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Race to the Center: Competition for the Nikkei 225 Futures Trade

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Abstract

This paper examines the impact of changes in margin requirements on returns, transaction volumes, and price volatility of Nikkei 225 futures on the Osaka Securities Exchange (OSE) and the Singapore International Monetary Exchange (SIMEX). An increase in margin requirement on one exchange is shown to reduce trading volume in the implementing exchange and to shift trade to the competing exchange. Price volatility or returns are not systematically affected by changes in margin requirements. The loss of OSE's market share of Nikkei futures trade is partly due to the increased transactions costs (relative to SIMEX), including the margin requirement.

Keywords: margin requirements, futures price volatility, trading volume, GARCH

JEL Classification Numbers:

G13, G18, G2

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Summary

Three futures exchanges--Osaka Securities Exchange, Singapore International Monetary Exchange, and Chicago Mercantile Exchange--list and trade Nikkei 225 Futures, a Japanese stock index futures. This paper first examines whether a change in margin requirements in one of the exchanges contributed to the shift in trading volumes of 225 Futures contracts from the Osaka to the Singapore exchange. Second, it investigates whether and how changes in margin requirements affected the stochastic processes of return and price volatility.

The findings are as follows. An increase in margin requirements at an exchange reduces trading volume in that exchange and shifts trading to the other exchange. Evidence supports a view that opposite movements in margin requirements in Osaka and Singapore from 1991 to 1993 contributed to the decline in the trading at the Osaka exchange and increased trading at the Singapore exchange, even controlling for various factors. Setting a low margin requirement seems to be a strong weapon in attracting business and establishing a financial center. However, a closer look at the timing of margin changes suggests that changes in margin requirement in the Singapore exchange are consistent with changes in volatility: higher volatility prompted an increase in the margin requirement, while lower volatility prompted a decrease in the margin requirement.

An increase in the margin requirement in one market had no significant systematic effects on returns or volatility. Nevertheless, surprise movements of the returns in the Osaka exchange have been observed to cause volatility in subsequent days in all three markets.

In 1993, it became clear to traders in Tokyo that [cash-futures] arbitrage could be executed more cheaply in Singapore than in Osaka. Margin requirements on SIMEX were 15 percent of a contract's face value, compared with 30 percent on the Osaka stock exchange. ... [Barings] Tokyo began asking the Singapore office to execute Nikkei 225 trades on SIMEX early in 1993, and the trader who assumed the role as Tokyo's man on SIMEX was Nick Leeson. -- Fay (1996, p. 106)

I. INTRODUCTION

Three futures exchanges---Osaka Securities Exchange (OSE), Singapore International Monetary Exchange (SIMEX), and Chicago Mercantile Exchange (CME)---list and trade Nikkei 225 futures, a Japanese futures stock index.² Traditionally, trading volumes of the Nikkei 225 futures on OSE were far higher than on SIMEX. The trading volume of CME has been much smaller than SIMEX. However, since 1991, trading volumes on SIMEX have increased, while those on OSE have declined. By 1994, trading volumes (in contract values) on SIMEX rose by about half that of OSE. The difference in the transactions costs between the two markets is often cited as a reason for the contrasting performance in trading volumes. In particular, OSE increased margin requirements three times in 1991, while SIMEX lowered them twice in the same year. The case of competing exchanges for business of the same *financial product presents an interesting case.*

The objective of the paper is twofold. First, the paper examines whether a change in margin requirements in one of the exchanges we examine contributed to the shift in trading volumes of Nikkei 225 futures contracts between the two exchanges, OSE and SIMEX. Second, the paper investigates whether and how changes in margin requirements had impacted on the stochastic processes of return and price volatility. This paper is unique in analyzing a spillover effect of a regulatory change in one market on the market activities of another market.

