

## The Effect of Initial Margin on Long-run and Short-run Volatilities in Japan\*

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This paper examines the effect of initial margin requirements on long-run and short-run volatilities in the Japanese stock market using the Component GARCH model. Our empirical results show that when we do not divide the margin requirement into positive and negative changes, increasing margin requirement is effective for reducing long-run volatility, while not effective in short-run volatility. However, separating the positive and negative changes in margin requirements reveals the fact that the negative changes in margin requirements decrease long-run volatilities, while the higher margin requirements increase short-run volatilities in the Japanese stock market. This suggests that if the Japanese financial authorities intend to increase margin level to reduce volatility, unexpectedly, short-run volatility would be even higher.

Keywords: Margin Requirement, Long-run Volatility, Short-run Volatility, Component GARCH Model

JEL Classification: G10, G14, G18

### I. Introduction

Do margin requirements play an important role in reducing stock market volatility? Many government regulators of the stock markets thought that volatility in the stock market might be controlled by some restrictions about buying on margin and short-selling. In other words, margin and short-selling can be easily used to stimulate the stock prices when the stock market is in

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recession, while these policies can be adopted to reduce the bubble of the stock prices when it is in boom.

Initial margin requirements were firstly imposed by the US Congress with the Securities and Exchange Act of 1934 to reduce the credit-financed speculation in the stock market, which may lead to excessive price volatility through a “pyramiding-depyramiding” process<sup>1</sup> (Garbade, 1982). Therefore, initial margin requirements are designed and adopted to prevent excess volatility in the stock markets. However, the previous literatures show mixed results. For example, some studies (Kupiec, 1989; Hardouvelis, 1990, Hardouvelis and Theodossiu, 2002 among others) find the negative relationship between margin requirements and stock volatility, while the other studies (Schwert, 1989; Hsieh and Miller, 1990; Kim and Oppenheimer, 2002 among others) find no reliable evidence.

Basically, the pyramiding-depyramiding process takes for granted the presence of both rational and irrational investors (speculators) and expects the negative relationship between margin requirement and stock volatility. DeLong, Shleifer, Summers and Waldman (1990) theoretically show that the amount of nonfundamental volatility in the stock market increases, when noise (destabilizing) traders lever their positions. Therefore, higher margin requirements primarily restrict the participation of irrational investors in the stock market and settle excess volatilities and mispricing. Kumar et al. (1991) refer to this as the speculative effect.

Along with the speculative effect, Kumar et al. (1991) also mentioned the liquidity effect. If speculation is inherently stabilizing, then higher margin requirements restrict the activities of rational investors. That is, higher margins could potentially generate the lack of liquidity in the stock market. This lack of liquidity would cause higher volatility. This implies that when the liquidity effect prevails, there could be a positive relationship between margin requirement

<sup>1</sup> The pyramiding-depyramiding process is related to the excessive price movements. For example, the pyramiding effect can be created when the stock market is boom. Optimistic investors could borrow large amounts of money and bring stock prices up to levels unjustified by the intrinsic values of firms if there is no margin requirement restriction. In addition, if speculators were to use their increased wealth to buy more stocks on margin, this increased price could feed on itself. Suppose that brokers were to ask for additional collateral when there are some adverse news in the stock market and that some speculators lacked the requested margin funds. In this case brokers would sell their stocks driving the stock prices down further. This further declined stock price would generate more margin calls for collateral, more liquidations, and additional price declines. This is called the depyramiding effect (Hardouvelis and Theodossiou, 2002).

and stock volatility.

Depending on which effect between the speculative effect and the liquidity effect is dominant, the positive or negative relationship can be observed. In other words, if irrational (rational) investors play a role in the stock market, we can observe the negative (positive) relationship. It is natural that irrational investors play an important role in the short-run than in the long-run because sufficient time is given to collect information over the long-run. Therefore, we expect that dividing volatility into long-run and short-run components gives more insights for the effect of initial margin requirements.

The purpose of this paper is to examine the effect of initial margin requirements on long-run and short-run volatilities in the Japanese stock market. To consider the effect of initial margin requirement on long-run volatilities, the previous literatures (e.g., Hardouvelis, 1990; Hsieh and Miller, 1990; Hardouvelis and Theodossiu, 2002) construct longer horizon volatilities such as monthly and annual volatilities to examine the relationship between margin requirements and stock volatility. When using longer horizon volatilities, the relationship may be unreliable due to a handful of independent observations from generating long horizon volatilities. In the study of Hardouvelis (1990), he constructs the rolling 12-month estimator of volatility by implicitly assuming that volatility is nonstationary.<sup>2</sup> Considering this problem, we adopt the component GARCH (CGARCH) model,<sup>3</sup> proposed by Engle and Lee (1999). This model assumes that volatility consists of two components: one is the long-run volatility component whose shocks are highly persistent, and the other is the short-run volatility component whose shocks are less persistent.

This paper uses Japanese data for the investigation. As mentioned in Kim and Oppenheimer (2002), the Japanese experience is very useful for examining the relationship between margin requirements and volatilities due to frequent revision of margin requirements by the Tokyo Stock Exchange (TSE) and high

<sup>2</sup> Furthermore, in the study of Hardouvelis (1990), the time path of margin requirements is persistent. Therefore, Schwert (1989) argue that the spurious regression problem is likely to be serious in Hardouvelis (1990).

