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Systematic risk determinants of stock returns after financial crisis: evidence from United Kingdom.

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Systematic risk determinants of stock returns after financial crisis: Evidence from United Kingdom

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Abstract

This paper provides an empirical analysis of FTSE100 stock returns during the period of 2009 to 2013 with an aim to assess the relevancy of Fama- French three factor model post financial crisis of 2008. FTSE100 index was chosen in particular as it is benchmark of the prosperity among UK stocks. Assortment of six portfolios S/L, S/M, S/H, B/L, B/M and B/H based on firm's size and book-to-market ratio was constructed as per guidelines of Fama- French model. The ordinary least square estimation showed consistently positive and significant in all observed portfolios. However the results indicated that *excess market return* is the dominant variable among three risk factors meanwhile size factor (SMB) was significant while explaining only small-scale portfolios returns but had no effect on the average returns of large-scale portfolio. Likewise value factor (HML) appeared to be somewhat effective only in case of high book-to-market stock portfolios. Thus the impact of book-to-market value on the average excess returns of these observed portfolios behave in an un-systematic manner.

JEL classification numbers: C1, C3, G3

Key words: Stock market returns, stock exchanges, Fama and French, CAPM

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1 Introduction

In the aftermath of global financial crisis investors are weary regarding the expectation of pay off that investment in financial markets can eventually yield. Despite the heightened cautiousness towards investment, the basic tenet for success in stock market still remains same - maximize return and minimize risk. The apparent risk return tradeoff which entails higher return for lower risk or lower uncertainty and vice versa is fundamental concept of financial economics [1]. As a result, the investors should make their investment decisions based on their risk-taking capabilities or risk tolerance. Seminal work by Markowitz [2] introduced mean variance model which assumes all investors are risk-averse, and the portfolios selection which is efficient in diversification of investments must meet two main conditions: “(1) minimize the variance of portfolio return, given expected return, and (2) maximize expected return, given variance” (Markowitz [2]). Later Capital Asset Pricing Model (Sharpe [3] and Lintner [4]) further built upon Markowitz and suggested that excess average returns of particular assets are only impacted by excess average returns of the market portfolio or the non-diversified risk (β - beta) that is explained by the correlation between its return to market average return. In other words, investors will be compensated by time values that are represented by returns of risk-free assets and returns required for any additional risks from excess average returns of the market portfolio. Initially in accordance to CAPM model studies Fama and MacBeth [5] suggested that the market risk was the sole factor explaining cross-sectional expected returns of stocks. However later studies suggested that besides Market risk other explanatory variable such as size effect (Reinganum [6] and Banz [7]), value effect (Fama and French [8]) and liquidity (Amihud and Mendelson, [9]; [10]) exist to explain the expected market return. In particular Fama and French [8] showed that CAPM failed to explain the cross section of average return in US stock from 1962- 1990. As a result Fama French three factor model ([8], [11]) was introduced that established empirical relationship between excess return with market risk, size factor and value factor. Its three central findings are firstly there are pervasive market-based, size-based and value-based risk factors in the United States stocks average earnings. Secondly, there exists a linear correlation between these factors and cross-sectional expected average returns. And finally, these three risk factors are pervasive in United States earnings growth rates, and these earnings factors can be connected closely to the stocks return factors.

It is imperative that before making any investment decisions, investors should know what factors can affect expected average returns of stocks so that they can build an optimal portfolio (Amanda and Husodo, [12]). Yet employing the wrong theory or model can result in serious inaccuracies in capital budgeting, investment evaluations, and risk analysis decisions (Griffin [13]) and not all these theories

created can work effectively in different financial markets and period of times. In other words, many anomalies or problems could arise when applying them in different international market conditions which have motivated academics to investigate these theories or models more occasionally in order to prove that they are still available and reliable up to date.

This research attempts to investigate the relevancy of predicting power of single factor and multi-factor models in case of United Kingdom stock market post global financial crisis. In other words, this study will test and compare the robustness of the single-factor (CAPM) and multi-factor model (Fama and French three-factor model) in asset pricing for FTSE100 securities listed in London Stock Exchange (LSE) period 2009-2013 post global financial crisis.

The study constructed six cross sectional portfolios namely Small Cap Low Value (S/L), Small Cap Medium Value (S/M), Small Cap High Value(S/H), Big Cap Low Value (B/L), Big Cap Medium Value(B/M) and Big Cap High Value (B/H). Upon testing all six portfolios it was found that all three risk factors market, size (SMB) and value (HML) are important in explaining the variations in excess returns of portfolios which is consistent with Fama and French [11] result. However, the market factor was shown more to be more significant than other two. For instance, the size risk factor (SMB) only played an important role in explaining small size portfolios returns but it had no effect on the average returns of large-scale portfolio. Further, three factors (market, size and value risk factor) together in Fama-French three-factor model and market risk factor in traditional CAPM model has explanatory power the considerable part of the variation on excess portfolio monthly returns for each portfolio at the significant level of 1%. Finally the performance of Fama-French three-factor model in terms of adjusted R-square values is better than that of CAPM model, particularly in high book-to-market value portfolios (S/H, B/H). This finding is consistent study of Al-Mwalla and Karasneh [14]

The paper is organized as follows: ‘Literature Review’ section provides a review of the relevant literature, ‘Data and Methodology’ section discusses the data and describes the methodology, ‘Empirical Results and Discussion’ section presents empirical results and discussion of the main findings and the last section concludes

2 Literature Review

Capital Asset Pricing Model (CAPM), proposed by Sharpe [3], Lintner [4] and Black [15], has been considered as the fundamental empirical relationship between the average return on the individual risky assets or securities and their market beta (Bartholdy and Peare [16]). This relationship is linear, and the Beta

coefficient can be considered as index of the security's systematic risk to the market portfolio (Sharpe [3] and Lintner, [4]). Black, Jensen and Scholes [15] study on New York Stock Exchange from 1926 to 1966 using time series method further corroborated the model's validity. They concluded that the variations in expected average return across stocks can be explained by variations in market beta. Then, Fama and MacBeth [5] added squared market beta and residual variances as two new variables from the regression of returns on the market.

