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Assessing the Effciency of Fama-French Five-Factor Model in Nepal

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Abstract

This paper aimed to assess the superiority and efficiency of Fama-French five-factor model compared to its competing subset asset pricing models in Nepal Stock Exchange (NEPSE) using descriptive, correlational and analytical research design. Sixty five companies were selected based on purposive sampling design among 228 companies listed in NEPSE. Secondary source was used for collecting panel data covering six years from 16 July, 2016 till 16 July 16, 2022. Similarly, stock prices and dividends were attained from NEPSE. Accounting data were attained from annual financial reports of sample companies. 28 days Treasury bill rates were used as risk-free rate which was attained from Nepal Rastra Bank. The 32 Size-BM-ROE portfolios were constructed to determine dependent variable. Factor returns were computed by using 2 × 2 and 2 × 3 sorting for creating independent varibles such as size, value, profitability and investment premium. Results are based on Gibbons, Ross, and Shanken test and regression analysis. Though not perfect, Fama-French five-factor model is efficient to explain the volatility in cross-sectional stock returns in NEPSE. Furthermore, four-factor model without value premium is equally efficient to five-factor model because HML is found as a redundant factor. Market risk is revealed as the most prominent factor affecting security returns.

Keywords: Asset pricing model, Fama-French five-factor model, Cross-section stock returns, Portfolio returns

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1. Introduction

Stock returns have always been the most intriguing research area in finance literature. The pioneer study was conducted by Markowitz (1952) that innovated Modern Portfolio theory. It was the groundwork of several concepts and theories later developed in the sector of risk and return. This theory is based on mean-variance relationship which searches for trade-off between portfolios' returns and variance. Later, Sharpe (1964), Lintner (1965) and Black (1972) established Capital Asset Pricing Model (CAPM). Also known as single factor model, it advocates that the market beta is the sole factor responsible for variation in stock returns.

However, Ross (1976) explored that the volatility in security returns are affected by market risk only upto the range of 40%. Critisizing single factor model, Ross (1976) innovated Arbitrage Pricing Theory (APT). It explains that security returns are better clarified by multi-factor model which is in contrast of single factor model such as CAPM. As a result, there is mounting consent among finance scholars that market risk alone is insufficient to explain the volatility in security returns. Later, CAPM was criticized by the value premium of Stattman (1980), the size premium of Banz (1981), the earnings–price factor of Basu (1983) and the leverage factor of Bhandari (1988).

In addition, Fama and French (1992) discovered that the variation in security returns is described by market, size and value premium. As a result, Fama and French (1993) formed a three-factor model which solved the anomalies included in the CAPM. Later, Carhart (1997) established a four-factor model. It added one more factor i.e. momentum factor to the Fama-French three-factor model. Momentum factor explains that stocks which have outperformed in the past, would continue to outperform in the future and stocks which have underperformed in the past, would continue to underperform in the future.

To address the shortcomings of three-factor model, Fama and French (2015) established five-factor asset pricing model. This model claimed that variation in security returns is explained by five factors namely market risk, size, value, profitability and investment premium. However, this model also describes that value premium (HML) is a redundant factor. Hence, four-factor model without HML is equally competent to five-factor model in explaining the variation in security returns.

Fama-French five-factor model is still in infant stage which has just been in finance literature since 2015. Hence, more researches should be conducted to test its validity in emerging market like NEPSE. An important cause to conduct this research is that empirical evidences have leaned towards inconsistent findings. Hence, conducting research on this topic gives more light to the literature of multi-factor asset pricing models. Hence, this paper tries to fill the gap by conducting research in the context of NEPSE. Therefore, this paper aims to assess the superioty and efficiency of Fama-French five-factor model to explain volatility in security returns in NEPSE. In this course, this study has formulated following research questions.

- Is Fama-French five factor model efficient to explain volatility in stock returns in NEPSE?
- Whether Fama-French five factor model is better than its competing models in explaining the variation in cross section stock returns?

The remaining section of this paper are outlined as: second section addresses theoretical and empirical reviews. Third section includes research methodology. Fourth section comprehends results and discussion. Finally, fifth section covers conclusion and implication of the research.

2. Review of Literature

Valuation theory is considered as the base for Fama-French five-factor model (Fama & French, 2015). The model reveals that market value of stock is the sum of expected dividend discounted by the appropriate discount rate. This proposition is explained in model (1).

$$m_t = \sum_{\tau}^{\infty} \frac{E(d_{t+\tau})}{(1+r)^{\tau}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

In model (1), m_t represent the stock price at time *t,* $E(d_{t+\tau})$ is the expected dividend at time $t+\tau$, *r* is the long-term stock return . Model (1) implies that if two stocks have similar dividends, the stock with low price tends to have higher return and the stock with higher price tends to have lower return.

By small manipulation, the model (1) can further be extracted including the relationship between expected return and profitability, investment and book to market equity ratio in model (2).

$$m_t = \sum_{\tau}^{\infty} \frac{E(Y_{t+\tau} - dB_{t+\tau})}{(1+r)^{\tau}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

In the model (2), $Y_{t+\tau}$ is the total equity earnings for the period $t+\tau$ and $dB_{t+\tau} = B_{t+\tau} - B_{t+\tau-1}$ is the change in the total book equity. Dividing by book value of equity at time *t* gives model (3).

$$\frac{m_t}{B_t} = \sum_{\tau=1}^{\infty} \frac{E(Y_{t+\tau} - dB_{t+\tau})/(1+r)^{\tau}}{B_t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Model (3) reveals three propositions about stock returns. First, if everything remains constant except value of the stock M_t and expected stock return r, higher book-to-market equity (B_t/Mt) produces higher stock returns. Second, if everything remains constant except earnings on stock and stock returns, higher equity earning results in higher stock returns. Third, if everything remains constant except investment and stock returns, there is inverse relationship between investment and stock returns. Hence, value, profitability and investment premium are the natural choices to be included as third, fourth and fifth factors in Fama-French five-factor model beside market and size premium.

