On relationship between initial margin requirements and volatility : New evidence from Japan Stock Market

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Abstract

This paper investigates on whether there is the asymmetric relation between initial margin requirements and volatility across bull and bear markets for Japanese TOPIX and NIKKEI225 index during 1970-1999. 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 during normal, but show no relationship during bull and bear markets from regression and EGARCH model. As matter of fact, we conclude no evidence that there is an asymmetric process, i.e., pyramiding and depyramiding effect in terms of bull and bear markets from Japanese TOPIX and NIKKEI225. However, for normal periods, we find that there is evidence of asymmetric process in Japanese stock market. In conclusion, we confirm that the policy tool of margin requirements does not work when stock market is in crash or bubble state.

Keywords: Initial Margin Requirements, Pyramiding or Depyramiding effect, Volatility, Bootstrap Simulation, Granger causation, EGARCH

JEL classifications: G14, G18

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1. 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 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. Is this process worked or not? Due to this question, we are invoked to study whether this argument is correct or not. That is, do these policies matter for stabilizing or destabilizing volatile of stock market? Thus this paper examines whether margin requirement is worked well as the policy tool of stock market stabilization in different market conditions such as boom, normal, and recession. In this paper, we will find some evidence that the effect of these policies could be from Japanese stock market because margin requirement in Japanese stock market had been many changed.

Actually how margin requirements affect stock prices, stock return and return volatility[2] 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 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 margins change also affects to investors when stock price is crashed or

[2] To stabilize stock price volatility, in general there are three proposals which are changing initial margin level, setting price limit or circuit breaker, and imposing transaction taxes.

irrational turbulence. The margin requirements bind stock purchaser's ability to speculate, thus they tend to reduce the stock price volatility in sense, especially when stock investor's beliefs are more divergent. 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[3].

As a result, the role of initial margin requirements is in fact, designed to prevent excess volatility and fragility on market system[4]. Has been it really worked in market system? Prior studies have tried to identify the relationship between initial margin requirements and market volatility. 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; Lockwood and Linn, 1990; Hardouvelis, 1988, 1990; Hardouvelis-Peristiani, 1989-90, 1992; Hardouvelis-Theodossiou, 2002; Zhang, Seyedian and Li, 2005). On the other hand, other studies claimed that there is no such evidence (Moore, 1966; Ferris and Chance, 1988; Kumar, Ferris, and Chance, 1991; Salinger, 1989; Schwert, 1989; Hsieh and Miller, 1990; Kim and Oppenheimer, 2002; Zhang, Seyedian, and Li, 2005).

Due to controversial results in prior literatures[5], we reexamine the relationship initial margin requirements and return volatility using different methodology on whether there are pyramiding

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[3] As described by Bogen and Krooss(1960), because security credit is cheaper than the cost of investor equity, access to broker's loans stimulates the demand for stocks, inducing price increases that provide the additional equity that is the foundation of further borrowing to finance additional stock purchases. During this period of pyramiding, stock prices are pushed above intrinsic values. A subsequent reversal of stock prices leads to depyramiding as price declines induce brokers to issue margin calls. Forced sales of stocks further depress prices, inducing additional sales and sending prices to a level below intrinsic values. The amplitude of cycles in stock prices is thereby increased, with a potential for particularly severe price declines.

[4] The 1934 U.S. Congress established Federal margin authority with three apparent objectives: to reduce the use of "excessive" credit in securities transactions; to protect investors form over-leveraging; and to reduce the volatility of stock prices (Moore, 1966).

[5] Hardouvelis and Theodossiou (2002) provoked the sixty-year-old question once again: To what extent do to low margins increase systemic risk, which means that it leads stock prices to levels over fundamental price and hence makes the stock market vulnerable to crashes?

and depyramiding hypothesis in different market states for Japanese Stock Market[6], i.e., the asymmetric relation across bull and bear markets.

Pyramiding-depyramiding process is as follows. Optimistic investors could borrow large amount of money and bring stock prices up to levels unjustified by intrinsic value of each firm if there is no margin requirement restriction. This price rise could subsequently feed on itself if speculators were to use their increased wealth to buy more stocks on margin, creating a pyramiding effect. In turn, prices could make very fast, creating a depyramiding effect if in the case of some adverse news brokers were to ask for additional collateral. If some speculators lacked the requested margin funds, brokers would sell their stocks driving prices down further. This outcome would generate further calls for collateral, more liquidations, and additional price declines (Hardouvelis and Theodossiou, 2002).

This process, i.e., asymmetry process, 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 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 requirements' 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 example, as explained by Hardouvelis (1990), while the FRB raised margins to prevent the excesses of an ongoing bull market, it lowered margins with

[6] Hardouvelis-Peristiani (1989-90) studied already for Japan stock market through event study. They argued that initial margin requirements are negatively related to stock price. However, Kim and Oppenheimer (2002) claimed using event study that there is no evidence in this contention. As a result, two papers support different evidences using same data and same methodology in Japanese stock market. In this paper, we reexamine using same data to which one is supported. Hardouvelis and Theodossiou (2002) investigated this relationship for U.S stock market, not Japanese stock market using new methods. This paper catches up methods used in Hardouvelis and Theodossiou (2002).

the intention of simply counteracting the earlier increase once and it believed that the excesses of the earlier bull market were over[7].

In summing up above stories, there are two mechanisms, i.e., pyramiding and depyramiding, in explaining the relationship between initial margin requirements and stock price variability and two mechanisms are worked in terms of the asymmetric relationship. For Japanese stock market, since 1951, initial margin requirements were introduced and changed 68 times (including cash) until now. Thus, because of many changes in initial margin requirements, we have good opportunity to investigate this asymmetric relationship.

Why there are so different conclusions in many previous papers? It is tool in measuring the proxies of market vulnerability and an empirical method used in testing models. In general, event study and regression method have been used in most previous studies[8]. Thus the results of previous studies depend upon mainly methodology used in testing models and tool employed in calculating stock return volatility. Using U.S. stock market data, Hardouvelis (1990) investigated three alternative measures, i.e., volatility of annual and monthly frequency, excess volatility from one month to five years, and mean reversion of stock prices from one month to five years at capturing market vulnerability. From these measures, he found that there is a negative relation between initial margin requirements and these all three alternative measures of market vulnerability and concluded that the imposition of margin regulation turned out to be an appropriate measure.

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[7] For U.S, FRB changed the initial margin requirement 22 times during 1934-1974. That is, it raised margins when it saw signs of excessive speculative activity, such as rising stock prices and rising margin credit in appearing unusually. In turn, it decreased margins when it thought that the factors which led it earlier to increase margins ceased to exist. Hardouvelis (1988, 1990) argues that while setting margin requirements, the FRB acknowledged that it seems to be signed both of high credit use to buy stocks and of potential stock price bubbles.

[8] To test relationship between initial margin requirements and stock return volatility, Grube-Joy-Panton (1979) and Hardouvelis-Peristiani(1989-90, 1992) used event study method; and Hardouvelis(1988), Kupiec(1989), Salinger (1989), Schwert(1989), Hardouvelis(1990), Hsieh-Miller(1990), Kofman-Moser(2001), Hardouvelis-Theodossiou(2002) and Zhang, Seyedian and Li(2005) employed regression method.

To investigate the conclusion that the appropriate level of officer initial margin requirements reduce systemic risk, Kupiec (1989), Schwert (1989), Salinger (1989), and Hsieh and Miller (1990) have scrutinized it using only one of the three measures of market vulnerability, i.e., monthly volatility, examined by Hardouvelis (1990). Since volatility is a very important item of regulatory concern, it should be desirable to use more robust statistical models together with full set of available data. Most prior studies used month-to-month end return to make volatility measure even if daily returns are available easily except Hardouvelis and Theodossiou (2002). Especially, from point of view of method, they adopt regressions in terms of first difference form in order to test the effect of margins on volatility except Hardouvelis and Theodossiou (2002) and Salinger (1989) and their empirical conclusions came up with substantially different results among many studies. Furthermore, the effect on the initial margin requirements of Japanese stock market has been not tested at all by regression method based on weekly data by using averaged daily data. This is what we contribute. Our analysis is performed in levels and also each method is compared to previous one for the initial margin requirements in Japanese stock market. As shown in our paper, first difference estimator would lead to misspecified models and erroneous results if the model is not performed in levels correctly.

Now we suggest new method and find new further evidence from Japanese stock market, which supports the findings of Hardouvelis and Theodossiou (2002). Although test methods employed in our paper are similar to that of Kupiec(1989) and Hardouvelis and Theodossiou (2002) based on U.S stock market, but different in several ways. This paper adapts not only regression in terms of conditional variance of returns, i.e., Exponential GARCH model suggested by Nelson (1991), but also the bootstrap simulation to check robustness of OLS findings using weekly return by recent daily return average (1970-1990) of Tokyo Price Index (TOPIX) and NIKKEI 225 Index in Japanese Stock Exchange Market. Additionally we implement Granger causality test to investigate the causation between margin requirements policy and market volatility.

The motivation for this paper is as follows. First of all, it is to find potential asymmetry phenomena, which is never investigated in previous literature for Japanese stock market. Through historical policy recordings for U.S initial margin requirements regulation, we are assured that there is asymmetrical role of initial margin requirements during bull, normal, and bear market state respectively. Second, it is to enhance and elaborate accuracy of correct model specification for the relation of initial margin requirements and volatility and also to compare with the first difference model and to explain why is mixed conclusion. Third, it is to measure and utilize more precise volatility process using available daily data in Japanese stock market.

The remainder of this paper is organized as follows. Section 2 describes theoretical issues and related literatures in terms of initial margin requirements and volatility. In section 3, institutional characteristics are described and section 4 provides data and some statistic issues. In section 5, regression analysis in levels is run and section 6 mentions a misspecification in regression in – difference. In section 7, we investigate an asymmetric relation across bull and bear markets. In section 8, EGARCH model is designed to find the linkage between margin requirements and conditional volatility. In section 9, the results from EGARCH model is discussed. Finally in section 10, we conclude this paper.