Nonetheless, several papers since 1980 have impugned the usefulness of the CAPM model. For instance, Banz [7] found that small stocks have a higher return than expected while Bhandari [17] showed that leverage stocks earned greater returns relative to their market betas (Bhandari [17]). This adverse correlation between company size and expected average returns and a positive correlation between book-to-market value and expected average returns are considered as CAPM anomalies. These pricing anomalies can be explained by two competing sets of financial theories namely risk-based and non-risk-based (Tai [18]). According to the non-risk-based explanations stocks mispricing is caused by over-reaction of investors to the news of companies or by their naive evaluation of the company based on past performances such as earnings growth. Further over-price or under-price the company's growth leads to low or high book-to-market value of stocks resulting in value effect that captures biases in investor expectations Lakonishok et al,[19]. On the other hand, the risk-based explanations contend that CAPM model cannot capture all of systematic risk of the economy or financial markets (Tai,[18]). Additionally, Schwert and Seguin [20] indicated that the systematic beta of small-size companies increase at a quicker rate than the beta of big-size companies when the market volatility increases. These findings above imply that some other asset characteristics besides market risk can have explanatory power on assets expected return. This was reported by Banz [7], and Fama and French[8] for the CAPM model and by Mankiw and Shapiro [21] and Breeden, Gibbons and Litzenberger [22] for the consumption-based CAPM model or standard C-CAPM model with a power utility framework.

On this circumstances Fama and French [8] while investigating average returns of stocks on the US market period 1963-1990 argued the market beta alone does not have power suffice to explain fully expected average returns of securities which is corroborated by other academics during a thirty-year of intensive investigation (Miller [23]). Actually, by employing the cross-sectional regression method of Fama and MacBeth [5], Fama and French [8] found that the earnings-price ratio, the stock's underlying company size, financial leverage and book-to-market value also have a high level of appreciation in describing securities' expected returns. Therefore, the market-based, size-based and value-based exposures should represent the sensitivity to pervasive risk factors in expected average returns. Further Fama and French [11] constructed a useful asset pricing model for both stocks and bonds which is made up of market risk factor and the addition of two

other risk factors related to firm-scale and firm value. The result showed that bond and stock returns variations and the cross-sectional average returns is explained by all factors explains with value-based risk being most important factor. Fama and French [24] applied the three factor model on three different stock markets (NYSE, AMEX and NASDAQ) and found the returns are explained by market factor and size factor. Meanwhile the value factor could not describe the variations in expected returns of stocks.

Over the years Fama and French model have contributed to create the a large body of new empirical researches investigating the relationship between characteristics of securities and the cross-sectional average returns in many different countries as well as markets (Moez, Mahdavikhou and Khotanloz, [25]). Some of which that have corroborated with Fama-French model in some degree are illustrated in table below..

Table 1 Brief overview of Fama and French literature

Study	Country	Data and Methodology	Finding
Maroney and Protopapadakis [26]	Germany, Canada, France, Japan, the Britain, Australia, and the United States		Results showed a scale effect and value premium, both are international in character, for all the observed markets
Connor and Sehgal [27]	India	Monthly data of the share prices including dividends and splits of 364 securities over ten years from June 1989 to March 1999	Market, size and value have pervasive returns in Indian Stock market.
Faff [28]	Australia	Stock return on Australia stock 1991 to 1999	Fand F better than CAPM

Gaunt [29]	Australia	stock returns on Australia Stock Exchange from 1993 to 2001	Beta to be less than one and HML factor playing significant role in asset pricing
Faff [30]	Australia	Used Method of Moments	the Fama and French three-factor better but less powerful while considering risk premium
Drew and Veeraraghavan [31]	Stock Exchange of Korea, Malaysia, Hong Kong, and Philippines		Companies with small-scale and high book-to-market ratio produce greater average earnings than companies with large-scale and low book-to-market ratio
Al-Mwalla and Karasneh [14]	Jordan	Return on the Amman security market over 11 years from 1999 to 2010	Fama and French three-factor model outperformed the traditional CAPM model
Griffin [13]	Integrated Data from United States, Canada, Japan and United Kingdom	Monthly returns from January 1981 to December 1995 that includes 1521 firms in Japan, 1234 firms in UK, and 631 Canadian firms	Country-specific models provide a better security valuing than the Fama-French three-factor models which consistent for both individual returns and stock portfolios.

Lin, Wang and Cai [32]	China	100 portfolios were constructed from the intersection of ten portfolios forming upon on firm scale and ten portfolios forming upon on firm value for 237 stocks in China's stock market from January, 2000 to December, 2009	Fama and French factors are better proxies for portfolio risks in China's stock market
Eraslan [33]	Turkey	Returns from Istanbul Stock Exchange 2003 to 2010.	Size factor impacts on the portfolios with small and medium-size stocks. Meanwhile value factor has a significant impact on high-value stock portfolios.
Cakici, Fabozzi, and Tan [34]	Asia, Latin America, and Eastern Europe	18 different markets 1990-2011	Value effect is significant in these observed markets.

However, considerable volume of work has questioned the robustness of Fama and French three-factor model (Lam [35]). For instance while examining irrational pricing Daniel and Titman [36]. showed that expected return is only related to the companies' specific characteristics but not linked to any economic risk factors as mentioned by three-factor model. However Davis et al. [37] argued the sample study period of is too short to conclude concisely. Later Daniel and Titman [36] indicated a stronger explanation power of this model for the value effect than that of characteristic model. Similarly, Malin and Veeraraghavan [38] did not identify the value effect on three major European markets while testing Fama-French three-factor model. This finding supports the results of Al-Horani,

Pope and Stark [39] who indicated that the CAPM model's market risk do not explain United Kingdom stock expected returns properly. Also, they argued that even though findings of Chan and Chui [40] as well as the results of Strong and Xu [41] in the UK market support the findings of the Fama and French [11], the nonappearance of the significant company-scale effect is inconsistent with the findings on United States market. In addition, Shum and Tang [42] while investigating three factor model in Singapore, Hong Kong, and Taiwan - three emerging markets in Asia found that the market risk is the dominant contributing factor whilst the size and value factor do not have the significant impact in several cases. Later, Liu and Yang [43] found that Size value factor both did not contribute significantly to explain average expected returns of bonds in China.

