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Stock Return Prediction Based on Some Forms of Capital Asset Pricing Model (CAPM)

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Abstract

Establishment of general equilibrium models allow us to determine the relevant measure of investment risk, and determine how the relationship between investment risk for any assets when capital markets are in balance. In a balanced market conditions, the correlation between expected return of a risky asset with the risk freeasset can be modeled with the CAPM. In CAPM, change risky asset returns are influenced by the market return and the return of risk-free assets, which is a risk-free asset return is the lowest gain required in investing. The problem that arises is why do not gain the required lows is not based on a risk-free asset. In this paper studied the determination of asset returns based on some form of CAPM which refers to zakat, NGDP, inflation, and the price of gold (GP). Based on the study results obtained by the return of assets is determined based form of ICAPM, NGDP-CAPM, Inf-CAPM, and GP-CAPM. So with by some form of the CAPM can be used as a measure of determining asset returns and investment risk that is relevant.

Keywords:
General equilibrium model, investment risks, market return, CAPM.

1. Introduction

Capital Asset Pricing Model (CAPM) is a model for determining the price of an investment asset. The model is formulated based on an equilibrium asset market condition. In an equilibrium state the level of returns required by investors for an investment asset will be affected by the risk of the price of investment assets in the market (Choudhary&Choudhary, 2010; Ferson& Locke, 1998). Here investment risk is no longer interpreted as a standard deviation of the rate of returnof an investment asset, but is measured based on the value of beta parameters in the CAPM model (Shamim, Abid, & Shaikh, 2015). Use of beta parameters β This is consistent with the theory of investment portfolios, which says that if investors diversify well, the risk gauge is the contribution of risk from additional assets to the investment portfolio (Shamim, Abid, & Shaikh, 2015; Wakyiku, 2010). If an investor holds an investment market portfolio, then this risk contribution is nothing but a beta parameter β (Alqisie and Alqurran, 2016).

Based on the return used as a reference standard, the CAPM has several forms. The form of the CAPM standard uses risk-free asset returns that are used as a reference. Risk-free asset returns that are often used are: central bank interest rates, bond returns, and so on. The standard CAPM approach was developed by Sharpe in 1964 (Chukwuemeka, 2016). If the return as the reference standard is nominal gross domestic product growth (NGDPg), then the GDP-CAPM form is obtained. Based on the form of the GDP-CAPM, it shows that asset returns depend on market returns and nominal GDP. This form of GDP-CAPM was developed by Sheikh in 2010 (Sadaf &Andleeb, 2014). If the return is the Inflation (Inf) reference standard, then the Inf-CAPM form is obtained. Based on the form of the Inf-CAPM, it shows that asset returns depend on market returns and inflation rates. This form of Inf-CAPM was developed by Hanif in 2011 (Sadaf &Andleeb, 2014). Some forms of CAPM above are often used in conventional economic systems. In Islamic economic systems, the return of risk-free assets as a reference is zakat, so that it is recognized as an Islamic CAPM or ICAPM form. Based on the form of ICAPM, it shows that asset returns depend on Islamic market returns and the level of zakat (Sadaf &Andleeb, 2014).

Referring to the aforementioned studies, in this paper the determination of asset returns is based on several forms of CAPM. The aim is to analyze differences in characteristics rather than returns calculated using each form of CAPM. As a numerical illustration, an analysis of stock asset returns traded on the capital market in Indonesia is carried out.

2. Research Methods

In this part of the form of the CAPM regression equation with several forms of return as a reference.However, previously studied first in a row about asset returns, the standard form CAPM regression equation.

2.1 Asset Return

Return is the result obtained by an investor from an investment he made. Return can be measured using several methods, including: total return, relative return, cumulative return, adjusted return, and logarithmic return. In this paper the measurement of returns is done using the logarithmic return, as follows. If it is assumed P_t asset price at the time t, and likewise r_t asset return at time t, then assets return r_t in the logarithmic method is measured using equations:

$$r_t = \ln P_t - \ln P_{t-1}. \tag{1}$$

Where $t = 1,2,...,T$ with T the number of observations on stock price data (Hakim, Hamid, and Meera, 2016). Furthermore, this return data is used to estimate the Capital asset Pricing Model (CAPM) regression equation.