Various empirical evidences acknowledged the reign of Fama-French five-factor model. For illustration, Acaravci and Karaomer (2017) showed that Fama-French five-factor didn't demonstrated any pricing error and hence, seems to be valid in the Turkish stock market. Similarly, Ishtiaq et al. (2019) suggested that Fama-French five-factor model is more efficient than three-factor model to explain the variation in portfolio returns in Pakistani stock market. Furthermore, Paliienko and Naumenkova (2020) acknowledged the superior performance of the five-factor model over single factor model.

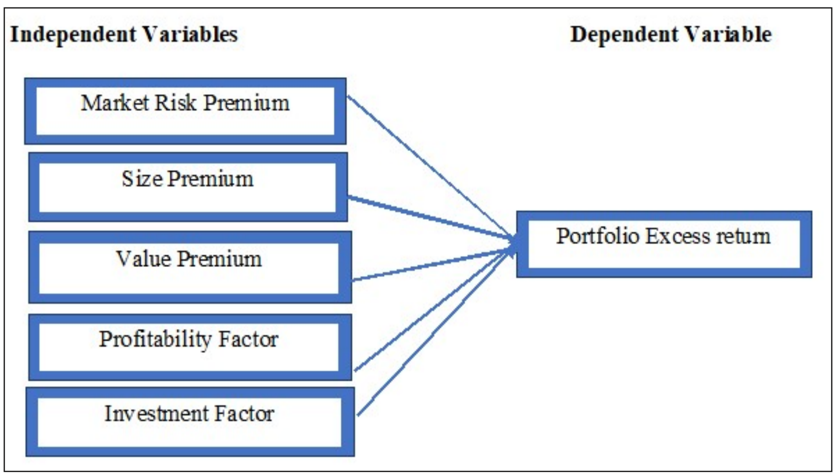
However, some studies rejected the dominance of Fama-French five-factor model. For instance, Kubota and Takehara (2017) found that investment and profitability premium are not statistically significant and hence, concluded that the Fama-French five-factor model is not the superior pricing model in Japanese stock market. Similarly, Lin (2017) concluded that Fama-French five factor model is less competent to capture both extreme high and low stock returns. Mosoeu and Kodongo (2020) found that even-though, the profitability is considered as significant factor, the five-factor model performs below par on country-specific portfolios.

2.1. Theoretical Framework

Figure 1 explains the theoretical framework of Fama-French five-factor model. Dependent variable in the model is porfolio excess returns. Similarly, market risk, value, size, profitability and investment premium are the five components which are assumed to explain the volatility in portfolio excess returns.

Fama and French (1993) developed three-factor asset pricing model which explains that portfolio returns are explained by three factors namely market risk, size and value premium. Market risk premium is defined as the excess of market returns over risk-free returns. Similarly, size premium is considered as the firm size. Furthermore, value premium is the ratio of book value of equity to market value of equity. Fama and French (1993) found that portfolio returns are positively affected by market risk premium and value premium. In contrast, portfolio returns are negatively affected by size premium. In other words, small-sized firms tend to yield more returns than big-sized firms. Fama and French (2015) augmented two additional factors namely profitability factor and investment factor to the original three-factor model. Profitability factor is the fourth augmented factor which positively affected the portfolio returns (Fama & French, 2015). Similarly, investment factor is the growth rate in total assets in year *t-1* compared to year *t-2* (Fama & French, 2015).

Figure 1: Theoretical Framework



Source: Fama and French (2015)

3. Methodology

This study was based on descriptive, correlational and analytical research designs. Purposive sampling design was applied to choose samples from companies actively traded in NEPSE as on July 5, 2023. Certain criteria were considered to select sample companies (See Table 1 & Appendix A).

Table 1: Sampling Criteria

SN	Sampling Criteria
1	Delisted and suspended companies in NEPSE are excluded in the study.
2	NEPSE had reached its peak at 1881.88 in 27 July, 2016. Then, it plunged to the index of 1102.02 in March 03, 2019. Then, it again reached to the peak

SN	Sampling Criteria
	of 3132.87 on August 15, 2021. Thus, NEPSE had completed bull and bear cycle during that period. Hence, the researcher took six years of study period from July 16, 2016 to July 16, 2022. Hence, companies which were listed in NEPSE before July 16, 2016 are selected as sample companies.
3	Financial institutions declared as crisis-ridden by NRB are excluded in the study due to lack of regular trading.
4	Companies which published annual reports duly and completely are choosen as sample.

Among 228 companies listed in NEPSE as on July 5, 2023, 65 companies were selected which met the criteria set in table 1. In this process, 20 commercial banks, 7 finance companies, 8 development banks, 11 micro-finance companies, 7 non life insurance companies, 4 life insurance companies, 1 manufacturing company, 4 hydropower companies, 1 company from investment, 1 company from hotel and tourism, and 1 company from other sector were selected as sample. Secondary source was used to collect panel date for six years from July 16, 2016 till July 16, 2022. Stock prices and dividends were attained from NEPSE. Accounting data of each companies were obtained from annual audited reports. Total 28-days weighted average rates of Treasury bill rates were used as risk-free rates which were attained from NRB.

