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Full Length Research Paper

An asymmetric process between initial margin requirements and volatility: New evidence from Japanese stock market

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This paper investigates on whether there is the asymmetric relation between initial margin requirements and volatility across bull and bear markets as well as normal for the Japanese TOPIX and NIKKEI 225 indices over period of 1970 to 1990. We use regression in levels to scrutinize relation between margin requirements and volatility. We find that there is negative relation. This result is confirmed significantly by bootstrap simulation. The findings show that margin requirement affects and causes stock return volatility. Thus higher margin requirements are associated with lower subsequent stock market volatility across normal but bear markets marginally, but show no relationship during bull markets from regression and exponential general autoregressive conditional heteroskedasticity (EGARCH-M) model with GED. As a result, we conclude that there is an asymmetric process that is, depyramiding effect regarding bear markets from Japanese stock market. However, for bull periods, we find that there is no evidence of asymmetric process. In conclusion, we confirm that the policy tool of margin requirements does more effectively work when stock market is in deep recession, but not work in bubble state.

Key words: Initial margin requirements, pyramiding or depyramiding effect, volatility, bootstrap simulation, granger causation, exponential general autoregressive conditional heteroskedasticity (EGARCH-M).

INTRODUCTION

After the 1987 U.S stock market crash and also recent 2008 U.S. credit crunch in financial field, many government regulators of the stock markets in the world have imposed some restrictions about buying on margin and short selling because they believe that these investment strategies make stock market volatility increase rapidly. Before this argument, actually many have been thought that volatility in stock market might be controlled by these policies, which means that margin and short selling is easy to use to stimulate stock price depression when stock market is in recession; and in turn these policies are tighten to reduce the bubble of stock price when it is in boom.

This paper examines whether margin requirement could be worked well as the policy tool of stock market stabilization in different market conditions such as boom, normal, and recession. To verify these arguments suggested in prior studies, Japanese stock market allows us to use sample because this market had been very often changed margin requirement policy.

In many previous literatures, how margin requirements affect stock prices, stock return and return volatility has been continuously an interesting question among academic research and practice. Margin requirements are official restrictions on the amount of borrowing available to investors from brokers and dealers for the purpose of buying stocks. An initial margin requirement

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policy has been used to protect financial market system when stock market is so volatile.

Thus, it is constraint for individual or institutional investor to buy additional stock at credit, which means high leverage. An initial margin change also affects to investors when stock price is crashed or irrational turbulence. Furthermore, if the margin requirements are limited, increasing the margin requirements leads to a decrease in stock volatility when the investor is relatively optimistic and in turn, leads to an increase in stock volatility when investor is relatively pessimistic. Thus, margin requirements may stabilize or destabilize the distribution of stock return and volatility.

As a result, the role of initial margin requirements is in fact, designed to prevent excess volatility and fragility on market system. However, the results of these studies are mixed. For instance, some studies insisted that there is evidence of negative relationship between margin requirements and stock volatility (Kupiec, 1989; Hardouvelis, 1990; Hardouvelis and Peristiani, 1990, 1992; Hardouvelis and Theodossiou, 2002). On the other hand, other studies claimed that there is no such evidence (Ferris and Chance, 1988; Kumar et al., 1991; Salinger, 1989; Schwert, 1988; Hsieh and Miller, 1990; Kim and Oppenheimer, 2002).

Due to controversial results in many previous literatures, we re-examine the relationship initial margin requirements and return volatility using different methodology on whether there is the asymmetric relationship in different market states that is, bull, bear, and normal, using Japanese stock market.

This asymmetry is also acknowledged through U.S. economy policy in history. When U.S. Congress instituted firstly an initial margin requirements' regulation, it had in mind that pyramiding-depyramiding process was an asymmetric process: prudential margin regulation was thought to be an effective tool of avoiding the excesses of a bull market, thus, minimizing the probability of disruptions and also higher margin requirements were not thought to be effective tool of smoothing the effects of disruptions (Garbade, 1982; Hardouvelis and Theodossiou, 2002).

We see this different role of initial margin requirement regulation across bear and bull markets in the historical decisions of the U.S Federal Reserve for changing the level of initial margin requirements. For Japanese stock market, since 1951, initial margin requirements were introduced and have been changed 68 times (including cash) until 1990. We use the sample data from 1970 to 1990 because initial margin requirements have not been changed since 1991. Therefore, because of many changes in initial margin requirements, we have a good opportunity to investigate this asymmetric relationship in Japanese stock market.

The remainder of this paper is organized as follows: theoretical issues and related literature in terms of initial margin requirements and volatility; explanation of institutional characteristics; presentation of data and some statistic issues; implementation of regression analysis in levels; misspecification in regression in-difference; investigation of asymmetric relation across bull and bear markets; EGARCH model is designed to find the linkage between margin requirements and conditional volatility; discussion of the results from EGARCH model; conclusion.

THEORETICAL ISSUES AND RELATED LITERATURE

It has been known that the initial margin requirements generally are strong and forced policy tool to control sharp stock price changes and market volatility. From U.S. Securities Exchange Act of 1934, margin requirements would discourage the redirection of credit from business uses to speculative activity, they would protect investors and brokers from the risks posed by excessive leverage, and they would contribute to the stability of stock prices by intervening in the pyramiding-depyramiding process (Fortune, 2001).

Initial margin requirements determine the maximum legal collateral value of a marginable security. Thus, it restricts the amount of credit that brokers and dealers can extend to their customers for the purpose of buying stocks. In addition, the considerations on the effect of initial margin requirements are the question of which type of trader is more affected. If increasing margin requirements discourages only noise traders, not informed traders, the market volatility will be reduced effectively. But unfortunately if reversing, it will stimulate volatility.

In theory, Kupiec (1989) analyzed in hypothesizing a negative relationship that it restricts the trading of destabilizing speculators, whose trading activity creates excess volatility. This hypothesis is based on noise trader concept in Delong et al. (1987). The average return variance on risky assets increases due to noise traders and also the influence of the noise traders causes risky assets to exhibit excess volatility over that which is justified by economic factors.

As lowering initial margins, noise trader's abilities to leverage their positions are higher and create irrational excess volatility. This kind of trading behavior is called pyramiding and depyramiding process. In turn, as increasing initial margin requirements, the leverage on the noise traders' positions decrease and also the excess volatility will be smaller.

However, on the other hand, Goldberg (1985) hypothesizes a positive relationship between the initial margin requirements and stock return volatility by using the debt and tax model of Miller (1977). Therefore, these theories have focused as follows. Some papers evaluate the efficacy of initial margin requirements in protecting investors without solving the question of market stability and others have stressed on the stabilization goal without addressing the issue of investor protection.

In empirical findings, the results on matter of margin requirements are very mixed and controversial evidences as follows. Largay and West (1973) found that the S and P 500 index rose before margin increases and fell before margin decreases and no significant abnormal return on the S and P 500 index either on the day a margin change was announced or during the 30 days after a margin change. This result is consistent with the view that the FRB system changed regulation of initial margin requirements in response to recent stock price movements.

Grube et al. (1979) also found an asymmetry effect in terms of stock return and trading volume using an event study method and furthermore although, increasing an initial margin requirements significantly reduces trading volume, decreasing an initial margin requirements does not affect trading volume. However, Ferris and Chance (1988) and Hartzmark (1986) found no relationship between margin changes and price volatility.

This debate was initiated by Hardouvelis (1988) and it has continued. Hardouvelis (1988, 1990) argues that with regard to Fed's reaction function, the Fed looks to sign both of high credit use to buy stocks and of potential stock price bubbles when setting margin requirements. This behavior also is found in Japanese stock market. He concludes that speculative bubbles which mean excess volatility are a source of volatility and furthermore the level of excess volatility is affected by margin requirements. That is, an increase (decrease) in margin requirements reduces (increases) excess volatility.

Hardouvelis and Peristiani (1992) investigated Japanese initial requirements using event study and conclude that margin increases (decreases) are negatevely associated with stock return decreases (increases) statistically and economically.

In contrast to these evidences, Kupiec (1989, 1998), Salinger (1989), and Kofman and Moser (2001) reject Hardouvelis' evidences and insist that there is no clear relationship between initial margin requirements and stock return volatility.

In addition, Seguin and Jarrell (1993) documented that using NASDAQ securities data, there is no evidence that margin activity stimulated additional price down. That is, margin-eligible securities actually fell by 1% less than the ineligible securities over bear market, that is, the crash of 1987.

Fortune (2001) investigates margin lending and stock market volatility using the jump diffusion model and argues that a higher level of margin debt tends to raise returns in a bull market and induce greater declines in a bear market. Thus margin loans seem to aggravate the magnitude of stock price changes in either direction.

In Fortune (2001) paper, the economic significance is so low that it is not able to support a return to the active margin policy of the 1934 to 1974 periods even if margin loan affects statistically stock returns and their volatility.

