Do Margin Requirements Matter? Evidence from U.S. and Japanese Stock Markets

The October 1987 stock market crash has prompted regulators to seek out policy tools that can control abrupt stock price changes and market volatility. The sudden 23 percent drop in stock prices in a single day was a reminder that the market is often dominated by investors whose actions may violate economists' rules of rational behavior. One possible curb on volatility and "irrational" speculation that has recently generated some interest is the use of margin requirements. This article considers whether margin requirements are in fact an effective policy tool. It reviews the evidence on the relationship between margin rules and volatility in the United States and offers new evidence drawn from the Japanese experience with margin requirements.

The function of margin requirements in the stock market is to restrict the amount of credit that brokers and dealers can extend to their customers for the purpose of buying stocks.[1] The U.S. Congress first imposed official margin requirements on stock transactions in 1934, after a period of great turbulence in the stock market. Congress believed that the margin restrictions would rid the market of highly leveraged speculators and hence lead to greater stability. The Federal Reserve, given jurisdiction over the appropriate level of margin requirements, changed the official margin requirement twenty-two times between 1935 and 1974 in response to what it perceived as excessive speculation (or the lack of sufficient speculation) in the market. In the last fifteen years, however, the Federal Reserve has effectively suspended the use of margin requirements as a policy tool.

The effect of margin requirements on the U.S. stock market has been the focus of many empirical studies. Most earlier studies concentrated on the effect of margin requirements on the level of the market: they found that increases in margin requirements decreased stock prices while decreases in margin requirements boosted stock prices, although both effects were weak.[2] Only two of the earlier studies, one by Douglas (1969) and another by Officer (1973), concentrated on stock market volatility.[3] Both authors found a negative association between the level of official margin requirements and stock market volatility. Recently, one of the authors of this *Quarterly Review* article corroborated the findings of Douglas and Officer and extended the analysis by examining excess volatility—volatility that cannot be explained by the variability of the economic environment—and long-run deviations of stock prices from their fundamental values. He concluded that in periods

[1]For example, an official margin requirement of 60 percent implies that an investor can only borrow up to $40 in order to buy a stock worth $100.

[2]See Jacob Cohen, "Federal Reserve Margin Requirements and the Stock Market," *Journal of Financial and Quantitative Analysis,* September 1966, pp. 30-54; James Largay, "100% Margins: Combating Speculation in Individual Security Issues," *Journal of Finance,* September 1973, pp. 973-86; and Dudley Luckett, "On the Effectiveness of the Federal Reserve's Margin Requirement," *Journal of Finance,* June 1982, pp. 783-95. Luckett finds that investors' equity in their margin accounts with brokers is affected negatively by a change in margin requirements. For further references, see Gikas Hardouvelis, "Margin Requirements, Volatility, and the Transitory Component of Stock Prices," Federal Reserve Bank of New York, Research Paper no. 8818, to be published in the September 1990 *American Economic Review.*

[3]George Douglas, "Risk in the Equity Markets: An Appraisal of Market Efficiency," *Yale Economic Essays,* Spring 1969, pp. 3-45; and R. Officer, "The Variability of the Market Factor of the New York Stock Exchange," *Journal of Business,* vol. 46 (July 1973), pp. 434-53.

of high margin requirements and in periods when margin requirements increase, excess volatility is low and deviations from fundamentals tend to subside.[4]

These empirical findings have sparked a number of new studies disputing the effectiveness of margin rules. These studies question the extent of the negative effect of margin requirements on actual volatility but do not address the findings about the reduction of excess volatility and long-run stock price deviations from fundamentals.[5]

The existence of such distinctly different points of view on the effectiveness of margin rules is partly attributable to the small sample that is available for empirical analysis—a total of twenty-two changes in margin requirements. Because of the small sample size, the negative association between margin requirements and stock market volatility cannot be estimated very precisely. Hence, the evidence is not sufficiently strong to alter some economists' belief that regulatory restrictions on the stock market are ineffective.

This article seeks to remedy the small sample problem and expand the available evidence by examining the Japanese experience with margin requirements. While margin requirements in the U.S. market changed twenty-two times over the last fifty-five years, margin requirements in the Japanese market changed over one-hundred times in the last thirty-five years. The more frequent margin changes in Japan provide considerable statistical power that should shed light on the contested effectiveness of margin regulation. Furthermore, Japanese authorities, unlike their U.S. counterparts, administer margin requirements very actively even today. Hence the recent Japanese experience with margin requirements may provide significant additional information about the contemporary impact of margin policy.

The article is organized as follows: We begin by presenting the theoretical link between margin requirements and volatility and then review the recent evidence on the effects of margin requirements on the volatility of U.S. stock prices. The next three sections shift the focus to Japan. First, we review some institutional characteristics of the Japanese stock market and describe the regulation of margin trading. Next we estimate the average relationship between changes in margin requirements and changes in the momentum of stock prices over the sample period from 1951 through 1988. Finally, we extend the analysis to daily stock price volatility. The article concludes with a summary of our principal findings.

Margin requirements and volatility: is there a precise theoretical link?

Economic theory does not posit an exact and unambiguous link between margin requirements and volatility but does suggest that an increase in margin requirements is likely to lower excess volatility. In order for margin requirements to reduce excess volatility, they must impose a binding constraint on the market activities of investors, and they must primarily restrict the behavior of destabilizing speculators.

The first of these requirements would be met if the alternative sources of credit available to investors for the purpose of investing in stocks were more costly. In this case, margin requirements—official quantity ceilings on the cheaper broker-dealer funds—would constrain the amount of total borrowing for the purpose of investing in stocks. This constraint would affect the equilibrium price in the market. In particular, one expects to observe that margin requirements bind during periods when financial markets are not fully developed and alternative sources of credit are scarce or when the overall supply of credit in the economy is tight.

Many economists would argue, however, that even if margin requirements have a binding effect on investors, such an effect is short-lived. Smart investors who like to obtain financial leverage in order to invest in stocks can find alternative sources of credit at no extra cost in the long run and hence undo the constraining effect of the increase in margin requirements.[6] This argument is only partly persuasive, however. In a dynamic market with new entrants and exitors every period, even a con-

[4]Gikas Hardouvelis, "Margin Requirements and Stock Market Volatility," this *Quarterly Review*, Summer 1988, pp. 80-89; and "Margin Requirements, Volatility, and the Transitory Component of Stock Prices."

[5]See G. William Schwert, "Business Cycles, Financial Crises and Stock Volatility," University of Rochester, William Simon Graduate School of Business, Working Paper no. 88-06, October 1988; David Hsieh and Merton Miller, "Margin Regulation and Stock Market Volatility," *Journal of Finance*, vol. 45 (March 1990), pp. 3-30; Paul Kupiec, "Initial Margin Requirements and Stock Returns Volatility: Another Look," *Journal of Financial Services Research*, vol. 3 (November 1989), pp. 287-301; Richard Roll, "Price Volatility, International Market Links, and Their Implications for Regulatory Policies," *Journal of Financial Services Research*, vol. 3 (November 1989), pp. 211-46; Michael Salinger, "Stock Market Margin Requirements and Volatility: Implications for Regulation of Stock Index Futures," *Journal of Financial Services Research*, vol. 3 (November 1989), pp. 121-38; Raman Kumar, Stephen Harris, and Don Chance, "The Differential Impact of Federal Reserve Margin Requirements," Virginia Polytechnic Institute, November 1988, mimeo. For a response to these arguments, see Gikas Hardouvelis, "Commentary: Stock Market Margin Requirements and Volatility," *Journal of Financial Services Research*, vol. 3 (November 1989), pp. 139-51.

[6]For a related argument, see Michael Goldberg, "The Relevance of Margin Regulations," *Journal of Money, Credit and Banking*, vol. 11 (1985), pp. 521-27. Hardouvelis ("Margin Requirements, Volatility, and the Transitory Component of Stock Returns," Tables 5b, 6c) does present evidence consistent with the view that in the period immediately following a margin increase, the effects of margin requirements are stronger.

stant level of margin requirements can reduce the amount of leverage of the new entrants and consequently affect the price fluctuations in the stock market.

The second requirement if margin requirements are to reduce excess volatility is that their force be felt primarily by destabilizing speculators. Finance theory suggests that the less risk-averse investors hold more stocks and less cash in their portfolios and are likely to lever themselves through the use of broker-dealer margin credit. Hence it is the aggressive, risk-prone investors that will be affected by the imposition of margin requirements. If the same aggressive investors are influenced by waves of optimism and pessimism and do not pay proper attention to economic fundamentals, they will create unnecessary market volatility. This volatility can be reduced by the imposition of margin requirements.

Economists who reject the view that an increase in margin requirements decreases destabilizing speculation and market volatility argue that the market is dominated by rational investors and that speculation by rational investors is a stabilizing force overall. In their opinion, increasing margin requirements is harmful to the market. An increase in the cost of investing in stocks will lead to reduced participation in the market by rational investors, less liquidity, and ultimately, higher volatility.

The question whether speculation — even by rational investors — is stabilizing or destabilizing cannot be resolved theoretically. Economists have constructed models in which speculation can either stabilize or destabilize prices.[7] It follows that the effect of margin requirements on excess market volatility also cannot be determined theoretically and will require some form of empirical test.