3.1. Factor sorting

Building blocks were formed through factor sorting. Summary statistics of building blocks are presented in appendix. Then, building blocks were used to construct factors such as value premium (HML), size premium (SMB), investment premium (CMA) and profitability premium (RMW) by using 2 × 2 and 2 × 3 sorting (see Table 2 & Appendix A).

Table 2: Factor construction by 2 × 2 and 2 × 3 sorting

Sort	Breakpoint	Factors and their components
2 × 2 sorts Size and B/M, or Size and ROE, or Size and Inv.	Median	SMB = (SH+SL+SR+SW+SC+SA)/6 – (BH+BL+BR+BW+BC+BA)/6 HML = (SH+BH)/2 – (SL+BL)/2 RMW = (SR+BR)/2 – (SW+BW)/2 CMA = (SC+BC)/2 – (SA+BA)/2

Sort	Breakpoint	Factors and their components
2 × 3 sorts Size and B/M, Size and ROE, Size and Inv.	Size: Median B/M, ROE and Investment: 30^{th} and 70^{th} percentiles	$SMB_{B/M}$ = (SH+SN+SL)/3 – (BH+BN+BL)/3 SMB_{ROE}=(SR+SN+SW)/3 – (BR+BN+BW)/3 SMB_{Inv} = (SC+SN+SA)/3 – (BC+BN+BA)/3 SMB = ($SMB_{B/M}$ + SMB_{ROE} + SMB_{Inv})/3 HML = (SH+BH)/2 – (SL+BL)/2 RMW = (SR+BR)/2 – (SW+BW)/2 CMA = (SC+BC)/2 – (SA+BA)/2

Source: Fama and French (2015)

2 × 2 Sorting: Building blocks were constructed using 2 × 2 sorting based on Size-BM, Size-Investment and Size-ROE at the end of year *t-1*. In 2 × 2 Size-BM sorting, companies were arranged in ascending order by market equity (size). Then, 65 companies were grouped into two categories divided by median of firm size. One company which lied on median point was excluded and remaining 64 companies were grouped into two categories: small-sized (S) group and big-sized (B) group each with 32 companies. Further, companies in each size category was again arranged in ascending order by book-to-market equity (BM) ratio. Each group was further subdivided into two BM groups using median of BM ratio: low B/M ratio (L) and high B/M ratio (H) each with 16 companies. In this process, four building blocks were constructed, i.e., SL, SH, BL and BH including 16 companies in each block. The procedure of 2 × 2 Size-ROE sorting and 2 × 2 Size-Investment sorting were similar with 2 × 2 Size-BM sorting except the case that included ROE and Investment instead of BM ratio. Four building blocks were constructed in 2 × 2 Size-ROE sorting which SW, SR, BW and BR with 16 companies in each blocks. Similarly, four building blocks were constructed in 2 × 2 Size-Investment sorting which are SC, SA, BC and BA with 16 companies in each block (See Table 2).

2 × 3 Sorting: Building blocks were constructed using 2 × 3 sorting based on Size-BM, Size-ROE and Size-Investment at the end of year *t-1*. Under 2 × 3 Size-BM sorting, companies were arranged and sorted by market equity (firm size) same as 2 × 2 sorting including 32 companies in each size category. Companies in each size category were again arranged in ascending order by BM ratio. Each category was further subdivided into three BM categories using 30^{th} and 70^{th} percentiles of BM ratio: low B/M category (L) with 10 companies, neutral group (N) with 12 companies and high B/M group (H) with 10 companies. Hence, six building blocks were created, i.e., SH, SN, SL, BH, BN and BL. The procedure of 2 × 3 Size-ROE sorting and 2 × 3 Size-Investment sorting were same with 2 × 3 Size-BM sorting except the case that included ROE and Investment in place of BM ratio. Six building blocks were created in 2 × 3 Size-ROE sorting which are SR, SN, SW, BR, BN and BW. Similarly, six building blocks were created in 2 × 3 Size- Investment sorting which are SC, SN, SA, BC, BN and BA (See Table 2).

32 Size-BM-ROE portfolios were constructed according to size, BM and profitability with the help of MS Excel to construct excess portfolio returns (dependent variables). Mean and standard deviation of each risk premium (independent variable) are presented in the table. Furthermore, correlation coefficient between different sorts of same factors and between different factors within same sorts were presented to examine whether there is exist any relationship among them.

3.2. Empirical Model

The empirical model adopted by this study is described in model (4):

$E(Rp)= \alpha+b_iMKT + s_iSMB + h_iHML + r_iRMW + c_iCMA + e_i$ ………….. (4)

Which indicates,

$E(Rp)$ = Excess portfolio returns

α = Intercept

b_i, s_i, h_i, r_i and c_i = Regression Cofficients

MKT = Market Risk Premium

SMB = Small minus Big (Size Premium)

HML = High minus Low (Value Premium)

RMW = Robust minus Weak (Profitability Premium)

CMA = Conservative minus Weak (Investment Premium)

3.3. Hypotheses

This section is divided into two sub-sections: Gibbons, Ross and Shanken (GRS) test hypothesis and Regression hypotheses.

3.4. Gibbons, Ross and Shanken (GRS) Hypothesis

Gibbons et al. (1989) proposed a specific test to examine the efficiency of asset pricing models to explain variation in cross-section portfolio returns. They argued that if an asset pricing model completely captures the portfolio return, the intercept is equal to zero in the regression of portfolios' excess return on the factor returns. This study used GRS test to assess the supremacy of Fama-French five factor model among its competing models. Hence, alternative hypothesis of GRS test can be established as model (5).