Kim and Oppenheimer (2002) examines relationship between initial margin requirements and return volatility for the individual investor using Japanese stock market data, and concludes that there is no relationship between initial margin requirements and volatility. Now still other studies suggest that volatility is either unaffected by margin requirements or that it is positively or negatively or no correlated with margin requirements.

Institutional characteristics

Since June 1, 1951, margin system was firstly introduced in Japanese stock market. Japanese margin regulation is similar to regulation of U.S. stock exchange but regulation authority is different, that is, U.S. stock exchange controlled by FRB and Tokyo stock exchange controlled by the Ministry of Finance. Since 1951 imposed firstly, it has changed margin requirements over 100 times. We think that our study using sample data of Japanese Tokyo stock exchange (TSE) may provide considerable statistical power than studying U.S. stock exchange because of more frequent of margin requirements.

The Japanese margin system incorporates both an initial margin requirement and a maintenance margin into its stock market; and cash or stocks can be used to satisfy the initial margin requirement. Margin in TSE is defined by collateral deposited to a securities firm, when borrowing money or stocks needed for margin transactions. TSE imposes function of margin transaction to provide more depth and secure more liquidity, and to contribute to the fair and orderly price formation.

Also purpose on margin imposed by TSE is to make profits from a short-term capital gain, expecting a rise or fall of stock prices in a short period time and to avoid the risks associated with a fall in stock prices, selling hedge.

Table 1 shows a summary of all margin requirement changes since 1970. Initial margin requirements vary between 30 and 70%. Since September 6, 1990, margin requirements have not changed until now. Specifically, the first official level of margin requirement was set in October 1951 at 45% (M_t=0.45); the current official level is 30%, a level which has been in effect since September 9, 1990. The highest level of the initial margin requirement was 70%, which occurred on January 9, 1973, May 17, 1979, February 17, 1987, and Jun 3, 1988. The lowest level has been 30%, which is also the current level. In addition, for the relationship between margin requirements and volatility based on daily return, the plot is shown in Figures 1 and 2.

DATA AND STATISTICAL ISSUES

In this paper, the daily sample time period over which the model is estimated is from 1970 to 1990 although, official margin requirements were introduced in June 1, 1951. As mentioned in earlier part, we do not use data after 1991 and we cannot identify this relationship after this year because initial margin requirements had not been changed after 1991.

Table 1. Summary of initial margin requirements changes in Japan since 1970.

Effective date	Initial margin (%)	Effective date	Initial margin (%)	Effective date	Initial margin (%)
01/01/ 1970	30	07/29//1977	30	09/09/1981	50
03/06/1970	40	03/08/1978	40	09/24/1981	40
05/01/1970	30	03/29/1978	50	09/29/1981	30
04/13//1971	40	04/03/1978	60	11/26/1981	40
04/19/1971	50	05/31/1978	60	02/18/1982	30
08/19/1971	40	08/10/1978	50	12/03/1982	40
08/20/1971	30	10/20/1978	60	07/08/1983	50
12/17/1971	40	03/18/1979	50	03/24/1984	60
01/08/1972	50	05/02/1979	60	05/19/1984	50
01/29/1972	60	05/17/1979	70	01/17/1985	60
12/01/1972	60	06/15/1979	60	11/06/1985	50
01/09/1973	70	07/23/1979	50	03/13/1986	60
12/05/1973	60	01/16/1980	60	02/27/1987	70
10/11/1973	50	04/02/1980	50	10/21/1987	50
11/24/1973	40	04/26/1980	60	03/17/1988	60
10/03/1974	30	06/11/1980	50	06/03/1988	70
01/13/1976	40	12/17/1980	40	06/03/1989	60
02/02/1976	50	03/14/1981	30	02/21/1990	50
07/30/1976	40	03/26/1981	40	02/27/1990	40
12/22/1976	50	04/02/1981	50	09/06/1990	30
01/27/1977	60	04/15/1981	60		
03/25/1977	50	06/09/1981	50		
06/04/1977	40	07/03/1981	60		Total 63 times

Source: Tokyo stock exchange.

In this paper, we use the daily returns for TOPIX and NIKKE 225 indices to measure volatility at weekly frequency. The daily data are collected from DATASTREAM. After all, the weekly sample based on geometric daily average is used.

Market returns are constructed from TOPIX and NIKKEI 225 indices, using the formula R_t=ln($TOPIX_t$/$TOPIX_{t-1}$)*100 and R_t=ln($NIKKEI225_t$/$NIKKEI225_{t-1}$)*100. Calculated returns are expressed in a continuously compounded percentage form and include dividend. Table 2 summarizes the descriptive statistics for TOPIX and NIKKEI 225 time series.

As shown in Table 1, Japanese authority has changed official initial margin requirements 63 times over the sample period in this paper. Because margin requirement policy is discrete variable, it is bounded to take values from 0.3 (30%) to 1 (100%). The level of margin requirements which is a discrete policy cannot be regarded as a random walk process, and thus it may have a unit root because of being finite variance.

Furthermore, if the margin series are differenced in testing model, they results in a new series with all zeros, except for 63 cases when the value is non-zero. This problem is discussed in Hardouvelis and Theodossiou (2002). Hardouvelis and Theodossiou (2002) insist that using such a variable as an explanatory variable of the conditional volatility series is equivalent to testing for temporary blips in volatility at each instance margins were changed and would make it difficult to uncover the long-run relationship between level of margin requirements and volatility.

According to weak of sample time series in this paper as mentioned earlier, before implementing regression analysis in levels, we conduct a unit root test for margin series because infrequent margin changes could lead to produce an autocorrelation function similar to one originating from a stochastic series with a unit root.

To check margin original time series stationary, we employ a simple Phillips and Perron (1988) and Augmented Dickey and Fuller (1979) test method. Let M_t the level of margin requirements at the end of week t and Δ the first-difference operator. As employed by Hardouvelis and Theodossiou (2002), we estimate the k^{th}-order autoregressive model as follows:

$$\Delta M_t = a_0 + b_1 M_{t-1} + \sum_{p=1}^{k} a_p \Delta M_{t-p} + e_{m,t} \tag{1}$$

We chose lag k=2, 4, 6, 12 to eliminate any serial correlation in the residuals and test the null hypothesis that b_1=0 for each lag k. We expect that less change of margin requirements make the coefficient b_1 close to zero.

However, in empirical test of unit root, the estimated coefficient value of b_1 is -0.013 with t-value of-3.36 for k=2; -0.0132 with t-value of -3.45 for k=4; -0.0137 and t- value of -3.47 for k=6; and -0.0157 and t-value of -2.45 for k=12. All coefficients are significant statistically at the 1%. As unexpectedly, we confirm that there is no unit root in margin series. Thus, we conclude that the unit root hypothesis is statistical rejected significantly and so the margin series are stationary to test additional analysis. We also look at the volatility series in TOPIX and NIKKEI 225 indices and run Phillips and Perron and Augmented Dicky-Fuller test at weekly frequency by using the standard deviation of daily returns during week t.

Let $\sigma_{d,t}$ the standard deviation of returns at end of week t based on the standard deviation of daily returns. Δ is the first-difference

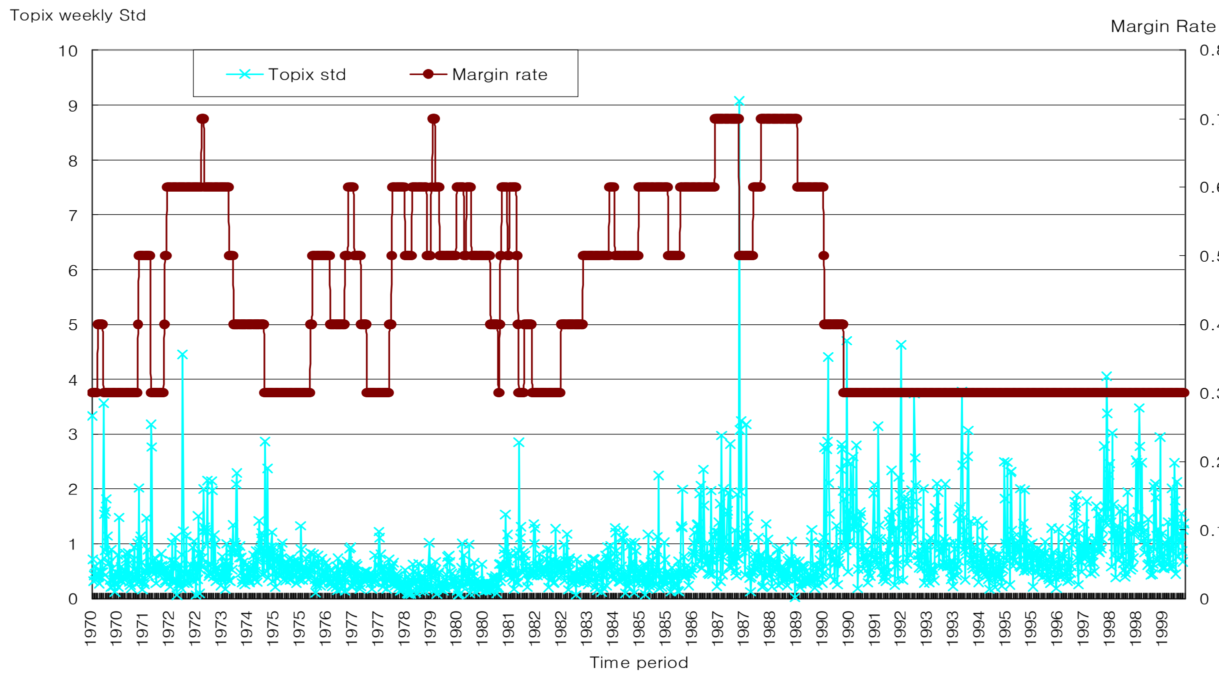

Figure 1. TOPIX volatility and margin rate.