Margin requirements in the U.S. stock market: a review

The evidence from the cash market

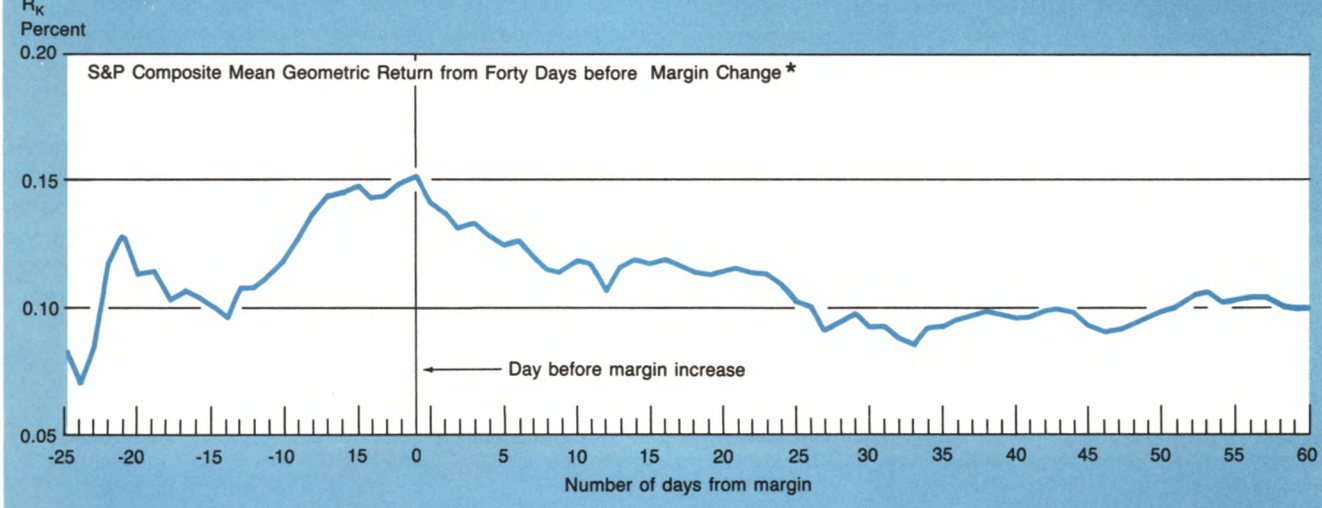
We now turn to a brief summary of the U.S. stock market experience with margin requirements. Chart 1 illustrates the momentum of stock prices before and after an increase in margin requirements. Chart 2 repeats the same analysis for a margin decrease. For each business day, the charts show the total return excluding dividends — average geometric daily capital gain or loss — obtained by investors who buy the portfolio of stocks in the Standard and Poor's 500 index on the fortieth business day before the margin change and subsequently sell the same portfolio of stocks k busi-

[7]See, for example, Oliver Hart and David Kreps, "Price Destabilizing Speculation," *Journal of Political Economy*, vol. 94 (October 1986), pp. 927-52. Hart and Kreps show that rational investors can destabilize prices.

Chart 1

U.S. Stock Prices before and after an Increase in Margin Requirements

February 1936 - November 1972



*First fifteen observations were erratic and frequently fell off the scale; they are not shown in this chart.

ness days later (k = 15, ..., 100), that is, $R_k = (SP_{k-40}/SP_{-40})^{1/k}-1$, where SP denotes the Standard and Poor's index. The return of a business day k is estimated as the arithmetic average of individual returns across the eleven historical margin increases (Chart 1) or the eleven historical margin decreases (Chart 2). Chart 1 shows that margin requirements increase following a period of rising stock prices and that after the increase in margin requirements, stock prices decline slowly. Chart 2 shows that margin requirements decline long after the market falls and rebounds and that after the decrease in margin requirements, stock prices continue to increase. Overall, the evidence is consistent with an interpretation that margin requirements affect the movement of the market in the desired direction.

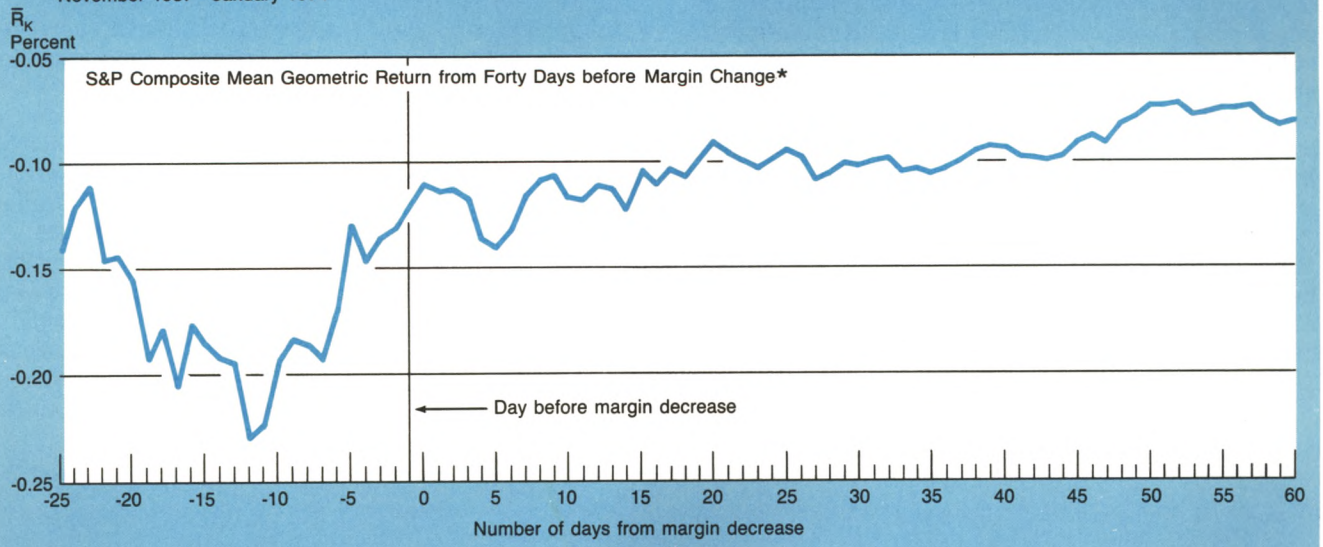
Most earlier studies of margin requirements concentrated on the market responses shown in Charts 1 and 2 and argued that these responses were economically and statistically insignificant. Observe that the evidence is particularly weak in Chart 2: the margin decrease does not occur until after the market rebounds, so it is unclear whether the margin decrease pushes prices up or the market simply follows its own upward momentum. Recent research, however, has shifted attention to the volatility of the market as opposed to the level of the market. The question asked is: Have margin requirements prevented the occurrence of unusual swings in stock prices? After all, one of the basic aims of margin regulation in the 1930s was to prevent the so-called pyramiding-depyramiding process in stock prices that was thought to result from the high degrees of leverage available to investors through broker-dealer loans. Congress believed that official margin requirements would restrain excessive speculation and reduce large unjustified stock price fluctuations.

One way to capture long swings in stock prices is to calculate the standard deviation of stock returns over a horizon long enough to allow the pyramiding-depyramiding process to run its course — a horizon, for example, of one year. The summer 1988 issue of this *Quarterly Review* presented evidence of statistically and economically significant negative association between the level of margin requirements and this measure of volatility. Of course, volatility per se is not a measure of speculative excess; part of the observed

Chart 2

U.S. Stock Prices before and after a Decrease in Margin Requirements

November 1937 - January 1974



*First fifteen observations were erratic and frequently fell off the scale; they are not shown in this chart.

stock market volatility is due to the variability of the fundamental determinants of stock prices.

The *Quarterly Review* article did not present evidence of the association between margin requirements and excess volatility, that is, volatility that cannot be explained by the variability of the economic environment. The study on which this article was based, however, showed that periods of high or increasing margin requirements are associated with lower excess volatility and smaller deviations of stock prices from their fundamental values.[8] Here we present an example that gives a flavor of these findings.

The example draws on the empirical observation that an increase in current price-dividend ratios is followed by a decrease in stock returns over a period of three months to five years.[9] Two alternative hypotheses are proposed to explain this negative correlation. The first hypothesis assumes that the market is often subject to destabilizing speculation. It runs as follows: A high price-dividend ratio reflects an overvalued market. Later, stock prices fall, lining up closer to fundamentals, and this movement generates a negative return. The second hypothesis assumes a rationally priced market and asserts that a high price-dividend ratio is due to a low risk premium. The low subsequent stock returns simply reflect a low reward for the small amount of risk that market participants rationally expected to assume. It turns out that the size of the negative correlation between price-dividend ratios and subsequent stock returns varies with the level of margin requirements. The negative correlation is weaker in periods of high margin requirements and in periods when margin requirements increase. This evidence suggests two possibilities: high or increasing margin requirements reduce the degree of mispricing in the market and hence the long-term excess volatility that is generated by the presence of irrational price swings; or, high or increasing margin requirements reduce the perceived risk in the market. Under either interpretation, higher margin requirements are effective.

Recent studies responding to these volatility results have concentrated on the negative association between margin requirements and actual volatility rather than on the evidence of a relationship between margin requirements and excess volatility.[10] In general, the commentators do not disagree with the presence of an overall negative association between margin requirements and volatility, but they believe that such an association is not robust enough to justify the use of margin requirements as a tool for controlling market volatility. Unfortunately, the few historical episodes of a change in margin requirements provide very little statistical power for even the most carefully designed test of the effectiveness of margin requirements. The only way to obtain a decisive test is to examine other economies or other markets where margin requirements are administered on a more frequent basis.

Can futures data be used to examine the effects of margin requirements on volatility?

Margin requirements have been imposed on the Standard and Poor's 500 futures contract since its inception in 1982. The initial margin, a fixed dollar amount per contract, is designed to minimize the probability of default by any single investor and thus to ensure the smooth functioning of the market. In setting the appropriate amount of margin, the exchange's margin committee takes into account the expected future volatility of futures prices so that the margin money will be sufficient to cover losses arising from a single day's unusual price fluctuation.[11]

Futures margin requirements are substantially lower than the cash market margin requirements, and for this reason, the current policy debate on the appropriate level of margin requirements has focused on futures margins. The question of immediate regulatory concern is whether an increase in futures margins would decrease stock market volatility. This question is hard to answer with direct empirical evidence, however, because futures margin requirements have changed only eight times since 1982 and three of these changes occurred in October 1987 following the stock market crash. In fact, the few changes in futures margin requirements provide even less statistical power for testing the hypothesis that margin requirements affect volatility than do the cash market margin changes.

Another problem in correlating stock market volatility with futures margins could not be solved even if a large number of futures margin changes had taken place. The margin committee increases futures margins in anticipation of an increase in volatility and revises its expectations of future volatility based on what happens to current

[8]See Hardouvelis, "Margin Requirements, Volatility, and the Transitory Component of Stock Prices."

[9]Eugene Fama and Kenneth French, "Dividend Yields and Expected Stock Returns," *Journal of Financial Economics*, vol. 22 (October 1988), pp. 3-25.

[10]See the Appendix for a brief summary of these studies and a discussion of their relevance. A detailed response to the studies is

Footnote 10 continued
contained in Hardouvelis, "Commentary: Stock Market Margin Requirements and Volatility."

[11]See the summer 1988 *Quarterly Review* articles by George Sofianos, "Margin Requirements on Equity Instruments," pp. 47-60; and Arturo Estrella, "Consistent Margin Requirements: Are They Feasible?" pp. 61-79.

volatility relative to the past. Consequently, there is a built-in positive correlation between margin changes and volatility changes that reflects a causal link from volatility to margin changes. For example, four of the eight futures margin changes occurred over a two-month period following the stock market crash of October 1987. Volatility increased after the crash, and subsequently the exchanges increased margin requirements three times in October 1987. Then, when volatility began to decline in late November, the exchanges apparently revised their volatility estimates downward and decreased margin requirements in mid-December. Thus, any study that attempts to correlate futures margins with volatility would be biased in favor of a positive association.[12] Such a bias does not exist in cash market margin requirement studies. In the cash markets, the authorities have traditionally responded to run-ups and rundowns of prices but not to daily volatility.

