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GARCH-M MODEL AND THE BEHAVIOR OF RISK-RETURN RELATIONSHIP IN INDONESIA STOCK MARKET

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Abstract: This study examines the risk-return trade-off and volatility behaviour in Indonesia stock market. As the analytical tool this study uses GARCH-M model with symmetric GARCH(1,1). To obtain more reliable results, this study takes daily and weekly stock index as well as 5 individual stock returns from January 2004 to November 2020 as a sample. This study also investigates the results with two alternative mean equations, simple regression and AR(1) model. The first finding of this study is that in Indonesia stock market both in stock index and in individual stocks, the volatilities of return are time varying. From investigating the risk-return relationship the results are mixed. This study finds that positive risk-return relationships in stock market index are observed both in daily and weekly data. A positive risk-return relationhip in stock market index is also found either in AR(1) model of mean equation or in simple regression model. The same results are observed in two stocks investigated. There is one stock where a positive risk return relationship is observed only in daily return data not in weekly return data. A negative risk-return relationships is observed in one stock and there is no evidence of risk-return trade-off in one stock. The conclusion is that a positive risk-return relationship as a postulated by investment theory only exists in stock index and does not exist in all stocks.

Keywords: *Indonesia stock market, Risk-return trade-off, GARCH-M, GARCH(1,1), Time-varying volatility*

INTRODUCTION

In finance literatures, the contention is that investors are basically risk averse. Risk is an unattractive aspect to investors, other things equal, investors prefer less risk to more risk (Archer et al 1983, 7). This implies that investors expect compensation for bearing risk and without such compensation they will reject risky investment. (Ahn and Shrestha 2009, 34). Various measures of risk are used in investment literatures. This uncertainty makes the actual return to differ from expected return. Other definitions of risk include the uncertainty of future outcomes, the probability of adverse outcomes (Reilly and Brown 2006, 202). Return variability is also called volatility (Reilly and Brown 2006, 285).

The concept of high risk high return should be operationalized by letting the security return be partly determined by its risk (Brooks, 2014, 445). Damodoran (2020, 7) notes 4 such models as the Capital Asset Pricing Model (CAPM), Arbitrage Pricing theory or Model (APT or APM), Multifactor model, and Proxy model. In CAPM, the risk is measured with a beta then multiplied by equity risk premium produces total risk premium. These models are regression based that rely on the assumption that the variances are homoscedastic. Earlier, stock market volatility was assumed to be constant or homoscedastic but now, it is well accepted that stock market volatility varies over time (Ali 2019, 96). In financial data there is a tendency for volatility clustering (Bollerslev et al 1992, 8).

Since financial time series exhibit non-constant variance(heteroskedasticity), Heteroskedasticity exists when the variance of error term depends on the size

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of previous errors. To accomodate non constant variance for empirical study, Engle (1982,) introduced Auto-Regressive Conditional Heteroskedasticity (ARCH) model to deal with time varying variance. In ARCH. Bollerslev(1986) proposed a Generalised Auto-Regressive Conditional Heteroskedasticity or GARCH model. Then, Engle, Lilien, dan Robins (1987) introduced a model called GARCH-in-Mean or GARCH-M.

Many studies on the relationship between return and its volatility as a proxy for risk have been conducted using GARCH-M model; however, the results are mixed. For example, Yakob and Delpachitra (2016) investigate risk-return relationship taking stock indices in several countries (i,e, Australia, China, Hong Kong, India, Indonesia, Japan, Malaysia, Singapore, South Korea and Taiwan) as a sample. They find that only stock index in China and Malaysia show a positive risk and return relation. For Indonesia they found a negative sign and insignificant. Nyber (2010) used monthly data from stock index of NYSE, AMEX and NASDAQ from 1960 to 2009. Nyber found a positive risk-return relation and the relation did not depend on the condition of economy. Dedi and Yavas (2016) examined risk-return relation in Germany, Britain, China, Russia, and Turkey. This study reveals that risk-return trade off is observed only in British stock market. Lahmiri (2013) investigates trade-off between risk and return using stock market data in Jordan, Saudi Arabia, Kuwait, and Morocco. His study shows that the trade-off of risk and return are observed at all the stock exchanges in these four countries.

This study investigates whether a positive risk return relationship exists in Indonesia Stock market (IDX). As the analytical tool, this study uses GARCH-in-Mean or GARCH-M model for period 16 years (January 2004 to November 2020). Specifically, this study will investigate daily and weekly returns data of Indonesia Stock Market Index and 5 individual actively traded stocks. GARCH (1,1) model is employed to examine the time varying volatility series of returns. In order to examine the consistence of results, in addition with daily versus weekly data, this study compares the results from using AR(1) mean equation versus simple regression model in which the only regressor is the volatility of return. Since the results for aggregate represented by stock market index might be misleading due to individual stocks heterogeneity, this study adds 5 individual stocks to be studied. These stocks are INTP (Building Material), GGRM (Tobacco), UNVR (Household & Personal Products), BBRI (Financial Service) and ICBP (Packaged Foods).

LITERATURE REVIEW

The risk-return trade-off or relationship is an important part in investment theory. Practitioners can make decision on the basis on the risk-return relationship. The relation of risk and return can be positive or negative. The followings are various Risk-return Tradeoff models that allow positive relation between risk and return.

Sharpe (1964) and Lintner (1965a,b) introduced this formal framework called CAPM to answer the question how investment risk affects its expected return. The CAPM is a single variable (factor) model, that is, it added only one single risk premium to risk free rate . According to the CAPM, stock returns can be defined using the following equation:

$$R_i = R_F + \beta_i (R_M - R_F) \quad (1)$$

Where is return on investment, is risk free rate, is stock beta, and is average return in the market. This formula implies that expected return on a security is related to beta linearly (Ross et al 2008, 308). According to Ross et al (2008), the term is presumably positive. In this model, is called systematic risk, that is the sensitivity of asset return to the return on the market portfolio of risky assets . This CAPM predicts a positive influence of systematic risk on expected return. In CAPM, risk premium varies in direct proportion to beta (Brealey et al 2006, 189).

Solnik and McLeavey (2004,153) extended the CAPM to International CAPM that adds foreign currency risk premium into the model. Hence the expected return on asset determined by market risk premium and various foreign currency risk premium.

$$E(R_i) = R_F + \beta RP + \lambda_1 SRP_1 + \lambda_2 SRP_2 + \dots\dots\dots + \lambda_k SRP_k \qquad (2)$$

Here, is domestic risk free rate, represents the world market risk premium, are risk premium on foreign currencies 1 to k. represent the sensitivities of asset domestic currency return to the exchange rate on currencies 1 to k.

APT developed by Ross in the early 1970 and published in 1976 (Reilly and Brown, 1997, 223). While CAPM added only one risk premium, APT added more than one risk premium to the risk free rate. The APM model is also called multi-factor model and may be written mathematically as.

$$R_i = E_i + \beta_{i1}\delta_1 + \beta_{i2}\delta_2 + \dots\dots\dots + \beta_{ik}\delta_k + \varepsilon_i \qquad (3)$$

Where is the actual return on asset during a specified time period, is expected return if all the factors have zero change, is reaction in asset i's return to movements in a common risk factor k, is a set of common factors that influence the return on all assets, and is a random error.

APT model starts by assuming that return depends on macroeconomic factors and noise. This can be written as follows (Brealey et al 2006, 199)

$$Return = a + b_1(r_{Factor1}) + b_2(r_{Factor2}) + \dots\dots\dots\dots\dots + noise \qquad (4)$$

In this formula, a is constant and b is factor sensitivity. Arbitrage Pricing Theory states that the risk premium is affected only by factors or macroeconomic risks not by unique risk, that is:

$$Expected\ risk\ premium = r - r_F + b_1(r_{Factor1} - r_F) + b_2(r_{Factor2} - r_F) + \dots\dots\dots\dots \qquad (5)$$

Risk Premiums for individual (unspecified) market risk factors = factor sensitivity*factor risk premium. Since many factors can be included in the right-hand side of equation, the expected return can be more accurate than CAPM. Nevertheless APT model does not determine which factors are the appropriate factors (Ross et al 2008, 333 Reilly and Brown 1997 323, Brealey et al 2006, 199). Burmeister, Roll and Ross (1994) proposed five factors that include Confidence factor, Time horizon factor, Inflation factors, Business-cycle factors, and Market timing factors. Fama and French (1993) include company-specific attributes as factors that affect stock retun. These factors include market factors, size factors and book to market factor.