H_{11}: Average absoluted value of intercept of portfolios returns are not zero……(5)

For GRS test, GRS values and average absolute values of intercept, was obtained from Stata.

3.5. Regression Hypotheses

This study tested five alternative hypotheses by means of Ordinary Least Square (OLS) regressions to examine whether or not five factors capture the portfolio excess returns. Thirty two regression models were examined through SPSS to examine the prominent factors to describe the volatility in portfolio excess returns.

H_{12}: Market risk premium impacts the volatility in portfolio excess returns.

H_{13}: Size premium explains the volatility in portfolio excess returns.

H_{14}: Value premium explains the fluctuation in portfolio excess returns.

H_{15}: Profitability pattern explains the variation in portfolio excess returns.

H_{16}: Investment factor influences the volatility in portfolio excess returns.

3.6. Operational Definition of Variables

3.6.1. Definition and formulation process of dependent and independent variables are explained in this section.

Portfolio Excess Returns: In this study, portfolio excess returns were employed as dependent variable. Monthly returns of 65 stocks each were calculated as the difference of stock price at the end of month *t* and stock price at the end of month *t-1* plus dividend at the end of month *t* whole divided by stock price at the end of month *t-1*. Then, monthly excess stock returns were calculated as difference between each stock's monthly returns and risk-free returns. After that, monthly excess security returns were used to form 32 VW Size-BM-ROE portfolios. Firm size (market equity) at the end of year *t-1* was used as value weight to each portfolios. Portfolio excess return is explained with the help of model 6, 7 and 8.

$$\text{Stock Return } (r_s) = \frac{(P_t - P_{t-1}) + D_t}{P_{t-1}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

$$\text{Excess Stock Return} = r_s - r_f \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

$$\text{Excess Portfolio Return } (r_p) = \sum_{i=1}^{n} w_i . r_i \ldots\ldots\ldots.\ldots\ldots\ldots (8)$$

Where,

P_t = Closing price of each security at month *t*

P_{t-1} = Closing price of each security at month *t-1*

D_t = Dividend of each security at the close of month *t*

r_f= Risk-free rate (28-days rate of Treasury bill)

w_i = Value weight of security *i* in each portfolio (calculated from market equity)

r_i = Monthly excess return of security *i* in each portfolio

Market Risk Premium: The first predictor in the model is market risk premium which is expected to capture the volatility in portfolio returns. It was defined as monthly market returns minus risk-free returns. Market returns were calculted as closing NEPSE index at month *t* divided by closing NEPSE index at *t-1* minus 1. Furthermore, risk-free return was defined as 28-days Treasury bill rates.

$$R_{mt} = \frac{NEPSE_t}{NEPSE_{t-1}} - 1 \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (9)$$

$$MKT = \text{Market Risk Premium} = R_{mt} - R_{ft} \dots\dots\dots (10)$$

Where,

$NEPSE_t$ = Closing NEPSE Index at month *t*

$NEPSE_{t-1}$ = Closing NEPSE Index at month *t-1*

R_{mt} = Market return at the end of time t

R_{ft} = Risk free return at the end of time t

Size Premium: Size premium is the second predictor of portfolio excess returns. Market equity was considered as the proxy for firm size. Market equity was calculated as number of shares outstanding mutiplied by stock prices of each company at the end of year *t-1*. Size premium was defined as the difference between returns of portfolio of small companies and returns of portfolio of big companies. SMB was used as a proxy for size premium which was constructed by 2 × 2 and 2 × 3 sorting using different building blocks (See Table 2).

Value Premium: Value premium is the third independent variable of portfolio returns. Book-to-market equity was considered as a proxy for value premium. It was calculated as book equity divided by market equity. Book equity was defined as shareholder's fund invested in the company which included equity share, preference share, share premium, reserve and other fund related to stockholders.

Value premium was defined as the difference between returns of portfolio of companies with high book-to-market equity and returns of portfolio of companies with low book-to-market equity. HML was used as a proxy for value premium which was constructed by 2 × 2 and 2 × 3 sorting using different building blocks (See Table 2).

Profitability Factor (Premium): Profitability premium is the fourth predictor of portfolio returns. Return on Equity (ROE) was used for profitability premium. ROE was defined as net profit after tax divided by book equity. Profitability premium was defined as the difference between returns of portfolio of companies with high ROE and returns of portfolio of companies with low ROE. RMW was used as a proxy for profitability premium which was constructed by 2 × 2 and 2 × 3 sorting using different building blocks (Table 2).

Investment Factor (Premium): Investment premium is the fifth predictor of portfolio returns in Fama-French five-factor model. It was defined as growth rate of total assets which is algebraically expressed as total assets at the end of year *t*-1 divided by total assets at the end of year *t-2* minus 1. Investment premium was defined as the difference between returns of portfolio of companies with conservative investment and returns of portfolio of companies with aggressive profitability. CMA was used as a proxy for investment premium which was constructed by 2 × 2 and 2 × 3 sorting using different building blocks (See Table 2).

4. RESULTS AND DISCUSSIONS

This section presents the results of the study in three sections: descriptive statistics of variables, GRS test results and regression results.

4.1. Descriptive Results

This section is further divided into two subgroups – portfolio analysis and factor returns. Portfolio analysis is concerned with summary statistics of dependent variables, i.e. average monthly excess returns of 32 Size-BM-ROE portfolios. Similarly, summary statistics of factor returns are concerned with VW portfolios excess returns used as proxy for independent variables.

4.2. Portfolio Analysis of Dependent Variable

At first, it is to examine the impact of size, B/M, investment and profitability on 32 Size-B/M-ROE portfolios excess returns.

