The Indonesian Capital Market Review

Volume 9
Number 2 *July*

Article 5

7-30-2017

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Recommended Citation

Awwaliyah, Intan Nur and Husodo, Zäafri Ananto (2017) "On the Robustness of The Extended Fama-French Three Factor Model," *The Indonesian Capital Market Review*: Vol. 9 : No. 2 , Article 5.
DOI: 10.21002/icmr.v9i2.10014
Available at: https://scholarhub.ui.ac.id/icmr/vol9/iss2/5

ON THE ROBUSTNESS OF THE EXTENDED FAMA-FRENCH THREE FACTOR MODEL

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Abstract

The aim of this paper is to examine the validity of the four-factor asset pricing as a comparison the standard Fama-French three factor model using U.S. monthly stock return data from period January 1963 to December 2010. Monthly stock return are constructed into 25 portfolio while the four-factor model includes the market factor (*beta*), the size factor (SMB), the book-to-market factor (HML), and the 'momentum' factor (MOM) which represents *winners minus losers* in terms of returns. Time series regressions following Fama and French (1993) are employed which includes the three-factor model as well as the four-factor model. Results indicated that the four-factor model to some extent have significant capability in explaining the variations in average excess stock return which consistent with Carhart (1997). R^2 from the four-factor model is just slightly higher than the three factor model yet it provides indicative for the robustness of the model. Meanwhile, the January seasonals are also able to be absorbed by the risk factors including the market, SMB, HML, and MOM. Since the four-factor model seems capable in explaining the variation of the stock returns then application of this model in emerging markets may provide guidance for investor in understanding the market condition.

On The Robustness of The Extended Fama-French Three Factor Model

1. Introduction

Trade-off between risk and return is one of the most important discussion in the modern financial economics. A fundamental issue in finance is the way the risk of an investment affects the expected return for investors. Investors' objectives are to maximize the portfolio expected return subject to an acceptable level of risk (or minimize risk, subject to an acceptable expected return). Started with Markowitz (1952), valuation to portfolio as well as stock behaviour has become major attention in asset pricing subject. Building on the Markowitz framework, The Capital Asset Pricing Model (CAPM) offered for the first time a coherent framework for the understanding of the risk and return issue. CAPM was developed in the beginning of the 1960s by William Sharpe (1964) and is based on the idea that not all the risks influence the prices of the assets and that a risk can be diversified and reduced by introducing an asset in portfolio.

CAPM suggest that the *beta coefficient* is the only relevant risk measure for investment and hence, a positive trade-off between beta and expected return should exist. In other word, expected return should be linearly and positively related to its systematic risk or market beta. This lead beta to commonly accepted interpretation as the sensitivity of the asset's return to variation in the market. Early empirical support also seems to support the model (Lintner, 1965; Black, Jensen, and Scholes, 1972; Fama and Macbeth, 1973). However, later evidence pointed out several firm characteristics to have been a significant explanatory power towards average returns, for instance, firm size (Banz, 1981; Reinganum, 1982), earnings yield (Basu, 1983), book-to market ratio (Chan, Hamao, and Lakonishok,1991), and earning per price ratio (Basu, 1977)

Encouraged by these findings, in 1992, an influential paper was published by Fama and French that brought together size, leverage, E/P, Book to Market (BE/ME) and beta in a single cross sectional study. There are two main results of this study. *First*, when beta is allowed to vary unrelated to size, then the positive linear beta-return relationship will disappear which contradicts CAPM's prediction. *Second*, since beta does not perform well in explaining returns, Fama and French (1992) compared the explanatory power of size, leverage, E/P, BE/ME and size and concluded that *BE/ME* and *size* were the variables that

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have the strongest relations to returns and were able to describe the cross-section of average stock return satisfactory. However, reactions to this study were also not timid. Some were argued that those result are due to data snooping (Black, 1993; MacKinlay, 1995) while others attack the data processed that suffer from survivorship bias and beta mis-measurement (Kotari, Shanken, and Sloan, 1995). Nevertheless, most researchers reached the conclusions that size and BE/ME effects are real through observation in U.S. data.

In their extension research, Fama and French (1993) tried to provide answer using risk-based concepts and showed that factors related to size and BE/ME are able to explain significant amount of variation in stock return.

Fama and French (1993), hereafter FF, extend their previous study by using a time-series regression approach to U.S stocks data for the 1963 to 1991 period. In their results, FF (1993) proposed a three factor asset pricing model to account for two firm-specific characteristics, size and book-to market ratio. The three factor model includes a market factor (excess market return), a size factor (SMB) and book-to-market ratio factor (HML). SMB (small minus big) is the return on portfolio of small stock minus the return on a portfolio of big stocks, while HML (high minus low) is the return on the portfolio of value stocks minus the return on a portfolio of growth stocks. FF (1993) study is interesting, since it was able to show that the return premia associated with size and book-to-market are compensation for risk, in line with the spirit of Merton's ICAPM (1973).

In a follow up study, Fama and French (1996) provide a multifactor explanation and state that their model successfully explains the anomalies not captured by CAPM. Fama and French (1996) report that an overall market factor and factors related to firm size and book-to-market equity are of interest to investors. However, there is one exception to this study shown by Jegadesh and Titman (1993) in which short-term momentum strategy that remains anomaly. Other anomalies including E/P, cash flow yield, sales growth and long-term past return are disappear in the model.

The momentum effect or the effect that past winners (losers) continue to perform well (poorly)) become one of the most debated issue found as anomalies. Momentum strategies applied by investors that buy stocks with high returns as well as sell stocks with low returns over the previous three to 12 months could significantly generate returns in most equity markets. Toward the issue of momentum as revealed by Jegadesh and Titman (1993), Carhart (1997) constructs a risk factor related to momentum effect (WML), and proposes a four-factor model by adding this risk factor into the FF three-factor model. WML is the return on portfolio of winner-stocks minus the return on a portfolio of loser-stocks (winners minus losers in terms of return). He reveals that his four factor model, compare to three factor model of FF (1993), could remarkably reduce the average pricing errors of portfolios sorted by 1-year lagged returns.

Subsequent research are then conducted based on the result of Carhart (1997). Daniel et al. (1997) and Wermers (1997) find evidence that the Carhart's (1997) fourth factor does well in investigating the strategies that drive the persistence in mutual fund performance. Brav et al. (2000) document that the four factors have the ability to explain the underperformance in returns from a sample of initial public offering (IPO) and seasoned equity offering (SEO) firms. Kim and Kim (2003) find that the four-factor model can, to a large extent, explain the abnormal pattern of the post-earning announcement returns, which are sorted by standardized unexpected earnings.

The three-factor model of FF (1993) as well as the four factor model of Carhart (1997) are both in their fancy. To the best of my concern, there is still no direct comparison to both of this model using the same data, and thus re-assessment of both study is considered important to highlight the relevance of each model with current condition in the stock market. Therefore, this paper are aimed to contrast the three factor model versus the four factor model and examine the validity of each using longer data period. In particular, the objective are as follows: (1) re-examine the empirical performance of the three factor model and the four , by employing data from 1963 up to recently, which is the year 2010 (2) analyse the result to shed the light towards discussion on the four factor model, i.e. whether size and book to market only are able to explain the common variation in U.S. stock returns, or the four factor which attached momentum factor, are better in explanation. In overall, the consistency of both model are able to investigate.

2. Theoretical Background

FF (1993) model said that the expected return on a portfolio in excess of the risk free rate is explained by the sensitivity of its return to three factors: (i) the excess return on a broad market portfolio, (ii) the 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

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the return on a portfolio of high-book-to-market stocks and the return on a portfolio of low-book-to- market stocks (HML). size and book-to market. They included size and book to market ratio as explanatory factors in explaining the cross-section of stock returns. SMB, which stands for *Small Minus Big*, is intended to measure the additional return investors have historically received from investing in stocks of companies with relatively small market capitalization. This additional return is often referred to as the "*size premium"*. Meanwhile, HML, which stands for *High Minus Low*, characterized to measure the "*value premium*" for investors that investing in companies with high book-to-market values (essentially, the value placed on the company by accountants as a ratio relative to the value the public markets placed on the company, commonly expressed as BE/ME).