Composite or Melded models, In this model, more risk premium is added to the CAPM expected return. For instance, for valuing small company,the melded model adds small cap premium to the CAPM expected return. Here,

$$R_i = R_F + \beta_i(R_M - R_F) + Small\ cap\ premium. \qquad (6)$$

Rath (2014) called this model as expanded CAPM.

Proxy or Empirical Models, According to Damodoran (2017), the proxies are firm characteristics such as market capitalization, price to book ratios or return momentum, etc. The proxy model for risk return relationship is as follows:

$$Expected\ return = a + b(proxy1) + c(proxy2) + \dots\dots\dots \qquad (7)$$

The coefficients on proxies reflect risk preferences. Ross et al (2008, 334)

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explain a model called empirical model that is similar to proxy model. According to Ross et al (2008, 334), while CAPM and APT model are risk-based model and have a strong basis in theory, the empirical models are based less on theory and more on the relations in the history of market data.

Model With Heteroskedastic Variance, In regression model, it is assumed that the variance for times series of financial returns is constant. Accomodating a non constant variance , Engle (1982) introduced the Autoregressive Conditional Heteroscedasticity (ARCH) models. This heteroscedastic variance model is obtained from the following regression equation called the mean equation as follows.

$$\text{The mean equation } R_i = \alpha + \beta X_i + \varepsilon_i \qquad (8)$$

Here is investment return, is constant, is a set of factors affecting return, is regression coefficient and is error term. An ARCH is a variance model representing non constant or time varying variance. The variance is denoted by that is dependent or conditional on the previous variances or the lagged values of the square of , that is:

$$\text{The Variance Equation: } \sigma_t^2 = h_t = \omega + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 \qquad (9)$$

In this model q is the order of ARCH terms. This model shows that the conditional variance is not constant from time to time but it is time varying. It should be noted that the variance represented by this ARCH model has no error term in it (Franses 2000 p. 157). An alternative model of time-varying variance is the model called the generalized autoregressive conditional heteroscedasticity (GARCH) introduced by Bollerslev (1986). The GARCH model assumes that the conditional variance not only depends on lagged values of previous conditional variances but also depend on lagged values of squared residuals. The GARCH (,) model can be represented by the followings:

$$\text{The Variance Equation: } \sigma_t^2 = h_t = \omega + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^{p} \beta_i \sigma_{t-1}^2 \qquad (10)$$

Where p is the order of GARCH terms and q is the order of ARCH terms. In this model, ε_{t-1}^2 is the ARCH term and σ_{t-1}^2 is the GARCH term. Actually an ARCH model is a special form of GARCH model in which $p = 0$. Like in ARCH model, applying GARCH model involves two equations, that are the mean equation and the variance equation. Either for the ARCH model or the GARCH model, the residuals ε_t is obtained from the mean equation. The simple model of GARCH is when p = q = 1 or called GARCH (1,1,). The GARCH(1,1) model is a popular model used in research. Bollerslev et al. (1992) found, the GARCH(1,1) model is sufficient to describe the volatility evolution of the stock return series. The GARCH(1,1) can be expressed as

$$\sigma_t^2 = h_t = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 \qquad (11)$$

Equation (11) represents the model of conditional variance called GARCH (1,1). In this equation ω is a constant and α is the coefficient of lagged squared error (also called ARCH term) generated from the mean equation. The β is the coefficient of previous conditional variance (also called GARCH term). The significant value of α implies that past value of squared error influences current volatility whereas significant value of β suggests that current volatility is influenced by past volatility. Because investors need compensation for taking risk, the risk premium is presumably positive (Ross et al, 2008 p 307). To ensure that h_t is non-negative or positive, the sufficient conditions are that the parameters of the model satisfy the followings: $\omega > 0$, $0 < \alpha < 1$, $0 < \beta < 1$, and $(\alpha + \beta) < 1$. Non-explosiveness condition is represented by $(\alpha + \beta) < 1$. Dedi and Yavas (2016) define α as the coefficient that measures the extent to which a volatility shock today

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feeds through the next period volatility, while $(\alpha+\beta)$ as a measure of persistence of volatility shock and it measures the rate at which this effect dies over time.

GARCH-in-Mean or GARCH-M Model, The GARCH-M model was introduced by Engle, Lilien, dan Robins (1987). This is an extension of the GARCH framework in which the conditional mean is to depend on its conditional variance. Specifically, in GARCH-M model, the variance is included as a regressor of the mean equation. The simplest GARCH-M model, that is GARCH(1,1) is given by

The mean equation : $R_t = \mu + \delta h_t + \varepsilon_t$ (12)

Where $h_t = \omega + \alpha h_{t-1} + \beta \varepsilon^2_{t-1}$ (13)

Where μ and ω are constants. R_t is investment return, α is the coefficient of the GARCH component, β is the coefficient of ARCH or lagged squared residual component. To satisfy the stationary condition, $(\alpha+\beta)\prec 1$. This model can be used to operationalise the financial market theory that a financial asset with high risk is expected to generate higher return than that with lower risk. If R_t represents investment return then the impact of the uncertainty of return is shown by the parameter δ on the mean equation (Hamilton, 1994). It is expected that the value of δ is positive. The mean equation in this GARCH-M model can also be given by a simple regression form in which the only regressor in the mean equation is h_{t-1} (Brooks, 2014 p. 445) or h_t (Brooks 2014, 445 and Tsay 2010, 142). The conditional variance wil vary over time or time varying as a result of the linear dependence on the behavior of past value of ε^2_{t-1} and it's own that is h_{t-1} (Hossein et al 2011, 4). The inclusion of h_t in the mean equation (1) is called a "volatility feedback" effect (Nyberg, 2010). A positive coefficient of δ means that risk-averse investors require a higher expected return (a higher risk premium) when the risk is higher. The coefficient δ is also called the risk premium parameter (Ahmed and Suliman 2011). The sum of the ARCH and GARCH effects, that is $(\alpha+\beta)$ is a measure of volatility persistence. If that sum is closer to one, it means that effects of shocks fade away very slowly. The lower the values of GARCH & ARCH effects, the faster the effects fade away.

METHOD

Data used were consist of daily and weekly returns on Jakarta Composite Index or in Indonesian language called Indeks Harga Saham Gabungan (IHSG). Other data used are daily and weekly returns on 5 individual stocks that actively traded in Indonesia stock Exchange formerly named Jakarta Stock Exchange. Data are available at yahoo finance in the internet. There were IHSG Market Index, INTP (Building Materials), GGRM (Tobacco), UNVR (Household & Personal Products), BBRI (Banks-Regional) and ICBP (Packaged Foods). The data, daily and weekly index or stock rises, were collected during January 2004 to November 2020.

This study used Augmented Dickey Fuller (ADF test) for stationary. The ADF test is formulated as follows:

Model without intercept and trend

$$\Delta Y_t = \delta Y_{t-1} + \sum_{i=1}^{n} \beta \Delta Y_{t-1+1} + \varepsilon_t \qquad (16)$$

Model with intercept and no trend

$$\Delta Y_t = \alpha_0 + \delta Y_{t-1} + \sum_{i=1}^{n} \beta \Delta Y_{t-1+1} + \varepsilon_t \qquad (17)$$

Model with intercept and trend

$$\Delta Y_t = \alpha_0 + \alpha_1 T + \delta Y_{t-1} + \sum_{i=1}^{n} \beta \Delta Y_{t-1+1} + \varepsilon_t \qquad (18)$$

Testing unit root test with ADF test has the following hipotheses , the series has a root or not stationary with an alternative hipothesis of that is the series has no unit root or has been stationary. Ho

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is rejected if absolute value of ADF test statistic is greater than its critical value at alpha 5 percent.

