COMPARISON STUDY BETWEEN GARCH AND STANDARD DEVIATION.

SKRIPSI

Presented in partial fulfillment of the requirements for
The Bachelor's Degree in Accounting

by

Jesrin

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I realize that this research is still far from perfection. Thus, any recommendations and suggestions are very welcome in order to establish a better research in the future.

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ABSTRACTS

In this research, the implementation of GARCH Model to Sharpe formula to replace standard deviation . In this research, the analysis data of Adaro Energy Tbk, Adhi Karya Tbk and Astra Agro Lestari Tbk from the Indonesia LQ45 are studied by using analysis time series AR(p)-GARCH(p,q) modeling. From the analysis, it was found that the data Adaro Energy Tbk, Adhi Karya Tbk and Astra Agro Lestari Tbk are nonstationary. To make the data stationary, the differencing process with lag=2 (d=2) is used and the time series data then attain stationary. From the test of ARCH effects by using Q test and Lagrange Multiplier it concludes that all the data Adaro Energy Tbk, Adhi Karya Tbk and Astra Agro Lestari Tbk have ARCH effects. Based on this situation, then the AR(p)-GARCH(p,q) model are used to modeling the data.The best model for all data Adaro Energy Tbk, Adhi Karya Tbk and Astra Agro Lestari Tbk are the AR(1)-GARCH(1,1) models. The result that the models AR(1)-GARCH(1,1) for data Adaro Energy Tbk, Adhi Karya Tbk and Astra Agro Lestari Tbk are very fit with the data and based on the criteria MAPE (**The mean** absolute percentage error). It shows that the forecasting are very reliable. From the analysis we can get that GARCH is better than standard deviation witf differences 2,9% for PT Adhi Karya Tbk, -0,5% for PT Astra Agro Lestari Tbk, and -3,7% for PT Astra Agro Lestari.

Keywords: *stationary, nonstationary, AR(1)-GARCH(1,1), volatility, forecasting*

INTISARI

Dalam penelitian ini, penerapan Model GARCH menggunakan formula Sharpe untuk menggantikan standar deviasi. Dalam penelitian ini, data analisis Adaro Energy Tbk, Adhi Karya Tbk dan Astra Agro Lestari Tbk dari LQ45 Indonesia dipelajari dengan menggunakan analisis deret waktu (time series) AR (p) -GARCH (p, q) pemodelan. Dari analisis, ditemukan bahwa data Adaro Energy Tbk, Adhi Karya Tbk dan Astra Agro Lestari Tbk bersifat nonstasioner. Untuk membuat data stasioner, proses diferensiasi dengan lag = 2 (d = 2) digunakan dan data deret waktu (time series) kemudian mencapai stasioner. Dari pengujian efek ARCH dengan menggunakan uji Q dan Lagrange Multiplier disimpulkan bahwa semua data Adaro Energy Tbk, Adhi Karya Tbk dan Astra Agro Lestari Tbk memiliki efek ARCH. Berdasarkan situasi ini, maka model AR (p) -GARCH (p, q) digunakan untuk memodelkan data. Model terbaik untuk semua data Adaro Energy Tbk, Adhi Karya Tbk dan Astra Agro Lestari Tbk adalah AR (1) -GARCH (1,1) model. Hasil bahwa model AR (1) -GARCH (1,1) untuk data Adaro Energy Tbk, Adhi Karya Tbk dan Astra Agro Lestari Tbk sangat sesuai dengan data dan berdasarkan kriteria MAPE (Rata-rata persentase kesalahan absolut). Ini menunjukkan bahwa peramalannya sangat andal. Dari hasil analisis didapatkan bahwa GARCH lebih baik daripada standar deviasi dengan perbedaan 2,9% untuk PT Adhi Karya Tbk, -0,5% untuk PT Astra Agro Lestari Tbk, dan -3,7% untuk PT Astra Agro Lestari.

Kata kunci: stasioner, nonstasioner, AR (1) -GARCH (1,1), volatilitas, peramalan

CHAPTER I

INTRODUCTION

1.1 Research Background

Portfolio is a group or combination of two or more investments with different level of risk and profit in certain period of time and how to get maximum profit with minimal risk.

Investment in stock market has a high refund rate in the long term. But in addition investment in stocks has the highest risk. Investment analysis often faces problems, namely the assessments of risks faced by investors. If the risk of investment increase, the level of profit required by investors is greater. A very important stage of the investment process is to evaluate the performance of the investment and reduce losses / investment risks so that investors can invest in various types of stocks by forming a portfolio, it is necessary to evaluate the performance of the portfolio that has been formed previously. Portfolio is a set or combination of two or more types of investments with maximum risk and profit levels with less risk.

There are 3 measurement tools in assessing the performance of a portfolio

1. Sharpe Index (reward to variability ratio)
2. Treynor index (reward to volatility ratio)
3. Jensen Index (Jensen's differential return)

For some company will use daily time series for this research, before GARCH model will be test based on assumption. After assumption tested and best GARCH model that suitable used in forecasting. Some of data can't be done with

Autoregressive Moving Average (ARIMA) or Autoregressive Moving Average (ARMA). To solve Heterogeneity of Variance is Autoregressive Conditional Heteroscedasticity (ARCH) and is being generalized by Bollersley in 1986 knows as Generalized Autoregressive Contional Heterosdasticity (GARCH)

1.2 Research Problem

This research was focused to see which one is better, calculation with sharpe, treynor, Jensen index that the divider is standard deviation or the divider use Generalized Autoregressive Conditional Heteroscedastic (GARCH).