The theoretical model of three-factors regression is as follows:

$$R_{jt} - R_{ft} = a_j + \beta_j (R_{mt} - R_{ft}) + s_j SMB + h_j HML \quad (1)$$

where R_{jt} is the return weighted return on portfolio j in period t; R_f is the risk-free rate; β_j is the coefficient loading for the excess return of the market portfolio over the risk-free rate; s_p is the coefficient loading for the excess average return of portfolios with small equity class over portfolios of big equity class. h_j is the coefficient loading for the excess average returns of portfolios with high book-to-market equity class over those with low book-to-market equity class. The s_j and h_j coefficients measures the sensitivity of the portfolio's return to the SMB and HML factors. From this model, it can be seen that portfolios of value stocks will have a high value for *h*, while growth portfolios will have a negative *h*. Therefore, large cap portfolio will load negatively on SMB (*s* negative) and small cap portfolios will have large positive values for *s*

It can be seen that the model is an extension to the standard CAPM. It augmented CAPM with the two factors identified by Fama and French (1992) in addition to market factor which represents the size effect and the book-to- market equity effect. SMB is a measure of "size risk", and reflects the view that, small companies stocks is expected to be *more sensitive to many risk* factors since their nature are relatively undiversified thus lack of ability to absorb negative effect of financial events. On the other hand, the HML factor represents higher risk exposure for typical "value" stocks (high BE/ME) versus "growth" stocks (low BE/ME). Intuitively, new companies need to reach a minimum size in order to execute an Initial Public Offering; and if we later observe them in the bucket of high BE/ME, this is usually an indication that their public market value has dropped because of hard times or doubt regarding future earnings (Allen et al., 2009).

On the other hand, Jegadesh and Titman (1993) reported that the *momentum strategy* yields average returns of 1% per month for the following 3–12 months. Momentum strategy, also sometimes known as "Fair Weather Investing", is a system of buying stocks or other securities that have had high returns over the past three to twelve months, and selling those that have had poor returns over the same period. In an attempt to also capture momentum returns, Carhart (1997) adds a fourth factor, which is nearly orthogonal to the FF's factors, into the model. Carhart's (1997) fourth factor is based on longing on winner-stocks as well as shorting on loser-stocks on the basis of their returns over the previous year. To mimic such momentum factor or premium, WML is defined as the difference between the return on a portfolio of winner-stocks and the return on a portfolio of loser-stocks. The theoretical model of the four factor regression are as follows:

$$R_{jt} - R_{ft} = a_j + \beta_j (R_{mt} - R_{ft}) + s_j SMB + h_j HML + w_j WML \quad (2)$$

where $R_{jt} - R_f$ is portfolio excess returns and the factor sensitivities or loadings, β_j, s_j, h_j, and w_j, are the slope coefficients in the time-series regressions.

3. Data and Methodology

3.1 Data

Data employed in this paper were obtained from Kenneth French website which includes monthly stocks returns on portfolio and the Fama-French factors from the period of January 1963 to December 2010. Kenneth French are kindly updated this data till recent period as well as providing guidance to portfolio and factors construction as in FF (1993). Monthly stock return are constructed into value weighted 25 portfolio while the factors including SMB, HML, and MOM (momentum).

3.2 Methodology

Method of analysis used in this paper follows step by step procedures as employed by FF (1993) in order to obtain results which could serve as comparisons of three-factors

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models with an update data. At the first stage variables used in this paper are explained along with its measurement. Next, details method of analysis is also discussed.

The brief explanation of factors creation and returns to be explained are as follows:

a. Factors Construction

At the end of June each year, NYSE, AMEX, and NASDAQ stocks are allocated to groups based on its size (S, B), and BE/ME (H, M, L). Six portfolios are constructed as the intersection of the 2 portfolios formed on size (market equity, ME) and 3 portfolios formed on the ratio of book equity to market equity (BE/ME). The size breakpoint for year t is the median NYSE market equity at the end of June of year t. BE/ME for June of year t is the book equity for the last fiscal year end in t-1 divided by ME for December of t-1. The BE/ME breakpoints are the 30th and 70th NYSE percentiles as shown in Figure 2. SMB and HML for July of year t to June of t+1 include all NYSE, AMEX, and NASDAQ stocks for which we have market equity data for December of t-1 and June of t, and (positive) book equity data for t-1

	Median ME	
	Small Value	Big Value
70th BE/ME percentile		
	Small Neutral	Big Neutral
30th BE/ME percentile		
	Small Growth	Big Growth

Figure 2: BE/ME Breakpoints
Source: French (2011)

1) SMB Factor

The portfolio SMB (Small Minus Big)is intended to mimic the risk factor in return related to size. SMB is the average return on the three small portfolios (S/L, S/M, S/H) minus the average return on the three big portfolios return on the three big portfolios (B/L, B/M, B/H). SMB is calculated as follow:

SMB = 1/3 (Small Value + Small Neutral + Small Growth)- 1/3 (Big Value + Big Neutral + Big Growth) (3)

2) BE/ME Factor

The portfolio HML (High Minus Low) is intended to mimic the risk factor in returns related to book to market equity. is the average return on the two value portfolios (S/H and B/H) minus the average return on the two growth portfolios (S/L and B/L). HML formulation is as follow:

HML =1/2 (Small Value + Big Value) - 1/2 (Small Growth + Big Growth)	(4)

3) Market Factor

Proxy for the market factor in stock returns is the excess market return (R_m-R_f). R_m-R_f, is the value-weight return on all NYSE, AMEX, and NASDAQ stocks (from CRSP) minus the one-month Treasury bill rate (from Ibbotson Associates).

4) Momentum Factor

Six value-weight portfolios formed on size and prior (2-12) returns to construct MOM. The portfolios, which are formed monthly, are the intersections of 2 portfolios formed on size (market equity, ME) and 3 portfolios formed on prior (2-12) return. The monthly size breakpoint is the median NYSE market equity. The monthly prior (2-12) return breakpoints are the 30^{th} and 70^{th} NYSE percentiles. Mom is the average return on the two high prior return portfolios minus the average return on the two low prior return portfolios, which can be calculated as follow:

MOM =1/2 (Small High + Big High) - 1/2 (Small Low + Big Low)	(5)

b. Portfolio Stock Returns Formation

Stock used in this paper follows what FF (1993) did in which excess returns on 25 portfolios, formed on size and BE/ME will be served as dependent variables in the time series regressions. The 25 size-BE/ME portfolios, which are constructed at the end of each June, are the intersections of 5 portfolios formed on size (market equity, ME) and 5 portfolios formed on the ratio of book equity to market equity (BE/ME). The size breakpoints for year t are the NYSE market equity quintiles at the end of June of t. BE/ME for June of year t is the book equity for the last fiscal year end in t-1 divided by ME for December of t-1. The BE/ME breakpoints are NYSE quintiles. The portfolios for July of

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DOI: 10.21002/icmr.v9i2.10014

year t to June of t+1 include all NYSE, AMEX, and NASDAQ stocks for which we have market equity data for December of t-1 and June of t, and (positive) book equity data for t-1. Value-weighted monthly returns on portfolios are calculated from July-June. For example of portfolio formation of can be seen in Figure 3. At the beginning of each month all NYSE firms with returns from t-x to t-y are allocated to deciles based on their continuously compounded returns between t-x and t-y. Portfolios are reformed monthly.

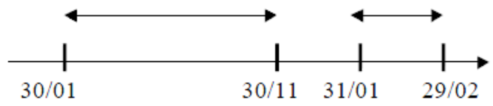

Figure 3: Example of Portfolio Formation
Source: Fama and French (1993)

Meanwhile, the 25 portfolio representations used in this paper can be seen in Table 1 below along with its name for each quintile.

Table 1: The 25 Portfolio Representations

		BE/ME (Low-High)				
Size (Small-Big)		Low	2	3	4	High
	Small	S-L	S-2	S-3	S-4	S-H
	2	2-L	2-2'	2-3'	2-4'	2-H
	3	3-L	3-2'	3-3'	3-4'	3-H
	4	4-L	4-2'	4-3'	4-4'	4-H
	Big	B-L	B-2	B-3	B-4	B-H

The details analysis conducted in this paper are as follows:

a. Descriptive statistics

Descriptive statistics of each variable that represents common risk factors including Size (ME), Book to Market Equity (BE/ME), and number of firm are discussed in the first step of analysis. Descriptive statistics for dependent variables (average excess return) as well as independent variables (the market, SMB, HML and MOM factor) are also presented in order to examine whether the same data pattern are still preserved on the longer and more current data.

b. Time Series Regressions

The next step of analysis includes time series regression of dependent variable and independent variables. These variables can be summarized in the following table.