Table 3: Size-B/M-ROE Portfolios (Monthly returns in %)

	Small				Large			
BM/ROE	**Low**	**2**	**3**	**High**	**Low**	**2**	**3**	**High**
Low	-1.83	-0.19	-0.57	-4.19	-1.25	-1.26	-1.52	-0.68
2	-0.04	0.67	-0.15	0.47	-1.91	-2.21	-1.01	-0.62
3	2.17	0.08	0.43	1.33	-1.12	-0.51	-0.94	-1.01
High	0.99	3.36	1.81	1.19	-0.01	-0.29	0.64	0.09

Source: SPSS Output

Table 3 displays average monthly returns for 32 VW Size-B/M-ROE portfolios. In small-sized stocks, average portfolio returns rise from low ROE category to high ROE catrgoey except first row. The profitability effect seems to be weak. However, value effect is stronger as average excess portfolio returns increase from low B/M stocks to high B/M stocks. Large-sized stocks shows that average portfolio returns rise from low ROE category to high ROE category though the effect is weak. However, value effect seems stronger because average returns tend to surge from low B/M category to high B/M category with monotonic effect in the third column. However, it can be inferred that value effect is stronger in small-sized stocks compared to large-sized stocks.

4.3. Summary Statistics of the Factor Returns (Independent Variables)

Four factors i.e. SMB, HML, CMA and RMW were created as a proxy for predictors such as value, size, investment and profitability premium through 2 × 2 and 2 × 3 sorting. Table 4 demonstrates mean and standard deviation of each factor returns. Mean and standard deviation of market risk premium are 0.3% and 3.42% respectively which are identical for both sorting. It is because market risk premium is mutual for all portfolios.

Table 4: Mean and Standard Deviation of Factor Returns (Figure in %)

	Rm-Rf	**SMB**	**HML**	**RMW**	**CMA**
Panel A: 2 × 2 Factors					
Mean	0.30	1.36	1.2	-0.39	-0.08
Standard Deviation	3.42	1.97	1.27	0.97	1.12
Panel B: 2 × 3 Factors					

	Rm-Rf	**SMB**	**HML**	**RMW**	**CMA**
	Rm-Rf	SMB	HML	RMW	CMA
Mean	0.30	1.42	1.55	-0.56	-0.17
Standard Deviation	3.42	2.00	2.04	1.02	1.26

Source: SPSS Output

Mean SMB factors varies from 1.36% to 1.42% for two versions of sorting. Standard deviations between two versions of SMB are similar and ranges between 1.97% to 2.00%. It is obvious because all stocks are incorporaated by both versions of SMB. Similarly, mean HML returns varies from 1.2% to 1.55% and standard deviation varies from 1.27% to 2.04% in two versions of sorting. Both mean returns and standard deviation is higher in 2 × 3 sorting. It is predictable because 2 × 3 sorting excludes central 40% stocks and therefore, does not contain all stocks. 2 × 3 sorting focuses more on the extreme values of the factors and produces larger mean returns. Hence, it results in poor diversification to create portfolios.

Mean RMW is negative in both versions of sorting which is quite shocking which claims that weak profitable stocks produce more average returns than robust profitable stock. Similarly, negative mean of CMA in both versions of sorting indicates that returns of aggressive stocks are more than those of conservative stocks. Standard deviation is higher in 2 × 3 sorting in both RMW and CMA which proves that 2 × 3 sorting results in poor diversification compared to 2 × 2 sorting.

Table 5: Correlation between different versions of the factor returns

	SMB		**HML**		**RMW**		**CMA**	
	2 × 2	**2 × 3**	**2 × 2**	**2 × 3**	**2 × 2**	**2 × 3**	**2 × 2**	**2 × 3**
2 × 2	1	.995**	1	.935**	1	.817*	1	.894*
2 × 3	.995**	1	.935**	1	.817*	1	.894*	1
**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).								

Source: SPSS Output

Table 5 shows the correlation between 2 × 2 and 2 × 3 versions of factor returns. The relationship between two versions of SMB sorting is significant ($p<.01$). High correlation is not surprising because SMB sorting includes all sample stocks. Similary, the relationship between two versions of HML sorting is significant (p<.01). Similarly is the case in RMW and CMA (p<.05) level. Significant correlation implies that joint control has little effect on HML, RMW and CMA.

Table 6: Correlation between different factors in 2 × 2 and 2 × 3 Sorting

Panel A: 2 × 2 Factor sorting	**R_m-R_f**	**SMB**	**HML**	**RMW**	**CMA**
R_m-R_f	1	.644	.288	-.475	-.739
SMB	.644	1	-.021	-.708	-.307
HML	.288	-.021	1	-.576	.285
RMW	-.475	-.708	-.576	1	-.158
CMA	-.739	-.307	.285	-.158	1
Panel B: 2 × 3 Factor sorting	**R_m-R_f**	**SMB**	**HML**	**RMW**	**CMA**
R_m-R_f	1	.694	.440	.036	-.805
SMB	.694	1	.162	-.256	-.498
HML	.440	.162	1	-.565	.106
RMW	.036	-.256	-.565	1	-.413
CMA	-.805	-.498	.106	-.413	1

Source: SPSS Output

Table 6 shows the correlation among independent variables (factors) in 2 × 2 and 2 × 3 sorting separately. None of the correlation coefficient among the factors are significant. It implies that the linear relationship among the independent variables (factors) are insignificant. Hence, the problem of multicollinearity is not severe in the study.