2.2 CAPM Regression Equation

The basic standard CAPM equation is known that the balance of the capital market will be indicated by the asset market line, where the line connects the opportunity of a risk-free investment portfolio with the opportunity of a risky investment portfolio. This relationship applies to all assets, both efficient and inefficient. To determine the location of this market portfolio, it is necessary to combine risk assets (Lee, Cheng, & Chong, 2016). If it is assumed r_{ft} risk-free asset returns at the time, the risk-free asset expectations are $\mu_f = E(r_{ft})$, and the variance of risk-free assets is $\sigma_f^2 = Var(r_{ft}) = 0$. All investors are assumed to invest in the same portfolio, namely in the market portfolio. This assumption applies because of the assumptions on the CAPM, that is, all investors use the same analysis, namely using the Markowitz's method. In a state of balance, all risk assets must be in the market portfolio, because all investors will hold the portfolio (Lee, Cheng, and Chong, 2016).

If the portfolio consists of all assets in the market, and is assumed r_{mt} market return at time t, then the expected market return is $\mu_m = E(r_{mt})$ and the variance of market returns $\sigma_m^2 = Var(r_{mt})$. The difference between market return expectations and expectations of risk-free asset returns is equal to $[E(r_{mt}) - \mu_f]$ referred to as market risk premiums, and the ratio between market risk premiums to market risk σ_m, that is $[E(r_{mt}) - \mu_f]/\sigma_m$ is an equal slope of the capital market line (Sukono et al., 2018; 2017; 2016). If it is assumed r_{pt} capital market portfolio return at the time t, then the expectations of capital market portfolio returns are

$\mu_p = E(r_{pt})$, and the variance of capital market portfolio returns is $\sigma_p^2 = Var(r_{pt})$. The equation of the capital market portfolio line can be expressed as

$$E(r_{pt}) = E(r_f) + \frac{[E(r_m) - E(r_f)}{\sigma_m}\sigma_p .$$

Slope of $[E(r_m) - \mu_f]/\sigma_m$ is the market price of an efficient portfolio risk. Market prices indicate additional desired returns by the market (Lee, Cheng, and Chong, 2016).

Furthermore, suppose r_t asset return at time t, with asset return expectations $\mu_t = E(r_t)$ and variance $\sigma_t^2 = Var(r_t)$. Based on the concept of the capital market portfolio line mentioned above, the relationship between $E(r_t)$, $E(r_{mt})$, and $E(r_{ft})$, can be stated as

$$E(r_t) - E(r_{ft}) = \beta\{E(r_{mt}) - E(r_{ft})\}, \quad (2)$$

where β is a slope. The difference between asset return expectations and expectations of risk-free asset returns is equal to $[E(r_t) - E(r_{ft})]$ referred to as asset risk premiums (Shamim, Abid, & Shaikh, 2015).

Equation (2) cannot be tested statistically empirically, because equation (2) is an expectation equation, is a value that has not been observed. Therefore, so that the CAPM regression equation can be empirically tested it must be changed to the following

$$r_t - r_{ft} = \beta_0 + \beta_1(r_{mt} - r_{ft}) + e_t . \quad (3)$$

Therefore the risk-free asset returns have a constant mean, it can be written as $\mu_f = E(r_{ft})$. Also because of risk-free assets, then the variance $\sigma_f^2 = Var(r_{ft}) = 0$ [(Sukono et al., 2018; 2017; 2016).So equation (3) can be expressed as

$$r_t - \mu_f = \beta_0 + \beta_1(r_{mt} - \mu_f) + e_t . \quad (4)$$

Where β_0 constant term, β_1 is a slope, and e_t is a residual. Residual squence $\{e_t\}$ assumed to be white noise, which is normally distributed with zero mean and variance σ_e^2 (Lee, Cheng, and Chong, 2016; Barberis, et al, 2016). Equation (4) is the empirical form of the CAPM with risk-free asset returns r_{ft} as a reference.