With regard to the UK stock market, Bhatnagar and Ramlogan, [44] showed that book-to-market value is considered as a key factor in explaining the differences of cross-sectional average returns. Strong and Xu [41] found a positive linear correlation between three variables mentioned in Fama and French model [11] and expected returns and an adverse correlation between book leverage, market value and expected average returns in UK. However, they only employed the simple regression to measure; thus, the accurate of findings may be not strong enough (Bhatnagar and Ramlogan, [44]). Likewise, Dimson, Nagel and Quigley [45] carried out the test for a value effect in the United Kingdom and realized a significant effect for securities within the small-cap and big-cap universe. Morelli [46] also indicated a significant effect of Book-to-Market value and insignificant effect of firm size while examining expected earnings in LSE market from July 1980 to June 2000. More recently, Bhatnagar and Ramlogan [44] used procedure of Fama and French [47] as their foundation by applying the multiple regression to test and compare CAPM model. The results indicated that the Fama-French model outperformed the remaining models in describing both returns of securities and value premium effects. Meanwhile Brzezczynski and McIntosh [48] while comparing performances of the British Social Responsible Investment (SRI) stocks portfolio and two benchmarks which are FTSE100 and FTSE4GOOD from 2000 to 2010 found that only market risk plays an important role in describing expected returns of the SRI portfolios whilst other factors (Size and Value factor) do not.

3 Data and Methodology

The data for study pertaining to UK market all were collected from Bloomberg database. These variables consist of the risk free rate, market-to-book value, market capitalization, stock price, market return (FTSE100). In particular, the risk-free rate employed was the yield of one-month UK Treasury Bill complying with

the study of Fama and French [11] Lam [35] and Hung [49] whilst Stock price data is the monthly closing price including dividend.

Table 2: The sources of variables of Fama-French three-factor model

Variable	Content	Sources
Risk free rate	The yield of one-month UK Treasury Bill	Bloomberg access date: 12/7/2014
Market-to-book ratio		
Market Capitalization	Simply multiplying the number of issued shares with the market share price (Morelli [47])	
Stock price	The monthly closing price including dividend	
Market return	The return of FTSE100 index	

4 Methodology

The sample includes the securities which were listed on Financial Times Stock Exchange FTSE 100 from January 2009 to December 2013. 60 months analysis period was restricted to only those companies that were listed on LSE for at least 5 years prior to the portfolio formation and had at least 5 years of accounting data available. These restrictions was placed to increase data reliability thus filtering 94 stocks for analysis. The monthly-base test is applied, and monthly-end data is collected on Bloomberg database together with audited financial statements. This period is selected to avoid the effect of crisis 2008 which may lead to reduce the validity and efficiency of the model

Fama and French [7] and Fama and French [47] is employed for the study that considers risk factor viz- Market risk, company size and book-to-market as **predictor variables**, and excess return of portfolios as **criterion variable**. Mathematically it is given by following

The Fama and French three factor model(Fama and French [11]):

$$R_{it} - R_{ft} = \alpha_{it} + \beta_{iM}(R_{Mt} - R_{ft}) + \beta_{is}SMB_t + \beta_{ih}HML_t + \varepsilon_{it}$$

The dependent variable of monthly excess average return ($R_{it} - R_{ft}$) of the portfolios is computed by subtracting the risk-free rate of return that constitute one-month UK Treasury bill rates (Petkova [50]), from the average of the total monthly excess average returns of the individual assets in these portfolios (Eraslan [33]). The first independent variable market risk factor ($R_{Mt} - R_{ft}$) is computed as difference return of market and risk free rate. Its coefficient yields market beta. Meanwhile the size based risk factor was represented by Small Minus Big (SMB) that constitutes average return on the portfolio consisting of small-size securities over the portfolio consisting of big-size securities (Burghof and Prothmann, [51]). It is given by relation

$$\text{SMB} = \frac{1}{3}(\text{Small Low} + \text{Small Medium} + \text{Small High}) - \frac{1}{3}(\text{Big Low} + \text{Big Medium} + \text{Big High})$$

It is also referred as the “size premium” since it measures the additional average returns of the investors received from stock investment with relatively small market capitalization (Allen, Singh and Powell [52]).

Finally value factor represented by High Minus Low (HML_t) which is the difference between the average rate of return of the portfolio including high book-to-market assets and the portfolio including low book-to-market assets. Book value of stock is defined as the net asset worth of the company obtaining from its accounting balance sheet (Ruppert [53]). It is given by

$$\text{HML} = \frac{1}{2}(\text{Small High} + \text{Big High}) - \frac{1}{2}(\text{Small Low} + \text{Big Low})$$

Evidences show that there are different methods to form SMB and HML factors in the United Kingdom market (Lui, Strong and Xu [54]; Miles and Timmermann [55]; Gregory, Harris and Michou [56]). On this regard January was selected as start date of the estimated period as per the study of Lui, Strong and Xu [54]. The breakpoint of Book-to-market value were selected to be bottom 30 percent, middle 40 percent and top 30 percent (Gregory, Harris and Michou [56]) whilst the breakpoint of Size will be 50th percentile according to sample median (Fama and French [11]). In addition, the equally-weighted method of Fletcher [57] was employed to calculate the average returns of the observed portfolios, whilst Independent sort of Fama and French ([8], [24], and [47]) was used as sorting method of this study.

