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The Extended Fama-French Three Factor Model: Revisited

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This paper is aimed to validate the four-factor asset pricing model as an improvement towards the standard Fama-French three-factor model. Using U.S. monthly stock returns data from period January 1963 to December 2010, we construct 25 portfolios and the four-factor model includes the market factor (beta), the size factor (SMB), the book-to-market factor (HML), and the 'momentum' factor (MOM). Similar time series method as in Fama and French (1993) are employed to elaborate the three-factor model and the four-factor model regression. Our findings show that the four-factor model to some extent has significant capability in explaining the variations in average excess stock returns. Although the R2 extracted from the four-factor model is just slightly higher than the three-factor model, yet it provides suggestive for the robustness of the four-factor model. In addition, our robustness test shows that January seasonal effect is absorbed by the risk factors including the market factors, SMB, HML, and MOM factor. The consistency of the four-factor model in explaining the U.S stock market return variations for the newest data, provide relevance to apply this model in emerging markets data in order to give guidance for investor in understanding the market condition.

Keywords: *factor model, four-factor model, three-factor model, asset pricing, stock return*

JEL classification: G12; G17

Introduction

One of the most important long-term argument in asset pricing is the trade-off between risk and return while the most relevant issue is how investment risk affects investors' expected return. Previous empirical research papers in asset pricing have been attributed to provide best guidance to help investors achieved their goals in maximizing their portfolio of expected return subject to a relevant level of risk or minimizing their risk subject to relevant expected return. Markowitz (1952) has pioneered the work ground for asset pricing in which portfolio valuation as well as stock behaviour has become major interest subject. Inspired by the Markowitz framework, Sharpe's Capital Asset Pricing Model (CAPM) was introduced in the early 1960s which offered comprehensive view on understanding the return and risk concepts. The CAPM is a breakthrough concept which based on the idea that not all the risk would affect assets' prices and can be diversified away through portfolio construction. The theory also suggests that the only relevant risk measure for investment is *beta coefficient* or systematic risk. Therefore, CAPM implies the linear and positive relationship between expected return of asset and its market beta or systematic risk. In other word, there is a trade-off between expected return and beta factor.

CAPM's notion has provide commonly ac-

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ceptable interpretation that beta is the main sensitivity measurement for assets return variation in the stock market. Early studies towards asset pricing are able to support this idea (Lintner, 1965; Black, Jensen, and Scholes, 1972; Fama and Macbeth, 1973) but later finding seems to point out on different directions. Other firms' characteristics has been proven to also have important explanatory power toward average stock returns such as 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).

Motivated by those deviations in later studies, Fama and French (1992) elaborate influential research which take into considerations all factors including *size*, *leverage*, *Earning per Share (E/P)*, *Book to Market* (BE/ME) and *Beta* in a single cross-sectional model. Two important findings from this study are: First of all, regarding CAPM's estimation, if beta is permitted to vary unrelated to size, then the positive linear beta-return relationship will vanish. Secondly, due to lack performance of beta in explaining stock returns, this research then evaluated the explanatory power of *size, leverage, E/P, BE/ME* and *size* and concluded that *BE/ME* and *size* were two variables that have significant impact in defining stock returns. Not only appreciated as innovative but negative reactions were also emanated. Some were argued that those result are due to data mining (Black, 1993; MacKinlay, 1995) while others commented the data evaluated which cannot be excluded from survivorship bias and possible beta mis-measurement (Kotari, Shanken, and Sloan, 1995). Nevertheless, most researchers approved that *size* and *BE/ME* is two important factors to consider in explaining cross-section of returns in the U.S. data.

Motivated by the negative reactions of their study, Fama and French (1993) pulled out research extensions to provide answer by using risk-based concepts, that two-firm specific factors including size and book-to-market ratio are able to explain significant amount of variation in stock returns. Fama and French (1993), hereafter FF, employed a time-series regression model to the U.S. stocks data for the year 1963 to year 1991. In their results, FF (1993) provided a three-factor asset pricing model which include a market factor (excess market return), a size factor (SMB) and book-to-market ratio factor (HML). SMB (small minus big) defined as 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 high value stocks minus the return on a portfolio of growth stocks. FF (1993) study is supported by findings from Merton's ICAPM (1973) that investors demand risk premium as compensation from risk that comes from size and book-to-market. FF expand further their studies in 1996 in order to provide explanation towards anomalies which cannot be explained by CAPM. FF (1996) shows that overall market factors as well as firm size and book-to market-ration are

