IOP Conf. Series: Materials Science and Engineering **166** (2017) 012001 doi:10.1088/1757-899X/166/1/012001

Modelling of capital asset pricing by considering the lagged effects

Sukono[1*], Y. Hidayat[2], A. Talib bin Bon[3], S. Supian[4]

[1,4]Department of Mathematics, Universitas Padjadjaran, Indonesia

[2]Department of Statistics, Universitas Padjadjaran, Indonesia

[3]Department of Production and Operations, Universiti Tun Hussein Onn Malaysia, Malaysia.

[*]corresponding author: sukono@unpad.ac.id

Abstract. In this paper the problem of modelling the Capital Asset Pricing Model (CAPM) with the effect of the lagged is discussed. It is assumed that asset returns are analysed influenced by the market return and the return of risk-free assets. To analyse the relationship between asset returns, the market return, and the return of risk-free assets, it is conducted by using a regression equation of CAPM, and regression equation of lagged distributed CAPM. Associated with the regression equation lagged CAPM distributed, this paper also developed a regression equation of Koyck transformation CAPM. Results of development show that the regression equation of Koyck transformation CAPM has advantages, namely simple as it only requires three parameters, compared with regression equation of lagged distributed CAPM.

1. Introduction

Referring Allen & Bujang [1] and Franses & Oest [5] standard form of Capital Asset Pricing Model (CAPM) was first developed separately by Sharpe in 1964, Lintner in 1965 and Mossin in 1969, therefore, the model is often called the CAPM form Sharpe-Lentner-Mossin. Most of the making of CAPM is based on a series of assumptions, namely: (i) An evaluation of the portfolio based on the expected return and standard deviation of the portfolio over a specified period of time; (ii) investor action based solely on considerations of expected return and standard deviation of the portfolio; (iii) The assets of the individual (individual assets) can completely broke up the smallest (fully divisible). Based on asset, it can buy assets on the desired amount; (iv) There is an interest rate and a risk-free savings (risk free lending and borrowing rate).This rate applies to all investors; (v) There are no transaction costs and income taxes; (vi) Information can be obtained directly (instantly) and free for all investors; (vii) individual investor action can not affect the price of the asset. In contrast, the actions of all investors (together and in the same direction) may affect the price of assets in the market; (viii) Each investor has the same hope (homogeneous expectations) against expectations of return, standard deviation and covariance of assets; and (ix) All assets can be traded (marketable) [6], [10].

According to Allen & Bujang [1] and Kuehn *et al*. [7], CAPM regression Equality is used to analyze the effect of the market index return on asset returns. The regression equation of CAPM is to link the level of expected returns on risk assets with a risk of the asset in a balanced condition [11]. In the equilibrium conditions of the capital markets, the difference between the market return with the return of risk-free assets referred to as the market risk premium, while the difference between the returns of assets with a risk-free asset return is referred to as the risk premium asset. In the CAPM, the risk premium of assets was affected by the independent variable market risk premium in the same period [11].We estimate that the risk premium assets are not only influenced by the market risk premium in the same period, but it can be influenced also by the market risk premium in the period - previous period or periods lagged. So that the CAPM model like this, known as the lagged distributed CAPM model. The weakness of distributed lagged CAPM is no sign that is efficient to determine the length lagged [3].

Associated with the lagged distributed, according Franses & Oest [5], Koyck transformation model assumes that the lagged effect on the explanatory variables are unlimited (infinite), but the coefficient parameter (for the variables lagged) down geometrically. Transformation model of Koyck has advantages, namely simple as it only requires three parameters. Therefore, in this paper intends to develop equation of Koyck transformation CAPM. The goal is to get an alternative model CAPM analysis. To clarify the application of this CAPM models, in this paper is given a numerical illustration.

2. Model of Capital Asset Pricing Model (CAPM)

In this section we explore the regression equation of CAPM, distribution lagged CAPM, and the development of the model of Koyck transformation CAPM.

