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A Study on the Asymmetric Volatility of the U.S. and Japanese REITs Returns

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Abstract

This study analyzed whether the effects of information type on the volatility of each index are asymmetric through the GJR(1,1)-MA(1) model using the U.S. equity REITs (Real Estate Investment Trusts) stock price index released by the FTSE NAREIT and the Japanese equity REITs stock price index released by SMTRI. Using the GJR method to consider asymmetric volatility effects which are widely observed in the stock market. This study also analyzed the GARCH-MA(1) model to examine whether the volatility of REITs returns changes depending on the flow of time. As a result of the analysis, it was revealed that time change of the REITs return volatility can be estimated in the GARCH model analysis. The GJR(1,1)-MA(1) model was shown to be a suitable model to capture asymmetric effects affecting the REITs stock price volatility concerned with information. At the time when capital market opening accelerates, the portfolio and risk rate management according to information is required.

Keywords: *REITs, Information, Asymmetric volatility, GARCH model, GJR model*

1. Introduction

Real Estate Investment Trusts (REITs) is essentially a closed-end fund created exclusively for holding real properties, mortgage assets, or both. This investment vehicle is an indirect investment tool that can be invested in securitized real estate. REITs shares are also typically traded on the stock exchange. Stock price volatility in stock markets strongly or weakly reacts to the flow of information. The more information affecting stock markets is important, the more the volatility strongly reacts. French and Roll asserted a close correlation between information and stock price volatility [1]. Like volatility in the stock markets reacts importantly according to the flow of information, information in the REITs market is also handled importantly Such information as the ease of REITs establishment conditions, expansion of investment-targeted real estate, capital market openness, and income tax rate increase have directly/indirectly affected on the REITs market, which may increase or decrease the REITs market volatility. Black reported that stock price volatility asymmetrically effect depending on whether the information arriving at the stock market is a favorable or an unfavorable factor [2] Bollerslev analyzed asymmetric effects to information using various asymmetric models [3].

Michayluk, Wilson, and Zurbruegg suggested significant asymmetric effects on both the volatility and correlation between the U.S and U.K. securitized real estate markets [4]. Nikbakht, Shahrokhi, and Spieler analyzed asymmetric volatility spillover effect on REITs

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return from U.S. markets to European markets. They presented volatility transmission from U.S. real estate markets to European real estate markets, but there was no evidence of the opposite [5]. Nevertheless, there are relatively few studies of asymmetric volatility of REITs stock price indices for information type. Therefore, this study empirically analyzes whether the volatility of REITs stocks price is asymmetric according to the type of information reaching the REITs market using the GARCH model and GJR model. The studies on the asymmetric effects in the stock markets include those performed by Black, Bollerslev, Nelson [6], Engle and Ng [6], Stevenson [8], and Ling and Naranjo [9]. The domestic studies include those carried out by Ji and Kim [10], Kim, Po, and Do [11], and Lee and Lee [12].

This study was empirically analyzed to examine whether the effects of information arriving at the REITs market on the stock price volatility vary using the GJR model. A comparative analysis of the U.S. REITs market that proactively adopted the REITs system and the Japanese REITs market that adopted the REITs system in the period similar to Korea and that the system is actively traded can provide insight in dramatically understanding the REITs market's movement at the time when capital market opening accelerates. From the aspect of presenting a model to predict the return of REITs, this study also has a practical purpose. The differentiation of this study is that an empirical analysis of asymmetric effects depending on information type arriving at the REITs market was attempted for the first time, while most existing studies focused on the analysis of stock market volatility. The analysis method is examined in Chapter II, the analysis result is presented in Chapter III, and the conclusion and implications are presented in Chapter IV of this study.

2. Methodology

2.1. GARCH(1,1)-MA(1) model

To explain the GARCH model that can show asymmetric response on the information of REITs stock price, the GARCH model, presented by Bollerslev, should first be explained. Bollerslev explained conditional volatility of stock price using the GARCH model. Replacing stock price with REITs stock price, the GARCH model changes as equation (1).

$$h_t = \alpha_0 + \sum_{i=1}^{p} \beta_i \, e_{t-i}^2 + \sum_{j=1}^{q} \gamma_j \, h_{t-j} \tag{1}$$