Table 2: Variables Definitions

No	Dependent Variables		
	Variable	Definition	Measurement
1	R_i-R_f	Average excess return	Ri is value weighted of monthly stock returns performed on 25 portfolios Rf is the one-month treasury bill rate, observed at the beginning of the month
	Independent Variable (Common Risk Factors)		
	Variable	Definition	Measurement
1	R_m-R_f	Excess return on market portfolio	R_m is the value weighted monthly percent return on all stocks in the 25 size BE/ME portfolios plus the negative BE stocks excluded from the 25 portfolios Rf is the one-month treasury bill rate, observed at the beginning of the month
2	SMB	Small Minus Big (return on mimicking portfolio for the common size factor in stock returns)	the difference between return on small and big stock portfolio with about the same weighted average book to market equity
3	HML	High Minus Low (return on mimicking portfolio for the common book to equity factor in stock returns	the difference between returns on high and low book to market equity portfolios with about the same average size
4	MOM	the average return on the two high prior return portfolios minus the average return on the two low prior return portfolios	the difference between two high prior return portfolios minus two low prior return with about the same the same weighted average book to market equity

Source: adapted from Fama and French (1993), Carhart (1997)

Examination of role of stock market factors in returns are then conducted in two stages of time series regression. The two regression model are explained below.

1) The Market, SMB, and HML

Regression model in this step is preordained to examine the role of all three factors in explaining variation of stock returns. Consequently, R_m-R_f , SMB and HML are used as explanatory variables in this following equation.

$$Ri_t - Rf_t = a + b_t(Rm_t - Rf_t) + s_t(SMB) + h_t(HML) + e_t \quad (6)$$

2) The Market, SMB, HML and MOM

Regression model in this step is intended to examine the role of all four factors in explaining variation of stock returns, an in particular to show whether MOM is

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DOI: 10.21002/icmr.v9i2.10014

valid in explaining the variation of stock return instead of R_m-R_f , SMB and HML as in the following equation:

$$Ri_t - Rf_t = a + b_t(Rm_t - Rf_t) + s_t(SMB) + h_t(HML) + m_t(MOM) + e_t \quad (7)$$

Coefficient of determination (R^2) in each model provides indicator of how well each factor in explaining average excess return while the sign of coefficient b, s, h, and *m* each of which represents the magnitude and direction of relationship with stocks returns. In addition, given the risk premiums captured by the risk factors, the coefficients of the regressions can measure the magnitude of compensation that should pay for such factors. So, if the four factor model is valid, it is expected that the regression coefficients of the factors (*b, s, h,* and *m*) to be significantly different from zero

c. *Cross Sections Average Returns*

After conducting time series regression with the two previous model, then it is necessary to test how well the average premium for the three factors as well as the four factors representing risk in explaining the cross-section of average return on stocks. Following Merton (1973), a well-specified asset pricing model produces an intercept that is insignificantly different from zero. Such claim imposes a stringent standard on assessing asset pricing models. If an intercept is estimated by regressing (stock or portfolio) excess returns on excess returns or returns on zero-investment portfolios, there is nothing left to be captured in the intercept. Thus, if the four-factor asset pricing model is able to capture the variation of average returns, the intercept in Eq. (7) is expected to be not significantly different from zero.

d. *Robustness Check*

A check on the model performance can be conducted in several ways. The first robustness test in this paper portfolio that performed based on size and previous return or the portfolio that constructed based on *size and momentum*. This analysis is intended to observed whether the stock market factors that capture the average return on size and BE/ME portfolios performed size and momentum.

For this purpose, the value weighted monthly excess return in percentage of portfolios that formed size and momentum are required. Both of this portfolio data also obtained from Kenneth French website for the period January 1963 to December 2010. This portfolio are constructed monthly from the intersections of 5 portfolios formed on size (market equity, ME) and 5 portfolios formed on prior (2-12 month) return. The monthly size breakpoints are the NYSE market equity quintiles. The monthly prior (2-12) return breakpoints are NYSE quintiles. Next, analysis of whether R_m-R_f, SMB, HML, and MOM can explain the returns on portfolios formed size and momentum, time series regression such as previously conducted on portfolios based on size and book to market equity are necessary. The regression model specifically duplicates equation (6) and (7) above.

Other validity test is test of *seasonality effect* in both three factor and four factor model since previous study such as Roll (1983) and Keim (1983) documented that the stock returns especially returns on small stock tend to be higher in January. Test for January are common in checking for asset pricing validity to checked the average returns during January compare to other months and whether the difference can be explained by the model. Test on the residuals performance can also give insight of the efficiency of the model. In the model are functioning well, then it is expected that the residuals should have no impact on the average returns of each month i.e. not significant.

4. Findings and Discussions

Main results obtained from time series regression of the three factor model as well as the four factor model along with the cross section average return and the robustness test are presented in this section.

4.1 Descriptive Statistics

At the first stage, descriptive statistics of 25 portfolio formed on size and book to market equity ratio are analyse. The complete result are presented in Table 3. It shows that the portfolio in the smallest size quintiles (S-L) contains the largest stocks number compare to other portfolio. As the size increase, the number of stock are reduced. Together, the five portfolios in the largest ME quintiles average about 78% of total value.

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DOI: 10.21002/icmr.v9i2.10014

The portfolios of stocks in both the largest size and the lowest BE/ME (B-L) only, comprises for more than 32% of the combines value of the 25 portfolios. In the biggest size quintile, market value display a strong decreasing trend with increasing BE/ME. Therefore, the inverse relationship between size and BE/ME is likely to be caused by the biggest size quintile. In overall, the result are slightly higher compare to FF (1993). This condition was plausibly due to longer period of observation used in this study which accounts for largest number of firms and stocks listed in NYSE, AMEX, and Nasdag.

Table 3: Descriptive Statistics for 25 portfolios formed on Size and Book to Market Equity: 1963-2010, 37 years

	Book to Market Equity (BE/ME) quintiles									
Size quintile	Low	2	3	4	High	Low	2	3	4	High
	Average of annual averages of firm sizes					Averages of annual B.E ratios for portfolio				
Small	57.84	61.38	58.63	51.25	38.98	0.327	0.486	0.640	0.932	1.883
2	267.62	271.32	275.19	271.46	266.89	0.507	0.710	0.969	1.155	1.479
3	620.03	626.86	628.98	635.45	647.68	0.847	1.277	1.626	1.826	2.048
4	1584.66	1539.50	1518.28	1531.13	1545.10	1.806	3.004	3.608	3.711	4.019
Big	13212.23	11245.75	9496.10	8096.48	7391.56	13.724	15.793	14.429	14.381	10.833
	Average of annual percent of market value in portfolio					Averages of annual numbers of firm in portfolio				
Small	0.769	0.520	0.497	0.536	0.630	512.07	334.78	337.64	406.76	625.32
2	1.083	0.795	0.768	0.685	0.539	160.03	117.39	114.97	102.22	77.90
3	1.857	1.417	1.279	1.082	0.771	118.95	89.58	79.77	66.79	46.83
4	3.919	2.942	2.513	2.153	1.493	101.15	75.59	62.78	52.51	36.34
Big	32.489	15.887	11.627	9.084	4.663	109.07	66.49	51.92	43.87	25.82

Source: Appendix 1

The clear pattern of each size and book to market equity quintiles portfolios with respect to firm size and market value of equity can be seen in figure 2a and 2b in the following.