2. Theoretical Issues and Related Literatures

The initial margin requirements generally are strong and forced policy tool for controlling 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[9]. 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 discourage only noise traders, not informed traders, the market volatility will be reduced effectively. But unfortunately if reversing, it will stimulate volatility.

In theoretical point of view, 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, Schliefer, Summers, and Waldman (1987)[10]. 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 so 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) [11] hypothesizes a positive relationship between

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[9] For example, initial margin requirements of 40% restrict brokers, financial institutions and other regulated lenders from lending in excess of 60% of the market value of a marginable equity security pledged as collateral.

[10] They construct expectations based on nonfundamental information, and in turn, nonfundamental factors affect equilibrium prices.

[11] Goldberg (1985) theorized as follows. If firms acting in the best interests of their shareholders respond

the initial margin requirements and stock return volatility by using the debt and tax model of Miller (1977)[12]. 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. Pyramiding and depyramiding process capture the destabilizing effects of initial margin requirements. In the point of view of efficient market, the initial margin requirements will affect the decisions of only a subset of investors, those for whom the requirements are binding, and that those investors will elect to shift their portfolios toward securities with a higher level of risk (Fortune, 2001).

Beaver (1968) insists that if changing the initial margin requirements level conveys information, they should be accompanied by changes in stock prices, which reflect changes in investor expectations. It is important to note that such changes in stock prices reflect not only a change of market expectations, but also a new consensus equilibrium price for securities. The above view suggests that changes of the initial margin requirements by the FRB disseminate information to market and if so, the market reaches to an equilibrium state.

With regard to recent theoretical paper, Chowdhry and Nanda (1998)[13] show that sufficiently

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to an initial margin increase by issuing new debt with the proceeds used to buy back, at current market prices, outstanding shares of their stock, then the resulting increased corporate leverage increases the dispersion of end-of-period share prices. After all, the initial margin requirements would have the opposite effects to those originally intended by the Securities Exchange Act of 1934 in U.S. As a result, increasing initial margin requirements may result in greater price variability and through tax-induced wealth effects may also reduce the amount of fund available to the private sector for investment in the stock of risky assets.

[12] Miller's Debt and Taxes theoretical model (1977) suggests that there is a positive relationship between margin requirements and stock returns volatility. For example, if FRB increases initial margin requirements, firms have the incentive to increases financial leverage to offset investor's decreased leverage abilities. After all, tax incentives encourage a new equilibrium where firms have higher debt, individual investors have lower margin debt, and volatility on aggregate stock returns is higher due to increased corporate leverage. Conversely, decreasing the initial margin requirements lead to lower corporate leverage and stock return volatility.

[13] Chowdhry and Nanda(1998) prove that by tightening margin requirements, price stability can always be achieved and but it may be socially optimal to choose the lowest feasible margin requirement that preserves stability. In addition, they demonstrate how price limits might enhance the stability of the market because price limits constrain the feasible set of prices at which trading is allowed to occur at any

large margin requirements are always associated with market stability and decreasing the margin requirements sufficiently may also ensure stability. Also Li (2007) documents that margin requirements have significant impacts on the equilibrium using two agents of heterogeneous beliefs with continuous time model. That is, higher margins could lead to a lower stock price volatility and stabilize the wealth distribution between these two agents in simulated economy.

In empirical findings, the results on matter of margin requirements are very mixed and controversial evidences as follows[14]. Largay and West (1973) found that the S&P 500 index rose before margin increases and fell before margin decreases and no significant abnormal return on the S&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 FR system changed Regulation of initial margin requirements in response to recent stock price movements. Grube, Joy, and Panton(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) find no relationship between margin changes and price volatility.

This debate was initiated in Hardouvelis (1988) and it continuous now. 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[15]. This behavior also is found in Japanese market. He concludes that speculative bubbles which

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moment in time. After all, an appropriate choice of price limits may be a useful device to rule out potentially destabilizing prices.

[14] Ths U.S margin requirements data is mainly used in order to examine this relation in previous many studies. For Japanese margin requirements policy, there is few paper such as Hardouvelis and Peristiani (1992), Kim and Oppenheimer (2002), and Lee and Yoo (1993). However, the empirical results in these papers are mixed.

15.During the bull market of the 1920's, investors borrowed heavily to finance their purchases of stock from brokers and then they bought many stocks at credit (Rappoport and White, 1994).

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's initial requirements using event study and conclude that margin increases (decreases) are negatively 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) document 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, i.e., the crash of 1987. Dat and Lewis(1997) also find that using a mean-reverting diffusion process for volatility, change of margin policy does not affect the subsequent market volatility in examining relationship between the volatility of crude oil futures market and the changes in initial margin requirements.

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.

After all, this evidence is consistent with the pyramiding/depyramiding hypothesis. 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 1934-1974 period 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.

Zhang, Seyedian, and Li (2005) examine the time series relation among margin borrowing, stock returns, and market volatility using margin credit balance as a measure of leverage based on U.S. S&P 500 index return during 1980-2001. They provide evidence that, over time, both margin borrowing and market volatilities are influenced by prior market returns and observe a strong market momentum effect. Also they find a significantly positive causal relation between prior market returns and both the contemporaneous margin borrowing as well as price volatility. This positive relationship is caused by the dependence of both margin borrowing and volatility on prior market returns. Thus they conclude that there is no relationship between leverage from margins and price volatility after controlling for the market momentum effect.

In summarizing many empirical results, the above statistical evidences show no clear response of stock returns to changes in Federal margin requirements. Some studies find a significant but brief effect on volatility and others provide a longer-lasting relationship between margin requirements and stock volatility. Now still other studies suggest that volatility is either unaffected by margin requirements or that it is positively or negatively correlated with margin requirements.

3. Institutional Characteristics[16]

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 and but regulation authority is

[16] This section refers Japan Fact Book (2001) issued by Tokyo Stock Exchange. See Fact Book in details. In addition, it comes from the explanations in Kim and Oppenheimer (2002) and Hardouvelis and Peristiani (1992).

different, i.e., FRB in U.S and Tokyo Stock Exchange controlled by the Ministry of Finance in Japan. Since 1951 imposed firstly, it has changed margin requirements over 100 times[17]. Because of more frequent of margin requirements, studying based on Japanese Tokyo Stock Exchange (TSE) may provide considerable statistical power than studying U.S. Stock Exchange.

The TSE is divided into three sections: The First Section consists of the largest stocks, and forms over 90% of the capitalized value of the TSE, and encompasses listings of the largest companies. Second section consists of newly listed company stocks. Foreign stock is traded in the Foreign Section. The Japanese margin system incorporates both an initial margin requirement and a maintenance margin and cash or stocks can be used to satisfy the initial margin requirement. Maintenance margins also are used after the transaction has occurred.

Margin in TSE is defined by collateral deposited to a securities firm, when borrowing money or stocks needed for margin transactions. For margin transactions, Article 156-3 of the Securities and Exchange law defines as follows: a margin transaction is the purchase/sale or other transaction of securities affected on credit extended to the customer by a securities company. Investors buying or selling stocks on margin must deposit warranty deposit (margin) equivalent to at least 30% of the transaction value with the securities company. The transaction must be settled within a predetermined period. 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. For whole market, margin requirement is to prevent over-heated trading of the stock market; and to raise the margin requirement, and to change the

[17] This paper covers recent data after 1970. Thus since 1970, the change of initial margin requirement was 68 times including cash.

loan value, and to increase cash portion of deposited margin.

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 are not changed up to now.

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

Effective date	Initial Margin	Effective date	Initial Margin	Effective date	Initial Margin
1/1/70	0.3	7/29/77	0.3	9/9/81	0.5
3/6/70	0.4	3/8/78	0.4	9/24/81	0.4
5/1/70	0.3	3/29/78	0.5	9/29/81	0.3
4/13/71	0.4	4/3/78	0.6	11/26/81	0.4
4/19/71	0.5	5/31/78	0.6	2/18/82	0.3
8/19/71	0.4	8/10/78	0.5	12/3/82	0.4
8/20/71	0.3	10/20/78	0.6	7/8/83	0.5
12/27/71	0.4	3/19/79	0.5	3/24/84	0.6
1/8/72	0.5	5/2/79	0.6	5/19/84	0.5
1/29/72	0.6	5/17/79	0.7	1/17/85	0.6
12/1/72	0.6	6/15/79	0.6	11/6/85	0.5
1/9/73	0.7	7/23/79	0.5	3/13/86	0.6
2/5/73	0.6	1/16/80	0.6	2/27/87	0.7
10/11/73	0.5	4/2/80	0.5	10/21/87	0.5
11/2473	0.4	4/26/80	0.6	3/17/88	0.6
10/3/74	0.3	6/11/80	0.5	6/3/88	0.7
1/13/76	0.4	12/17/80	0.4	6/3/89	0.6
2/2/76	0.5	3/14/81	0.3	2/21/90	0.5
7/30/76	0.4	3/26/81	0.4	2/27/90	0.4
12/22/76	0.5	4/2/81	0.5	9/6/90	0.3
1/27/77	0.6	4/15/81	0.6		
3/25/77	0.5	6/9/81	0.5		
6/4/77	0.4	7/3/81	0.6		total 63 times

4. Data and Stationary issues

The daily sample time period over which the model is estimated is from 1970 year to 1999 although official margin requirements were introduced in June 1, 1951. First of all, we use the daily returns for TOPIX index and NIKKE225 index to measure volatility at weekly frequency[18]. The daily data are collected from DATASTREAM.

The weekly sample data by geometric daily average contains 1,547 observations. Market returns are constructed from TOPIX index and NIKKEI 225 index, 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, including dividends. Table 2 summarizes the descriptive statistics for TOPIX and NIKKEI225 time series.