<sup>3</sup> In relation to using the GARCH model, Hardouvelis and Theodossiu (2002) and Sohn and Kim (2009) use the EGARCH model. However, as noted in Watanabe and Harada (2006), who examine the effect of the intervention of the Bank of Japan on the exchange rate volatility, the use of a GARCH model has an important drawback, which results from well known phenomenon called volatility clustering, that shocks to volatility are highly persistent. Incorporating policy variables into the GARCH volatility equation is equivalent to assuming that the effects of policy changes are also persistent. If the effects of policy changes are transitory, this approach is not valid.

proportion of margin transaction in all transactions in the country. Since 1970, during our sample period, there were 63 margin changes. Among a total of 63 margin policy changes, margin policy change is overlapped 10 times in monthly data.<sup>4</sup> Therefore, there are possibility to lose some important information for investigating the relationship between margin requirements and volatility.

Overall, our results show that increasing margin requirement is effective for reducing long-run volatility, while not effective in short-run volatility. However, separating the positive and negative changes in margin requirements reveals the fact that the negative changes in margin requirements decrease long-run volatilities, while the higher margin requirements increase short-run volatilities in the Japanese stock market. This suggests that if the Japanese financial authorities intend to increase margin level to reduce volatility, unexpectedly, short-run volatility would be even higher.

The remainder of this paper is organized as follows. Section 2 describes the CGARCH model as our main empirical model. Data and empirical results are discussed in Section 3. In section 4, we discuss the results of dividing the positive and negative changes in margin requirements, while Section 5 presents concluding remarks with a summary of our results.

## II. Data and descriptive statistics

Our study uses the NIKKEI225 index and TOPIX index as proxy for the Japanese stock market.<sup>5</sup> Our data from are composed of daily closing prices, obtained from Datastream for the period of January 5, 1970 to December 27, 1990.<sup>6</sup> Daily returns are computed by  $\log(p_t / p_{t-1})$ . Table 1 summarizes selected basic statistics for returns of two indices. All mean returns are positive and all skewnesses are negative. We also report the Jarque-Bera statistics for check the normality of the return series. The value of Ljung-Box statistics for up to 24 lags (hereafter LB(24)) for the return series and the squared return series

<sup>4</sup> More detail discussion for our data will be provided in section 3.

<sup>5</sup> The data series are obtained while the second author visited University of Michigan. In addition, we use Eviews 6.0 for our empirical examination.

<sup>6</sup> Because the margin requirement has not changed since September 7, 1990, we expect that the latest data sample cannot possibly add much information about the relation between margin requirements and stock volatility. Therefore, this sample period has been chosen in our study.

Table 1. Descriptive Statistics

	Mean	Std.Dev.	Skewness	Kurtosis	Jarque-Bera	LB(24)	LB2(24)
Nikkei225	0.044%	0.993%	-1.077	29.426	151896.600 (0.000)	89.228 (0.000)	840.440 (0.000)
TOPIX	0.043%	0.882%	-1.422	34.708	218996.500 (0.000)	160.810 (0.000)	774.860 (0.000)

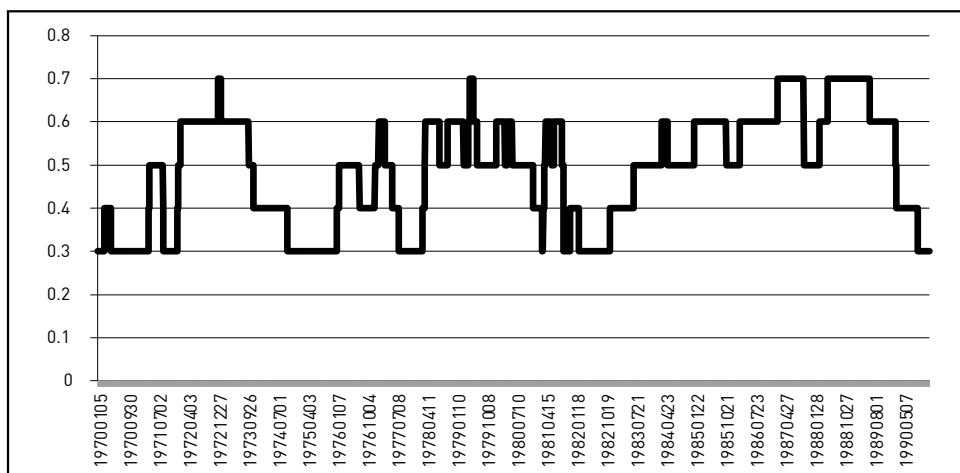
Note: This table reports the basic statistics for daily returns of NIKKEI225 and TOPIX. In this table, 'Kurtosis' indicates the excess kurtosis. In addition, LB(24) and LB2(24) are Ljung-Box statistics for up to 24 lags for returns and squared returns, respectively. Significance levels are in parentheses.

are significant at the 1% level, suggesting the possibility of the presence of autoregressive conditional heteroskedasticity.

The data on initial margin requirements,  $M_t$ , are taken from Sohn and Kim (2009). They are expressed in decimals and thus, can vary from zero to one. Figure 1 presents a plot of  $M_t$ . Over the sample period, official initial margin requirements were adjusted 63 times. The lowest official level of margin requirements was set a 30% ( $M_t = 0.3$ ) and the highest level is set a 70% ( $M_t = 0.7$ ).