GARCH-in-the-Mean or GARCH-M Model developed by Engle, Lilien and Robins (1987) is applied to examine the risk-return trade-off. By this model, the significance of volatility effect on stock returns can be examined. The GARCH-M models consists of two equations namely the mean equation and variance equation. In order to obtain consistent results, this study investigate results from daily return versus weekly return data as well. This study also investigate the results from AR(1) model in mean equation versus simple regression model in mean equation. For variance equation this study uses a popular GARCH(1,1) model. The analytical models are presented in the following table.

Table 1
. The Models to be Estimated

Time Series Data	Two Mean Equations Used	Variance Equation GARCH(1,1)
Daily Return	(1) $R_t = \mu + \lambda_1 R_{t-1} + \delta h_t + \varepsilon_t$	$h_t = \sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2$
	(2) $R_t = \mu + \delta h_t + \varepsilon_t$	
Weekly Return	(1) $R_t = \mu + \lambda_1 R_{t-1} + \delta h_t + \varepsilon_t$	$h_t = \sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2$
	(2) $R_t = \mu + \delta h_t + \varepsilon_t$	

The first mean equation is an AR(1) model with GARCH in it. The use of AR(1) model for the mean equation is based on the fact that the period of time between one observation to other observation is very close; therefore, it is reasonable to assume that current return is correlated to previous return. Chiang and Li (2012) also used this AR(1) model with adding other control variables. The second mean equation is a simple regression model. For variance equation, this study will use GARCH(1,1). The GARCH (1,1) is represented by $\sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2$. In this study this GARCH(1,1) is expressed by the following notations: $h_t = \omega + \alpha\varepsilon_{t-1}^2 + \beta h_{t-1}$ where h_t represents σ_t^2.

RESULT AND DISCUSSION

The descriptive statistics for the daily and weekly return on Stock Index and 5 individual stocks are presented in Table 2.

Table 2
Statistics of Daily Returns in Percent

Description	Composite	Individual Stocks				
	IHSG	INTP	GGRM	UNVR	BBRI	ICBP
Minimum	-10.6902	-33.0834	-20.6395	-12.5683	-13.1148	-15.5556
Maximum	10.1907	19.9461	23.3871	19.6078	20.4918	18.4211
Mean	0.0591	0.0751	0.0559	0.0764	0.11456	0.1037
Std Dev	1.3192	2.7804	2.4335	2.0210	2.5306	2.3537
Period (Days)	4199	4199	4199	4199	4199	4199

Table 2 shows that the mean returns in individual stocks are higher than that in composite or market index denoted by IHSG, with GGRM stock as the exception. The mean return in stock index was 0.0591 % while the mean returns in individual stocks are higher except for GGRM. The maximum returns in individual stocks with no exception are also higher than that in composite index. The maximum return in stock index was 10.1907 %. The range of maximum return in individual stocks is from 18.4211 % to 23.3871 %.

Table 3
Statistics of Weekly Returns in Percent

Description	Composite	Individual Stocks				
	IHSG	INTP	GGRM	UNVR	BBRI	ICBP
Min	-20.7824	-35.7143	-35.7895	-15.4286	-24.4624	-35.7143
Maximum	12.2847	31.6177	59.5628	20.1754	34.6535	30.4000
Mean	0.2772	0.3752	0.2889	0.3416	0.5240	0.48819
Std Dev	2.8873	5.6631	5.8198	3.7766	5.1833	5.1023
Period (Weeks)	881	881	881	881	881	881

The statistics on weekly return are presented in Table 3. Similar to daily return, the figures for weekly returns also show that the mean rate of returns in all individual stocks are higher than that in composite index. This study covers as many as 881 weeks from January 2004 to November 2020

The returns series are tested for stationarity or unit root using the ADF test for Daily Returns as well as Weekly Returns. The result of the test were Stationary. (The table could not be shown due to limited of space).

This paper will examine whether daily and weekly return frequencies guarantee a positive risk return relation. Two models for mean equation are examined, the first is a simple regression and the second is an AR(1) regression.

a.Using Simple Regresion Model for Mean Equation

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The empirical results using daily returns with simple regression for mean equation are reported in Table 4.

Table 4
Empirical Results With Simple Regression for Mean Equation
The Figures in Parentheses are p-values or Prob

Stocks	Mean Equations GARCH-M $R_t = \mu + \delta h_t + \varepsilon_t$	Variance Equations with GARCH (1,1,) $h_t = \sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2$
IHSG	$R_t = -0.096677 + 0.0852562\ log(h_t)$ (0.0000) (0.0034)	$h_t = 0.040507 + 0.138531\varepsilon_{t-1}^2 + 0.842260h_{t-1}$ (0.0000) (0.0000) (0.0000)
INTP	$R_t = -0.205767 + 0.201187 log(h_t)$ (0.1969) (0.0312)	$h_t = 0.458309 + 0.127652\varepsilon_{t-1}^2 + 0.818738h_{t-1}$ (0.0000) (0.0000) (0.0000)
GGRM	$R_t = -0.209659 + 0.189757 log(h_t)$ (0.0870) (0.0288)	$h_t = 0.607404 + 0.165252\varepsilon_{t-1}^2 + 0.731076h_{t-1}$ (0.0000) (0.0000) (0.0000)
UNVR	$R_t = -0.007564 + 0.059036 log(h_t)$ (0.8857) (0.0911)	$h_t = 0.232963 + 0.175798\varepsilon_{t-1}^2 + 0.779403h_{t-1}$ (0.0000) (0.0000) (0.0000)
BBRI	$R_t = 0.216217 - 0.018140h_t$ (0.0000) (0.0604)	$h_t = 0.108046 + 0.111801\varepsilon_{t-1}^2 + 0.876205h_{t-1}$ (0.0000) (0.0000) (0.0000)
ICBP	$R_t = 0.164478 - 0.010672h_t$ (0.0003) (0.2777)	$h_t = 0.290988 + 0.179625\varepsilon_{t-1}^2 + 0.777859h_{t-1}$ (0.0000) (0.0000) (0.0000)

Table 4 shows that daily returns are characterized by the existence of time varying variance or heteroscedasticity in the residuals. The variance equations of stock Index and 5 stocks all have significant coefficients for ε_{t-1}^2 and h_{t-1}. The parameters in variance equations, ω, α *and* β of GARCH(1,1) model are all positive and significant at 1% level. The significant value of ARCH term (α) implies that previous error affects current volatility whereas significant GARCH parameter (β) suggests that current volatility is affected by previous volatility. The non-negativity conditions for h_t are met. In this case the parameters : $\omega > 0$, $0 < \alpha < 1$, $0 < \beta < 1$. Non-explosiveness condition is represented by $(\alpha + \beta) < 1$.

For the mean equations, the risk premium parameter with positive sign in the mean equation describes the risk-return relationship. Table 4 shows that positive risk-return relatioships are observed for Stock Index IHSG, INTP stock, and GGRM stock at 5% significant level while UNVR Stock is at 10 percent significant level. A significant coefficient with positive sign indicate that investors are rewarded for assuming greater risk. Then, BBRI stock has a negative and significant coefficient while ICBP stock has a negative coefficient but insignificant. The empirical results show that volatility on daily returns for stock index and individual stocks follow the GARCH(1,1) process. For daily return data, the variance parameters, that are the coefficients of ε_{t-1}^2 and h_{t-1} for stock market index and all the 5 stock returns are significant at 1% alpha with a positive sign. This supports the time varying volatility in stock market index and 5 stock returns. The volatility is aslo persistence since for each variance equation $(\alpha + \beta) < 1$.

The empirical results for daily return using AR(1) model for the mean equation are presented in Table 5.