Since futures markets cannot provide reliable evidence to test the effects of margin requirements on destabilizing speculation, we look next to foreign cash markets in which authorities follow an active margin policy. Of the markets in this group, the Japanese market is the logical choice for analysis because it is the largest foreign stock market in terms of both capitalized value and trading volume.

Margin requirements in Japan: the regulatory structure

Institutional structure of the Tokyo Stock Exchange

Japan currently has eight stock exchanges and a small over-the-counter market. The Tokyo Stock Exchange (TSE) is the largest of the exchanges and has gained significance over time. The TSE's share in stock trading increased from 56 percent in 1950 to 86 percent in 1988.[13] The average daily volume in 1988 was 1,035 million shares, worth 1,045.9 billion yen (about $7.7 billion).[14] By comparison, the New York Stock Exchange (NYSE) has a volume of 161 million shares with an approximate value of $5.4 billion. Financial institutions own 44.6 percent of the shares at the TSE, business corporations 24.9 percent, securities companies 2.5 percent, the government 0.8 percent, individuals 23.9 percent, and foreigners 3.6 percent. Individual stock ownership has declined relative to the ownership of financial institutions and business corporations over time.

The TSE divides listings into two categories. The first category, termed the "First Section," encompasses listings of the largest companies. New companies are usually classified in the "Second Section." At the end of each business year, the exchange reviews all stock listings. Qualified Second Section companies are moved up to the First Section, and First Section companies that fail to meet the appropriate criteria may be relegated to the Second Section. Foreign stocks are treated according to different criteria and are classified in the "Foreign Section." At the end of October 1989, 1,705 stocks were listed on the TSE. Of these, 1,156 were listed on the First Section, 433 on the Second Section, and 116 on the Foreign Section.[15]

The TSE and the other Japanese stock exchanges are best described as auction markets. Their microstructure is quite different from American and British exchanges, in which specialists act as market makers. There are market makers in Japan, called *saitori,* but they are not allowed to trade on their own account. Currently, there are 4 *saitori* members and 114 regular members at the TSE. Regular members are brokers and dealers who can trade on behalf of their own accounts or their customers' accounts. All orders are placed by regular members and are handled by the *saitori* members, who execute orders according to well-specified auction rules. Stock trading takes place between 9:00 a.m. and 11:00 a.m. and between 1:00 p.m. and 3:00 p.m.

Although the most commonly cited index for the TSE is the Nikkei-Dow, the Japanese counterpart of the Dow-Jones index, a more comprehensive index is the Tokyo Stock Price Index (TOPIX). The TOPIX reflects all stocks traded in the TSE. It was introduced on July 1, 1969, and has been computed retroactively to May 1949, when trading began at the TSE. In our data analysis we use the TOPIX of the First Section stocks.

Until very recently, the TSE had no futures trading in stocks. On September 3, 1988, the TSE introduced trading in futures contracts based on TOPIX. As in the United States, these contracts carry very low margin requirements relative to the margin requirements in the cash markets and hence represent a cheaper method of leveraging. The introduction of futures contracts does not affect our empirical analysis, which focuses on cash market margin requirements. The last margin

[12]See, for example, Paul Kupiec, "Futures Margins and Stock Price Volatility: Is There a Link?" Board of Governors of the Federal Reserve System, December 1989, mimeo. Kupiec's analysis suffers from an additional problem because he correlates volatility with the margin requirement expressed as a percent of the value of the futures contract. This correlation is dominated by the positive association between the inverse of the stock price level and volatility, an association which is observed in the data even before the establishment of futures markets.

[13]See Shinji Takagi, "The Japanese Equity Market: Past and Present," *Journal of Banking and Finance,* vol. 13 (1989), pp. 537-70.

[14]See the 1989 *Tokyo Stock Exchange Fact Book.*

[15]The source is private correspondence with officials of the TSE.

change in the cash market that we examine occurred in June 1988, three months before trading began in the futures market.

Margin finance[16]

Finance companies play a major role in margin transactions. These companies were created by the Bank of Japan and the Ministry of Finance in 1950 to provide badly needed liquidity. The largest finance company is Japan Securities Finance Company (JSF), which is privately owned and handles margin transactions settled on the TSE. JSF borrows funds in the call market and from member firms and banks, and provides funds to securities houses; the securities houses then filter the funds to individual investors who purchase stocks on margin. JSF also lends stock certificates to securities houses, which subsequently make the certificates available to customers who wish to short sell on margin.

In the 1950s and 1960s, JSF dominated the market for margin finance. However, by the early 1970s Japan's four largest security houses—Nomura, Nikko, Daiwa, and Yamaichi—had improved their financial positions and obtained direct bank loans at interest rates lower than those offered by JSF. Their new ability to borrow from direct sources and their improved profitability enabled the big security houses to finance a growing portion of their margin clients internally. Since then, JSF's share in margin financing has dropped, although it continues to be the main source of funds for medium and small security houses.

At the end of October 1989, margin transactions represented 16.5 percent of all the "regular way" volume transactions.[17] In 1987 and 1988 the corresponding percentages were 16.7 and 19.6, respectively. These percentages are slightly below those of the early 1980s. The recent relative decline in margin trading may be partly attributed to the declining share of individual investors and to the greater activity of foreign investors, who are only allowed to deal on a limited margin basis.

Margin regulation

Margin regulation in Japan is broadly similar to margin regulation in the United States but has some special features of its own. Margin transactions were introduced in 1951, two years after trading began at the TSE. Originally, the margin loan had a maximum term of thirty days, but later the maximum term was extended to three months and then to six months.[18] The total interest on margin loans has an unusual feature: Customers who purchase securities on margin pay the quoted interest rate on the *full* amount of the stock transaction, not on the amount of the actual loan.[19] If customers continue to hold the stock after the expiration of the margin loan, the terms of the margin loan are recontracted. Customers who sell short borrow the securities from the brokers. Brokers keep the cash they receive from selling the securities on behalf of their customers and pay the customers interest. The interest rate received by margin short sellers is typically 4.5 percentage points below the interest rate paid by margin borrowers.

Margin regulation in Japan, as in the United States, specifies both initial and maintenance margin requirements. Initial margin requirements can be fulfilled by depositing either cash or securities. The securities can be either bonds or stocks. If the margin requirement is 60 percent and the investor chooses to deposit cash as collateral, the required amount of cash is 60 yen per 100 yen transaction. However, if the investor chooses to deposit securities in lieu of cash as collateral for the 100 yen loan, the market value of the required securities will be larger than 60 yen. Japanese authorities discount the market value of securities by a certain percentage, which is called the "loan value." For instance, if the loan value on collateral stocks is 70 percent, the investor is required to deposit stocks with a minimum market value of 60/.7 = 85.71 yen. The loan value varies with the type of security: 95 percent for government bonds, 90 percent for government-guaranteed bonds, 85 percent for other bonds, and 80 percent for convertible bonds. Stocks have a lower loan value than bonds. The loan value of stocks has varied over time but the loan value of bonds has remained constant.

Initial margin requirements are imposed only at the time of the transaction. After the transaction, the margin requirements become less strict and are called maintenance margins. In Japan, maintenance margins specify that the customer's capital with the broker must

[16]The information in this subsection and the following subsection comes from a variety of sources, the most important of which is private correspondence with TSE officials. See also Stephen Bronte, *Japanese Finance: Markets and Institutions*, Euromoney Publications Limited, London, 1982; *Securities Markets in Japan*, Japan Securities Research Institute, Tokyo, 1986; and *Tokyo Stock Exchange Fact Book*, 1989.

[17]All market orders are considered "regular way" unless otherwise specified. A regular way transaction is settled through the clearing department of the exchange on the third business day following the day of contract.

[18]See Shinji Takagi, "The Japanese Equity Market: Past and Present." Note that the U.S. authorities, unlike their Japanese counterparts, do not regulate the maturity on the margin plan.

[19]This requirement implies that the lower the amount of the loan, the higher the interest rate. Hence, if investors decide to use margin borrowing, they have an incentive to maximize the amount of borrowing.

always be larger than 20 percent of the price of the stock at the time it was originally bought or sold on margin. If the customer's capital drops below the designated minimum of 20 percent, margin calls will occur. For example, if a customer bought a stock worth 100 yen and deposited 60 yen as collateral, the price of the stock could fall to 60 yen without triggering a margin call, but a further price drop below 60 yen would cause an immediate margin call. The 60 yen new market price implies an unrealized loss of 40 yen; hence the customer's capital with the broker becomes 20 yen, or exactly 20 percent of the original price of 100 yen.[20]

Although the official initial margin requirement has changed many times since 1951, the official maintenance margin requirement has remained at 20 percent. Of course, brokers and dealers can always impose more stringent initial or maintenance margin requirements on their customers. But data on individual dealers' margin requirements, although desirable, are not available. Our empirical analysis, therefore, will be based on the historical changes of the official initial margin requirements.

Chart 3 presents a summary of all margin require-

[20]When investors deposit securities in lieu of cash, margin calls can also occur if the collateral security declines in value. Suppose the loan value is 70 percent for stocks and the customer deposits a stock worth 60/.7 = 85.71 yen. Assume for simplicity that the price of the stock bought on margin remains at 100 yen. Then a margin call will occur if the market price of the collateral stock falls from 85.71 yen to slightly below 28.57 yen, a level that is equivalent to (28.57) × (.7) = 20 yen of cash.