How movements of securities prices are modified in response to a change in regulatory policy, such as changes in margins and commissions, is an interesting policy question. Although many papers have been written on the subject, no definite answers have been given. Many regulatory requirements, imposed either by the securities exchange or the authority, are intended as prudential measures to reduce systemic risk. For example, a margin, which is a

²Nikkei 225 futures are the simple average of 225 selected stocks traded on the Tokyo Stock Exchange (TSE). Very recently, OSE and SIMEX started to trade another futures index--Nikkei 300--along with the Nikkei 225 futures. Nikkei 225 is a simple average of 225 stock prices, while Nikkei 300 is the value-weighted average of 300 TSE stocks.

fraction of the contract values to be deposited at the futures exchange, is a prudential requirement to insure the soundness of the futures exchange as a clearinghouse. However, a higher margin also affects profitability of operations, thus reducing the incentives of investors to trade on the futures exchanges. Reduced trading activities, or lower transactions volumes, cause loss in market depth. Although it is often argued that higher transaction costs reduce price volatility by discouraging speculative, noise trading, price volatility may rise due to a lack of liquidity in the market, if large enough trading are lost due to higher transactions costs. Similarly, the effect of higher transactions costs on the returns process is unclear. Suppose that the higher transactions costs produce lower price volatility, then this may allow the lower average return to be acceptable to market investors. On the other hand, the higher transactions costs must be compensated by the higher premium (average returns) in this market. Hence, it is an empirical question whether higher margin requirements result in higher or lower average returns, or higher or lower price volatility. This paper addresses the issue by investigating the return and volatility processes as well as the transaction volume of the Nikkei 225 futures contracts on OSE and SIMEX in response to changes in their margin requirements.

A change in margin requirements in one futures exchange influences trading activities not only in that exchange but also in "related" markets, such as an exchange that lists the same financial products or the underlying cash market. The dual listing of financial products is an obvious example of such a spillover.

Since almost identical Nikkei 225 products are traded on OSE and SIMEX, a change in margin requirements in one market may cause a shift in activities from one market to the other. A margin increase in one market may increase or decrease the volume of the other market, depending on whether a substitution effect between the two markets more than compensates a decline in combined market activities due to higher costs. Such a spillover effect based on a rigorous time series model has not been investigated before.

To examine the above issues, an econometric model that describes the processes of returns, time-varying volatility, and trading volume with dummy variables for margin change events will be employed. The dummy variables allow us to test whether returns, price volatility, and trading volume have changed in response to changes in margin requirements. In addition to these "event dummy variables," a time series model is constructed in a way that makes it possible to examine the spillover effects in OSE, SIMEX, and CME. The returns process allows spillovers from lagged returns of all three markets. The volatility process follows a generalized autoregressive heteroskedasticity (GARCH) process to capture the time-varying volatility. The trading volume process is specified as a process with breaks in the long-term trend to capture the effect of shifts in trading shares between the two futures exchanges, OSE and SIMEX, and spillovers from trading volume innovations of all three markets.

This empirical study will contribute to the existing literature in two ways. First, it examines the impact of changes in margin requirements by either OSE or SIMEX on the

returns, price volatility, and trading volume in their exchanges, and the cash markets. The issue of policy spillovers across international markets has not been analyzed before. Second, it analyzes the linkage between returns, volatility, and trading volume between OSE, SIMEX, and the cash markets.

The rest of the paper is organized as follows. In Section II, the relevant literature is surveyed. Section III, presents market structures of a Nikkei 225 futures contract in OSE, SIMEX, and CME, as well as a history of margin changes in both OSE and SIMEX. The section also shows changes in market shares of trading volumes between SIMEX and OSE across different margin levels. In Section IV, an event analysis is performed to examine the immediate effect of margin requirement changes. Section V presents the econometric models for our analysis and reports the empirical results. These econometric models include the linear regression model and GARCH models for returns, price volatility, and trading volume. Section VI discusses the policy implications of our findings, and Section VII concludes the paper.

II. LITERATURE SURVEY

A. Theoretical Prediction

Theoretically, the level of margins is decided to insure the safety of an exchange system against risk of default by an exchange member.³ Default risk is positively related with price volatility, since the probability of a large price jump, which drives a member to default, increases as price volatility increases, other things being constant. Thus, the prudent clearinghouse will increase the level of margins in response to increased volatility as the credit risk faced by the exchanges rises. However, many papers consider the level of margin requirements as exogenous and only analyze the impact of changes in margin requirements and other transactions costs on market activities, but not the other way around.

