

Volatility in GARCH Models of Business Tendency Index

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Abstract. This paper aims to obtain a model of business tendency index by considering volatility factor. Volatility factor detected by ARCH (Autoregressive Conditional Heteroscedasticity). The ARCH checking was performed using the Lagrange multiplier test. The modeling is Generalized Autoregressive Conditional Heteroscedasticity (GARCH) are able to overcome volatility problems by incorporating past residual elements and residual variants.

1. Introduction

The business condition and economy in Indonesia experienced a sharp change. This is in line with the growth of Indonesia's economic growth every quarter from 2000 to 2017 which has fluctuated and tends to decline by 2017 compared to 2000. Statistics Indonesia has measured the Business Tendency Index (BTI) that is able to provide information on the state of business and the economy in the short term, which is in the current quarter and the prediction of the next quarter. The BTI is one of financial time series. Modeling financial time series is a complex problem that is difficult to reproduce artificially using stochastic models [2]. However, long-term economic development information is needed by businessman to take action in business decision-making. Therefore accurate measurements are needed to determine the state of the business and the long-term economy.

The movement of BTI figures for second quarter 2000 until first quarter 2017 experienced very sharp fluctuations. The BTI in the first quarter of 2017 amounted to 103.42, this value decreased from fourth quarter of 2016 amounted to 106,7. The value of BTI in third quarter of 2016 amounted to 107,89. This indicates that business conditions very fluctuated compared to the previous quarter. On the other hand, Indonesia's economic growth in the first quarter compared to the fourth quarter contracted by 0.34 percent where the components of exports of goods and services is the largest component that supports economic growth. The business condition in the first quarter 2017 increased was caused by three components, such as the use of production/business capacity with the achievement index of 104.60, operating income with the achievement of the index value of 104.54 and the average number of working hours with the achievement of the index value of 101.13.

This fluctuation makes it difficult for businessmen to predict the movement of BTI in the coming quarter. The change of BTI figure that is very drastic every quarter is supposed to contain volatility elements so that in statistical modeling it is necessary to consider the heteroscedasticity element in the model. The simplest measurement of volatility can see



from typically non independent and identically distributed with leptocurtic and skewed of distributions [3]. GARCH model calculate volatility by demeaned squared return [1]. GARCH model work simply if volatility is changing gradually over time because The Business Tendency Index Indonesia figures in this study were modeled using ARCH and GARCH.

2. ARCH and GARCH Models

ARCH models were introduced by Engle (1982) and their GARCH extension is due to Bollerslev (1986). The key concept in these models are the conditional variance, that is, the variance conditional on the past. In the classical GARCH models, the conditional variance is expresses as a linear function of squared past values of the series [2]. GARCH models is hardly compatible with the assumption of constant conditional variance, that is called conditional heteroscedasticity: $\text{Var}(\varepsilon_t|\varepsilon_{t-1}, \varepsilon_{t-2}, \dots) \neq \text{const.}$ Conditional heteroscedasticity is perfectly compatible with stationary.

A process (ε_t) is called a GARCH (p,q) process if its first two conditional moments exist and satisfy: [2]

- (i) $E(\varepsilon_t|\varepsilon_u, u < t) = 0, t \in \mathbb{Z}$
- (ii) There exist constant $\omega, \alpha_i, i = 1, \dots, q$ and $\beta_j, j = 1, \dots, p$, such that $\sigma_t^2 = \text{Var}(\varepsilon_t|\varepsilon_u, u < t) = \omega + \sum_{i=1}^q \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^p \beta_j \sigma_{t-j}^2, t \in \mathbb{Z}$ or $\sigma_t^2 = \text{Var}(\varepsilon_t|\varepsilon_u, u < t) = \omega + \alpha(B) \varepsilon_{t-1}^2 + \beta(B) \sigma_{t-1}^2, t \in \mathbb{Z}$

The GARCH (1,1) model when $p = q$, has the form: $\varepsilon_t = \sigma_t \eta_t$ $\sigma_t^2 = \omega + \alpha \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2$ with $\omega \geq 0, \alpha \geq 0, \beta \geq 0$. The conditional variant σ_t^2 (as it depends on the previous period) has three parts, namely the mean (ω), the volatility of the previous period σ_{t-1}^2 (called ARCH), previous period variant σ_{t-1}^2 (called GARCH).