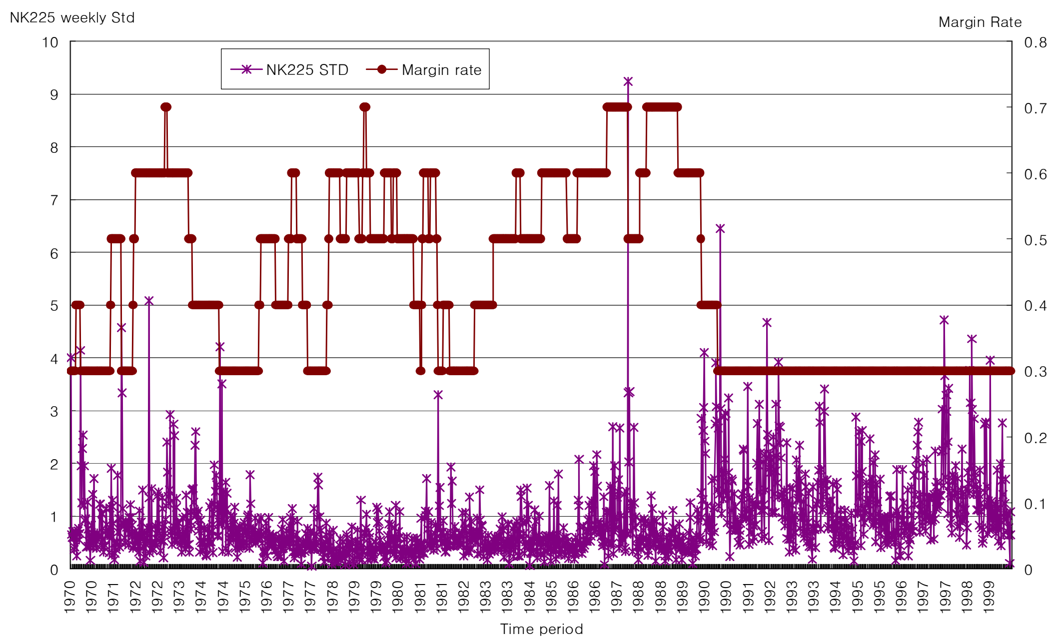

Figure 2. NIKEEI 225 volatility and margin rate.

operator as well. The autoregressive model is as follows:

$$\Delta\sigma_{d,t} = a_0 + b_1\sigma_{d,t-1} + \sum_{p=1}^{k} a_p \Delta\sigma_{d,t-p} + e_{d,t} \tag{2}$$

For TOPIX, we chose k=2, 4, 6, 12 and test the null hypothesis that b_1=0. The estimated coefficient value, b_1 is -0.2998(t-value= -7.81) for k=2; -0.1538(t-value=-6.19) for k=4; -0.2181(t-value=-6.45) for k=6; -0.1784(t-value=-6.22) for k=12.

For NIKKEI225, we also chose k=2, 4, 6, 12 and test the null hypothesis that $b_1 = 0$. The estimated coefficient value, b_1 is –

Table 2. The summary of descriptive statistics based on weekly time series by daily average.

Variable	Mean	Median	Std	Min	Max	Skewness	Kurtosis
TOPIX return (%)	0.0330	0.0475	0.4755	-3.3162	2.1677	-0.6835	5.3329
NIKKEI 225 return (%)	0.0301	0.0511	0.5148	-3.5524	2.2094	-0.6392	5.2154
Margin requirements Rate (%)	43.05	40	13.81	30	70	NA	NA

0.2536(t-value= -10.08) for k=2; -0.1278(t-value=-8.07) for k=4; -0.1987(t-value=-7.31) for k=6; -0.1103(t-value=-5.97) for k=12.

As the same over, the unit root hypothesis is rejected definably in TOPIX and NIKKEI 225 series. Because a unit root in both the margin series and volatility series does not appear, we suggest that the model specification in level which relates the two variables is proper and this specification give us robust results statistically.

Nevertheless, as mentioned in Hardouvelis and Theodossiou (2002), and Granger and Newbold (1974), because there is the near-unit-root behavior of the margin series together with the high serial correlation in the volatility series, spurious regression results could be produced between the levels of the two series, that is, biased coefficient estimates. Because of possibility of these phenomena, many previous researchers examine the relation between margin requirement series and volatility series in first-difference form. Later, we handle and test this issue in more details, and also compare with the results of each model.

THE RESULT OF REGRESSION ANALYSIS IN LEVELS

In this area, we analyze a linear regression in level form to find the relationship between margin requirements and volatility. The volatility used in this paper is proxy by the standard deviation of daily returns during each week. Overlapping data, which means that authority changes over twice at same week, is averaged in margin requirements.

The data overlapping issue generates serious problem which is artificial serial correlation and the information effect on the margin requirements would be disappeared or overstated. As Hardouvelis and Theodossiou (2002), the general form of regression model is as follows:

$$\sigma_{d,t} = \beta_0 + \beta_1\sigma_{d,t-1} + \beta_2\sigma_{d,t-2} + \beta_3 |R_{d,t-1}| + \beta_4 R_{d,t-1} + \beta_5 M_{t-1} + \beta_6 (R_{d,t-1}\cdot M_{t-1}) + e_{d,t} \quad (3)$$

$$M_{d,t} = \beta_0 + \beta_1\sigma_{d,t-1} + \beta_2\sigma_{d,t-2} + \beta_3 |R_{d,t-1}| + \beta_4 R_{d,t-1} + \beta_5 M_{t-1} + \beta_6 (R_{d,t-1}\cdot M_{t-1}) + \varepsilon_{d,t} \quad (4)$$

where $\sigma_{d,t}$ is weekly standard deviation based on daily return; M_t is margin requirement level; $\sigma_{d,t-1}$ and $\sigma_{d,t-2}$ are weekly standard deviation based on daily return at (t-1) and (t-2), respectively; $|R_{d,t-1}|$ is the volatility shock at (t-1) measured by the absolute value of the average daily return within the week, and $R_{d,t-1}$ is the weekly return at (t-1) by averaging daily returns to control for leverage effect on volatility, M_{t-1} is the level of margin requirements at (t-1), and $R_{d,t-1}\cdot M_{t-1}$ is the cross product or interaction term at (t-1) to capture a possible asymmetric relation between margin requirements and volatility.

First of all, in order to decide which one influences to other one, that is, causation relation between margin level and volatility, we do Granger causality test using two equations specified in Equations 3 and 4. In the test result, the null hypothesis which states that margin rate does not Granger cause volatility is rejected and statistically significant at 1% with F-value of 6.6568 and 15.0725 for TOPIX and NIKKEI 225 respectively. Finally, we make sure that margin requirement level affects stock return volatility in both indices.

In Equation 3, volatility as dependent variable is analyzed and estimated based on OLS with Newey-West HAC. Especially the main goal in this regression is to make sure whether or not there is a bias in the estimated coefficients of these variables because estimated results of OLS could be originating from Granger-Newbold spurious regression.

As mentioned earlier, additionally, we run bootstrap simulation to confirm whether findings of OLS are robust or not. Average coefficients estimated in bootstrap simulation are produced using 2,000 bootstrap samples each generated randomly from the empirical distribution of the OLS residuals of the model as implemented in Hardouvelis and Theodossiou (2002). We try to confirm whether the results of OLS are robust by using bootstrap simulation method.

The empirical results are summarized in Table 3. Model 1 of Table 3 shows the multivariate OLS of weekly volatility based on the daily return. That is, model 1 in Table 3 is enhanced by adding two lags of volatility, $\sigma_{d,t-1}$, $\sigma_{d,t-2}$, and one lag of the volatility shock as proxy $|R_{d,t-1}|$.

We confirm no serial correlation from DW (Durbin Weston autocorrelation test) in model 1. For model 1, the margin requirement coefficients, β_5's for both markets are negative and significant at the 1%, respectively.

Table 3. The result of regression analysis in levels for TOPIX and NIKKEI 225.