As can be seen in Figure 1, the margin requirement is a discrete variable, which is constrained to take values from 0.3 to 0.7. As mentioned in Hardouvelis and Theodossiu (2002), due to its finite variance, the level of margin requirements

Figure 1. Initial Margin Requirement in the Japanese Stock Market



cannot be conceptually treated as a random walk process, i.e., a process with a unit root. However, because our sample series are a finite sample, the infrequent changes in margin requirement could produce empirically an autocorrelation function, which is very similar to one originating from a series with a unit root. Therefore, it is important to examine the stochastic process of margin requirement. We adopt the Augmented Dickey-Fuller (hereafter ADF) test and Kwiatkowski, Phillips, Schmidt and Shin (1992, hereafter KPSS) test.

Table 2. Results of the Unit Root Tests for Margin Requirement

		ADF	KPSS
level	constant	-3.139*	1.858**
	constant and a linear trend	-3.076	0.192*
first difference	constant	-70.910**	0.064
	constant and a linear trend	-70.912**	0.030

Note: \* and \*\* indicate significance at 5% and 1% level. The null hypothesis for the ADF test is that margin requirement has a unit root, while that of the KPSS test is that margin requirement is stationary.

Table 2 reports the results of unit root tests at levels and first differences with and without a trend using the ADF and KPSS tests. The reason for using the KPSS test is that the ADF test has been shown to fail to distinguish between a unit root and weakly stationary process due to its null hypothesis that the series has a unit root (Lee and Mathur, 1999). The result of the ADF test suggests that the level of margin requirement is stationary at 5% significance level, consistent with Hardouvelis and Theodossiu (2002) and Sohn and Kim (2009). However, those of the KPSS, whose null hypothesis of the KPSS test is that margin requirement is stationary, indicate that margin requirements are non-stationary at level, while stationary at first difference. Overall, the results of the unit root tests depend on which methods are adopted for the unit root test. Based on this conflicting result, we use the level and a dummy variable for the margin changes for our analysis.

Note that the purpose of an increase (decrease) in margin requirements is to reduce excess volatility in the stock market. Therefore, the effect of the negative changes in margin requirement could be offset by that of the positive changes or vice versa. For this possible reason, this paper uses the dummy variable for the margin changes.

### III. Empirical model

In this section, we present the CGARCH model developed by Engle and Lee (1999) to decompose market volatility into a short-run component,  $s_t$ , and a long-run component,  $l_t$ . Christoffersen et al. (2004) show that distinguishing the long-run and short-run components of volatility enables the CGARCH model to describe volatility dynamics better than the standard GARCH model. To set up the basic CGARCH model, we define conditional mean specification as:

$$R_{m,t} = \mu + a_0 \sqrt{h_t} + a_1 hol_{t-1} + \varepsilon_t, \quad \varepsilon_t = \sqrt{h_t} z_t \quad \text{and} \quad z_t \sim i.i.d(0,1) \quad (1)$$

where  $R_{m,t}$  and  $\mu$  are market returns and unconditional mean market return, respectively.  $h_t$  is the conditional variance, while  $z_t$  is the standardized innovations with zero mean and unit variance.  $hol_{t-1}$  is a holiday dummy, which has a value of 1 if the previous day is a holiday, otherwise zero. We include  $h_t$  in the conditional mean equation (1) to capture a possible linkage between the conditional first and second moments of the distribution of returns, as in Hardouvelis and Theodossiu (2002).

We define the conditional volatility specification, which permits both the long-run component of conditional variance,  $l_t$ , which is slowly mean reverting and the short-run component,  $s_t$ , which is more volatile (for more detail, see Engle and Lee, 1999):

$$h_t = l_t + s_t = l_t + \alpha_1(\varepsilon_{t-1}^2 - l_{t-1}) + \alpha_2(h_{t-1} - l_{t-1}) + \alpha_3 hol_{t-1} \quad (2)$$

$$l_t = w + \beta_1(l_{t-1} - w) + \beta_2(\varepsilon_{t-1}^2 - h_{t-1}) + \beta_3 hol_{t-1} \quad (3)$$

In addition, by rearranging equation (2), Engle and Lee (1999) specify the dynamics of the short-run volatility components as follows:

$$s_t = (\alpha_1 + \alpha_2)s_{t-1} + \alpha_1(\varepsilon_{t-1}^2 - h_{t-1}) \quad (4)$$

Using equations (3) and (4), the persistence of short-run and long-run volatility can be captured by  $\alpha_1 + \alpha_2$  and  $\beta_1$ , respectively. It is assumed that  $0 < \alpha_1 + \alpha_2 < 1$  and  $0 < \beta_1 < 1$ , to ensure that both components will converge to their means, 0, and  $w/(1 - \beta_1)$ , respectively. In addition, it is assumed that

long-run volatility is more persistent than short-run volatility. Mathematically, this assumption can be expressed as follows:

$$0 < \alpha_1 + \alpha_2 < \beta_1 < 1 \quad (5)$$

To examine the effect of initial margin on short- and long-run volatilities, our empirical model is specified by adding the initial margin dummy into equation (1), (2) and (3) as follows:

$$R_{m,t} = \mu + a_0 \sqrt{h_t} + a_1 Mdum_{t-1} + a_2 hol_{t-1} + \varepsilon_t \quad (6)$$

$$h_t = l_t + \alpha_1 (\varepsilon_{t-1}^2 - l_{t-1}) + \alpha_2 (h_{t-1} - l_{t-1}) + \alpha_3 Mdum_{t-1} + \alpha_4 hol_{t-1} \quad (7)$$

$$l_t = w + \beta_1 (l_{t-1} - w) + \beta_2 (\varepsilon_{t-1}^2 - h_{t-1}) + \beta_3 Mdum_{t-1} + \beta_4 hol_{t-1} \quad (8)$$

where  $Mdum_{t-1}$  is a margin dummy, which has a value of 1 if margin requirement level is changed at time  $t-1$ , otherwise zero.