Six portfolios constructed from two firm scale groups and three value groups in accordance to Fama and French [11]; Lui, Strong and Xu [54]; Al-Horani, Pope and Stark [39]. From 2009 to 2013, FTSE 100 (includes 94 firms) are allocated to two different groups, one consists of small-size (S) stocks and another consists of big-size (B) stocks, upon on whether the market capitalization of these stocks is

smaller or greater the median market capitalization for FTSE100 stocks. These stocks are sorted in three independent book-to-market equity groups named: value (high book-to-market or H), neutral (medium book-to-market or M) and growth (low book-to-market or L). This classification is based on the breakpoints for the bottom 30 percent, middle 40 percent and top 30 percent of the values of Book-to-market equity for FTSE100 stocks (Fama and French,[24]). The term "growth" is just a label given to assets with low book-to-market value, without regard to whether or not they were actually growing.

The final six portfolios (S/L, S/M, S/H, B/L, B/M and B/H) were constructed as the intersection of the two market capitalization groups and the three book-to-market value groups. Finally, despite both time series regression (Fama and French [11]) and cross-sectional regression (Fama and French [8]) has been accepted for three factor model, time series regression was chosen for the study as it considered as more powerful test of model validity (Lam [35]).

4 Empirical Results and Discussion

4.1 Descriptive Statistics

Table 3 illustrates the number of securities in each of the six observed portfolios for given year. It shows large-size and medium book-to-market value stocks (B/M) and small-size and medium book-to-market value stocks (S/L) account for the largest portions over five years thus implies that the companies, both small and large ones, listed in UK market – FTSE100 tend to have the medium book-to-market value.

Table 3: Number of stocks in each of the six portfolios

Year	S/L	S/M	S/H	B/L	B/M	B/H	Total
2009	12	17	18	16	21	10	94
2010	15	17	15	13	21	13	94
2011	15	18	14	13	20	14	94
2012	14	18	15	14	20	13	94
2013	16	18	13	12	20	15	94
Average	14.4	17.6	15	13.6	20.4	13	

Table 4 reports the descriptive statistics of the average returns of six portfolios along Rm-Rf, SMB and HML. As can be seen, the average returns of all these portfolios and three independent variables (market risk, SMB and HML) are quite small and positive. In addition, the standard deviations, which show the difference of these variables from the mean value fall within the range of 0.041% - 0.08%, are small and almost the same for all of the portfolios implying the low volatility of the portfolio average returns. The small expected returns indicates that the investors, in general, have the same rational on every portfolio. Furthermore, the expected average returns of all observed portfolios are normally distributed since their mean and median are quite similar.

Table 4: Summary statistics for six portfolios, excess market return, SMB and HML

	S/L	S/M	S/H	B/L	B/M	B/H	Rm-Rf	SMB	HML
Mean	0.021	0.027	0.022	0.01	0.009	0.013	0.004	0.013	0.002
Standard Error	0.006	0.006	0.01	0.005	0.006	0.01	0.005	0.002	0.007
Median	0.02	0.023	0.025	0.014	0.013	0.016	0.006	0.013	-0.004
Standard Deviation	0.05	0.049	0.076	0.041	0.049	0.08	0.042	0.017	0.054
Sample Variance	0.003	0.002	0.006	0.002	0.0024	0.006	0.002	0.0003	0.003
Kurtosis	1.151	2.086	2.657	3.598	2.462	4.353	-0.545	0.525	7.396
Skewness	-0.287	-0.396	0.67	-1.166	-0.901	0.824	-0.192	0.163	1.961
Range	0.283	0.303	0.486	0.237	0.29	0.538	0.165	0.088	0.361
Minimum	-0.147	-0.147	-0.184	-0.16	-0.177	-0.191	-0.084	-0.03	-0.113
Maximum	0.136	0.156	0.302	0.077	0.114	0.346	0.082	0.058	0.248

Table 4 further shows based on standard deviations market risk and value based risk to be more volatile than size-based risk. All these three factors have positive mean returns, meaning that they all have a value premium to compensate risks. Moreover small scale portfolios (S/L, S/M and S/H) has higher yield than large portfolios (B/L, B/M, and B/H). This is reasonable since small companies entails greater risk than larger ones; thus requiring greater returns for small stocks.

4.2 Diagnostic tests

For application of ordinary least square (OLS) multiple regression for estimating time-series requires that data should not suffer from Nonstationarity,

Autocorrelation, Heteroscedasticity and Multicollinearity. If any of this pathology exist then assumption of OLS will be violated making its estimates biased and inefficient. Hence diagnostic test was done to test the suitability of the data for OLS (Cochrane [58]).

4.2.1 Non-stationarity Test

Non-stationarity in time series implies mean or variance or both varying over time (Gujarati, [59]). Augmented Dickey-Fuller (ADF) Unit root test was used in Eviews was used to test the Non-stationarity with following hypothesis and outcome as indicated in table 5

Null hypothesis: *The times series variable under consideration is non-stationary*

Alternative hypothesis: *The times series variable under consideration is stationary*

Table 5: Augmented Dickey-Fuller Test

Variables	Augmented Dickey-Fuller Test statistic		Test critical values		
	t-Statistic	p-value	1%	5%	10%
Rm-Rf	-8.0004	0	-3.5461	-2.9117	-2.5936
SMB	-7.0378	0	-3.5461	-2.9117	-2.5936
HML	-6.5644	0	-3.5461	-2.9117	-2.5936
S/L	-7.2364	0	-3.5461	-2.9117	-2.5936
S/M	-6.4995	0	-3.5461	-2.9117	-2.5936
S/H	-6.3644	0	-3.5461	-2.9117	-2.5936
B/L	-7.4696	0	-3.5461	-2.9117	-2.5936
B/M	-6.823	0	-3.5461	-2.9117	-2.5936
B/H	-6.3913	0	-3.5461	-2.9117	-2.5936

The result shows for all variables being significant ($p\text{-value} < 0.05$) thus rejecting null hypothesis of existence of non-stationarity.

