The Application of Three-Factor Pricing Model in LQ45 Index

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Abstract

The Capital Asset Pricing Model has been widely used in many countries and modified to several models such as to Three-Factor Pricing Model and Four-Factor Pricing Model. The objective of this research is to compare the Three-Factor Pricing Model and Four-Factor Pricing Model for stocks in Indonesia Stock Exchange LQ45 index. Financial data for the period 2006 to 2011 were obtained from the Indonesia Stock Exchange's website. Fama-French methodology was used to construct equations Three-Factor Pricing Model, while to build a Four-Factor Pricing Model the methodology used was developed by Carhart. The result of using quantitative method and multiple-regression indicates that Four-Factor Pricing Model is fitter than Three-Factor Pricing Model for Indonesia Stock Exchange LQ45 index in that period.

Keywords: Capital market, CAPM, Three-Factor Pricing Model, Four-Factor Pricing Model, LQ45 Index.

1. Introduction

The capital market is a place for the companies that have to go public to raise funds. People can take advantage of the capital markets for long-term investments or seek short-term profits. The investors aiming at getting short-term gains are usually very concerned about news and events (event) that affect the stock price changes. Empirical analysis of the behavior of stock prices that are around a certain event is called event study. Based on the efficient market hypothesis theory, efficiency is defined as an expression of speed and perfection of capital markets which include the relevant information into the stock price. Based on this theory, abnormal return cannot be obtained in the long run by using investment strategies based on historical share prices or other historical data.

Research related to the abnormal return among other things was made by Ball and Brown [1968], Ball and Kothari [1991], Bessembinder et al [2008], Chopra, Lakonishok, and Ritter [1992], De Bondt and Thaler [1986], Fama and French [1993], and Carhart [1997]. Research conducted by Fama and French [1993] formulated several quantitative variables called Three-Factor

Pricing Model. The study was reinforced and further developed by Carhart [1997] by adding an independent variable called Four-Factor Pricing Model.

Numerous studies have shown that there is no significant abnormal return in the Indonesia Stock Exchange, but there are a number of other studies proving abnormal return on a number of shares on the Indonesia Stock at events (event) specific case. According to Kothari and Warner [2006], systematically nonzero abnormal security returns that persist after a particular type of event are inconsistent with market efficiency. Based on this gap, this research was conducted to examine what variables cause stocks experiencing abnormal return in Indonesia Stock Exchange using Three-Factor Pricing Model and Four-Factor Pricing Model.

2. Discussion and hypothesis

Problem identification in this research starts by looking at the deviation between the real conditions in Indonesia capital market with a grand theory underlying the establishment of the stock market. Abnormal returns that often occur in the Indonesia Stock Exchange LQ45 are against to Efficient Market Hypothesis theory. The problem in this study focuses on quantitative variables suspected to affect stocks in the Indonesia Stock Exchange LQ45 using Fama's Three Factor Pricing Model, and Carhart's Four Factor Pricing Model.

Hypothesis 1:
Annual market risk premium (Rmt-Rft) has a significant influence on annual expected excess return (Rpt-Rft).

Hypothesis 2:
Size (SMBpt) has a significant influence on annual expected excess return (Rpt-Rft).

Hypothesis 3:
Book-to-market ratio (HMLpt) has a significant influence on annual expected excess return (Rpt-Rft).

Hypothesis 4:
The difference between the return on the portfolio of past one-year "winners" and "losers" (UMDpt) has a significant influence on the difference in annual portfolio return and risk-free rate (Rpt-Rft).

3. Procedures for collecting data

3.1. Data

I examine the yearly return of the four factors: Rm-Rf, SMB, HML, UMD from Indonesia Stock Exchange historical data from 2006-2011 period. Financial statement data for that period was taken from JKSE historical price-Yahoo! Finance. Risk free rate return was taken from Banks Sentral Republik Indonesia's website using 3-month SBI rate (SBI: Sertifikat Bank Indonesia). Book Equity (BE) is computed as the book value of stockholders' equity plus balance sheet deferred taxes minus the book value of preferred stock, negative Book Equity is excluded from the sample (see L'Her et al, 2004). Market Equity (ME) is stock price times a number of outstanding stock. Book to Market ratio is book equity divided by market equity. The final sample includes 120 data from 20 companies in 6 years' period. The companies that are incorporated into observation are companies that consistently appears in the list of LQ45 from December 2006 until December 2011.