First of all, an increase in transactions costs, such as margin requirements, is expected to depress trading volume of the market. If there are two or more closely related markets (such as cash versus futures and dual listings of the futures) for a financial product, then an increase in transactions costs in one market will drive the businesses away from that market to another market, in addition to causing a net loss of trading volume to the combined markets of the product. Hence, an increase in the margin requirements in one market will unambiguously lower the trading volume of that market (the "own-market effect" is negative), while the effect on the trading volume of the other competing market(s) is ambiguous. If a substitution in trading location occurs, e.g., an increase in trading due to the other market implementing

³Because arbitrage between OSE and CME is more difficult owing to the different currency units used (OSE uses yen and CME U.S. dollars) and the time difference, CME has become a niche market for Nikkei 225 futures rather than a market directly competitive to OSE. Thus, this paper deals mainly with competition between OSE and SIMEX.

higher transactions costs, which more than offset the loss of the market-wide decline in trading, then the competing market, without changing costs, gains trading activities from an increase in transactions in the implementing market. However, if the increase in the transactions cost depresses trading activities sufficiently and overwhelms the substitution effect, then the trading volume of the competing market may also decline. The substitution effect can be valid between dual listing futures market or between the futures market and the cash market. Arbitrage trading between the futures and cash market push trading volume up or down together. If the futures transactions are discouraged by an increase in transactions costs, then cash market activities will be depressed through discouragement of arbitrage. In sum, an increase in margin requirements on OSE should depress the trading volume of OSE, whereas the trading volume of SIMEX may rise (if the substitution effect dominates) or decline (if the arbitrage effect dominates).

Next, we can make some predictions from the theoretical models about what the impact of a change in margin requirement in one market will be on the behavior of the returns and volatility processes of its own and the related markets. The existing literature, which investigates how the introduction of stock price index futures market affects cash market volatility, is usually based on a noisy rational expectations model of heterogeneous traders, some of them informed and some uninformed. See, for example, Danthine (1978), Fremault (1991), and Subrahmanyam (1991).

In noisy rational expectations models, information content on price level and volatility depends on how the composition of informed and uninformed traders changes after the introduction of the futures market; some investors may shift from the cash market to the futures market, and new types of investors may be attracted to the market. The entry of new noisy speculators lowers the information content on prices and tends to make prices more volatile. In contrast, the introduction of a futures market can add more informed traders to the cash market, making the cash market more liquid and less volatile.

Similar conclusions regarding the impact of changes in margins on the market structure of the underlying market and on related markets can be drawn from the above studies as well as from Pliska and Shalen (1991), who set up a multi-period noisy rational expectations model to investigate the impact of changes in margin regulation on futures market volatility. The effect of an increase in margin requirements on price volatility also depends on the changing composition of informed and uninformed traders. If an increase in transaction costs drives liquidity traders to the cash market or to overseas futures markets, then price volatility in the cash market or the other futures markets will increase while the price volatility in the market where transaction costs are raised will decrease. Of course, the prices of the related market do not deviate beyond a certain band because of arbitrage activities. However, if uninformed traders shift their trade from the futures market to the cash market (or to other futures markets), then the cash market impounds more information and hence, price volatility in the cash market (or the overseas futures markets) can decrease while the volatility in the underlying futures market will increase.

Finally, the introduction of index futures provides another avenue for revealing market-wide information. If domestic futures markets are closely linked to the cash market or the overseas futures market, we can predict that the information revealed in one market can impact the returns, volatility, or trading volume of the other markets. Chan, Chan, and Karyoli (1991) have investigated the volatility and return linkage between the Standard and Poors (S&P) 500 stock index in the cash market and the same futures index and found a bi-directional volatility link between the two markets. Theoretical work by Subrahmanyam (1991) also predicts the lead and lag relation between the futures and cash returns. In this study, we control and test for such spillovers between the three markets--the Nikkei 225 futures contracts, OSE, and SIMEX, as well as the Nikkei 225 cash index, while also examining the impact of changes in margins in OSE and SIMEX futures contracts on these three markets.