1.3 Research Objectives

This research aims to identify which one is better, using standard deviaton as the divider or using GARCH as the divider and this research aims to calculate and make the new measurement.

1.4 Research Scope and Limitation

This research is done with certain scope of studies and therefore some limitations are existed in this research. the limitations for this research are only cover 3 years period of observation from July 01, 2014 to December 31, 2016 and the data takes three different company which are Mining Industry Adaro Energy Tbk, Property, Real Estate & Construction industry Adhi Karya Tbk, and Agriculture Industry Astra Argo Tbk

1.5 Research Benefits

The result of this research is expected to give benefits to several parties:

1.5.1 Researcher

This research will provide knowledge to evaluate the indication of portfolio measurement and the practice of Sharpe , Treynor Jensen Index with GARCH

1.5.2 Investor

This research is expected to give a useful information and reference for investor to make decision toward a stock. The research estimates the future share price by GARCH model and assess the indication of portfolio measurement by the closing share price to make the right decision toward a share.

CHAPTER II

LITERATURE REVIEW

2.1 Portfolio

Portfolio is a investments with different levels of acquisition and different levels of risk, that are combined to fulfilled investment objectives and reduce risk. And investment portfolio is a collection of some investment that are designed to get expected return.

2.2 Stock

In Indonesian capital market, there are two common types of shares known by the public, namely common stock and preference stock. Where these two types of shares that have their respective meanings and rules.

Common Stock, Common stock is securities sold by a company that describes the nominal value (rupiah, dollar, yen etc.) in which the holder is given the right to participate in the General Meeting of Shareholders (AGM) and General Meeting Extraordinary Shareholders (EGMS) and shall be entitled to determine the purchase of Right Issue (limited stock seller) or not, which in turn at the end of the year will benefit in the form of dividends.

Preference Stock, Preference stock is securities sold by a company that describes the nominal value (rupiah, dollar, yen etc.) in which the holder will earn a fixed income in the form of dividends which will normally be received quarterly (quarterly).

2.3 Sharpe Index

This measurement was introduced by Bill Sharpe and is closely related to the capital asset pricing model (CAPM). The Sharpe index bases its calculations on the Capital Market Line (CML) concept as a benchmark.

This index is measured with comparing the risk premium of portfolio with risk that divided by standard deviation.

The Sharpe index evaluates the manager's portfolio based on the rate of return and diversification (such as considering the total portfolio risk as measured by the standard deviation of the denominator). Therefore, the Sharpe index is more suitable for a well-diversified portfolio, because it is more accurate in calculating portfolio risk. Measurement of portfolio performance using the Sharpe index is often referred to as the reward to variability ratio (Sharpe , 1994)

CHAPTER III

DATA AND RESEARCH METHOD

3.1 Variables and sample periods specifications

The data analyzed in this study are daily closing price of most liquid companies in Indonesia such as the data of Astra Agro Lestari Tbk., Adhi Karya Tbk., and Adaro Energy Tbk. The data taken from 1 January 2014 to 31 December 2016. The total number of observations in this period are 3,285 days. The data are taken from www.finance.yahoo.com

3.2 Instrument

The instrument to collect the data LQ45 is conducted through the retrieve the available data which was available in www.finance.yahoo.com, about the closing price data LQ45. The data was taken on 21 April 2017, with the total number of data about 1.095/Company. In this study, three companies will be sampled from the 36 companies.

3.3 Data Analysis

The first step to plot the time series data to see the behavior of the data and for the second step is check the stationary data, stationary data is checked by Augmented Dickey Fuller (ADF) test and then checked the white noise. Third step is to estimate and test the parameter to diagnose and test the residual. Residual that we get from the ARIMA model is check by Lagrange Multiplier (LM) to know if there is ARCH effect or not. If there is ARCH effect data is modelled by using

ARCH or GARCH model. And last is fourth step, to estimate and test model of parameter and to forecast the daily closing price.

1. Plotting the data

To see the behavior of closing data is to plot the time series data. From the plot of data, the behavior of data can be explain, especially about stationary data, stationary data in mean and variance. This is the basic from analysis the time series.

