and emerging markets.

$$(R_i - R_f) = a_i + b_i[\beta] + s_i E(SMB) + h_i E(HML) + e_i \tag{1}$$

β: Market Risk, SMB: Small Minus Big (Size) , HML: High Minus Low (Value). The Carhart model is described in equation:

$$E(R_i - R_f) = a_i + b_i E[(R_m - R_f)] + s_i E[(SMB)] + h_i E[(HML)] + w_i E[WML] \tag{2}$$

Where, $E(R_i - R_f)$,E(SMB), E(HML) & E(WML) describes the expected outcomes and a_i, b_i, s_i, h_i and w_i describes the slopes in the time series regression, The model suggests that the expected return for a portfolio in excess of the risk free rate is explained by the three factors: (i) the excess return on expansive business sector portfolio, (ii) difference between the return on a portfolio of small stocks and the return on a portfolio of large stocks (SMB) and (iii) the difference between the return on a portfolio of high-book-to-market stocks and the return on a portfolio of low-book-to-market stocks (HML) & (iv) WML is the difference between the return of winner and loser stock portfolios.

This study examines the application of the three-factor model developed by Fama and French & Carhart Model on KSE-100 index during the time period from 2004 to 2019. For brief understanding of the methodology, please see the paper written by (Ammann and Steiner 2008).

The data is collected from the balance sheets of the companies listed on the KSE-100 Index & their closing prices were taken from the KSE, over the period of 2004-2019. All KSE-100 index companies were taken, then a filtration process was done in which firms with negative returns, small value firms and firms which are thinly traded were discarded as done by (Fama and French 1993). Only those companies were taken in which shares prices data for our time span was available, the rest were discarded following the methodology of Fama and French (1993). The closing prices of KSE-100 Index were taken as a representative of the market. The risk-free rate was taken from T-Bills 3-month. At first,

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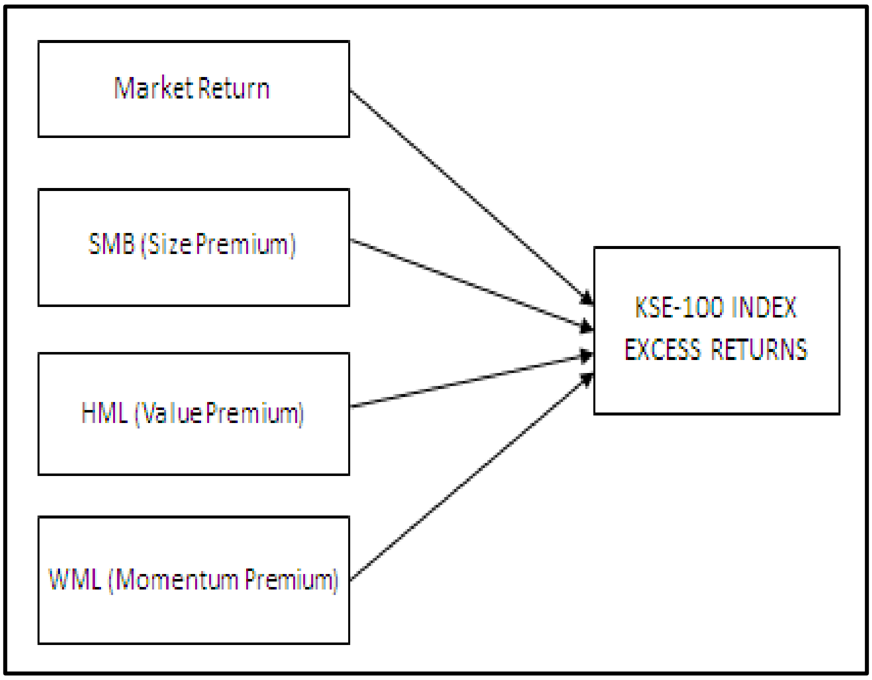

Fig. 1: Theoretical Framework
Source: According to Carhart (1997) methodology

the data was on daily basis, but for the ease of understanding we convert the data into monthly basis.