<Table 2> The summary of descriptive statistics for weekly time series TOPIX and NIKKEI225 based on daily return series

Variable	Mean	Median	Std	Min	Max	Skewness	Kutosis
TOPIX return(%)	0.033	0.0475	0.4755	-3.3162	2.1677	-0.6835	5.3329
NIKKEI225 return(%)	0.0301	0.0511	0.5148	-3.5524	2.2094	-0.6392	5.2154
TOPIX Std(%)	0.7538	0.5828	0.6264	0.0168	9.0758	3.5652	26.2245
NIKKEI225 Std(%)	0.9031	0.6854	0.7311	0.0470	9.2398	2.9742	17.0179
Margin Rate(%)	43.05	40	13.81	30	70	NA	NA

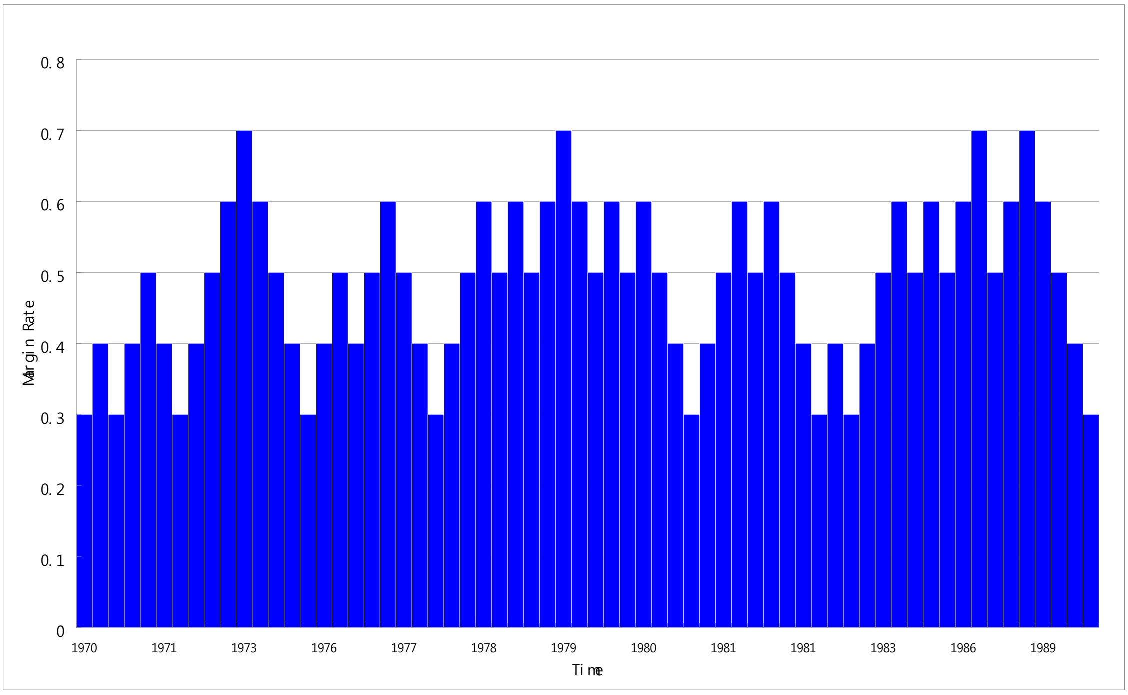
The data on initial margin requirements (M_t) are taken from Tokyo stock exchange data base and expressed in decimals. Thus initial margin requirements can vary from zero (0%) to one (100%). Figure 1 shows a plot of M_t (See Table 1 in detail). Over the sample period in this paper, Japanese authority changed official initial margin requirements 63 times. Since the first official

[18] To measure volatility, if monthly data are used, the effect on margin change may be tested inappropriately because the changes of initial margin requirements occur over twice at same month. In addition, daily data use is not proper because margin policy has long term effect (Hardouvelis and Theodossiou, 2002). Thus in addition to statistical considerations, weekly return data by daily average is appropriate. In weekly data cases, margin policy change is overlapped only two times.

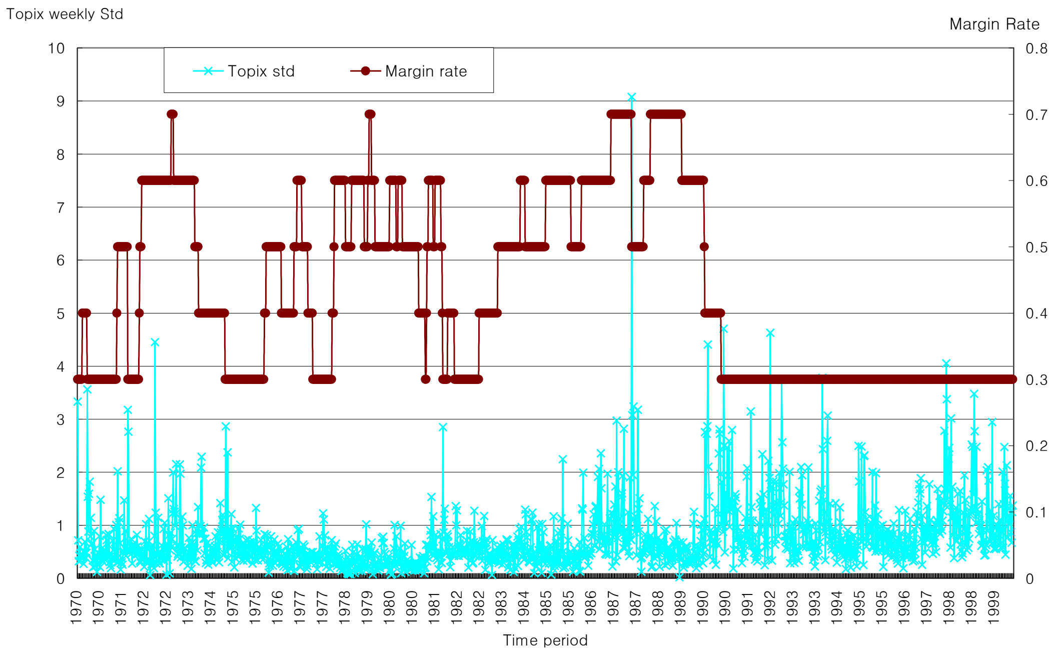
level of margin requirements in October 1934 was set at 45%(M_t=0.45), the current official level is 30% and has been in effect up to now after September 9, 1990. The highest level, 70% in initial margin requirements occurred at January 9, 1973, April 17, 1979, February 17, 1987, and Jun 3, 1988. The lowest level, 30% is in effect after September 6, 1990. Thus Japan authority did not change 30% at all until now since September 6, 1990.

Because Margin requirements' 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 nonzero. This problem is discussed in Hardouvelis and Theodossiou (2002). That is, 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.

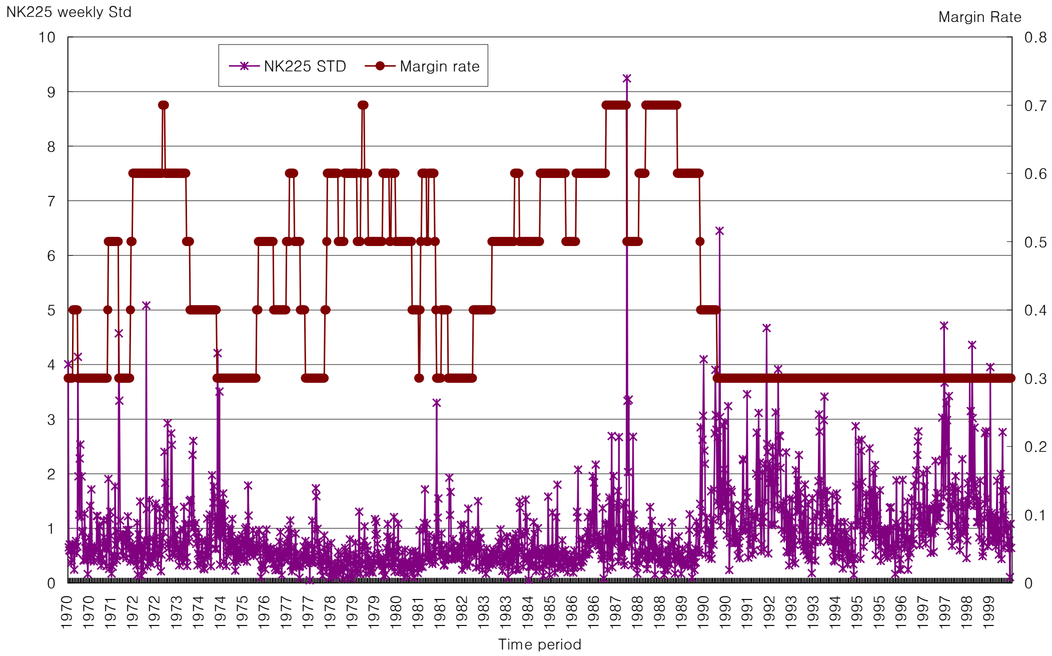
<Figure 1> Initial margin requirements in Japan stock market after 1970



<Figure 2> TOPIX Volatility and Margin Rate



<Figure 3> NIKEEI 225 Volatility and Margin Rate



Before doing 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 out, we employ a simple Phillips-Perron (1988) and Augmented Dickey-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:

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

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-statistic value of-3.36 for k=2; -0.0132 with t-statistic value of -3.45 for k=4; -0.0137 and t-statistic value of -3.47 for k=6; and -0.0157 and t-statistic value of -2.45 for k=12. All coefficients are significant statistically at 1%[19]. 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 NIKKEI225 index and run Phillips-Perron and Augumented 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 operator as well. The autoregressive model is as follows:

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

For TOPIX, we chose k=2, 4, 6, 12 and test $b_1=0$. 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 $b_1=0$. The estimated coefficient value, b_1 is -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 above, the unit root hypothesis is rejected definably[20] in TOPIX and NIKKEI225 series.

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[19] Also we implemented Phillips-Perron and Augmented Dicky-Fuller test. These test results are similar and the unit root hypothesis is rejected with tau value=-2.99(p-value=0.0365) significantly at 5% for Phillips-Perron test, and with tau value=-3.28(p-value=0.0165) significantly at 5%.

