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Research paper

How Well the Implementation of Carhart Model in Market Overreaction Condition? Evidence in Indonesia Stock Exchange

Ferikawita M. Sembiring

Department of Management
Faculty of Economics & Business, Jenderal Achmad Yani University, West Java, Indonesia
**Corresponding author E-mail: ferikawita@yahoo.com*

Abstract

This study aims to determine an ability of the four-factor model of Carhart in explaining the portfolio returns formed in condition of market overreaction. The four-factor model is basically a model proposed by Fama and French and then developed by Carhart which adds price momentum factor into the model. While market overreaction is a market condition caused by excessive reactions from investors when receiving information. The portfolios used are the winner and loser formed based on the returns of each portfolio to the average of the returns. Both portfolio consist are the stocks of non-financial sector in Indonesia Stock Exchange during the period July 2005 - December 2015. The data used are the Composite Stock Price Index (CSPI), stock market capitalization, book to market ratio of each shares and the difference of returns of the loser over of the winner, as an indicator of price momentum factor that formed in market overreaction condition characterized by occurance the reversal of returns.
The results show that the four-factor model can explain the portfolio return well. Implementation of the GARCH (1,1) model to improve the accuracy of the estimation results also shows similar findings.

Keywords: *CAPM, Carhart Model, Fama And French's Model, Market Overreaction*

1. Introduction

The three-factor model proposed by [8] states that in addition to market risk factors (beta) which have a positive effect on portfolio returns, small-market capitalized stocks with high BE/ME ratios have higher returns than large-market capitalized stocks with the low BE/ME ratio. [6] further added the price momentum factor into the model of [8] and found that the model can explain portfolio returns, especially in mutual funds. The four-factor model is further used by [9] to test the factors affecting the returns in North American, European, Japanese and Asian Pacific stock markets, where momentum factor are found to affect stock returns in all those countries, except in Japan.
Several studies have also been conducted to test the factors that can explain the portfolio returns that are formed under market overreaction condition. Market overreaction is a phenomenon in the capital market characterized by the occurrence of reversal of stock returns and subsequently underlies the implementation of contrarian strategies. Based on CAPM, [1] found that the implementation of contrarian strategies was able to generate significant profits on the winner and loser portfolio in the American stock market and the profit of the losers were able to outperform winners. Another finding is that in addition to winners having higher beta than losers, the constants (alpha) of both portfolios are found to be significantly positive. The results of this study are supported by [16] who conducted research on the Indonesia Stock Exchange.

This study was conducted as a follow up of our previous research [16], [17]. If from the previous research we found that CAPM can explain well the returns of the winner and loser, then in this study, the factors in four-factor model will be tested it ability in explaining the return of both portfolios. Because it is implemented in market overreaction condition, then momentum factor is conditioned as the difference returns of loser over winner. Based on this, then the problem formulated is how well the four-factor model on market overreaction condition is able to explain the returns of winners and losers portfolio in Indonesia Stock Exchange.

2. Literature Review

The testing of Capital Asset Pricing Model (CAPM) presented by [18] is basically to prove that the only relevant risk factors in equilibrium market conditions are market risk or systematic risk as measured by beta. In addition, CAPM testing is also performed to prove that the magnitude of the constant is equal to the risk-free asset level or equal to zero. However [12] found that the value of constants in the CAPM model is greater than the risk-free asset level or not equal to zero. [3] also found that a portfolio with low beta has a positive constant, while a high beta portfolio has a negative constant. This finding supports the previous finding that the constant is not equal to zero.
[10] then tested the relationship between beta and stock returns in the American stock market. They found a linear and positive relationship between beta and the stock returns, while constants were significantly positive. This cross-sectional methodology is also applied to estimate the premium of beta and the premium of size for selecting portfolios based on risk factors and firm size. The

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results show that there is a negative and significant coefficient for the size factor, this result is contrary to the assumption in the CAPM model which states that no other factors than the beta can significantly explain the returns.