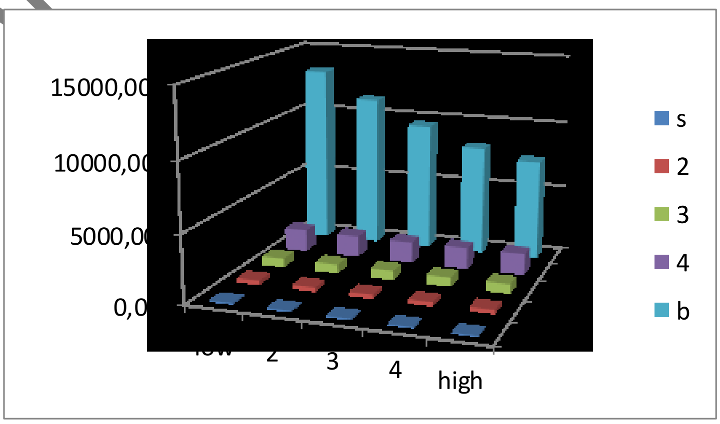

Figure 1a. Average Firm Size for 25 stock portfolios performed on Size and BE/ME

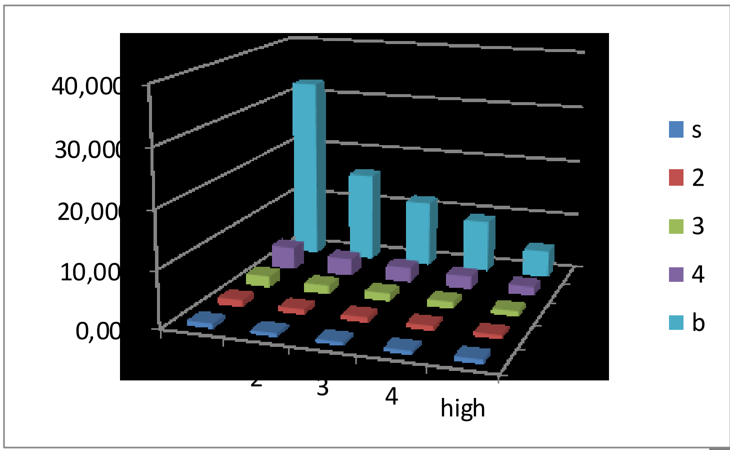

Figure 1a. Average of annual percent of market value for 25 stock portfolios performed on Size and BE/ME

From the two graphs above it can be seen that since 1963, small stocks in U.S have outperformed large stocks. In addition, stock with low ratios of book to market ratios have outperformed stocks with high BE/ME.

Next stage of analysis concern with assessing descriptive statistics of dependent variable and independent variables used. Summary of dependent and explanatory returns variables in the time series regression are presented in Table 4.

Table 4 indicates that average excess returns of 25 portfolio performed on size and book to market equity are ranged from 0.262% to 1.005% per month. This patters confirms result of FF (1993) while also specifies Fama and French (1992) evidence that size and average return exhibit negative relationship. On the contrary, a strong positive relation between average return and BE/ME are also evidence. In overall BE/ME portfolio, except the lowest, average return tend to decrease from small to big size portfolio. This evidence also confirms previous description of firm size and market value in Figure 2a and 2b. In addition, in every size quintile, average returns tend to increase with BE/ME. This pattern can also be observed in Figure 3.

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DOI: 10.21002/icmr.v9i2.10014

Table 4: Summary Statistics for monthly dependent and explanatory returns (in percent) for period January 1963-December 2010, 576 observations

Name	Mean	Std.	t(mn)	Autocorr. For lag 1	2	12	Correlations RM	RMRF	SMB	HML	MOM
	Explanatory Returns										
Rm	0.982	5.184	4.546	0.095	-0.030	0.029	1.000	0.999	0.308	-0.302	-0.129
Rm-Rf	0.458	4.521	2.431	0.087	-0.038	0.029	0.999	1.000	0.306	-0.302	-0.127
SMB	0.269	3.164	2.038	0.059	0.037	0.114	0.308	0.306	1.000	-0.234	-0.004
HML	0.421	2.932	3.446	0.158	0.037	0.018	-0.302	-0.302	-0.234	1.000	-0.157
MOM	0.716	4.329	3.968	0.062	-0.064	0.080	-0.129	-0.127	-0.004	-0.157	1.000

Dependent Variables: Excess returns on 25 stocks portfolios formed on ME and BE/ME

Size quintile	Low	2	3	4	High	Low	2	3	4	High
	Means					**Standard Deviations**				
Small	0.262	0.792	0.830	1.005	1.159	8.117	6.982	6.074	5.735	6.200
2	0.420	0.697	0.910	0.929	1.027	7.320	6.062	5.489	5.343	6.088
3	0.435	0.732	0.766	0.865	1.070	6.756	5.530	5.033	4.928	5.552
4	0.543	0.531	0.691	0.838	0.838	5.989	5.242	5.100	4.867	5.556
High	0.412	0.464	0.454	0.525	0.590	4.776	4.527	4.429	4.427	5.008
	t-stat for means									
Small	0.775	2.723	3.278	4.206	4.487					
2	1.378	2.758	3.979	4.173	4.049					
3	1.547	3.178	3.655	4.212	4.625					
4	2.178	2.430	3.249	4.132	3.619					
High	2.068	2.458	2.463	2.844	2.825					

Source: Appendix 2

In the portfolios of BE/ME quintiles, standard deviations of average return ranges from 4.429% to 8.117% which is quite high. FF (1993) suggest this findings as indicative that common risk factors in return could absorb most of the variation in stock returns, and hence making the test of an intercept in time series regression more precise.

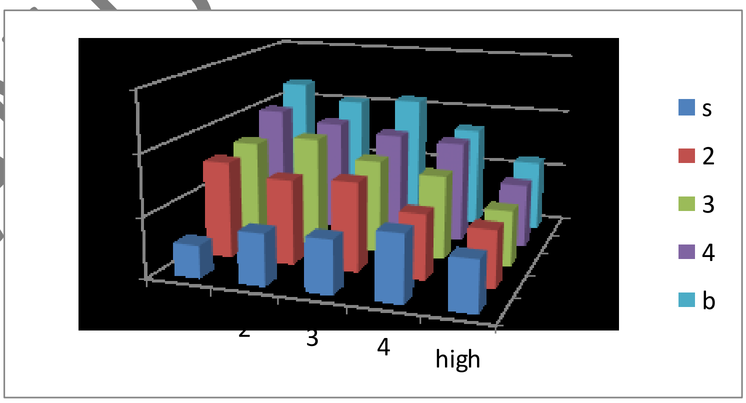

Figure 2: Average Excess Return for 25 portfolio formed on Size and BE/ME

From *explanatory variables descriptions*, it can be seen that the average value of R_m-R_f is 0.48% per month while R_m on average is 1.00. It implies that market premium plays an important role in the model and able to capture the systematic risk from macroeconomic factors in the U.S. stock markets. Meanwhile the average SMB return is

0.269% per month (t=2.038) which indicates that the estimated spread in expected returns that caused by size factor is about 0.55% which higher compare to FF (1993). On the other hand, HML (BE/ME factor) produces average returns premiums as high as 0.421% per month (t=2.068) which cause spread in expected return around 0.878% which sufficiently high. The fourth factor, momentum, indicates average returns about 0.716% per month (t=3.968) while the correlation to all other factors are negative.

5. Time Series Regressions

Time series regression of average excess stocks return and common risk factor are developed using two regression models including (1) the market, SMB and HML and (2) the market, SMB, HML and MOM. Findings for each model are discussed briefly in this following section.

1) Model 1: The Three Factor Model

Excess returns on 25 stock portfolios formed on size and book to market equity are regressed on excess market return (Rm-Rf), SMB (size factor) and HML (book to market equity factor).

The result exhibit in Table 5 are quiet fascinating. *First,* it depicts the same coefficients figure as in FF (1993) although the data employed are longer in period. *Second,* it can be seen that, together, the three-stock market factors can serve well in capturing variation of stock returns. SMB, as the mimicking return for the size factor, indicates significant relation to excess return shows value t-statistic that mostly higher than 10. In each book to market quintile, SMB exhibit monotonic decrease from lower to higher portfolios as well as in size from smaller to bigger except for the biggest size portfolio that slightly higher compare to pervious size as depicted in Figure 3a .

HML, as the mimicking factor for book to market equity, also has significant relationship to excess stock returns. The increasing pattern of HML factor from the smallest to biggest BE/ME quintile ranging from strong negative coefficient to strong positive coefficient with t-statistic greater than 4.0 (Figure 3b).