In 1996, FF extend their research by restating their model through multifactor explanation which able to explain certain CAPM anomalies. FF (1996) show that in overall market factor, firm size factor and book-to-market equity factor are important for investors. Only one factor that remains anomaly which is the momentum factor in relation to the study of Jegadesh and Titman (1993). Other anomalies including E/P, cash flow yield, sales growth and long-term past return dissolve in the model. The momentum factor anomaly or "momentum effect" in which past winners (losers) continue to perform best (poor) need to be further investigated so that investors' strategies to hold one stock for 12 months will work. Following up this issue, Carhart (1997) constructs a risk factor related to momentum effect called WML and extend the FF three-factor model into a four-factor model. WML is defined as the return on portfolio of winner-stocks minus the return on a portfolio of loser-stocks. Surprisingly, Carhart (1997) is able to show that the four-factor model is outperformed the three-factor model of FF (1993) by reducing the average pricing errors of portfolios which sorted by 1-year lagged returns. Subsequently, Daniel et al. (1997) and Wermers (1997) provide supporting evidence that the four-factor does well in mutual fund per-

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formance while Brav et al. (2000) documents the ability of the four-factor in explaining the underperformance of return in Initial Public Offering (IPO) and Seasoned Equity Offering (SEO) firms. Later study by Kim and Kim (2003) also state that the four-factor model is important in explaining the abnormal pattern of the post-earning announcement returns.

Despite the novelty of both the three-factor model of FF (1993) and the four-factor model of Carhart (1997) to date there is still no direct comparison to both models in the same market data, and thus re-assessment of both models is interesting. Not only to highlight the relevance of each model with newest condition in the stock market by updating the data from the same U.S. market as well as contrasting each model performance after almost a decade. Therefore, this paper is intended to provide empirical re-examination and validity of both the three-factor model and the four-factor model by using longer and newer data period. Particularly, the objective are as follows: (1) re-examine the empirical performance of the three-factor model and the four-factor model, by employing data from the year 1963 up to the year 2010; (2) evaluate the findings to contribute the discussion on the robustness of the four-factor model, whether the size factor and the book-to-market factor are the main variables that able to explain the common variation of the U.S. stock returns, or the additional momentum factor that is outperform. Hence, the consistency of both models is able to evaluate.

Literature Review

FF (1993) model states that the expected return on a portfolio in extra to the risk free rate can be explained by the explanatory power of these three variables including: (i) the excess return on market portfolio; (ii) the difference between the return on a portfolio of small stocks and the return on a portfolio of large stocks (SMB which stands for *Small Minus Big*); and (iii) the difference between the return on a portfolio of high-book-to-market stocks and the return on a portfolio of low-book-to-market stocks (HML which stands for *High Minus Low*). SMB represents the size premium or the additional return that investors get from investing in stock of small firms while HML represents the value premium or the extra return that investors get from investing in stock with high market book-to-ratio which commonly refers to BE/ME ratio. The theoretical model of three-factors regression is as follows:

$$R_{jt}\text{-}R_{ft} = a_j+\beta_j(R_{mt}-R_{ft})-s_jSMB+h_jHML \qquad (1)$$

where R_{jt} is the weighted return on portfolio j in period t; R_f is the risk-free rate; β_j is the coefficient for the excess return of the market portfolio over of the risk-free rate; s_j is the coefficient for the excess average return of portfolios with small market capitalization over portfolios of big market capitalization; while h_j is the coefficient for the excess average returns of portfolios with high book-to-market ratio over portfolio with low book-to-market ratio. Since s_j and h_j coefficients, each of which represent the sensitivity of the portfolio's return to the SMB and HML factors, then it implies that large market cap portfolios will have negative s value while small market cap portfolios will have positive s value as well as negative value of h for portfolios constructed from growth stock and positive h value for portfolios constructed from value stocks.

It is clear that FF (1993) model is the extension toward the standard CAPM through inclusions of two factors as identified in Fama and French (1992) which are the size effect and book-to-market ratio effect. Again, SMB factor is a measure of "size premium" which implies that stocks of small companies are more sensitive to various risk since they are more pronounce to negative effect of financial events. Meanwhile, the HML factor represents "value premium" in which value stocks with high BE/ME tend to have less risk exposure compare to growth stocks with low BE/ME. Instinctively, new IPO companies will require minimum size in order to be able to do so and if later these companies report the high BE/ME, this might be an indication that their public market value since they are unable to cope their future earnings (Allen et al., 2009).