Testing the existence of heteroscedasticity in time series data uses Lagrange Multiplier. Lagrange Multiplier works by linear regression equation $h_t = \alpha_0 + \alpha_1 u_{t-1}^2 + \alpha_2 u_{t-2}^2 + \dots + \alpha_m u_{t-m}^2$ so that the coefficient of determination (R^2). The Lagrange Multiplier (LM) test statistic is $T \times R^2$ where T is the number of observations. The decision maker of LM test statistics is when the value of LM larger than chisquare table. Then reject the initial hypothesis (no heteroskedasticity). The value of α is the value of signifinance and m is number of parameters.

3. GARCH Model of BTI

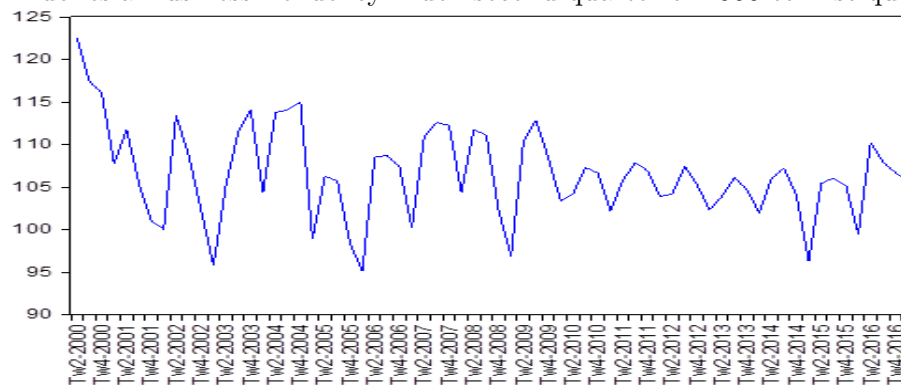
BTI in this research is BTI from second quarter of 2000 to first quarter of 2017 or as much as 68 observation. Table 1 shows BTI was highest in the second quarter of 2000 is 122.5. The lowest BTI occurred in the first quarter of 2006 is 95.12.

Table 1. Descriptive Statistics

Mean	Maximum	Minimum	Std. Dev	Skewness	Kurtosis	Observations
106.5866	122.5000	95.1200	5.3520	0.2199	3.2759	68

BTI numbers fluctuate during the observation period. The following graph of the development of the Indonesian business tendency index in the second quarter of 2000 to first quarter of 2017.

Figure 1 shows that BTI Indonesia has high volatility. In other words, drastic increase and decrease can occur at any time. BTI in first quarter of 2006 then jumped to 108.5 in second quarter of 2006. The right econometric model to estimate high volatility data is ARCH and GARCH analysis.

Figure 1. Indonesia Business Tendency Index second quarter of 2000 to first quarter of 2017

Source: Statistics Indonesia

Table 2. Test Stationary

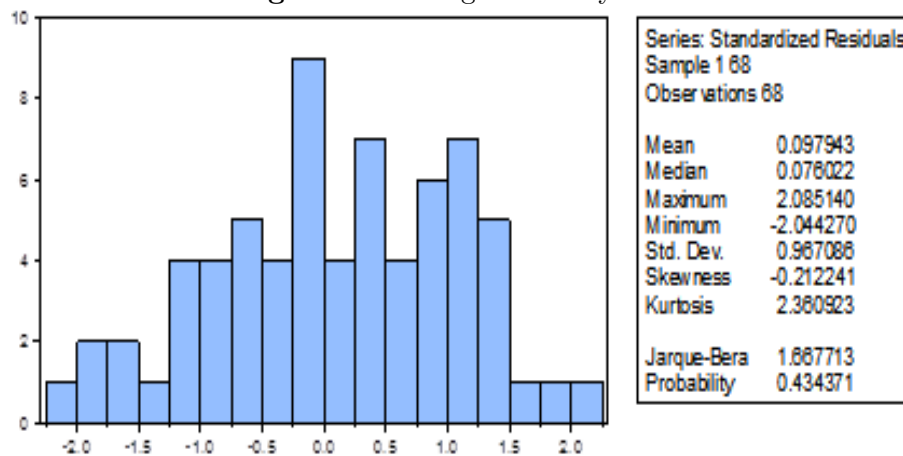
	t-statistics	Prob*
Augmented Dickey-Fuller test statistic	-5.091501	0.0001
Test critical values:		
1 percent level	-3.53862	
5 percent level	-2.908420	
10 percent level	-2.591799	