Table 5
Empirical Results With AR(1) Model for Mean Equations
The Figures in Parentheses are p-values or Prob

Stocks	Mean Equations using GARCH-M $R_t = \mu + \lambda_1 R_{t-1} + \delta h_t + \varepsilon_t$	Variance Equations with GARCH (1,1,) $h_t = \sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2$
IHSG	$R_t = 0.092524 + 0.062696R_{t-1} + 0.080952log(h_t$ (0.0000) (0.0003) (0.0045)	$h_t = 0.040836 + 0.138544\varepsilon_{t-1}^2 + 0.841314\ h_{t-}$ (0.0000) (0.0000) (0.0000)
INTP	$R_t = -0.207714 - 0.000930R_{t-1} + 0.200344log($ (0.1994) (0.9548) (0.0320)	$h_t = 0.461710 + 0.128219\varepsilon_{t-1}^2 + 0.817857\ h_{t-}$ (0.0000) (0.0000) (0.0000)
GGRM	$R_t = -0.187366 + 0.061082R_{t-1} + 0.174317 log($ (0.1231) (0.0002) (0.0435)	$h_t = 0.597918 + 0.163290\varepsilon_{t-1}^2 + 0.733892\ h_{t-}$ (0.0000) (0.0000) (0.0000)
UNVR	$R_t = -0.008130 - 0.110150R_{t-1} + 0.096450log($ (0.8748) (0.0000) (0.0663)	$h_t = 0.218054 + 0.168583\varepsilon_{t-1}^2 + 0.788241\ h_{t-}$ (0.0000) (0.0000) (0.0000)
BBRI	$R_t = 0.210384 - 0.026344R_{t-1} - 0.017482\ h_t$ (0.0000) (0.0864) (0.0707)	$h_t = 0.108577 + 0.111435\varepsilon_{t-1}^2 + 0.876370\ h_{t-}$ (0.0000) (0.0000) (0.0000)
ICBP	$R_t = 0.162691 - 0.058136R_{t-1} - 0.009154\ h_t$ (0.0004) (0.0002) (0.3557)	$h_t = 0.288820 + 0.178500\varepsilon_{t-1}^2 + 0.779006\ h_{t-}$ (0.0000) (0.0000) (0.0000)

Table 5 presents the results of mean equation using AR(1) model and return volatility as the independent variable. The column on the right hand side presents variance equation. Table 5 shows that daily stock returns are characterized by the existence of time varying variance or heteroscedasticity in the residuals. The variance equations of stock Index and 5 stocks all have significant coefficients for and . The table shows that positive risk-return relatioships are observed at 5 percent significant level for Stock Index IHSG, INTP stock, GGRM stock while the coefficient for UNVR Stock is significant at 10 percent. A significant and positive relationship indicates that investors are compensated for assuming greater risk

Empirical Results Using Weekly Returns with Simple Regression for Mean Equation are presented in Table 6.

Table 6
Results of Weekly Returns with Simple Regression for Mean Equation
The Figures in Parentheses are p-values or Prob

Stocks	Mean Equations GARCH-M $R_t = \mu + \delta h_t + \varepsilon_t$	Variance Equations GARCH (1,1) $h_t = \sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2$
IHSG	$R_t = -0.114155 + 0.286917\ log(h_t$ (0.6470) (0.0771)	$h_t = 0.683886 + 0.250513\varepsilon_{t-1}^2 + 0.686665h_{t-1}$ (0.0000) (0.0000) (0.0000)
INTP	$R_t = -1.047652 + 0.283458\sqrt{h_t}$ (0.2339) (0.0881)	$h_t = 1.395142 + 0.0920262\varepsilon_{t-1}^2 + 0.866650\ h_{t-1}$ (0.0000) (0.0000) (0.0000)
GGRM	$R_t = -0.385948 + 0.021737\ h_t$ (0.2934) (0.0914)	$h_t = 0.744980 + 0.058458\varepsilon_{t-1}^2 + 0.918738\ h_{t-1}$ (0.0000) (0.0000) (0.0000)
UNVR	$R_t = 0.219225 + 0.009070\ h_t$ (0.6108) (0.3532)	$h_t = 2.3866004 + 0.2427228\varepsilon_{t-1}^2 + 0.608053\ h_{t-}$ (0.0000) (0.0000) (0.0000)
BBRI	$R_t = 1.282168 - 0.0344460\ h_t$ (0.0000) (0.0083)	$h_t = 2.257094 + 0.216696\ \varepsilon_{t-1}^2 + 0.715057\ h_{t-1}$ (0.0000 (0.0000) (0.0000)
ICBP	$R_t = 0.543401 + 0.003196\ h_t$ (0.0459) (0.7827)	$h_t = 6.224541 + 0.334913\ \varepsilon_{t-1}^2 + 0.459435\ h_{t-1}$ (0.0000) (0.0000) (0.0000)

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The column on the right-hand side of Table 6 presents the estimate of variance equations for stock market index (IHSG) and for 5 stock returns. The non-negativity conditions are also met. The non-negativity conditions for h_t are met. In this case the parameters : ω > 0, 0 < α < 1, 0 < β < 1. This supports the time varying volatility in stock market index and 5 stock returns. The volatility is also persistence since for each variance equation $(\alpha+\beta)\prec 1$. Table 8 shows that the existence of positive risk-return relationship is found at market index, INTP stock and GGRM stock all with 10% significant levels. This significant and positive relationship indicate that investors are rewarded for assuming greater risk. BBRI stock has a negative and significant coefficient. A negative relationship indicates that investors react to factor(s) other than the standard deviation of return (Abonongo et al 2016). Two stocks, UNVR and ICBP stocks have positive but insignificant coefficient.

Empirical Results Using Weekly Returns with AR(1) Model for Mean Equation are presented in Table 7.

Table 7
Empirical Results of Weekly With AR(1) Model for Mean Equation
The Figures in Parentheses are p-values or Prob

Stocks	Mean Equations GARCH-M $R_t=\mu+\lambda_1 R_{t-1}+\delta h_t+\varepsilon_t$	Variance Equations with GARCH (1,1,) $h_t=\sigma_t^2=\omega+\alpha\varepsilon_{t-1}^2+\beta\sigma_{t-1}^2$
IHSG	$R_t=-0.081030-0.070649R_{t-1}+0.280863\ log($ (0.7487) (0.0573) (0.0861)	$h_t=0.649891+0.256050\varepsilon_{t-1}^2+0.689481h_{t-1}$ (0.0000) (0.0000) (0.0000)
INTP	$R_t=-0.0318422-0.120274R_{t-1}+0.028021h_t$ (0.4603) (0.0006) (0.0494)	$h_t=0.927664+0.070156\varepsilon_{t-1}^2+0.901248h_{t-1}$ (0.0038) (0.0000) (0.0000)
GGRM	$R_t=-1.716445-0.178482R_{t-1}+0.385106\sqrt{h_t}$ (0.0642) (0.0000) (0.0400)	$h_t=0.600349+0.049811\varepsilon_{t-1}^2+0.930838h_{t-1}$ (0.0000) (0.0000) (0.0000)
UNVR	$R_t=0.166330-0.152587R_{t-1}+0.016161h_t$ (0.5006) (0.0000) (0.3957)	$h_t=2.242363+0.226854\varepsilon_{t-1}^2+0.628128h$ (0.0000) (0.0000) (0.00000)
BBRI	$R_t=1.342835-0.094329R_{t-1}-0.034390h_t$ (0.0000) (0.0112) (0.0088)	$h_t=2.065950+0.205251\varepsilon_{t-1}^2+0.731688\ h_{t-1}$ (0.0000) (0.0000) (0.0000)
ICBP	$R_t=0.529403-0.036935R_{t-1}+0.005412h_t$ (0.0627) (0.0056) (0.6600)	$h_t=5.574169+0.302478\ \varepsilon_{t-1}^2+0.507226\ h_{t-1}$ (0.0000) (0.0000) (0.0000)

The empirical results for mean equation with AR(1) process from weekly data are reported in Table 7. include the variance equation on the right hand column. For weekly return data, the variance parameters, that are the coefficients of ε_{t-1}^2 and h_{t-1} for stock market index and 5 stock individual returns are significant with a positive sign. This supports the time varying volatility in stock market index and 5 individual stocks. The volatility is also persistence since for each variance equation $(\alpha+\beta)\prec 1$. Table 10 shows the existence of positive risk-return relationship is found at market index at 10% alpha, INTP stock and GGRM stock both at 5% significant levels. A significant and positive relationship indicates that investors are rewarded for assuming greater risk. BBRI stock has a negative and significant coefficient. This negative relationship indicates that investors react to factor(s) other than the standard deviation of return while UNVR and ICBP stocks have positive but insignificant coefficient.