3.2 Explained Variables

The explained variable in our study is the excess portfolio return, represented by $E(R_i - R_f)$. The surplus return mirrors the expected returns lower or greater than the risk-free rate required by the financial specialists to legitimize risk taking. The 25 extended portfolios formed will act as a proxy for the dependent variable.

3.3 Explanatory Variables

Explanatory variables used in this study are the β i.e. market risk premium, size factor i.e. SMB, value factor i.e. HML, & momentum factor i.e. WML.

3.4 Data Analysis Techniques

STATA coding is utilized to analyze the data, and MS Excel was not used for portfolio making due to reformation of the portfolios, as per the methodology of (Fama and French 1993).

The model that will be applied is the Fama and French three factors. The model suggests that the anticipated outcomes of a portfolio in surplus of the risk-free rate are described by the reactivity of the returns to three factors:

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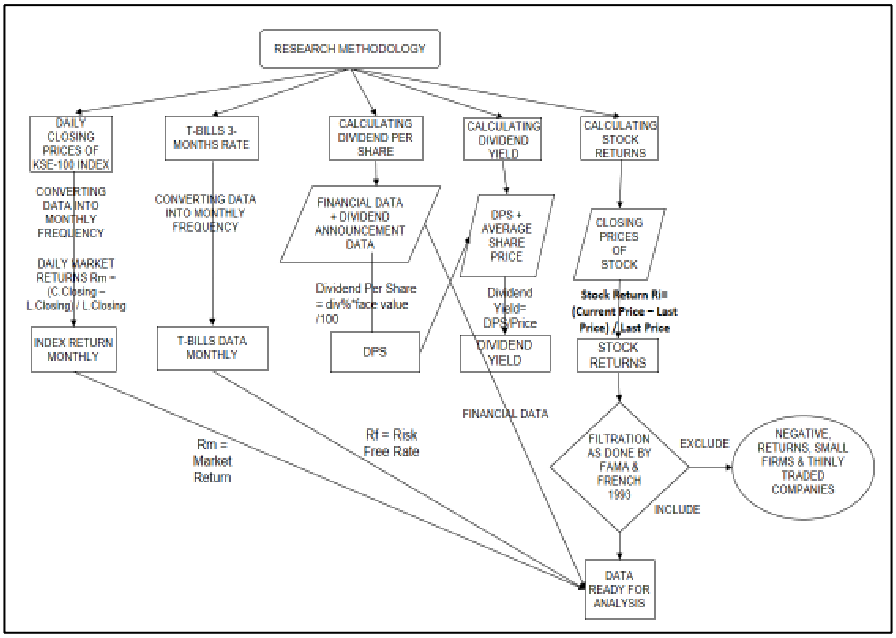

Fig. 2: Overview of Research Methodology
Source: According to Carhart (1997) methodology

$$E(R_i - R_f) = a_i + b_i[E(R_m - R_f)] + s_iE(SMB) + h_iE(HML) \quad (3)$$

- Excess security returns of a broad market portfolio
- SMB (Small minus Big) i.e. change among the returns of a portfolio of small stocks with the returns of a portfolio of large stocks
- HML (High minus Low) i.e. the difference with the returns of a portfolio of high-BE/ME stocks to the returns of a portfolio of low-BE/ME stocks.

The third model tested will be of the Carhart Model, with an addition of the momentum factor along with Fama and French three factor model.

$$E(R_i - R_f) = a_i + b_i[E(R_m - R_f)] + s_iE[(SMB)] + h_iE[(HML)] + w_iE[(WML)] \quad (4)$$

Where,
$E(R_m - R_f), E(SMB), E(HML)\&(WML)$ denotes the expected premiums and $b_i, s_i, h_i\&w_i$ denotes the slope for the regression analysis.