In the mean equation (6), we include the dummy variable for the margin changes,  $Mdum_{t-1}$ , in order to capture a possible direct influence of the changes in margin requirements on the risk premium. As Hardouvelis and Theodossiu (2002) noted, if the margin changes reduce uncertainty about future uncertainty, which is not fully incorporated in our CGARCH model, they may reduce the rate of required returns to invest in the stock market.

In addition, we also incorporate the margin dummy in the conditional variance equations (7) and (8). If the pyramiding-depyramiding process is likely to last a few months (Hardouvelis, 1990), the margin changes influence the volatility trend (i.e., long-run volatility). However, if the effect of the margin changes is transitory, the changes in margin requirements do not affect long-run volatility of the stock market, but only influence short-run volatility.

The studies of Hardouvelis and Theodossiu (2002) and Sohn and Kim (2009) use the EGARCH model, which specifies asymmetric effect of news on conditional volatility. Following their studies, we also incorporate the asymmetric component in our CGARCH model by introducing asymmetric effects in short-run volatility equation (7) as:



$$h_t = l_t + \alpha_1(\varepsilon_{t-1}^2 - l_{t-1}) + \gamma(\varepsilon_{t-1}^2 - l_{t-1})d_{t-1} + \alpha_2(h_{t-1} - l_{t-1}) + \alpha_3 Mdum_{t-1} + \alpha_4 hol_{t-1} \quad (9)$$

In this specification,  $d_{t-1}$  is the dummy variable, which takes the value of 1 when  $\varepsilon_{t-1}$  is negative, otherwise zero.  $\gamma > 0$  implies transitory leverage effects in conditional volatility.

#### IV. Empirical results

In this section, we discuss the empirical results of the CGARCH model. The estimation results of the CGARCH model, presented in equations (1) - (3), are reported in Table 3. In this table, we report the CGARCH model estimates and t-statistics. In addition, SR and SSR denote standardized residuals and squared standardized residuals, respectively. LB(24) indicates the Ljung-Box test of significance of autocorrelation of up to 24 lags. Estimation of the CGARCH model reported here is by maximum likelihood under the assumption that the distribution of shock is GED.

The estimated mean equation in Table 3 shows that the coefficient for the conditional variance ( $a_0$ ) is statistically significant in both indices, indicating that there is positive linkage between conditional stock market volatility and conditional mean returns, consistent with Harvey (1989) and Turner, Startz and Nelson (1989).

In addition, Table 3 shows that the persistence of long-run volatility is very high (0.981 for NIKKEI225 and 0.982 for TOPIX), while the persistence of short-run volatility is relatively low (0.713 for NIKKEI225 and 0.652 for TOPIX). The parameter,  $\beta_1$ , which captures the influence of the driving force for the time-dependent movement of the permanent component, is significant at 1% level. This result implies that the CGARCH specification provides a more adequate description of stock market volatility than a GARCH specification, as in Black and McMillan (2004). Finally, residual diagnostics (Lung-Box statistics) for the CGARCH model, reported in the lower panel of Table 3, confirm the presence of residual non-normality, which show no serial dependency in the square of the standardized residuals at the 1% significance level. In addition, we found that the holiday dummy for short-run volatility is significantly positive, while that of long-run volatility is not significant. This implies that the effect of information accumulation during holiday is temporary, not permanent.

Table 3. CGARCH Estimation Results without Margin Requirements

	NIKKEI 225		TOPIX	
$\mu$	-0.00065**	(-2.57867)	-0.00031	(-1.44267)
$a_0$	0.18826**	(4.89765)	0.14527**	(3.87816)
$a_1$	0.00082**	(3.94028)	0.00063**	(3.41374)
$w$	0.00008	(1.51628)	0.00008	(1.77313)
$\beta_1$	0.98136**	(175.27610)	0.98173**	(165.74200)
$\beta_2$	0.09990**	(5.17334)	0.11834**	(6.18801)
$\beta_3$	4.17E-07	(0.09588)	-3.12E-07	(-0.09680)
$\alpha_1$	0.17973**	(7.47551)	0.16235**	(6.69534)
$\alpha_2$	0.53328**	(7.71315)	0.48981**	(6.23488)
$\alpha_3$	0.00002**	(3.21957)	0.00001**	(3.75331)
Log-L	18038.460		18707.270	
SR LB(24)	117.560	[0.00000]	240.440	[0.00000]
SSR LB(24)	9.450	[0.99600]	17.357	[0.83300]

Note: \* and \*\* indicate significance at 5% and 1% levels, respectively. t-statistics are presented in parentheses, while significance levels are presented in brackets. SR LB(24) and SSR LB(24) are Ljung-Box statistics for up to 24 lags for standard residuals and squared standard residuals, respectively.

The main purpose of this paper is to examine the impact of margin requirements on long-run and short-run volatilities. To do so, we first estimate the CGARCH model, presented in equations (6) - (8). In this estimation, we use a dummy variable for the changes in margin requirements. In addition, we also estimate the CGARCH model with the level of margin requirements as a robustness check because the results of the two unit root tests (ADF and KPSS) are different.