3.2. Construction of the three factors and four factors pricing model

3.2.1. Three factor pricing model (TFPM)

Three factor pricing model (TFPM) created by Fama and French in 1993 to estimate the abnormal return of the portfolio that they form. (Jogiyanto, 2010).
According to the TFPM, stocks excess return are equal to (Kothari, 2006):
Rpt – Rft = ap + bp (Rmt – Rft) + sp SMBpt + hp HMLpt + ept
Where
• Rpt is the equal or value-weighted return for calendar year t for the portfolio of event firms that experienced the event within the previous t year.
• Rft is the risk-free rate,
• Rmt is the market return,
• SMBpt is the difference between the return on the portfolio of "small" stocks and "big" stocks;
• HMLpt is the difference between the return on the portfolio of "high" and "low" book-to market stocks;
• ap is the average monthly abnormal return on the portfolio of event firms over the T-year post-event period,
• bp, sp, and hp, are sensitivities (betas) of the event portfolio to the three factors.

3.2.2. Four factor pricing model (FFPM)

Three-factor pricing model was modified by Carhart in 1997 to incorporate the momentum factor. According to Carhart's four factor pricing model (FFPM), stocks excess return is equal to:
Rpt – Rft = ap + bp (Rmt – Rft) + sp SMBpt + hp HMLpt + mp UMDpt + ept
Where
• UMDpt is the difference between the return on the portfolio of past one-year "winners" and "losers".
• mp is sensitivity (beta) of the event portfolio to the fourth factor. (Kothari, 2006).

The construct of SMB and HML is constructed according to Fama and French (1993) , and UMD is constructed as up minus down (winner minus loser) according to Vassalou (1999). For each year from December 2006 to December 2011, I rank the stock based on size and book to market ratio.

Based on Fama and French (1993), size is ranked as 50% breakpoints to form Big and Small classification, book-to-market is ranked as 30% and 70% breakpoints to form High and Low classification. Classification for the momentum factor formed as for book-to-market factor, stocks above the 70% prior performance breakpoint are designated U for upper, the middle 40% are designated N for neutral and the firms below the 30% prior performance breakpoint are designated D for Down. I form all the formula as the intersection of size and prior performance groups follows L'her research (2004).

SMB = [(S/H-B/H) + (S/L-B/L) + (S/U-B/U) + (S/D-B/D)]/4

HML = [(S/H+B/H) - (S/L+B/L)]/2

UMD = [(S/U+B/U)-(S/D+B/D)]/2

This research use data from December 2006 to December 2011 to derive the time-series of the market, size, book-to-market, and momentum premiums, as described in the next sections.

3.3. Portfolio Formation

3.3.1. Portfolio Formation for Dependent Variable.

There are nine portfolios for each year:

Portfolio A, small size and low BE/ME
Portfolio B, small size and middle BE/ME
Portfolio C, small size and high BE/ME
Portfolio D, medium size and low BE/ME
Portfolio E, medium size and middle BE/ME
Portfolio F, medium size and high BE/ME
Portfolio G, big size and low BE/ME
Portfolio H, big size and middle BE/ME
Portfolio I, big size and high BE/ME

2006

		BE/ME tercile		
		Low	**Middle**	**High**
Size tercile	**Small**	0.85941	0.52908	0.91454
	Medium	0.27260	0.43251	0.60909
	Big	0.40016	0.42635	0.52471

The values of 2006 portfolios are:
Portfolio A = 0.85941
Portfolio B = 0.52908
Portfolio C = 0.91454
Portfolio D = 0.27260
Portfolio E = 0.43251
Portfolio F = 0.60909
Portfolio G = 0.40016
Portfolio H = 0.42635
Portfolio I = 0.52471

2007

		BE/ME tercile		
		Low	**Middle**	**High**
Size tercile	**Small**	1.006356	0.629478063	1.740217
	Medium	0.913258	-0.092341424	0.323133
	Big	1.961699	0.268678955	0.338032

The values of 2007 portfolios are:
Portfolio A = 1.006356
Portfolio B = 0.629478063
Portfolio C = 0.1740217
Portfolio D = 0.913258
Portfolio E = -0.092341424
Portfolio F = 0.323133

Portfolio G = 1.961699
Portfolio H = 0.268678955
Portfolio I = 0.338032

2008

		BE/ME tercile		
		Low	**Middle**	**High**
Size tercile	**Small**	(0.75083)	(1.06791)	(1.89271)
	Medium	(0.99219)	(1.06510)	(1.65745)
	Big	0.08521	(0.70175)	(1.65745)

The values of 2008 portfolios are:
Portfolio A = (0.75083)
Portfolio B = (1.06791)
Portfolio C = (1.89271)
Portfolio D = (0.99219)
Portfolio E = (1.06510)
Portfolio F = (1.65745)
Portfolio G = 0.08521
Portfolio H = (0.70175)
Portfolio I = (1.65745)