3.5 Establishment of Portfolios

The portfolios are constructed according to the methodology described in (Fama and French 1993) & can be seen in Figure 3 & Figure 4. Nugraha and Susanti (2019) gives definition of momentum i.e. the stocks having good market prices in the past are considered as winners and the stocks having average or low markets price in the past are considered as losers, the momentum factor can

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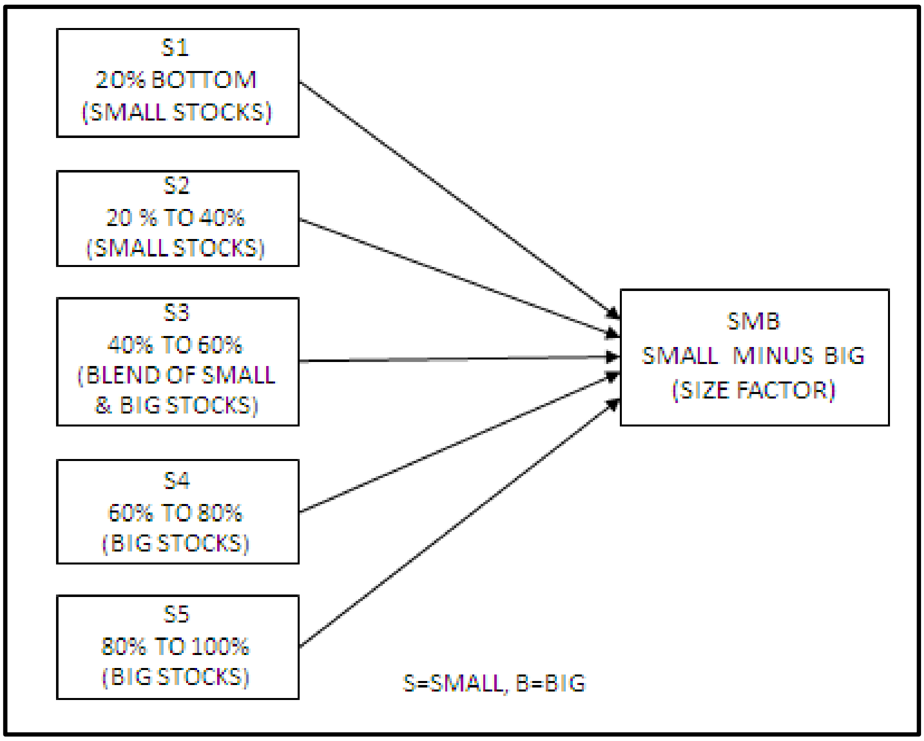