Table 1. BE/ME Breakpoints

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

Source: French (2011)

Subsequently, Jegadesh and Titman (1993) reported that the *momentum strategy* could at least contributes average returns of 1% per month for the following 3–12 months. Momentum strategy, also sometimes known as "Fair Weather Investing", is a way to invest by buying stocks or other securities that reported high returns over the past three to twelve months, and selling those that reported poor returns over the same period (Jegadesh and Titman, 1993). In an attempt to also capture momentum strategy returns, Carhart (1997) adds the fourth factor into the FF (1993) model called WML (which stands for *Winner minus Loser*). WML is constructed by sorting the winner stocks and the loser stocks on the market based on previous year return. WML is then calculated as the difference between the return of winner stocks' portfolio and the return of loser stocks' portfolio. Theoretically, the extended three-factor model or the four-factor model can be written as follows:

$$R_{jt}\text{-}R_{ft} = a_j+\beta_j(R_{mt}-R_{ft})-s_jSMB+h_jHML +w_jWML \quad (2)$$

where $R_{jt}-R_f$ is the excess returns of portfolio, a_j is the slope coefficient while β_j, s_j, h_j, and w_j are the factor loadings for each independent variable including market factor, SMB, HML and WML

Data and Methodology

Data

In order to achieve the objectives, this study used the same data and methodology as in FF (1993). To test the robustness, the same data as in the original study of FF (1993) but with longer period is necessary. These data were collected from Kenneth French website including the monthly stocks returns on portfolio of the U.S market 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 toward the portfolio and the factors construction as in FF (1993). The U.S. market monthly stock returns are created into 25 portfolio based on their value weighted while the factors construction including SMB (small minus big), HML (high minus low), and MOM (momentum).

Methodology

In order to obtain results which could serve as robustness comparisons between the three-factor model and the four-factor model, this study employs similar methodology and evaluation process as in FF (1993). At the first step, explanation towards factor constructions as well as how it is measured is important. Later the discussions on method of analysis is also clarified. The factors construction and stock returns formation details are as follows:

a. Factors Construction

In every year, at end of month June, the NYSE, AMEX, and NASDAQ stocks are assigned to groups based on their size (Small-S, Big-B), and BE/ME ratio (High-H, Medium-M, Low-L). Six portfolios are then 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 1. SMB and HML factor 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 De-

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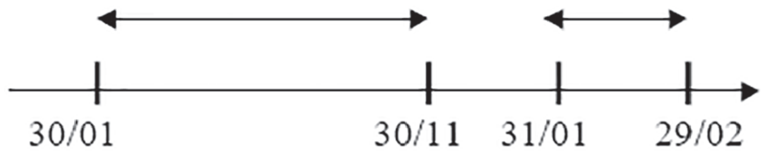
Figure 1. Window Period of Portfolio Formation



Source: Fama and French (1993)

cember of *t-1* and June of *t*, and (positive) book equity data for t-1 (French, 2011).

Each variable calculation is then conducted as follow:

1) Market
Market factor is proxied as the excess market return from the risk-free rate return $(R_m - R_f)$. R_m-R_f, is calculated as the value-weight return on all NYSE, AMEX, and NASDAQ stocks (from CRSP) minus the one-month Treasury bill rate (collected from Ibbotson Associates).

2) SMB
The portfolio SMB (*Small minus Big*) is intended to mimic the risk factor in return related to size. SMB is calculated as 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 formulation is as follow:

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

3) BE/ME
The portfolio HML (High Minus Low) is aimed to proxy the risk factor in returns related to book-to-market equity. HML is calculated as 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 in the following:

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

4) Momentum
To proxy momentum factor, 6 value-weight portfolios are constructed based on size and previous returns (2-12). These portfolios, which constructed monthly, are the intersections of 2 portfolios constructed based on size (market equity, ME) and 3 portfolios formed on previous return (2-12). The monthly size cut-off point is the median of NYSE market equity. The monthly previous return (2-12) breakpoints are the 30th and 70th NYSE percentiles. Similar to, SMB and HML return portfolios, MOM factor is then calculated as the average return on the two high previous return portfolios minus the average return on the two low previous return portfolios. The formula is as follow:

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

b. Portfolio Stock Return Construction

The next important stage is the construction of portfolio stock return construction. As FF (1993), it is required to form 25 portfolios based on size and BE/ME. These portfolios later will be used as dependent variables in the time series regressions. The 25 size-BE/ME portfolios are performed at the end of each June for each year of data. They are basically the joints between 5 portfolios formed on size (market equity) 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 themselves are the NYSE quintiles. Thus, the portfolios for July of year *t* to June of *t+1* will include all NYSE, AMEX, and NASDAQ stocks since the market equity data for December of *t-1* and June of *t*, and book equity data for *t-1* are all available. Value-weighted monthly returns on portfolios are calculated from July to June. The date of portfolio construction details is presented in Figure 2.