4.2.2 Autocorrelation Test

Autocorrelation implies existence of correlation between members of series of observations ordered in time or space Gujarati [59]. Since Breusch-Godfrey Serial Correlation LM Test is considered to be superior to Durbin-watson test Gujarati [59], the test was chosen and performed in Eviews .

Null hypothesis: there is no autocorrelation in the residual

Alternative hypothesis: there is autocorrelation in the residual

The results show that Prob. Chi-Square (p) at $p = 1, 2, 3, 4$ of all observed portfolios are greater than 0.05 of significant level (appendix 5). Thus, there is not enough evidence to reject the null hypothesis thus autocorrelation didn't exist.

4.2.3 Heteroscedasticity Test

Heteroscedasticity arises if the standard deviations of a variable are not constant over time. The White Heteroscedasticity test is used through Eviews Software with the following hypothesis.

Null hypothesis: Time series data is Homoscedasticity

Alternative hypothesis: Time series data is Heteroscedasticity

The results show p-value not significant ($p > 0.05$) thus we could not reject null hypothesis that data were homoscedastic.

4.2.4 Multicollinearity Test

Multicollinearity suggested that some independent variables in a multiple regression model are closely linked to one another in some ways. Multicollinearity can be detected by two main methods: correlation test or variance inflation factor (VIF). The result of correlation test in Table 6 shows that the model coefficients is less than 0.8 thus eliminating possibility Multicollinearity is eliminated. Same conclusion is also supported by the VIF coefficients as VIF for all three independent risk factor is less than 2 as shown in table 6.

Table 6: Multicollinearity test

	Correlation Test			VIF Test
	Rm-Rf	SMB	HML	
Rm-Rf	1	0.05252	0.50408	1.341
SMB	0.05252	1	0.12078	1.015
HML	0.50408	0.12078	1	1.357

4.2.5 Estimation Results

Findings in table 7 illustrates the significance of factor coefficient while regressing excess portfolio return against three factors.

Table 6: Regression result for 6 portfolios

	α_{it}	β_{iM}	β_{is}	β_{ih}
S/L	-0.404	0.882*	0.962*	-0.097
S/M	0.499	0.724*	0.713*	0.224*
S/H	-0.578	0.903*	1.047*	0.706*
B/L	-0.147	0.825*	-0.082	-0.238*
B/M	0.364	0.878*	-0.028	0.111
B/H	0.028	0.805*	-0.168	0.960*

* significant at 1%

The result indicates that the market premium is statistically significant at level of 1% in all 6 observed small portfolios meaning that there existed a correlation between market beta and expected return of these portfolios. Furthermore, SMB factor is statistically significant at 1% in three small-size portfolios. This indicates that the size effect only appears in three portfolios having small-scale (S/L, S/M and S/H) and has no size effect on the average returns of large-scale portfolio. Whist HML factor is statistically significant at 1% level indicating value effect in case of S/M, B/H, B/L and S/H portfolios but shows no effect on S/L and B/M. Further result shows the value factor for B/L is negatively significant and contrary to popular notion that excess return on (S/H) > (B/H). This inconsistency means the book-to-market value impacts on the average excess returns of these observed portfolios behave in an un-systematic/ unexplained manner.

Following table illustrates the comparison of Fama-French three-factor model against traditional CAPM model.

Table 7 Adjusted R-Square, F-statistic and P-value of both models

	Adjusted R-Square		F-statistic		P-value		α_{it}	
	Fama-French model	CAPM model	Fama-French model	CAPM model	Fama-French model	CAPM model	Fama-French model	CAPM model
S/L	59.70%	49.30%	30.127	58.317	0	0	-0.404	0.792
S/M	67.90%	56.60%	42.546	77.959	0	0	0.499	1.382
S/H	85.10%	58.20%	113.131	83.082	0	0	-0.578	0.716
B/L	52.60%	46.50%	22.821	52.347	0	0	-0.147	-0.247
B/M	67.40%	67.30%	41.57	122.682	0	0	0.364	-0.4
B/H	84.70%	54.30%	109.769	71.232	0	0	0.028	-0.189

As can be seen from the table 8 above, all p-value of F-statistics for both Fama and French and CAPM is significant (p value < 0.05 level) thus both models are robust in the LSE market FTSE100 during the estimated period. Meanwhile the high Adjusted R-squared values reflect that the Fama-French three-factor model outperforms CAPM model as Adjusted R-square of the former (the range of 52.6% - 85.1%) are higher than that of the latter (the range of 46.5% - 67.3%) in all portfolios, particularly in portfolios including high book-to-market value stocks (S/H, B/H). In other words, the average of 74% difference in portfolio expected returns is explained by three-factor Model whilst the average of 67.2% in portfolio expected returns is explained by CAPM Model.

Additionally, table 8 shows that the absolute pricing errors or values of the average intercepts of Fama-French model are less than those of traditional CAPM model. This means during the estimated period if the average absolute intercepts are employed to compare these two models then the Fama-French model is superior to CAPM for all six observed portfolios. Hence, the conclusion drawn from the time series regression test is consistent with the author's expectation and what Fama and French claims as well as results of many prior researches such as the study of Al-Mwalla and Karasneh [14], and Bhatnagar and Ramlogan [44].

5 Conclusion

This study investigate the robustness of Fama and French three-factor model on London Stock Exchange FTSE100 over 5 years from 2009 post global financial crisis and compare it to the traditional CAPM model. The author has constructed 6 portfolios from 94 stocks upon on firm size and book-to-market value as the studies of Fama and French [11]; Lui, Strong and Xu [54] ; Al-Horani, Pope and

Stark [39]. The model is found to produce the significant results on the UK market over the estimated period which can be summarized below.