2009

		BE/ME tercile		
		Low	**Middle**	**High**
Size tercile	**Small**	0.92292	0.82788	0.62285
	Medium	0.92292	0.85530	0.20051
	Big	0.74805	1.04735	0.56354

The values of 2009 portfolios are:
Portfolio A = 0.92292
Portfolio B = 0.82788
Portfolio C = 0.62285
Portfolio D = 0.92292
Portfolio E = 0.85530
Portfolio F = 0.20051
Portfolio G = 0.74805
Portfolio H = 1.04735
Portfolio I = 0.56354

2010

		BE/ME tercile		
		Low	**Middle**	**High**
	Small	0.11952	0.24646	(0.19153)
Size tercile	**Medium**	0.11952	0.29889	0.25754
	Big	0.35540	0.08177	0.35387

The values of 2010 portfolios are:
Portfolio A = 0.11952
Portfolio B = 0.24646
Portfolio C = (0.19153)
Portfolio D = 0.11952
Portfolio E = 0.29889
Portfolio F = 0.25754
Portfolio G = 0.35540
Portfolio H = 0.08177
Portfolio I = 0.35387

2011

		BE/ME tercile		
		Low	**Middle**	**High**
	Small	(0.19201)	(0.00002)	(0.17340)
Size tercile	**Medium**	(0.25418)	(0.18136)	(0.03620)
	Big	0.27671	0.07203	(0.03620)

The values of 2011 portfolios are:
Portfolio A = (0.19201)
Portfolio B = (0.00002)

Portfolio C = (0.17340)
Portfolio D = (0.25418)
Portfolio E = (0.18136)
Portfolio F = (0.03620)
Portfolio G = 0.27671
Portfolio H = 0.07203
Portfolio I = (0.03620)

3.3.2. Portfolio Formation for Independent Variables.

2006

B/H	B/L	S/H	S/L
0.55284	0.5475	0.91454	0.24658
S/D	**S/U**	**B/D**	**B/U**
0.18643	0.9778	0.20598	0.73909

SMB= 0.06999
HML= 0.33667
UMD= 0.66223

2007

B/H	B/L	S/H	S/L
0.33058	1.39763	1.74022	0.95646
S/D	**S/U**	**B/D**	**B/U**
0.38451	1.45582	0.1829	1.9617

SMB= 0.16605
HML= -0.1416
UMD= 1.42505

2008

B/H	B/L	S/H	S/L
-1.6575	0.08521	-1.8927	-0.7508
S/D	**S/U**	**B/D**	**B/U**
-2.1854	-0.5095	-1.7817	-0.0084

SMB= -0.494
HML= -1.4423
UMD= 1.7246

2009

B/H	B/L	S/H	S/L
0.56354	0.78014	0.46578	0.92292
S/D	**S/U**	**B/D**	**B/U**
0.22797	1.12763	0.4321	1.11332

SMB= -0.0362
HML= -0.3369
UMD= 0.79044

2010

B/H	B/L	S/H	S/L
0.353872	0.347649	-0.12098	0.119519
S/D	**S/U**	**B/D**	**B/U**
-0.17105	0.366596	-0.21001	0.448754

SMB= -0.1865
HML= -0.11714
UMD= 0.598205

2011

B/H	B/L	S/H	S/L
-0.0362	-0.0198	-0.1734	-0.192
S/D	**S/U**	**B/D**	**B/U**
-0.3316	0.21916	-0.3144	0.22527

SMB= -0.0832
HML= 0.00112
UMD = 0.54524

4. Results

4.1. Result using Three-Factor Pricing Model

Using principal components regression the result is:

Independent Variable	Regression Coefficient	Standard Error	Stand'zed Regression Coefficient	t-VALUE	p-VALUE	VIF
Intercept	0.2624762					
RmRf	0.4838264	0.0481949	0.289	10.0390	0.00000000000003	0.1249
R_SMB_	1.047394	0.104333	0.2915	10.0390	0.00000000000003	0.1272
R_HML_	0.3935596	3.92E-02	0.2893	10.0390	0.00000000000003	0.1252
R-Squared	0.6684					
Adj R-Squared	0.64849581					

Table above shows the number VIF under 10, which means there is no multicollinearity. The p-value that is less than 10% for RmRf (market return minus risk-free rate), R_SMB (the difference between the return on the portfolio of “small” stocks and “big” stocks) and R_HML (the difference between the return on the portfolio of “high” and “low” book-to market stocks) indicates that these variables have a significant effect on the dependent variable (Rpt-Rft).