Conditional dispersion h_t in Equation (1) is a model where an unpredictable change in REITs stock price that are the information indices of period t-1, that is, the square of residual in period t-1, conditional volatility of REITs stock price in period t-1, which reflects all information before period t-1, express conditional volatility of REITs stock price in period t. Assuming that information in period t-1 is known, setting expected yield rate as $\overline{R_t}$ and conditional dispersion as h_t results in $\overline{R_t} \equiv E(R_t|\Omega_{t-1}),\ h_t = Var(R_t|\Omega_{t-1})$. Unpredictable yield rate in period t is $e_t \equiv R_t - \overline{R_t}$, and e_t is the aggregate of information in period t. Here, a large value of $|e_t|$, which is the absolute value of unpredictable yield rate of REITs stock price that is expressed as residual, means that a large change occurred in REITs stock price Equation (2-4) is GARCH(1,1)-MA(1) model. In Equation (2), R_t is the daily yield rate in REITs stock prices, and Ω_{t-1} refers to the aggregate of all information up to period t-1.

$$R_t = \alpha_0 + \alpha_1 e_{t-1} + e_t \tag{2}$$

$$e_t = e_t|\Omega_{t-1}|\sim N(0, h_t) \tag{3}$$

$$h_t = \beta_0 + \beta_1 e_{t-1}^2 + \gamma h_{t-1}, (\beta_0 > 0,\ \ \beta_1 > 0,\ \ \gamma \geq 0) \tag{4}$$

Equation (2) sets e_{t-1} corresponding to MA(1) as the discriminative variable of the mean equation R_t term and e_t as an error, Equation (2) means the shock or news that is not predicted in t period. The h_t of the conditional variance equation was expressed as an equation by adopting squared residuals β_0 and squared residuals e_{t-1}^2 and σ_{t-1}^2, which are the conditional variance in the previous period. That β_1 is large means that volatility sensitively responds to the market change. $\beta_1 + \gamma$ is a parameter measuring the continuity of volatility or measuring has fast it perishes. The closer the $\beta_1 + \gamma$ value is to 1, the higher the possibility of continuity is. However, this model always shows the asymmetric effect, irrelevant that the shock of the conditional volatility h_t in the t period in terms of e_{t-1}, the newsgroup in the t-1 period, is positive (+) or negative (-) value. Therefore, the model is unsuitable for analyzing the asymmetric effect of information that becomes an issue recently.

2.2. GJR(1,1)-MA(1) model

Although there are diverse models to analyze asymmetric effects according to information type, the GJR-MA model of Glosten, Jagannathan, and Runkle (1993) [13] whose excellence was verified was used in this study. The reason why moving average (MA) was added to the GJR model is to remove the autocorrelation of the unexpected return of REITs. Concerning the lag of MA, the GJR(1,1)-MA(1) model was adopted under the parsimony principle according to AIC and SBC statistical norms. The GJR(1,1)-MA(1) model can be expressed as shown in Expression (5-7) as follows:

$$R_t = \alpha_0 + \alpha_1 e_{t-1} + e_t \tag{5}$$

$$e_t = e_t|\Omega_{t-1}| \sim N(0, h_t) \tag{6}$$

$$h_t = \beta_0 + \beta_1 e_{t-1}^2 + \beta_D S_{t-1}^- e_{t-1}^2 + \gamma h_{t-1} \tag{7}$$

where,

$$S_{t-1}^- = \begin{cases} 1, e_{t-1} < 0 \\ 0, \quad e_{t-1} \geq 0 \end{cases}$$

In Equation (5), R_t is daily return and Ω_{t-1} means all information sets until the t-1 period. e_t, e_{t-1} indicate new information sets at each point in time and when it is a positive value, favorable information is indicated, and when it is a negative value, unfavorable information is indicated. h_t indicates conditional dispersion. S_{t-1}^- is the dummy variable to indicate asymmetric information. If the value of e_{t-1} is negative, 1 is indicated and if the value of e_{t-1} is positive, 0 is indicated. Therefore $S_{t-1}^- e_{t-1}^2$ reveals the asymmetry of REITs return volatility. If the coefficient β_D is a positive value, it means that unfavorable factors increase the volatility of REITs return int period.

3. Analysis result

3.1. Analysis data and stability test

The data used in this study are the U.S. REITs price index [14] released by NAREIT and the Japanese REITs price index [15] released by SMTRI. This study took the daily REITs price index. The REITs returns were calculated like $R_i = ln(P_t/P_{t-1})$ using Taylor expansion. The analysis period was from January 4, 2010, to December 30, 2020, in consideration of being able to take data and daily data were used. [Table 1] shows the basic statistics of the data.

Table 1. The basic statistics of the U.S. and Japanese REITs stock index returns

	The U.S.	Japan
Mean (×102)	0.0225	0.0439
SD (×102)	1.3974	1.2244
Skewness	-1.3580	-1.2500
Kurtosis	25.368	48.809
Jarque-Bera Statistics	56950.17 (0.0000)	236080.10 (0.0000)

Note) ( ) is the significance level that may reject the null hypothesis

Skewness showed skewed distribution in the negative (-) direction in the U.S. and Japan, Kurtosis showed distribution having leptokurtic distribution compared to normal distribution. Jarque-Bera statistics reject the null hypothesis at a 1% significance level and so the GARCH model based on the heteroscedasticity of the U.S. and Japan is appropriate. Since a time, series analysis needs stability inspection, this study performed ADF (Augmented Dickey-Fuller) unit root tests through PP (Phillips and Perron) unit root test [16][17] and [Table 2] shows the results. The logarithmic differencing time series data of each index were stable at a 1% significance level.