In Figure 1, it is clear that at the beginning of each month all NYSE firms with returns from

Table 2. The 25 Portfolio Representations

Size (From Small-to Big)		BE/ME (From Low to High) 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

Source: adapted from Fama and French (1993)

t-x to *t-y* are grouped into deciles based on their continuously compounded returns between *t-x* and *t-y* (Fama and French, 1993). From which then the portfolios are constructed each month. Next, the 25 portfolio representations employed in this paper along with the name for each quintile is presented in Table 2.

After the data collections and portfolios constructions for all available data, analysis is then conducted. The details of analysis tested in this paper are in the following:

a. Descriptive statistics

The first step of evaluation is explaining the descriptive statistics for each variable including size (ME), book-to-market equity ratio (BE/ME), as well as the number of firms employed. In addition, the descriptive statistics for dependent variables which is average excess return as well as independent variables including the market, SMB, HML and MOM factor are also depicted so that it can be examined whether the data patterns are still exist even though the period of evaluation is extended.

b. Time Series Regressions

The second stage of evaluation is conducting the time series regression for dependent variable and independent variables. Definition of each variables is presented in Table 3.

Further evaluation towards the role of stock markets variables involves two models as follows.

1) The Market, SMB, and HML

This model in aimed to examine the role of all three factors in explaining variation of stock returns. The independent variables include R_m-R_f , SMB and HML as in the following:

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

2) The Market, SMB, HML and MOM

The role of the four-factor model is investigated using this following model in which R_m-R_f , SMB and HML as well as MOM are the explanatory variables. The main intention is to evaluate the role of MOM

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

The evaluation on each model, in particular for its R^2 shows how well each model in the average excess return. In addition, the sign of coefficient *b, s, h,* and *m* will represent the size and direction of relationship of each variable with stocks returns as well as the level of compensation that should be paid for each variable. Therefore, if the four-factor model worked, then the regression coefficients of each variable (*b, s, h,* and *m*) would be significant and different from zero.

c. Cross Sections Average Returns

The next step conducted after the time series regression using two previous models is to evaluate the the average risk premium for each model in explaining the cross-section of average return on stocks. As Merton (1973) argued that a well-specified asset pricing model creates an intercept that is insignificantly different from zero. If an intercept is estimated by regressing excess returns of stock or portfolio on excess returns of zero-investment portfolios, then the intercept is simply will capture nothing. Therefore, if the four-factor model is valid, then the intercept created using Eq. (7) would be be not significantly different from zero.

d. Robustness Check

The robustness test of each model performance is run in few ways. Firstly, it will be performed based on size and previous return or the portfolio that constructed based on *size and momentum*. This analysis is aimed to check whether the stock market factors that capture

Table 3. Variables Definitions

No	Variable	Definition	Measurement
		Dependent Variables	
1	R_i-R_f	Average excess return	R_i is value weighted of monthly stock returns performed on 25 portfolios R_f is the one-month treasury bill rate, observed at the beginning of the month
		Independent Variable (Common Risk Factors)	
No	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 R_f 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) and Carhart (1997)

the average return on size and BE/ME portfolios performed size and momentum. In order to run this check, the value weighted monthly excess return in percentage of portfolios that formed size and momentum are necessary. Both of this portfolios data are also available in Kenneth French website. These portfolios 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 for the period January 1963 to December 2010. The monthly size cut-off points are the NYSE market equity quintiles while the monthly prior (2-12) return cut-off points are NYSE quintiles. Next, the time series regression that duplicates the equation (6) and (7) such as previously conducted on portfolios based on size and book to market equity is conducted in order to check whether R_m-R_f, SMB, HML, and MOM can explain the returns on portfolios formed size and momentum.

The second robustness test is the test of *seasonality effect* conducted for both models (the three-factor and the four-factor). Previous studies such as Roll (1983) and Keim (1983) documented that the stock returns on small stocks tend to be higher in January. Therefore, the January effect test is commonly used to check the validity asset pricing model since it can be seen the difference of return between January and other months explained by the model. If the model is valid and efficient, then it is expected to see that the residuals created would have no impact on the average stock returns.

Findings and Discussions

Descriptive Statistics

The first result presented is the descriptive statistics of 25 portfolio formed on size and book to market equity ratio as shown in Table 4. It is apparent that 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 stocks are getting smaller. In overall, the five portfolios in the largest ME quintiles accounts for about 78% of total value. The portfolios of stocks in both the largest size and the lowest BE/ME (B-L) only, includes for more than 32% of the combines value of the 25 portfolios. In the biggest size quintile, the market value indicates a strong decreasing trend along with the increasing BE/ME. This inverse relationship between size and BE/ME is expected to be caused by the biggest size quintile while in overall the result is slightly higher compare to FF (1993). One possible explanation was due to longer period of observation used in this study which accounts for larger number of firms and stocks included in observation.