2. Testing for stationary data

To check stationary data we use Augmented Dicky Fuller Test (ADF Test). Most of time series data is non stationary, for example a price series data. Root unit is a fiture of some process stochastic that can make a problem in time series modelling. ADF test process are :

Let $x_1, x_2, \ldots, x_n$ are time series data and $\{x_t\}$ follows the AR(p) model with mean μ given by:

$$x_t - \mu = \phi_1(x_{t-1} - \mu) + ... + \phi_p(x_{t-p} - \mu) + \varepsilon_t$$

Where ε_t is white noise and hasmean 0 and variance σ^2, and $\varepsilon_t \sim WN(0,\sigma^2)$. The model can be written as

$$\nabla x_t = \phi_o^* + \phi_1^* x_{t-1} + \phi_2^* \nabla x_{t-1} + ... + \phi_p^* \nabla x_{t-p+1} + \varepsilon_t$$

Here $\phi_o^* = \mu(1 - \phi_1 - ... - \phi_p)$, $\phi_1^* = \sum_{i=1}^{p} \phi_i - 1$, $\phi_j^* = \sum_{i=j}^{p} \phi_i$, j=2,3, ..., p, and $\nabla x_t = x_t - x_{t-1}$. For p=3, then model become

$$\nabla x_t = \phi_o^* + \phi_1^* x_{t-1} + \phi_2^* \nabla x_{t-1} + \phi_3^* \nabla x_{t-2} + \varepsilon_t$$

The test for nonstationary data of model by using ADF test or tau test (τ) is conducted as follows:

Ho: $\phi_1^* = 0$ (data nonstationary)

Against Ha: $\phi_1^* < 0$ (data stationary).

The test statistics is (ADF test)

$$\tau = \frac{\hat{\phi}_1^*}{\hat{S}e_{\phi_1^*}}$$

For the level of significance (α=0.05), Reject Ho if τ< -2.57 or if p-value <0.05 (Brockwell & Davis, 2002)

3. Checking for White Noise

Time series will consists of uncorrelated observations and has constant variance its called white noise. If a time series is white noise, the distribution of sample auti correlation coefficient at lag K in large sample is approximately normal distributin with mean 0 and varians 1/T.

$r_k \sim N(0, \frac{1}{T})$. (Montgomery, Cheryl, & Kulahci, 2008)

Based on the equation therefore we could test the hypothesis of autocorrelation of lag k Ho: $\varrho_k = 0$ against Ha: $\varrho_k \neq 0$ using the test statistic

$$Z = \frac{r_k}{\sqrt{1/T}} = r_k \sqrt{T}$$

If the data are non stationary so the differencing process and data transformation are used. When the data already stationary in mean,

Autocorrelation Function (ACF) anf Partial Autocorrelation Function (PACF) are applied for ARMA. When differencing already done so Innovation process are check with same method.

4. Testing for the ARCH effects

Third step is to estimate and parameter test, to diagnose and residual test, to choose best model based on the criteria, smallest value AIC or SC. Residual that we get from best ARMA model are checked by using Lagrange Multiplier (LM) to check whether they have ARCH effect or not. If yes data are modelled with ARCH model or GARCH.

A. Autoregressive model of order p, AR(p)

General form of AR(p) model is as follows:

$$\Phi(B)x_t = \delta + \varepsilon_t$$

where$\Phi(B) = 1 - \phi_1 B \ - \phi_2 B^2 \ - \cdots - \phi_p B^p$. .$Bx_t = x_{t-1}$,

$B^p x_t = x_t$

B. Moving average (MA) model

Moving average (MA) model with order q is defined by MA (q) and can be written as follows:

$$x_t = \mu + (1 + \theta_1 B + \theta_2 B^2 + \ldots + \theta_q B^q)\varepsilon_t$$

$$= \mu + (1 - \sum_{i=1}^{q} \theta_i B^i)\ \varepsilon_t$$

$$= \mu + \Theta(B)\varepsilon_t$$

$$\text{where } \Theta(B) = 1 - \sum_{i=1}^{q} \theta_i B^i$$

where:x_t is a variable at time t; ε_t: is an error at time t; θ_i: is regression coefficient, i: 1,2,3, …,q; and q: is the order of MA.

3.4 Autoregressive Moving Average (ARMA) model

In a general form, Autoregressive Moving Average of order p,q, ARMA(p,q), is defined as follows:

$$x_t = \delta + \emptyset_1 x_{t-1} + \emptyset_2 x_{t-2} + \cdots + \emptyset_p x_{t-p} + \varepsilon_t - \theta_1 \varepsilon_{t-1} - \theta_2 \varepsilon_{t-2} - \cdots - \theta_q \varepsilon_{t-q}$$

$$= \delta + \sum_{i=1}^{p} \emptyset_i x_{t-i} + \varepsilon_t - \sum_{i=1}^{q} \theta_i \varepsilon_{t-i}$$

or $\Phi(B)x_t = \delta + \Theta(B)\varepsilon_t$(Wei, 2006).

where x_t: is variable at lag t; $\emptyset_i$: coefficient of regression, i= 1, 2, 3, ..., p;p: order of AR;θ_j: is the parameter MA model, j=1, 2, 3, .., q; ε_t: is the error at time t.

3.5 Model Autoregressive Integrated Moving Average (ARIMA) Model

$\{x_t\}$ is said to be an ARIMA process if $Y_t := (1 - B)^d x_t$ is generated from ARMA process. So $X_t\}$ satisfied the equation:

$$\phi^*(B)X_t \equiv \phi(B)(1 - B)^d x_t = \theta(B)\varepsilon_t, \ \{\varepsilon_t\} \sim WN(0, \sigma^2)$$

where $\phi(B)$ and $\theta(B)$ are polinomial with the degree p and q respectively, $\phi(B) \neq 0$ for $|\phi(B)| < 1$.