Table 2. Unit root test result

	The U.S.		Japan	
	Level variable	1st difference variable	Level variable	1st difference variable
ADF(lag1)	-2.4110	-34.7097	-1.3471	-37.4677
	0.1387	0.0000***	0.6095	0.0000***
PP(1ag1)	-2.4496	-55.78647	-1.2834	-44.8129
	0.1283	0.0000***	0.6394	0.0000***

*Note) 1. p<0.01***, p<0.05**, p<0.1**

When including constant term, the significance level is 1% threshold is 3.43.

3.2. Estimation by the model

[Table 3] shows the asymmetric effect analysis of REITs return volatility concerned with information. Before explaining the GJR(1,1)-MA(1) model, the reason why the GARCH(1,1)-MA(1) model is analyzed first is to examine whether the REITs return volatility of the U.S. and Japan change according to the flow of time and to compare with the asymmetric model GJR(1,1)-MA(1).

In the GARCH model analysis, the estimated coefficients β_1 and γ indicating time change of the REITs return volatility were significant at a 1% significance level. The model is analyzed to be an appropriate model in that the time change of REITs return volatility can be estimated with the GARCH model for the U.S. and Japan. In the GJR(1,1)-MA(1) model, the coefficient β_D showing an asymmetric effect of REITs return volatility was shown to be positive values at a 1% significance level in both the U.S. and Japan. The result means that unexpected negative return increases REITs price volatility more than the unexpected positive return. This means that the information arriving the market should be discerned if it is a favorable or unfavorable factor when stock price volatility is expected due to the asymmetric effect of information on the REITs price volatility. To test the excellence of the GARCH(1,1)-MA model (1) and GJR(1,1)-MA(1) model, the LR statistics of the GJR(1,1)-MA(1) rejected the null hypothesis at a 10% significance level as a result of a likelihood ratio test (LR statistics). This means that the GJR(1,1)-MA(1) model is appropriate to capture the asymmetric effect of information on REITs stock price volatility.

Table 3. Model estimation result

Category	The U.S.	Japan
	GARCH-MA	
α_0(×102)	0.0788	0.0513
	(0.0000)***	(0.0000)***
α_1	0.5987	0.3776
	(0.0000)***	(0.0000)***
β_0(×102)	0.0004	0.0513
	(0.0000)***	(0.0000)***
β_1	0.4152	0.3776
	(0.000)***	(0.000)***
γ	0.5545	0.6233
	(0.000)***	(0.001)***
Log-Likelihood	9735.87	9798.02
	GJR-MA	
α_0(×102)	0.0747	0.0002
	(0.0000)***	(0.001)***
α_1	0.5992	0.4523
	(0.0000)***	(0.000)***
β_0(×102)	0.0004	0.0002
	(0.061)***	(0.0000)***
β_1	0.3310	0.3309
	(0.0000)***	(0.005)***
β_D	0.1310	0.0861
	(0.0016)***	(0.0058)***
γ	0.5662	0.6259
	(0.000)***	(0.0000)***
Log Likelihood	9740.10	9800.45
LR statics	8.46***	4.86*

*Note) 1. ( ) indicates z statistics: 2. p<0.01***, p<0.05**, p<0.1**

Based on the analysis result of Table 3, the relationship between the unpredictable yield rate (e_{t-1}) in the t-1 period and the conditional volatility (h_t) in the t period is shown in [Figure 1] and [Figure 2]. [Figure 1] shows the asymmetric response of volatility in the U.S. REITs Stock Price as discussed previously; the graph shows that unexpected negative returns in the U.S REITs markets increase the REITs stock price volatility more than the unexpected positive returns. The result means that REITs stock price volatility concerned with information is asymmetric. [Figure 2] shows the asymmetric response of volatility in Japanese REITs stock price. The graph shows that unexpected negative returns in Japanese REITs markets increase the REITs stock price volatility more than the unexpected positive returns. The result means that REITs stock price volatility concerned with information is asymmetric. The asymmetric effect of the U.S. was a bit larger than that of Japan.