2.3 Development of Several Forms of CAPM

In this section, several development of CAPM forms based on asset returns are used as reference standards, which include forms: Ob-CAPM, Inflation-CAPM, Gold Price-CAPM, and Islamic-CAPM.

- ***Ob-CAPM***

In an economic system when determining the return of assets on a balanced market is calculated based on bond returns as a reference. That is, that the return of assets must be at least as large as the return ofbonds. The Ob-CAPM equation is in the form of:

$$r_t - r_{ob} = \tilde{\beta}_0 + \tilde{\beta}_1(r_{mt} - r_{ob}) + \varepsilon_t . \quad (5)$$

Where are the variables r_t asset return at time t, r_{mt} market return at time t, and r_{ob} level of bond return. While $\tilde{\beta}_0$ constant term, $\tilde{\beta}_1$ is a slope, and ε_t is a residual. Residual squence $\{\varepsilon_t\}$ assumed to be white noise, which is normally distributed with zero mean and variance σ_ε^2 (Sadaf &Andleeb, 2014).

- ***Inflation-CAPM***

In an economic system when determining the return of assets on a balanced market is calculated based on the inflation return as a reference. That is, that the return of assets must be at least equal to the monthly inflation rate. The Inf-CAPM equation is in the form of:

$$r_t - Inf = \hat{\beta}_0 + \hat{\beta}_1 (r_{mt} - Inf) + a_t . \quad (6)$$

Where are the variables r_t asset return at time t, r_{mt} market return at time t, and Inf inflation rate. While $\hat{\beta}_0$ constant term, $\hat{\beta}_1$ is a slope, and a_t is a residual. Residual squence $\{a_t\}$ assumed to be white noise, which is normally distributed with zero mean and variance σ_a^2 (Sadaf &Andleeb, 2014).

- ***Gold Price-CAPM***

In an economic system if the determination of asset returns on a balanced market is calculated based on the gold price return (GP) as a reference. That is, that the return of assets must be at least as big as a GP return. The GP-CAPM equation is in the form of:

$$r_t - GP_r = \breve{\beta}_0 + \breve{\beta}_1 (r_{mt} - GP_r) + u_t . \quad (7)$$

Where are the variables r_t asset return at time t, r_{mt} market return at time t, and GP_r gold price return. While $\breve{\beta}_0$ constant term, $\breve{\beta}_1$ is a slope, and u_t is a residual. Residual squence $\{u_t\}$ assumed to be white noise, which is normally distributed with zero mean and variance σ_u^2.

- ***Islamic-CAPM***

In the Islamic economic system that determines the return of assets on a balanced market is calculated based on the level of zakat as a reference. That is, that the return of assets must at least be at the level of zakat. The ICAPM equation is in the form of:

$$r_t - z_r = \dot{\beta}_0 + \dot{\beta}_1 (r_{mt} - z_r) + v_t . \quad (8)$$

Where are the variables r_t asset return at time t, r_{mt} market return at time t, andlevel of zakat. While $\dot{\beta}_0$ constant term, $\dot{\beta}_1$ is a slope, and v_t is a residual. Residual squence $\{v_t\}$ assumed to be white noise, which is normally distributed with zero mean and variance σ_v^2 (Sadaf &Andleeb, 2014). To estimate equations (4), (5), (6), (7), and (8) can be done by the least square method.

3. Analysis of Numeric Illustrations

This section analyzes the data used in numerical illustrations, estimates of asset return movements, and comparison analysis of asset return movements.