CONCLUSIONS

This study found the stock market index show a positive risk-return relationship.This positive risk-return relationship in stock market index was observed both in daily and weekly data. Thus from these empirical results, the first conclusion is that in Indonesia stock market both in stock index and in individual stocks, the volatilities of return are time varying. The second conclusion is that in Indonesia stock market the risk-return relationship as postulated by investment theory exists in stock market index. The third conclusion is that such risk-return relationship as a postulated by investment theory does not exist in all stocks**.**

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GARCH-M MODEL AND THE BEHAVIOR OF RISK-RETURN RELATIONSHIP IN INDONESIA STOCK MARKET

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Abstract: This study examines the risk-return trade-off and volatility behaviour in Indonesia stock market. As the analytical tool this study uses GARCH-M model with symmetric GARCH(1,1). To obtain more reliable results, this study takes daily and weekly stock index as well as 5 individual stock returns from January 2004 to November 2020 as a sample. This study also investigates the results with two alternative mean equations, simple regression and AR(1) model. The first finding of this study is that in Indonesia stock market both in stock index and in individual stocks, the volatilities of return are time varying. From investigating the risk-return relationship the results are mixed. This study finds that positive risk-return relationships in stock market index are observed both in daily and weekly data. A positive risk-return relationhip in stock market index is also found either in AR(1) model of mean equation or in simple regression model. The same results are observed in two stocks investigated. There is one stock where a positive risk return relationship is observed only in daily return data not in weekly return data. A negative risk-return relationships is observed in one stock and there is no evidence of risk-return trade-off in one stock. The conclusion is that a positive risk-return relationship as a postulated by investment theory only exists in stock index and does not exist in all stocks.

Keywords: *Indonesia stock market, Risk-return trade-off, GARCH-M, GARCH(1,1), Time-varying volatility*

INTRODUCTION

In finance literatures, the contention is that investors are basically risk averse. Risk is an unattractive aspect to investors, other things equal, investors prefer less risk to more risk (Archer et al 1983, 7). This implies that investors expect compensation for bearing risk and without such compensation they will reject risky investment. (Ahn and Shrestha 2009, 34). Various measures of risk are used in investment literatures. This uncertainty makes the actual return to differ from expected return. Other definitions of risk include the uncertainty of future outcomes, the probability of adverse outcomes (Reilly and Brown 2006, 202). Return variability is also called volatility (Reilly and Brown 2006, 285).

The concept of high risk high return should be operationalized by letting the security return be partly determined by its risk (Brooks, 2014, 445). Damodoran (2020, 7) notes 4 such models as the Capital Asset Pricing Model (CAPM), Arbitrage Pricing theory or Model (APT or APM), Multifactor model, and Proxy model. In CAPM, the risk is measured with a beta then multiplied by equity risk premium produces total risk premium. These models are regression based that rely on the assumption that the variances are homoscedastic. Earlier, stock market volatility was assumed to be constant or homoscedastic but now, it is well accepted that stock market volatility varies over time (Ali 2019, 96). In financial data there is a tendency for volatility clustering (Bollerslev et al 1992, 8).

Since financial time series exhibit non-constant variance(heteroskedasticity), Heteroskedasticity exists when the variance of error term depends on the size of previous errors. To accomodate non constant variance for empirical study, Engle (1982,) introduced Auto-Regressive Conditional Heteroskedasticity (ARCH) model to deal with time varying variance. In ARCH. Bollerslev(1986) proposed a Generalised Auto-Regressive Conditional Heteroskedasticity or GARCH model. Then, Engle, Lilien, dan Robins (1987) introduced a model called GARCH-in-Mean or GARCH-M.

Many studies on the relationship between return and its volatility as a proxy for risk have been conducted using GARCH-M model; however, the results are mixed. For example, Yakob and Delpachitra (2016) investigate risk-return relationship taking stock indices in several countries (i,e, Australia, China, Hong Kong, India, Indonesia, Japan, Malaysia, Singapore, South Korea and Taiwan) as a sample. They find that only stock index in China and Malaysia show a positive risk and return relation. For Indonesia they found a negative sign and insignificant. Nyber (2010) used monthly data from stock index of NYSE, AMEX and NASDAQ from 1960 to 2009. Nyber found a positive risk-return relation and the relation did not depend on the condition of economy. Dedi and Yavas (2016) examined risk-return relation in Germany, Britain, China, Russia, and Turkey. This study reveals that risk-return trade off is observed only in British stock market. Lahmiri (2013) investigates trade-off between risk and return using stock market data in Jordan, Saudi Arabia, Kuwait, and Morocco. His study shows that the trade-off of risk and return are observed at all the stock exchanges in these four countries.

This study investigates whether a positive risk return relationship exists in Indonesia Stock market (IDX). As the analytical tool, this study uses GARCH-in-Mean or GARCH-M model for period 16 years (January 2004 to November 2020). Specifically, this study will investigate daily and weekly returns data of Indonesia Stock Market Index and 5 individual actively traded stocks. GARCH (1,1) model is employed to examine the time varying volatility series of returns. In order to examine the consistence of results, in addition with daily versus weekly data, this study compares the results from using AR(1) mean equation versus simple regression model in which the only regressor is the volatility of return. Since the results for aggregate represented by stock market index might be misleading due to individual stocks heterogeneity, this study adds 5 individual stocks to be studied. These stocks are INTP (Building Material), GGRM (Tobacco), UNVR (Household & Personal Products), BBRI (Financial Service) and ICBP (Packaged Foods).

LITERATURE REVIEW

The risk-return trade-off or relationship is an important part in investment theory. Practitioners can make decision on the basis on the risk-return relationship. The relation of risk and return can be positive or negative. The followings are various Risk-return Tradeoff models that allow positive relation between risk and return.

Sharpe (1964) and Lintner (1965a,b) introduced this formal framework called CAPM to answer the question how investment risk affects its expected return. The CAPM is a single variable (factor) model, that is, it added only one single risk premium to risk free rate . According to the CAPM, stock returns can be defined using the following equation:

$$R_i = R_F + \beta_i(R_M - R_F) \quad (1)$$

Where is return on investment, is risk free rate, is stock beta, and is average return in the market. This formula implies that expected return on a security is related to beta linearly (Ross et al 2008, 308). According to Ross et al (2008), the term is presumably positive. In this model, is called systematic risk, that is the sensitivity of asset return to the return on the market portfolio of risky assets . This CAPM predicts a positive influence of systematic risk on expected return. In CAPM, risk premium varies in direct proportion to beta (Brealey et al 2006, 189).

Solnik and McLeavey (2004,153) extended the CAPM to International CAPM that adds foreign currency risk premium into the model. Hence the expected return on asset determined by market risk premium and various foreign currency risk premium.

$$E(R_i) = R_F + \beta RP + \lambda_1 SRP_1 + \lambda_2 SRP_2 + \ldots\ldots\ldots + \lambda_k SRP_k \qquad (2)$$

Here, is domestic risk free rate, represents the world market risk premium, are risk premium on foreign currencies 1 to k. represent the sensitivities of asset domestic currency return to the exchange rate on currencies 1 to k.

APT developed by Ross in the early 1970 and published in 1976 (Reilly and Brown, 1997, 223). While CAPM added only one risk premium, APT added more than one risk premium to the risk free rate. The APM model is also called multi-factor model and may be written mathematically as.

$$R_i = E_i + \beta_{i1}\delta_1 + \beta_{i2}\delta_2 + \ldots\ldots\ldots + \beta_{ik}\delta_k + \varepsilon_i \qquad (3)$$

Where is [illegible] change, is [illegible] return [illegible] risk [illegible] that influence the return on all assets, and is a random error.

APT model starts by assuming that return depends on macroeconomic factors and noise. This can be written as follows (Brealey et al 2006, 199)

$$Return = a + b_1(r_{Factor1}) + b_2(r_{Factor2}) + \ldots\ldots\ldots\ldots + noise \qquad (4)$$

In this formula, a is constant and b is factor sensitivity. Arbitrage Pricing Theory states that the risk premium is affected only by factors or macroeconomic risks not by unique risk, that is:

$$Expected\ risk\ premium = r - r_F + b_1(r_{Factor1} - r_F) + b_2(r_{Factor2} - r_F) + \ldots\ldots\ldots\ldots \qquad (5)$$

Risk Premiums for individual (unspecified) market risk factors = factor sensitivity*factor risk premium. Since many factors can be included in the right-hand side of equation, the expected return can be more accurate than CAPM. Nevertheless APT model does not determine which factors are the appropriate factors (Ross et al 2008, 333 Reilly and Brown 1997 323, Brealey et al 2006, 199). Burmeister, Roll and Ross (1994) proposed five factors that include Confidence factor, Time horizon factor, Inflation factors, Business-cycle factors, and Market timing factors. Fama and French (1993) include company-specific attributes as factors that affect stock retun. These factors include market factors, size factors and book to market factor.