B. Review of Stylized Facts

There is a long list of work on the analysis of margin requirements, price volatility, and transaction volumes. To name a few, see Hardouvelis (1990), Hardouvelis and Peristiani (1992), Hsieh and Miller (1990), and Sofianos (1988). In both theoretical models and empirical evidence in the literature, there is a consensus that high margins slow market activity (volume of transactions) by increasing the cost of speculation (Hartzmark (1986)). However, no agreement is found on the stabilizing effect (less volatility) of margins on futures prices. Some argue that high margins are stabilizing because they restrict the entry of irrational speculators; others argue that high margins may increase volatility because the market becomes thinner, and higher margins are as likely to drive out naive traders as informed ones. In general, whether higher margins are stabilizing or destabilizing to the market depends on the composition of informed and uninformed traders who are most sensitive to the change in transaction costs in making their investment decisions. If uninformed or speculative traders are likely to be more liquidity-constrained than the informed traders, the increase in margins causes the uninformed or speculative traders to shift trading from the underlying cash market to a futures market. This leads to a decrease (increase) in the composition of uninformed traders relative to informed traders in the underlying (related, respectively) market. In this case, the higher (lower) the ratio of speculative traders in the market the less (more, respectively) informative the price discovery in the market becomes, or vice versa. However, in either case, we expect that trading volume in the underlying market, which increases margin requirements, will decline while the trading volume in the futures markets will increase.

Hardouvelis (1990) and Hardouvelis and Peristiani (1992) have shown that in both the New York Stock Exchange and the Tokyo Stock Exchange, an increase in margin requirements for cash market transactions significantly dampens the volatility of cash market prices. The results reopened the debate on whether margin requirements can affect price volatility. Hsieh and Miller (1990) conducted the Monte Carlo study of the statistical methodology used by Hardouvelis (1990) to demonstrate that the findings of a negative relation between the margins and price volatility was subject to statistical flaws. However,

they reaffirmed that there existed a negative relation between the trading volume and the level of margins. Moreover, the changes in margin requirements by the regulators tended to follow rather than lead changes in market volatility. The evidence on the futures market presented by Hartzmark (1986), Salinger (1989), and Schwert (1989) is similar to these conclusions on the cash market. It should be noted that the above studies focus on how the regulation in one market affects the returns, volatility, and trading volume of that market. If similar and related products are traded somewhere else, investors have the choice to change places to trade. Obvious examples are the cash versus the derivative markets, and the dual listing of the same futures contracts on different exchanges. The derivative markets such as the futures market are often known to have a cheaper transaction cost and to transmit market-wide information faster than the cash market (Chan (1992)). The changes in the margin regulation in one market will have an impact on a related market. Moser (1991) and Mayhew, Sarin, and Shastri (1994) recently analyzed how the impact of changes in margins on futures or options markets affects the volatility of the cash markets. In the related work, Board and Sutcliffe (1994) examined the arbitrage between the dual listing of Nikkei 225 futures; Bacha and Vila (1994) examined the Nikkei 225 futures and concluded that adding a new futures market (OSE and CME) has no effect on volatility in the stock market. They found that effects of tighter regulations with respect to higher margins in 1991 were too weak to detect.

III. MARKET STRUCTURES AND TRADING VOLUMES

It was SIMEX that introduced the Nikkei 225 futures first--trading started on September 3, 1986. It is somewhat unusual that futures trading was introduced first in a country where the underlying markets are not traded. However, Japan at that time was still unsure about the introduction of futures products and took a "gradualist" approach to the financial innovation. The Osaka Securities Exchange started trading a smaller-scale index futures product called Kabusaki 50 first, before it introduced the more popular Nikkei 225 index. OSE in Japan launched the Nikkei 225 futures on September 3, 1988, exactly two years later than SIMEX. Although details of contracts and the organization of the two exchanges are slightly different, as will be described shortly, the Nikkei futures on SIMEX and OSE use the identical underlying index (Nikkei 225--the simple average of 225 selected stocks traded in the Tokyo Stock Exchange (TSE)), and both contracts are denominated in yen. In September 1990, the Chicago Mercantile Exchange (CME) also started to trade Nikkei futures.