Fig. 3: SMB (Size) Factor
Source: According to Carhart (1997) methodology

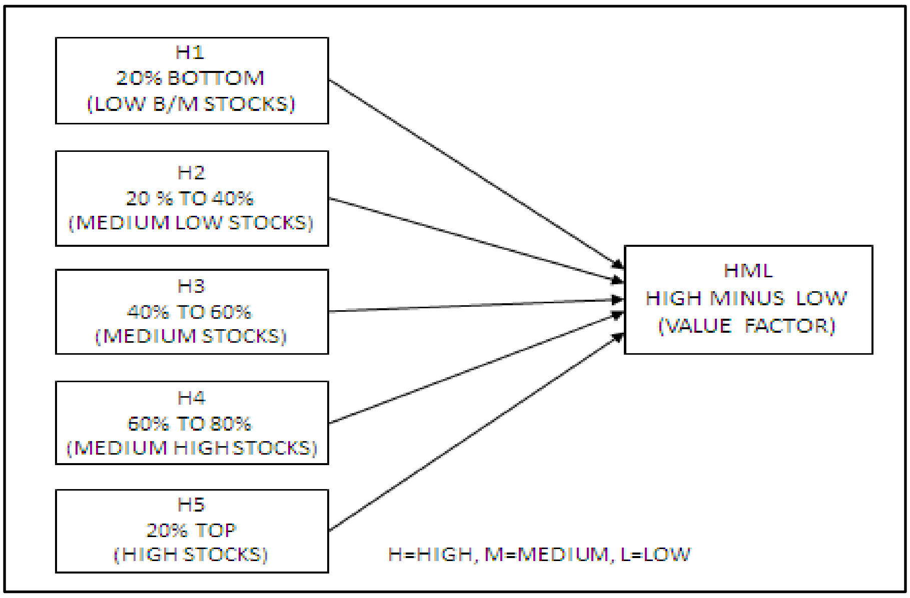

Fig. 4: HML (Value) Factor
Source: According to Carhart (1997) methodology

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be explained by subtracting the returns of the winner portfolio from the losers' portfolio and is denoted by WML.

For Winner minus Losers, from July 2004, the securities are sorted according to the size of the previous years, and the current performance of this year. Now, according to this criterion, a median will be the breakpoint for size at 50%, whereas 30% & 70% are the breakpoints for the performance. The assets above the 70% are the winners, the middle 40% are the neutrals and the below 30% are the losers & can be seen in Figure 5.

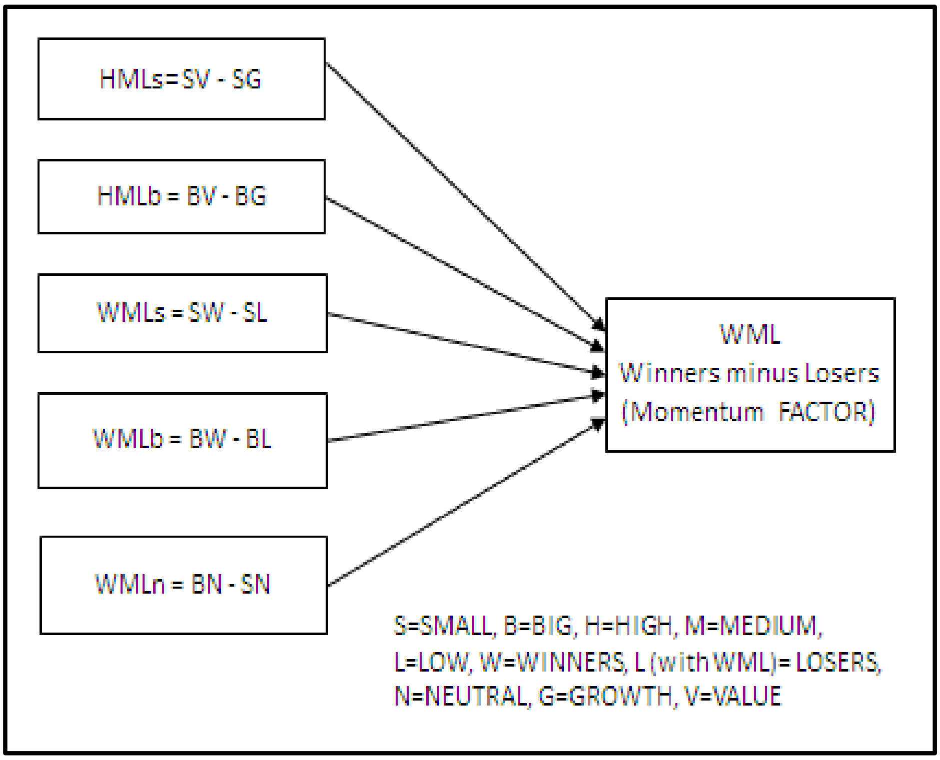

Fig. 5: Momentum Factor
Source: According to Carhart (1997) methodology

3.6 Making of the Portfolios

The Dividend announcement data which is a part of financial data is taken and dividend per share is calculated, then the dividend yield is calculated by dividing the dividend per share by its average share price. The data from stock exchange is in daily frequency which is converted into monthly frequency, historical returns are then being calculated, also the frequency of index data is changed from daily to monthly, T-bills data is also converted from daily to monthly, now the data is being merged, the T-bills and the index data is being merged along

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with the financial data.