Table 4 illustrates the estimated results of the CGARCH model with margin requirements.<sup>7</sup> Consistent with the findings of the previous literature and Table 3, the coefficients for the conditional variance ( $a_0$ ) are significantly positive in NIKKEI225, indicating that conditional mean returns are positively associated with conditional volatility. However, the coefficient of margin requirements,  $a_1$ , is not significant in both indices.

<sup>7</sup> We do not report t-statistics for the estimated coefficients for the sake of brevity.

Moving to the conditional variance equations, the coefficients,  $\beta_1$ , are close to unity, indicating high persistence of long-run volatility over time. In addition, the persistences of short-run volatilities in both indices, measured by  $\alpha_1 + \alpha_2$ , are lower than those of long-run volatility, which range from 0.724 for TOPIX with the level of margin requirement and 0.884 for TOPIX with margin dummy.

Overall, our result shows that the changes in margin requirement are effective for reducing long-run volatility, while not effective in short-run volatility. More specifically, the coefficients  $\beta_3$  and  $\alpha_3$  show the impact of the change in margin requirements on long-run and short-run volatilities, respectively. The coefficients,  $\beta_3$ , are significantly negative in both indices, except for NIKKEI225 with the level of margin requirement. Hardouvelis (1990) explain this negative relationship between margin requirement and long-run volatility by arguing that the pyramiding-depyramiding process is likely to last a few months. The pyramiding-depyramiding process takes for granted the presence of irrational investors along with rational investors. This process implies that during the bullish market, higher margins restrict the activities of irrational (noise) investors, then destabilizing volatility will subside. In general, it would be difficult to assume the presence of irrational investors in the long-run because in the long-run the sufficient time is given for collecting information. Therefore, the negative effect of the change in margin requirement on long-run volatility would not be explained by the pyramiding-depyramiding process.<sup>8</sup>

The coefficients,  $\alpha_3$ , are insignificant in both indices when using the margin dummy, while significantly positive when adopting the level of margin requirement, which is inconsistent with the result of Hardouvelis and Peristiani (1992) who find that margins effectively moderate volatility in the short-run using the daily returns. The different results between the uses of the margin dummy and the level of margin requirement could be because the effect of the changes in margin requirements is temporary, while that of the level of margin requirement is persistent. More important question is why higher margin requirement increases short-run volatility. This positive effect can be explained by the liquidity effect. According to Kumar et al. (1991), the positive and negative relationship between margin requirements and stock market volatility is due to the liquidity effect and the speculative effect. The speculative effect is well explained by Hardouvelis (1990). This effect implies that an increase in stock volatility is driven by speculators (irrational investors) trading on

<sup>8</sup> We thank an anonymous referee for pointing this out.

Table 4. CGARCH Estimation Results with Margin Requirements

	Margin dummy		Level of margin requirements	
	NIKKEI225	TOPIX	NIKKEI225	TOPIX
$\mu$	-0.00064**	-0.00030	-0.00224**	-0.00092**
$a_0$	0.19193**	0.15016**	0.21127**	0.14735**
$a_1$	0.00008	-0.00058	0.00292**	0.00126*
$a_2$	0.00081**	0.00064**	0.00079**	0.00061**
$w$	0.00024	0.00028	0.00011	0.00010
$\beta_1$	0.99480**	0.99675**	0.98391**	0.98451**
$\beta_2$	0.02954**	0.02190**	0.08010**	0.08824**
$\beta_3$	-9.20E-06*	-5.82E-06*	-2.61E-06	-2.16E-06*
$\beta_4$	-3.52E-06	-3.07E-06	-1.71E-06	-1.98E-06
$\alpha_1$	0.22558**	0.21497**	0.20065**	0.18621**
$\alpha_2$	0.63572**	0.66897**	0.53228**	0.53762**
$\alpha_3$	0.00001	0.00001	0.00004**	0.00003**
$\alpha_4$	0.00002**	0.00001**	0.00002**	0.00001**
Log-L	18034.810	18705.770	18044.670	18708.010
SR LB(24)	113.360**	233.130**	116.000**	251.560**
SSR LB(24)	7.205	8.850	8.309	28.149

Note: \* and \*\* indicate significance at 5% and 1% levels, respectively. SR LB(24) and SSR LB<sup>2</sup>(24) are Ljung-Box statistics for up to 24 lags for standard residuals and squared standard residuals, respectively.

margins. The liquidity effect illustrates that the higher level of margin requirements makes margin trading more costly for all participants in the stock market and makes some investors exit the stock market. Therefore, the higher level of margin requirements may lead to less trading activity due to fewer active market participants. This resulting lack of liquidity in the stock market cause higher volatility. This implies that the changes in margin requirement are positively related to the changes in short-run volatility.