Figure 2. Average Firm Size for 25 stock portfolios performed on Size and BE/ME

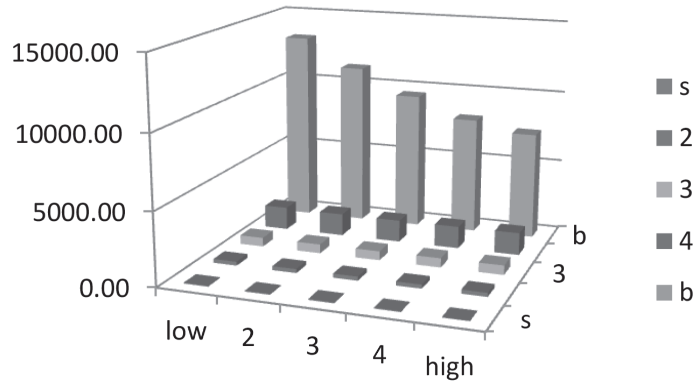


Figure 3. Average of annual percent of market value for 25 stock portfolios performed on Size and BE/ME

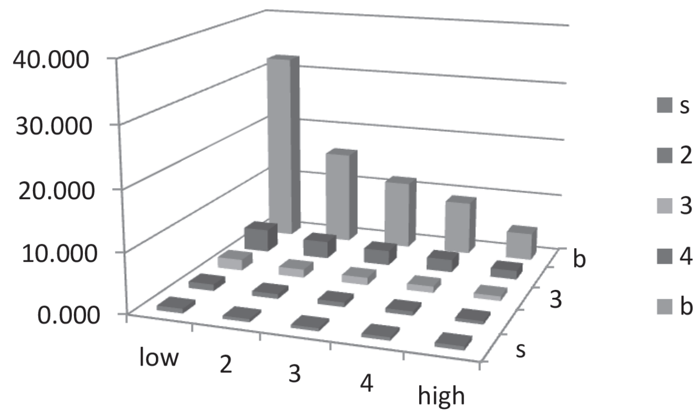


Table 4. Descriptive Statistics for 25 portfolios formed on Size and Book-to-Market Equity: 1963-2010, 37 years

	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: data analysis

Pattern of each size and book to market equity quintiles portfolios in regard to size and market value of equity can be seen in Figure 2 and 3 in the following. It is evident that since 1963, small stocks in the U.S. have outperformed large stocks. Similarly, stock with low ratios of book to market ratios have outperformed stocks with high BE/ME.

The second result concerning the descriptive statistics of both dependent variable and independent variables are presented in Table 4. It can be observed that average excess returns of 25 portfolio constructed on size and book to market equity are ranged from 0.262% to 1.005% per month. This pattern confirms the result of FF (1993) as well as validates result

Figure 4. Average Excess Return for 25 portfolios formed on Size and BE/ME

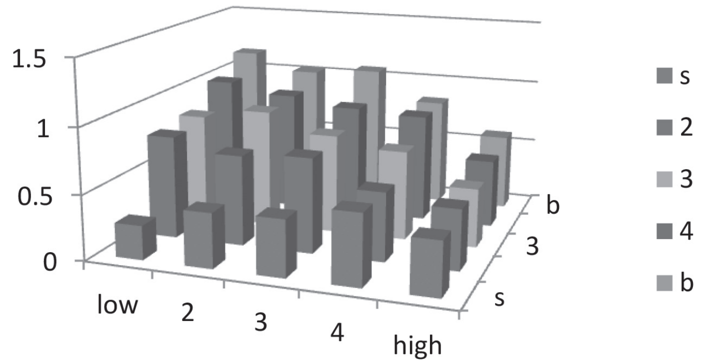


Table 5. Summary Statistics for monthly dependent and explanatory returns (in percent) for period January 1963-December 2010, 576 observations

Name				Autocorr. For lag			Correlations				
				1	2	12					
	Explanatory Returns										
	Mean	Std.	t(mn)				RM	RMRF	SMB	HML	MOM
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: data analysis

in Fama and French (1992) in which size and average return exhibit the negative relationship. In contrast, there is a strong positive relationship between average return and BE/ME. In overall BE/ME portfolio, except the lowest, average return monotonically decrease from small to big size portfolio. This evidence also confirms previous descriptions of firm size and market value as in Figure 3 and 4. In addition, in every size quintile, average returns tend to increase along with BE/ME as can be seen in Figure 5. On the other hand, the standard deviations of average return of portfolios of BE/ME quintiles varies from 4.429% to 8.117%, which is subsequently high. FF (1993) suggests that this might be an indicative that common risk factors in returns can absorb most of the variation in stock returns, so that enable the test of an intercept in time series regression to be more accurate (Fama and French, 1993).