3.7 Construction of the Factors of Carhart & Fama and French

The SMB, HML & WML factors are derived from the following equations as described by the (Fama and French 1993; Carhart 1997).

$$SMB = \frac{[\frac{S}{L} + \frac{S}{M} + \frac{S}{H}]}{3} - \frac{[\frac{B}{L} + \frac{B}{M} + \frac{B}{H}]}{3} \tag{5}$$

$$HML = \frac{[\frac{S}{H} + \frac{B}{H}]}{2} - \frac{[\frac{S}{L} + \frac{B}{L}]}{2} \tag{6}$$

$$WML = \frac{[\frac{S}{W} + \frac{B}{W}]}{2} - \frac{[\frac{S}{L} + \frac{B}{L}]}{2} \tag{7}$$

SMB proxies the component of risk associated with returns which are related to size, free from the impact of BE/ME, also the HML intermediaries the component of risk variable associated with returns related to book-to-market value free from the impact of the size, whereas WML is equal-weight average of the returns on the winner stock portfolios minus the returns on the loser stock portfolios.

4 Results and Discussion

Table 5: Application of Carhart Model on Data

Variable	Mean	Std. Dev.	Min	Max
rm rf	0.016	0.07	-0.227	0.358
SMB	0.013	0.049	-0.134	0.19
HML	-0.03	0.043	-0.155	0.133
UMD	0.005	0.054	-0.213	0.162

Note: Authors own calculations.

The descriptive are described in the Table (5), the mean of HML was having a negative correlation, which is comparable as the growth stocks in the case of FF 3 factor also makes the HML i.e. value factor redundant.

Table (6) provides the correlation matrix between the variables, all the co-

Table 6: Correlation Matrix

Variables	(1)	(2)	(3)	(4)
(1) rm_rf	1			
(2) SMB	-0.352	1		
(3) HML	-0.017	-0.041	1	
(4) UMD	-0.104	0.041	-0.297	1

Note: Authors own calculations.

efficients are having weak association among themselves, only the correlation

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between size & momentum is found to be significant and positive relation exists, market factor also is negatively correlated to all the factors which in case of Malaysia was positively correlated. Also, the SMB & HML were having positive relation in Malaysia but not in Pakistan, the momentum factor is having negative relation in case of Malaysia but in case of Pakistan it has a positive relation with the size factor, which indicates that the size & momentum both exists and cannot be neglected.

The 25 portfolios thus made are then being described in Table (7), the scenario of Malaysia was that the analysis was done on 6 portfolios, but in order to replicate the results at an advanced level we use the 25 portfolios, the results are somehow, very much similar, the small portfolio is having positive mean, also the medium low portfolio is also having a positive mean, whereas, in the medium portfolio the higher stocks are having a negative mean, and in the medium high portfolio the negative mean is evident from the medium stocks as well, and the highest portfolio is having a negative mean, which is evident from the previous tables that the HML factor will become redundant due to the momentum of the stocks.