In order to consider the asymmetric effect of conditional volatility, similar

Table 5. Asymmetric CGARCH Estimation Results with Margin Requirements

	Margin dummy		Level of margin requirements	
	NIKKEI225	TOPIX	NIKKEI225	TOPIX
$\mu$	-0.00037**	-0.00039**	-0.00191**	-0.00071**
$a_0$	0.13744**	0.15967**	0.15374**	0.10741**
$a_1$	0.00015	-0.00041	0.00302**	0.00117*v
$a_2$	0.00077**	0.00058**	0.00057**	0.00068**
$w$	0.00023**	0.00020**	0.00014**	0.00009
$\beta_1$	0.99259**	0.99008**	0.98665**	0.98736**
$\beta_2$	0.02354**	0.04398**	0.04871**	0.05586**
$\beta_3$	-0.000007**	-0.000008**	-0.000001**	-0.000001
$\beta_4$	-0.000006**	-0.000007**	-0.000004**	-0.000002
$\alpha_1$	0.02780	0.05531**	0.04411	0.09187**
$\gamma$	0.23912**	0.20866**	0.27840**	0.21617**
$\alpha_2$	0.71230**	0.69701**	0.52996**	0.47308**
$\alpha_3$	0.00001	0.00001	0.00002**	0.00002**
$\alpha_4$	0.00002**	0.00002**	0.00002**	0.00001**
Log-L	18068.580	18724.550	18075.420	18725.630
SR LB(24)	136.570**	281.640**	139.970**	257.720**
SSR LB(24)	8.730	11.858	7.726	10.301

Note: \* and \*\* indicate significance at 5% and 1% levels, respectively. SR LB(24) and SSR LB<sup>2</sup>(24) are Ljung-Box statistics for up to 24 lags for standard residuals and squared standard residuals, respectively.

to Hardouvelis and Theodossiu (2002) and Sohn and Kim (2009), we estimate the asymmetric CGARCH model, shown in equations (6), (8) and (9). The estimated results are reported in Table 5. When we incorporate the asymmetric factor of conditional short-run volatility, we find that the coefficient,  $\gamma$ , is significantly positive in both indices, suggesting that there exists a leverage effect in the Japanese stock market.

Besides, the overall result is same as those of Table 4, by showing that the coefficients,  $\beta_3$ , are significantly negative in both indices except for NIKKEI225 with the level of margin requirement and that the coefficients,  $\alpha_4$ , are insignificant

in the changes in margin requirement while significantly positive in the level of margin requirement. This result confirms our finding in Table 4 that increasing margin requirement is effective for reducing long-run volatility, while not effective in short-run volatility. Overall, our results are not supportive to the pyramiding-depyramiding process.

## V. Further analysis

Until now, we examined the effect of the changes in margin requirements on the long-run and short-run volatilities. Hardouvelis and Theodossiu (2002) mentioned that “the Federal Reserve raised margins when it saw signs of “excessive” speculative activity, such as rising stock prices and rising margin credit that appeared unusual. The Fed decreased margins when it thought that the factors which had led it earlier to increase margins ceased to exist.” Therefore, it would be expected that increasing and decreasing margin requirements influence long-run (short-run) volatility differently. For example, Kumar et al. (1991) argue that the changes in margin requirement could be positively related to the changes in short-run volatility due the liquidity effect. More specifically, if that higher margin increases short-run volatility by lack of liquidity in the stock market, lowering margin requirement generate more liquidity in the market and thus lowering short-run volatility. To this end, we extend our asymmetric CGARCH model by incorporate the positive and the negative margin dummies as follows:

$$R_{m,t} = \mu + a_0 \sqrt{h_t} + a_1 Mdum_{t-1}^+ + a_2 Mdum_{t-1}^- + a_3 hol_{t-1} + \varepsilon_t \quad (10)$$

$$h_t = l_t + \alpha_1 (\varepsilon_{t-1}^2 - l_{t-1}) + \gamma (\varepsilon_{t-1}^2 - l_{t-1}) d_{t-1} + \alpha_2 (h_{t-1} - l_{t-1}) + \alpha_3 Mdum_{t-1}^+ + \alpha_4 Mdum_{t-1}^- + \alpha_5 hol_{t-1} \quad (11)$$

$$l_t = w + \beta_1 (l_{t-1} - w) + \beta_2 (\varepsilon_{t-1}^2 - h_{t-1}) + \beta_3 Mdum_{t-1}^+ + \beta_4 Mdum_{t-1}^- + \beta_5 hol_{t-1} \quad (12)$$

where  $Mdum_{t-1}^+$  ( $Mdum_{t-1}^-$ ) is a positive (negative) margin dummy, which takes

the value of 1 when the margin requirement is increased (decreased) at day  $t-1$ , otherwise zero<sup>9</sup>.

The estimated results are reported in Table 6. The effects of the positive and negative changes in margin requirements on stock returns are captured by the coefficients,  $a_1$  and  $a_2$ , respectively. The estimation results show that  $a_1$  and  $a_2$  are not statistically significant when adopting the changes in margin requirement, while significant when incorporating the level of margin requirement with different sign in two indices.

The purpose of including the asymmetric term in the conditional volatility equation is to consider the possible effect of the asymmetric effect in volatility. The results show that the coefficient,  $\gamma$ , is significant in both indices, suggesting that there exists an asymmetric effect in the Japanese stock market.

The effects of the positive and negative changes in margin requirement on the conditional long-run volatility are captured by the coefficients,  $\beta_3$  and  $\beta_4$ . The result shows that when adopting the changes in margin requirement,  $\beta_4$  is negatively significant in both indices, while  $\beta_3$  is not significant. However, incorporating the level of margin requirement shows that  $\beta_4$  is negatively significant in both indices, while  $\beta_3$  is not significant in TOPIX. Overall, our result suggests that decreasing margin requirements influence long-run volatility negatively, while increasing margin requirements do not. Hardouvelis (1990) explain this negative relationship between margin requirement and volatility by arguing that higher margins restrict the activities of irrational (noise) investors. However, our result shows that the higher margins do not influence long-run volatility. This result shows again that the negative relationship between long-run volatility and margin requirement can be explained by pyramiding-depyramiding process.