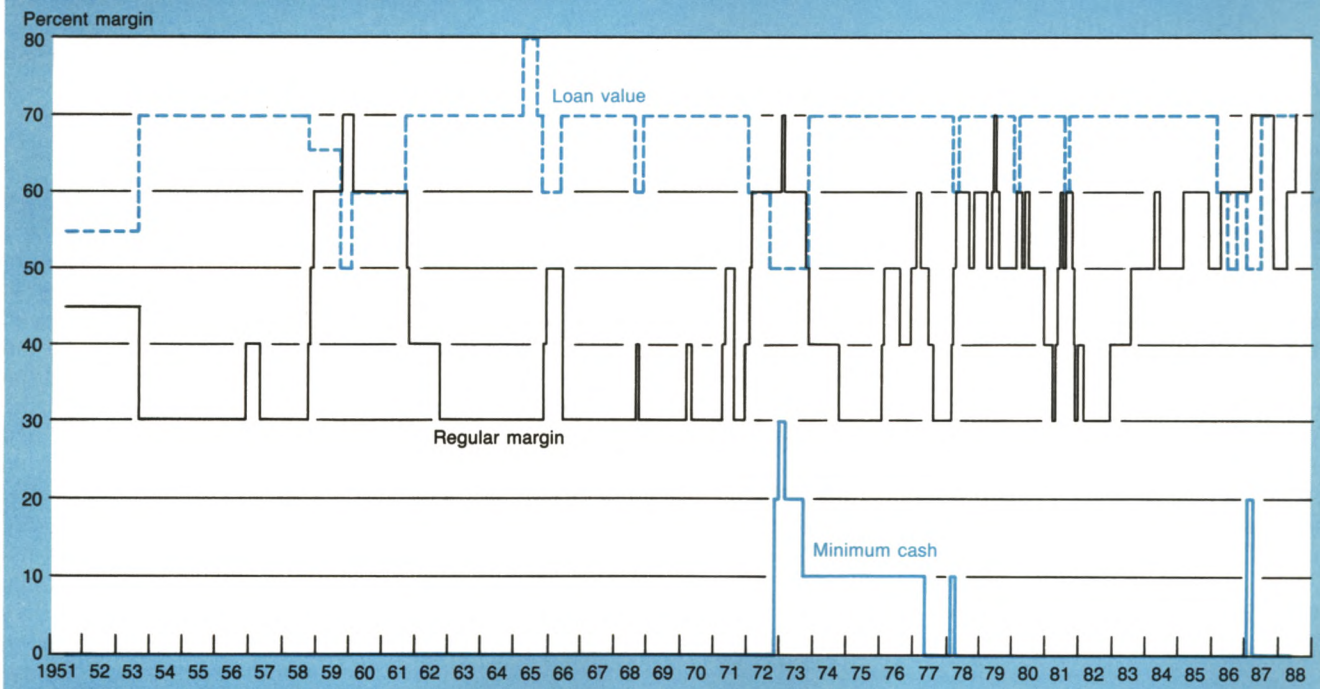
The calculation of the official maintenance margin is more complicated when, in addition to the change in the price of the collateral stock, a change occurs in the price of the stock that was

Footnote 20 continued

originally bought on margin. An increase in the price of the stock bought on margin does not count as a capital gain in the calculation of maintenance margins, but a decrease in its price does count as a capital loss. For example, let us assume that the price of the collateral stock falls from 85.71 yen to 28.57 yen *and* that the price of the stock bought on margin increases from 100 yen to 110 yen. Despite the unrealized capital gain of 10 yen, margin calls will occur the moment the collateral stock drops below 28.57 yen, as in the earlier example. Next, suppose that the price of the stock bought on margin dips from 100 yen to 90 yen, causing an unrealized capital loss of 10 yen. In this case, margin calls will occur well before the collateral stock drops to 28.57 yen. Margin calls will occur when the price of the collateral stock falls below 42.86 yen, which is equivalent to (42.86) × (.7) = 30 yen of cash.

Chart 3

Tokyo Stock Exchange Margin Requirements



Source: Tokyo Stock Exchange.

ment changes since the imposition of official margin requirements in 1951. Initial margin requirements have varied between 30 and 70 percent; the loan value of stocks has varied from a discount of 70 percent to a heavier discount of 50 percent. Only once did the discount value rise to 80 percent. Observe that in the early to late 1970s, the TSE employed an additional regulatory restriction on margin loans, a minimum cash requirement. On two occasions the minimum cash requirement reached a maximum of 30 percent, but the more typical requirement was 10 percent. In the framework of our previous example of a margin requirement of 60 percent and a loan value of 70 percent, a 10 percent minimum cash requirement implies that customers have to deposit 10 yen in cash and then choose between an additional 50 yen of cash or an additional minimum of 50/.7 = 71.43 yen worth of securities. Given a positive premium on cash, a positive minimum cash requirement has the same effect on the market as raising the margin requirement.[21]

In addition to imposing all these straightforward margin controls, the TSE can affect trading on individual stocks by a number of direct methods. For instance, if the daily stock price variation or margin activity of an issue is large, then margin trading can be temporarily stopped. Clearly, control of individual stocks affects the volatility estimates of these stocks. If the affected stocks carry a large weight in the construction of the TOPIX, the TOPIX volatility will also be affected. However, if individual stock restrictions are imposed randomly across time and are consequently uncorrelated with the decision to change margin requirements uniformly for all stocks, the resulting measurement error in the TOPIX volatility does not create systematic bias in the estimated effect of margin requirements. It follows that our subsequent empirical analysis would not be affected by individual stock manipulations.

The effective margin requirement

The TSE has traditionally used two different methods to affect investor behavior in the stock market: changing the initial margin requirement, M_t^c, and changing the loan value of stocks, L_t, where the subscript t denotes the business day. To incorporate both tools in one variable, we define the effective margin requirement as the required market value of stocks per unit of margin loan.[22] The effective requirement, M_t, is then the ratio of the official margin requirement, M_t^c, and the loan value of stocks, L_t:

$$(1a) \qquad M_t = 100\ (M_t^c\ /\ L_t).$$

The above ratio does not take into account the additional cash-only requirements, C_t, which are sometimes imposed. To incorporate these requirements, we adjust the definition of the effective margin requirement as follows:

$$(1b) \qquad M_t = 100\ [\delta\ C_t/L_t + (M_t^c - C_t)/L_t],$$

where δ is a parameter that reflects the extra opportunity cost associated with cash deposits. In the empirical analysis of the following sections, we arbitrarily assume that δ equals 1.5, but we have checked the sensitivity of the results to different values of δ ranging from 1 to 2. The results are not very sensitive to the particular choice of δ. To verify this last point, we also present the results by excluding all cases when C_t is changed. For this purpose we use equation 1a to describe our effective margin requirement.

Over the thirty-seven-year period from 1951 to June 1988, M_t has changed ninety-six times. Of the ninety-six changes, sixty are changes in initial margin requirements alone, seventeen are changes in the loan value alone, five are minimum cash changes alone, ten represent simultaneous changes in initial margin and loan value, and four reflect concurrent changes in the minimum cash requirement and loan value.

The effect of a change in margin requirements on Japanese stock prices

We begin by examining the behavior of Japanese stock prices around the days of a margin change. We ask the questions: Do margin changes affect the momentum of the stock market? If they do, does the effect persist in the 1980s? Charts 4, 5, 6, and 7 provide a first view of the effects of margin changes. We have partitioned the sample in the middle of 1978 so that forty-eight margin changes — changes in M_t of equation 1b — occur in the first part and forty-eight occur in the second part; and for each subperiod, we present the results for margin increases and margin decreases separately.

Like Charts 1 and 2 for the U.S. stock market, the charts for the Japanese stock market plot the total return excluding dividends — geometric average daily capital gain or loss — obtained by investors who buy the portfolio of stocks in the TOPIX on the fortieth business day before the margin change and subse-

[21]We have confirmed this statement with the TSE.

[22]The opportunity cost of depositing cash as collateral is larger than the opportunity cost of depositing stocks. Cash pays no interest while stocks carry dividends and the potential for appreciation during the time of the margin loan. Similarly, given the very low interest rate of bonds, stocks have a greater potential for high returns. Investors would prefer depositing stocks to depositing cash or bonds as

Footnote 22 continued
collateral. Hence, a change in the loan value of stocks is an effective restriction for most investors and should be taken into account.