1. The estimation of Parameter of ARIMA Model

Technique that we used to find a specific point to maximize a function is called Maximum Likelihood Estimation technique. This technique is used very much in estimating a parameter data distribution and still dominantly used in the development of new trials. This method is to use maximize the

likehood function with respect to parameters. ARMA (p,q) equation as follows :

$$\varepsilon_t = \theta_1\varepsilon_{t-1} + \theta_2\varepsilon_{t-2} + \cdots + \theta_q\varepsilon_{t-q} - x_t - \delta - \emptyset_1 x_{t-1} - \emptyset_2 x_{t-2} - \cdots - \emptyset_p x_{t-p}$$

where $\varepsilon_t \sim N(0, \sigma^2)$ and vektor parameter to be estimate is

$$\vartheta = (\delta, \emptyset_1, \emptyset_2, \ldots, \emptyset_p, \theta_1, \theta_2, \ldots, \theta_q)$$

2. Model Autoregressive Conditional Heteroscedastic (ARCH)

Homoscedasticity is basic idea of the least squares model, assume that expected value of the squares error term is the same at any given point. (Engle, 2001). And Heteroscedasticity is the assumption that ARCH/GARCH models are build based on the variances are not constant. ARCH is function from automatic regretion which are assume that variance is not constant time by time and affected by past data.

where the variance residual depends on the-q squares of residual, and is called Autoregressive Conditional Heteroscedasticity (ARCH). The ARCH model can be written as.

$$x_t = \delta + \sum_{i=1}^{p} \emptyset_i x_{t-i} - \sum_{i=1}^{q} \theta_i \varepsilon_{t-i} + \varepsilon_t$$

$$\varepsilon_t \sim N(0, \sigma^2)$$

$$\sigma_t^2 = \omega + \lambda_1\varepsilon_{t-1}^2 + \lambda_2\varepsilon_{t-2}^2 + \cdots + \lambda_q\varepsilon_{t-q}^2$$

x_t is the equation of conditional mean (Brooks, 2008)

3. Lagrange Multiplier (LM) Test

Engle (1982) stated that the time series data beside has a problem with autocorrelation also has a problem with heteroscedasticity. Weiss (1984) has shown the importance of detecting the present of ARCH effect in time series data. He showed that ignoring the presence of heteroscedasticity not only because the estimation of parameters to be inefficient, but it also could result in an over parameterized ARMA model. The test that can be used to detect the heteroscedasticity or ARCH effect is ARCH-Lagrange Multiplier (ARCH-LM) (Engle, 1982; Tsay, 2005).

The steps are as follows:

1. Define the linear regression as follows:

$$x_t = \mu + \lambda_1 x_{t-1} + \lambda_2 x_{t-2} + \cdots + \lambda_p x_{t-p} + \varepsilon_t$$

2. Squares the residual and regress on the variance t to test the order of q ARCH,

$$\sigma_t^2 = \lambda_0 + \lambda_1 \varepsilon_{t-1}^2 + \lambda_2 \varepsilon_{t-2}^2 + \cdots + \lambda_q \varepsilon_{t-q}^2$$

where ε_t is residual. Find the R^2 from this residual.

3. The test Statistic is

$$LM = TR^2$$

where

$$R^2 = \frac{\sum_{i=1}^{n} (\hat{x}_i - \bar{x})^2}{\sum_{i=1}^{n} (x_i - \bar{x})^2}$$

Total number of observation, R^2 is R-square and has $\chi^2(q)$ distribution.

4. The null and alternative hypothesis is

Time series data have both a problem of autocorrelation and heteroscedasticity. TheLagrange Multiplier (LM) test can be used to detect the presence or the existence of heteroscedasticity or ARCH effect. The null and alternative hypotheses are as follows:

$$H_0 = \lambda_1 = \lambda_2 = \cdots = \lambda_q = 0$$

$$H_1 : \lambda_1 \neq 0 \text{ or } \lambda_2 \neq 0 \text{ or ... or } \lambda_q \neq 0 \text{(Brooks, 2014)}$$

Although the Lagrange multiplier is helpful in detecting ARCH effect, but it is still difficult in practice to determine the order of the process. One method to determine the order of the model is to fit several competing models and then compare the AIC (Akaike Information Criterion) values for these competing models.

3.6 Generalized ARCH(GARCH) Model

GARCH model (GeneralizedAutoregressive Conditional Heteroscedastic) model is a generalized of ARCH. This model is built to avoid the order of ARCH model which is too high. GARCH model is not only to see the relationship among some residual, but also depend on some past residuals. GARCH was introduced by Bollerslev (1986). GARCH model with degree p and q is defined:

$$x_t | F_{t-1} \sim N(0, \sigma_t^2)$$

GARCH model was developed by Bollerslev (1986). GARCH model allows the conditional variance to depend on the conditional variance of the previous lag. So that, the equation of conditional variance become.

$$\sigma_t^2 = \omega + \sum_{i=1}^{q} \lambda_i \varepsilon_{t-i}^2 + \sum_{j=1}^{p} \beta_j \sigma^2{}_{t-j}$$

Where the present values of the conditional variancewas parameterized and depend on the-q lag from the squares residual and the p-lag of the conditional variance, is written as GARCH (p,q). So, GARCH model if its time varying conditional variance is heteroscedastic with both auto regression and moving average (Wang, 2009). GARCH model can be written as.

$$x_t = \delta + \sum_{i=1}^{p} \emptyset_i x_{t-i} - \sum_{i=1}^{q} \theta_i \varepsilon_{t-i} + \varepsilon_t \; \varepsilon_t \sim N(0, \sigma^2)$$

$$\sigma_t^2 = \omega + \sum_{i=1}^{q} \lambda_i \varepsilon_{t-i}^2 + \sum_{j=1}^{p} \beta_j \sigma^2{}_{t-j}$$

x_t is the equation of conditional mean [Bollerslev (1986)].