In addition, the coefficients,  $\alpha_3$  and  $\alpha_4$ , measure the effects of the positive and negative changes in margin requirements on short-run volatility, respectively. Table 6 shows that only the coefficient,  $\alpha_3$ , is positively significant when using the changes in margin requirement, while both coefficients are positively significant by adopting the level of margin requirement. This result can be explained by the speculative effect and the liquidity effect of Kumar et al. (1991). More precisely, in case of increasing margin requirement, fewer participants in the stock market generate lower liquidity, and thus short-run volatility

<sup>9</sup> We also examine the effect of the level of margin requirement as in Table 4 and 5. In case of the level of margin requirements,  $Mdum_{t-1}^+$  ( $Mdum_{t-1}^-$ ) is the level of margin requirement when margin requirement is increased (decreased) at day  $t-1$  and remains until next changes in margin requirement.

Table 6. Asymmetric CGARCH Estimation Results with Positive and Negative Margin Requirements.

	Margin dummy		Level of margin requirements	
	NIKKEI225	TOPIX	NIKKEI225	TOPIX
$\mu$	-0.00008	0.00003	-0.00147**	0.00051**
$a_0$	0.10022**	0.08671**	0.13176**	0.06196**
$a_1$	-0.00047	-0.00084	0.00228**	-0.00039
$a_2$	0.00075	-0.00012	0.00220**	-0.00111**
$a_3$	0.00074**	0.00058**	0.00084**	0.00063**
$w$	0.00032**	0.00023**	0.00009**	0.00011
$\beta_1$	0.99261**	0.99454**	0.98437**	0.98913**
$\beta_2$	0.02432**	0.02748**	0.04692**	0.05920**
$\beta_3$	-5.300E-06	-2.620E-06	-1.460E-06**	-7.510E-07
$\beta_4$	-1.150E-05**	-1.110E-05**	-1.680E-06*	-1.270E-06*
$\beta_5$	-8.970E-06**	-4.300E-06**	-2.510E-06	-1.640E-06
$\alpha_1$	0.03215	0.07291**	0.06671**	0.05707*
$\gamma$	0.24427**	0.18107**	0.23520**	0.21967**
$\alpha_2$	0.70708**	0.71487**	0.57040**	0.64917**
$\alpha_3$	0.00002*	0.00002*	0.00002**	0.00001**
$\alpha_4$	3.340E-06	5.180E-06	2.270E-05**	8.960E-06**
$\alpha_5$	0.00003**	0.00002**	0.00002**	0.00001**
Log-L	18072.500	18735.700	18080.200	18732.310
SR LB(24)	130.980**	267.280**	138.870**	264.410**
SSR LB(24)	8.611	15.606	9.855	18.105

Note: \* and \*\* indicate significance at 5% and 1% levels, respectively. SR LB(24) and SSR LB<sup>2</sup>(24) are Ljung-Box statistics for up to 24 lags for standard residuals and squared standard residuals, respectively.

increases. This implies that when margin requirements are increased, the liquidity effect is more dominant than the speculative effect. However, lowering margin requirement allows the speculator (irrational investors) to purchase additional stock. If the increase in stock prices is fueled by strictly by speculation, stock price deviates significantly from its equilibrium. Therefore, lower margins generate higher short-run volatility, suggesting that the speculative effect prevails.<sup>10</sup>

<sup>10</sup> We do not examine whether or not raising margin requirement reduces the participation of irrational



Overall, our results show that the negative changes in margin requirement decrease long-run volatilities, while the higher margin requirements increase short-run volatilities in the Japanese stock market. This implies that, similar to Sohn and Kim (2009), if Japanese financial authority intends to increase margin level to reduce volatility, unexpectedly, short-run volatility would be even higher.

Recent studies (Hardouvelis and Theodossiu, 2002; Sohn and Kim, 2009) examine the asymmetric effect of margin requirements in the bull and bear markets. It is also of interest to examine how margin requirements influence long-run and short-run volatilities in the bull and bear markets.<sup>11</sup> To do so, we extend the asymmetric CGARCH model as:

$$R_{m,t} = \mu + a_0 \sqrt{h_t} + a_1 Bull_t M dum_{t-1} + a_2 Bear_t M dum_{t-1} + a_3 hol_{t-1} + \varepsilon_t \quad (13)$$

$$l_t = w + \beta_1 (l_{t-1} - w) + \beta_2 (\varepsilon_{t-1}^2 - h_{t-1}) + \beta_3 Bull_t M dum_{t-1} + \beta_4 Bear_t M dum_{t-1} + \beta_5 hol_{t-1} \quad (14)$$

$$h_t = l_t + \alpha_1 (\varepsilon_{t-1}^2 - l_{t-1}) + \gamma (\varepsilon_{t-1}^2 - l_{t-1}) d_{t-1} + \alpha_2 (h_{t-1} - l_{t-1}) + \alpha_3 Bull_t M dum_{t-1} + \alpha_4 Bear_t M dum_{t-1} + \alpha_5 hol_{t-1} \quad (15)$$

where  $Bull_t$  ( $Bear_t$ ) takes the value of unity during bull (bear) periods<sup>12</sup> and the value zero otherwise.<sup>13</sup>

Table 7 illustrates the estimated results of equations (13) - (15). The effects of the changes in margin requirement in the bull and bear markets on the

investors or rational investors as in the previous studies because it is beyond our scope. We leave this in the future study.