[20] We conducted Phillips-Perron and Augumented Dickey-Fuller test. These test results are similar and the unit root hypothesis is rejected with tau=-24.30(p-value=0.0001) in Phillips-Perron test and tau=-17.50(p-value=0.0001) in Augumented Dickey-Fuller test for TOPIX, and with tau=-22.95(p-value=0.0001) in Phillips-Perron test and tau=-16.47(p-value=0.0001) in Augumented Dickey-Fuller test for NIKKEI225. All are significant at 1%.

After all, because a unit root in both the margin series and volatility series doe 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, i.e., biased coefficient estimates. Because of possibility of these phenomena, prior many researchers examine the relation between margin requirement series and volatility series in first-difference form. Later, we handle and test this issue in more detail, and also compare with the results of each model.

As shown the results of regression in levels of weekly volatility on margin requirement for TOPIX in Table 3, for model 1, autocorrelation problem comes up from and we see it from DW (Durbin-Watson) statistic, which does not include any lags of the explanatory variable.

5. Regression analysis in levels

In this section, 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[21].

It is a daily volatility measure during every week t. In contrast, subsequently either the absolute weekly returns in week t is used as a proxy for the volatility of week t. The data

[21] For example, if Japanese authority changes 0.3 and 0.4 twice at same week, margin requirement is 0.35 by (0.3+0.4)/2. Fortunately, overlapping data is just 2 cases.

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:

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

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

where $\sigma_{d,t}$ is the weekly values of daily volatility at t; and $M_{d,t}$ is margin requirement level; and $\sigma_{d,t-1}$ and $\sigma_{d,t-2}$ is the weekly values of daily volatility at (t-1), (t-2) respectively; and $| R_{d,t-1} |$ is the volatility shock at (t-1) measured by the absolute value of the average daily return within the week, $R_{d,t-1}$ is the weekly return at (t-1) by averaging daily returns to control 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, i.e., causation relation between margin level and volatility, we do Granger causality test using two equations specified above equation (3), (4)[22]. In test result, null hypothesis that margin rate doe not Granger Cause volatility is rejected and statistically significant at 1% with F-value, 6.6568 for TOPIX and with F-value, 15.0725 for NIKKEI225. Finally, we make sure that margin requirement level affects stock return volatility in both indexes.

Above equation (3) with volatility as dependent variable is analyzed and estimated based on

[22] In Hardouvelis and Theodossiou(1989, 2000, and 2002) paper, volatility as dependent variable is predetermined and causation relation between margin levels and volatility is not tested at all.

OLS with Newey-West HAC. Especially, the main goal in this regression run 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 in above section, additionally we run bootstrap simulation whether findings of OLS are robustness 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 robustness by using bootstrap simulation method.

The empirical results are summarized in Table 3 and Table 4. Model 1 of Table 3 and Table 4 shows the simple univariate OLS of weekly volatility averaged by the daily return standard deviation. Because the margin coefficients at (t-1), β_5's are negative and statistically significant at 1% for both TOPIX and NIKKEI225, these results are consistent with that the high initial margins are associated with lower subsequent volatility, i.e., today stock market volatility is negatively affected by past initial margin changes. The coefficients, β_5,-0.5298(TOPIX) and -1.4227(NIKKEI225) indicate that increasing margin requirements from 0.5 to 0.6(or from 1.4 to 1.5 at annual) is associated with a decline of volatility by 0.05298, or 5.298(0.14227 or 14.227 at annual) basis points.

Therefore, we confirm that past margin requirements are a negative effect on stock volatility in Japanese stock market and it is consistent with Hardouvelis and Theodossiou (1989, 1990, and 2002) findings in U.S stock market.

This result, however, could be not reliable because model 1 in both series has a serious serial autocorrelation and this is evidence by DW statistic value of 1.1679[23]. To check it out, the

[23] If DW statistic value is close to value of 2, then, in general, there is no autocorrelation in time series. For this paper, since DW statistic value, 1.1679 is very far from 2 in this model 1, we conclude that there is autocorrelation in model 1 and as a result, spurious relationship.

bootstrap simulation is used. In bootstrap simulation, we test under the null hypothesis that volatility is not correlated to margins. An average coefficient estimate in bootstrap is -0.4092 with t-value=-6.40 for TOPIX and -0.7772 with t-value=-8.94 for NIKKEI225; and as result, both are significant statistically and economically at 1%. Under null hypothesis that mean of Bootstrap coefficient is equal to coefficient of OLS regression, we conclude that OLS result may not be spurious with accepting the null hypothesis because the bias statistic is small value than theoretical value of distribution.

As a result, with rejecting the null hypothesis, volatility and margins are related each other in both markets. However, estimated coefficient values in bootstrap are smaller than coefficient values of OLS, and but t-values in bootstrap are bigger than t-values of OLS. This finding implies that the result of OLS could be inferred inappropriately.

Nevertheless, the results of two regression methods for both series have same direction in coefficient sign in our paper. As a matter of fact, Thus bootstrap suggests that OLS does not mislead our results and but overestimate the effect on margin requirements in this paper. We conclude that the model 1 does not have a serious bias problem, but it does have an inference problem due to a serial correlation in the residuals or any other model misspecification.

To fix some problems in inferring model, we add up additional explanatory variables to model 2 of Table 3 and 4. That is, model 2 in Table 3 and 4 is enhanced by adding two lags of volatility, $\sigma_{d,t-1}$, $\sigma_{d,t-2}$, and one lag of the volatility shock, proxy $|R_{d,t-1}|$. The serial correlation in model 1 is absorbed in these variables. We confirm no serial correlation from DW in model 2. For model 2, the margin requirement coefficient, β_5 's for both markets continue to be negative and significant at 1%, but size is smaller from -0.5298 in Model 1 to -0.2343 in Model 2 for TOPIX and from -1.4227 in Model 1 to -0.4328 in Model 2. However, because there are positive autoregressive coefficients and all are significant at 1%, i.e., $\beta_1 = 0.2319$ and

$\beta_2 = 0.136$ for TOPIX and $\beta_1 = 0.2811$ and $\beta_2 = 0.1555$ for NIKKEI225, 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/(1-0.2319-0.136)=-0.3707 for TOPIX, and $\beta_5/(1-\beta_1-\beta_2)$ =-0.4328/(1-0.2811-0.1555)=-0.7682 for TOPIX. These values are not far for TOPIX from the coefficient of -0.5298 and but far for NIKKEI225 from the coefficient of -1.4227 estimated in model 1of Table 3 and 4.

In bootstrap simulation for model 2 of Table 3 and 4, the above results are also confirmed, but average coefficient, -0.2065 and -0.3566 for both markets are smaller than -0.2343 and -0.4328 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 the model 3, model 4, and model 5 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-values of OLS is not affected by the Granger-Newbold spurious problem.

As mentioned by Hardouvelis(1990, 2002), the weak statistical significance with smaller t values of the margin requirement coefficients in model 2 of Table 3 and 4 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's financial authority to change margin requirements and in turn, could be correlated with volatility. This logic implies that the asymmetric relationship may be exist, which means that the models 1 and 2 of Table 3 and 4 would be misspecified even if they were enhanced by other control variables(Hardouvelis and Theodossiou, 2002).

For model 3 of Table 3 and 4, we control 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 t[24]. The estimated coefficient, β_4 's with -0.2394(t-value -6.68) for TOPIX and -0.2775(t-value -6.57) for NIKKEI225 in model 3 of Table 3 and 4 are negatively associated and significant statistically at 1%. Thus these results are consistent with prior study. After controlling $R_{d,t-1}$, 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 of Table 3 and from -3.90 to -4.14 for NIKKEI225 of Table 4. The long run relation between margins and volatility in model 3 of Table 3 and 4 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)=-0.842 for NIKKEI225. These values are very close to coefficient of -0.5298 for TOPIX and but far from -1.4227 for NIKKEI225 estimated in model 1 of Table 3 and 4.

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 NIKKEI225, where 0.4305 is the average margin requirements during 1970-1999; and 0.989 and 1.1488 are the average daily volatility in both indexes. As mater of fact, interestingly, this evidence documents that the effect of margin requirements on volatility is bigger in NIKKEI225 than in TOPIX. But these effects are smaller than as -0.35% in U.S by finding of Hardouvelis and Theodossiou (2002).

Now we investigate on whether there is a possible asymmetric relation between margin requirements and volatility or not. Model 4 of Table 3 and 4 is to test presence of an asymmetry in terms of the sign and size of the price change weekly at (t-1). Model 4 could enhance model 2 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 $\beta_5 + \beta_6 R_{d,t-1}$ and variation according to both the sign and the size of the earlier stock price change is also allowed.

[24] For this result, see Black(1976), Christie(1982), Campbell and Hentschel(1992), Duffee (1995), and Gallant, Rossi, and Tauchen(1992), Hardouvelis and Theodossiou (2002).

Both coefficients β_5 and β_6 for TOPIX and NIKKEI225 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 NIKKEI225. They are negatively significant at 1% or 5% in both indexes. 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 5 of Table 3 and 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_4 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 indexes 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 $(R_{d,t-1} \cdot M_{t-1})$.

<Table 3> The result of regression analysis in levels for TOPIX

This Table is regression result of weekly volatility on margin requirement. The regression with Newey-West HAC standard error is estimated during 1970-1999. Estimated model in this paper is as follows: $\sigma_{d,t} = \beta_0 + \beta_1\sigma_{d,t-1} + \beta_2\sigma_{d,t-2} + \beta_3 |R_{d,t-1}| + \beta_4 R_{d,t-1} + \beta_5 M_{t-1} + \beta_6(R_{d,t-1} \cdot M_{t-1}) + e_{s,t}$. The dependent variable, $\sigma_{d,t}$ is the weekly standard deviation at week t, computed using daily return during week t Parentheses, ( ) is t-value for regression with Newey-West HAC and bracket, [ ] is the bias t statistics from bootstrap simulation under null hypothesis that average of Bootstrap coefficient is equal to coefficient of OLS regression. { } is t-value from bootstrap simulation with replacement.