3.7 Calculate the new Formula.

After you get the result of GARCH the input it to Sharpe formula

$$Sharpe\ Ratio = \frac{R_p - R_f}{\sigma_p}$$

Change the standard deviation to GARCH, so we can get the new calculation for Sharpe and get new result that we can use to calculate Portfolio measurement.

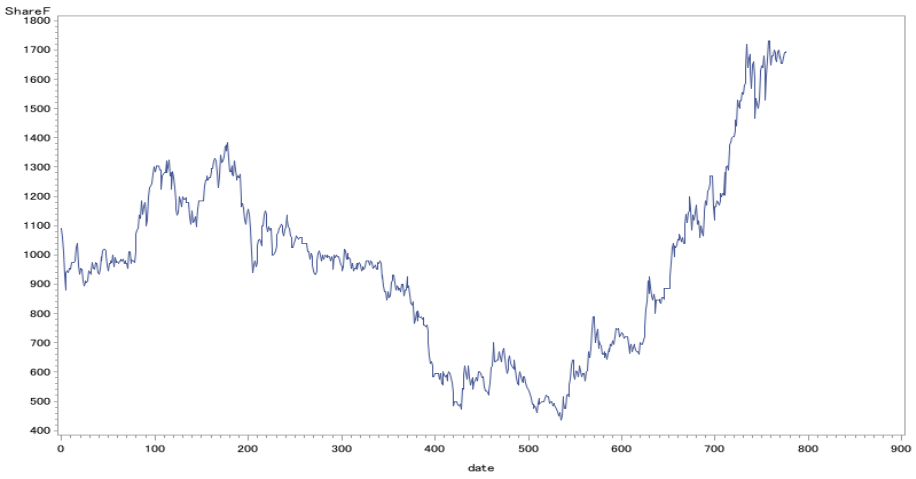
CHAPTER IV

RESULTS AND DISCUSSION

4.1 Check the Stationarity or nonstationary data.

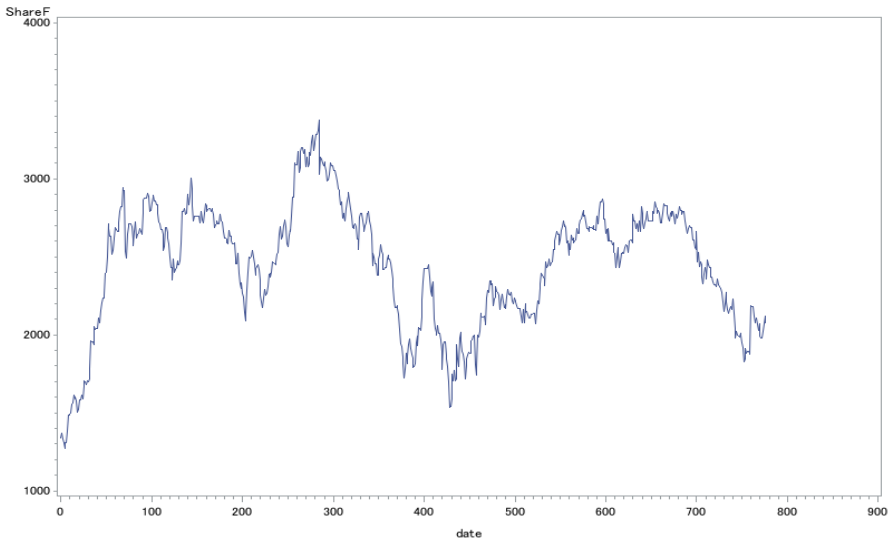
To check the stationary data we have several ways, first we looking at the plot of data, we can judge the data stationary or not, second by statistic test ADF test.