2.1. Regression Equations of CAPM

The basic equation of the standard CAPM is known that the balance of the capital market will be indicated by the asset markets, where the line connecting the investment portfolio of a risk-free opportunity to opportunity-risk investment portfolio [2]. This relationship applies to all assets, either efficient or inefficient. To determine the position of the market portfolio, it needs to be combined between risky assets [6], [7].If we let r_{ft} returns risk-free assets at time t, then the expectation of risk-free asset is $\mu_f = E(r_{ft})$, and the variance of the risk free asset is $\sigma_f^2 = Var(r_{ft}) = 0$. All investors are assumed to invest in the same portfolio, namely the market portfolio. This assumption is valid because the assumptions in the CAPM, which all investors using the same analysis, which uses Markowitz's method [9]. In a state of equilibrium, all risk assets should be on the market portfolio, because all investors would hold that portfolio [8].

If the portfolio is composed of all the assets in the market, and we let r_{mt} market return at time t, then the expected market return is $\mu_m = E(r_{mt})$ and the variance of the market return is $\sigma_m^2 = Var(r_{mt})$. The difference between the return expectations of the market with expectations of returns risk-free assets amounted to $[E(r_{mt}) - \mu_f]$ referred to as market risk premiums, and the ratio between the risk of a market premium to market risk σ_m, ie, $[E(r_{mt}) - \mu_f]/\sigma_m$ is the slope of the capital market line equation [9].If we let r_{pt} portfolio return of capital markets at the time T, then the portfolio return expectations of the capital market is $\mu_p = E(r_{pt})$, and the variance of portfolio return of capital markets is $\sigma_p^2 = Var(r_{pt})$. Line equation of capital market portfolios can be expressed as:

$$E(r_{pt}) = E(r_f) + \frac{[E(r_m) - E(r_f)}{\sigma_m}\sigma_p \tag{1}$$

Slope $[E(r_m) - \mu_f]/\sigma_m$ is the market price of the portfolio risk efficiency. The market price shows the additional return required by the market [11], [8].

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

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

where β is the slope. The difference between the expected return of assets to the expected return of risk-free assets amounted to $[E(r_t) - E(r_{ft})]$ known as the risk premium for assets [2].

Equation (2) empirically cannot be tested statistically, since the equation (2) is an equality expectation. Expectations equation is a value that has not been observed. Therefore, in order regression equation of CAPM empirically testable shall be amended as follows:

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

Therefore the risk-free asset returns have flats constant, it can be written as $\mu_f = E(r_{ft})$. Because it is a risk-free assets, then the variance is $\sigma_f^2 = Var(r_{ft}) = 0$ [11]. So the equation (3) can be expressed as:

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

Where β_0 is the constant term, β_1 is the slope, and e_t is the residual. Sequence of residual $\{e_t\}$ are assumed white noise, which is normal distribution with the average 0 and variance σ_e^2 [5].

Estimation of equation (4) can be done with the least squares method.

2.2. Distributed Lagged CAPM

The assumptions in the making of the standard CAPM is still used in the making of a distributed lagged CAPM. An important difference that the distributed lagged CAPM can be accommodate a possible effect of the risk premium on some past period, while the standard CAPM cannot do it [2].

Let r_t be an asset returns in the period t, and r_{mt} market index return in the period t. It is known that the return of risk-free assets in the period t, r_{ft} has the average $\mu_f = E(r_{ft})$ constant and $\sigma_f^2 = Var(r_{ft}) = 0$. The regression equation of distributed lagged CAPM as follows:

$$r_t - \mu_f = \alpha_0 + \beta_0(r_{mt} - \mu_f) + \beta_1(r_{mt-1} - \mu_f) + \dots + \beta_l(r_{mt-l} - \mu_f) + e_t \tag{5}$$

Where α_0 is constant term, β_i $(i = 1,\dots,l)$ is coefficient of market risk premium, with l is length lagged, and e_t is the residuals row of the regression equation of lagged distributed CAPM, which is assumed to be normally distributed white noise with the average 0 and variance σ_e^2. Constants α_0 and coefficients β_i of parameters where $i = 1,\dots,l$ can be estimated using the least squares method (least square). A difficulty in the CAPM model with the lagged is to determine the length lagged influential.

Estimation of length lagged with Ad-Hoc method. To overcome the difficulties of determining the length of the lagged effect, it can be done by looking at signs of stability coefficient parameters. The way that is done by looking at the changes in positive sign (+) or negative (-) of the coefficient parameters. Length lagged is selected at the time showed stability (continued positive or continued negative) if lagged changed in length. If lagged extended, then the sign of the coefficient parameter inconsistent, it means that lagged cannot be selected. The weakness of this method is there are no clues about long lagged. Another weakness especially respect to economic data (time series) often have a high correlation (Gujarati, 1978).