- The market factor is observed to be significant in explaining expected average returns of six observed portfolios (S/L, S/M, S/H, B/L, B/M and B/H). Meanwhile the value effect is also significant at 1% in 4 out of 6 observed portfolios (S/M, S/H, B/L and B/H). But the size effect was seen to be significant at 1% in describing only small-scale portfolios (S/L, S/M, S/H) returns but it has no effect on the average returns of large-scale portfolio.
- In addition to three risk factors (market, size and value) together in Fama-French three-factor model, and market risk factor in traditional CAPM model has explanatory power the substantial part of the monthly excess returns difference of each portfolio at the significant level of 1%.
- Furthermore, the performance of Fama-French three-factor model was found to be superior to CAPM model in terms of Adjusted-R square which is consistent with the prior research of Al-Mwalla and Karasneh [14] and Bhatnagar and Ramlogan [44].

References

- [1] Ghysels, E. , Santa-Carla, P., Valkanov, R. (2005). There is a Risk-Return Tradeoff After ,*The Journal of Financial Economics* , 76 (3), 509-548
- [2] H. *Markowitz*. , "Portfolio Selection", "*The Journal of Finance*", vol. 7, no. 1., March 1952, pp. 77-91.
- [3] Sharpe, W. F. (1964). Capital asset prices: a theory of market equilibrium under conditions of risk, *Journal of Finance*, 19(3), 425-442.
- [4] Lintner, J. (1965). The valuation of risk assets and selection of risky investments in stock portfolios and capital budgets, *Review of Economics and Statistics*, 47(1), 13-37.
- [5] Fama, E. F. and MacBeth, J. D. (1973). Risk, return and equilibrium: empirical tests, *Journal of Political Economy*, 81(3), 607-636.
- [6] Reinganum, Marc R. (1981). Misspecification of capital asset pricing: Empirical anomalies based on earnings' yields and market values, *Journal of Financial Economics*, 9(1), 19-46.
- [7] Banz, R. W. (1981). The relationship between return and market value of common stocks, *Journal of Financial Economics*, 9(1), 3-18.
- [8] Fama, E. F. and French, K. R. (1992). The cross-section of expected stock returns, *Journal of Finance*, 47(2), 427-465.

- [9] Amihud, Y. and Mendelson, H. (1986). Asset pricing and the bid-ask spread, *Journal of Financial Economics*, 17(2), 223-249.
- [10] Amihud, Y. and Mendelson, H. (1991). Liquidity, maturity, and the yields on U.S. Treasury securities, *Journal of Finance*, 46(4), 1411-1425.
- [11] Fama, E. F. and French, K. R. (1993). Common risk factors in the returns on stocks and bonds, *Journal of Financial Economics*, 33(1), 3-56.
- [12] Amanda, C. and Husodo, Z. A. (2014). Empirical test of Fama French Three Factor Model and Illiquidity Premium in Indonesia. University of Indonesia.
- [13] Griffin, J. M. (2001). Are the Fama and French Factors Global or Country-Specific? Arizona State University.
- [14] Al-Mwalla, M., and Karasneh, M. (2011). Fama and French three factor model: Evidence from emerging market, *European Journal of Economics, Finance and Administrative Sciences*, 41, 132-140.
- [15] Black, F., Jensen, M. and Scholes, M. (1972). The capital asset pricing model: some empirical tests, Michael C. Jensen, *Studies in the theory of capital markets*, Praeger Publishers Inc.
- [16] Bartholdy, J. and Peare, P. (2005). Estimation of expected return: CAPM vs. Fama and French, *International Review of Financial Analysis*, 14(4), 407-427.
- [17] Bhandari, L. (1988). Debt/Equity ratio and expected common stock returns: empirical evidence, *Journal of Finance*, 43(2), 507-528.
- [18] Tai, C. S. (2003). Are Fama/French and momentum factors really priced? *Journal of Multinational Financial Management*, 13(4-5), 359-384.
- [19] Lakonishok, J., Shleifer, A. and Vishny, R. W. (1994). Contrarian investment, extrapolation, and risk. *Journal of Finance*, 49, 1541-1578.
- [20] Schwert, G. W. and Seguin P. J. (1990). Heteroscedasticity in Stock Returns, *Journal of Finance*, 35(4), 915-919.
- [21] Mankiw, N.G., Shapiro, M.D., 1986. Risk and return: consumption beta versus market beta. *The Review of Economics and Statistics*, 68(3), 452-459.
- [22] Breeden, D.T., Gibbons, M.R. and Litzenberger, R.H. (1989). Empirical tests of the consumption-oriented CAPM, *Journal of Finance*, 44(2), 231-262.
- [23] Miller, M. H. 1999. The history of finance. *Journal of Portfolio Management*, 25, 95-101.
- [24] Fama, E. F., and French, K. R. (1995). Size and book-to-market factors in earnings and returns, *Journal of Finance*, 50(1), 131-155.
- [25] Moez, A. H. A., Mahdavikhou, M. and Khotanloz, M. (2013). Feasibility of the Alternative Three-Factor Model on the TSE, *World Applied Sciences Journal*, 25(12), 1676-1683.
- [26] Maroney, N. and Protopapadakis, A. (2002). The Book-to-Market and Size Effects in a General Asset Pricing Model: Evidence from Seven National Markets, *European Finance Review*, 6(2), 189-221.
- [27] Connor, G and Sehgal, S. (2001). Tests of the Fama and French Model in India, Discussion paper, 379, Financial Markets Group, London School of Economics and Political Science, London, UK.