Coefficients	Model 1		Model 2		Model 3		Model 4		Model 5	
β_0	0.9374	***	0.3346	***	0.4064	***	0.3984	***	0.4126	***
	(9.62)		(6.64)		(8.37)		(8.13)		(8.37)	
β_1			0.2319	***	0.2240	***	0.2187	***	0.2306	***
			(7.77)		(7.25)		(6.95)		(7.41)	
β_2			0.1360	***	0.1694	***	0.1698	***	0.1673	***
			(4.78)		(5.88)		(5.88)		(5.81)	
β_3			0.5397	***	0.4691	***	0.4837	***	0.4595	***
			(6.50)		(6.66)		(6.72)		(6.54)	
β_4					-0.2394	***			-0.3816	***
					(-6.68)				(-3.49)	
Bootstrap(β_4)					-0.1401	***			-0.2995	***
					{-4.81}				{-2.98}	
					[0.029]				[0.100]	
β_5	-0.5298	***	-0.2343	**	-0.2851	***	-0.5184	***	-0.3670	
	(-2.53)		(-2.14)		(-2.49)		(-5.99)		(-1.46)	
Bootstrap (β_5)	-0.4092	***	-0.2065	***	-0.2317	***	-0.1961	***	-0.2292	***
	{-6.40}		{-3.50}		{-3.82}		{-3.18}		{-3.80}	
	[0.064]		[0.059]		[0.061]		[0.062]		[0.060]	
β_6							-0.2139	**	-0.2546	**
							(-1.94)		(-2.26)	
Bootstrap(β_6)							-0.2558	***	-0.3697	***
							{-3.83}		{-2.75}	
							[0.067]		[0.011]	
Adj R^2	0.0142		0.2764		0.3086		0.3015		0.3094	
F-Value	20.99	***	148.46	***	138.82	***	134.29	***	116.31	***
DW for residual	1.1679		2.11		2.15		2.14		2.16	

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

<Table 4>The result of regression analysis in levels for NIKKEI225

This Table is regression result of weekly volatility on margin requirement. The regression with Newey-West HAC standard error is estimated during 1970-1999. Estimated model in this paper is as follows: $\sigma_{d,t} = \beta_0 + \beta_1\sigma_{d,t-1} + \beta_2\sigma_{d,t-2} + \beta_3 |R_{d,t-1}| + \beta_4 R_{d,t-1} + \beta_5 M_{t-1} + \beta_6(R_{d,t-1} \cdot M_{t-1}) + e_{s,t}$. The dependent variable, $\sigma_{d,t}$ is the weekly standard deviation at week t, computed using daily return during week t. Parentheses, ( ) is t-value for regression with Newey-West HAC and bracket, [ ] is the bias t statistics from bootstrap simulation under null hypothesis that average of Bootstrap coefficient is equal to coefficient of OLS regression. { } is t-value from bootstrap simulation with replacement.

Coefficients	Model 1	Model 2	Model 3	Model 4	Model 5
β_0	1.5137 ***	0.5470 ***	0.5486 ***	0.5384 ***	0.5545 ***
	(13.53)	(9.11)	(9.44)	(9.23)	(9.53)
β_1		0.2811 ***	0.2512 ***	0.2449 ***	0.2575 ***
		(9.11)	(7.72)	(7.43)	(8.08)
β_2		0.1555 ***	0.1716 ***	0.1729 ***	0.1694 ***
		(5.83)	(6.15)	(6.19)	(6.07)
β_3		0.4621 ***	0.4523 ***	0.4654 ***	0.4453 ***
		(4.91)	(5.35)	(5.38)	(5.33)
β_4			-0.2775 ***		-0.4208 ***
			(-6.57)		(-3.64)
Bootstrap(β_4)			-0.2029		-0.4055 ***
			{-4.81}		{-3.72}
			[0.001]		[0.005]
β_5	-1.4227 ***	-0.4328 ***	-0.4860 ***	-0.6421 ***	-0.3868
	(-6.19)	(-3.90)	(-4.14)	(-6.27)	(-1.54)
Bootstrap(β_5)	-0.7772 ***	-0.3566 ***	-0.3942 ***	-0.3345	-0.2292 ***
	{-8.94}	{-4.70}	{-5.17}	{-4.22}	{-3.80}
	[0.001]	[0.004]	[0.005]	[0.006]	[0.003]
β_6				-0.4020 ***	-0.4560 ***
				(-3.62)	(-4.07)
Bootstrap(β_6)				-0.3809 ***	-0.4806 ***
				{-5.05}	{-2.14}
				[-0.002]	[-0.004]
Adj R^2	0.0725	0.3161	0.3533	0.3462	0.3539
F-Value	121.72 ***	179.42 ***	169.75 ***	164.54 ***	142.01 ***
DW for residual	1.15	2.10	2.15	2.13	2.15

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

6. Is there a misspecification in regression in first-difference?

In earlier model test, we identified that regression model in levels is correctly specified. Nevertheless, regression model in first-difference has been used in many prior 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 3 in Table 1 is chosen 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 NIKKEI225 index is as follows:

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

where the these notations in this equation are same as defined above. Due to the problem that the M_t series is highly autocorrelated, 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 NIKKE225, 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 3 of Table 3 and 4. 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 NIKKEI225.

Due to multicollinearity, the two coefficients for both indexes 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 NIKKEI225 and these numbers are close to the β_5 in model 3 of Table 3 and 4. 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 NIKKEI225. These numbers are also close to the -0.386 and -0.7498, respectively in model 3 of Table 3 and 4.

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

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

$$+ (\beta_5 + \beta_6) M_{t-1} - \beta_6 \Delta M_{t-1} + e_{s,t} \qquad (6)$$

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 is misspecified. As specified in Hardouvelis and Theodossiou (2002), equation (6) is specified to compare equation (5).

Table 5 and 6 report regression estimates for equation (6). Model 1 and 2 of Table 5 and 6 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[25] 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 with 2.1665(t-value=1.22) and 1.6284(t-value=1.80) for TOPIX; and 2.3128(t-value=1.28) and 1.774(t-value=1.80) for NIKKEI225, respectively. These values all are positive and, the coefficients in model 2 and 3 for TOPIX, and model 2 for NIKKEI225 are statistically significant at 10% as well. Hardouvelis and Theodossiou (2002) argue that estimating model 1 and 2 of Table 5 and Table 6 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 5 and 6, 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 indexes is close to -0.2382 for TOPIX and identical to -0.4374 for NIKKEI225 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 3 in Table 3 and 4.

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 prior researchers have used regression model in first-difference form and could most likely omit the lagged levels of volatility and margin requirements. Estimating regression model in first-difference may lead to serious misinterpretation of the estimated coefficients. Based on our findings above, the true associated with margin requirements and volatility is detected and appeared from regression model in levels.

[25] If DW statistic value closes to 2, there is no serial correlation. In addition, in Ljung and Box test(LB) and modified LB test, these test results are same.

<Table 5 > Regressions of Changes in Weekly TOPIX Volatility on Margin Requirement

This table represents the result of volatility changes on margin requirement for TOPIX index. The estimated regression with Newey-West HAC is as follows: $\Delta\sigma_{d,t} = \beta_0 + (\beta_1 + \beta_2 - 1)\sigma_{d,t-1} - \beta_2\Delta\sigma_{d,t-1} + \beta_3 | R_{d,t-1} | + \beta_4 R_{d,t-1} + (\beta_5 + \beta_6)M_{t-1} - \beta_6\Delta M_{t-1} + e_{s,t}$ This equation is based on equation (5) and Δ is first difference operator. ( ) is t-value with robust error.

Coefficients	Model 1	Model 2	Model 3
β_0	0.0004	-0.0283	0.406***
	(0.05)	(-1.05)	(8.35)
$(\beta_1 + \beta_2 - 1)$			-0.6049***
			(-17.19)
$-\beta_2$		-0.4203***	-0.1673***
		(-13.52)	(-5.82)
β_3		0.1051	0.4752***
		(1.32)	(6.78)
β_4		-0.2229***	-0.2470***
		(-4.88)	(-6.98)
$(\beta_5 + \beta_6)$			-0.2406***
			(-2.18)
$-\beta_6$	2.1665	1.6284*	1.0177*
	(1.22)	(1.80)	(1.83)
Adjusted R^2	0.0041	0.1841	0.3773
F-value	7.43***	88.12***	156.95***
DW	2.79	2.29	2.16

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

<Table 6> Regressions of Changes In Weekly NIKKEI 225 Volatility On Margin Requirement

This table represents the result of volatility changes on margin requirement for TOPIX index. The estimated regression with Newey-West HAC is as follows: $\Delta\sigma_{d,t} = \beta_0 + (\beta_1 + \beta_2 - 1)\sigma_{d,t-1} - \beta_2\Delta\sigma_{d,t-1} + \beta_3 | R_{d,t-1} | + \beta_4 R_{d,t-1} + (\beta_5 + \beta_6) M_{t-1} - \beta_6 \Delta M_{t-1} + e_{s,t}$ This equation is based on equation (5) and Δ is first difference operator. ( ) is t-value with robust error.

Coefficients	Model 1	Model 2	Model 3
β_0	-0.0001	-0.0191	0.5474***
	(-0.001)	(-0.65)	(9.46)
$(\beta_1 + \beta_2 - 1)$			-0.5756***
			(-13.91)
$-\beta_2$		-0.4132***	-0.1696***
		(-14.09)	(-6.05)
β_3		0.0706	0.4574***
		(0.92)	(5.44)
β_4		-0.2524***	-0.2846***
		(-5.05)	(-6.85)
$(\beta_5 + \beta_6)$			-0.4374***
			(-3.92)
$-\beta_6$	2.3128	1.774*	1.0301
	(1.28)	(1.80)	(1.47)
Adjusted R^2	0.0044	0.1869	0.3703
F-value	6.752***	88.502***	150.77***
DW	2.7854	2.2882	2.1511

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

7. An asymmetric effect on across bull and bear markets

In this section, we investigate the possible existence of an asymmetric relation between margin requirements and stock market volatility across bull and bear markets. In above section, 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 three week and longer.