1. PT. Adaro Energy.



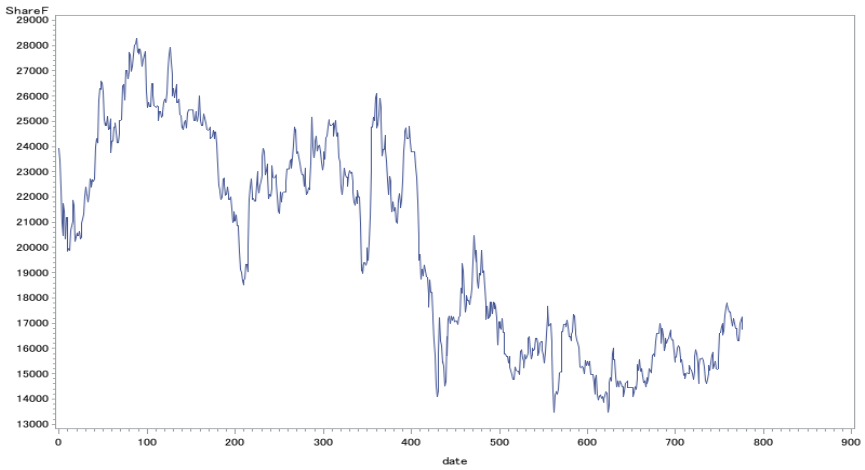
From this picture we can get that PT Adaro Energy is non stationary data. Because the data is very fluctuative. Half of data is decrease and half of data is increase. The data is not constant from certain number. If we use ADF test we can be conclude that PT. Adaro Energy is nonstationary because the result is 0,9652 it is nonsignificant (Table 4.1-1) and next is white noise test, last part to check the stationary or nonstationary data. From (Table 4.1 - 2) we can see that P values is less than 0.0001 which is the data is non stationary.

2. PT. Adhi Karya Tbk.



The data shows that PT. Adhi Karya Tbk is nonstationary because the data are fluctuative and confirms the data not constant from certain number. And if we test use ADF test PT. Adhi Karya are Stationary because the result is significant 0.0308 (Table 4.1-1). Even the data from ADF is stationary, but from the plot data confirm that the data is non stationary, and the P value is less than 0.0001 so we can conclude the data PT Adhi Karya is nonstationary. (Table 4.1-2)

3. PT. Astra Agro Lestari. Tbk.



The data shows that the trend is decrease so the data of PT. Astra Agro Lestari, Tbk is nonstationary. And from ADF test we can get that PT. Astra Agro Lestari is nonstationary because the result is 0.4636 (Table 4.1-1). From white noise test the p value is less than 0.0001 so the data is nonstationary. (Table 4.1-2)

Table 4.1 - 1 Augmented Dickey-Fuller Unit Root Test

Type	Data	Lags	Tau	p-value
Mean	Adaro Energy Tbk	3	0.0936	0.9652
	Adhi Karya Tbk	3	-3.0586	0.0308
	Astra Agro Lestari Tbk	3	-1.6363	0.4636

Table 4.1-2 Checking for white noise after differencing (d=2)

PT. Adaro Energy Tbk									
To lag	Chi-Square	DF	p-value	Autocorrelation					
6	168.56.00	6	<0.0001	0.459	-0.069	-0.007	0.023	-0.021	- 0.013
12	171.37.00	12	<0.0001	0.009	-0.027	-0.046	-0.016	0.013	-0.013
18	208.20.00	18	<0.0001	-0.076	-0.057	0.063	0.146	0.113	0.011
24	218.99	24	<0.0001	-0.030	-0.019	0.059	0.052	0.051	0.051

PT. Adhi Karya Tbk									
To lag	Chi-Square	DF	p-value	Autocorrelation					
6	155.96	6	<0.0001	0.432	-0.118	-0.070	-0.032	0.008	0.040
12	160.71	12	<0.0001	0.058	0.032	0.013	0.030	0.022	0.009
18	164.52.00	18	<0.0001	-0.018	-0.025	0.033	0.045	0.002	-0.027
24	167.05.00	24	<0.0001	0.003	0.018	-0.017	0.031	0.038	-0.011

PT. Astra Agro Lestari Tbk									
To lag	Chi-Square	DF	p-value	Autocorrelation					
6	221.30.00	6	<0.0001	0.530	0.014	-0.009	0.005	-0.020	-0.052
12	238.70	12	<0.0001	-0.007	0.080	0.033	-0.055	-0.070	-0.081
18	255.12.00	18	<0.0001	-0.091	-0.063	0.015	0.037	-0.038	-0.074
24	269.96	24	<0.0001	-0.076	-0.084	-0.039	-0.011	-0.048	-0.042

This is the result from ADF test. PT Adaro Energy and PT Astra Agro Lestari is bigger than the lags which means 0.3The next step is to differencing data to make the data are stationary. We use differencing with lag = 2 (d=2) respectively so the data attain to stationary time series data. the behavior of residual data after differencing are distributed around zero.

4.2 ARCH Effect

Before we use GARCH model, the heteroscedasticity need to be check. And to check ARCH Lagrange we can use ARCH effect.

Table 4.2 - 1 ARCH Effects

PT. Adaro Energy Tbk				
Test for ARCH Disturbances Based on OLS Residuals				
Order	Q	p-value	LM	p-value
1	7.740.236	<0.0001	7.571.325	<0.0001
2	15.156.166	<0.0001	7.571.558	<0.0001
3	2.321.119	<0.0001	7.577.645	<0.0001
4	29.259.635	<0.0001	7.577.900	<0.0001
5	35.955.155	<0.0001	7.578.749	<0.0001
6	42.450.302	<0.0001	7.581.264	<0.0001
7	48.735.983	<0.0001	7.581.282	<0.0001
8	54.782.147	<0.0001	7.582.621	<0.0001
9	60.553.213	<0.0001	7.582.832	<0.0001
10	66.007.807	<0.0001	7.583.670	<0.0001
11	71.450.417	<0.0001	7.583.681	<0.0001
12	76.576.351	<0.0001	7.584.107	<0.0001