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DOI: 10.21002/icmr.v9i2.10014

Table 5: Regression of excess stock returns (in percent) on the size (SMB) and book to market equity (HML) for period January 1963 to December 2010, 576 months

Model	$Ri_t - Rf_t = a + b_t(Rm_t - Rf_t) + s_t(SMB) + h_t(HML) + e_t$									
Dependent Variable: Excess return on 25 portfolios formed on size and book to market equity										
Book to market equity (BE/ME) quintiles										
Size quintiles	**Low**	**2**	**3**	**4**	**High**	**Low**	**2**	**3**	**4**	**High**
	b					**t(b)**				
Small	1.084	1.108	1.090	1.055	0.970	47.274	56.941	67.720	64.172	68.688
2	0.954	1.011	1.037	1.076	1.001	69.145	68.313	69.017	72.930	76.525
3	0.916	0.959	0.984	1.073	0.978	72.057	61.800	59.994	61.727	57.677
4	0.882	0.966	0.980	1.015	0.990	71.020	61.952	60.850	61.593	57.318
Big	0.983	1.083	1.058	1.144	1.036	80.216	68.432	58.655	68.164	46.269
	s					**t(s)**				
Small	1.355	0.985	0.724	0.375	-0.250	42.190	55.354	57.464	53.388	54.339
2	1.300	0.860	0.518	0.207	-0.230	43.871	41.455	39.433	38.374	43.329
3	1.089	0.768	0.424	0.164	-0.235	34.125	22.041	18.455	17.154	20.722
4	1.029	0.712	0.382	0.210	-0.218	18.004	8.504	6.626	9.113	8.139
Big	1.090	0.859	0.533	0.228	-0.095	-14.768	-11.235	-10.078	-10.718	-3.014
	h					**t(h)**				
Small	-0.314	-0.403	-0.441	-0.437	-0.368	-9.071	1.177	13.332	21.330	32.059
2	0.030	0.126	0.176	0.202	0.100	-16.662	5.614	18.077	27.990	37.087
3	0.272	0.379	0.437	0.448	0.277	-19.315	6.962	17.636	25.107	28.013
4	0.443	0.560	0.602	0.565	0.592	-19.469	7.696	16.810	22.708	26.470
Big	0.693	0.793	0.776	0.798	0.745	-20.156	4.524	11.008	26.990	22.023
	R^2					**s(e)**				
Small	0.921	0.943	0.951	0.943	0.947	2.292	1.675	1.352	1.375	1.431
2	0.952	0.941	0.936	0.939	0.946	1.602	1.480	1.390	1.325	1.415
3	0.950	0.908	0.894	0.897	0.891	1.513	1.678	1.641	1.588	1.835
4	0.939	0.891	0.881	0.886	0.872	1.486	1.737	1.764	1.647	1.995
Big	0.936	0.896	0.859	0.893	0.801	1.209	1.462	1.667	1.452	2.240

Source: Appendix 3

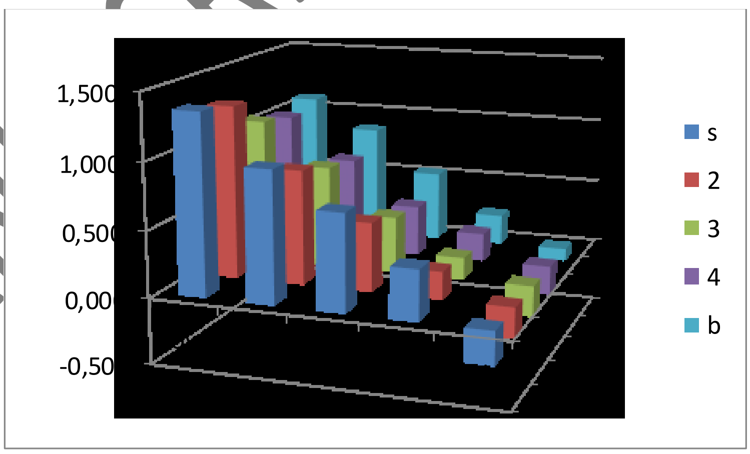

Figure 3a: SMB coefficient resulted from Model 1 in regression of 25 portfolio formed on Size and BE/ME

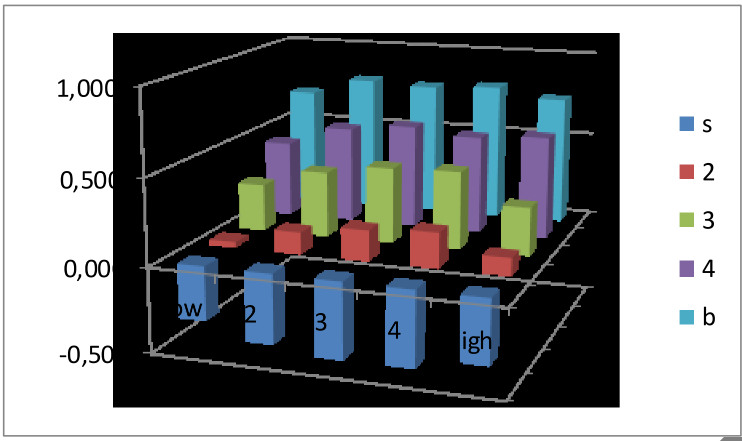

Figure 3b: HML coefficient resulted from Model 1 in regression of 25 portfolio formed on Size and BE/ME

These results suggest two important findings. *Firstly*, SMB was able to capture shared variation which cannot be explained by market factor and by HML. *Secondly*, HML also able to capture common variation which cannot be explained by R_m-R_f and SMB. Both SMB and HML exposed interesting impact to market βs.

The R^2 value also confirms the result that adding SMB and HML factor along with market factor could increase capability of explaining excess stock returns. In this three factor model all portfolio have R^2 more than 0.8. This findings suggest that SMB and HML are able to describe variation in stock returns that are missed by the market factor. In other word, market factor is not the only component that able to describe excess return variability as argued by standard CAPM. In addition, the three factor model in the spirit of multifactor model as suggested by Merton (1973) might provide better explanation towards risk.

2) Model 2: The Market, SMB, HML and MOM

Table 6 presents the results of the time series regression of the 25 size-BE/ME portfolios' excess returns on the on the Fama and French (1993) three factors, MP, SMB, and HML, and the Carhart's (1997) momentum factor, MOM.

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DOI: 10.21002/icmr.v9i2.10014

Table 6: Regression of excess stock returns (in percent) on the size (SMB), book to market equity (HML) and momentum (MOM) for period January 1963 to December 2010, 576 months

Model	$Ri_t - Rf_t = a + b_t(Rm_t - Rf_t) + s_t(SMB) + h_t(HML) + m_t(MOM) + e_t$									
Dependent Variable: Excess return on 25 portfolios formed on size and book to market equity										
Book to market equity (BE/ME) quintiles										
Size quintiles	**Low**	**2**	**3**	**4**	**High**	**Low**	**2**	**3**	**4**	**High**
	b					**t(b)**				
Small	1.075	1.101	1.084	1.056	0.969	46.255	67.863	70.741	69.889	78.747
2	0.952	1.002	1.032	1.069	1.003	55.874	67.172	60.577	60.748	67.507
3	0.916	0.957	0.980	1.063	0.978	66.609	67.709	58.800	59.742	57.664
4	0.886	0.967	0.980	1.013	0.984	63.466	71.714	60.628	60.430	66.874
Big	0.978	1.082	1.053	1.135	1.030	67.375	75.132	56.516	56.181	45.285
	s					**t(s)**				
Small	1.356	0.985	0.724	0.375	-0.250	42.336	44.073	34.286	17.990	-14.757
2	1.300	0.861	0.519	0.207	-0.230	55.321	41.827	22.083	8.547	-11.241
3	1.089	0.768	0.425	0.164	-0.235	57.417	39.429	18.485	6.690	-10.070
4	1.028	0.712	0.382	0.210	-0.218	53.442	38.341	17.140	9.111	-10.745
Big	1.090	0.859	0.533	0.228	-0.094	54.493	43.301	20.759	8.186	-3.011
	h					**t(h)**				
Small	-0.330	-0.415	-0.453	-0.435	-0.370	-9.352	-16.885	-19.495	-18.953	-19.838
2	0.027	0.110	0.168	0.189	0.105	1.044	4.871	6.484	7.089	4.647
3	0.274	0.375	0.429	0.431	0.278	13.105	17.513	16.970	15.947	10.793
4	0.449	0.561	0.601	0.561	0.582	21.218	27.428	24.523	22.085	26.060
Big	0.684	0.791	0.767	0.782	0.734	31.060	36.190	27.133	25.526	21.276
	m					**t(m)**				
Small	-0.049	-0.039	-0.037	0.007	-0.007	-2.175	-2.455	-2.464	0.465	-0.571
2	-0.009	-0.048	-0.028	-0.040	0.015	-0.527	-3.301	-1.683	-2.334	1.066
3	0.004	-0.012	-0.025	-0.054	0.002	0.309	-0.892	-1.559	-3.123	0.125
4	0.021	0.003	-0.003	-0.011	-0.032	1.526	0.234	-0.181	-0.666	-2.244
Big	-0.029	-0.006	-0.030	-0.049	-0.034	-2.017	-0.462	-1.633	-2.482	-1.521
	R^2					**s(e)**				
Small	0.921	0.953	0.951	0.939	0.936	2.285	1.595	1.506	1.487	1.210
2	0.943	0.942	0.909	0.892	0.896	1.676	1.468	1.675	1.730	1.462
3	0.951	0.936	0.895	0.883	0.859	1.353	1.390	1.639	1.751	1.668
4	0.943	0.939	0.897	0.886	0.894	1.373	1.326	1.589	1.648	1.447
Big	0.947	0.946	0.892	0.873	0.802	1.427	1.416	1.832	1.986	2.237

Source: Appendix 4

The results indicate that, under the four-factor asset pricing model, all the four factors, MP, SMB, HML, and MOM, help in explaining the variation of average returns in the U.S stock market. The coefficient of SMB (s) range from -0.250 to 1.356 and negative in the biggest BE/ME quintile only. All are significant and are systematically related to size from the smallest to the biggest quintile. In overall, the pattern of SMB coefficient are similar to model 1 as well as original FF (1993).