By 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 four possible values, N=3, 4, 5, and 6 weeks.

Table 7 and 8 report the results estimated for these periods. For N=3, there are 60 disjoint bull periods, which means periods consisting of least three consecutive positive weekly returns. These periods contain 302 weekly observations, or 19.52% of the sample. The bear market periods are 30 and number of observations is 151, or 9.76% of the sample. Other N is same as above. We see that as the horizon N increases, the number 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 3 of Table 3 we include two interaction terms, ($BULL_t$* M_{t-1}) and ($BEAR_t$* M_{t-1}). Model 3 is chosen because it controls for the leverage effect. The general regression equation is as follows:

$$\sigma_{d,t} = \beta_0 + \beta_1\sigma_{d,t-1} + \beta_2\sigma_{d,t-2} + \beta_3 | R_{d,t-1} | + \beta_4 R_{d,t-1} + \beta_M M_{t-1}$$

$$+ \beta_{MBull} Bull_t M_{t-1} + \beta_{MBear} Bear_t M_{t-1} + e_{s,t} \qquad (7)$$

Table 7 and 8 present the regression results estimated for all four bull and bear periods. For bull periods, the coefficients β_{MBull} are positive for both markets, implying that in both markets the margin requirements are positively correlated to volatility and this relationship is more stronger as N goes to N=6 and these coefficients are statistically significant at 1%, 5%, and 10% except N=3 for TOPIX. This finding implies that there is no pyramiding-depyramiding effect in bull periods of Japanese stock market. 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. Therefore, when it is in bull state, the government policy tool of margin requirements is useless.

The sum of $\beta_M + \beta_{MBull}$, is close to 0 for TOPIX and NIKKEI225 as N goes to 6[26], suggesting that the whole short-run relationship between margin requirements and volatility disappears during bull periods in both markets.

For bear periods, the strength of associated with margin requirements and volatility is weaker than in bull periods for both markets except N=3, N=5, N=6 for TOPIX, and N=3, N=5 for NIKKEI225. Also the coefficients β_{MBear} are positive for both markets except N=6 for TOPIX and statistically significant at 5% and 10% except N=4 for TOPIX and N=4, 6 for NIKKEI225. This finding implies that there is no evidence of asymmetric process as pyramiding and depyramiding effect during bear periods in Japanese stock market. This result is same to bull periods.

In contrast to bull periods, the sum of $\beta_M + \beta_{MBull}$, is diverge for both markets as N goes to

[26] For bull periods, the sum of $\beta_M + \beta_{MBull}$ is -0.1877(N=3), -0.2043(N=4), -0.078(N=5), and -0.0504(N=6) for TOPIX; and -0.2552(N=3), -0.1803(N=4), 0.008(N=5), and -0.0977(N=6) for NIKKEI225.

6[27], implying that the total short-run association on margin requirements and volatility turns to negative. As these results, interestingly we find that the negative short-run of relation between margins and volatility strengthens marginally relative to normal periods in N=6 for TOPIX, and weakens marginally relative to normal periods for N=6 for NIKKEI225.

Therefore, we conclude that there is no evidence of the asymmetric process, i.e., pyramiding and depyramiding during the Bull and Bear periods in Japanese stock market (TOPIX and NIKKEI225)[28], and but there is evidence of the asymmetric process during normal periods. This finding is inconsistent with results of Japanese stock market in Hardouvelis & 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. Especially it is contrast to what Hardouvelis (1990), and Kupiec and Sharpe (1991) point out that margin requirements are supposed to primarily purpose moderating speculative behavior by imposing a cost impediment. This explanation may be fitted to only normal stock market.

[27] For bear periods, the sum of $\beta_M + \beta_{MBull}$ is -0.1088(N=3), -0.2584(N=4), 0.324(N=5), and -1.1006(N=6) for NIKKEI225 for TOPIX; and -0.2922(N=3), -0.2357(N=4), 0.1258(N=5), and -0.373(N=6) for NIKKEI225.
[28] Additionally we extend time horizon N to 8, 12, and 14 to confirm this results again and also reach to same result.

<Table 7> The results of margin requirements and TOPIX Volatility across Bull and Bear Markets

This table presents margin requirement effect on volatility during each bull and bear markets. The estimated regression with Newey-West HAC is as follows: $\sigma_{d,t} = \beta_0 + \beta_1 \sigma_{d,t-1} + \beta_2 \sigma_{d,t-2} + \beta_3 |R_{d,t-1}| + \beta_4 R_{d,t-1} + \beta_M M_{t-1} + \beta_{MBull} Bull_t M_{t-1} + \beta_{MBear} Bear_t M_{t-1} + e_{s,t}$ The dependent variable, $\sigma_{d,t}$ is the weekly standard deviation at week t, computed using daily return during week t.. Parentheses, ( ) is t-value for regression with Newey-West HAC.

	N=3	N=4	N=5	N=6
Bull number of Obs.	302(19.52%)	188(12.15%)	121(7.82%)	80(5.17%)
Bull periods	60	38	24	16
Bear number of Obs.	151(9.76%)	73(4.71%)	34(2.19%)	14(0.90%)
Bear periods	30	15	7	3
β_0	0.4106***	0.4257***	0.4138***	0.4213***
	(8.33)	(9.35)	(8.36)	(8.58)
β_1	0.2209***	0.2204***	0.2211***	0.2235***
	(7.18)	(7.22)	(7.03)	(7.27)
β_2	0.1682***	0.1687***	0.1693***	0.1711***
	(5.82)	(5.83)	(5.89)	(5.93)
β_3	0.471***	0.4655***	0.4626***	0.4719***
	(6.66)	(6.48)	(6.65)	(6.69)
β_4	-0.2366***	-0.2499***	-0.2375***	-0.2541***
	(-6.29)	(-6.87)	(-6.70)	(-6.84)
β_M	-0.2702**	-0.3154***	-0.2699***	-0.2811***
	(-2.20)	(-3.49)	(-2.33)	(-2.46)
β_{MBull}	0.0825	0.3111*	0.1919**	0.2307**
	(1.18)	(2.00)	(2.32)	(2.46)
β_{MBear}	0.1614*	0.2570	0.5939*	-0.8195**
	(1.34)	(1.07)	(1.55)	(-2.30)
Adjusted R^2	0.309	0.314	0.3119	0.3111
DW	2.16	2.16	2.15	2.16
F value	99.66***	102.06***	100.98***	100.62***

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

<Table 8> The result of margin requirements and NIKKEI 225 volatility across Bull and Bear Markets

This table presents margin requirement effect on volatility during each bull and bear markets. The estimated regression with Newey-West HAC is as follows: $\sigma_{d,t} = \beta_0 + \beta_1 \sigma_{d,t-1} + \beta_2 \sigma_{d,t-2} + \beta_3 |R_{d,t-1}| + \beta_4 R_{d,t-1} + \beta_M M_{t-1} + \beta_{MBull} Bull_t M_{t-1} + \beta_{MBear} Bear_t M_{t-1} + e_{s,t}$ The dependent variable, $\sigma_{d,t}$ is the weekly volatility at week t, computed using averaged daily return standard deviation during daily t. Parentheses, ( ) is t-value for regression with Newey-West HAC.

	N=3	N=4	N=5	N=6
Bull number of Obs	273(18.74%)	161(10.41%)	95(6.14%)	59(3.91%)
Bull periods	55	32	19	12
Bear number of Obs	145(9.37%)	70(4.52%)	37(2.39%)	19(1.23%)
Bear periods	29	14	7	4
β_0	0.5619***	0.5688***	0.5768***	0.5625***
	(9.8)	(10.02)	(10.17)	(9.70)
β_1	0.2461***	0.2464***	0.2466***	0.2494***
	(7.67)	(7.59)	(7.54)	(7.66)
β_2	0.175***	0.1717***	0.1674***	0.1754***
	(6.22)	(6.13)	(5.98)	(6.11)
β_3	0.4563***	0.4543***	0.4530***	0.4516***
	(5.36)	(5.35)	(5.34)	(5.35)
β_4	-0.2854***	-0.286***	-0.2836***	-0.2839***
	(-6.62)	(-6.78)	(-6.82)	(-6.69)
β_M	-0.5402***	-0.5232***	-0.5326***	-0.4801***
	(-5.39)	(-5.33)	(-5.53)	(-4.25)
β_{MBull}	0.285***	0.3429***	0.5406**	0.3824***
	(2.80)	(2.16)	(2.14)	(2.91)
β_{MBear}	0.248**	0.2875	0.6584**	0.1071
	(1.82)	(1.11)	(2.09)	(0.21)
Adjusted R^2	0.358	0.358	0.3634	0.3553
DW	2.15	2.16	2.14	2.15
F value	124.29***	124.21***	126.92***	122.48***

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

8. An EGARCH model for testing asymmetric effect

In this section, we adapt a complementary model as EGRCH 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 based on daily observations. 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). However, here are different things. In contrast, we measure weekly stock market volatility for TOFIX index and NIKKEI225 index based on daily observations even though we adapt the methodology of Kupiec (1989) and Hardouvelis and Theodossiou (2002). They used the volatility measures for daily, weakly, and monthly observations alone. In general, initial requirement policy changes, in fact, rely nearly on weekly base in Japanese stock market. This policy effect could be activated each week, but this policy would affect daily stock market returns. Hence if weekly volatility measure based on daily stock market returns is employed, we might identify more clearly the relationship between the initial requirements and stock market return volatility. If monthly volatility based on monthly observations is adopt, the effect on margin requirement policy change could be diluted because month is too long period to capture the effect of margin requirement change. If daily volatility based on daily observations is employed, also the effect on margin requirement change could be underestimated to find the long term effect on the margin requirement change and volatility because the margin requirement change is less often event. Thus the weekly volatility measure based on daily observations in this paper has more advantage than those used by Hardouvelis and Theodossiou (2002).