Chart 4

Japanese Stock Prices before and after an Increase in Margin Requirements

December 1956 - April 1978

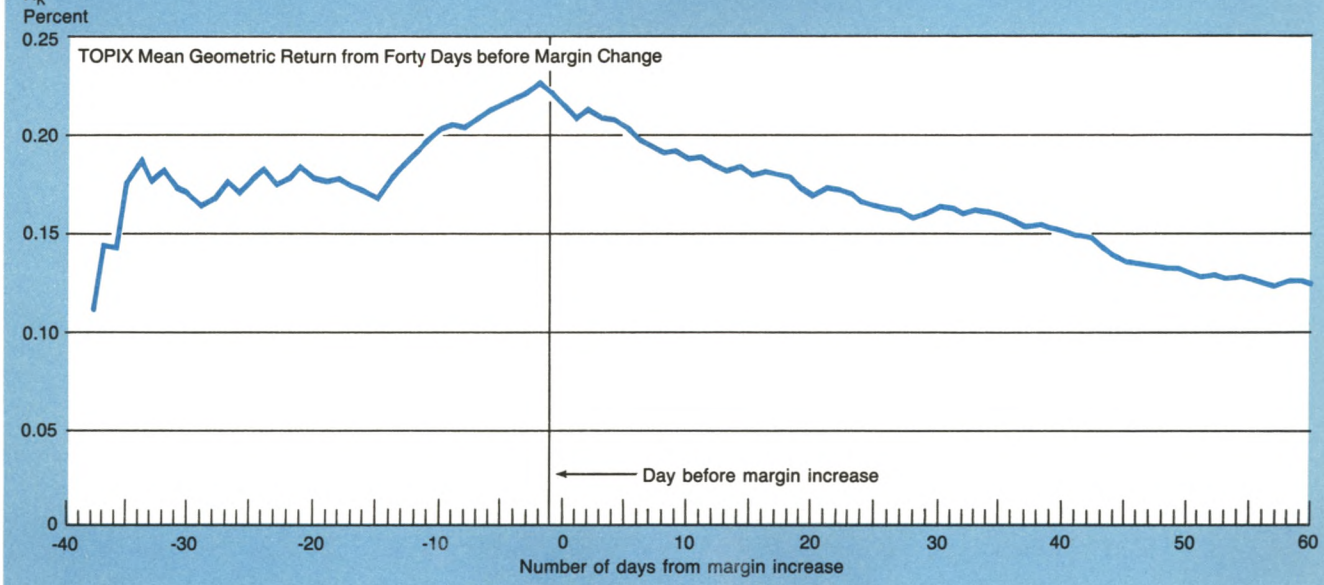


Chart 5

Japanese Stock Prices before and after an Increase in Margin Requirements

October 1978 - June 1988

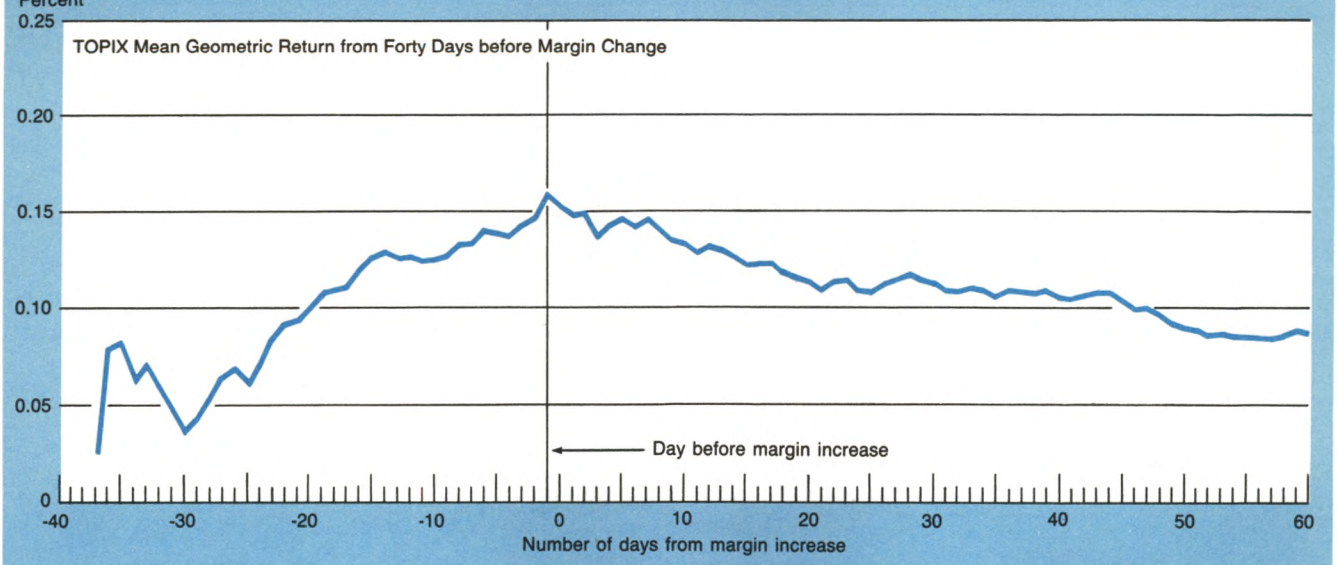


Chart 6

Japanese Stock Prices before and after a Decrease in Margin Requirements

September 1953 - May 1978

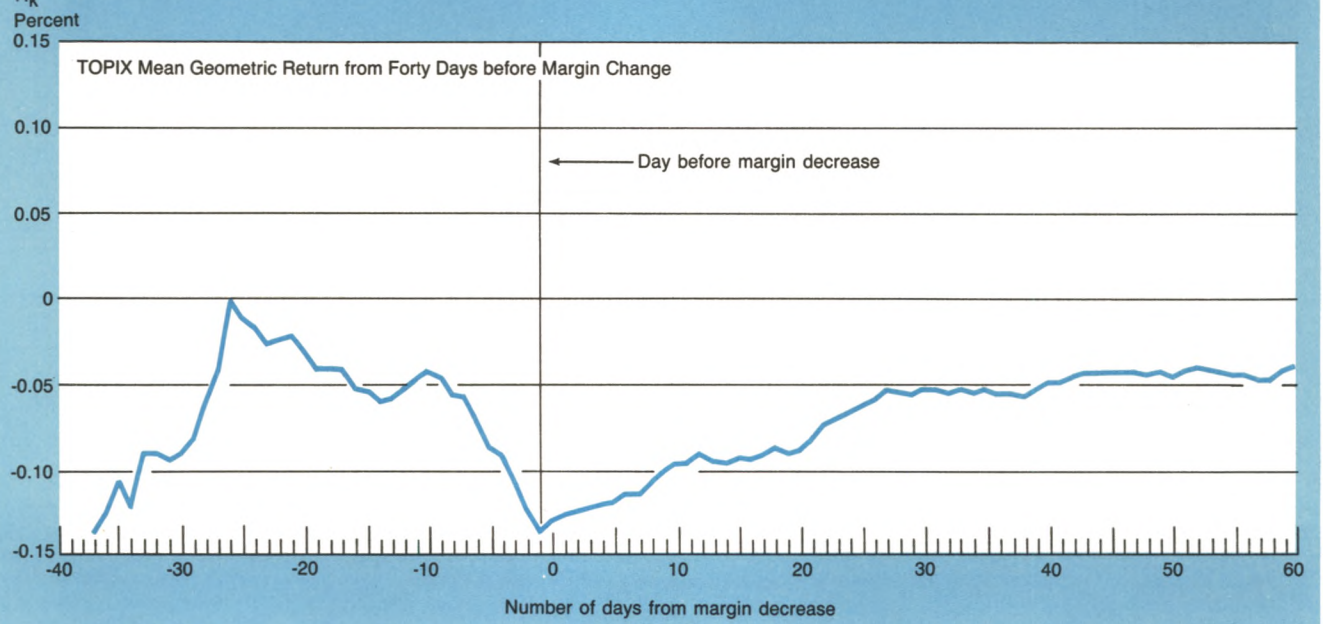
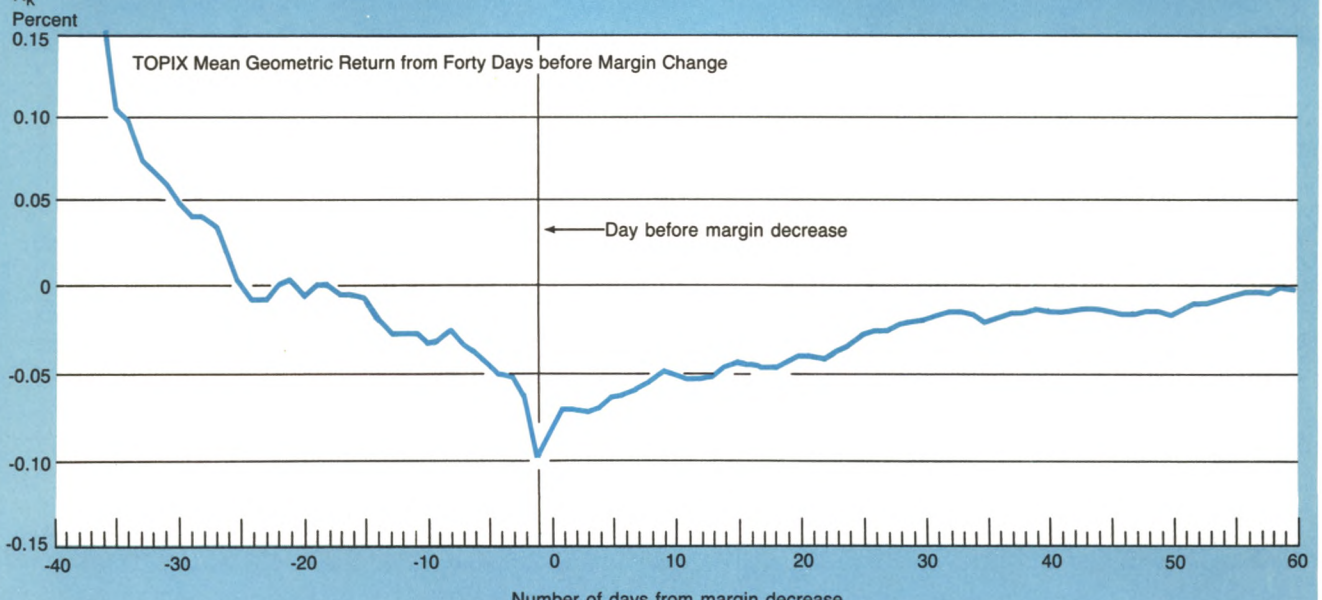


Chart 7

Japanese Stock Prices before and after a Decrease in Margin Requirements

June 1978 - October 1987



quently sell the same portfolio of stocks k business days later (k=1, ..., 100).[23] The return of a business day k is the arithmetic average of individual returns across the historical margin changes (approximately twenty-four cases per chart).[24]

The charts show that margin increases occur after a run-up in stock prices and that, on average, the moment the increase in margin requirements becomes effective, the market begins a downward trend. Similarly, margin decreases take place following a rundown in stock prices; on average, the moment the decrease in margin requirements takes place, the market begins an upward trend. In each chart we plot a vertical line on business day -1. Margin requirement changes are announced after the market closes on business day -1 and become effective for all transactions on business day 0. Hence, if changes in margin requirements affect the market, we ought to see a price reversal on business day 0. Indeed, the peaks in stock prices in Charts 4 and 5 coincide exactly with the market close of business day -1, before a margin increase is announced and implemented; and the troughs in stock prices in Charts 6 and 7 coincide with the market close of business day -1, before a margin decrease is announced and implemented. This is strong evidence that the margin changes have a *causal* role in the observed reversal of price trends. Recall that such an immediate reversal is not always observed in the U.S. data presented in Charts 1 and 2.

Comparisons of Chart 4 with Chart 5 and of Chart 6 with Chart 7 show that the quantitative effect of margin requirements is similar across the two subsamples. This similarity suggests that margin requirements continue to be important in today's financial environment. Another item of interest is the relatively slow reversal in stock price trends following a margin change. In an efficient market, one expects full and immediate adjustment towards equilibrium. In the absence of a precise benchmark for a normal return or normal price level, however, it is hard to make judgments about market efficiency.

While the charts show that the effects of margin requirements are quantitatively very important, they do not provide evidence on the statistical significance of the plotted price reversals. The statistical significance of the observed price reversals can be inferred from the regression results of Tables 1 and 2. In Table 1, we examine the TOPIX return over an interval of twenty-four days preceding the margin change and a like interval following the margin change. A horizon of twenty-four business days corresponds approximately to a cal-

Table 1

The Effect of Margin Requirements on Stock Returns—Interval of Twenty-Four Business Days

Dependent Variable: $\Delta R = R_A - R_B$ = Change in Return		
Independent Variables	Effective Margin Change	Cash Margin/ Loan Value Change
Sample Period: June 1951 to June 1988		
Constant	0.0290	0.0337
	(1.121)	(1.265)
ΔM	−0.0078**	−0.0075**
	(−7.434)	(−6.650)
R^2	0.3303	0.3319
Sample size	96	91
RMSE	0.2536	0.2542
Sample Period: June 1951 to April 1978		
Constant	0.0480	0.0508
	(1.416)	(1.646)
ΔM	−0.0077**	−0.0084**
	(−5.941)	(−5.723)
R^2	0.4342	0.4324
Sample size	48	45
RMSE	0.2334	0.2401
Sample Period: May 1978 to June 1988		
Constant	0.0093	0.0184
	(0.233)	(0.462)
ΔM	−0.0081**	−0.0066**
	(−4.684)	(−3.741)
R^2	0.3229	0.2413
Sample size	48	46
RMSE	0.2759	0.2701
F-Test for Structural Stability across Subperiods		
All parameters	0.294	0.455
p-value	0.755	0.636
ΔM-parameter	0.032	0.602
p-value	0.857	0.440

Notes: t-statistics are in parentheses.