- [28] Faff, R. (2001). An examination of the Fama and French three-factor model using commercially available factors, *Australian Journal of Management*, 26(1), 1-17.
- [29] Gaunt, C. (2004). Size and book to market effects and the Fama French three factor asset pricing model: Evidence from Australian Stock Market, *Accounting and Finance*, 44(1), 27-44.
- [30] Faff, R. (2004). A simple test of Fama and French model using daily data: Australian evidence, *Applied Financial Economics*, 14(2), 83-92.
- [31] Drew, M. E. and Veeraraghavan, M. (2003). Beta, firm size, book-to-market equity and stock return, *Journal of the Asia Pacific Economy*, 8(3), 354-379.
- [32] Lin, J., Wang, M. and Cai, L. (2012). Are the Fama–French factors good proxies for latent risk factors? Evidence from the data of SHSE in China, *Economics Letters*, 116(2), 265-268.
- [33] Eraslan, V. (2013). Fama and French Three-Factor Model: Evidence from Istanbul Stock Exchange, *Business and Economics Research Journal*, 4(2), 11-22.
- [34] Cakici, N., Fabozzi, F. J., and Tan, S. (2013). Size, value, and momentum in emerging market stock returns, *Emerging Market Review*, 16, 46-65.
- [35] Lam, K. (2005). Is the Fama-French three-factor model better than the CAPM? Department of Economics, Simon Fraser University.
- [36] Daniel, K., & Titman, S. (1997). Evidence on the characteristics of cross sectional variation in stock returns, *The Journal of Finance*, 52(1), 1-33.
- [37] Davis, J., Fama, E., and French, K. (2000). Characteristics, covariances and average returns: 1927-1997, *Journal of Finance*, 55(1), 389-406.
- [38] Malin, M. and Veeraraghavan M. (2004). On the Robustness of the Fama and French multifactor model: Evidence from France, Germany, and the United Kingdom. *International Journal of Business and Economics*, 3(2), 155-176.
- [39] Al-Horani, A., Pope, P. and Stark, A. W. (2003). Research and development activity and expected returns in the United Kingdom. *European Finance review*, 7(1), 27-46.
- [40] Chan, A. and Chui, A. P. L. (1996). An Empirical Re-Examination of the Cross-Section of Expected Returns: UK Evidence, *Journal of Business Finance & Accounting*, 23(9-10), 1435–1452.
- [41] Strong, N. and Xu, G. (1997). Explaining the Cross Section of UK Expected Stock Returns, *British Accounting Review*, 29(1), 1-23.
- [42] Shum, W. C. and Tang, Y. N. (2005). Common Risk Factors in Returns in Asian Emerging Stock Markets, *International Business Review*, 14(6), 695–717.
- [43] Liu, G., and Yang, C. (2010). Application of Fama-French multi-factor model in china's bond market during recent financial crisis, *Journal of Zhejiang University (Science Edition)*, 4, 396-400.
- [44] Bhatnagar, C. S. and Ramlogan, R. (2010). The capital asset pricing model versus the three-factor model: a United Kingdom perspective.

- [45] Dimson, E., Nagel, S., Quigley, G. (2003). Capturing the Value premium in the UK 1955-2001, *Financial Analysts Journal*, 59(1), 35-46.
- [46] Morelli, D. A. (2007). Beta, size, book-to-market equity and returns: A study based on UK data, *Journal of Multinational Financial Management*, 17(3), 257-272.
- [47] Fama, E. F. and French, K. R. (1996). Multifactor explanations of asset pricing anomalies, *Journal of Finance* 51(1), 55–84.
- [48] Brzeszczyński, J. and McIntosh, G. (2014). Performance of Portfolios Composed of British SRI Stocks, *Journal of Business Ethics*, 120(3), 335–362.
- [49] Hung, C. D. (2008) Momentum, Size and Value Factors versus Systematic Co-Moments in Stock Returns.
- [50] Petkova, R. (2006). Do the Fama–French Factors Proxy for Innovations in Predictive Variables?, *Journal of Finance*, 61(2), 581-612.
- [51] Burghof, H. and Prothmann, F. (2011). The 52-week high strategy and information uncertainty, *Financial Markets and Portfolio Management*, 25(4), 345-378.
- [52] Allen, D. E., Singh A. K. and Powell, R. (2009). Asset pricing, the Fama-French factor model and the implications of quantile regression analysis. Edith Cowan University.
- [53] Ruppert, D. (2011). *Statistics and data analysis for financial engineering*. New York: Springer.
- [54] Lui, W., Strong, N., Xu, X. (1999). The profitability of momentum investing. *Journal of Business Finance and Accounting*, 26(9,10), 1043-1091.
- [55] Miles, D., Timmermann, A. (1996). Variation in expected stock returns: Evidence on the pricing of equities from a cross-section of UK companies. *Economica*, 63 (251), 369-382.
- [56] Gregory, A., Harris, R.D.F., Michou, M. (2001). An analysis of contrarian investment strategies in the UK. *Journal of Business Finance and Accounting*, 28(9,10), 1192-1228.
- [57] Fletcher, J. (2001). An examination of alternative factor models in UK stock returns. *Review of Quantitative Finance and Accounting*, 16(2), 117-130.
- [58] Cochrane, J. H. (2001). *Asset Pricing* (1st edn.). Princeton University Press
- [59] Gujarati, D. N. (2004). *Basic Econometrics*. (4th edn.). New York: The McGraw–Hill.

Appendix 1: List of observed Stocks

	Name	Symbol		Name	Symbol
1	Anglo American PLC	AAL LN Equity	48	Lloyds Banking Group PLC	LLOY LN Equity
2	Associated British Foods PLC	ABF LN Equity	49	London Stock Exchange Group PLC	LSE LN Equity
3	Admiral Group PLC	ADM LN Equity	50	Meggitt PLC	MGGT LN Equity
4	Aberdeen Asset Management PLC	ADN LN Equity	51	Marks & Spencer Group PLC	MKS LN Equity
5	Aggreko PLC	AGK LN Equity	52	Mondi PLC	MNDI LN Equity
6	Ashtead Group PLC	AHT LN Equity	53	Morrison (Wm) Supermarkets PLC	MRW LN Equity
7	Antofagasta PLC	ANTO LN Equity	54	National Grid PLC	NG/ LN Equity
8	ARM Holdings PLC	ARM LN Equity	55	Next PLC	NXT LN Equity