[8] developed a multifactor model based on observations when stocks in the US stock market were selected based on firm size and book to market ratio. Small-cap stocks with high BE / ME ratios (or called as value stocks) were found to have higher returns than large-cap stocks with low BE / ME ratios (or called as growth stocks). Based on observations made, they introduced a three factor model consisting of: market portfolio factor; SMB ie the returns from the portfolio of small capitalized stocks minus the return from the portfolio of large capitalized stocks, and; HML ie the returns of the stock portfolio with the BE / ME ratio high minus the return of the stock portfolio with the low BE / ME ratio:

$$R_{it} - R_{ft} = \alpha_i + b_i(R_{mt} - R_{ft}) + s_iSMB_t + h_iHML_t$$

The three-factor model states that the expected excess return for each portfolio is explained by the sensitivity of the portfolio returns to the excess return of the market portfolio, SMB, and HML, with the direction of a positive relationship.

Some researchers then try to identify other factors that also have the potential to be a determinant of return, in addition to market factors, firm size and value. [6] added the price momentum factor into the three-factor model, hereinafter referred to as the four-factor model, and tested the effect on the performance of mutual funds:

$$R_{it} - R_{ft} = \alpha_i + b_i(R_{mt} - R_{ft}) + s_iSMB_t + h_iHML_t + m_iMOM_t + \varepsilon_i$$

He found that the four factors in this model could explain the return of the stock mutual fund portfolio. The findings resulting from the model are that the winner's stocks have a positive correlation to the expected return of the stock portfolio, which means that the winner's stocks will provide a higher rate of return.

The four-factor model is further used by [9] to test the factors affecting stock returns in North America, Europe, Japan and Asia Pacific. Price momentum is found in all these countries except in Japan.

The price momentum in the Carhart model is measured by forming a selected portfolio based on the difference returns of the winner portfolio over the loser relevant to condition of market underreaction. However, several adjustments need to be implemented in this study related to condition of market overreaction. Market overreaction is a phenomenon of the occurrence of anomalies in the capital market is marked by the reversal of the returns, where winners become losers and losers become winners. The occurrence of this reversal of return further becomes the basis of the implementation of contrarian strategies. [20] who do research on the stock market in Taiwan found a not significant profit from the implementation of this strategy while the firm size factor found to affect the return. Then [1] who conducted research on US stock markets found that the implementation of contrarian strategies was able to generate significant profits on winner and loser stocks, where the advantages of losers were found to outperform winners. Another finding is that in addition to winners having higher beta than losers, the constants of both portfolios are found to be significantly positive. The results of this study are also supported by [16].

The empirical findings that occurred in the capital market have shown the tendency of rapid and dynamic price movement of securities to follow changes in economic conditions. As a result, stock price movements are become more varying and have an effect on the difficulty of predicting the returns of securities because they become unstable all the time [11]. The consequences of the difficult conditions of predicting returns are that the distribution of historical data in the stock market tends to be non-normal [19]), clustered volatility [7]), heteroskedastic [15], and non-stationary [13], [14).

The time-varying volatility condition that contains heteroscedasticity is called conditional heteroscedasticity. [7] introduces a model that takes into account the time varying volatility known as model ARCH (autoregressive conditional heteroscedasticity) developed by [4] become model GARCH (generalized autoregressive conditional heteroscedasticity). Beta estimate by considering conditional time varying is expected can improve beta accuracy as a predictor of return as well as a systematic risk gauge [5), [2).

The ARCH / GARCH test is related to beta volatility testing by using time series data. Time series data has a high volatility behavior and is very sensitive to any information coming into the market so that it has a constant and variable variation of error or residual (error term) from one period to another (a time varying volatility) or also called contains elements of heteroscedasticity. The variant of this residual is due to the function of the independent variable and how much residual it has in the past. For example, when predicting stock returns, the residual variant occurring at this point will depend on the residual variant of the previous period.

Referring to some empirical findings related to the purpose of this study, ie to test how well the four-factor model of Carhart in explaining portfolio returns formed in market overreaction condition, including by incorporating the ARCH / GARCH model into the Carthart model, then the research hypothesis is defined as following:

H1: Market factor (Rm-Rf) have a positive effect to the portfolio returns of winner and loser
H2: SMB has a positive effect to the portfolio returns of winner and loser
H3: HML has a positive effect to the portfolio returns of winner and loser
H4: MOM has a negative effect to the portfolio returns of winner and loser

3. Research Method

This study still uses the same data as our previous research, ie the returns of all non-financial stocks which actively operated in Indonesia Stock Exchange during the period July 2005-December 2015. These stocks have been formed into the portfolio group of winner and loser each amounted 20 portfolios. Composite Stock Price Index (CSPI) is used as a proxy for the market portfolio.