R_A = geometric daily return from the business day before margin change to twenty-four business days after margin change (in percent).
R_B = geometric daily return from twenty-four business days before margin change to the business before margin change (in percent).
ΔM = M_A-M_B = change in average margin.
M_A = average margin level in the twenty-four business day period before margin change (in percent).
M_B = average margin level in the twenty-four business day period after margin change (in percent).
RMSE = root mean squared error.
R^2 = coefficient of determination.

**Significant at the 5 percent level.

[23] In Japan, dividends are very small relative to the size of the capital gain. Their inclusion in the definition of stock return would not alter our results.

[24] Similar figures were included in Hardouvelis, "Commentary: Stock Market Margin Requirements and Volatility," but there the returns were arithmetic instead of geometric daily averages.

endar month. We regress the change in the average geometric daily return on the change in the average level of M_t over each interval, as follows:[25]

$$(2) \qquad \Delta R_i = \alpha_0 + \alpha_1 \Delta M_i + u_i,$$

where ΔR_i denotes the change in the average geometric daily return from before and after the margin change i, ΔM_i is the change in average level of the effective margin, and u_i is white noise. The regression coefficients are negative and, indeed, statistically significant. The estimated regression coefficient of −.0078 for the full sample implies that after the initial margin requirement increases from 50 to 60 percent (assuming a typical level of 70 percent for the loan value and no minimum cash requirements), there will be a full price reversal in the market equal to [(.0078) × (10/.7)]/2, or 0.06 percent, each day over a period of a month. This reversal is equivalent to a cumulative drop of about 1.44 percent over the month.

The regression coefficient of ΔM_i remains very similar across the two subperiods, as we expected from the subperiod responses shown in the charts. Table 1 also shows that a formal F-test of structural change cannot reject the null hypotheses of parameter stability.

The second column in Table 1 presents the results of regressions that exclude the five cash-only margin changes; the effective margin requirement is defined by equation 1a. The results do not change.

Table 2 repeats the exercise of Table 1 but considers a longer horizon of seventy-five business days, or approximately three calendar months. The purpose of this exercise is to examine the effects of stock price swings that may last longer than one month. The results in Table 2 confirm the price reversals of Table 1: there is a statistically significant reversal in prices following a change in margin requirements. However, the size of the reversal — measured in daily returns — is smaller, approximately one-third the size of the reversal in Table 1. This finding suggests that the effects in the three-month intervals before and after the margin change of Table 2 are primarily due to the effects of the one-month horizon of Table 1. Apparently, the TSE responds to a run-up or rundown in prices after approximately one month and then it requires approximately one month for an almost complete reversal. The extra two months in Table 2 primarily add noise to the parameter estimates, reducing the size of the t-statistics.[26]

One might argue that the negative correlation between changes in margin requirements and changes in stock returns does not reflect a causal relation but simply the simultaneous response of the TSE and private investors to macroeconomic developments or other third factors. For example, suppose news hits the market that the Bank of Japan and the Ministry of Finance have adopted a restrictive policy to counter an overheated economy that is driving stock prices up. A fall in the market that coincides with an increase in margin requirements might stem from the anticipated negative effect of the future restrictive monetary policy on the economy and on the profitability of publicly

[25] We average the individual business day M_t's over each interval of twenty-four business days because in some cases another margin change occurs within these intervals.

Table 2

The Effect of Margin Requirements on Stock Returns — Interval of Seventy-Five Business Days

Dependent Variable: $\Delta R = R_A - R_B$ = Change in Return

Independent Variables	Effective Margin Change	Cash Margin/ Loan Value Change
Sample Period: June 1951 to June 1988		
Constant	−0.0094	−0.0029
	(−0.619)	(−0.188)
ΔM	−0.0024**	−0.0022**
	(−4.641)	(−3.786)
R^2	0.1864	0.1387
Sample size	96	91
RMSE	0.1498	0.1490
Sample Period: June 1951 to April 1978		
Constant	0.0009	0.0133
	(0.376)	(0.510)
ΔM	−0.0027**	−0.0026**
	(−3.856)	(−3.123)
R^2	0.2443	0.1849
Sample size	48	45
RMSE	0.1652	0.1736
Sample Period: May 1978 to June 1988		
Constant	0.0255	0.0168
	(−1.325)	(−0.942)
ΔM	−0.0019*	−0.0015*
	(−2.484)	(−1.919)
R^2	0.1183	0.0773
Sample size	48	46
RMSE	0.1331	0.1209
F-Test for Structural Stability across Subperiods		
All parameters	0.845	0.811
p-value	0.433	0.448
ΔM-parameter	0.493	0.826
p-value	0.484	0.366

*Significant at 10 percent level.
**Significant at 5 percent level.

[26] In the horizon of seventy-five business days there is considerable overlapping between the 96 × 2 = 192 intervals; this overlap diminishes the precision of the estimates.

traded companies, and not from the increase in margin requirements. If this interpretation were correct, the sequence of events would create a spurious negative association between margin requirements and stock returns. However, such interpretations cannot withstand rigorous scrutiny. First, margin requirement changes are administered by the TSE and are not necessarily coordinated with other fiscal or monetary measures. Second, if one estimates a hypothetical TSE margin response function to information variables, it becomes clear that macroeconomic variables do not play a vital role. The only variables that appear to affect the TSE's decision to change margin requirements are related to the stock market directly: unusual stock price trends, unusual trading volume, the percentage of trading volume due to margin trading, and so forth.[27] Controlling for such variables in the regressions of Tables 1 and 2 has no effect on the results.

Margin requirements and the volatility of daily returns in the Japanese stock market

We have seen that margin requirements in Japan can significantly affect the stock market by reversing a previous upward or downward trend in prices and that this impact did not diminish in the 1980s. We now turn to the issue of volatility. In this article we consider only actual volatility, leaving for future research the questions of excess volatility and long waves of stock prices away from fundamental values. Measuring excess volatility in the Japanese financial and economic environment can be quite involved and is beyond the scope of the present article.

The relation between volatility and returns

Recall that in the United States, volatility and the level of the market are negatively correlated. One explanation of this phenomenon is that high stock prices imply low debt-to-equity ratios and hence lower risk and volatility. The importance of controlling for the effects of market level on volatility is discussed in the Appendix. Thus, before we examine the effects of margin requirements on the volatility of Japanese stock returns, we will want to know if a similar relationship between stock returns and volatility is present in the Japanese data.

We study the relation between stock returns and volatility using monthly observations on volatility and returns from 1949 to June 1988. Our monthly measure of returns, R_m, is an average of daily returns within the month. Our monthly measure of volatility, σ_m, is the standard deviation of the residuals of a second-order autoregressive model of returns. The second-order autoregression eliminates the serial correlation in Japanese daily stock returns. The model is estimated separately for each month using the daily returns of that month alone. In addition, to ensure the independence of the volatility estimates across consecutive months, we have eliminated the first two daily returns from the sample size of each individual month.[28] The results of regressing contemporaneous volatility on contemporaneous return are as follows:

$$(3) \qquad \sigma_m = \underset{(15.389)}{0.6417} - \underset{(-6.178)}{0.3875}\, R_m, \qquad R^2 = 0.0762,\ \text{RMSE} = 0.0030,\ \text{DW} = 1.154,\ m = 1, \ldots, 469$$

where R^2 denotes the coefficient of determination, RMSE the root mean squared error of the regression, and DW the Durbin-Watson statistic for serial correlation. The t-statistics are given inside the parentheses below the estimated coefficients.[29] The regression equation shows that an increase in stock returns of 1 percent is associated with a decline in volatility of 0.39 percent. This negative association is similar to the relation between volatility and returns in the United States.

Examining the theoretical underpinnings of the negative relation between returns and volatility is beyond the scope of this paper. However, the presence of such a relationship implies that in our regressions of volatility on margin requirements we ought to control for the size of stock returns. This is especially important because stock returns are affected by the change in margin requirements. An increase in margin require-

[27]For a detailed description of a TSE response function, see Gikas Hardouvelis and Steve Peristiani, "Do Margin Requirements Stabilize the Market? The Case of Japan," Federal Reserve Bank of New York, Research Paper, April 1990. The only macroeconomic variable that has a statistically significant effect on the probability of a change in margin requirements is the Bank of Japan discount rate of the previous month. The relation between the two variables is negative, implying that the TSE is less likely to increase margin requirements if the Bank of Japan's discount rate is high. Hence, restrictive monetary policy cannot explain the negative association between an increase in margin requirements and a fall in stock prices.

[28]This measure of volatility is similar in spirit to the measure used by Kenneth French, G. William Schwert, and Robert Stambaugh in "Expected Returns and Volatility," *Journal of Financial Economics*, vol. 19 (1987), pp. 3-29. Their measure takes into account first-order serial correlations in daily stock returns, while ours takes into account second-order serial correlation as well. Estimating a single regression over the entire sample of daily stock returns R_t on R_{t-1} and R_{t-2} yields the following results:

$$R_t = \underset{(5.013)}{0.000361} + \underset{(21.4)}{0.199}\, R_{t-1} \underset{(-3.536)}{-0.032}\, R_{t-2}, \quad R^2 = 0.038,\ \text{RMSE} = 0.0077,\ T = 11{,}482$$

where R^2 is the coefficient of determination, RMSE is the regression root mean squared error, T is the sample size of more than 11,000 observations, and t-statistics are in parentheses.

[29]Coefficient estimates were obtained by a maximum likelihood method that corrected for the presence of a fourth-order autoregressive model of the errors. Note that the reverse regression of returns on volatility produces a statistically significant negative relation as well.

ments causes a decrease in stock returns, and the decline in stock returns may cause an increase in volatility. A failure to account for this relationship would generate a spurious positive correlation between changes in margin requirements and changes in volatility.