2.3. Koyck Transformation CAPM

Based on the shape of CAPM with lagged, in this paper can be developed into a form of Koyck transformation CAPM, which equation can be written as follows:

$$r_t - \mu_f = \alpha_0 + \beta_0(r_{mt} - \mu_f) + \beta_0\lambda(r_{mt-1} - \mu_f) + \beta_0\lambda^2(r_{mt-2} - \mu_f) + ... + \varepsilon_t \quad (6)$$

or can be written into a simpler form as follows:

$$r_t - \mu_f = \alpha_0 + \beta_0 \sum_{l=0}^{\infty} \lambda^{\kappa}(r_{mt-l} - \mu_f) + \varepsilon_t \quad (7)$$

The first lagged from equation (7) as follows:

$$r_{t-1} - \mu_f = \alpha_0 + \beta_0 \sum_{l=0}^{\infty} \lambda^{l}(r_{mt-l-1} - \mu_f) + \varepsilon_{t-1} \quad (8)$$

If equation (8) multiple by λ, the obtained:

$$\lambda(r_{t-1} - \mu_f) = \lambda\alpha_0 + \beta_0 \sum_{l=0}^{\infty} \lambda^{l+1}(r_{mt-l-1} - \mu_f) + \lambda\varepsilon_{t-1} \quad (9)$$

When the equation (7) is subtracted by equation (9) obtained:

$$(r_t - \mu_f) - \lambda(r_{t-1} - \mu_f) = \alpha_0 - \lambda\alpha_0 + \beta_0(r_{mt} - \mu_f) + \varepsilon_t - \lambda\varepsilon_{t-1} \quad (10)$$

or

$$(r_t - \mu_f) = \alpha_0(1-\lambda) + \beta_0(r_{mt} - \mu_f) + \lambda(r_{t-1} - \mu_f) + \varepsilon_t - \lambda\varepsilon_{t-1} \quad (11)$$

For example $v_t = \varepsilon_t - \lambda\varepsilon_{t-1}$, equation (11) can be written as follows:

$$r_t - \mu_f = \alpha_0(1-\lambda) + \phi_0(r_{mt} - \mu_f) + \lambda(r_{t-1} - \mu_f) + v_t \quad (12)$$

Compared to CAPM by lagged form, Koyck transformation CAPM simpler form only requires three parameters, namely: α_0, λ and β_0. In addition, there is no reason multikolinier occurrence. Noteworthy is that the initial form (equation (6)) begins with lagged, but the final form (equation (12)) ends with autoregresi. Referring Franses & Oest [5], equation (11) is a ARMAX model. Coefficient parameter equation (11) can be estimated using the method of instrumental variables or conditional *likelihhod*.

3. Illustration Numerical Results and Discussion

In this section we explore numerical illustration of estimation of CAPM regression, estimation of distributed lagged CAPM, and estimation of Koyck transformation CAPM.

3.1. Estimation of CAPM regression

Suppose that there are as many as 400 stocks return data S and the market return (ISHG). It is known that the risk-free asset returns are relatively constant, with an average of $\hat{\mu}_f$ =0.0026462 and variance $\hat{\sigma}_f^2 = 0$. Estimator CAPM regression such data is:

$$\underset{Stat-t}{r_t - 0.0026462} = \underset{(40.53)}{0.00412} + \underset{(33.04)}{0.256}\,(r_{mt} - 0.0026462) + \varepsilon_t$$

R^2 =73.30% $\quad F$ = 109.85 $\quad P-Value = 0.000$

- The verification test of the parameter estimator

  To constants estimator $\hat{\beta}_0$, the hypothesis being tested is $H_0 : \hat{\beta}_0 = 0$ with alternative $H_0 : \hat{\beta}_0 \neq 0$. Statistical $t_{rasio}(\hat{\beta}_1)$ = 33.04. While at significant level α = 0.05; critical value $t_{(0.05;925)}$ = 1.645. Show that $t_{ratio}(\hat{\beta}_1) > t_{(0.05;925)}$, hypothesis H_0 is rejected, it is mean that $\hat{\beta}_1$ = 0.256 significant.
- The suitability test of the model