Coefficients of HML, has also depicted similar pattern as in model 1. After controlling for ME, the coefficient of HML (h) shows an increasing pattern along with BE/ME and range from -0.404 to 0.782 which is slightly decrease compare to model 1.

Most of them are positive instead of the smallest size quintile, and all are significantly different from zero.

On the other hand, the interesting figure are shown by MOM coefficient (m) which range from -0.049 to 0.021 with most of them are negative (22 out of 25) as can be seen in Figure 4. The positive coefficient mainly appear in the smallest BE/ME portfolio. No clear relationship appears between the momentum factor and the 25 size BE/ME portfolios. Only 9 coefficient are significantly different from zero at 0.05 significance level and 1 coefficient at 0.10 significance level while other coefficient are not significant. This result indicates that *the MOM factor have somewhat ability* to explain the time-series return variation.

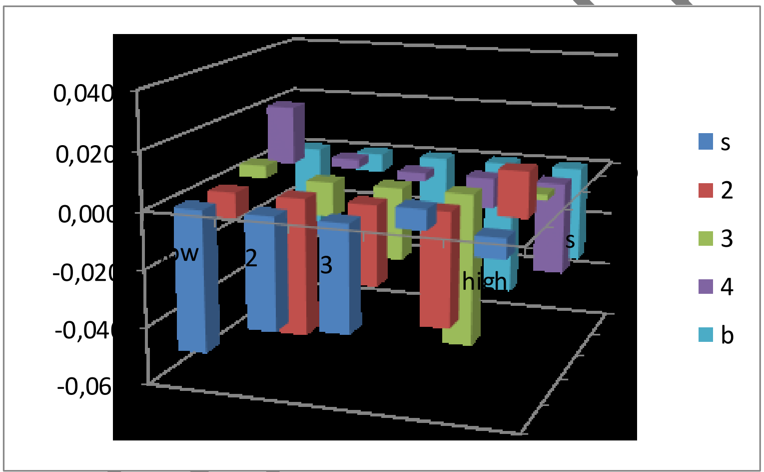

Figure 4: MOM coefficient resulted from Model 2 in regression of 25 portfolio formed on Size and BE/ME

The R2 value from regression of the four factor model indicates only slightly increase from the three factor model. It range from 0.802 to 0.953 while in the three factor model it range from 0.801 to 0.952. There 13 case out of 25 portfolio that experiences an increase in R2 after inclusion of MOM factor, however the 12 other case are decrease. Interestingly, the fourth biggest BE/ME portfolio all experience decrease. This evidence seems to suggest that the return variation is somewhat better to be explained by the four factors that associated with bigger firms.

6. Cross-Section Average Returns

To further check the validity of both the three factor and the four factor model, assessment to the intercepts resulted from the model could adding the explanation.

https://scholarhub.ui.ac.id/icmr/vol9/iss2/5
DOI: 10.21002/icmr.v9i2.10014

Focusing on the intercepts resulted from the three regression model employed in this paper, capability of average premium risk factors in explaining the cross-section returns of stock are able to examine. Summary of intercept for each regression model is depicted in Table 7.

Table 7: Intercepts from excess stock returns regression for 25 stock portfolios formed on size and book market equity: January 1963 to December 2010, 576 months.

Book to market equity (BE/ME) quintiles										
	a					t(a)				
Size quintiles	Low	2	3	4	High	Low	2	3	4	High
Model 1: $Ri_t - Rf_t = a + b_t(Rm_t - Rf_t) + s_t(SMB) + h_t(HML) + e_t$										
Small	-0.466	-0.182	-0.073	0.143	0.190	-4.762	-2.660	-1.123	2.257	3.670
2	-0.006	-0.050	0.044	-0.103	0.025	-0.090	-0.798	0.609	-1.385	0.404
3	0.003	0.105	0.018	-0.034	-0.047	0.052	1.762	0.251	-0.447	-0.655
4	0.138	0.059	0.060	0.079	-0.119	2.353	1.051	0.879	1.123	-1.924
Big	0.124	-0.033	0.115	-0.083	-0.173	2.031	-0.554	1.470	-0.972	-1.812
Model 2: $Ri_t - Rf_t = a + b_t(Rm_t - Rf_t) + s_t(SMB) + h_t(HML) + m_t(MOM) + e_t$										
Small	-0.420	-0.146	-0.038	0.137	0.196	-4.209	-2.091	-0.580	2.106	3.705
2	0.002	-0.006	0.070	-0.065	0.011	0.023	-0.088	0.952	-0.865	0.169
3	-0.001	0.116	0.041	0.017	-0.049	-0.015	1.910	0.576	0.221	-0.667
4	0.119	0.057	0.062	0.089	-0.089	1.979	0.977	0.897	1.238	-1.412
Big	0.151	-0.027	0.143	-0.037	-0.142	2.418	-0.443	1.784	-0.429	-1.451

Source: Appendix 3 and 4

For model 1, where all the three factors are analysed, intercepts values are closer to zero. The t-statistic observed also indicated that only *six out of 25 portfolios that significantly different from zero*, while *others are insignificant*. This results confirms the findings of FF (1993). It implies that through extending the data to the longest period still approximately maintain the main findings of the three factors model. Intercept that are not different from zero indicates that together, R_m-R_f, SMB, and HML can satisfactory explain the cross-section of average stock returns.

On the other hand, the four factor model with extension to the four factor, where MOM (momentum) are attached to the model, the result still somewhat indifference with the three factor model. Only *six case out of 25 portfolios* appears to significant different from zero with the intercept coefficient ranging from -0.420 to 0.151 which are slightly higher. from model 1 (-0.466 to 0.138). The evidence confirms *the significance of the four factor model to explain the time-series variation of average returns in the U.S. stock market*.

7. Robustness Test

The first robustness test is conducted by forming portfolio using size and ME which is market cap at the end of the previous month. This analysis was intended to observed the capability of the three factor model as well as the four factor model in explaining return of portfolios from previous month and indicate the informative relation with average returns. Each portfolio that formed on size and momentum are then regress with factor excess market return (R_m-R_f) and factors mimicking portfolio of size, book to market ratio, and momentum using model 1 and model 2 as in the equation 6 and 7. The complete results are shown in table 8 and table 9.