9	Aviva PLC	AV/ LN Equity	56	Old Mutual PLC	OML LN Equity
10	AstraZeneca PLC	AZN LN Equity	57	Petrofac Ltd	PFC LN Equity
11	BAE Systems PLC	BA/ LN Equity	58	Prudential PLC	PRU LN Equity
12	Babcock International Group PLC	BAB LN Equity	59	Persimmon PLC	PSN LN Equity
13	Barclays PLC	BARC LN Equity	60	Pearson PLC	PERSON LN Equity
14	British American Tobacco PLC	BATS LN Equity	61	Reckitt Benckiser Group PLC	RB/ LN Equity
15	Barratt Developments PLC	BDEV LN Equity	62	Royal Bank of Scotland Group PLC	RBS LN Equity
16	BG Group PLC	BG/ LN Equity	63	Royal Dutch Shell PLC	RDSA LN Equity
17	British Land Co PLC	BLND LN Equity	64	Royal Dutch Shell PLC	RDSB LN Equity

18	BHP Billiton PLC	BLT LN Equity	65	Reed Elsevier PLC	REL LN Equity
19	Bunzl PLC	BNZL LN Equity	66	REX American Resources Corporation	REX LN Equity
20	BP PLC	BP/ LN Equity	67	Rio Tinto PLC	RIO LN Equity
21	Burberry Group PLC	BRBY LN Equity	68	Rolls-Royce Group PLC	RR/ LN Equity
22	Carnival PLC	CCL LN Equity	69	Randgold Resources Ltd	RRS LN Equity
23	Centrica PLC	CNA LN Equity	70	RSA Insurance Group PLC	RSA LN Equity
24	Compass Group PLC	CPG LN Equity	71	SABMiller PLC	SAB LN Equity
25	Capita PLC	CPI LN Equity	72	Sainsbury (J) PLC	SBRY LN Equity
26	CRH PLC	CRH LN Equity	73	Schroders PLC	SDR LN Equity
27	Diageo PLC	DGE LN Equity	74	Sage Group (The) PLC	SGE LN Equity

28	Experian PLC	EXPN LN Equity	75	Shire PLC	SHP LN Equity
29	easyJet PLC	EZJ LN Equity	76	Standard Life PLC	SL/ LN Equity
30	Fresnillo PLC	FRES LN Equity	77	Smiths Group PLC	SMIN LN Equity
31	G4S PLC	GFS LN Equity	78	Smith & Nephew PLC	SN/ LN Equity
32	GKN PLC	GKN LN Equity	79	Sports Direct International PLC	SPD LN Equity
33	GlaxoSmithKline PLC	GSK LN Equity	80	SSE PLC	SSE LN Equity
34	Hargreaves Lansdown PLC	HL/ LN Equity	81	Standard Chartered PLC	STAN LN Equity
35	Hammerson PLC	HMSO LN Equity	82	St James's Place PLC	STJ LN Equity
36	HSBC Holdings PLC	HSBA LN Equity	83	Severn Trent PLC	SVT LN Equity

37	InterContinental Hotels Group PLC	IHG LN Equity	84	Tullow Oil PLC	TLW LN Equity
38	3i Group PLC	III LN Equity	85	Travis Perkins PLC	TPK LN Equity
39	IMI PLC	IMI LN Equity	86	Tesco PLC	TSCO LN Equity
40	Imperial Tobacco Group PLC	IMT LN Equity	87	TUI Travel PLC	TT/ LN Equity
41	intu properties plc	INTU LN Equity	88	Unilever PLC	ULVR LN Equity
42	Intertek Group PLC	ITRK LN Equity	89	United Utilities Group PLC	UU/ LN Equity
43	ITV PLC	ITV LN Equity	90	Vodafone Group PLC	VOD LN Equity
44	Johnson Matthey PLC	JMAT LN Equity	91	Weir Group PLC	WEIR LN Equity
45	Kingfisher PLC	KGF LN Equity	92	Wolseley PLC	WOS LN Equity

46	Land Securities Group PLC	LAND LN Equity	93	WPP PLC	WPP LN Equity
47	Legal and General group PLC	LGEN LN Equity	94	Whitbread PLC	WTB LN Equity

Appendix 2: Test results for Fama and French three-factor model

	Portfolios					
	S/L	S/M	S/H	B/L	B/M	B/H
Constant C	-0.403823 (0.4279)	0.499171 (0.2656)	-0.578367 (0.2198)	-0.146784 (0.7455)	-0.363995 (0.4132)	0.027760 (0.9561)
Market risk coefficient	0.881813 (0.0000)	0.723957 (0.0000)	0.902626 (0.0000)	0.825477 (0.0000)	0.878255 (0.0000)	0.804664 (0.0000)
SMB coefficient	0.961955 (0.0001)	0.712636 (0.0011)	1.047183 (0.0000)	-0.082373 (0.6967)	-0.028252 (0.8916)	-0.167601 (0.4775)
HML coefficient	-0.097096 (0.2828)	0.224036 (0.0061)	0.705750 (0.0000)	-0.237628 (0.0042)	0.110793 (0.1620)	0.959526 (0.0000)
Adjusted R-Squared	0.596941	0.678717	0.850781	0.525963	0.673509	0.846875

*(): prob(F-statistic)

Appendix 3: Test results for CAPM model

	Portfolios					
	S/L	S/M	S/H	B/L	B/M	B/H
Constant C	0.791914 (0.0918)	1.382414 (0.0017)	0.716229 (0.2642)	- (0.5280)	- (0.2705)	- (0.7899)
Market risk coefficient t	0.840472 (0.0000)	0.883765 (0.0000)	1.379732 (0.0000)	0.670771 (0.0000)	0.948921 (0.0000)	1.418369 (0.0000)
Adjusted R- Squared	0.49277	0.56605	0.5818	0.46532	0.67346	0.84688

*(): prob(F-statistic)