The suitability test generated value determination R^2 =73.30%. It means that the market risk premium is correlated quite strongly with the risk premium stocks. To test the significance of the model, the hypothesis is $H_0:\hat{\beta}_0=\hat{\beta}_1=0$ with alternative $H_1:\exists\hat{\beta}_i\neq 0\,(i=0,1)$. The regression model generates statistics $F=$ 109.85with probability $P-Value=$ 0.000; at the level of significance $\alpha=$ 0.05. It is clear that $P-Value<\alpha$, hypotehsis H_0 is rejected . it means regression model is significant. Residual normality test shows $\varepsilon_t\sim N(0,0.00000376)$, it means that *residual* ε_t *white noise*.

3.2. *Estimation of distributed lagged CAPM*

Suppose that there are as many as 400 stocks return data S and the market return (JCI). It is known that the risk-free asset returns are relatively constant, with an average of $\hat{\mu}_f$ =0.0026462 and variance $\hat{\sigma}_f^2=0$. Regression estimator of CAPM for such data is

$$\underset{Stat-t}{r_t-\mu_f} = 0.00388 + \underset{(18.24)}{} \; \underset{(27.32)}{0.436}\,(r_{mt}-\mu_f) + \underset{(16.26)}{0.270}\,(r_{mt-1}-\mu_f) + \underset{(17.20)}{0.201}\,(r_{mt-2}-\mu_f) + \underset{(8.23)}{0.132}(r_{mt-3}-\mu_f)+\varepsilon_t$$

R^2 =79.60% $F=381.99$ $P-Value=0.000$

The length of the lag regression estimator is 3. The coefficient signs become inconsistent parameter if lag extended again. It means that positive sign turn negative sign.

- The verification test of the parameter estimator

  To constants estimator $\hat{\alpha}_0$,the hypothesis being tested is $H_0:\hat{\alpha}_0=0$ with alternative $H_0:\hat{\alpha}_0\neq 0$. Statistical $t_{rasio}(\hat{\alpha}_0)$ =18.24; while at significant level $\alpha=$ 0.05; critical value $t_{(0.05;925)}$ = 1.645. Because $|t_{rasio}(\hat{\alpha}_0)|>t_{(0.05;925)}$ so that hypothesis H_0 is rejected. It means that $\hat{\alpha}_0=0.00388$ is significant. For parameter estimator $\hat{\beta}_0$, the hypothesis being tested is $H_0:\hat{\beta}_0=0$ with alternative $H_0:\hat{\beta}_0\neq 0$. Statistical $t_{rasio}(\hat{\beta}_0)=$ 27.32; it shows $t_{rasio}(\hat{\beta}_0)>$ $t_{(0.05;925)}$. So that hypothesis H_0 is rejected and $\hat{\beta}_0=$ 0.436 is significant. Parameter estimator $\hat{\beta}_1$, the hypothesis being tested is $H_0:\hat{\beta}_1=0$ with alternative $H_0:\hat{\beta}_1\neq 0$. Statistical $t_{rasio}(\hat{\beta}_1)=$ 16.26; it shows $t_{rasio}(\hat{\beta}_1)>t_{(0.05;925)}$. So that hypothesis H_0 is rejected and $\hat{\beta}_1=$ 0.276 is significant. Parameter estimator $\hat{\beta}_2$, the hypothesis being tested is $H_0:\hat{\beta}_2=0$ with alternative $H_0:\hat{\beta}_2\neq 0$. Statistical $t_{rasio}(\hat{\beta}_2)=$ 17.20; it shows $t_{rasio}(\hat{\beta}_2)>t_{(0.05;925)}$. So that hypothesis H_0 is rejected and $\hat{\beta}_2=$ 0.261 is significant. Parameter estimator $\hat{\beta}_3$, the hypothesis being tested is $H_0:\hat{\beta}_3=0$ with alternative $H_0:\hat{\beta}_3\neq 0$. Statistical $t_{rasio}(\hat{\beta}_3)=$ 8.23; it shows $t_{rasio}(\hat{\beta}_3)>$ $t_{(0.05;925)}$. So that hypothesis H_0 is rejected and $\hat{\beta}_3=$ 0.132 is significant.