Table 8: Regression of excess stock returns (in percent) on portfolios formed on size and previous month return using model 1 with explanatory variable the size (SMB) and book to market equity (HML) for period January 1963 to December 2010, 576 months

Model	$Ri_t - Rf_t = a + b_t(Rm_t - Rf_t) + s_t(SMB) + h_t(HML) + e_t$									
Dependent Variable: Excess return on 25 portfolios formed on size and book to market equity										
Book to market equity (BE/ME) quintiles										
Size quintiles	Low	2	3	4	High	Low	2	3	4	High
	b					t(b)				
Small	1.190	1.318	1.286	1.327	1.295	31.131	37.147	33.406	32.409	32.771
2	0.948	1.036	1.068	1.138	1.017	48.032	50.434	51.953	48.596	40.968
3	0.895	0.957	0.991	1.027	0.971	54.676	62.684	60.458	59.309	60.630
4	0.876	0.953	0.977	1.011	0.946	52.732	66.325	58.551	60.497	57.413
Big	0.987	1.071	1.049	1.036	0.999	42.213	48.548	44.533	40.402	38.681
	s					t(s)				
Small	1.222	0.938	0.587	0.294	-0.141	22.820	18.869	10.887	5.130	-2.549
2	0.960	0.746	0.447	0.152	-0.214	34.674	25.893	15.498	4.635	-6.146
3	0.878	0.651	0.446	0.150	-0.212	38.263	30.415	19.436	6.177	-9.449
4	0.911	0.736	0.412	0.138	-0.246	39.121	36.546	17.629	5.877	-10.668
Big	1.131	0.938	0.690	0.426	-0.041	34.523	30.362	20.886	11.846	-1.133
	h					t(h)				
Small	0.396	0.298	0.231	0.279	0.168	6.860	5.567	3.973	4.508	2.818
2	0.517	0.411	0.369	0.356	0.212	17.325	13.250	11.870	10.060	5.657
3	0.480	0.377	0.402	0.352	0.142	19.422	16.363	16.262	13.447	5.878
4	0.352	0.318	0.335	0.243	0.055	14.028	14.660	13.274	9.643	2.212
Big	0.071	-0.057	-0.119	-0.121	-0.204	2.017	-1.718	-3.335	-3.125	-5.233
	a					t(a)				
Small	0.396	0.298	0.231	0.279	0.168	-6.345	-5.661	-3.663	-3.769	-3.035
2	0.517	0.411	0.369	0.356	0.212	-2.929	-2.586	-2.452	-1.792	-0.918
3	0.480	0.377	0.402	0.352	0.142	0.725	0.338	-0.911	-0.900	-2.096
4	0.352	0.318	0.335	0.243	0.055	3.636	3.627	0.672	2.196	1.733
Big	0.071	-0.057	-0.119	-0.121	-0.204	6.204	5.364	5.649	4.581	3.578
	R^2					s(e)				
Small	0.782	0.805	0.737	0.693	0.670	0.782	0.805	0.737	0.693	0.670
2	0.891	0.881	0.864	0.826	0.752	0.891	0.881	0.864	0.826	0.752
3	0.912	0.917	0.897	0.876	0.870	0.912	0.917	0.897	0.876	0.870
4	0.911	0.931	0.890	0.882	0.860	0.911	0.931	0.890	0.882	0.860
Big	0.884	0.896	0.864	0.816	0.768	0.884	0.896	0.864	0.816	0.768

Source: Appendix 5

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DOI: 10.21002/icmr.v9i2.10014

From table 8 above, it is evidence the three factor model are capable to capture the common variation in risk returns since Most coefficients on the three risk factors (b, s, h, and m) remain significant at 0.05 significance level. The market betas are still all significantly positive at the 0.05 significance level. No clear inverse relationship between market beta and size can be found. The SMB coefficients are again negative in the biggest size quintile only. All are significant at the 0.05 significance level except one with the associated t-values of -1.13. The HML coefficient range from -0.204 to 0.517 and all are significantly different from zero. In overall, it suggest that the three factor model three factor model could explain the cross section of average stock returns. However the R^2 resulted from the model is lower compare to model 1 that applied to 25 portfolios formed on sized and BE/ME. In addition it also evidence that 17 out of 25 coefficient of intercepts (*a*) are significantly different from zero at 0.05 level of significance which is lower compare to model 1 applied to portfolio formed on size and BE/ME.

Meanwhile, the four factor model that applied the portfolio of excess return formed on size and previous month return can be seen in Table 9 in the following. It can be seen that the overall four factor model are slightly better compare to the result of the three factor model in Table 8. In overall, market beta are undoubtedly highly significant with all coefficient indicates positive value. The SMB factor again have similar pattern as in Table 8 where the negative coefficient are only accounted for the highest BE/ME quintile while all remain significant. The HML coefficients range from -0.052 to 0.456 but 20 out of 25 are significant at 0.05 significance level. The MOM coefficients, on the other hand, indicates overall significant at 0.05 significance level which is better that the previous model with excess return of portfolio performed on size and BE/ME. The intercepts coefficient are slightly better compare to the three factor model since 9 out of 25 are not significantly different from zero. Further the R2 reported for model 2 again higher compare to model 1 (the three factor) which range from 0.875 to 0.948. Therefore, the four factors, the market, SMB, HML, and MOM, may be sufficient to capture common variation of average returns.

Table 9: Regression of excess stock returns (in percent) on portfolios formed on size and previous month return using model 1 with explanatory variable the size (SMB), book to market equity (HML), and momentum (MOM) for period January 1963 to December 2010, 576 months

Model	$Ri_t - Rf_t = a + b_t(Rm_t - Rf_t) + s_t(SMB) + h_t(HML) + m_t(MOM) + e_t$									
Dependent Variable: Excess return on 25 portfolios formed on size and book to market equity										
Book to market equity (BE/ME) quintiles										
Size quintiles	**Low**	**2**	**3**	**4**	**High**	**Low**	**2**	**3**	**4**	**High**
	b					**t(b)**				
Small	1.061	1.184	1.145	1.180	1.158	42.416	63.771	52.490	49.359	46.887
2	0.900	0.978	1.009	1.068	0.938	53.798	60.985	64.029	61.068	53.585
3	0.881	0.946	0.966	1.002	0.953	53.929	61.710	61.830	60.423	60.522
4	0.890	0.968	0.996	1.027	0.979	53.729	68.262	60.654	61.849	65.133
Big	1.042	1.138	1.125	1.120	1.087	51.722	70.556	68.973	63.770	66.295
	s					**t(s)**				
Small	1.227	0.943	0.592	0.299	-0.137	35.565	36.825	19.680	9.086	-4.011
2	0.961	0.748	0.449	0.154	-0.211	41.659	33.804	20.656	6.407	-8.747
3	0.878	0.651	0.447	0.151	-0.212	39.006	30.808	20.778	6.601	-9.745
4	0.910	0.735	0.412	0.137	-0.248	39.849	37.611	18.190	5.991	-11.952
Big	1.129	0.936	0.687	0.423	-0.044	40.683	42.106	30.558	17.479	-1.945
	h					**t(h)**				
Small	0.176	0.070	-0.009	0.027	-0.066	4.639	2.472	-0.280	0.736	-1.765
2	0.435	0.312	0.267	0.236	0.078	17.111	12.824	11.166	8.904	2.921
3	0.456	0.359	0.359	0.308	0.111	18.401	15.423	15.163	12.227	4.650
4	0.377	0.344	0.367	0.271	0.110	14.978	15.998	14.716	10.741	4.832
Big	0.165	0.058	0.011	0.022	-0.052	5.392	2.370	0.448	0.810	-2.109
	m					**t(m)**				
Small	-0.695	-0.722	-0.759	-0.796	-0.741	-28.435	-39.836	-35.617	-34.124	-30.702
2	-0.259	-0.313	-0.321	-0.377	-0.425	-15.871	-19.971	-20.881	-22.109	-24.840
3	-0.076	-0.058	-0.137	-0.140	-0.098	-4.775	-3.903	-8.956	-8.651	-6.392
4	0.078	0.083	0.101	0.086	0.174	4.812	5.974	6.315	5.296	11.863
Big	0.296	0.364	0.410	0.451	0.479	15.031	23.118	25.741	26.286	29.906
	a					**t(a)**				
Small	-0.388	-0.185	0.105	0.083	0.178	-3.611	-2.313	1.120	0.808	1.673
2	-0.005	0.065	0.084	0.173	0.299	-0.074	0.937	1.240	2.296	3.966
3	0.122	0.076	0.064	0.064	-0.052	1.733	1.161	0.946	0.897	-0.766
4	0.185	0.145	-0.046	0.077	-0.040	2.603	2.386	-0.658	1.076	-0.622
Big	0.344	0.166	0.186	0.082	-0.052	3.976	2.394	2.659	1.085	-0.734
	R^2					**s(e)**				
Small	0.910	0.948	0.918	0.899	0.875	2.461	1.827	2.146	2.350	2.430
2	0.925	0.930	0.923	0.906	0.881	1.646	1.578	1.550	1.720	1.722
3	0.916	0.919	0.910	0.890	0.879	1.606	1.508	1.536	1.630	1.549
4	0.915	0.935	0.897	0.887	0.887	1.630	1.395	1.615	1.633	1.478
Big	0.917	0.946	0.937	0.917	0.910	1.981	1.586	1.604	1.727	1.613

Source: Appendix 5

Since model 2 are considered better to some extent in capturing the variation of stock return, then the second robustness check associated with seasonality are considered important for the residuals of the four factor model. January eefect become standard test in asset pricing models to look for unexplained January effects. It is necessary to examined the ability of model in explaining January seasonals. In FF (1993), January seasonals are also intended to seek whether January seasonals are due to sampling error that may cause

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bias toward rejection. Therefore the test of January seasonals are also conducted in the residuals from the four factor model.