PT. Adhi Karya Tbk				
Test for ARCH Disturbances Based on OLS Residuals				
Order	Q	p-value	LM	p-value
1	7.391.402	<0.0001	7.015.839	<0.0001
2	14.160.571	<0.0001	7.015.902	<0.0001
3	20.342.396	<0.0001	7.016.235	<0.0001
4	25.944.340	<0.0001	7.017.554	<0.0001
5	30.969.974	<0.0001	7.019.519	<0.0001
6	35.524.281	<0.0001	7.020.571	<0.0001
7	39.644.705	<0.0001	7.020.619	<0.0001
8	43.363.019	<0.0001	7.020.640	<0.0001
9	46.750.712	<0.0001	7.021.519	<0.0001
10	49.841.509	<0.0001	7.021.524	<0.0001
11	52.638.560	<0.0001	7.022.094	<0.0001
12	55.182.277	<0.0001	7.022.119	<0.0001

PT Argo Lestari Tbk				
Test for ARCH Disturbances Based on OLS Residuals				
Order	Q	p-value	LM	p-value
1	258.911	<0.0001	248.624	<0.0001
2	358.953	<0.0001	298.904	<0.0001
3	370.500	<0.0001	298.991	<0.0001
4	397.710	<0.0001	310.936	<0.0001
5	411.283	<0.0001	313.723	<0.0001
6	415.922	<0.0001	313.727	<0.0001
7	438.850	<0.0001	325.497	<0.0001
8	491.644	<0.0001	350.027	<0.0001
9	510.258	<0.0001	350.641	<0.0001
10	580.123	<0.0001	383.054	<0.0001
11	626.283	<0.0001	391.280	<0.0001
12	673.928	<0.0001	398.717	<0.0001

Table presented Portmanteau Q and Lagrange Multiplier Test for ARCH Effect. The squared residuals are used to test nonlinear effects is to calculated the Q. From the table we can see P values is less than 0.0001 so we can conclude that PT Adaro Energy Tbk, PT Adhi Karya Tbk and PT Astra Agro Lestari have Arch effects.

4.3 AR – GARCH (Autoregressive-GARCH) Modelling.

Table 4.3 - 1 The statistics of GARCH Estimate Data Adaro Energy Tbk, Adhi Karya Tbk, and Astra Agro Lestari Tbk.

Statistics	GARCH Estimate Data Adaro Energy Tbk (Model AR(1)-GARCH(1,1))	GARCH Estimate Data Adhi Karya Tbk (Model AR(1)-GARCH(1,1))	GARCH Estimate Data Astra Agro Lestari Tbk (Model AR(1)-GARCH(1,1))
Observations	777.00	777.00	777.00
SSE	599507.51	2909418.23	179146533.00
MSE	771.57	3744.00	230562.00
LogLikelihood	-3638.42	-4296.20	-5871.19
SBC	7310.11	8625.68	11775.68
AIC	7286.84	8602.41	11752.39
AICC	7286.92	8602.48	11752.48
HQC	7295.79	8611.36	11761.35
MAE	19.79	42.28	338.00
MAPE	**2.16**	**1.79**	**1.73**
Uncond Var	791.47	3758.53	235105.65
R-Square	0.99	0.97	0.98
Normality Test	40.99	876.25	104.00
p-value	<0.0001	<0.0001	<0.0001

Table 4.3 - 2 AR(1) – GARCH (1,1) PT. Adaro Energy Tbk. (ADRO.JK)

Variable	DF	Estimate	Standard Error	t-value	p-value
Intercept	1	1090.0000	1049.0000	1.04	0.2991
AR1	1	-0.9992	0.0029	-337.28	<0.0001
ARCH0	1	27.8789	8.1608	3.42	0.0006
ARCH1	1	0.0934	0.0192	4.87	<0.0001
GARCH1	1	0.8714	0.0226	38.58	<0.0001

Result of the analysis PT Adaro Energy Tbk using AR(1) – GARCH (1,1) model is as follows :

Model AR(1) : $x_t = 1090 - 0.9992\, x_{t-1} + \varepsilon_t$

The Variance model GARCH (1,1) : $\sigma_t^2 = 27.8789 + 0.0934\,\varepsilon_{t-1}^2 + 0.8714\,\sigma_{t-1}^2$

Table 4.3 - 3 AR(1) – GARCH (1,1) PT. Adhi Karya Tbk. (ADHI.JK)

Variable	DF	Estimate	Standard Error	t-value	p-value
Intercept	1	1344.0000	1301.0000	1.03	0.3016
AR1	1	-0.9984	0.0024	-408.18	<0.0001
ARCH0	1	145.0911	105.7665	1.37	0.1701
ARCH1	1	0.0161	0.0092	1.74	0.0812
GARCH1	1	0.9453	0.0357	26.48	<0.0001

Result of the analysis PT Adhi Karya Tbk (ADHI.JK) using AR(1) – GARCH (1,1) model is as follows :

Model AR(1) : $x_t = 1344 - 0.9984\ x_{t-1} + \varepsilon_t$

The Variance model GARCH (1,1) : $\sigma_t^2 = 145.0911 + 0.0161 \varepsilon_{t-1}^2 + 0.9453\ \sigma_{t-1}^2$