<sup>11</sup> We also thank an anonymous referee for pointing this out.

<sup>12</sup> We define a bull or a bear market as follows: a period during which there are at least 3 consecutive monthly stock returns with same algebraic sign, after constructing monthly stock returns using stock indices at the end of each month.

<sup>13</sup> We calculate the correlation coefficients between NIKKEI225 and the level of margin requirement and between TOPIX and the level of margin requirement. The estimated correlations are 0.460 and 0.479, respectively.

Table 7. CGARCH Estimation Results with the Bull and Bear Market Dummies.

	Margin dummy		Level of margin requirements	
	NIKKEI225	TOPIX	NIKKEI225	TOPIX
$\mu$	-0.00022	-0.00026*	-0.00086**	-0.00067**
$a_0$	0.11558**	0.13501**	0.18122**	0.16798**
$a_1$	0.00126	0.00076	0.00181**	0.00176**
$a_2$	-0.00511	-0.00615	-0.00297**	-0.00316**
$a_3$	0.00077**	0.00053**	0.00075**	0.00048**
$w$	0.00035*	0.00019**	0.00019**	0.00026**
$\beta_1$	0.99412**	0.99021**	0.99044**	0.99408**
$\beta_2$	0.03887**	0.04295**	0.03681**	0.06244**
$\beta_3$	-8.40E-06*	-8.44E-06*	3.23E-08	-3.72E-08
$\beta_4$	-3.00E-06	-4.89E-06	-4.33E-07	-1.89E-07
$\beta_5$	-0.00001**	-0.00001**	-0.00001**	-0.00001**
$\alpha_1$	0.03051	0.04930*	0.04083*	0.04152*
$\gamma$	0.25010**	0.21413**	0.23213**	0.22157**
$\alpha_2$	0.72122**	0.69963**	0.69981**	0.70872**
$\alpha_3$	1.83E-05	1.38E-05	-5.14E-07	8.20E-07
$\alpha_4$	0.00002	0.00001	0.00002**	0.00001**
$\alpha_5$	0.00002**	0.00002**	0.00002**	0.00002**
Log-L	18067.860	18722.760	18104.360	18761.870
SR LB(24)	117.230**	250.650**	115.710**	235.950**
SSR LB(24)	10.145	19.983	10.738	18.342

Note: \* and \*\* indicate significance at 5% and 1% levels, respectively. SR LB(24) and SSR LB<sup>2</sup>(24) are Ljung-Box statistics for up to 24 lags for standard residuals and squared standard residuals, respectively.

conditional long-run volatility are captured by the coefficients,  $\beta_3$  and  $\beta_4$ . The result shows that when adopting the changes in margin requirement,  $\beta_3$  is negatively significant in both indices, while  $\beta_4$  is not significant. However, incorporating the level of margin requirement shows that  $\beta_3$  and  $\beta_4$  are not significant.<sup>14</sup> Overall, our result suggests that the effect of margin requirement

<sup>14</sup> Note that in the margin dummy, we do not consider the degree of margin changes. Therefore, the difference between the changes in margin requirement and the level of margin requirement could be affected by the scale effect of margin requirement.

in the bull and bear markets is very weak.

Furthermore, the coefficients,  $\alpha_3$  and  $\alpha_4$ , measures the effects of the changes in margin requirement in the bull and bear markets on conditional short-run volatility, respectively. Table 7 shows that only the coefficient,  $\alpha_4$ , is positively significant when using the level of margin requirement.

Overall, our finding is similar to those of Sohn and Kim (2009) who find that during bear periods, margin requirement policy is not effective for reducing volatility in the Japanese stock market.

## VI. Concluding remarks

The purpose of this paper is to examine the effect of initial margin requirements on long-run and short-run volatilities in the Japanese stock market using the Component GARCH model, whose advantage is to decompose market volatility into the short-run component and the long-run component. We choose the Japanese stock market for examining the effect of initial margin requirements for two reasons: frequent revision of margin requirements and high proportion of margin transactions in total transactions in Japan.

This study is important for investors and policy makers to have more insights for the effect of initial margin requirements. According to the pyramiding-depyramiding process, which takes for granted the presence of rational and irrational investors in the stock market, the effect of initial margin requirements depends on which investors' participations are more restricted by the changes in margin requirements. To this end, we adopt the various Component GARCH models.

When we use the margin dummy and the level of margin requirement without dividing them into the positive and negative changes or into the bull and bear markets, we find that increasing margin requirement is effective for reducing long-run volatility, while not effective in short-run volatility, which is inconsistent with the result of Hardouvelis and Peristiani (1992) who find that margins effectively moderate volatility in the short-run using the daily returns.

By dividing the changes in margin requirement into the positive and negative changes, we find that the negative changes in margin requirements decrease long-run volatilities, while the higher margin requirements increases short-run volatilities in the Japanese stock market, similar to Sohn and Kim (2009). This suggests that if the Japanese financial authority increases margin to reduce volatility, it could face higher short-run volatility.

In addition, we divide the sample period into the bull and bear periods to examine the possible asymmetric effect of margin requirement in long-run and short-run volatilities, similar to Hardouvelis and Theodossiu (2002) and Sohn and Kim (2009). The overall result shows that during bear periods, margin requirement policy is not effective for reducing volatility in the Japanese stock market, similar to those of Sohn and Kim (2009).

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