4.2. Result using Four-Factor Pricing Model

Using principal components regression the result is:

Independent Variable	Regression Coefficient	Standard Error	Stand'zed Regression Coefficient	t-VALUE	p-VALUE	VIF
Intercept	9.42E-02					
RmRf	0.4983547	4.91E-02	0.2976	10.15990	0.000000000000021	0.1373
R_SMB_	1.588294	0.2220702	0.4421	7.15222	0.000000001774263	0.611
R_HML_	0.2827135	3.46E-02	0.2078	8.18182	0.000000000034314	0.1032
R_UMD_	0.1942295	0.1133705	0.1157	1.71323	0.092105325071749	1.0097
R-Squared	0.6936					
Adj R-Squared	0.66861021					

Table above shows the number VIF under 10, which means there is no multicollinearity. The p-value that less than 10% for RmRf (market return minus risk-free rate), R_SMB (the difference between the return on the portfolio of "small" stocks and "big" stocks), R_HML (the difference between the return on the portfolio of "high" and "low" book-to market stocks), and R_UMD (is the difference between the return on the portfolio of past one-year "winners" and "losers") indicates that these variables have a significant effect on the dependent variable (Rpt-Rft). This equation has higher adjusted r-squared value than the previous one, indicating this model is better to predict the future outcomes on the basis of other related information

5. Conclusions

The conclusions that can be drawn are:

1. Annual market risk premium (Rmt-Rft) has a significant influence on annual expected excess return (Rpt-Rft) for both model.
2. Size (SMBpt) has a significant influence on annual expected excess return (Rpt-Rft) both in Three-Factor Pricing Model and Four-Factor Pricing Model.
3. Book-to-market ratio (HMLpt) has a significant influence on annual expected excess return (Rpt-Rft) both in Three-Factor Pricing Model and Four-Factor Pricing Model.
4. The difference between the return on the portfolio of past one-year "winners" and "losers" (UMDpt) has a significant influence on the difference in annual portfolio return and risk-free rate (Rpt-Rft).

The result indicates that Four-Factor Pricing Model is fitter than Three-Factor Pricing Model for Indonesia Stock Exchange LQ45 index in 2006-2011 periods. In that period Four-Factor Pricing Model has higher adjusted r-squared value than Three-Factor Pricing Model, although the difference is only slight. This indicates the Four-Factor Pricing Model is better to predict the future outcomes on the basis of other related information.

6. International and Managerial Implications

International implications: Three-Factor Pricing Model and Four-Factor Pricing Model can be applied in Indonesia. Thus, we can conclude the model is valid internationally.

Managerial Implications: Three-Factor Pricing Model and Four-Factor Pricing Model can be used as a forecasting tool.

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Appendix

Normality Test

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Error	.107	54	.187	.935	54	.006

a. Lilliefors Significance Correction

Both p-value (Kolmogorov-Smirnov and Shapiro-Wilk) are bigger than 0.05, so it has a normal distribution.

Autocorellation Test

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.859[a]	.738	.722	.403102531	1.462

a. Predictors: (Constant), HML, RmRf, SMB

b. Dependent Variable: RjRf

$d_{L.05} = 1.45$ $d_{U.05} = 1.68$

The result lies between $d_{L.05}$ and $d_{U.05}$ that yield inconclusive results.

Heteroscedasticity Test

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.030	.418		.073	.942
	RmRf	1.063	.818	.635	1.298	.199
	SMB	1.513	1.191	.421	1.271	.210
	HML	-.240	.503	-.176	-.476	.636
	UMD	.028	.431	.017	.065	.949

a. Dependent Variable: abresid

All independent variables have a significance value greater than 0.05 so there are no heteroscedasticity.

The final sample includes 120 data from 20 companies in 6 years' period. The companies are:

AALI	**BDMN**	**INCO**	**PTBA**
ANTM	**BMRI**	**INDF**	**SMCB**
ASII	**BNBR**	**ISAT**	**TLKM**
BBCA	**BUMI**	**MEDC**	**UNSP**
BBRI	**ENRG**	**PGAS**	**UNTR**

The data for each portfolio are:

Emiten	Year	Annually RjRf	Annually RmRf	Annually R(SMB)	Annually R(HML)	Annually R(UMD)
PRTF A	2006	0.764408	0.345155	0.069991	0.336667	0.662232
PRTF A	2007	0.928056	0.340935	0.166049	-0.14164	1.425053
PRTF A	2008	-0.86163	-0.81678	-0.49402	-1.44227	1.724604
PRTF A	2009	0.857015	0.559937	-0.0362	-0.33687	0.79044
PRTF A	2010	0.053502	0.313323	-0.18655	-0.11714	0.598205
PRTF A	2011	-0.2424	-0.0189	-0.08317	0.001115	0.545238
PRTF B	2006	0.434085	0.345155	0.069991	0.336667	0.662232
PRTF B	2007	0.551178	0.340935	0.166049	-0.14164	1.425053
PRTF B	2008	-1.17871	-0.81678	-0.49402	-1.44227	1.724604
PRTF B	2009	0.761981	0.559937	-0.0362	-0.33687	0.79044
PRTF B	2010	0.180441	0.313323	-0.18655	-0.11714	0.598205
PRTF B	2011	-0.0504	-0.0189	-0.08317	0.001115	0.545238
PRTF C	2006	0.81954	0.345155	0.069991	0.336667	0.662232
PRTF C	2007	1.661917	0.340935	0.166049	-0.14164	1.425053
PRTF C	2008	-2.00351	-0.81678	-0.49402	-1.44227	1.724604
PRTF C	2009	0.556953	0.559937	-0.0362	-0.33687	0.79044
PRTF C	2010	-0.25755	0.313323	-0.18655	-0.11714	0.598205
PRTF C	2011	-0.22379	-0.0189	-0.08317	0.001115	0.545238
PRTF D	2006	0.177603	0.345155	0.069991	0.336667	0.662232
PRTF D	2007	0.834958	0.340935	0.166049	-0.14164	1.425053
PRTF D	2008	-1.10299	-0.81678	-0.49402	-1.44227	1.724604
PRTF D	2009	0.857015	0.559937	-0.0362	-0.33687	0.79044
PRTF D	2010	0.053502	0.313323	-0.18655	-0.11714	0.598205
PRTF D	2011	-0.30457	-0.0189	-0.08317	0.001115	0.545238
PRTF E	2006	0.337513	0.345155	0.069991	0.336667	0.662232
PRTF E	2007	-0.17064	0.340935	0.166049	-0.14164	1.425053
PRTF E	2008	-1.1759	-0.81678	-0.49402	-1.44227	1.724604
PRTF E	2009	0.789402	0.559937	-0.0362	-0.33687	0.79044
PRTF E	2010	0.232878	0.313323	-0.18655	-0.11714	0.598205
PRTF E	2011	-0.23175	-0.0189	-0.08317	0.001115	0.545238
PRTF F	2006	0.514092	0.345155	0.069991	0.336667	0.662232
PRTF F	2007	0.244833	0.340935	0.166049	-0.14164	1.425053
PRTF F	2008	-1.76825	-0.81678	-0.49402	-1.44227	1.724604
PRTF F	2009	0.134605	0.559937	-0.0362	-0.33687	0.79044
PRTF F	2010	0.191525	0.313323	-0.18655	-0.11714	0.598205
PRTF F	2011	-0.08659	-0.0189	-0.08317	0.001115	0.545238
Emiten	**Year**	**Annually RjRf**	**Annually RmRf**	**Annually R(SMB)**	**Annually R(HML)**	**Annually R(UMD)**
PRTF G	2006	0.305158	0.345155	0.069991	0.336667	0.662232
PRTF G	2007	1.883399	0.340935	0.166049	-0.14164	1.425053

PRTF G	2008	-0.02559	-0.81678	-0.49402	-1.44227	1.724604
PRTF G	2009	0.682146	0.559937	-0.0362	-0.33687	0.79044
PRTF G	2010	0.289383	0.313323	-0.18655	-0.11714	0.598205
PRTF G	2011	0.226329	-0.0189	-0.08317	0.001115	0.545238
PRTF H	2006	0.331353	0.345155	0.069991	0.336667	0.662232
PRTF H	2007	0.190379	0.340935	0.166049	-0.14164	1.425053
PRTF H	2008	-0.81255	-0.81678	-0.49402	-1.44227	1.724604
PRTF H	2009	0.981451	0.559937	-0.0362	-0.33687	0.79044
PRTF H	2010	0.015758	0.313323	-0.18655	-0.11714	0.598205
PRTF H	2011	0.021649	-0.0189	-0.08317	0.001115	0.545238
PRTF I	2006	0.429709	0.345155	0.069991	0.336667	0.662232
PRTF I	2007	0.259732	0.340935	0.166049	-0.14164	1.425053
PRTF I	2008	-1.76825	-0.81678	-0.49402	-1.44227	1.724604
PRTF I	2009	0.497638	0.559937	-0.0362	-0.33687	0.79044
PRTF I	2010	0.287856	0.313323	-0.18655	-0.11714	0.598205
PRTF I	2011	-0.08659	-0.0189	-0.08317	0.001115	0.545238