Table 2 shows testing stationarity of data BTI using unit root test (unit root test). Table 2 shows that the probability value of 0.0001 means the data is not stationary. Because of the data not stationary, we must checked heteroscedasticity using Lagrange Multiplier (LM).

The existence of ARCH from box jenkins model can be checked using Lagrange Multiplier test. The result of LM test shows that the data of Indonesian business tendency index from second quarter of 2000 to first quarter of 2017 contains heteroscedasticity. It is characterized by a probability value of F - statistic less than 5 percent is 0.0099 and value of Obs*R-squared more than chi-square table.

Table 3. LM Test

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	7.057053	Prob.F(1,66)	0.0099
Obs*R-squared	6.568560	Prob. Chi-Square(1)	0.0104

Figure 2. Testing Normality Error

GARCH Estimation

In the BTI modeling, several model simulations were performed to obtain the best model. The measurements to obtain the best model comparison use Akaike Info Criterion (AIC) and Schwarz Information Criterion (SIC) values. Models that provide the smallest AIC and SIC values are selected as the best model for the BTI Indonesia.

Table 4. GARCH Model Comparison for Business Tendency Index

Model	AIC	SIC
GARCH(1,0)	6,126480	6,224399
GARCH(0,1)	6,023624	6,12544
GARCH(1,1)	5,859331	5,989890
GARCH(1,1) Regresorvarian	5,994182	6,158711

Selection of GARCH model with different order to find the most appropriate model. The best model is GARCH (1,1). The GARCH model has been obtained, evaluated to ensure that the model is feasible. The GARCH model is evaluated in several ways as follows: Normal error checking is used to determine whether or not there is heteroscedasticity in residual. Figure 2 shows testing normality error shows that the value of Jarque-Bera and probability is more than 5 percent each of 1.667713 and 0.434371. With a 5 percent error rate it can be concluded that the residual is normally distributed. The result of residual randomness test using Correlogram Q-Statistics shows that the probability value is greater than = 5 percent so that the annoying variable has no autocorrelation element.

Table 5 shows heteroscedasticity test that the probability value of F statistic and probability value of chi-square is greater than 0,05. The ARCH effect test using Lagrange Multiplier is performed to ensure that the GARCH (1,1) model does not contain heteroscedasticity. Table 6 shows results of model estimated. GARCH Model (1,1) on the BTI is

$$\sigma^2 = 0,7361 - 0,2011\varepsilon_{t-1}^2 + 1,1074\sigma_{t-1}^2$$

$$GARCH = 0,73610,2011 * RESID(-1)^2 - 1,1074 * GARCH(-1)$$

Table 5. Heteroskedasticity Test

Heteroskedasticity Test: ARCH			
F-statistic	3.158376	Prob.F(1,65)	0.0802
Obs*R-squared	3.104698	Prob. Chi-Square(1)	0.0781

Table 6. Results of Model Estimated

Coefficient	ARCH(1,0)	GARCH(0,1)	GARCH(1,1)	GARCH(1,1) Regressor variant
C	106.0179	105.7457	105.8258	105.5697
AR(1)				0.2674
Variance equation				
C	15.4864	0.5786	0.7361	1.6385
Resid(-1) ²	0.42692	0.9291	-0.2011	0.1549
GARCH(-1)			1.1074	0.7541

4. Conclusion

GARCH model can know the volatility that occurs in movement of business tendency index. Based on model evaluation results, it can be concluded that GARCH (1,1) model is suitable to predict business tendency index with 5 percent error rate.

References

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