3.1 Illustration Data

The data used in this illustration analysis include: Indofood Tbk (INDF) stock asset price data, joint stock price index (CSPI)data, information on Bank Indonesia benchmark interest rates, bond price data, inflation rate data, data about the movement of 24-carat gold prices, and provisions on the amount of zakat. The data is collected from related sources for the period January-October 2018.

Furthermore, stock asset price data, joint stock price index (CSPI) data, and gold price movement dataare determined by each return using equation (1). In this illustration analysis, the benchmark interest rate of Bank Indonesia (BI rate) is as conventional risk-free asset returns of 6% per year, INDF stocks as asset returns, CSPI as market returns, bonds as bond returns, inflation rate as inflation returns, and the amount of zakat as a risk free return is 2.5%.The predetermined return data is then used to estimate asset return movements as follows.

3.2 Estimating the Movement of asset returns

Asset return movements based on the CAPM with reference to Bank Indonesia interest rates (BI rate). In this estimation the data used includes return data on INDF stock assets, CSPI return data, and Bank Indonesia's

benchmark interest rate of 6% per year. The estimation is done by referring to equation (4). Estimation is done by using the least square method using the help of MINITAB 14. Estimation results, after testing the significance obtained by the form of the CAPM equation as:

$$\begin{matrix} r_t \\ Stat-t \end{matrix} = \begin{matrix} 0.0600 + \\ (-8.77) \end{matrix} \begin{matrix} 0.724\ (r_{mt} - \hat{\mu}_f) + e_t, \\ (33.34) \end{matrix} R^2 = 57.40\%,\ F = 1111.47,\ P = 0.00,\ e_t \sim N(0; 0.00819)$$

The CAPM estimator with the interest rate of Bank Indonesia as this reference is used to estimate asset return movements, as given in the graph in Figure 1.

Asset return movements based on CAPM with reference to bond returns. In this estimation the data used includes return data on INDF stock assets, CSPI return data, and Bank Indonesia's benchmark interest rate of 6% per year. The estimation is done by referring to equation (5). If the estimation is carried out using the assumption that the level of investment risk is the same, that is measured by the magnitude of the coefficient $\hat{\beta}$=0.724; then Ob-CAPM forms are obtained as follows:

$$\hat{r}_t = r_{ob} + 0.724(r_{mt} - r_{ob})$$

The CAPM estimator with the interest rate of Bank Indonesia as this reference is used to estimate asset return movements, as given in the graph in Figure 1.

Movement of asset returns based on the CAPM with reference to the inflation rate. In this estimation, the data used includes return data on INDF stock assets, JCI return data, and monthly inflation rates. The estimation is done by referring to equation (6). If the estimation is carried out using the assumption that the level of investment risk is the same, that is measured by the magnitude of the coefficient $\hat{\beta}$=0.724; then the form of Inf-CAPM is obtained as follows

$$\hat{r}_t = r_{\inf} + 0.724(r_{mt} - r_{\inf})$$

The CAPM estimator with Bank Indonesia interest rates as a reference is used to estimate the movement in asset returns, as given as a graph in Figure 1.

Asset return movements based on CAPM with reference to the return of gold prices. In this estimation, the data used includes return data on INDF stock assets, CSPI return data, and the movement of gold prices. The estimation is done by referring to equation (7). If the estimation is carried out using the assumption that the level of investment risk is the same, that is measured by the magnitude of the coefficient $\hat{\beta}$=0.724; then the GP-CAPM form is obtained as follows:

$$\hat{r}_t = r_{GP} + 0.724(r_{mt} - r_{GP})$$

The CAPM estimator with the interest rate of Bank Indonesia as this reference is used to estimate asset return movements, as given in the graph in Figure 1.