4.4. Gibbons, Ross and Shanken (GRS) Test Results

This section provides details on GRS (1989) test results on 32 VW Size-BM-ROE portfolios on 2 × 2 and 2 × 3 sorting. GRS test explains that competing models are said to be efficient to capture cross-section excess portfolio return if average absolute intercept is equal to zero. is defined as average absolute intercept of GRS test. Speaking precisely, the competing models with GRS and near to zero and p-value greater than 0.05 is considered efficient model. In other words, the model whose GRS and are the lowest are considered as the most efficient model among its competing counterparts.

The study considers five asset pricing models: i) one three-factor model that combine R_m -R_f, and SMB with HML, ii) three four-factor models that combine R_m -R_f, and SMB with pairs of HML, RMW or CML. iii) one five-factor model comprising all factors R_m -R_f, SMB, HML, RMW and CML. Since, R_m -R_f and SMB are common for all competing models, these factors are not shown in the table due to lack of space. In fact, the table shows the augmented factors besides R_m -R_f and SMB.

Table 7 shows the GRS values, average absolute values and corresponding p-values of 32 Size-BM-ROE portfolios for competing factor models in different versions of sorting. Five-factor model outperforms in 2 × 2 sorting with lowest value of GRS and average absolute value of intercept. Four-factor model without HML is equally efficient to five-factor model in 2 × 2 sorting which supports the findings of Fam and French (2015) that HML is a redundant factor. However, four-factor model with HML outperforms in 2 × 3 sorting. It is because it does not include all stocks rather extreme low stock below 30th percentile and extreme high stocks above 70th percentile.

GRS test suggests that five-factor model outperforms three-factor model. However, four-factor model with RMW and CMA is equally good compared to five-factor model and even better in most of the cases. It also reinforces that HML is a redundant factor and elimination of HML factor improves the efficiency of asset pricing models.

Table 7: GRS Results of 32 Size-BM-ROE Portfolios

Factors	2 × 2 Sorting			2 × 3 Sorting		
	GRS	$A\|\alpha_i\|$	p-value	GRS	$A\|\alpha_i\|$	p-value
HML	1.54	1.27	.106	1.34	1.06	.199
HML RMW	1.48	1.29	.132	1.34	1.08	.199
HML CMA	1.52	1.24	.116	1.69	1.02	.068
RMW CMA	1.48	1.07	.133	1.73	1.08	.058
HML RMW CMA	1.44	1.07	.149	1.64	1.08	.081

Source: SPSS Output

4.5. Regression Results

The regression result of portfolio returns on factor returns in 32 Size-BM-ROE portfolios are explained in this section. Resuls under 2 × 2 and 2 × 3 sorting are similar. Therefore, the result are shown in only 2 × 3 sorting.

Table 8 displays the ordinary least square regression of portfolios returns on factor returns run in 32 Size-BM-ROE portfolios. Portfolios are organized by size in ascending order from P1 to P32. Though GRS test rejects the superiority of five factor model, regression result shows that five factor model is significant ($p<.05$). This implies that though may not be 100 percent, five-factor model is efficient to describe majority of volatility in portfolio returns.

Factor-wise analysis reveals that market risk premium is significant in all portfolios ($p<.05$). Size premium is prominent factor in small-sized portfolios from P1 to P21 ($p<.05$). Profitability and investment premium are significant in almost half of the portfolios ($p<.05$). However, value premium is almost insignificant in almost all cases ($p>.05$). It indicates that size premium, market risk premium, profitability and investment premium are significant in describing the variation in cross section stock returns while value premium, HML fails to describe in most cases and reinforces its redundancy in this case too. Negative sign of RMW, HML and CMA is quite amazing because it shows the dominance of less profitable, low valued and aggressive stocks over more profitable, high valued and conservative stocks. R^2 is less spread over the portfolios. It indicates that 32 Size-BM-ROE portfolios are better in diversifying the factor risk.

Table 8: Regression results on 32 VW Size-BM-ROE portfolios

P1	-0.741 (0.502)	0.41* (0.023)	1.243** (0.000)	-0.43** (0.003)	-0.02 (0.950)	0.88** (0.002)	.54	8.66	14.81	.000
P2	-1.955 (0.106)	0.59** (0.003)	0.83** (0.004)	-0.24 (0.119)	0.385 (0.157)	0.71* (0.021)	.47	9.39	11.53	.000
P3	-1.035 (0.354)	0.38* (0.038)	1.61** (0.000)	-0.53** (0.000)	0.75** (0.004)	0.065 (0.816)	.71	8.75	31.16	.000
P4	-2.587* (0.047)	0.285 (0.169)	1.17** (0.000)	-0.27 (0.096)	0.884** (0.003)	-0.05 (0.878)	.53	10.09	14.55	.000
P5	-1.369 (0.267)	0.62** (0.002)	0.831** (0.005)	-0.38* (0.016)	0.08 (0.778)	0.65* (0.037)	.47	9.63	11.32	.000