- The suitability test of the model

  The suitability test generated value determination $R^2=$79.60%. It means that the market risk premium is correlated quite strongly with the risk premium stocks. To test the significance of the model, the hypothesis is $H_0:\hat{\alpha}_0=\hat{\beta}_i=0$ with alternative $H_1:\exists\hat{\alpha}_0\neq 0$ and or $\hat{\beta}_i\neq 0$, ($i=0,1,2,3$). The regression model generates statistics $F=381.99$with probability $P-Value=$ 0.000; at the level of significance $\alpha=$ 0.05. It is clear that $P-Value<\alpha$, hypotehsis H_0 is rejected. It means regression model is significant. Residual normality test shows $\varepsilon_t \sim N(0,0.00001668)$, it means that *residual* ε_t *white noise*.

3.3. Estimation of Koyck transformation CAPM

Koyck models assume that the lagged effect on the explanatory variables are unlimited (infinite), but the coefficient parameter (for the variables lagged) down geometrically. Transformation model of Koyck has advantages, namely simple as it only requires three parameters, namely: α_0, λ and β_0.

Furthermore, suppose that $Y_{it} = S_{it} - \hat{\mu}_f$ in the risk premium return stock i ($i = 1,...,N$ and N number of shares) at the time t ($t = 1,...,T$ and T the number of data), and W market risk premium return on time. Transformation Koyck CAPM form refer ARMAX model of equation (12). Because regression Koyck Y_{it} to I_{mt} produces small coefficient of determination R^2. Variable Y_{it} is transformed to $M_{it} = \ln\{(1+Y_{it})/(1-Y_{it})\}$. Koyck regression equation to be estimated subsequently in the form $M_{it} = c_i + \beta_i I_{mt} + \lambda M_{it-1} + u_{it} - \lambda u_{it-1}$. Constant estimation $c_i = \alpha_i(1-\lambda_i)$, parameter coefficient λ_i and *multiplier* β_i conducted using the method of instrumental variables referring to equation (12) or conditional *likelihood* estimator. For example, the data will be analyzed regression of stock returns based Koyck transformation CAPM. Based on the results of the regression analysis, obtained estimator constants $\hat{c}_1$ = -0.0155 has a statistical value $t_{rasio}(\hat{c}_1)$ = -5.40 with probability P = 0.000. The hypothesis tested is H_0: $\hat{c}_1$ = 0alternatively: H_1: $\hat{c}_1 \neq$ 0.Using a significance level of α = 0.05was obtained critical value statistic $t_{(0.05;824)}$ = 1.962847. Because $t_{rasio}(\hat{c}_1) > t_{(0.05;824)}$, the hypothesis H_0 is rejected, which means significant estimator constants $\hat{c}_1$ = -0.0155.

To test the hypothesis estimator coefficient $\hat{\lambda}_1$ and *multiplier* $\hat{\beta}_1$ conducted in the same manner as a test of hypothesis estimator constants. The test results concluded that coefficient $\hat{\beta}_1$ = 0.713 and $\hat{\lambda}_1$ = 0.321 is significant.

The above regression coefficient of deterministic R^2 = 67.80%. Simultaneous test on statistical regression models F = 862.50 with probability P = 0.000.The hypothesis tested is H_0: $\hat{c}_1 = \hat{\beta}_1 = \hat{\lambda}_1 =$ 0alternatively: H_1: $\exists\, \hat{c}_1 \neq 0$, $\hat{\beta}_1 \neq 0$ and or $\hat{\lambda}_1 \neq 0$. For significant level α = 0.05was obtained critical value statistic $F_{(0.05;3;824)}$ = 2.615708.Because$F > F_{(0.05;3;824)}$ and *P-Value*$<\alpha$, so that hypothesis H_0 is that means regression model M_{1t} = -0.0155 + 0.713 I_{mt} +0.321 $M_{1t-1} + u_{1t}$ -0.321 u_{1t-1} or M_{1t} = -0.0155 +0.713 $(r_{mt} - \hat{\mu}_f)$ +0.321 $(S_{1t-1} - \hat{\mu}_f)$ $+u_{1t}$ -0.321 u_{1t-1} is significant. Testing the assumption of normality*residula* u_t, results show that u_t normal distribution with an average $\hat{\mu}_{u1}$ = -4.4479$\times 10^{-17} \approx 0$ and standard deviation $\hat{\sigma}_{u1}$ = 0.07880 or variance σ^2_{u1} = 0.00621. Thus the above regression model accordingly.