From the explanatory variables' descriptions in Table 5, 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 contributes an important role in the model and able to capture the systematic risk 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

Figure 5. SMB coefficient resulted from Model 1 in regression of 25 portfolio formed on Size and BE/ME

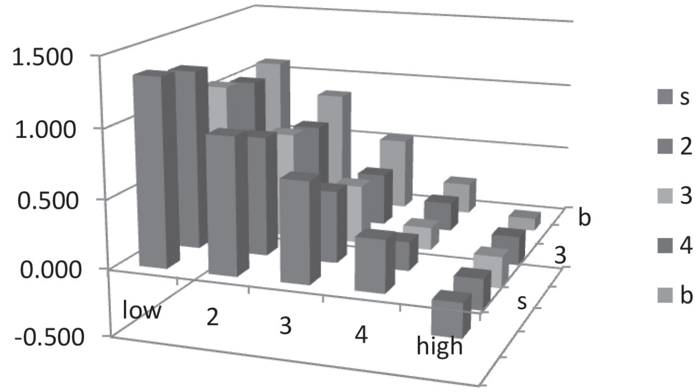


Table 6. Regression of excess stock returns (in percent) on the size (SMB) and book to market equity (HML) for period January 1963 to December 2010, 576 months

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: data analysis

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 is also relatively high. As the fourth factor, momentum, the average returns is about 0.716% per month (t=3.968), while the correlation to all other factors are found to be negative.

Time Series Regressions

The Three-Factor Model

The result of time series regression of excess returns on 25 stock portfolios formed on size and book to market equity with excess market returns (*Rm-Rf*), SMB (size factor) and HML (book to market equity factor) is presented in

Figure 6. HML coefficient resulted from Model 1 in regression of 25 portfolio formed on Size and BE/ME

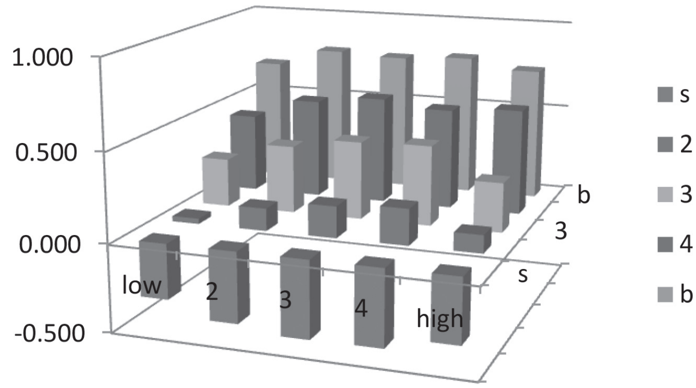


Table 5. The are some important findings to highlight. *First,* it depicts the same coefficients figure as in FF (1993) although the data employed are longer in period. *Second,* it is evident that altogether the three-stock market factors can serve well in capturing variation of stock returns. *Thirdly*, SMB, as the mimicking return for the size factor, indicates significant relation to excess return. It shows mostly higher *t-statistic* value which is more than 10. Meanwhile, in each book to market quintile, SMB factor displays monotonic decrease from lower to higher portfolios as well as as from smaller to bigger size portfolio except for the biggest size portfolio that slightly higher compare to previous size as depicted in Figure 6. *Fourthly*, HML, as the mimicking factor for book to market equity, also has significant relationship to excess stock returns. As shown in Figure 6, the increasing pattern of HML factor from the smallest to biggest BE/ME quintile varies from strong negative coefficient to strong positive coefficient with *t-statistic* greater than 4.0.

Overall, both SMB and HML are able to capture the shared variation of excess stocks return 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 particular, SMB was able to capture shared variation which cannot be explained by market factor and by HML while HML was also able to capture common variation which cannot be explained by R_m-R_f and SMB. As for the R^2 value also confirms the result that by including SMB and HML factor along with market factor could increase capability of model in explaining excess stock returns. The R^2 value of all portfolio are more than 80%. Along with the motivation of multifactor model suggested by Merton (1973), these results confirm that the three-factor model might provide better explanation towards risk.