Coefficient	Panel A. TOPIX				Panel B. NIKKEI 225			
	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
β_0	0.3346 ***	0.4064 ***	0.3984 ***	0.4126 ***	0.5470 ***	0.5486 ***	0.5384 ***	0.5545 ***
	(6.64)	(8.37)	(8.13)	(8.37)	(9.11)	(9.44)	(9.23)	(9.53)
β_1	0.2319 ***	0.2240 ***	0.2187 ***	0.2306 ***	0.2811 ***	0.2512 ***	0.2449 ***	0.2575 ***
	(7.77)	(7.25)	(6.95)	(7.41)	(9.11)	(7.72)	(7.43)	(8.08)
β_2	0.1360 ***	0.1694 ***	0.1698 ***	0.1673 ***	0.1555 ***	0.1716 ***	0.1729 ***	0.1694 ***
	(4.78)	(5.88)	(5.88)	(5.81)	(5.83)	(6.15)	(6.19)	(6.07)
β_3	0.5397 ***	0.4691 ***	0.4837 ***	0.4595 ***	0.4621 ***	0.4523 ***	0.4654 ***	0.4453 ***
	(6.50)	(6.66)	(6.72)	(6.54)	(4.91)	(5.35)	(5.38)	(5.33)
β_4		-0.2394 ***		-0.3816 ***		-0.2775 ***		-0.4208 ***
		(-6.68)		(-3.49)		(-6.57)		(-3.64)
Bootstrap(β_4)		-0.1401 ***		-0.2995 ***		-0.2029		-0.4055 ***
		{-4.81}		{-2.98}		{-4.81}		{-3.72}
β_5	-0.2343 **	-0.2851 ***	-0.5184 ***	-0.3670	-0.4328 ***	-0.4860 ***	-0.6421 ***	-0.3868
	(-2.14)	(-2.49)	(-5.99)	(-1.46)	(-3.90)	(-4.14)	(-6.27)	(-1.54)
Bootstrap (β_5)	-0.2065 ***	-0.2317 ***	-0.1961 ***	-0.2292 ***	-0.3566 ***	-0.3942 ***	-0.3345 ***	-0.2292 ***
	{-3.50}	{-3.82}	{-3.18}	{-3.80}	{-4.70}	{-5.17}	{-4.22}	{-3.80}
β_6			-0.2139 **	-0.2546 **			-0.4020 ***	-0.4560 ***
			(-1.94)	(-2.26)			(-3.62)	(-4.07)
Bootstrap(β_6)			-0.2558 ***	-0.3697 ***			-0.3809 ***	-0.4806 ***
			{-3.83}	{-2.75}			{-5.05}	{-2.14}
Adj. R^2	0.2764	0.3086	0.3015	0.3094	0.3161	0.3533	0.3462	0.3539
F-Value	148.46 ***	138.82 ***	134.29 ***	116.31 ***	179.42 ***	169.75 ***	164.54 ***	142.01 ***
DW	2.11	2.15	2.14	2.16	2.10	2.15	2.13	2.15

This table shows the regression result of weekly volatility from daily data on margin requirement. The regression with Newey-West HAC standard error is estimated during 1970-1990. Estimated model in this paper is as follows: $\sigma_{d,t} = \beta_0 + \beta_1\sigma_{d,t-1} + \beta_2\sigma_{d,t-2} + \beta_3 | R_{d,t-1} | + \beta_4 R_{d,t-1} + \beta_5 M_{t-1} + \beta_6 (R_{d,t-1} \cdot M_{t-1}) + e_{d,t}$. The dependent variable $\sigma_{d,t}$ is weekly standard deviation based on daily return. Parentheses, ( ) is t-value for regression with Newey-West HAC and bracket, { } is t-value from bootstrap simulation with replacement. ***, **, * are significant at the 1, 5, and 10% level, respectively.

However, because there are positive autoregressive coefficients and all are significant at the 1%, that is, $\beta_1 = 0.2319$ and $\beta_2 = 0.136$ for TOPIX; and $\beta_1 = 0.2811$ and $\beta_2 = 0.1555$ for NIKKEI 225, as mentioned in Hardouvelis and Theodossiou (2002), it indicates that, following a permanent change in margins, the cumulative long-run association between margins and volatility remains approximately the same.

Thus, this long run association is $\beta_5/(1-\beta_1-\beta_2)$ = -0.2343/ (1-0.2319 - 0.1360) = -0.3707 for TOPIX, and $\beta_5/(1-\beta_1-\beta_2)$=-0.4328/ (1-0.2811-0.1555) =-0.7682 for NIKKEI 225. In bootstrap simulation for model 1 of Table 3, the afore-mentioned results are also confirmed, but average coefficient, -0.2065(t-value=-3.50) and -0.3566(t-value=-4.70) for both markets are smaller than -0.2343 (t-value=-2.14) and -0.4328(t-value=-3.90) in OLS with same sign or direction except smaller coefficients and bigger t-values.

Hence, we suggest that the Granger-Newbold spurious regression problem does not affect estimated coefficients of OLS. The same conclusion is found in model 2, 3, and 4, respectively. This evidence is not only for the β_5, but also for the coefficients β_4 and β_6. Hence, inference from the t-value of OLS is not affected by the Granger-Newbold spurious problem.

As suggested by Hardouvelis (1990), the weak statistical significance with smaller t- values of the margin requirement coefficients in model 1 of Table 3 could be due to the lack of the appropriate control variables in the regressions.

In logical process, margin requirements or stock price movements affect the decision of Japanese financial authority to change margin requirements and in turn could be correlated with volatility. For model 2 of Table 3, we control for average daily stock return at (t-1), $R_{d,t-1}$ based on prior literature that stock returns at (t-1) are also negatively associated with volatility at time t. The estimated coefficients, β_4's with -0.2394(t-value=-6.68) for TOPIX and -0.2775(t-value=-6.57) for NIKKEI 225 in model 2 of Panel A and Panel B are negatively associated and significant statistically at 1%. Thus, these results are consistent with prior studies.

After controlling for $R_{d,t-1}$, a statistical power of coefficient(β_5) for both in models is boosted slightly, which means that t-values are from -2.14 to -2.49 for TOPIX and from -3.90 to -4.14 for NIKKEI 225.

The long run relation between margins and volatility in model 2 of Table 3 is $\beta_5/(1-\beta_1-\beta_2)$= - 0.2851/(1-0.224-0.1694) = - 0.47 for TOPIX, and $\beta_5/(1-\beta_1-\beta_2)$= - 0.486/ (1-0.2512-0.1716) =-0.84 for NIKKEI 225.

These findings imply that the percentage change in volatility with respect to a percentage in terms of long run elasticity is approximately -0.205% (=- 0.47(0.4305 /0.989)) for TOPIX and -0.316%(=-0.842(0.4305/1.1488) for NIKKEI 225, where 0.4305 is the average margin requirements during 1970 to 1999; and 0.989 and 1.1488 are the average daily volatility in both indices.

As a matter of fact, interestingly, this evidence documents that the effect of margin requirements on volatility is bigger in NIKKEI 225 than in TOPIX. But these effects are smaller than as -0.35% in U.S by findings of Hardouvelis and Theodossiou (2002).

Now we investigate on whether there is a possible asymmetric relation between margin requirements and volatility or not. Model 3 is to test presence of an asymmetry in terms of the sign and size of the price change weekly at (t-1).

Model 3 could enhance model 1 through including the interaction term, $(R_{d,t-1} \cdot M_{t-1})$ instead of $R_{d,t-1}$. The association between margin levels and volatility is now reflected in the composite coefficient ($\beta_5 + \beta_6$) and variation according to both the sign and the size of the earlier stock price change is also allowed. Both coefficients β_5 and β_6 for TOPIX and NIKKEI 225 are -0.5184 with t-value= -5.99 and -0.2139 with t-value= -1.94, respectively for TOPIX; and -0.6421 (t-value= -6.27) and -0.4020 (t-value=-3.62), respectively for NIKKEI 225. They are negatively significant at the 1% or 5% in both markets.

This evidence implies that the relation of margin levels to volatility could be nonlinear. We will check this result using E-GARCH model. The negative sign value of β_6 suggests that the negative sensitivity of volatility to margins gets larger in absolute term, $|R_{d,t-1}|$ the higher the return at (t-1). We include two terms, $R_{d,t-1}$ and $(R_{d,t-1} \cdot M_{t-1})$ to model 4 because interaction term, $(R_{d,t-1} \cdot M_{t-1})$ could be dominated by the information in $R_{d,t-1}$.

If the leverage effect dominates the information in $(R_{d,t-1} \cdot M_{t-1})$, then β_4 should be significant and β_6 insignificant as well (Hardouvelis and Theodossiou, 2002). Conversely, if the information in the interaction term, $(R_{d,t-1} \cdot M_{t-1})$ shows mainly an asymmetry effect, then β_6 should continue to be significant despite the presence of $R_{d,t-1}$ in regression (Hardouvelis and Theodossiou, 2002).