8.1 The conditional mean of stock market returns

In the point of view with statistical considerations, an empirical model of stock market return and volatility should allow the conditional expected excess return to be linearly related to conditional nondiversifiable risk. As specified by Hardouvelis and Theodossiou (2002), the conditional mean for stock market returns is specified as follows:

$$r_{m,t} = \mu_{m,t} + e_t$$
$$\mu_{m,t} \equiv E(r_{m,t} \mid \Omega_{t-1})$$
$$\mu_{m,t} = \beta_0 + \beta_M M_{t-1} + \sum_{n=1}^{N} \beta_n r_{m,t-n} + \gamma \sigma_t^2 \qquad (8)$$

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 $\sigma_t^2 \equiv \mathrm{var}\left(r_{m,t} \mid \Omega_{t-1}\right)$ 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 investors require in order to invest in the stock market may be diminished.

8.2 The conditional variance of stock market returns

Given the asymmetry in the market volatility, we specify the extended Nelson's(1992) EGARCH-M model 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 $g(z_{t-1}) = |z_{t-1}| - E|z_{t-1}| + \delta \cdot z_{t-1}$,

In equation (9), $a_M M_{t-1}$ term captures the influence of a change in margin requirements during normal periods. Also each terms for ($a_{MBear} Bear_t \cdot M_{t-1}$) and ($a_{MBull} Bull_t \cdot M_{t-1}$) 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, i.e., $E\left[g(z_{t-1})\right] = 0$, $g(z_{t-1})$ under stationary of the conditional variance has a transitory impact on current conditional volatility and no impact on unconditional volatility(Hardouvelis & 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 $|z_{t-1}| - E|z_{t-1}|$ 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[29]. As a result, a negative δ implies that the volatility rises more following "bad news" than "good news."

Furthermore, from equation (9), the expected value of the long-run elasticity of volatility with respect to a permanent change in margin requirements during normal periods is as follows:

$$E_t\left[\lim_{k\to\infty}\frac{\partial\ln(\sigma_{t+k})}{\partial\ln(M_{t-1})}\right]=0.5\frac{(\alpha_M M_{t-1})}{(1-\gamma)} \tag{10}$$

8.3 The distribution of the error term of conditional returns

In practical distribution from market returns, the conditional distribution is not simply assumed to be normal. Instead, we model an empirical test with the generalized error distribution (GED) as follows:

$$f(r_{m,t}\mid\mu_t,\sigma_t,v)=\frac{1}{2}\frac{v}{\sigma_t}\Gamma\left(\frac{3}{v}\right)^{1/2}\exp\left\{-\left(\frac{\Gamma(3/v)}{\Gamma(1/v)}\right)^{\frac{v}{2}}\left|\frac{e_t}{\sigma_t}\right|^{v}\right\} \tag{11}$$

where $\Gamma(\cdot)$ is the gamma function and v is a scale parameter that controls the shape of GED. If v=2, the GED gives the normal distribution and if v=1, it gives the Laplace distribution.

To estimate the parameter vector $\Theta\equiv(\beta_0,...,v)$, the following sample log-likelihood function is maximized.

$$L(\Theta\mid k,p,q)=\sum_{t=1}^{T}\ln f(\mu_{m,t},\sigma_t,v\mid r_{m,t}) \tag{12}$$

The log-likelihood function of equation (12) is highly nonlinear in the parameters. Therefore,

[29] For example, if the asymmetry coefficient, $\delta\cdot z_{t-1}$ 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.

we employ GED distribution to estimate EGARCH-M model.

9. The results from EGARCH model

We estimate EGARCH-M with GED distribution for daily and weekly returns. The results are shown in Table 9 and 10 for daily return and in Table 11 and 12 for weekly return. Each table has two panels. Panel A presents the estimates of the conditional mean equation, and Panel B shows the estimates of the conditional volatility equation.

9.1 The estimation result from the conditional mean equation of stock returns

We interpret the estimated results for the TOPIX and NIKKEI225 daily and weekly return series. When daily stock market returns are modeled as AR (2), the estimated coefficient for AR(2) is not significant at all for daily return series[30]. Thus the second term of AR in return series is dropped and we setup EGARCH-M model with AR (1) In Table 9. However, we use EGARCH-M model with AR (2) specification for weekly return series in Panel A of Table 11 and 12 because the second term is significant statistically at 1%.

Panel A of Table 9, 10, 11 and 12 for TOPIX and NIKKEI225 index shows that the coefficient λ for conditional variance is positive but not statistically significant in Model 1 regardless of both markets and also in Model 2 of Table 9 with daily frequencies, implying that there is very weak positive linkage between conditional means returns and conditional stock market volatility[31].

However, Model 2 of Table 10, 11 and 12 shows that this linkage is stronger in including

[30] Here we do not report the result of AR(2) model in this paper.
[31] From this evidence, we drop conditional volatility term in incorporating model 3, 4, 5, 6 in Table 9.

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 key role to condition mean return.

For the association of margin requirements and conditional mean returns in Model 2 of Table 9, 10, 11 and 12, interestingly the coefficients, β_M 's are even positive with 0.186(TOPIX) and 0.3076(NIKKEI225) for daily frequencies; and 0.1582(TOPIX) and 0.2454(NIKKEI225) for weekly frequencies. Also all coefficients of β_M in Model 2 are positively significant at 1% and 5%, implying that in daily and weekly 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 NIKKEI225 index than in TOPIX index.

Thus this result indicates that an increase in margin requirements is associated with an increase in the required rate of return on the aggregate stock market at daily and weekly periods. As mentioned by Hardouvelis (1990), the financial authority raises margins 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 US stock market.

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

Panel B in Tables 9, 10, 11, and 12 shows the estimated results for the conditional variance of stock market returns. Firstly, we exclude the margin variable from the Model 1. In the daily and weekly frequencies of Table 9-12, 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. This level of persistence in volatility of Japanese stock market is less high than the persistence of US stock market. For the daily level of persistence in volatility, NIKKEI225 return series are stronger than TOPIX and but for the monthly level, TOPIX return series are stronger than NIKKEI225. All persistence coefficients are statistically significantly at 1%.

Specifically, for daily, the coefficient γ =0.9702 for TOPIX and γ =0.9734 for NIKKEI225 indicates 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 monthly, the coefficient γ =0.9676 for TOPIX and γ =0.9468 for NIKKEI225 imply that it would take approximately 70=ln(0.1)/ln(0.9676) for TOPIX and 42=ln(0.1)/ln(0.9468) business weeks for the influence of current volatility on future volatility to diminish to one-tenth the size of its influence on next period’s volatility. Thus in weekly horizons, the persistence is stronger.

For asymmetry effect, in the daily and weekly frequencies, all asymmetry coefficients δ ’s from model without margins, are negative and statistically significant at 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.

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

In Tables 9-12 for the daily and weekly Japanese stock market returns, we add the margin variable as an explanatory variable in the conditional variance equation. Thus estimated coefficients are presented for the α_M in all Models. In model 4 for TOPIX daily returns and model 3 for TOPIX and NIKKEI225 weekly returns, Bear and Bull periods ($\alpha_{M,Bear}$, $\alpha_{M,Bull}$) are separated respectively to distinguish each effects on margins and volatility. Coefficient α_M captures the association between the level of margin requirements and volatility and $\alpha_{M,Bear}$ and $\alpha_{M,Bull}$ also identify the relationship between the margin and volatility for each Bear and Bull periods

For TOPIX daily returns, in Table 9, all coefficients, α_M are negative and statistically significant at 1%, 5%, and 10%. For TOPIX weekly return, in Table 11, all of them are also negative, and statistically significant at 1% except model 5. These indicate that the past margin requirements affect to current conditional volatility negatively. These findings confirm pyramid effect that the higher requirements reduce the volatility. However, this effect is activated in normal periods when we focus on model 3(model 4 for TOPIX daily return). During bear periods, interestingly, margin requirement policy does not affect to volatility of TOPIX daily return except model 6 and of TOPIX weekly returns, even positive effect in weekly returns whereas during bull periods, it plays an important role to volatility in TOPIX daily and weekly returns, but unlike expected, the higher margin, the higher volatility, which means depyramiding effect. 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.

In NIKKEI225 daily and weekly, the results are similar to TOPIX except one. The margin requirement coefficients are negatively significant at 1% for daily, but not significant for weekly. This finding implies that the margin policy affect to volatility during short time as day, not long time as week.

<Table 9> The result of EGARCH model of TOPIX daily returns with margin requirements

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

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

$$\ln(\sigma_t^2) = \alpha_0 + \alpha_M M_{t-1} + \alpha_{M,Bear}(Bear_t \cdot M_{t-1}) + \alpha_{M,Bull}(Bull_t \cdot M_{t-1})$$

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

Coefficient	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Panel A: Conditional Mean of Returns						
β_0	0.0312***	-0.0612**	-0.0461*	-0.0476*	-0.0476*	-0.0464*
	(3.51)	(-2.19)	(-1.84)	-(1.89)	(-1.89)	(-1.85)
β_M		0.1861***	0.1700***	0.1731***	0.1732***	0.1703***
		(3.47)	(3.27)	(3.29)	(3.31)	(3.27)
β_1	0.1394***	0.1404***	0.1399***	0.1399***	0.1399***	0.1400***
	(12.09)	(12.09)	(12.14)	(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***	-0.1743***	-0.1759***	-0.1982***
	(-18.09)	(-13.56)	(-13.29)	(-13.29)	(-13.39)	(-14.31)
α_M		-0.0449***	-0.0426***	-0.0738**	-0.0769***	-0.0391*
		(-2.10)	(-2.02)	(-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***	0.2452***	0.2461***	0.2691***
	(18.14)	(18.24)	(17.99)	(17.99)	(17.97)	(18.17)
δ	-0.0811***	-0.0825***	-0.0978***	-0.0978***	-0.0959***	-0.0866***
	(-10.36)	(-10.27)	(-11.88)	(-11.87)	(-11.87)	(-10.54)
γ	0.9702***	0.9663***	0.9679***	0.9725***	0.9717***	0.9696***
	(264.47)	(234.43)	(245.24)	(278.97)	(282.48)	(246.67)
GED(v)	1.2987***	1.2914***	1.2899***	1.2958***	1.2954***	1.2905***
	(77.56)	(74.54)	(74.56)	(76.35)	(77.05)	(74.21)
L_ratio	-8383	-8376	-8377	-8365	-8370	-8381
Adj. R^2	0.0143	0.0168	0.0132	0.0129	0.0131	0.0131
F-value	16.22***	14.97***	13.33***	10.66***	11.84***	11.85***
DW	2.02	2.01	2.02	2.02	2.02	2.02
Panel C: Model diagnostics						
mean for z_t	-0.0123	-0.0100	-0.0068	-0.0100	-0.0070	-0.0120

max	6.5583		6.574		6.494		6.494		6.532		6.5583	
min	-12.447		-12.7		-13.2		-13.2		-13.24		-12.45	
std	1.0135		1.014		1.0139		1.014		1.014		1.0135	
skewness	-0.6655		-0.68		-0.6936		-0.69		-0.702		-0.666	
kurtosis	11.8943		12.18		12.4627		12.46		12.57		11.894	
Jarque bera	24826.7	***	26412	***	28076.3	***	28076	***	28716	***	24827	***