Composite or Melded models, In this model, more risk premium is added to the CAPM expected return. For instance, for valuing small company,the melded model adds small cap premium to the CAPM expected return. Here,

$$R_i = R_F + \beta_i(R_M - R_F) + Small\ cap\ premium. \qquad (6)$$

Rath (2014) called this model as expanded CAPM.

Proxy or Empirical Models, According to Damodoran (2017), the proxies are firm characteristics such as market capitalization, price to book ratios or return momentum, etc. The proxy model for risk return relationship is as follows:

$$Expected\ return = a + b(proxy1) + c(proxy2) + \ldots\ldots\ldots \qquad (7)$$

The coefficients on proxies reflect risk preferences. Ross et al (2008, 334)

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explain a model called empirical model that is similar to proxy model. According to Ross et al (2008, 334), while CAPM and APT model are risk-based model and have a strong basis in theory, the empirical models are based less on theory and more on the relations in the history of market data.

Model With Heteroskedastic Variance, In regression model, it is assumed that the variance for times series of financial returns is constant. Accomodating a non constant variance , Engle (1982) introduced the Autoregressive Conditional Heteroscedasticity (ARCH) models. This heteroscedastic variance model is obtained from the following regression equation called the mean equation as follows.

$$\textit{The mean equation } R_t = \alpha + \beta X_t + \varepsilon_t \qquad (8)$$

Here is investment return, is constant, is a set of factors affecting return, is regression coefficient and is error term. An ARCH is a variance model representing non constant or time varying variance. The variance is denoted by that is dependent or conditional on the previous variances or the lagged values of the square of , that is:

$$\textit{The Variance Equation: } \sigma_t^2 = h_t = \omega + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 \qquad (9)$$

In this model q is the order of ARCH terms. This model shows that the conditional variance is not constant from time to time but it is time varying. It should be noted that the variance represented by this ARCH model has no error term in [illegible] (Franses 2000 p. 157). An alternative [illegible] model called the [illegible]). The GARCH [illegible] the conditional variance not only depends on lagged values of previous conditional variances but also depend on lagged values of squared residuals. The GARCH (,) model can be represented by the followings:

$$\textit{The Variance Equation: } \sigma_t^2 = h_t = \omega + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^{p} \beta_i \sigma_{t-1}^2 \qquad (10)$$

Where p is the order of GARCH terms and q is the order of ARCH terms. In this model, ε_{t-1}^2 is the ARCH term and σ_{t-1}^2 is the GARCH term. Actually an ARCH model is a special form of GARCH model in which $p = 0$. Like in ARCH model, applying GARCH model involves two equations, that are the mean equation and the variance equation. Either for the ARCH model or the GARCH model, the residuals ε_t is obtained from the mean equation. The simple model of GARCH is when p = q = 1 or called GARCH (1,1,). The GARCH(1,1) model is a popular model used in research. Bollerslev et al. (1992) found, the GARCH(1,1) model is sufficient to describe the volatility evolution of the stock return series. The GARCH(1,1) can be expressed as

$$\sigma_t^2 = h_t = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 \qquad (11)$$

Equation (11) represents the model of conditional variance called GARCH (1,1). In this equation ω is a constant and α is the coefficient of lagged squared error (also called ARCH term) generated from the mean equation. The β is the coefficient of previous conditional variance (also called GARCH term). The significant value of α implies that past value of squared error influences current volatility whereas significant value of β suggests that current volatility is influenced by past volatility. Because investors need compensation for taking risk, the risk premium is presumably positive (Ross et al, 2008 p 307). To ensure that h_t is non-negative or positive, the sufficient conditions are that the parameters of the model satisfy the followings: $\omega > 0$, $0 < \alpha < 1$, $0 < \beta < 1$, and $(\alpha + \beta) < 1$. Non-explosiveness condition is represented by $(\alpha + \beta) < 1$. Dedi and Yavas (2016) define α as the coefficient that measures the extent to which a volatility shock today

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feeds through the next period volatility, while $(\alpha + \beta)$ as a measure of persistence of volatility shock and it measures the rate at which this effect dies over time.

GARCH-in-Mean or GARCH-M Model, The GARCH-M model was introduced by Engle, Lilien, dan Robins (1987). This is an extension of the GARCH framework in which the conditional mean is to depend on its conditional variance. Specifically, in GARCH-M model, the variance is included as a regressor of the mean equation. The simplest GARCH-M model, that is GARCH(1,1) is given by

The mean equation : $R_t = \mu + \delta h_t + \varepsilon_t$ (12)

Where $h_t = \omega - \alpha h_{t-1} + \beta \varepsilon_{t-1}^2$ (13)

Where μ and ω are constants. R_t is investment return, α is the coefficient of the GARCH component. β is the coefficient of ARCH or lagged squared residual component. To satisfy the stationary condition, $(\alpha + \beta) \prec 1$. This model can be used to operationalise the financial market theory that a financial asset with high risk is expected to generate higher return than that with lower risk. If R_t represents investment return then the impact of the uncertainty of return is shown by the parameter δ on the mean equation (Hamilton, 1994). It is expected that the value of δ is positive. The mean equation in this GARCH-M model can also be given by a simple regression form in which the only regressor in the mean equation is h_{t-1} (Brooks, 2014 p. 445) or h_t (Brooks 2014, 445 and Tsay 2010, 142). The conditional variance wil vary over time or time varying as a result of the linear dependence on the behavior of past value of ε_{t-1}^2 and it's own that is h_{t-1} (Hossein et al 2011, 4). The inclusion of h_t in the mean equation (1) is called a "volatility feedback" effect (Nyberg, 2010). A positive coefficient of δ means that risk-averse investors require a higher expected return (a higher risk premium) when the risk is higher. The coefficient δ is also called the risk premium parameter (Ahmed and Suliman 2011). The sum of the ARCH and GARCH effects, that is $(\alpha + \beta)$ is a measure of volatility persistence. If that sum is closer to one, it means that effects of shocks fade away very slowly. The lower the values of GARCH & ARCH effects, the faster the effects fade away.

METHOD

Data used were consist of daily and weekly returns on Jakarta Composite Index or in Indonesian language called Indeks Harga Saham Gabungan (IHSG). Other data used are daily and weekly returns on 5 individual stocks that actively traded in Indonesia stock Exchange formerly named Jakarta Stock Exchange. Data are available at yahoo finance in the internet. There were IHSG Market Index, INTP (Building Materials), GGRM (Tobacco), UNVR (Household & Personal Products), BBRI (Banks-Regional) and ICBP (Packaged Foods). The data, daily and weekly index or stock rises, were collected during January 2004 to November 2020.

This study used Augmented Dickey Fuller (ADF test) for stationary. The ADF test is formulated as follows:

Model without intercept and trend

$$\Delta Y_t = \delta Y_{t-1} + \sum_{t=1}^{n} \beta \Delta Y_{t-1+1} + \varepsilon_t \quad (16)$$

Model with intercept and no trend

$$\Delta Y_t = \alpha_0 + \delta Y_{t-1} + \sum_{t=1}^{n} \beta \Delta Y_{t-1+1} - \varepsilon_t \quad (17)$$

Model with intercept and trend

$$\Delta Y_t = \alpha_0 + \alpha_1 T + \delta Y_{t-1} + \sum_{t=1}^{n} \beta \Delta Y_{t-1+1} + \varepsilon_t \quad (18)$$

Testing unit root test with ADF test has the following hipotheses , the series has a root or not stationary with an alternative hipothesis of that is the series has no unit root or has been stationary. Ho

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is rejected if absolute value of ADF test statistic is greater than its critical value at alpha 5 percent.