The Four-Factor Model

Table 7 presents the results from the time series regression of the 25 size-BE/ME portfolios' excess returns on market factor, SMB, and HML, and MOM. The results indicate that all the four factors including market factor, SMB, HML, and MOM are able to explain the variation of average returns in the U.S stock market. As in the three-factor model, there are also some important highlights. *Firstly*, the pattern of SMB coefficients is similar to the three-factor model tested before and the original FF (1993). The coefficient of SMB varies from -0.250 to 1.356 and negative in the biggest BE/ME quintile only while all coefficients are significant and systematically related to size from the smallest to the biggest quintile. *Secondly*, the HML coefficients also has similar pattern as in previous model. The coefficient of HML indicates an increasing pattern along with BE/ME and their values varies from -0.404 to 0.782 which is slightly less than previous model 1. Most of these coefficients are positive, instead of the smallest size quintile, and all are significantly different from zero. *Thirdly*, the interesting figure are shown by MOM coefficients. As can be seen in Figure 7, MOM coefficients values vary from -0.049 to 0.021 with most of

Table 7. 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: data analysis

them are negative (22 out of 25). The positive coefficient is mainly found in the smallest BE/ME portfolio. There is no strong relationship detected between the momentum factor and the 25 size BE/ME portfolios since only 9 coefficients that are significantly different from zero at 5% significance level and 1 coefficient at 1% significance level while other coefficients are not. This result specifies that to a certain level the MOM factor has ability to explain the time-series return variations.

As for the R^2 value, it indicates that it only increases slightly compare from regression of the previous three-factor model. The R^2 varies from 80.2% to 95.3% while in previous model it ranges from 80.1% to 95.1%. There are 13 cases out of 25 that experiences R^2 increase after the inclusion of MOM factor while the other 12 case are decrease. Remarkably, the fourth biggest BE/ME portfolio all experience decreases which is an indicative that the return variations of bigger firms is somewhat better to be explained by the four-factor model.

Cross-Sections of Average Returns

Further analysis is focused on the intercepts resulted from the regressions model in order to test the validity of both the three-factor and the four-factor model. Summary of intercepts resulted from each regression model can be seen in table 8.

For *Model 1*, in which all the three factors are evaluated, the intercepts values are closer

Figure 7. 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

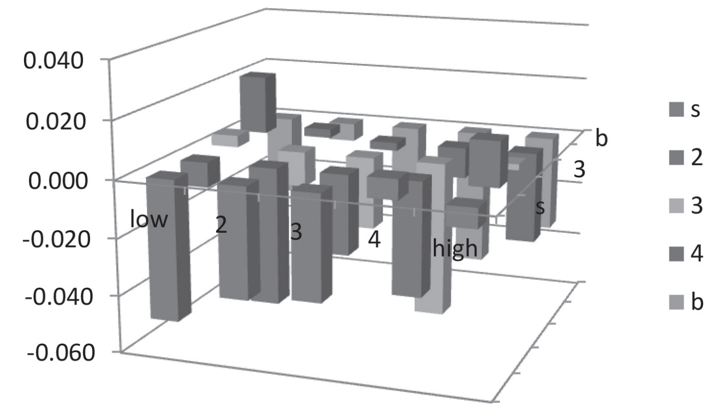


Table 8. Intercepts from excess stock returns regression for 25 stock portfolios formed on size and book market equity: January 1963 to December 2010, 576 months

	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: data analysis

to zero. The *t-statistic* observed also indicated that only 6 cases from 25 cases that significantly different from zero, while others are insignificant. This result is similar to FF (1993) which then can be concluded that the validity of the three-factor model still holds in the longer period of data. In addition, intercepts that are not different from zero indicates that together, R_m-R_f, SMB, and HML are able to explain the cross-section of average stock returns.

On the other hand, for *Model 2*, in which MOM factor is included in the model, the results are approximately similar to *Model 1*. There are only 6 cases from 25 cases that appears to be significantly different from zero with the intercept coefficients varies -0.420 to 0.151, which are slightly higher compare to *Model 1*. These results confirm the significance of the four-factor model in explaining the cross-section variation of average returns in the U.S. stock market.

Robustness Test

The first robustness test is performed by constructing portfolio using size and ME, which is market capitalization at the end of the previous month. This analysis is aimed to observed the capability of the three-factor model and the four-factor model in explaining return of portfolios from previous month. 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 robustness results for Model 1 and Model 2 are

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) and book to market equity (HML) for period January 1963 to December 2010, 576 months

Model	$Ri_t\text{-}Rf_t = a + b_t(Rm_t\text{-}Rf_t) + s_t(SMB) + h_t(HML) + e_t$									
	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: data analysis

presented in Table 9 and Table 10 subsequently.

It can be observed in Table 8 that the three-factor model are capable to capture the common variation in stock returns since most coefficients on the three risk factors (*b, s, h,* and *m*) continue to be significant at 5% significance level. Although, the market betas are all positive significant at the 5% significance level, yet there is no indication of reverse association with size. The SMB coefficients are again negative in the biggest size quintile only while all are significant at the 5% significance level except one case with the associated *t-values* of -1.13. The HML coefficients varies from -0.204 to 0.517 and all are significantly different from zero. In overall, it is suggested that both the three-factor model and the four-factor model could explain the cross section of average stock returns. However, the R^2 resulted from the Model 1 is lower compare to Model 1 that applied previously to 25 portfolios formed on sized and BE/ME. In terms of intercept, there are 17 out of 25 coefficient of intercepts (*a*) that significantly different from zero at 5% level of significance which is less than Model 1 that applied to portfolio formed on size and BE/ME.