The stages in this testing are as follows:

1) Sorting stocks in winner and loser portfolios based on stock market capitalization value which is an indicator of company size. As many as 50% of the stocks with the largest market capitalization are set as the big firm (B) and the remaining 50% are set as the small firm (S).
2) Sorting stocks in winner and loser portfolios based on book to market ratio (BE / ME ratio), from lowest to highest. As many as 30% of stocks with BE / ME ratio highest are defined as high-value stocks (H), 40% of stocks are defined as medium-value stocks (M), and 30% of stocks with BE / ME ratio lowest are defined as low-value stocks (L).
3) Establishing six portfolios (intersection) ie SL, SM, SH, BL, BM, BH, then calculating the monthly return of each portfolio which is the average return of each stocks in the portfolio
4) Calculating the portfolio returns of SMB and HML:
   The SMB returns are the difference between the average monthly return of three small portfolios (SL, SM, SH) and three big portfolios (BL, BM, BH), by the formula:

$$SMB = \frac{(SL + SM + SH) - (BL + BM + BH)}{3}$$

The HML returns are the difference between the average monthly returns of two high portfolios (SH, BH) and two low portfolios (SL, BL), by the formula:

$$HML = \frac{(SH + BH) - (SL + BL)}{2}$$

5) Sorting stocks in winner and loser portfolios based on firm size (market capitalization value stocks) and performance (stocks returns) of the previous period, from lowest to highest. Winner category is 30% high performing stock (W), neutral is 40% stock with medium performance (N), and loser is 30% stock with low performance (L).
6) Establishing six portfolios (intersection) ie SL, SN, SW, BL, BN, BW. Then calculating the monthly return of each portfolio which is the average return of each stocks in the portfolio.
7) Calculating the portfolio returns of MOM:
MOM is the difference between the average monthly return of two small-loser (SL) and big-loser (BL) with two small-winner (SW) and big-winner (BW). MOM returns are defined as the difference return of loser over the winner.

$$MOM = \frac{(SL + BL) - (SW + BW)}{2}$$

8) Performing regression process based on four-factor model Carhart:

$$R_p - R_{ft} = \alpha_p + {}_{bp}(R_{mt} - R_{ft}) + s_pSMB_t + h_pHML_t + m_pMOM_t + \varepsilon_{pt}$$

4. Result and discussion

Before performing the process of regression based on Carhart's four-factor model, firstly tested stationarity of data for both portfolios, winner and loser. The testing results based on the ADF model by using E-Views software show that all data is stationary at level. Based on these results, the time series regression process for the portfolios for 120 months (January 2006-December 2015) can be done with the following results:

Table 1. Regression Result Based on Four Factor Model
Period January 2006-December 2015

$\overline{R_p - R_{ft}} = \alpha_p + {}_{bp}(R_{mt} - R_{ft}) + s_pSMB_t + h_pHML_t + m_pMOM_t + \varepsilon_{pt}$

Portfolios	α_p	β_p	s_p	h_p	m_p	Adj. R^2	F-stat
Winner	**0.009** ***)	**0.675** ***)	**0.177** ***)	**0.302** ***)	**-0.170** ***)	0.684	**65.39** ***)
Loser	**0.013** ***)	**0.699** ***)	**0.164** **)	**0.188** ***)	0.055	0.493	**29.94** ***)

***) significant at α = 1%
**) significant at α = 5%

The results in Table 1 show that market factors (Rm-Rf), size factor (SMB), and value factor (HML) have a positive effect to the portfolio returns of winner and loser. The factor of momentum (MOM) was found to have no effect on the return of loser portfolio, meaning that the portfolio performance of loser in the previous period did not affect the current performance. While in the winner portfolio, past portfolio performance was found to negatively affect the current portfolio performance, this result confirms the existence of the reversal of return that become the basis of portfolio preparation.
To know the accuracy of estimation result need to do some testing to determine whether the regression model that established is BLUE model or not, based on normality test, heteroscedasticity test, autocorrelation test, and multicollinearity test. The testing result shows that the problem of heteroscedasticity happened so that need to use model ARCH-GARCH, with result as follows:

Table 2. Test Results of Four Factor Model Based on Model GARCH(1,1)
Period January 2006-December 2015

$\overline{R_p - R_{ft}} = \alpha_p + {}_{bp}(R_{mt} - R_{ft}) + s_pSMB_t + h_pHML_t + m_pMOM_t + \varepsilon_{pt}$

Portfolios	α_p	β_p	s_p	h_p	m_p	Adj. R^2	ARCH-LM *test*
Winner	**0.008** **)	**0.685** ***)	**0.125** ***)	**0.253** ***)	**-0.169** ***)	0.680	0.260
Loser	0.005	**0.658** ***)	**0.152** ***)	**0.237** ***)	0.013	0.474	1.977

***) significant at α = 1%

The GARCH model (1,1) in Table 2 shows that the residual variant of the time series data used in the model is influenced by residual values and residual variance values from 1 (one) previous period. While the test results based on ARCH-LM test method showed that both portfolio models have been free from heteroscedasticity problem.
Furthermore, if the results in Table 1 are compared with the results in Table 2, the conclusion obtained is similar, namely that market factors (Rm-Rf), size factors (SMB), and value factors (HML) has a positive effect to the returns, both for winner and loser, while momentum factor (MOM) only effect on winner portfolio. The constant value (αp) in the initial model which is significant for both portfolios (winner and loser) indicates that the implementation of the contrarian strategy on both portfolios is capable of producing an abnormal return. While on the GARCH (1,1) model, an abnormal return is only generated by the winner portfolio. Based on Table 1 and Table 2, the adjusted value of R2 of both models showing the ability of all variables in explaining returns for each portfolio tends to be the same.

The price momentum factor is found to negatively affect the average of the winner portfolio returns but does not affect to the loser portfolio. This means that for the winner portfolio, the price movement (returns) of stocks in the previous period will reverse in the next period. The price momentum indicator used in this study refers to the formation of expected returns from contrarian strategy, ie the returns difference of the loser over winner (loser minus winner), after portfolio selected based on the firm size factor. The test results of this four factor model with adjusted momentum factor, show that in winner portfolios, stocks that grouped into the loser's stock criteria (small stocks with low ME) will become the winner stock in the next period and the returns will be high. In the loser portfolio, the momentum effect which is a reversal of the returns does not affect the average of return. This result indicates that the momentum factor becomes redundant or does not have explanatory power.

In the related with the implementation of contrarian strategy that underlies the formation of portfolio, it is expected that there is profit obtained from positive difference between the returns of the loser over the winner. By doing the regression process between the difference of factors in the four factors in model with the difference of return of both portfolio, obtained the result as follows:

Table 3. The Profit of Implementing Contrarian Strategies Based on Four Factor Model in the Period of January 2006 - December 2015

Portfolio	α_p	b_p	sp	h_p	m_p
Loser Minus Winner	**0.005** ***)	-0.012	0.062	0.037	**0.021****

***) significant at α = 1%

*) significant at α = 10%

The results shown in Table 3 show that based on the four factor model, the contrarian investment strategy is able to produce a profitable abnormal return with alpha value significantly positive as the indicator. Market factors, size factors, and value factors were found to have no effect on the advantages of the strategy, while momentum factors were found to be influential although relatively weak.

5. Conclusions

The purpose of this study is to find out how the Carhart's four-factor model explains the portfolios returns that formed in condition of the market overreaction. The results showed that all proposed research hypotheses have been met, except that the momentum factor not found in the portfolio of losers, consistent with the findings of the previous researchers. Therefore, this study result can be considering to be used by the relevant stakeholders in designing of their investment decision.

As for the limitation of this research is that there are still opportunities from other factors that can influence the portfolios returns. Therefore, for further research it is advisable to try to incorporate another factor that relevant to get a better model.

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