GARCH-in-the-Mean or GARCH-M Model developed by Engle, Lilien and Robins (1987) is applied to examine the risk-return trade-off. By this model, the significance of volatility effect on stock returns can be examined. The GARCH-M models consists of two equations namely the mean equation and variance equation. In order to obtain consistent results, this study investigate results from daily return versus weekly return data as well. This study also investigate the results from AR(1) model in mean equation versus simple regression model in mean equation. For variance equation this study uses a popular GARCH(1,1) model. The analytical models are presented in the following table.

Table 1
. The Models to be Estimated

Time Series Data	Two Mean Equations Used	Variance Equation GARCH(1,1)
Daily Return	$(1) R_t = \mu + \lambda_1 R_{t-1} + \delta h_t + \varepsilon_t$	$h_t = \sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2$
	$(2) R_t = \mu + \delta h_t + \varepsilon_t$	
Weekly Return	$(1) R_t = \mu + \lambda_1 R_{t-1} + \delta h_t + \varepsilon_t$	$h_t = \sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2$
	$(2) R_t = \mu + \delta h_t + \varepsilon_t$	

The first mean equation is an AR(1) model with GARCH in it. [illegible]. For variance equation, this study will use GARCH(1,1). The GARCH (1,1) is represented by $\sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2$. In this study this GARCH(1,1) is expressed by the following notations: $h_t = \omega + \alpha\varepsilon_{t-1}^2 + \beta h_{t-1}$ where h_t represents σ_t^2.

RESULT AND DISCUSSION

The descriptive statistics for the daily and weekly return on Stock Index and 5 individual stocks are presented in Table 2.

Table 2
Statistics of Daily Returns in Percent

Description	Composite	Individual Stocks				
	IHSG	INTP	GGRM	UNVR	BBRI	ICBP
Minimum	-10.6902	-33.0834	-20.6395	-12.5683	-13.1148	-15.5556
Maximum	10.1907	19.9461	23.3871	19.6078	20.4918	18.4211
Mean	0.0591	0.0751	0.0559	0.0764	0.11456	0.1037
Std Dev	1.3192	2.7804	2.4335	2.0210	2.5306	2.3537
Period (Days)	4199	4199	4199	4199	4199	4199

Table 2 shows that the mean returns in individual stocks are higher than that in composite or market index denoted by IHSG, with GGRM stock as the exception. The mean return in stock index was 0.0591 % while the mean returns in individual stocks are higher except for GGRM. The maximum returns in individual stocks with no exception are also higher than that in composite index. The maximum return in stock index was 10.1907 %. The range of maximum return in individual stocks is from 18.4211 % to 23.3871 %.

Table 3
Statistics of Weekly Returns in Percent

Description	Composite	Individual Stocks				
	IHSG	INTP	GGRM	UNVR	BBRI	ICBP
Min	-20.7824	-35.7143	-35.7895	-15.4286	-24.4624	-35.7143
Maximum	12.2847	31.6177	59.5528	20.1754	34.5535	30.4000
Mean	0.2772	0.3752	0.2889	0.3416	0.5240	0.48819
Std Dev	2.8873	5.6631	5.8198	3.7766	5.1833	5.1023
Period (Weeks)	881	881	881	881	881	881

The statistics on weekly return are presented in Table 3. Similar to daily return, the figures for weekly returns also show that the mean rate of returns in all individual stocks are higher than that in composite index. This study covers as many as 881 weeks from January 2004 to November 2020

The returns series are tested for stationarity or unit root using the ADF test for Daily Returns as well as Weekly Returns. The result of the test were Stationary. (The table could not be shown due to limited of space).

This paper will examine whether daily and weekly return frequencies guarantee a positive risk return relation. Two models for mean equation are examined. the first is a simple regression and the second is an AR(1) regression.

a.Using Simple Regresion Model for Mean Equation

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The empirical results using daily returns with simple regression for mean equation are reported in Table 4.

Table 4
Empirical Results With Simple Regression for Mean Equation
The Figures in Parentheses are p-values or Prob

Stocks	Mean Equations GARCH-M $R_t = \mu + \delta h_t + \varepsilon_t$	Variance Equations with GARCH (1,1) $h_t = \sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2$
IHSG	$R_t = -0.096677 + 0.1852262 \log(h_t)$ (0.0000) (0.0034)	$h_t = 0.049307 + 0.138331\varepsilon_{t-1}^2 + 0.842260h_{t-1}$ (0.0000) (0.0000) (0.0000)
INTP	$R_t = -0.208767 + 0.201187 \log(h_t)$ (0.1969) (0.0312)	$h_t = 0.453309 + 0.127652\varepsilon_{t-1}^2 + 0.818738h_{t-1}$ (0.0000) (0.0000) (0.0000)
GGRM	$R_t = -0.209659 + 0.189757 \log(h_t)$ (0.0870) (0.0780)	$h_t = 0.607404 + 0.165253\varepsilon_{t-1}^2 + 0.731075h_{t-1}$ (0.0000) (0.0000) (0.0000)
UNVR	$R_t = -6.007564 + 0.059036 \log(h_t)$ (0.8557) (0.0911)	$h_t = 0.232963 + 0.175798\varepsilon_{t-1}^2 + 0.779405h_{t-1}$ (0.0000) (0.0000) (0.0000)
BBRI	$R_t = 0.216217 - 0.018140h_t$ (0.0000) (0.0604)	$h_t = 0.108046 + 0.111501\varepsilon_{t-1}^2 + 0.876265h_{t-1}$ (0.0000) (0.0000) (0.0000)
ICBP	$R_t = 0.264475 - 0.010672h_t$ (0.0003) (0.2777)	$h_t = 0.293955 + 0.179625\varepsilon_{t-1}^2 + 0.777839h_{t-1}$ (0.0000) (0.0000) (0.0000)

Table 4 shows that daily returns are characterized by the existence of time varying variance or heteroscedasticity in the residuals. The variance equations of stock Index and 5 stocks all have significant coefficients for ε_{t-1}^2 and h_{t-1}. The parameters in variance equations, ω, α *and* β of GARCH(1,1) model are all positive and significant at 1% level. The significant value of ARCH term (α) implies that previous error affects current volatility whereas significant GARCH parameter (β) suggests that current volatility is affected by previous volatility. The non-negativity conditions for h_t are met. In this case the parameters : $\omega > 0$, $0 < \alpha < 1$, $0 < \beta < 1$. Non-explosiveness condition is represented by $(\alpha + \beta) < 1$.

For the mean equations, the risk premium parameter with positive sign in the mean equation describes the risk-return relationship. Table 4 shows that positive risk-return relatioships are observed for Stock Index IHSG, INTP stock, and GGRM stock at 5% significant level while UNVR Stock is at 10 percent significant level. A significant coefficient with positive sign indicate that investors are rewarded for assuming greater risk. Then, BBRI stock has a negative and significant coefficient while ICBP stock has a negative coefficient but insignificant. The empirical results show that volatility on daily returns for stock index and individual stocks follow the GARCH(1,1) process. For daily return data, the variance parameters, that are the coefficients of ε_{t-1}^2 and h_{t-1} for stock market index and all the 5 stock returns are significant at 1% alpha with a positive sign. This supports the time varying volatility in stock market index and 5 stock returns. The volatility is aslo persistence since for each variance equation $(\alpha + \beta) < 1$.

The empirical results for daily return using AR(1) model for the mean equation are presented in Table 5.