Table 4.3 - 4 AR(1) – GARCH (1,1) PT. Astra Agro Lestari Tbk. (AALI.JK)

Variable	DF	Estimate	Standard Error	t-value	p-value
Intercept	1	23823.0000	2265.0000	10.52	<0.0001
AR1	1	-0.9976	0.0028	-352.40	<0.0001
ARCH0	1	3810.0000	1700.0000	3.422.24	0.0250
ARCH1	1	0.0498	0.0097	5.11	<0.0001
GARCH1	1	0.9340	0.0129	72.55	<0.0001

Result of the analysis PT Astra Agro Lestari Tbk using AR(1) – GARCH (1,1) model is as follows :

Model AR(1) : $x_t = 23823 - 0.9976\ x_{t-1} + \varepsilon_t$

The Variance model GARCH (1,1) : $\sigma_t^2 = 3810 + 0.0498\ \varepsilon_{t-1}^2 + 0.9340\ \sigma_{t-1}^2$

4.4 New Calculation

The calculation of sharpe from that companies are :

Table 4.4 - 1 Sharpe, Treynor, Jensen index Calculation with Standard deviation

	SHARPE	TREYNOR	JENSEN
ADHI	2,93%	-1,16%	0,07%
ADRO	-0,48%	0,16%	0,08%
AALI	-3,70%	-4,35%	0,07%

And after we calculation Sharpe with new formula, which is we use GARCH as the divider, the results are :

Table 4.4 - 2 New Formula with GARCH

	ADHI	ADRO	AGRO
GARCH	1205%	528%	6173%
New Formula	0,0066%	-0,0028%	-0,0016%

As we can see, After we calculate GARCH we can get that the new formula with result PT Adhi Karya Tbk 0,0066%, PT Adaro Energy Tbk -0,0028% and PT Astra Agro Lestari -0,0016%. And for the GARCH it self we get 1205% for PT Adhi Karya Tbk, 528% for PT Adaro Energy Tbk and PT Astra Agro Lestari 6173%.

CHAPTER V

CONCLUSION, LIMITATIONS AND SUGGESTIONS

5.1 Conclusion

From the analysis we can found that the data of PT Adaro Energy Tbk, PT Adhi Karya Tbk, PT Astra Argo Lestari Tbk are nonstationary, and we differencing it with lag = 2 (d-2) and then the data already stationary. From the ARCH effect test using Q test and LM test are conclude that all the data have ARCH effect. Then the AR(p) – GARCH (p,q) model are used to modelling the data. The models are sunnarized in the following table.

Table 5.1 - 1 AR (1)-GARCH (1,1) model data Adaro Energy Tbk, Adhi Karya Tbk and Astra Agro Lestari Tbk

Data	Model	
	AR (1)	GARCH (1,1)
Adaro Energy Tbk	$x_t = 1090 - 0.9992\ x_{t-1} + \varepsilon_t$	$\sigma_t^2 = 27.8789 + 0.0934\varepsilon_{t-1}^2 + 0.8714\sigma_{t-1}^2$
Adhi Karya Tbk	$x_t = 1344 - 0.9984\ x_{t-1} + \varepsilon_t$	$\sigma_t^2 = 145.0911 + 0.0161\varepsilon_{t-1}^2 + 0.9453\ \sigma_{t-1}^2$
Astra Agro Lestari Tbk	$x_t = 23823 - 0.9976\ x_{t-1} + \varepsilon_t$	$\sigma_t^2 = 3810 + 0.0498\ \varepsilon_{t-1}^2 + 0.9340\ \sigma_{t-1}^2$

The 3 models are significant the R-squares are 0,99 for PT Adaro Energy Tbk , 0,97 for PT Adhi Karya tbk and 0,98 for PT Astra Agro lestari. Application of this models are pretty good based on the criteria of MAPE (The mean absolute percentage error)

Table 5.1 - 2 Comparison Between Sharpe formula and new formula

	ADHI	ADRO	AALI
SHARPE	2,93%	-0,48%	-3,70%
New Formula	0,0066%	-0,0028%	-0,0016%
GARCH	1205%	528%	6173%

From the analysis, if we use Sharpe with Standard deviation as its divider the result for PT Adhi Karya Tbk 2,93%, PT Adaro Energy -0,48% and PT Astra Agro Lestari -3,70%. And if we use GARCH as its divider the result for PT Adhi Karya 0,0066%, PT Adaro Energy Tbk -0,0028% and PT Astra Agro Lestari -0,0016%. The differences between Standard Deviation quite significant, for PT Adhi Karya 2,9%, PT Adaro Energy -0,5% and PT Astra Agro Lestari -,3,7%. If we use GARCH the risk that we can get is smaller rather than we use standard deviation.

5.2 Limitation of the Study

1. The research only focuses with the GARCH method to see better risk.
2. The research only focus on three sector which are mining industry, property industry and agricultural industry.
3. The research has scope limitation on time period which is just 3 years.

5.3 Recommendation

1. Adding more time period that expected the result will be better that will be generate by GARCH model.
2. Add more several ways besides GARCH. There are ARCH and RV

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