Movement of asset returns based on the CAPM with reference to the provisions of zakat. In this estimation the data used includes data on return on INDF stock assets, JCI return data, and provisions for the amount of zakat 2,%. The estimation is done by referring to equation (5). If the estimation is carried out using the assumption that the level of investment risk is the same, that is measured by the magnitude of the coefficient $\hat{\beta}$=0.724; then the ICAPM form is obtained as follows:

$$\hat{r}_t = z_r + 0.724(r_{mt} - z_r)$$

The CAPM estimator with the interest rate of Bank Indonesia as this reference is used to estimate asset return movements, as given in the graph in Figure 1.

3.3 Comparative Analysis

The estimators ofCAPM, Ob-CAPM, Inf-CAPM, GP-CAPM, and ICAPM, the results of section 3.2 are then used to estimate the return of stock assets. The results of the estimated return movements of share assets are given in Figure 1.

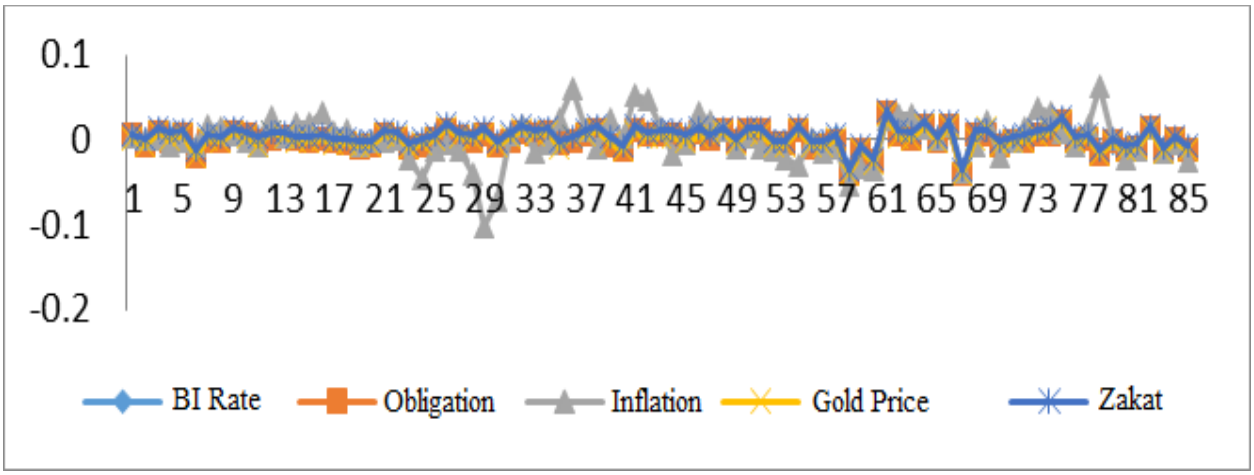

Figure 1. Comparison of Movement of Stock Returns

Taking into account the movement patterns of each asset return estimator in Figure 1, it appears that they have a pattern that is almost the same, only on the return movement of assets estimated using the inflation benchmark has higher fluctuations. Visually, it appears that even though asset return movements fluctuate, the average return on assets estimated using the terms of zakat is higher.

Based on a brief comparative analysis of the forms of CAPM, it is hoped that it can create insight for investors, that CAPM analysis can not only be done by referring to risk-free assets only. But it can also be done by referring to the return of other relevant assets.

4. Conclusions and Recommendations

This paper has discussed the determination of asset returns based on several forms of Capital Asset Pricing Model (CAPM). Here have been reviewed several forms of CAPM which include: standard CAPM, CAPM, Inflation-CAPM, Gold Price-CAPM, and Islamic-CAPM Bonds. Using some forms of CAPM, then used to determine the return of assets, and then analyzed differences in the characteristics of asset returns calculated using each form of CAPM. Based on the analysis, it shows that the estimators of each of the fluctuating asset return movements are similar, and the average return of assets estimated using ICAPM is higher than the others. Therefore, investors prior to investing should determine the reference used. Then in a balanced market the analysis of determining the return of assets, as a consideration in making investment decisions.