The complete result of January seasonals test from the four-factor model are presented in Table 10 below.

Table 10: Test for January seasonals in the dependent returns, and residuals from January 1963 to December 2010: 576 months

Model	$R_t = a + b_t(JAN) + e_t$									
	a	**b**	**t(a)**	**t(b)**	**R^2**	**a**	**b**	**t(a)**	**t(b)**	**R^2**
Stock Portfolio	**Excess Stock Returns**					**Four-factor regression residuals**				
	Smallest-size quintiles									
BE/ME Low	-0.153	4.983	-0.440	4.129	0.029	-0.147	1.768	-1.521	5.268	0.046
BE/ME 2	0.275	1.742	0.865	1.581	0.004	0.052	-0.623	0.754	-2.612	0.012
BE/ME 3	0.348	1.044	1.185	1.025	0.002	0.061	-0.735	0.945	-3.275	0.018
BE/ME 4	0.530	0.156	2.033	0.172	0.000	0.069	-0.826	1.080	-3.741	0.024
BE/ME High	0.409	0.035	0.208	0.721	0.000	-0.021	0.258	-0.410	1.419	0.003
	Size quintile 2									
BE/ME Low	0.433	4.312	1.445	4.154	0.029	-0.080	0.958	-1.111	3.848	0.025
BE/ME 2	0.534	1.953	2.030	2.143	0.008	0.063	-0.753	0.995	-3.447	0.020
BE/ME 3	0.637	1.141	2.649	1.370	0.003	0.077	-0.926	1.073	-3.718	0.024
BE/ME 4	0.484	0.562	2.120	0.711	0.001	0.080	-0.963	1.082	-3.748	0.024
BE/ME High	0.452	0.137	2.294	0.200	0.000	0.020	-0.234	0.308	-1.067	0.002
	Size quintile 3									
BE/ME Low	0.497	3.996	1.909	4.434	0.033	-0.068	0.819	-1.178	4.082	0.028
BE/ME 2	0.749	1.933	3.148	2.345	0.009	0.066	-0.795	1.112	-3.853	0.025
BE/ME 3	0.687	0.952	3.139	1.255	0.003	0.100	-1.201	1.437	-4.978	0.041
BE/ME 4	0.620	0.851	2.792	1.108	0.002	0.076	-0.911	1.010	-3.499	0.021
BE/ME High	0.415	0.469	2.154	0.702	0.001	0.010	-0.115	0.132	-0.458	0.000
	Size quintile 4									
BE/ME Low	0.671	4.010	2.737	4.724	0.037	-0.067	0.800	-1.134	3.929	0.026
BE/ME 2	0.744	2.224	3.217	2.777	0.013	0.049	-0.590	0.862	-2.984	0.015
BE/ME 3	0.722	1.711	3.381	2.312	0.009	0.043	-0.515	0.624	-2.163	0.008
BE/ME 4	0.725	1.361	3.428	1.859	0.006	0.043	-0.516	0.603	-2.089	0.008
BE/ME High	0.452	0.877	2.345	1.315	0.003	0.016	-0.196	0.260	-0.900	0.001
	Biggest-size quintile									
BE/ME Low	0.718	5.288	2.738	5.816	0.056	-0.124	1.486	-2.089	7.235	0.084
BE/ME 2	0.747	3.367	2.849	3.708	0.023	0.011	-0.129	0.175	-0.605	0.001
BE/ME 3	0.860	2.523	3.583	3.036	0.016	0.027	-0.323	0.339	-1.174	0.002
BE/ME 4	0.690	1.772	2.863	2.122	0.008	0.049	-0.587	0.570	-1.973	0.007
BE/ME High	0.427	1.948	1.970	2.593	0.012	-0.034	0.404	-0.347	1.203	0.003

Source: Appendix 6

Table 10 shows regression results of returns on a dummy variable which is 1 for month January and 0 for the other months. The regression intercepts measures the average return for non-January months and the slope of the dummy variables measure the differences between January returns and average returns in other months.

In table 10, it is evidence that there is indicative of January seasonals in average since the slope of the dummy in overall are range from 0.035 to 5.288 and about half are significantly different from zero. This seasonals effect are associated with size since the difference of average return between month January and other month tend to increase as the size of portfolio gets bigger. However, the January seasonals cannot be associated to Book-to-market ratio since after controlling for the size, the slopes on the January dummy tend to decrease. An interesting explanation to this results are the low returns firms produce January returns that higher compare to other months.

Meanwhile, the regression of four-factor residuals on the January dummy, indicates that in overall of lowest BE/ME quintiles have negative slopes on January dummy and these slopes are small. All other positive slopes of January dummy are also relative small and less than 0.100. In short, it can be seen that the four-risk factor which are the market, SMB, HML, and MOM are able to absorbs the seasonals effect in stocks returns. The January seasonals in the stocks returns are able to be explained by the corresponding seasonals in the risk factors in the four factor models.

8. **Conclusions**

The main objective of this paper is to examines the validity of the four-factor asset pricing in comparison to the Fama French three factor model by employing current data of U.S monthly stock returns. The three-factor asset pricing models includes the market factor (*beta*), the size factor (SMB), and the book-to-market factor (HML). The four-factor asset pricing on the other hand, enhance the three-factor model through inclusion of the fourth factor called "momentum' (MOM) that represents *winners minus losers* in terms of returns. To my concern, this may be the first study that explore both model and assess their performance using current data. In particular, there are some implications that provides by this paper in the spirit of the four-factor model. These implications are as follows:

a. The month-to-month performance of a diversified portfolio of U.S stocks can be explained by the four factor model which are: the portfolio's exposure to the market itself, the small-cap stocks, the value orientation (book to market equity ratio), and the previous month return. This is consistent with Carhart (1997) that argued for the capability of the four-factor model as a performance attribution model, where the premium coefficients for each factor: the market, SMB, HML, and MOM measure the relative power in explaining the volatility of stock returns which is attributable to

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DOI: 10.21002/icmr.v9i2.10014

factor mimicking portfolio. Momentum factor, in particular, are also evidence to able to contribute explanation towards variation in stocks returns

b. The four factor model have proven to some extent have significant capability in explaining the variation in average excess stock returns. The significant coefficient on the four factors in overall as well as insignificant intercepts contributes support to the ability of the four factor model in explaining the U.S stock returns. In addition, the high value of R^2 indicates by the model, although just slightly differs from the three factor model, provides indicative for the robustness of the model.
c. Using longer period data, it is evidence that January seasonals are able to be absorbed by the risk factors, which is the four factor including the market, SMB, HML, and MOM. This results confirms Fama and French (1993) that account for January seasonality in the U.S. stock markets.

Concerning the findings in this paper, it should provide new insights towards understanding to the four-factor model, and thus, there are few comments and suggestions that I believe would enhance future research. These suggestion are as follows:

a. Since the four factor model is seems capable in explaining the variation of the stock returns, then it would be useful to analyse the time variation that attached to each factor (SMB, HML, and MOM) as well as the time variation in the market premiums that best in explaining the variations of portfolio stock returns.
b. In line with the capability of the four-factor model in explaining the U.S. portfolio excess returns, application of the four-factor model in in the firms level would be even more promising since we might able to assess how well the risk factor in predicting return for firm specific.
c. In terms of validity of the model, inclusion of heterocedasticity and autocorrelation test for residuals in the stage of analysis would be useful since it may provide important information that still cannot be captured by the model.
d. With a valid asset pricing model, we can establish a better and accurate benchmark for investors and help them in understanding the market condition. Therefore, application of this model in emerging markets such as Indonesia would be important. First, emerging markets differs in structure compare to developed countries. Second, the data used would be not highly correlated to the data used in previous study, thus the results

will not subject to the criticism of data snooping. Finally, the results should contribute to better understanding on how investors price assets as well as checking the validity of the four factor model in different market context.

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DOI: 10.21002/icmr.v9i2.10014

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