Appendix (A1) shows regressions performed on 25 portfolios, S1H5, S2H3,

Table 7: Description of 25 Portfolios

Variable	**Mean**	**Std. Dev.**	**Min**	**Max**
S1H1	0.018	0.125	-0.383	0.572
S1H2	0.031	0.145	-0.331	0.626
S1H3	0.019	0.127	-0.471	0.561
S1H4	0.02	0.104	-0.191	0.725
S1H5	-0.011	0.092	-0.347	0.393
S2H1	0.033	0.136	-0.563	0.604
S2H2	0.021	0.093	-0.211	0.336
S2H3	0.013	0.077	-0.284	0.253
S2H4	0.008	0.074	-0.212	0.323
S2H5	-0.01	0.078	-0.242	0.358
S3H1	0.037	0.097	-0.207	0.352
S3H2	0.019	0.077	-0.311	0.373
S3H3	0.008	0.074	-0.189	0.292
S3H4	-0.001	0.075	-0.282	0.297
S3H5	-0.011	0.081	-0.315	0.2
S4H1	0.032	0.079	-0.147	0.273
S4H2	0.01	0.075	-0.172	0.339
S4H3	-0.004	0.074	-0.25	0.191
S4H4	-0.004	0.083	-0.323	0.243
S4H5	-0.018	0.095	-0.49	0.376
S5H1	0.018	0.066	-0.331	0.22
S5H2	0.006	0.07	-0.331	0.208
S5H3	-0.004	0.079	-0.303	0.213
S5H4	-0.009	0.091	-0.472	0.274
S5H5	-0.034	0.103	-0.464	0.221

Note: Authors own calculations.

S2H4, S2H5, S3H3, S3H4, S3H5, S4H3, S4H4, S5H1, S5H2, S5H3, S5H4 & S5H5 are having R^2 greater than 50%, which suggests that out of 25, 14 porftolios

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have been able to explain the returns, whereas there are some variations which can be further studied, in the case of Malaysia the 6 portfolios were rightly capturing the stock returns.

Appendix (A2) shows regressions performed on 25 portfolios, S1H4, S1H5, S2H3, S2H4, S2H5, S3H3, S3H4, S3H5, S4H2, S4H3, S4H4, S5H1, S5H2, S5H3 & S5H4 are having R^2 greater than 50%, which suggests that out of 25, 15 porftolios have been able to explain the returns, whereas there are some variations which can be further studied, in the case of Malaysia the 6 portfolios were rightly capturing the stock returns. The Carhart model has somehow indicated that the momentum exists & the no. of portfolios have increased after applying this model as compared to FF3 Factor Model.

5 Conclusions and Policy Implications

The Carhart Model applied on Malaysian stock market yield results which are capturing the stock returns but their study was on 6 portfolios, in our scenario we make 25 portfolios, based on size, value & momentum factor, and got results somewhat similar to Malaysian market, but since our Market is semi-efficient and also the data was from 2004 to 2019, keeping in mind the 2008, stock market crisis, the model has somehow able to explain the stock returns of the KSE-100 Index (now PSX-100). Out of 25 portfolios, 15 were able to explain the stock returns, which shows a 60% efficiency of the Carhart model, as compare with the efficiency of the FF 3 factor model which shows a 56% efficiency because only 14 portfolios were able to explain the stock returns.

Asset pricing models have far-reaching implications for policymaking and regulatory control. These models are used by policymakers and regulators to analyze the health and stability of financial markets. They can improve market integrity and protect investors by monitoring risk variables and market efficiency. Furthermore, asset pricing models aid in the formulation of monetary and fiscal policies by giving insights into the mechanisms by which these policies affect stock returns and market volatility.

Finally, Carhart asset pricing models are critical for explaining the performance of PSX-listed stocks. They provide investors with a systematic framework for understanding the risk-return trade-off, determining the fair value of equities, and making informed investment decisions. Furthermore, these models are critical in defining policy decisions as well as ensuring the stability and efficiency of the Pakistani stock market. In a volatile market with unique problems, asset pricing models provide useful insights that are critical for both investors and governments.

6 Limitations

A common problem can be the reason for the potential neglect of adding a unique methodology through changes to factor proxies. Despite the fact that many researches have been done on this subject in the context of emerging economies, these efforts could not result in a significant number of citations. This study successfully combined analysis of the Carhart Model in a number of developing and developed markets with the dynamics of both developed and

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emerging markets. However, there is still a gap that needs to be addressed by considering how restricting and increasing cash flows may affect monetary policy. This would make it easier to determine whether or not these rules have any impact on asset pricing models. The discount rate can act as a stand-in for monetary policy in this situation. By including this aspect its applicability, validity, and testability can be enhanced.