P6	-1.355 (0.086)	0.69** (0.000)	0.92** (0.000)	-0.16 (0.109)	0.112 (0.525)	-0.035 (0.857)	.72	6.12	33.25	.000
P7	-1.544 (0.259)	0.49* (0.026)	1.41** (0.000)	-0.12 (0.479)	-0.63* (0.045)	0.29 (0.394)	.53	10.69	14.52	.000
P8	-2.157* (0.048)	0.623** (0.001)	1.373** (0.000)	-0.286* (0.039)	-0.02 (0.935)	0.49 (0.071)	.63	8.43	21.77	.000
P9	-1.146 (0.377)	0.47* (0.026)	1.301** (0.000)	-0.12 (0.482)	-0.62* (0.036)	-0.35 (0.279)	.52	10.16	13.74	.000
P10	-2.249 (0.063)	0.38 (0.053)	1.25** (0.000)	0.09 (0.572)	-0.52 (0.057)	-0.17 (0.582)	.49	9.39	12.47	.000
P11	-1.491 (0.190)	0.63** (0.001)	1.35** (0.000)	-0.10 (0.480)	-0.833** (0.002)	-1.23** (0.000)	.72	8.87	33.17	.000
P12	-1.363 (0.271)	0.42* (0.034)	0.97** (0.001)	-0.08 (0.592)	-0.55 (0.052)	-0.74* (0.02)	.49	9.67	12.43	.000
P13	-1.024 (0.363)	0.52** (0.005)	1.04** (0.000)	-0.15 (0.311)	-092** (0.001)	-1.31** (0.000)	.66	8.81	25.15	.000
P14	-0.653 (0.708)	0.381 (0.174)	1.68** (0.000)	-0.34 (0.130)	-1.254** (0.002)	-1.563** (0.001)	.58	13.68	17.54	.000
P15	-0.884 (0.522)	0.56* (0.013)	1.04** (0.002)	-0.19 (0.276)	-1.19** (0.000)	-2.09** (0.000)	.67	10.82	26.28	.000
P16	0.975 (0.634)	0.51** (0.004)	0.48 (0.056)	-0.27 (0.054)	-0.73** (0.003)	-1.63** (0.000)	.63	8.41	22.02	.000
P17	-1.014 (0.127)	0.21 (0.053)	0.28 (0.071)	-0.13 (0.116)	0.06 (0.671)	0.14 (0.42)	.27	5.17	4.82	.001
P18	-2.752** (0.009)	0.568** (0.001)	0.563* (0.021)	-0.196 (0.135)	0.32 (0.170)	0.65* (0.015)	.46	8.08	11.01	.009
P19	-1.576 (0.186)	0.5** (0.009)	0.71* (0.012)	-0.19 (0.214)	0.13 (0.618)	0.15 (0.614)	.39	9.29	9.24	.000
P20	-1.820 (0.176)	0.59** (0.007)	0.44 (0.163)	-0.03 (0.849)	0.59* (0.05)	0.05 (0.876)	.35	10.48	7.02	.000
P21	-2.65* (0.032)	0.6** (0.003)	0.65* (0.023)	-0.11 (0.494)	0.095 (0.727)	0.29 (0.343)	.38	9.51	7.77	.002

P22	-1.902* (0.016)	0.67** (0.000)	-0.18 (0.322)	0.14 (0.145)	-0.16 (0.372)	0.27 (0.171)	.36	6.05	7.05	.000
P23	-1.317 (0.216)	0.57** (0.001)	0.28 (0.257)	0.14 (0.286)	0.66** (0.008)	0.39 (0.143)	.39	8.32	8.10	.000
P24	-2.718* (0.011)	0.52** (0.002)	0.81** (0.001)	-0.18 (0.168)	0.35 (0.137)	0.03 (0.906)	.53	8.14	14.48	.000
P25	-1.495 (0.159)	0.54** (0.002)	0.13 (0.605)	0.01 (0.935)	0.36 (0.129)	-0.27 (0.319)	.34	8.26	6.62	.000
P26	-2.127** (0.003)	0.548** (0.000)	0.14 (0.398)	-0.004 (0.960)	-0.054 (0.728)	-0.197 (0.260)	.47	5.43	11.19	.000
P27	-1.81* (0.05)	0.51** (0.001)	0.21 (0.323)	0.11 (0.36)	-0.10 (0.626)	-0.44 (0.061)	.37	7.15	7.63	.001
P28	-1.29 (0.113)	0.68** (0.000)	-0.09 (0.634)	0.08 (0.455)	-0.152 (0.407)	-0.496 (0.017)	.45	6.34	10.36	.000
P29	0.112 (0.928)	0.48* (0.018)	0.22 (0.445)	-0.181 (0.254)	-0.08 (0.776)	0.174 (0.580)	.19	9.76	3.18	.000
P30	-0.126 (0.895)	0.46** (0.004)	-0.38 (0.088)	-0.05 (0.695)	-0.29 (0.173)	-0.37 (0.129)	.16	7.53	2.51	.039
P31	-0.3111 (0.666)	0.594** (0.000)	0.01 (0.949)	0.15 (0.112)	-0.08 (0.064)	-0.24 (0.189)	.43	5.66	9.58	.000
P32	-0.190 (0.806)	0.39** (0.002)	0.03 (0.863)	-0.08 (0.414)	-0.152 (0.386)	-0.397* (0.045)	.31	6.08	5.8	.002
*. Results are significant at the 0.05 level (2-tailed). **. Results are significant at the 0.01 level (2-tailed).										
Figure in parenthesis indicates p-values of regression statistics.										

5. Conclusion

Though not perfect, Fama-French five-factor model is efficient to describe the volatility in stock returns in NEPSE. Moreover, four factor model without value premium is similar to five factor model because HML is redundant factor. However, the impact of RMW, HML and CMA is quite astonishing because it shows the dominance of less profitable, low valued and aggressive stocks over more profitable, high valued and conservative stocks. Furthermore, market risk is revealed as the most prominent factor affecting security returns.

References

Acaravci, S. K., & Karaomer, Y. (2017). Fama-French five factor model: Evidence from Turkey. *International Journal of Economics and Financial Issues*, *7*(6), 130-137.