We find that β_6 is still being negative and significant in both indices as before despite the presence of $R_{d,t-1}$ in the regression. We conclude that both the leverage effect and the asymmetry effect are not behind the information in $(R_{d,t-1} \cdot M_{t-1})$.

Is there a misspecification in regression in first-difference?

In the earlier model test, we identified that regression model in levels is correctly specified. Nevertheless, regression model in first-difference has been used in many previous papers and their papers give little evidence of a negative relationship between volatility and margin requirements. Thus, it is worthwhile to estimate the regression in first-difference form in order to compare the results of regression in levels form and identify the source of their different empirical results.

To enhance comparison, model 2 in Table 3 is chosen by incorporating the leverage effect, and we facilitate it by adding second lag of margin requirements, M_{t-2}, as an independent variable. Then general regression in levels form for both TOPIX and NIKKEI 225 indices is as follows:

$$\sigma_{d,t} = \beta_0 + \beta_1\sigma_{d,t-1} + \beta_2\sigma_{d,t-2} + \beta_3 | R_{d,t-1} | + \beta_4 R_{d,t-1} + \beta_5 M_{t-1} + \beta_6 M_{t-2} + e_{d,t} \quad (5)$$

Where the notations in this equation are same as defined in Equation 5. Due to the problem that the M_t series are highly auto correlated, which its first-order autocorrelation coefficient is 0.9879 in the weekly sample, there may be severe multicollinearity and endogenous problem between M_{t-1} and M_{t-2} in the regression Equation 5.

For TOPIX, estimated coefficient values are β_0 =0.4048(t-value=8.33), β_1=0.2273(t-value=7.56), β_2 =0.1678(t-value=5.83), β_3=0.4748(t-value=6.78), and β_4 =-0.2479(t-value=-7.02). For NIKKE 225, estimated coefficient values are β_0=0.4652(t-value=7.72), β_1 =0.2378(t-value=5.98), β_2=0.2325(t-value=5.25), β_3 =0.4879(t-value =5.75), and β_4= -0.3141(t-value = -6.79).

These estimated values are close to those in model 2 of Table 3. The estimated coefficients for the lagged values of margins are β_5=0.7793(t-value=1.38) and β_6 = -1.0175 (t-value= -1.84) for TOPIX; and β_5= 0.6032 (t-value=0.84) and β_6 = -1.0406(t-value = -1.34) for NIKKEI 225.

Due to multicollinearity, the two coefficients for both indices are pushed into opposite directions. The cumulative short run association of margins with volatility is $\beta_5 + \beta_6$ = -0.2382 for TOPIX and $\beta_5 + \beta_6$ = -0.4374 for NIKKEI 225 and these numbers are close to the β_5 in model 2 of Table 3.

Similarly, the long run association is $(\beta_5 + \beta_6)/(1-\beta_1-\beta_2)$ = -0.2382/ (1-0.2273-0.1678) = -0.3938 for TOPIX, and $(\beta_5 + \beta_6)/(1-\beta_1-\beta_2)$ = -0.4374/ (1-0.2378-0.2325) = -0.8257 for NIKKEI 225. These numbers are also close to the -0.47(= -0.2851/ (1-0.224-0.1694)) and -0.842(= -0.486/ (1-0.2512-0.1716)), long run association respectively in model 2 of Table 3.

Based on Equation 5, the volatility and the margin variables in first difference form are included in model 6.

$$\Delta\sigma_{d,t} = \beta_0 + (\beta_1 + \beta_2 - 1)\sigma_{d,t-1} - \beta_2\Delta\sigma_{d,t-1} + \beta_3 | R_{d,t-1} | + \beta_4 R_{d,t-1} + (\beta_5 + \beta_6)M_{t-1} - \beta_6\Delta M_{t-1} + e_{d,t} \quad (6)$$

That is, Equation 6 includes the lagged levels of both margin requirements and volatility as regressors. As explained in Hardouvelis and Theodossiou (2002), if these lagged levels from the regression are omitted, model would result in misspecification error. Most previous paper employed regression in first difference form to examine the relation between margin requirements and volatility and omitted these additional level terms. Therefore, estimated regression model could be misspecified. As pointed in Hardouvelis and Theodossiou (2002), Equation 6 is setup to compare Equation 5. Panel A and Panel B of Table 4 report regression estimates for Equation 6. Models 1 and 2 of Table 4 are similar to model used previously to investigate the relationship between margins and volatility, excluding the lagged levels of margin requirements and volatility as additional explanatory variables.

These models, however, have serial autocorrelation problem in the residual evidenced by DW statistics due to excluding $\sigma_{d,t-1}$, which is itself indicative of model misspecification. The coefficients of ΔM_{t-1} in these models are positive value with 2.1665 (t-value =1.22) and 1.6284 (t-value = 1.80) for TOPIX; and 2.3128

Table 4. The result of regressions of changes in TOPIX and NIKKEI 225 volatility on margin requirement.

Coefficient	Panel A. TOPIX			Panel B. NIKKEI 225		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
β_0	0.0004 (0.05)	-0.0283 (-1.05)	0.406*** (8.35)	-0.0001 (-0.00)	-0.0191 (-0.65)	0.5474*** (9.46)
$(\beta_1 + \beta_2 - 1)$			-0.6049*** (-17.19)			-0.5756*** (-13.91)
$-\beta_2$		-0.4203*** (-13.52)	-0.1673*** (-5.82)		-0.4132*** (-14.09)	-0.1696*** (-6.05)
β_3		0.1051 (1.32)	0.4752*** (6.78)		0.0706 (0.92)	0.4574*** (5.44)
β_4		-0.2229*** (-4.88)	-0.2470*** (-6.98)		-0.2524*** (-5.05)	-0.2846*** (-6.85)
$(\beta_5 + \beta_6)$			-0.2406*** (-2.18)			-0.4374*** (-3.92)
$-\beta_6$	2.1665 (1.22)	1.6284* (1.80)	1.0177* (1.83)	2.3128 (1.28)	1.774* (1.80)	1.0301 (1.47)
Adj. R^2	0.0041	0.1841	0.3773	0.0044	0.1869	0.3703
F-value	7.43***	88.12***	156.95***	6.752***	88.502***	150.77***
DW	2.79	2.29	2.16	2.78	2.29	2.15

This table represents the result of weekly volatility changes from daily data on margin requirement for TOPIX and NIKKEI index. The estimated regression with Newey-West HAC is as follows:

$$\Delta\sigma_{d,t} = \beta_0 + (\beta_1 + \beta_2 - 1)\sigma_{d,t-1} - \beta_2\Delta\sigma_{d,t-1} + \beta_3 | R_{d,t-1} | + \beta_4 R_{d,t-1} + (\beta_5 + \beta_6)M_{t-1} - \beta_6\Delta M_{t-1} + e_{d,t}$$

This equation is based on equation (5) and Δ is first difference operator. Parentheses, ( ) is t-value for regression with Newey-West HAC. ***, **, * are significant at the 1%, 5%, and 10% level, respectively.

(t-value =1.28) and 1.774 (t-value =1.80) for NIKKEI 225, respectively. These values all are positive and, the coefficients in models 2 and 3 for TOPIX, and model 2 for NIKKEI 225 are statistically significant at 10% as well.

Hardouvelis and Theodossiou (2002) argue that estimating models 1 and 2 of Table 4 would wrongly conclude that the relation between margins and volatility is positive, when in fact, according to Equation 6, the estimated coefficient is actually the coefficient, $-\beta_6$, denoting - even in these misspecified models - a negative association between margins and volatility.

In model 3 in Table 4, the lagged levels of margins and volatility are included. Thus, model 3 provides a more appropriate specification of the relations between margins and volatility. From this model, the sum of the coefficients of M_{t-1} and M_{t-2}, $(\beta_5 + \beta_6)$ = -0.2406, -0.4374, respectively in both indices is close to -0.2382 for TOPIX and identical to -0.4374 for NIKKEI 225 estimated in Equation 5. In turn, these values are also close to -0.2343 and -0.4328, which implies the results of the more correct specification of model 1 in Table 3.

As matter of fact, we are able to approximately replicate the results of regressions in levels even if the model in first-difference is used. In fact, many researchers had previously used regression model in first-difference form and could most likely omit the lagged levels of volatility and margin requirements. Based on our findings, the true associated with margin requirements and volatility is detected and appeared from regression model in levels.

An asymmetric effect on across bull and bear markets

Here, we investigate the possible existence of an asymmetric relation between margin requirements and stock market volatility across bull, bear, and normal markets. In earlier discussion, we found the possibility of an asymmetry according to the magnitude and sign of the price change of past week. Actually a bull or bear market defined is a period of consecutive weekly increases or decreases in stock market at time horizon. To define which market is bull or bear, we use time horizon of four weeks and longer.

As defined in Hardouvelis and Theodossiou (2002), we define a bull or a bear market as follows: a period during which there are at least N consecutive weekly stock returns with same algebraic sign. We chose the horizon N taking three possible values, N=4, 5, and 6 weeks.