Table 1 summarizes the different microstructures of the three markets.⁴ The OSE contract size is 1,000 yen times the index, while the SIMEX contract size is 500 yen times the index. For example, if the index is 20,000, a traded value of one contract in Osaka is 20 million yen, while in Singapore it is 10 million yen. (Thus, we divide the SIMEX contracts number by 2 to make it comparable in yen to OSE.) The CME contracts are denominated in U.S. dollars, and the contract size is \$5 times the index level. If the index is 20,000 yen, then

⁴For other features of stock (cash) markets in general, see Huang and Stoll (1991).

the dollar contract unit value is \$100,000, which, if the foreign exchange rate is 100 yen per dollar, amounts to 10 million yen. Since arbitrage between OSE and CME is more difficult because of the different currency units, and the time difference thus makes CME a niche market, rather than a market directly competitive to OSE. Hence, in the following analysis, we mainly deal with competition between OSE and SIMEX.

Table 2 summarizes the history of margin requirement changes in OSE, SIMEX, and CME. In fact, one of the striking differences in the trading requirement of Nikkei 225 futures between OSE and SIMEX is the difference in margin requirement behavior; in 1991, OSE increased margin requirements three times, while SIMEX decreased its margin requirements twice. Furthermore, in 1993, the margin requirements in SIMEX and CME decreased, whereas OSE maintained the same margin requirements. If the margin requirement should be decided according to price volatility alone, and the price volatility in the two markets were not much different (since the prices tend to be converged through arbitrage), then decisions in the two markets in 1991 were not mutually consistent.

Stock prices in the cash market (Nikkei 225 index on the Tokyo Stock Exchange) went down sharply in 1990. From the peak of 38,915.87 on the last trading day of 1989, the Nikkei 225 index dropped to below 21,000 by September 1990. Although the price level recovered somewhat in 1991, it plummeted again in 1992 to a low of 15,000. In the declining phase, strategic position takings in the futures and cash markets were evident, according to the financial press at the time: Those who bet on the decline took position in the futures market, sending futures prices down; then the decline in futures prices would change expectations in the cash market as well and arbitrage trading would bring cash prices down. When the newly established levels in the two markets were sustained, those who took positions in the beginning stood to reap profits. Since the time lag relationship between cash and futures prices looked as if speculation on futures had "caused" the decline in the cash market, there was political pressure in Japan (which was concerned about the decline in the levels of the cash market) to tighten regulations in the futures market, for example by raising the margin requirement. In short, steps to increase the margin requirements in Osaka were taken to make it more difficult to speculate, in order to prevent further declines in the cash market. However, these steps were not followed by SIMEX, which obviously did not share OSE's concern with the level of the cash price.

The stock price movement in 1992, which brought the cash price further down to below 15,000 in the summer, proved that price declines had been caused by something more than speculation. By then, it was standard to regard the price decline from 1990 to 1992 as a "burst bubble," a process to correct the inflated asset prices in the second half of the 1980s (see Ito and Iwaisako (1996)). Moreover, the real economy in Japan suddenly seemed weaker than previously believed, as the growth rate plummeted to near zero. Given that prices were bid up to a level that was not justifiable by the economic fundamentals, it was a matter of time before prices would come down, whether triggered by smart speculations or not.

The monthly transaction volumes in OSE and SIMEX are shown in Figure 1. The vertical grid lines show the timing of changes in margin requirements, which also corresponds to Table 1. Figure 2 shows the market share of OSE in terms of transactions volumes of Nikkei 225 futures on the three markets.⁵ The transactions volumes show a sharp increase in OSE in 1990. By the end of 1990, the OSE market share of worldwide transactions of Nikkei futures reached 95 percent. This is the period that the cash price was soaring to the peak (of the bubble). It seems straightforward that the transactions volumes in SIMEX only started to increase to a significant degree in late 1991.

A quick glance at the trading volume behavior of OSE and SIMEX prompts a hypothesis on how changes in margin requirements may be one way to affect market shares between the two markets in the following way. Financial centers have scale economies, in that a deep market attracts more trading by being a liquid market, where price discovery is fast. A deeper market attracts more trade, thus becoming even deeper. The OSE trading volume and market share had been boosted from 1988 to 1990 by this scale economies consideration. It is possible to attract business away from the leading, deep market only by developing a niche, for example by offering cheaper transaction costs, reducing the barriers to entry, and other inducements.⁶ It turned out that by late 1991 the difference in costs between OSE and SIMEX more than offset the scale disadvantage for SIMEX and the tide started to turn.