Table 5
Empirical Results With AR(1) Model for Mean Equations
The Figures in Parentheses are p-values or Prob

Stocks	Mean Equations using GARCH-M $R_t = \mu + \lambda_1 R_{t-1} + \delta h_t + \varepsilon_t$	Variance Equations with GARCH (1,1) $h_t = \sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2$
IHSG	$R_t = 0.092524 + 0.062696R_{t-1} + 0.050952\log(h_t)$ (0.0000) (0.0403) (0.0045)	$h_t = 0.040836 + 0.138544\varepsilon_{t-1}^2 + 0.841114 h_{t-1}$ (0.0000) (0.0000) (0.0000)
INTP	$R_t = -0.207714 - 0.006930R_{t-1} + 0.209344\log(h_t)$ (0.1994) (0.9548) (0.0320)	$h_t = 0.451710 + 0.128119\varepsilon_{t-1}^2 + 0.817357 h_{t-1}$ (0.0000) (0.000) (0.000)
GGRM	$R_t = -0.187366 + 0.061087R_{t-1} + 0.174337\log(h_t)$ (0.1231) (0.0002) (0.0485)	$h_t = 0.397029 + 0.163200\varepsilon_{t-1}^2 + 0.733303 h_{t-1}$ (0.0000) (0.0000) (0.0000)
UNVR	$R_t = -0.008130 - 0.110150R_{t-1} + 0.095450\log(h_t)$ (0.8740) (0.0000) (0.0465)	$h_t = 0.218054 + 0.165583\varepsilon_{t-1}^2 + 0.788241 h_{t-1}$ (0.0000) (0.0000) (0.0000)
BBRI	$R_t = 0.220384 - 0.026344R_{t-1} - 0.017482 h_t$ (0.0000) (0.0881) (0.0707)	$h_t = 0.198577 + 0.111435\varepsilon_{t-1}^2 + 0.876170 h_{t-1}$ (0.0000) (0.0000) (0.0000)
ICBP	$R_t = 0.162691 - 0.055136R_{t-1} - 0.009154 h_t$ (0.0004) (0.0042) (0.3557)	$h_t = 0.258870 + 0.175300\varepsilon_{t-1}^2 + 0.779006 h_{t-1}$ (0.0000) (0.0000) (0.0000)

Table 5 presents the results of mean equation using AR(1) model and return volatility as the independent variable. The column on the right hand side presents variance equation. Table 5 shows that daily stock returns are characterized by the existence of time varying variance or heteroscedasticity in the residuals. The variance equations of stock Index and 5 stocks all have significant coefficients for and . The table shows that positive risk-return relatioships are observed at 5 percent significant level for Stock Index IHSG, INTP stock, GGRM stock while the coefficient for UNVR Stock is significant at 10 percent. A significant and positive relationship indicates that investors are compensated for assuming greater risk

Empirical Results Using Weekly Returns with Simple Regression for Mean Equation are presented in Table 6.

Table 6
Results of Weekly Returns with Simple Regression for Mean Equation
The Figures in Parentheses are p-values or Prob

Stocks	Mean Equations GARCH-M $R_t = \mu + \delta h_t + \varepsilon_t$	Variance Equations GARCH (1,1) $h_t = \sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2$
IHSG	$R_t = -0.114155 + 0.386917 \log(h_t)$ (0.6470) (0.0771)	$h_t = 0.583886 + 0.250513\varepsilon_{t-1}^2 + 0.686665h_{t-1}$ (0.0000) (0.0000) (0.0000)
INTP	$R_t = -1.047652 + 0.383458\sqrt{h_t}$ (0.2339) (0.0881)	$h_t = 1.395142 + 0.0920262\varepsilon_{t-1}^2 + 0.866650h_{t-1}$ (0.0000) (0.0000) (0.0000)
GGRM	$R_t = -0.385948 + 0.021737h_t$ (0.2934) (0.0914)	$h_t = 0.744980 + 0.058458\varepsilon_{t-1}^2 + 0.918738h_{t-1}$ (0.0000) (0.0000) (0.0000)
UNVR	$R_t = 0.219225 + 0.009070h_t$ (0.6108) (0.3532)	$h_t = 2.3866004 + 6.2427228\varepsilon_{t-1}^2 + 0.608053h_t$ (0.0000) (0.0000) (0.0000)
BBRI	$R_t = 1.282168 - 0.0344460h_t$ (0.0000) (0.0083)	$h_t = 2.257094 + 0.216696\varepsilon_{t-1}^2 - 0.715057h_{t-1}$ (0.0000 (0.0000) (0.0000)
ICEP	$R_t = 0.543401 + 0.003196h_t$ (0.0459) (0.7827)	$h_t = 6.224541 + 0.334913\varepsilon_{t-1}^2 + 0.459435h_{t-1}$ (0.0000) (0.0000) (0.0000)

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The column on the right-hand side of Table 6 presents the estimate of variance equations for stock market index (IHSG) and for 5 stock returns. The non-negativity conditions are also met. The non-negativity conditions for h_t are met. In this case the parameters : $\omega > 0$, $0 < \alpha < 1$, $0 < \beta < 1$. This supports the time varying volatility in stock market index and 5 stock returns. The volatility is also persistence since for each variance equation $(\alpha + \beta) \prec 1$. Table 8 shows that the existence of positive risk-return relationship is found at market index, INTP stock and GGRM stock all with 10% significant levels. This significant and positive relationship indicate that investors are rewarded for assuming greater risk. BBRI stock has a negative and significant coefficient. A negative relationship indicates that investors react to factor(s) other than the standard deviation of return (Abonongo et al 2016). Two stocks, UNVR and ICBP stocks have positive but insignificant coefficient.

Empirical Results Using Weekly Returns with AR(1) Model for Mean Equation are presented in Table 7.

Table 7
Empirical Results of Weekly With AR(1) Model for Mean Equation
The Figures in Parentheses are p-values or Prob

Stocks	Mean Equations GARCH-M $R_t = \mu + \lambda_1 R_{t-1} + \delta h_t + \varepsilon_t$	Variance Equations with GARCH (1,1) $h_t = \sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2$
IHSG	$R_t = -0.081030 - 0.070649R_{t-1} + 0.250863\ log$ (0.7487) (0.0571) (0.0861)	$h_t = 0.649891 + 0.256650\varepsilon_{t-1}^2 + 0.689481h_{t-1}$ (0.0000) (0.0000) (0.0000)
INTP	$R_t = -0.0318422 - 0.120274R_{t-1} + 0.025021h_t$ (0.4603) (0.0006) (0.0494)	$h_t = 0.927664 + 0.070156\varepsilon_{t-1}^2 + 0.901248h_{t-1}$ (0.0038) (0.0000) (0.0000)
GGRM	$R_t = -1.716445 - 0.178482R_{t-1} + 0.395106\sqrt{h_t}$ (0.0642) (0.0000) (0.0400)	$h_t = 0.600349 + 0.049811\varepsilon_{t-1}^2 + 0.930838h_{t-1}$ (0.0000) (0.0000) (0.0000)
UNVR	$R_t = 0.166330 - 0.152587R_{t-1} + 0.015161h_t$ (0.5066) (0.0000) (0.3957)	$h_t = 2.242363 + 0.226854\varepsilon_{t-1}^2 - 0.628128h$ (0.0000) (0.0009) (0.00000)
BBRI	$R_t = 1.342835 - 0.094329R_{t-1} - 0.034390h_t$ (0.0000) (0.0112) (0.0088)	[illegible] (0.0000) (0.0000) (0.0000)
ICBP	$R_t = 0.329405 - 0.059953R_{t-1} + 0.005412h_t$ (0.0627) (0.0056) (0.6600)	[illegible] (0.0000) (0.0000) (0.0000)

The empirical results for mean equation with AR(1) process from weekly data are reported in Table 7. include the variance equation on the right hand column. For weekly return data, the variance parameters, that are the coefficients of ε_{t-1}^2 and h_{t-1} for stock market index and 5 stock individual returns are significant with a positive sign. This supports the time varying volatility in stock market index and 5 individual stocks. The volatility is also persistence since for each variance equation $(\alpha + \beta) \prec 1$. Table 10 shows the existence of positive risk-return relationship is found at market index at 10% alpha, INTP stock and GGRM stock both at 5% significant levels. A significant and positive relationship indicates that investors are rewarded for assuming greater risk. BBRI stock has a negative and significant coefficient. This negative relationship indicates that investors react to factor(s) other than the standard deviation of return while UNVR and ICBP stocks have positive but insignificant coefficient.

CONCLUSIONS

This study found the stock market index show a positive risk-return relationship.This positive risk-return relationship in stock market index was observed both in daily and weekly data. Thus from these empirical results, the first conclusion is that in Indonesia stock market both in stock index and in individual stocks, the volatilities of return are time varying. The second conclusion is that in Indonesia stock market the risk-return relationship as postulated by investment theory exists in stock market index. The third conclusion is that such risk-return relationship as a postulated by investment theory does not exist in all stocks.

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GENERAL COMMENTS

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