Table 5 reports the results estimated for these periods. For N=4 in Panel A, there are 38 disjoint bull periods, which means periods consisting of at least four consecutive positive weekly returns. These periods contain 188 weekly observations, or 12.15% of the sample. The bear market periods are 15 and number of observations is 73, or 4.71% of the sample. Other N is same as stated earlier. We see that as the horizon N increases, the numbers of bull and bear periods decline.

To investigate a possible asymmetry effect across bull and bear periods, two dummy variables, $BULL_t$ and $BEAR_t$ are defined as follows: We take the value of 1 during bull and bear periods, respectively and the value 0 otherwise.

Subsequently, in model 2 of Table 3, we include two interaction terms, ($BULL_t^* M_{t-1}$) and ($BEAR_t^* M_{t-1}$). Model 2 is chosen because it controls the leverage effect. The general regression equation is as follows:

$$\sigma_{d,t} = \beta_0 + \beta_1 \sigma_{d,t-1} + \beta_2 \sigma_{d,t-2} + \beta_3 | R_{d,t-1} | + \beta_4 R_{d,t-1} + \beta_M M_{t-1} + \beta_{MBull} Bull_t M_{t-1} + \beta_{MBear} Bear_t M_{t-1} + e_{d,t} \quad (7)$$

Table 5 presents the regression results estimated for all three bull and bear periods. For bull periods, the coefficients β_{MBull} are positive for both markets, implying that the margin requirements are positively correlated to volatility and these coefficients are statistically significant at the 1, 5, and 10%.

That is, when market is in bull, if Japanese government authority of stock market increases margin requirements to avoid high volatility, then stock market volatility will be even increased, and eventually market will be unstable in bull period. Moreover, the sum of $\beta_M + \beta_{MBull}$, is close to 0 for TOPIX and NIKKEI 225 as N goes to 6, suggesting that the whole short-run relationship between margin requirements and volatility weakens marginally during bull periods for both market indices.

This finding implies that there is no pyramiding effect in bull periods of Japanese stock market. Therefore, when market is in bull state, the government policy tool of margin requirements is useless.

Unlike bull periods, for bear periods, the statistical strength associated with margin requirements and volatility is strengthen marginally relative to normal periods for only N=6 for TOPIX, that is, the coefficient, β_{MBear} is negatively significant and the negative short-run of relation between margins and volatility strengthens marginally relative to normal periods.

In contrast to bull periods, the sum of $\beta_M + \beta_{MBear}$, is diverge for both markets as N goes to 6, implying that the total short-run association on margin requirements and volatility turns to negative. In normal state, however, initial margin policy works. That is, the coefficient of β_M is negative and significant at the 1% level for both market indices, indicating that as the initial margin requirements increases at time t-1, the volatility of market decreases at time t.

Therefore, we conclude that there is evidence of the effect for initial margin policy during the only deep bear period for TOPIX, but no evidence during bull periods in Japanese stock markets (TOPIX and NIKKEI225). This finding is inconsistent with results of Japanese stock market in Hardouvelis and Peristiani (1992) study, of U.S. market in Hardouvelis and Theodossiou (2002) study, and but is consistent to the result by Kim and Oppehneimer (2005) study for testing Japanese stock market based on the individual investor. When the market is in normal, our result is consistent with in Hardouvelis and Peristiani (1992, 2002), but inconsistent with Kim and Oppehneimer (2005). Specially, it is in contrast to what Hardouvelis (1990), and Kupiec and Sharpe (1991) point out those margin requirements are supposed to primarily purpose and deep recession marginally in Japanese stock market.

An EGARCH model for testing asymmetric effect

Here, we adapt a complementary model as EGARCH which can explain the asymmetric effect in order to investigate the relationship between initial margin requirements and the conditional mean and variance of weekly stock market returns.

To do this, we employ the extended version of Nelson's (1991) EGARCH model as conditional volatility model implemented by Kupiec (1989) and Hardouvelis and Theodossiou (2002).

Table 5. The results of margin requirements and TOPIX and NIKKEI 225 volatility across bull and bear markets.

	Panel A. TOPIX			Panel B. NIKKEI 225		
	N=4	N=5	N=6	N=4	N=5	N=6
Obs. of Bull	188(12.15%)	121(7.82%)	80(5.17%)	161(10.41%)	95(6.14%)	59(3.91%)
Bull periods	38	24	16	32	19	12
Obs. of Bear	73(4.71%)	34(2.19%)	14(0.90%)	70(4.52%)	37(2.39%)	19(1.23%)
Bear periods	15	7	3	14	7	4
β_0	0.4257*** (9.35)	0.4138*** (8.36)	0.4213*** (8.58)	0.5688*** (10.02)	0.5768*** (10.17)	0.5625*** (9.70)
β_1	0.2204*** (7.22)	0.2211*** (7.03)	0.2235*** (7.27)	0.2464*** (7.59)	0.2466*** (7.54)	0.2494*** (7.66)
β_2	0.1687*** (5.83)	0.1693*** (5.89)	0.1711*** (5.93)	0.1717*** (6.13)	0.1674*** (5.98)	0.1754*** (6.11)
β_3	0.4655*** (6.48)	0.4626*** (6.65)	0.4719*** (6.69)	0.4543*** (5.35)	0.4530*** (5.34)	0.4516*** (5.35)
β_4	-0.2499*** (-6.87)	-0.2375*** (-6.70)	-0.2541*** (-6.84)	-0.286*** (-6.78)	-0.2836*** (-6.82)	-0.2839*** (-6.69)
β_M	-0.3154*** (-3.49)	-0.2699*** (-2.33)	-0.2811*** (-2.46)	-0.5232*** (-5.33)	-0.5326*** (-5.53)	-0.4801*** (-4.25)
β_{MBull}	0.3111* (2.00)	0.1919** (2.32)	0.2307** (2.46)	0.3429*** (2.16)	0.5406** (2.14)	0.3824*** (2.91)
β_{MBear}	0.2570 (1.07)	0.5939 (1.55)	-0.8195** (-2.30)	0.2875 (1.11)	0.6584** (2.09)	0.1071 (0.21)
Adj. R^2	0.3140	0.3119	0.3111	0.358	0.3634	0.3553
DW	2.16	2.15	2.16	2.16	2.14	2.15
F value	102.06***	100.98***	100.62***	124.21***	126.92***	122.48***

This table reports margin requirement effect on volatility based on daily data across bull and bear and normal markets. The estimated regression with Newey-West HAC is as follows:

$$\sigma_{d,t} = \beta_0 + \beta_1\sigma_{d,t-1} + \beta_2\sigma_{d,t-2} + \beta_3 | R_{d,t-1} | + \beta_4 R_{d,t-1} + \beta_M M_{t-1} + \beta_{MBull} Bull_t M_{t-1}$$
$$+ \beta_{MBear} Bear_t M_{t-1} + e_{d,t}$$

The dependent variable, $\sigma_{d,t}$ is the weekly standard deviation based on daily return . Parentheses, ( ) is t-value for regression with Newey-West HAC.

***, **, * are significant at the 1, 5, and 10% level, respectively.

Conditional mean of stock market returns

In the point of view with statistical considerations, an moderating speculative behavior by imposing a cost impediment. This explanation may be fitted to only normal empirical model of stock market return and volatility should allow the conditional expected excess return to be linear related to conditional non-diversifiable risk. As specified by Hardouvelis and Theodossiou (2002), the conditional mean for stock market returns is specified as follows:

$$r_{m,t} = \mu_{m,t} + e_t$$

$$\mu_{m,t} \equiv E(r_{m,t} | \Omega_{t-1})$$

$$\mu_{m,t} = \beta_0 + \beta_M M_{t-1} + \sum_{n=1}^{N} \beta_n r_{m,t-n} + \gamma\sigma_t^2 \quad (8)$$

where $r_{m,t}$ is stock market returns, $\mu_{m,t} \equiv E(r_{m,t} \mid \Omega_{t-1})$ is the conditional mean of stock market returns at time t based on information set available up to time (t-1), Ω_{t-1}, e_t is an error term used as proxy for market shocks, M_{t-1} denotes the level of initial margin requirement at time t-1, r_{t-n} are historical returns up to (t-n), and $\sigma_t^2 \equiv \text{var}\left(r_{m,t} \mid \Omega_{t-1}\right)$ is the conditional variance of $r_{m,t}$ based on Ω_{t-1}.

Lagged returns, $r_{m,t-n}$, employed reduce serial correlations whenever they exist and the error term, σ_t^2 is intended to capture a possible linkage between the conditional mean and variance of the distribution of stock market returns, and the lagged margin requirement variable, M_{t-1} is intended in order to capture a possible influence of margin requirements on the risk premium through its possible association with volatility. Furthermore, if higher margin requirements reduce the volatility of future unwarranted stock price movements, the return that investors require in order to invest in the stock market may be diminished.