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Appendix

A1: Abstraction from the Papers

Portfolio	rm_rf	S.E	SMB	S.E	HML	S.E	Con	S.E	R^2
S1H1	0.830***	(0.125)	0.994***	(0.173)	0.255	(0.188)	-0.001	(0.01)	0.241
S1H2	0.745***	(0.141)	1.199***	(0.2)	0.832***	(0.217)	0.028**	(0.012)	0.245
S1H3	0.749***	(0.127)	0.908***	(0.178)	0.551***	(0.192)	0.011	(0.011)	0.222
S1H4	0.571***	(0.095)	0.998***	(0.135)	0.862***	(0.145)	0.024***	(0.008)	0.358
S1H5	0.883***	(0.068)	0.952***	(0.096)	0.759***	(0.104)	-0.015**	(0.006)	0.564
S2H1	1.030***	(0.13)	1.078***	(0.183)	0.124	(0.198)	0.006	(0.011)	0.283
S2H2	0.842***	(0.078)	1.031***	(0.107)	0.385***	(0.117)	0.005	(0.006)	0.472
S2H3	0.774***	(0.058)	0.890***	(0.082)	0.360***	(0.089)	-0.001	(0.005)	0.554
S2H4	0.725***	(0.049)	0.808***	(0.07)	0.714***	(0.075)	0.007	(0.004)	0.643
S2H5	0.777***	(0.051)	0.794***	(0.072)	0.829***	(0.078)	-0.008*	(0.004)	0.66
S3H1	0.915***	(0.085)	0.843***	(0.118)	0.148	(0.128)	0.015**	(0.007)	0.413
S3H2	0.687***	(0.07)	0.558***	(0.097)	0.297***	(0.105)	0.009	(0.006)	0.372
S3H3	0.842***	(0.055)	0.655***	(0.077)	0.345***	(0.083)	-0.004	(0.005)	0.579
S3H4	0.758***	(0.052)	0.587***	(0.073)	0.767***	(0.08)	0.002	(0.004)	0.615
S3H5	0.776***	(0.059)	0.660***	(0.083)	0.839***	(0.09)	-0.007	(0.005)	0.58
S4H1	0.761***	(0.07)	0.418***	(0.096)	0.376***	(0.105)	0.025***	(0.006)	0.411
S4H2	0.740***	(0.061)	0.390***	(0.086)	0.507***	(0.093)	0.008	(0.005)	0.477
S4H3	0.800***	(0.054)	0.264***	(0.076)	0.568***	(0.082)	-0.003	(0.005)	0.582
S4H4	0.881***	(0.057)	0.295***	(0.08)	0.838***	(0.087)	0.003	(0.005)	0.633
S4H5	0.728***	(0.085)	0.447***	(0.12)	0.857***	(0.129)	-0.01	(0.007)	0.377
S5H1	0.777***	(0.044)	0.018	(0.062)	0.174***	(0.067)	0.011***	(0.004)	0.658
S5H2	0.798***	(0.043)	-0.091	(0.061)	0.287***	(0.066)	0.003	(0.004)	0.692
S5H3	0.843***	(0.056)	-0.052	(0.079)	0.410***	(0.086)	-0.004	(0.005)	0.601
S5H4	0.948***	(0.063)	-0.085	(0.089)	0.646***	(0.097)	-0.004	(0.005)	0.618
S5H5	1.068***	(0.119)	0.178	(0.167)	0.544**	(0.208)	-0.026**	(0.011)	0.51

Note: Authors own calculations.