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

<Table 10> The result of EGARCH model of NIKKEI225 daily returns with margin requirements

This table is EGARCH-M model result of NIKKEI225 daily volatility on margin requirements. ( ) is t value of EGARCH(1,1)-M estimation. Estimated model is as follows:

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

$$\ln(\sigma_t^2) = \alpha_0 + \alpha_M M_{t-1} + \alpha_{M,Bear}(Bear_t \cdot M_{t-1}) + \alpha_{M,Bull}(Bull_t \cdot M_{t-1})$$

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

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	
L_ratio	-9561		-9549		-9534		-9535		-9546	
Adj. R^2	-0.0005		0.0007		0.0001		0.0002		0.0005	
F-value	0.45		1.60		1.05		1.13		1.39	
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	***	17805.6	***	18551	***	24808	***

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

<Table 11> The result of EGARCH model of TOPIX weekly returns with margin requirements

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

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

$$\ln(\sigma_t^2) = \alpha_0 + \alpha_M M_{t-1} + \alpha_{M,Bear}(Bear_t \cdot M_{t-1}) + \alpha_{M,Bull}(Bull_t \cdot M_{t-1})$$

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

Coefficients	Model 1	Model 2	Model 3	Model 4	Model 5
Panel A: Conditional Mean of Returns					
β_0	0.0231	-0.0615 *	-0.0605 *	-0.0576	-0.0665 *
	(1.57)	(-1.65)	(-1.64)	(-1.57)	(-1.79)
β_M		0.1582 **	0.1469 **	0.1439 **	0.1644 **
		(2.37)	(2.19)	(2.15)	(2.46)
β_1	0.0462 **	0.0394 *	0.0616 **	0.0571 **	0.0468 **
	(1.95)	(1.68)	(2.58)	(2.37)	(1.99)
β_2	0.0783 ***	0.0773 ***	0.0886 ***	0.0868 ***	0.0788 ***
	(3.29)	(3.26)	(3.65)	(3.52)	(3.31)
λ	0.0876	0.1724 **	0.1863 **	0.1794 **	0.1834 **
	(1.08)	(2.07)	(2.26)	(2.17)	(2.21)
Panel B: Conditional Variance of Returns					
α_0	-0.2027 ***	-0.2083 ***	-0.1747 ***	-0.1722 ***	-0.2162 ***
	(-5.76)	(-5.64)	(-5.18)	(-5.03)	(-5.88)
α_M		0.0055	-0.1124 ***	-0.0755 ***	0.0145
		(0.14)	(-2.93)	(-2.37)	(0.37)
$\alpha_{M,Bear}$			0.2329		0.3443
			(1.11)		(1.44)
$\alpha_{M,Bull}$			0.4747 ***	0.4778 ***	
			(6.79)	(6.81)	
θ_1	0.1986 ***	0.1998 ***	0.1628 ***	0.1633 ***	0.2031 ***
	(5.95)	(5.88)	(5.14)	(5.08)	(6.04)
δ	-0.0396 ***	-0.0407 ***	-0.1046 ***	-0.1153 ***	-0.0270
	(-2.64)	(-2.57)	(-4.48)	(-5.36)	(-1.41)
γ	0.9676 ***	0.9662 ***	0.9622 ***	0.9613 ***	0.9663 ***
	(92.86)	(88.67)	(103.78)	(99.15)	(92.18)
GED(v)	1.2079 ***	1.1955 ***	1.2784 ***	1.2764 ***	1.1987 ***
	(32.72)	(32.44)	(27.06)	(27.07)	(32.85)
L_ratio	-829.02	-825.35	-805.26	-805.89	-824.19
Adj. R^2	0.0009	0.0019	-0.0002	0.0010	0.0006
F-value	1.17	1.30	0.97	1.14	1.09
DW	2.05	2.03	2.06	2.05	2.05
Panel C: Model diagnostics					
mean for z_t	-0.0264	-0.0305	-0.0174	-0.0189	-0.0179
max	3.3381	3.3194	3.4068	3.3534	3.3402
min	-11.3804	-11.3072	-8.1255	-8.0908	-11.5517
std	1.0240	1.0244	1.0125	1.0125	1.0260
skewness	-1.2985	-1.2886	-0.7451	-0.7489	-1.3446

kurtosis	15.0950		14.9679		8.3047		8.2608		15.8867	
Jarque bera	9864.3	***	9654.2	***	1955.7	***	1927.3	***	11163.4	***

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

<Table 12> The result of EGARCH model of NIKKEI225 weekly returns with margin requirements

This table reports EGARCH-M model result of NIKKEI225 weekly volatility on margin requirements. ( ) is t value of EGARCH(1,1)-M estimation. Estimated model is as follows:

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

$$\ln(\sigma_t^2) = \alpha_0 + \alpha_M M_{t-1} + \alpha_{M,Bear}(Bear_t \cdot M_{t-1}) + \alpha_{M,Bull}(Bull_t \cdot M_{t-1})$$

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

Coefficient	Model 1	Model 2	Model 3	Model 4	Model 5
Panel A: Conditional Mean of Returns					
β_0	0.0231	-0.1135 ***	-0.1033 **	-0.1043 **	-0.1143 ***
	(1.42)	(-2.57)	(-2.48)	(-2.45)	(-2.60)
β_M		0.2454 ***	0.2298 ***	0.2314 ***	0.2469 ***
		(3.32)	(3.12)	(3.15)	(3.34)
β_1	0.0222	0.0193			
	(0.88)	(0.79)			
β_2	0.0774 ***	0.0753 ***	0.0782 ***	0.0772 ***	0.0732 ***
	(3.17)	(3.09)	(3.21)	(3.18)	(3.00)
λ	0.0891	0.2159 ***	0.1942 **	0.1971 **	0.2188 ***
	(1.22)	(2.58)	(2.41)	(2.43)	(2.66)
Panel B: Conditional Variance of Returns					
α_0	-0.2449 ***	-0.2308 ***	-0.1479 ***	-0.1484 ***	-0.2319 ***
	(-5.95)	(-5.68)	(-4.77)	(-5.29)	(-5.84)
α_M		-0.0516	-0.1241 ***	-0.1288 ***	-0.0452
		(-0.99)	(-3.09)	(-3.06)	(-0.91)
$\alpha_{M,Bear}$			0.3036		0.3413
			(1.55)		(1.31)
$\alpha_{M,Bull}$			0.4296 ***	0.4292 ***	
			(7.38)	(7.20)	
θ_1	0.2131 ***	0.2087 ***	0.1296 ***	0.1337 ***	0.2064 ***
	(5.53)	(5.96)	(4.23)	(4.29)	(5.47)
δ	-0.0918 ***	-0.0914 ***	-0.1330 ***	-0.1484 ***	-0.0754 ***
	(-4.50)	(-4.31)	(-5.64)	(-6.48)	(-3.23)
γ	0.9468 ***	0.9395 ***	0.9576 ***	0.9548 ***	0.9431 ***
	(69.62)	(59.89)	(91.37)	(83.52)	(65.46)
GED (v)	1.2433 ***	1.2281 ***	1.3030 ***	1.2993 ***	1.2276 ***
	(35.64)	(34.99)	(31.44)	(31.69)	(35.23)
L_ratio	-943.65	-937.62	-925.06	-926.43	-936.54
Adj. R^2	-0.0014	0.0017	-0.0001	0.0014	0.0003
F-value	0.72	1.23	0.98	1.19	1.05
DW	2.08	2.05	2.09	2.07	2.06
Panel C: Model diagnostics					
mean for z_t	-0.0379	-0.0400	-0.0280	-0.0283	-0.0292

max	3.0423		3.1547		3.4194		3.3814		3.0763	
min	-11.3045		-11.2146		-8.1983		-8.1416		-11.3871	
std	1.0243		1.0255		1.0152		1.0152		1.0257	
skewness	-1.4568		-1.4655		-0.9858		-0.9994		-1.4946	
kurtosis	15.5619		15.5498		9.4539		9.4685		16.1415	
Jarquebera	10718.8	***	10698.8	***	2933.6	***	2952.7	***	11700.3	***

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

10. Conclusions

From the original Hardouvelis (1990) and Hardouvelis 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. 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 U.S. 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 examine 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(i.e., EGARCH) to investigate the linkage of margin requirements and volatility. In regression analysis, margin requirements affect to volatility negatively and also there is nonlinear effect for TOPIX and NIKKEI225. This result is robust in various methods and for controlling additional variables. Thus we confirm that higher margin could reduce excess volatility. For separated periods such as bull and bear, the linkage between margin requirements and volatility is weaker in bear period, but even positive association in bull period for both markets. These findings indicate that during bull market, the volatility would be more volatile if Japanese financial authority intends to raise the level of margin requirements to reduce the volatility.

The above results are confirmed from EGARCH-M model. In this model, there is also a major asymmetry in the relation between margin requirements and volatility across bull, normal, and not bear markets.

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