The conditional variance of stock market returns

Given the asymmetry in the market volatility, we specify the extended Nelson's (1991) EGARCH-M model on the generalized error distribution (GED) with some modification. This model allows for a possible nonlinear and asymmetric association between margin requirements and conditional volatility:

$$\ln(\sigma_t^2) = a_0 + a_M M_{t-1} + a_{MBear} Bear_t \cdot M_{t-1} + a_{MBull} Bull_t \cdot M_{t-1} + \theta \cdot g(z_{t-1}) + \gamma \ln(\sigma_{t-1}^2) \qquad (9)$$

Where $g(z_{t-1}) = \mid z_{t-1} \mid - E \mid z_{t-1} \mid + \delta \cdot z_{t-1}$,

In Equation 9, M_{t-1} term captures the influence of a change in margin requirements during normal periods. Also each terms for ($Bear_t \cdot M_{t-1}$) and ($Bull_t \cdot M_{t-1}$) allow to a different relationship between margin requirements and volatility during bull and bear periods. z_{t-1} is $\frac{e_{t-1}}{\sigma_{t-1}}$ and the function $g(z_{t-1})$ is an asymmetric nonlinear function of z_{t-1} and can be viewed as a proxy function for past volatility shocks.

Assuming that the unconditional means of $g(z_{t-1})$ is zero, that is, $E[g(z_{t-1})] = 0$ $g(z_{t-1})$ under stationary of the conditional variance has a transitory impact on current conditional volatility and no impact on unconditional volatility (Hardouvelis and Theodossiou, 2002).

Generally, we expect that there is a positive relationship between past volatility shocks and present volatility, which is $\theta \cdot g(z_{t-1})$>0. Also the function $g(z_{t-1})$ is consisted of both a symmetric $\mid z_{t-1} \mid - E \mid z_{t-1} \mid$ as part of past innovations, and $\delta \cdot z_{t-1}$ as an asymmetric part. This functional form imposes a differential impact of past volatility shocks on current conditional volatility. For example, if the asymmetry coefficient, δ is negative, then negative past innovations $(z_{t-1} < 0)$ would have a greater impact on current volatility than positive innovations of the same magnitude. As a result, a negative δ implies that the volatility rises more following "bad news" than "good news."

THE RESULTS FROM EGARCH MODEL

Here, we estimate EGARCH-M with GED distribution. The results are shown in Tables 6 and 7. Panel A presents the estimates of the conditional mean equation, and Panel B shows the estimates of the conditional volatility equation.

The estimation result from the conditional mean equation of stock returns

We interpret the estimated results for the TOPIX and NIKKEI 225 weekly return series. When weekly stock market returns are modeled as AR (2), the estimated coefficient for AR (2) is not significant at all. Thus, the second term of AR in return series is dropped and we setup EGARCH-M model with AR (1) in Tables 6 and 7.

Panel A of Tables 6 and 7 for TOPIX and NIKKEI 225 indices shows that the coefficient λ for conditional variance is positive but not statistically significant in Model 1 and 2 for TOPIX and also in Model 1 for NIKKEI 225, implying that there is very weak positive linkage between conditional means returns and conditional stock market volatility. From this evidence, we drop conditional volatility term in incorporating model 3, 4, 5, and 6 in Table 6.

However, Model 2, 3, 4, and 5 of Table 7 show that this linkage is stronger in including σ_t^2 in the conditional mean equation. This evidence implies that there is significant positive relationship between conditional volatility and stock market returns if past margin variable is included to conditional mean model. This suggests that margin requirements play an important role in conditional mean return.

For the association of margin requirements and conditional mean returns in Model 2 of Tables 6 and 7, interestingly the coefficients, β_M, are even positive with 0.186(TOPIX) and 0.3076(NIKKEI 225). Also all coefficients of β_M in Model 2 are positively significant at 1 and 5%, implying that there is very strong positive linkage between margin requirements and conditional mean returns in Japanese stock market. Moreover, this finding also shows that the effect of margin requirements on stock market return affects strongly more power in NIKKEI 225 than in TOPIX.

As a result, this evidence indicates that an increase in margin requirements is associated with an increase in the required rate of return on the aggregate stock market. As mentioned by Hardouvelis (1990), the financial authority raises margins requirements because it anticipated further unusual increases, not declines, in stock prices. It is not consistent with findings of Hardouvelis and Peristiani (1992) for Japanese stock market, and of Hardouvelis and Theodossiou (2002), and of Zhang et al. (2005) for U.S. stock market.

The estimation result from the conditional volatility equation of stock returns without margin policy

Panel B in Tables 6 and 7 shows the estimated results for the conditional variance of stock market returns. Firstly, we exclude the margin variable from the Model 1. In the Tables 6 and 7, an EGARCH (1, 1) model fits the data best, meaning that the conditional volatility equation includes one own-lag and one lag of past volatility shocks. We observe that all coefficients for the logarithm of past conditional variances are close to unity, suggesting high persistence of volatility over time.

For level of persistence in volatility, NIKKEI 225 return series are stronger than TOPIX. All persistence coefficients are statistically significantly at the 1%. Specifically, the coefficients, γ=0.9702 for TOPIX and γ=0.9734 for NIKKEI 225 indicate that it would take approximately 76=ln (0.1)/ln (0.9702) for TOPIX and 85=ln (0.1)/ln (0.9734) business days for the influence of current volatility on future volatility to diminish to one-tenth the size of its influence on next period's volatility. For the asymmetry effect, all asymmetry coefficients, δ's from model without margin for TOPIX and NIKKEI 225, are negative and statistically significant at the 1%.

This result confirms that the past negative shocks on the conditional mean have a stronger association with current conditional volatility than past positive shocks.

The estimation result from the conditional volatility equation of stock returns with margin policy

In Tables 6 and 7, for the Japanese stock market returns, we add the margin as an explanatory variable in the conditional variance equation. Thus estimated coefficients are presented for the α_M in all models. Also, in model 4 for TOPIX and model 3 for NIKKEI 225, bear and bull periods ($\alpha_{M,Bear}$, $\alpha_{M,Bull}$) are interaction terms separated respectively to distinguish each effects on margins requirements and volatility. Coefficient α_M captures the association between the level of margin requirements and volatility during normal period and $\alpha_{M,Bear}$ and $\alpha_{M,Bull}$ also identify the relationship between the margin requirements and volatility for each bear and bull periods

In Tables 6 and 7, all coefficients, α_M are negative and statistically significant at the 1, 5, and 10% for both market indices. These evidences indicate that in the normal periods, the past margin requirements affect current conditional volatility negatively for TOPIX and NIEEI 225. These findings confirm that the higher margin requirements reduce the volatility. Also, during bear periods, in model 6 for TOPIX and in model 5 for NIKKEI 225 $\alpha_{M.Bear}$ are negative and statistically significant at the 1 and 5% marginally and respectively but except no significant in Model 3 for both market indices.

In model 3, 5 of TOPIX and model 3, 5 of NIKKEI 225 the interaction term sum of coefficient $\alpha_M + \alpha_{M,Bear}$ is -0.1139, -0.1069, -0.1468, and -0.1559, respectively. This means that margin requirement policy plays an important role in volatility, the higher margin, the lower volatility, thus this is consistent with depyramiding hypothesis that margin requirements tend to push stock prices down in bear periods and the counter-cyclical characteristics of volatility: in bear market, volatility is higher rather than in bull market.

However, the association of margin with volatility during bull periods is substantially weaker, even positive effect. Thus, it does not play a key role in volatility for model 4 and 5 of TOPIX and model 4 and 5 of NIKKEI 225, the higher margin, the higher volatility. This result implies that if Japanese financial authority intends to increase margin level to reduce volatility during bull periods, unexpectedly, the volatility would be even higher.

Also this finding implies that the margin policy only affect volatility in bear periods during short time as week. In bear state, a lower margin requirement would decrease the liquidity needs of investors and lessen the downward pressure on prices, thus, reduce volatility.

Conclusions

From the original Hardouvelis (1990) and Hardouvelis

Table 6. The result of EGARCH model of TOPIX index with margin requirements.