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A2: Abstraction from the Papers

Port	**rm_rf**	**S.E**	**SMB**	**S.E**	**HML**	**S.E**	**UMD**	**S.E**	**Cons**	**S.E**	**N**	R^2
S1H1	0.819***	(0.133)	1.007***	(0.179)	0.278	(0.205)	-0.026	(0.161)	-0.001	(0.011)	185	0.228
S1H2	0.898***	(0.142)	1.143***	(0.191)	0.614***	(0.22)	-0.281	(0.172)	0.019*	(0.011)	183	0.284
S1H3	0.696***	(0.129)	1.000***	(0.174)	0.680***	(0.198)	0.188	(0.156)	0.015	(0.01)	180	0.239
S1H4	0.788***	(0.077)	0.968***	(0.103)	0.642***	(0.118)	-0.234**	(0.093)	0.011*	(0.006)	180	0.523
S1H5	0.827***	(0.069)	1.020***	(0.093)	0.791***	(0.106)	-0.128	(0.083)	-0.012**	(0.006)	185	0.591
S2H1	0.997***	(0.118)	1.300***	(0.16)	0.404**	(0.183)	-0.089	(0.143)	0.012	(0.009)	185	0.374
S2H2	0.884***	(0.081)	1.050***	(0.11)	0.370***	(0.126)	0.044	(0.098)	0.005	(0.006)	185	0.473
S2H3	0.746***	(0.057)	0.971***	(0.077)	0.424***	(0.088)	-0.058	(0.069)	0.002	(0.005)	185	0.597
S2H4	0.745***	(0.047)	0.901***	(0.063)	0.789***	(0.072)	-0.045	(0.057)	0.007*	(0.004)	185	0.718
S2H5	0.788***	(0.048)	0.883***	(0.065)	0.847***	(0.074)	-0.096*	(0.058)	-0.008**	(0.004)	185	0.731
S3H1	0.918***	(0.088)	0.842***	(0.119)	0.049	(0.136)	-0.163	(0.107)	0.014**	(0.007)	185	0.416
S3H2	0.691***	(0.069)	0.562***	(0.093)	0.264**	(0.106)	-0.115	(0.083)	0.011*	(0.005)	185	0.402
S3H3	0.887***	(0.055)	0.722***	(0.074)	0.354***	(0.085)	-0.077	(0.066)	-0.006	(0.004)	185	0.628
S3H4	0.719***	(0.053)	0.631***	(0.071)	0.772***	(0.082)	-0.092	(0.064)	0.004	(0.004)	185	0.629
S3H5	0.750***	(0.059)	0.721***	(0.08)	0.838***	(0.091)	-0.108	(0.071)	-0.005	(0.005)	185	0.611
S4H1	0.763***	(0.073)	0.442***	(0.098)	0.338***	(0.112)	-0.157*	(0.088)	0.025***	(0.006)	185	0.42
S4H2	0.769***	(0.062)	0.409***	(0.084)	0.406***	(0.096)	-0.258***	(0.076)	0.005	(0.005)	185	0.527
S4H3	0.773***	(0.053)	0.295***	(0.071)	0.538***	(0.081)	-0.198***	(0.064)	-0.001	(0.004)	185	0.623
S4H4	0.857***	(0.057)	0.348***	(0.076)	0.801***	(0.088)	-0.184***	(0.069)	0.005	(0.005)	185	0.659
S4H5	0.608***	(0.084)	0.470***	(0.114)	0.857***	(0.13)	-0.102	(0.101)	-0.004	(0.007)	184	0.374
S5H1	0.736***	(0.044)	0.044	(0.059)	0.167**	(0.068)	-0.098*	(0.053)	0.013***	(0.004)	185	0.651
S5H2	0.777***	(0.041)	-0.029	(0.056)	0.275***	(0.064)	-0.205***	(0.05)	0.004	(0.003)	185	0.73
S5H3	0.817***	(0.056)	-0.011	(0.075)	0.316***	(0.086)	-0.331***	(0.067)	-0.005	(0.004)	185	0.64
S5H4	0.929***	(0.063)	-0.007	(0.084)	0.682***	(0.097)	-0.061	(0.076)	-0.001	(0.005)	185	0.636
S5H5	0.978***	(0.129)	0.321**	(0.161)	0.828***	(0.217)	0.172	(0.171)	-0.016	(0.011)	86	0.49

Note: Authors own calculations.

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