A casual observation indicates that a series of increases in margin requirements in OSE, and opposite movements in SIMEX, were responsible for the decline in the trading volumes on OSE and the increase in the trading volume on SIMEX. Although the timing of changes in margin requirement and the trend change in trading volume are not exactly matched, the effects of transactions costs on trading volume and price volatility seem to be strong. In the following subsection, a formal analysis will be conducted to examine this relationship. Since trading volumes and price volatility are affected by many factors other than margin requirements, a careful analysis to control for other factors is needed.

IV. DATA AND EVENT ANALYSIS

The daily data of the Nikkei 225 cash index and the settlement prices of futures contracts on OSE and SIMEX from September 3, 1988 to January 28, 1994 are used to construct daily returns, which are defined as the logarithm difference of the price indices

⁵The CME transaction volumes are converted to common units by using 100 yen per dollar exchange rate, the contract unit in SIMEX is half of OSE, and the number of contracts in SIMEX is divided by two to standardize the transaction volume for the yen value in Osaka.

⁶The cost comparison is relative. The above statement can apply to a situation where the leading market increases transactions costs or the following market decreases transactions costs, or both.

between business days t and $t-1$. The business hours for the two futures exchanges are identical, but the futures markets closes 10 minutes later than the cash market. The number of contracts traded is used as a measure of trading volume. For the cash market, we use the total number of contracts in the Tokyo Stock Exchange as trading volume. In SIMEX, since the monetary value per contract is half the OSE contract, the number of contracts in SIMEX is divided by two to obtain its trading volume standardized to the OSE unit. There are eleven changes in margins either on OSE or SIMEX, which, by using each event as a break point, breaks our sample into twelve regimes.

First of all, how the returns and volatility changed just before and after each margin change is analyzed in the manner of an "event analysis." Average trading volume, sample average returns, and sample standard deviation of returns on OSE and SIMEX over a period of 25 days before and after each change in margin requirement are calculated and examined against theoretical predictions. The statistics are also computed for the ratio of the sample statistic for OSE relative to SIMEX. The standard errors for each statistic are computed from a heteroskedasticity-consistent covariance matrix.

First, the effect of a change in margin requirement on trading volumes is analyzed. Theoretical predictions are that (i) the trading volume of the exchange that raised (lowered, respectively) the margin requirement would decline (increase, respectively) "after" the change, that is, the own market effect is negative; (ii) the trading volume of the other exchange may experience either an increase (decline, respectively) due to a substitution effect or a decline (increase, respectively), that is the spillover effect is uncertain;⁷ and (iii) the ratio of volumes of the exchange that raised (lowered) the margin requirement to the volume of the other exchange would decrease (increase), that is, the own effect dominates the spillover effect, or the ratio effect is negative.

The trading volumes and the volume ratios of SIMEX or OSE for a period "before" and "after" each change in margin requirement, are shown in Table 3. The table shows, for each time a market changed margin requirement, how trading volumes changed in the market that implemented the change in margin requirement (the own effect) and in the other market (the spillover effect).

⁷The two different effects can be predicted. First, some trades shift from the underlying market, which raised the margin requirement, to the related market. The "substitution effect" increases the trading volume in the related market. Second, an increase in transaction costs in one market may depress arbitrage-based trading activities, such as index arbitrage between the cash and futures markets, or between the two futures markets, and of portfolio insurance on strategic trading activities. Thus, this arbitrage effect depresses market activities in all the related markets. In sum, the increase in margin requirements on OSE should depress the trading volume of OSE (own effect), while trading volume on SIMEX (spillover effect) may rise (if the substitution effect dominates) or decline (if the arbitrage effect dominates).

Of the eleven events, the own market effect was confirmed seven times in right directions, with five of them statistically significant; while the ratio effect was confirmed nine times, six of them statistically significant. In general, the event analysis confirms that the market response to the change in margin requirement was reasonably quick, that within a month significant business was shifted from the exchange that raised margin to the competing exchange. We conclude from these results that the change in margin requirement definitely influence the location of business.