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References

Alqisie, A. and Alqurran, T., Validity of Capital Assets Pricing Model (CAPM), (Empirical Evidences from Amman Stock Exchange), *Journal of Management Research*, 2016, Vol. 8, No. 1. pp. 207-223.

Barberis, N., Greenwood, R., Jin, L., and Shleifer, A., X-CAPM: An extrapolative capital asset pricing model, *Journal of Financial Economics*, 115(2015), pp. 1–24.

Chukwuemeka, E., Application of Capital Asset Pricing Model (CAPM) on Real Property Investment in Nigeria, *International Journal of Business & Law Research 4(1): pp. 56-62, Jan-Mar. 2016.* © SEAHI PUBLICATIONS, 2016 www.seahipaj.org ISSN: 2360-8986.

Choudhary, K. &Choudhary, S., Testing Capital Asset Pricing Model: Empirical Evidences from Indian Equity Market. *Eurasian Journal of Business and Economics 2010*, 3 (6), pp. 127-138.

Ferson, W.E. & Locke, W.D., Estimating the Cost of Capital Through Time: An Analysis of the Sources of Error, *MANAGEMENT SCIENCE*/Vol. 44, No. 4, April 1998, pp. 485-500.

Hakim, S.A., Hamid, Z., and Meera, A.K.M., Capital Asset Pricing Model and Pricing of Islamic Financial Instruments, *JKAU: Islamic Econ.,* Vol. 29 No. 1, pp: 21-39 (January 2016), DOI: 10.4197 / Islec. pp. 29-1.2.

Lee, H-S., Cheng, F-F., and Chong, S-C., Markowitz Portfolio Theory and Capital Asset Pricing Model for Kuala Lumpur Stock Exchange: A Case Revisited, *International Journal of Economics and Financial Issues*, 2016, 6(S3), pp. 59-65. Special Issue for "Asia International Conference (AIC 2015), 5-6 December 2015, UniversitiTeknologi Malaysia, Kuala Lumpur, Malaysia.

Sadaf, R. and Andleeb, S., Islamic Capital Asset Pricing Model (ICAPM), *Journal of Islamic Banking and Finance*, March 2014, Vol. 2, No. 1, pp. 187-195. Copyright © The Author(s). 2014. All Rights Reserved. Published by American Research Institute for Policy Development.

Shamim, M.A., Abid, Y. and Shaikh, E.A., Validity of Capital Asset ricing Model in Pakistan's Capital Market (Karachi Stock Exchange). *Journal of Emerging Issues in Economics, Finance and Banking* (JEIEFB), *An Online International Research Journal* (ISSN: 2306-367X) 2014 Vol: 3 Issue 4.

Sukono,Susanti, D.,Najmia, M.,Lesmana, E.,Napitupulu, H.,Supian, S.,and Putra, A.S. Analysis of Stock Investment Selection Based on CAPM Using Covariance and Genetic Algorithm Approach. *IOP Conf. Series: Materials Science and Engineering*, **332** (2018), 012046. doi:10.1088/1757-899X/332/1/012046.

Sukono,Hidayat, Y.,Talib Bin Bon, A., and Supian, S.Modelling of Capital Asset Pricing by Considering the Lagged Effects. *IOP Conference Series: Materials Science and Engineering*, 166(2017) 012001. DOI: 10.1088/1757-899X/166/1/012001

Sukono,Bin Bon, A.T.,Mamat, M., and Supian, S. The APT with Lagged, Value-at-Risk and Asset Allocations by Using Econometric Approach. *Proceedings of the 2016International Conference on Industrial Engineering and Operations Management*, Detroit, USA, September 23-25, pp. 532-542, 2016. http://ieomsociety.org/ieomdetroit/pdfs/214.pdf

Wakyiku, D., Testing the Capital Asset Pricing Model (CAPM) on the Uganda Stock Exchange. *Working Paper.*African Institute for Mathematical Sciences, South Africa.2010, E-mail: davidw@aims.ac.za.

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