Margin requirements and volatility

We now turn to the main theme of this section: the relation between the change in volatility and the effective margin change itself in the period surrounding the margin change. Tables 3 and 4 present the results. Table 3 employs a volatility measure derived from horizons of twenty-four business days, while Table 4 uses a horizon of seventy-five days. As in the earlier section, we use both definitions of the effective margin requirement and estimate the various relations over the whole sample and over two subperiods. We also estimate the

Table 3

The Effect of Margin Requirements on Stock Volatility—Interval of Twenty-Four Business Days

Dependent Variable: $\Delta\sigma = \sigma_A - \sigma_B$ = Change in Volatility

Independent Variables	Effective Margin Change		Cash Margin/Loan Value Change	
		Sample Period: June 1951 to June 1988		
Constant	0.1063**	0.1359**	0.1111**	0.1485**
	(2.367)	(3.514)	(2.251)	(3.765)
ΔM	−0.0011	−0.0090**	−0.0012	−0.0096**
	(−0.587)	(−4.844)	(−0.628)	(−5.005)
ΔR		−1.0218**		−1.1096**
		(−7.019)		(−7.549)
R^2	0.0036	0.3487	0.0044	0.3958
Sample size	96	96	91	91
RMSE	0.4399	0.3576	0.4499	0.3525
		Sample Period: June 1951 to April 1978		
Constant	0.0681	0.0967**	0.0702	0.1001**
	(1.577)	(2.408)	(1.530)	(2.370)
ΔM	0.0013	−0.0031	0.0013	−0.0035
	(0.791)	(−1.582)	(0.721)	(−1.598)
ΔR		−0.5752**		−0.5864**
		(−3.696)		(−3.350)
R^2	0.0134	0.2153	0.0120	0.2203
Sample size	48	48	45	45
RMSE	0.2968	0.2676	0.3066	0.2756
		Sample Period: May 1978 to June 1988		
Constant	0.1333*	0.1458**	0.1469*	0.1742**
	(1.692)	(2.224)	(1.799)	(3.046)
ΔM	−0.0038	−0.0147**	−0.0041	−0.0140**
	(−1.119)	(−4.770)	(−1.145)	(−4.799)
ΔR		−1.3426**		−1.4818**
		(−6.210)		(−6.864)
R^2	0.0265	0.4758	0.0289	0.5367
Sample size	48	48	46	46
RMSE	0.5453	0.4045	0.5537	0.3869
		F-Test for Structural Stability across Subperiods		
All parameters	1.207	3.701**	1.198	3.847**
p-value	0.303	0.015	0.302	0.012
ΔM-parameter	1.946	10.095**	1.872	7.787**
p-value	0.166	0.002	0.175	0.007
ΔR-parameter		7.312**		9.905**
p-value		0.008		0.002

σ_A = volatility measure for the period of twenty-four business days before margin change (in percent).
σ_B = volatility measure for the period of twenty-four business days after margin change (in percent).

*Significant at 10 percent level.
**Significant at 5 percent level.

relation between the change in volatility and the change in the effective margin without controlling for the effect of stock returns on stock volatility. The regression equation has the following form:

$$(4) \qquad \Delta\sigma_i = \alpha_0 + \alpha_1 \Delta M_i + \alpha_2 \Delta R_i + u_i,$$

where $\Delta\sigma_i$ represents the change in volatility from the twenty-four-day interval before margin change i to the twenty-four-day interval after margin change i. As in the monthly case, the level of volatility was measured by the standard deviation of residuals obtained from a second-order autoregression for each interval.

Before we discuss the effects of margin requirements on volatility, note that the α_2 parameter in the above regression measures the effects of returns on volatility in the instances when margin requirements change. Since Table 3 uses a horizon of twenty-four business days, or approximately one month, estimates of α_2 in Table 3 can be compared to the regression coefficient

Table 4

The Effect of Margin Requirements on Stock Volatility—Interval of Seventy-Five Business Days

Dependent Variable: $\Delta\sigma = \sigma_A - \sigma_B$ = Change in Volatility

Independent Variables	Effective Margin Change		Cash Margin/Loan Value Change	
	Sample Period: June 1951 to June 1988			
Constant	0.0850**	0.0770**	0.0887**	0.0862**
	(2.714)	(2.679)	(2.771)	(2.938)
ΔM	−0.0005	−0.0025**	−0.0011	−0.0029**
	(−0.466)	(−2.344)	(−0.920)	(−2.506)
ΔR		−0.8429**		−0.8389**
		(−4.367)		(−4.230)
R^2	0.0023	0.1721	0.0094	0.1768
Sample size	96	96	91	91
RMSE	0.3061	0.2803	0.3041	0.2788
	Sample Period: June 1951 to April 1978			
Constant	0.0423	0.0475	0.0346	0.0412
	(1.282)	(1.579)	(1.070)	(1.371)
ΔM	0.0003	−0.0013	−0.00003	−0.0012
	(0.313)	(−1.283)	(0.033)	(−1.189)
ΔR		−0.5870**		−0.4950**
		(−3.199)		(−2.838)
R^2	0.0021	0.1870	0.0000	0.1609
Sample size	48	48	45	45
RMSE	0.2253	0.2056	0.2143	0.1986
	Sample Period: May 1978 to June 1988			
Constant	0.1216**	0.0918*	0.1362**	0.1124**
	(2.279)	(1.842)	(2.515)	(2.296)
ΔM	−0.0015	−0.0038*	−0.0026	−0.0048**
	(−0.706)	(−1.795)	(−1.105)	(−2.145)
ΔR		−1.1679**		−1.4145**
		(−3.117)		(−3.450)
R^2	0.0107	0.1864	0.0270	0.2379
Sample size	48	48	46	46
RMSE	0.3691	0.3384	0.3673	0.3288
	F-Test for Structural Stability across Subperiods			
All parameters	1.095	1.069	1.752	2.394*
p-value	0.338	0.367	0.180	0.073
ΔM-parameter	1.681	1.274	1.202	2.2486
p-value	0.411	0.262	0.127	0.137
ΔR-parameter		2.127		4.898**
p-value		0.148		0.002

*Significant at 10 percent level.
**Significant at 5 percent level.

of R_m in equation 3 above. In fact, we observe that the α_2 estimate for the full sample is −1.0218, while the estimate given by equation 3 is considerably lower at −.3875. This disparity is expected because the regressions in Table 3 are centered on the ninety-six margin changes, while the regression of equation 3 uses all 469 uncentered monthly observations. The discrepancy in the estimated coefficients arises because periods with margin changes are marked by higher price volatility. For instance, the average monthly volatility for the seventy-eight months that have at least one margin change is 0.702; the corresponding figure for the remaining months is 0.576. In fact, if we estimate the model given by equation 3 for only those seventy-eight months with margin changes, the coefficient estimate becomes −.998, which is more comparable to the estimates of Table 3.

Table 3 shows that both the partial effect—as in equation 4—and the total effect of margin requirements on volatility are negative. When the change in margin requirements is the only explanatory variable, the volatility response is not statistically significant, but such a relation suffers from omitted variables bias. When the change in stock returns is included in the regression in order to obtain a correct specification, the size of the volatility response to a change in margin requirements increases substantially and becomes statistically significant. A regression coefficient estimate of −.0096 implies that if stock returns are held constant, an increase in the margin requirements from 50 to 60 percent will cause a decline in the daily volatility of (.0096 × 14.3/2), or 0.07 percent.

A striking aspect of Table 3 is the increased impact of margin requirement changes on volatility during the second half of the sample. The negative regression coefficients (both total and partial) increase in size after 1978, and formal tests of structural change reject the hypothesis of parameter stability. This result is surprising for two reasons. First, Tables 1 and 2 showed that the effect of margin requirements on the market momentum did not change in the latter part of the sample. Second, one would expect to see that margin requirements had a smaller overall impact on the market in the 1980s, a period of increasing deregulation in the financial markets of Japan.[30]

Table 4 replicates the results of Table 3 using a horizon of seventy-five days. The impact of margin changes on volatility is still negative, but the magnitude is smaller. There are two explanations for the smaller magnitude. First, margin requirements may have only a temporary effect on volatility. After a month or so, investors who create volatility may find ways to avoid changes in regulatory restrictions. Second, this finding may be only an artifact of the estimation procedure. Results obtained using an interval of seventy-five days are contaminated by severe data overlapping. When the interval of twenty-four business days is employed, about fifty of ninety-six episodes have some overlap, but the overlapping margin changes are primarily in the same direction and thus logically consistent. When the horizon of seventy-five business days is used, about eighty of the ninety-six episodes have some overlap and many of the overlapping margin changes are in opposite directions. This blending of margin increases with margin decreases reduces the power to detect an association between margin requirements and volatility.

[30]Table 3 also shows that the impact of stock returns on volatility is higher in the latter subsample. It may be that in the late 1970s and the 1980s, volatility became more sensitive to many kinds of exogenous factors, including margin requirements, than it had been in earlier years. But whatever the explanation for this finding, the increased sensitivity of volatility to margin requirements in the 1980s shows that margins rules have gained more importance in recent years.

Conclusion

The strength of the negative association between cash market initial margin requirements and stock volatility in the U.S. data has recently generated considerable controversy among academic economists. The evidence is not strong enough to convince those economists who believe that regulatory restrictions on the stock market are ineffective. Margin requirements in the United States have changed only twenty-two times, a sample too limited to provide a decisive test of the effectiveness of margin regulation in calming the market.

This article shifted the focus to the effects of margin regulation in the Japanese stock market. In Japan, margin requirements have changed approximately 100 times during the last thirty-five years, and half of those changes occurred over the last ten years. Thus the margin experience in the Japanese market provides an unusually rich data set in a contemporary financial environment. Using this data, we found that changes in margin requirements are quite effective in curbing gyrations in stock prices. Margin requirements affect both the momentum of stock prices and the daily volatility of the market. An increase in margin requirements causes a complete reversal in the previous month's upward trend in stock prices and reduces daily volatility. Conversely, a decrease in margin requirements causes a rebound in a previously sluggish market and increases daily volatility. Furthermore, we found that margin policy in Japan has been at least as effective during the last ten years as it had been in the previous twenty-six years. The impact on daily volatility is stronger over the last ten years, a result which is quite surprising.

Recent episodes of unusual stock price fluctuations

have heightened the need for regulatory methods of containing volatility. Margin requirements represent one possible tool for influencing volatility, and the Japanese experience indicates that they may very well be an effective tool. Our evidence suggests that researchers can learn more about the importance of margin requirements in curbing market volatility by exploring other important foreign stock markets.

Gikas Hardouvelis
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Appendix: Some Technical Issues Raised by the U.S. Volatility Results

"Margin Requirements and Stock Market Volatility," published in the summer 1988 issue of the *Quarterly Review,* argued that higher initial margin requirements were statistically associated with a decrease in both actual stock market volatility and excess stock market volatility. The article elicited a number of responses that concentrated on the negative association between margin requirements and actual volatility rather than the more interesting relationship between margin requirements and excess volatility. Some questioned the robustness of the negative correlation across different subsamples; others took issue with the interpretation of the negative correlation, the estimation procedure, or the specification of the estimated equations. This appendix provides a brief evaluation of the issues raised by these responses.