Results presented in Table 10 show that to some extent, the four-factor model performs better compare to the three-factor model shown in Table 9. In overall, market betas are positive and significant while the SMB factor also has similar pattern as in Table 8, which is all positive and significant instead of the negative coefficient for the highest BE/ME quintile. The

Table 10. 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: data analysis

HML coefficients vary from -0.052 to 0.456 with 20 cases out of 25 cases are significant at 5% level. Meanwhile, the MOM coefficients are all significant at 5% level which is better than Model 2 that run on the portfolio constructed on size and BE/ME. The intercepts coefficients are slightly better than Model 1 since 9 out of 25 cases only that are not significant. Similarly, the R^2 reported for Model 2 is also higher than Model 1 which range from 87.5% to 94.8%. Therefore, as suggested in the main result, the four factors including the market, SMB, HML, and MOM might be important to explain common variation of average stock returns in the U.S. market.

Since Model 2 is considered well enough to capture the stock return variation, then the second robustness test concerning the seasonality effect will be conducted based on Model 2 or the four-factor model. The test of January effect will be conducted on both the dependent returns and the residuals of the four-factor model. Previous studies, including Fama and French (1993) agree that January effect is important in

Table 11. 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: data analysis

validating asset pricing model. It is important to look out whether the January seasonal is caused by sampling error that can cause bias. The complete results of this test are presented in Table 10.

The first part of Table 10 shows the regression results of dependent returns of the four-factor model with a dummy variable which is equal to 1 for month January and 0 for the other months. The regression intercepts indicate the average returns for non-January months while the coefficient of the dummy variables measure the differences between returns of January and average returns of other months. In table 10, there is an indicative of January effect in most cases since about half of the coefficients of the dummy variable mostly in overall are not significantly different from zero while their values vary from 0.035 to 5.288. This seasonal effect might also be linked with size since average return differences between month January and other month tend to increase as the size of portfolio gets bigger. However, the January effect seems unrelated to book-to-market ratio since the coefficients of dummy variable tend to decrease after controlling for the size. An intuitive interpretation from this result is that the small firms might higher returns in January compare to other months. However, this suggestion is still need to be evaluated further.

On the second part of Table 11 shows the regression of four-factor residuals on the January dummy. In overall, it shows that the lowest BE/ME quintiles have negative coefficient on January dummy while its value is also relatively small. Meanwhile, all other positive coefficients of January dummy are also relatively small and less than 0.100. This evidence suggests that the January effect in the U.S. stock returns is able to be absorbed by the four-risk factors which are the market, SMB, HML, and MOM. In other words, the January effect in the U.S. stocks returns can be explained by the corresponding January effect depicted in the risk factors included in the four-factor model while in turns validate the reliability of the model.

Conclusions

The main objective of this paper is to examines the validity of the four-factor model in contrast to the Fama French three-factor model by extending to longer and more recent data of the U.S. monthly stock returns. Based on the results of this research, there are some important implications to be highlighted. *First*, the monthly returns performance of the U.S. stock market can be explained by the four-factor model which is consistent with the finding from Carhart (1997) that suggest the four-factor model as a performance attribution model. In particular, momentum as factor mimicking portfolio is also evident to contribute explanation toward return variations. *Second*, to some extent, the four-factor model also has significant capability in explaining average excess return variations. The four-factor model is also found to be robust in the longer period of data since the R^2 values resulted from the model is relatively high. *Third*, the January seasonality is able to be absorbed by overall factor including the market, SMB, HML, and MOM which again clarifies the strength of the four-factor model.

Despite the important findings that provide insight in understanding the four-factor model this study is also limited since it does not account for time varying returns. Therefore, for future study it might be important to allow time variation in each factor as well as in the market premiums. It would also interesting to evaluate the ability of the four-factor model in the firm level and assess how well the risk factor in predicting return of specific firm or industries. In terms of model validity, conducting autocorrelation and heterocedasticity test for the residual is also important to provide information that cannot be captured by the model. As for model extension, adding the new risk factor toward the standard three-factor model is also interesting such as recent study by Fama and French (2014) with their five-factor model which include profitability and investment variable as their fourth and fifth factor. In addition, since a valid asset pricing model can provide accurate benchmark for investor in understanding the market condition, then applying this research using emerging market data such as Indonesia will be important. Testing the validity of the four-factor model in different market structure and trading scheme will be interesting yet challenging while in last the result will provide wide information on how asset pricing works.

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