Banz, R. W. (1981). The relationship between return and market value of common stocks. *Journal of Financial Economics*, *9*(1), 3-18.

Basu, S. (1983). The relationship between earnings' yield, market value and return for NYSE common stocks: Further evidence. *Journal of Financial Economics*, *12*(1), 129-156. https://doi.org/10.1016/0304-405X(83)90031-4

Bhandari, L. C. (1988). Debt/equity ratio and expected common stock returns: Empirical evidence. *The Journal of Finance*, *43*(2), 507-528. https://doi.org/10.1111/j.1540-6261.1988.tb03952.x

Black, F. (1972). Capital market equilibrium with restricted borrowing. *The Journal of Business*, *45*(3), 444-455. https://doi.org/10.1086/295472

Carhart, M.M. (1997). On persistence in mutual fund performance. *The Journal of Finance, 52,*57-82. https://doi.org/10.1111/j.1540-6261.1997.tb03808.x

Carhart, M.M. (1997). On persistence in mutual fund performance. *The Journal of Finance, 52,*57-82. https://doi.org/10.1111/j.1540-6261.1997.tb03808.x

Fama, E. F., & French, K. R. (1992). The cross-section of expected stock returns. *The Journal of Finance, 47*(2), 427-465. https://doi.org/10.1111/j.1540-6261.1992.tb04398.x

Fama, E. F., & French, K. R. (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics, 33,* 3-56. https://doi.org/10.1016/0304-405X(93)90023-5

Fama, E. F., & French, K. R. (2015). A five-factor asset pricing model. *Journal of Financial Economics, 116*, 1-22. https://doi.org/10.1016/j.jfineco.2014.10.010

Gibbons, M. R., Ross, S. A., & Shanken, J. (1989). A test of the efficiency of a given portfolio. *Econometrica, 57*(5), 1121-1152. https://doi.org/10.2307/1913625

Ishtiaq, M., Tufail, M. S., Muneer, S., & Sarwar, M. B. (2019). Application of Fama-French five factor model in stock pricing: Evidence from emerging market. *Pacific Business Review International*, *11*(7), 73-95.

Kubota, K., & Takehara, H. (2017). Does the Fama and French five-factor model work well in Japan? *International Review of Finance, 18*(1), 137–146. https://doi.org/10.1111/irfi.12126

Lin, Q. (2017). Noisy prices and the Fama–French five-factor asset pricing model in China. *Emerging Markets Review, 31,* 141–163. https://doi.org/10.1016/j.ememar.2017.04.002

Lintner, J. (1965). The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets. *The Review of Economics and Statistics, 471*(1), 13-37. https://doi.org/10.2307/1924119

Markowitz, H. (1952). Portfolio Selection. *The Journal of Finance, 7,* 77-91. https://doi.org/10.1111/j.1540-6261.1952.tb01525.x

Mosoeu, S., & Kodongo, O. (2022). The Fama-French five-factor model and emerging market equity returns. *The Quarterly Review of Economics and Finance*, *85*, 55-76. https://doi.org/10.1016/j.qref.2020.10.023

Paliienko, O., Naumenkova, S., & Mishchenko, S. (2020). An empirical investigation of the Fama-French five-factor model. *Investment Management and Financial Innovations*, *17*(1), 143-155. https://doi.org/10.21511/imfi.17.1.2020.13

Ross, S. (1976). The arbitrage theory of capital asset pricing model. *Journal of Economic Theory, 13,* 341 – 380. https://doi.org/10.1016/0022-0531(76)90046-6

Sharpe, W. F. (1964). Capital asset prices: A theory of market equilibrium under conditions of risk. *The Journal of Finance, 19*(3), 425-442. https://doi.org/10.1111/j.1540-6261.1964.tb02865.x

Stattman, D. (1980). Book values and stock returns. *Chicago MBA: A Journal of Selected Papers, 4,* 25 – 45.

Appendix

Appendix A: Building Blocks for Factors

Table A1: Building Blocks for Factors based on 2 × 2 Sorting

	Small Size		**Large Size**	
Size-B/M	**SL**	**SH**	**BL**	**BH**
Mean	-0.0012	0.0119	-0.0144	-0.0035
Standard Deviation	0.0411	0.0470	0.0317	0.0301

Size-ROE	**SW**	**SR**	**BW**	**BR**
Mean	0.0064	0.0018	-0.0079	-0.0111
Standard Deviation	0.0485	0.0409	0.0319	0.0306
Size-Investment	**SC**	**SA**	**BC**	**BA**
Mean	0.0032	0.0037	-0.0101	-0.0089
Standard Deviation	0.0376	0.0494	0.0285	0.0344

Table A2: Building Blocks for Factors based on 2 × 3 Sorting

	Small Size			**Large Size**		
Size-B/M	**SL**	**SN**	**SH**	**BL**	**BN**	**BH**
Mean	-0.0027	0.0089	0.0134	-0.0148	-0.0130	0.0001
Standard Deviation	0.0415	0.0459	0.0611	0.0378	0.0284	0.0319
Size-ROE	**SW**	**SN**	**SR**	**BW**	**BN**	**BR**
Mean	0.0090	0.0015	0.0008	-0.0083	-0.0104	-0.0113
Standard Deviation	0.0479	0.0424	0.0429	0.0292	0.0325	0.0345
Size-Investment	**SC**	**SN**	**SA**	**BC**	**BN**	**BA**
Mean	0.0015	0.0041	0.0043	-0.0085	-0.0126	-0.0079
Standard Deviation	0.0339	0.0486	0.0500	0.0266	0.0368	0.0317