We look first at the interpretation of the negative correlation. Some commentators posed the question: Does a negative correlation between margin requirements and volatility imply causation from margin requirements to volatility or the reverse? Intuition suggests that the Federal Reserve would not respond to an increase in volatility by decreasing margin requirements; hence it is difficult to accept the causation from volatility to margin requirements. In addition, statements by the Federal Reserve on its reasons for changing margin requirements never mention volatility as a causal variable. Further evidence is provided by a multivariate vector autoregressive system of equations for margin requirements, stock returns, stock volatility, and so forth: the results indicate that margin requirements are temporally prior to volatility and that volatility is not temporally prior to margin requirements.†

The second issue concerns the robustness of the negative correlation across the different subsamples.‡ The *Quarterly Review* article showed results for a sample period that began in 1931, before the establishment of official margin requirements, and for a sample period that began in 1935, after the establishment of official margin requirements. Since the latter sample period excluded the early 1930s, a period of very high volatility in the stock market and zero-level official margin requirements, it naturally showed a weaker negative correlation. The early 1930s were excluded because of a concern that the broker-dealer margin requirements of that time diverged from the official margin of zero much more than they diverged later on in the sample period—a possibility that would bias the results. Some commentators argued that even the results for the post-1934 period may be misleading and hence irrelevant for contemporary margin policy. They claimed that the negative correlation was primarily attributable to the depression years and that the correlation in the postdepression period, although negative, was statistically insignificant. It is unclear why the depression years' experience with margin policy should be discounted. If anything, the recent stock market crashes are reminiscent of similar abrupt stock price changes in the 1930s. Furthermore, the negative association between excess volatility and margin requirements was stronger in the postdepression sample.§

A third concern, raised primarily by Hsieh and Miller, focused on some technical aspects of estimation.‖ To

†See G. William Schwert, "Business Cycles, Financial Crises and Stock Volatility," and the response in Gikas Hardouvelis, "Commentary: Stock Market Margin Requirements and Volatility."

‡Perhaps it should not come as a surprise that at different sample periods the correlation has a slightly different size. Theoretically, there are two opposing effects from margin requirements to volatility—the effect on stabilizing investors and the effect on destabilizing investors—and at different

Footnote ‡ continued
points in time the relative importance of the two effects may well vary. In addition, estimation error induces differences in subsample coefficient estimates even when the true coefficient remains the same. The estimation problem is aggravated by the very few changes in margin requirements over the whole sample. In subsamples the margin changes are even less.

§In Tables 4a and 4b of Hardouvelis, "Margin Requirements, Volatility, and the Transitory Component of Stock Prices," the sample is partitioned in the middle and at other break points. Despite the arguments that the negative correlation is due to the depression years, the correlation in the second half of the sample is statistically significant.

‖See David Hsieh and Merton Miller, "Margin Regulation and Stock Market Volatility."

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estimate the effect of the level of margin requirements on the level of volatility, the *Quarterly Review* article made use of overlapping monthly observations and applied the Newey-West correction of the standard errors. Hsieh and Miller objected to the use of overlapping data but did not attempt to reestimate the relation between volatility and margin requirements using nonoverlapping observations. The results do not change when nonoverlapping annual observations are used instead of overlapping monthly observations.# Hsieh and Miller also claimed that the estimated correlation between the level of volatility and the level of margin requirements may be spurious and recommended as a better measure the correlation between the change in volatility and the change in margin requirements.* They found that the negative correlation was present in the first difference specification only when additional control variables were included in the estimated equation.†† This finding brings us to the interesting question: Which control variables should appear in the estimated regression equation?

The *Quarterly Review* article examined the statements made by the Federal Reserve about its motives for changing margin requirements. Two variables that the Fed itself consistently cites in explaining changes in margin requirements are the recent trend in stock prices and the recent trend in margin credit.‡‡ To avoid spurious effects on volatility from the variables that prompt the Fed to respond, we must control for their variation by including them in the regression. For example, it is an established empirical fact that volatility is low during a bullish stock market and high during a bear market.§§ Since stock prices are high before a margin increase and low thereafter, it is possible to observe a spurious positive association between volatility and margin requirements.

Hsieh and Miller questioned the inclusion of lagged growth of margin credit in the regression equation, despite the fact that lagged margin credit growth was a main indicator for changing margin requirements.‖‖ Their analysis makes it clear that from their perspective the proper specification is a general simultaneous equations system. Such a system would allow for margin requirements to have an effect on both margin credit and volatility and for margin credit to have an effect on volatility and margin requirements. The authors did not attempt to estimate such a system, however, and thus the original single equation specification employed by Hardouvelis remains the most complete specification in the literature so far.

Others also raised the issue of margin debt, though in a different context. Salinger claimed that in the matter of volatility, it is margin debt that matters and not margin requirements. In support of his position, he noted that when the contemporaneous values of both variables are included in the regression, the coefficient of margin debt is significant but the coefficient of margin requirements is insignificant. A similar argument was advanced by Jones, Mulherin, and Titman.## All these authors also contended that since margin debt is presently only about 1.5 percent of the capitalized value of the New York Stock Exchange, it is not a factor that in the present financial environment can seriously contribute to volatility. The response to such a line of reason-

#See Table 4a in Hardouvelis, "Margin Requirements, Volatility, and the Transitory Component of Stock Prices."

*They justify their use of first differences by pointing to the high serial correlation in volatility when overlapping data are used. However, given the data overlap, such a correlation is very typical and does not justify using first differences. To see whether volatility has a unit root, one has to examine nonoverlapping data.

††In Table 4c of Hardouvelis, "Margin Requirements, Volatility, and the Transitory Component of Stock Prices," the twenty-two instances when the margin requirement changed are isolated and then the change in volatility is regressed on the change in margin requirements. The correlation of margin requirements is statistically significant only when additional control variables appear in the regression.

‡‡See Board of Governors of the Federal Reserve System, *Annual Report*, various issues.

§§In a bullish stock market, corporate debt-to-equity ratios are by definition lower, implying lower volatility in stockholder returns. See Andrew Christie, "The Stochastic Behavior of Common Stock Variances: Value, Leverage and Interest Rate Effects," *Journal of Financial Economics*, vol. 10 (December 1982), pp. 407-32.

‖‖In the *Quarterly Review* article, Hardouvelis presents a Federal Reserve response function based on a simple regression of the change in margin requirements on past information variables. In the *American Economic Review* article, he sharpens the modeling of the Fed response by estimating an ordered response logit equation. The latter shows that recent changes in margin credit have a significant effect on the probability that the Fed will change margin requirements.

##See Jonathan Jones, J. Harold Mulherin, and Sheridan Titman, "Speculative Trading and Stock Market Volatility," Securities and Exchange Commission, January 1990, mimeo.

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ing is straightforward. First, margin debt is not an exogenous variable; it is affected by margin requirements. Hence evidence that margin debt matters is indirect evidence that margin requirements matter. Second, even though the size of margin debt represents a very small fraction of the value of the New York Stock Exchange stocks, trading based on margin accounts may represent a much larger fraction of total trading — perhaps as high as 20 percent — and thus volatility can be very sensitive to the presence of margin accounts.** In Japan, where data on margin trading are collected regularly, margin trading represents approximately 20 percent of trading volume despite the fact that margin accounts are, as in the United States, less than 2 percent of the capitalized value of the country's stock market. Overall, the role of margin debt is far from settled and more research is required in this direction.†††

The commentators raise one further point of interest: If margin requirements restrict the behavior of investors, one should observe an adverse effect on their trading activity and on the amount they borrow from brokers and dealers. The evidence on these variables is unambiguous: Luckett finds that investors' equity accounts with brokers and dealers in fact decline after an increase in margin requirements; Hardouvelis, using a vector autoregressive model, shows that both margin credit and trading volume decline following an increase in margin requirements.‡‡‡ Kupiec, however, argues otherwise. He shows that the amount of short sales increases slightly following an increase in margin requirements, and he interprets this relation as evidence contradicting the hypothesis that high margins reduce speculative trading activity.§§§ Yet Kupiec's interpretation seems arbitrary. The activity of short sellers, unlike that of long buyers, is ambiguously affected by an increase in margin requirements. Such an increase will raise the cost of leverage, resulting in less borrowing and less short selling. But if the increase in margin requirements causes investors to revise their expectations of the future movement in stock prices downward — that is, if margin requirements are effective — investors have an incentive to short sell before stock prices decline. A priori, it is unclear which of the two effects dominates the behavior of short sellers, while Kupiec's evidence simply suggests that the latter speculative effect is the dominant one.‖‖‖

In summary, although the economists who responded to the *Quarterly Review* article did not disagree with the presence of an overall negative association between margin requirements and volatility, they argued that such an association was not robust enough to support the idea of using margin requirements as a tool for controlling market volatility. Certainly, the few historical episodes of a change in margin requirements provide very little evidence with which to resolve the question of margin requirement effectiveness. For this reason, we direct our attention in this article to other economies and other markets where margin requirements are administered on a more frequent basis.

**Unfortunately, no contemporaneous data exist on the activity of margin accounts. A study by the Board of Governors of the Federal Reserve System, "A Review and Evaluation of Margin Requirements," 1974, presents some results from surveys performed in the 1960s and 1970s that show margin trading to be a relatively large fraction of total trading. Also note that margin requirements can have an effect on volatility without necessarily affecting margin debt. The reason is that a change in margin requirements affects the cost of leveraging even if investors can find alternative sources of credit.

†††Salinger and Hardouvelis (the latter responding to Salinger) find that the contemporaneous level of margin debt is positively related to volatility, as expected. However, the lagged growth rate in margin debt is negatively related to volatility, a result which is puzzling. Jones, Mulherin, and Titman add a new twist to the puzzle by showing that although the lagged growth rate of margin debt is negatively related to a volatility measure based on monthly observations, it is positively related to a volatility measure based on daily observations.

‡‡‡Luckett, "On the Effectiveness of the Federal Reserve's Margin Requirement"; Hardouvelis, "Margin Requirements, Volatility, and the Transitory Component of Stock Prices."

§§§Kupiec, "Initial Margin Requirements and Stock Returns Volatility."

‖‖‖In Japan, the behavior of short sellers has changed over time. In the first subsample (1951-78), short sellers borrowed less funds after an increase in margin requirements, but in the second subsample (1979-88), short sellers became more sophisticated and borrowed more in order to short sell following an increase in margin requirements. The behavior of long buyers in Japan is the same in both subsamples: they borrow less after an increase in margin requirements. See Hardouvelis and Peristiani, "Do Margin Requirements Stablilize the Market?"