4. Conclusions

In this paper discussed about modelling of Capital Asset Pricing Model (CAPM) with considering the delay effects. In the discussion of the CAPM includes the standard CAPM regression, lagged distributed CAPM regression, and CAPM regression Koyck transformation. Sharpe-Lentner-Mossin has introduced a regression equation of the standard CAPM. Regression standard CAPM does have a simple shape, but regression standard CAPM is not able to capture the effects of market risk premium in the past. Then the CAPM regression equation developed by lagged distributed, which is able to capture the effects of market risk premium in the past. The difficulty is not easy to determine the length lagged. In this paper developed CAPM regression Koyck transformation. Regression of CAPM Koyck transformation is a form ARMAX simple, and capable of capturing the effects of market risk premium in the past.

Acknowledgment
We would like thanks the Rector and Dean of Faculty of Mathematics and Natural Sciences Universitas Padjadjaran, which have provided a grant program, the Academic Leadership Grant (ALG), under the coordination of Prof. Dr. Sudradjat, M.S., which is a means to increase research activities and publications to researchers at the Universitas Padjadjaran.

References
[1] Allen, D.E. & Bujang, I., Conditional Beta Capital Asset Pricing Model (CAPM) and Duration Dependece Test, *Working Paper,* 18th World IMACS/MODSIM Congress, Cains, Australia 13-17 July 2009, [internet], 2009. [updated 2013 Jan 15; cited 2015 Apr 10]. Available from: http://www.mssanz.org.au/modsim09.
[2] Choudhary, K. & Choudhary, S. 2010. Testing Capital Asset Pricing Model: Empirical Evidences from Indian Equity Market. *Eurasian Journal of Business and Economics 2010*, 3 (6), 127-138.
[3] Demetriou, I.C. & Vassiliou, E.E., A Distributed Lag Estimator with Piecewise Monotonic Coefficients, *Proceedings of the Wold Congress on Enggineering,* 2008 Vol. II, WCE 2008, July 2-4, [internet] 2008, London, U.K. [updated 2013 Jan 15; cited 2015 Apr 10]. Available from: www.iaeng.org/publication/ WCE2008/WCE2008_pp1088-1094.pdf.
[4] Draper, N.R. & Smith H. 1998. *Applied Regression Analysis.* Third Edition. New York: John Wiley & Sons, Inc.
[5] Franses, P.H. & Van Oest, R., On the Econometrics of the Koyck Model, *Econometric Institute Report 2004-07,* retrived fromhttp://www.publishing.eur.nlfir/asset/1190/ei200407.pdf, on December 2009).
[6] Krause, A. 2001. *An Overview of Asset Pricing Models.* Preliminary Version. University of Bath School of Management.
[7] Kuehn, L.A., Simutin, M. & Wang,J.J., 2014, A Labor Capital Asset Pricing Model, *Working Paper,* Tepper School of Business Carnegie Mellon University, [internet], 2014. [updated 2015 Feb 15; cited 2015 Apr 10]. Available from: ww.andrew.cmu.edu/user/.../WangJessie_CV.pd...
[8] Shamim, M.A., Abid, Y. and Shaikh, E.A. 2014. 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.
[9] Suartini, N.K.A & Mertha, I.M. Perbandingan CAPM dengan APT dalam Memrediksi Return Saham. Kertas Kerja. Fakultas Ekonomi Universitas Udayana (Unud), Bali, Indonesia.
[10] Tadelilin, E., *Portofolio Investasi*: Teori dan Aplikasi, Edisi Pertama. Yogyakarta: Penerbit Kanisius, 2010
[11] Wakyiku, D. 2010. Testing the Capital Asset Pricing Model (CAPM) on the Uganda Stock Exchange. *Working Paper.* African Institute for Mathematical Sciences, South Africa. E-mail: davidw@aims.ac.za.