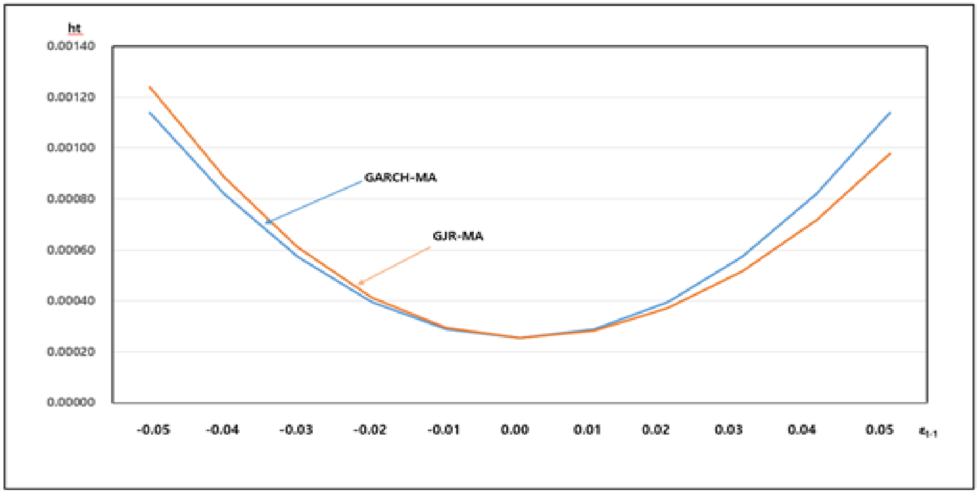

Figure 1. The asymmetric effects of the U.S. REITs stock price volatility (U.S.)

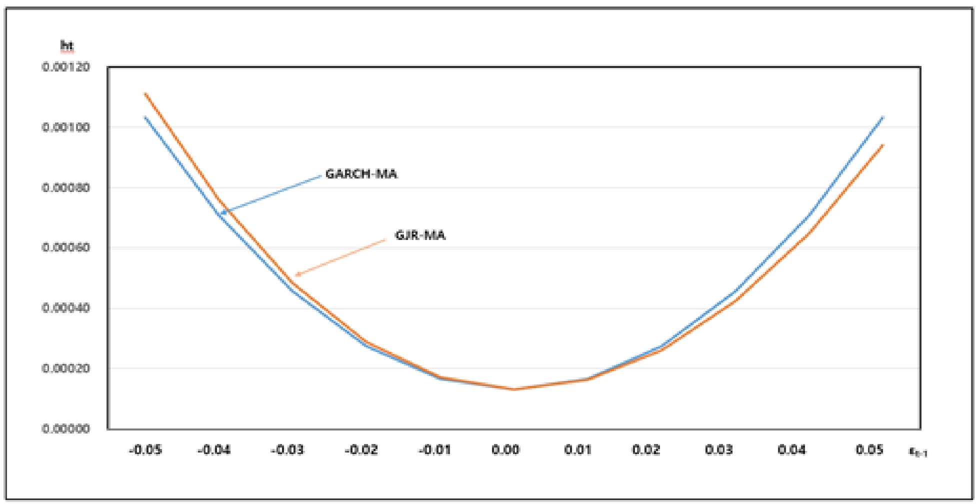

Figure 2. The asymmetric effects of the Japanese REITs stock price volatility (Japan)

4. Conclusion

The data used in this study were the U.S. REITs index released by NAREIT and the Japanese REITs index released by SMTRI. Whether the effects of information type on each index's volatility were asymmetric was analyzed using the GJR(1,1)-MA(1) model. Before explaining the GJR(1,1)-MA(1) model, this study also analyzed the GARCH(1,1)-MA(1) model to find out whether REITs return volatility changes depending on the flow of time. As a result of the analysis, the time change of the REITs return volatility could be estimated. In the GJR(1,1)-MA(1) model, the coefficient β_D showing the asymmetric effect of the REITs return volatility was shown as a positive value at a 1% significance level in both the U.S. and Japan. The result means that the unexpected negative return increases the REITs price volatility more than the unexpected positive return. Therefore this means that the GJR(1,1)-MA(1) model is suitable to identify the asymmetric effect on REITs stock price volatility. The asymmetric volatility effect in the U.S. was a bit larger than that in Japan. Through this research, the asymmetric volatility effect on information was found to exist in both the U.S. and Japanese REITs markets. The results of this study have the limitation that only the historical returns and volatility of the index are used as variables to explain the current returns and volatility. Nevertheless, the following implications can be drawn. Therefore, the need to manage portfolios and risk rates according to the information arriving at the REITs market is required. The result of these studies will provide practical information for a dynamic understanding of the REITs market. When interest in global real estate investment increases due to low-interest rates, it suggests the need to establish an investment strategy according to the type of information A further study is expected to be carried out for a sophisticated analysis method for the robustness of research and expanded study.

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