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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/Hbased on firm's size and book-to-market ratio was constructed as per gudielines 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* isthe 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 riskother explanatory variable such as 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 ofnew 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 Instanbul 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 donot 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 Brzeszczyński 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

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

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

$$\text{HML} = ½(\text{Small High} + \text{Big High}) - ½(\text{Small Low} + \text{Big Low})$$

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 $50^{th}$ 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 groupsin 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 3illustrates 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 datafor 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 Eviewswas 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

| | Augmented Dickey-Fuller Test statistic | | Test critical values | | |
|---|---|---|---|---|---|
| Variables | 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-value < 0.05) thus rejecting null hypothesis of existence of non-stationarity.

### 4.2.2 Autocorrelation Test

Autocorrelationimpliesexistence of correlation between members of series of observations ordered in time or spaceGujarati [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 |
|---|---|---|---|---|
| | Rm-Rf | SMB | HML | Test |
| 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

| | $\alpha_{it}$ | $\beta_{iM}$ | $\beta_{is}$ | $\beta_{ih}$ |
|---|---|---|---|---|
| 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 | | $\alpha_{it}$ | |
|---|---|---|---|---|---|---|---|---|
| | 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 researcheof Al-Mwalla and Karasneh [14] and Bhatnagar and Ramlogan [44].

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**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 | PSON 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 90.0042) | 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) | -0.247029 (0.5280) | -0.400055 (0.2705) | -0.188799 (0.7899) |
| Market risk coefficient | 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)