Coefficient	Model 1		Model 2		Model 4		Model 5		Model 6	
Panel A: Conditional mean of returns										
β_0	0.0312	***	-0.0612	**	-0.0476	*	-0.0476	*	-0.0464	*
	(3.51)		(-2.19)		-(1.89)		(-1.89)		(-1.85)	
β_M			0.1861	***	0.1731	***	0.1732	***	0.1703	***
			(3.47)		(3.29)		(3.31)		(3.27)	
β_1	0.1394	***	0.1404	***	0.1399	***	0.1399	***	0.1400	***
	(12.09)		(12.09)		(12.24)		(12.24)		(12.16)	
λ	0.0054		0.0185							
	(0.40)		(1.32)							
Panel B: Conditional variance of returns										
α_0	-0.2174	***	-0.2043	***	-0.1743	***	-0.1759	***	-0.1982	***
	(-18.09)		(-13.56)		(-13.29)		(-13.39)		(-14.31)	
α_M			-0.0449	***	-0.0738	**	-0.0769	***	-0.0391	*
			(-2.10)		(-3.45)		(-3.63)		(-1.88)	
$\alpha_{M,BEAR}$					-0.0401				-0.0678	**
					(-1.20)				(-1.97)	
$\alpha_{M,BULL}$					0.0955	***	0.0996	***		
					(5.06)		(5.38)			
θ_1	0.2682	***	0.2744	***	0.2452	***	0.2461	***	0.2691	***
	(18.14)		(18.24)		(17.99)		(17.97)		(18.17)	
δ	-0.0811	***	-0.0825	***	-0.0978	***	-0.0959	***	-0.0866	***
	(-10.36)		(-10.27)		(-11.87)		(-11.87)		(-10.54)	
γ	0.9702	***	0.9663	***	0.9725	***	0.9717	***	0.9696	***
	(264.47)		(234.43)		(278.97)		(282.48)		(246.67)	
GED(v)	1.2987	***	1.2914	***	1.2958	***	1.2954	***	1.2905	***
	(77.56)		(74.54)		(76.35)		(77.05)		(74.21)	
Lik. Ratio	-8383		-8376		-8365		-8370		-8381	
Adj. R^2	0.0143		0.0168		0.0129		0.0131		0.0131	
F-value	16.22	***	14.97	***	10.66	***	11.84	***	11.85	***
DW	2.02		2.01		2.02		2.02		2.02	
Panel C: Model diagnostics										
Mean for z_t	-0.0123		-0.0100		-0.0100		-0.0070		-0.0120	
Max	6.558		6.574		6.494		6.532		6.558	
Min	-12.447		-12.7		-13.2		-13.24		-12.45	
Std	1.0135		1.014		1.0140		1.0140		1.0135	
Skewness	-0.6655		-0.68		-0.69		-0.702		-0.666	
Kurtosis	11.8943		12.18		12.46		12.57		11.894	
Jarque Bera	24826	***	26412	***	28076	***	28716	***	24827	***

This table reports extended EGARCH-M model result of TOPIX weekly volatility on margin requirements. Parentheses, ( ) is t-value of EGARCH(1,1) estimation. Estimated model is as follows:

$$r_{m,t} = \beta_0 + \beta_M M_{t-1} + \beta_1 r_{m,t-1} + \lambda\sigma_t^2 + \varepsilon_t \quad \ln(\sigma_t^2) = \alpha_0 + \alpha_M M_{t-1} + \alpha_{M,Bear}(Bear_t \cdot M_{t-1}) + \alpha_{M,Bull}(Bull_t \cdot M_{t-1})$$

$$+\theta_1 \left\| |z_{t-1}| - E|z_{t-1}| \right\| + \delta \cdot z_{t-1} + \gamma \ln(\sigma_{t-1}^2)$$

***, **, * Are significant at the 1%, 5%, and 10% level respectively.

and Theodossiou (2002) paper, which finds the evidence of a negative relation between initial margin requirements and volatility, most studies conclude that margin is unrelated to volatility.

Table 7. The result of EGARCH model of NIKKEI 225 with margin requirements.

Coefficient	Model 1		Model 2		Model 3		Model 4		Model 5	
Panel A: Conditional mean of returns										
β_0	0.0395	***	-0.1171	***	-0.1029	***	-0.1046	***	-0.1158	***
	(3.81)		(-3.42)		(-3.01)		(-3.05)		(-3.39)	
β_M			0.3076	***	0.2879	***	0.2907	***	0.3057	***
			(4.89)		(4.55)		(4.60)		(4.86)	
β_1	0.0563	***	0.0540	***	0.0533	***	0.0532	***	0.0543	**
	(4.81)		(4.66)		(4.60)		(4.59)		(4.65)	
λ	0.0108		0.0276	**	0.0225	*	0.0228	*	0.0272	**
	(0.93)		(2.28)		(1.81)		(1.84)		(2.24)	
Panel B: Conditional variance of returns										
α_0	-0.1858	***	-0.1597	***	-0.1264	***	-0.1271	***	-0.1566	***
	(-17.59)		(-12.22)		(-10.35)		(-10.39)		(-12.08)	
α_M			-0.0761	***	-0.0980	***	-0.1025	***	-0.0697	***
			(-3.42)		(-4.82)		(-5.05)		(-3.21)	
$\alpha_{M,BEAR}$					-0.0488				-0.0862	***
					(-1.63)				(-2.64)	
$\alpha_{M,BULL}$					0.1258	***	0.1311	***		
					(7.83)		(8.28)			
θ_1	0.2367	***	0.2445	***	0.2019	***	0.2024	***	0.2409	***
	(17.31)		(17.40)		(15.89)		(15.91)		(17.27)	
δ	-0.0928	***	-0.0971	***	-0.1098	***	-0.1075	***	-0.1009	***
	(-11.66)		(-11.90)		(-14.00)		(-13.89)		(-12.24)	
γ	0.9734	***	0.9664	***	0.9759	***	0.9751	***	0.9685	***
	(301.89)		(234.69)		(290.97)		(291.11)		(238.48)	
GED(v).	1.3229	***	1.3109	***	1.3334	***	1.3317	***	1.3141	***
	(80.58)		(76.89)		(73.57)		(74.88)		75.92	
Lik. Ratio	-9561		-9549		-9534		-9535		-9546	
Adj. R^2	-0.0005		0.0007		0.0001		0.0002		0.0005	
F-value	4.52	***	16.05	***	10.51	***	11.34	***	13.92	***
DW	2.05		2.03		2.04		2.04		2.03	
Panel C: Model diagnostics										
Mean for z_t	-0.0247		-0.0200		-0.0214		-0.0200		-0.0220	
Max	6.4942		6.533		6.3733		6.419		6.4427	
Min	-13.497		-13.5		-12.187		-12.2		-13.37	
Std	1.0116		1.012		1.0102		1.011		1.0117	
Skewness	-0.7886		-0.81		-0.6964		-0.71		-0.793	
Kurtosis	11.92		12.16		10.49		10.64		11.85	
Jarque Bera	25206	***	26545	***	17805	***	18551	***	24808	***

This table shows EGARCH-M model result of NIKKEI 225 weekly volatility on margin requirements. Parentheses, ( ) is t-value of EGARCH(1,1)-M estimation. Estimated model is as follows:

$$r_{m,t} = \beta_0 + \beta_M M_{t-1} + \beta_1 r_{m,t-1} + \lambda\sigma_t^2 + \varepsilon_t$$

$$\ln(\sigma_t^2) = \alpha_0 + \alpha_M M_{t-1} + \alpha_{M,Bear}(Bear_t \cdot M_{t-1}) + \alpha_{M,Bull}(Bull_t \cdot M_{t-1}) + \theta_1 \| |z_{t-1}| - E|z_{t-1}| \| + \delta \cdot z_{t-1} + \gamma \ln(\sigma_{t-1}^2)$$

***, **, * are significant at the 1%, 5%, and 10% level respectively.

But Hardouvelis (1990) and Hardouvelis and Theodossiou (2002) studies provide the negative relation between margin and volatility. Also these findings are attacked from many authors, which mean that their results are more likely to bias from the spurious regression phenomenon of Granger Newbold (1974).

However, Hardouvelis and Theodossiou (2002) analyzed to find facts clearly using sophisticated methodologies. They provide that using US stock market data, both the volatility and the margin series are highly autocorrelated, but stationary, and that the Granger-Newbold bias in the level regressions is neither economically nor statistically significant.

With motivation of their study, we reexamine Japanese government policy of stock market margin to find the association between margin requirements and volatility. Using Japanese stock market data in order to securitize this relationship is very unique and good opportunity to us because there are lots of changes in margin policy.

We employ several sophisticated techniques such as regression and conditional volatility model to investigate the linkage of margin requirements and volatility. In regression analysis, margin requirements affect volatility negatively and also there is nonlinear effect for TOPIX and NIKKEI 225.

This result is robust in various methods and even after controlling for additional variables. Thus we confirm that higher margin could reduce excess volatility. Across bull and bear markets, the linkage between margin requirements and volatility is slightly stronger (more negative) in bear market for TOPIX but is weak in bull market, even positive association for all markets.

The afore-mentioned results are also confirmed by EGARCH-M model with GED distribution. In this model, there is also negative association relation between margin requirements and volatility across only bear and normal markets. These findings indicate when stock prices keep drop as in case of a sharp decline, it would be stabilizing to have higher margin requirements policy.

Conversely, for bull market, the volatility would be more volatile if Japanese financial authority intends to raise the level of margin requirements to reduce the volatility. These results suggest that for Japanese, government policy as tool of stabilizing stock market has to be scheduled and implemented in only deep bear and normal markets.

Therefore, government restriction does not work for stabilizing market turbulence in bull market, implying that imposing this financial policy into all market states should be cautious because the effect of this policy could be worked differentially.

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