Table 4 examines the price volatility "before" and "after" each change in margin requirement. There are at least two possible sources that may affect volatility when the level of margin requirement is changed.⁸ First, if the change in the carrying costs drives out some investors with particular risk tolerance compared with the rest of the investors in the market, then price volatility may be affected. Those marginal investors are most likely more risk averse than the others. Hence, the increase in margin requirement (increasing transactions costs) would drive out investors who are less risk tolerant, and may result in higher price volatility. Second, with a change in transactions costs (margin requirement), the strategy of the remaining investors would change. With higher transactions costs, fewer trades would be made and volatility would decrease. If a change in margin requirement merely shifts the location of business for the fixed set of traders, then the second effect remains. Table 4 shows that the change in margin requirement rarely resulted in statistically significant changes in price volatility. Only twice out of eleven times, did the volatility increase in both exchanges.

Table 5 presents mean returns over a period of 25 days before and after the change in margin requirements. Theory predicts that volatility changes, prompted by changes in margin requirement, change the risk of the asset and thus its expected returns. If volatility increases, the mean returns have to increase to compensate for the higher risk. However, in practice, as shown in Table 4, price volatility was rarely affected, thus the mean returns were rarely affected either. Moreover, the relationship between volatility and mean returns must be confirmed with a large sample, while ours is a short sample, due to the framework of event analysis and brief history of the exchanges being examined. As expected, most of the entries in Table 5, are statistically insignificant.

⁸Another explanation uses the differentiation of informed and uninformed traders. The effect of an increase in margin requirements on price volatility depends on the changing composition of informed and uninformed traders. If an increase in transaction costs drives liquidity traders to the cash market or the overseas futures markets, then price volatility in the cash market or to the overseas futures markets will increase while price volatility in the underlying market will decrease. On the contrary, if uninformed traders shift their trade from the futures market to the cash market (or to overseas futures markets), then the cash market impounds more information and hence, price volatility in the cash market (or overseas futures markets) can decrease while the volatility in the underlying futures market will increase.

Since the above analysis is based on sample statistics, several economic factors--such as the day-of-week effects, holiday effects, or other lagged returns, volume, or squared returns that are important to returns, variance, and volume--cannot be controlled when the tests are conducted. Accordingly, these results may be biased because of other the economic factors. In the next subsections, we will propose econometric specifications that will take account of these factors.

V. EMPIRICAL ANALYSIS

A. Trading Volume Process

Trading occurs when sellers and buyers have different expectations about the value of a financial product. Rational expectations models with noisy traders have been developed to analyze trading volumes, which are treated as a proxy to measure the degree of heterogeneous beliefs about the value of stocks.⁹ The empirical studies have shown that volume may be nonstationary and have strong day-of-week effects.

In Panel A of Table 6, we investigate nonstationarity of volume. All the volume data are transformed into the logarithm, and the Dicky-Fuller tests are conducted. As suggested in Table 2 as well as Table 3, March 28, 1991 (the 609th observation) seems to be a structural break point of trend in trading volume. The chosen specification allows a possible kinked linear trend (variable B) with the breaking point at the 609th observation.

The processes for the logarithm of trading volume in the cash, OSE futures and SIMEX futures markets as well as the logarithm of trading volume ratio between the OSE and SIMEX futures markets are modeled. A percentage change in the volume (the log-difference volume) is the dependent variable. Explanatory variables include predetermined variables such as past changes in trading volumes (lags one to five), the level of volume (lag one), the day-of-week effects (W), the January, May, and December dummy variables (M), which capture the holiday effects of New Years, Golden Week and Christmas, as well as the dummies for different regimes (D) defined by changes in margin requirements. Hence, the regressions are specified as:

$$\Delta V_{i,t} = \sum_{k=1,12} a_k D_{k,t} + \sum_{k=1,3} b_k M_{k,t} + \sum_{k=1,4} c_k W_{k,t} + d_1 t + d_2 B_t(t - 609) + \sum_{k=1,5} \beta_k \Delta V_{i,t-k} + \alpha V_{i,t-1} + u_{i,t}$$

where $i = c, o, \text{ and } s$, standing for, respectively, Cash, OSE and SIMEX.

Results are shown in Panel A of Table 6, the unit root hypothesis is rejected for the trading volume in the three markets, suggesting a trend-stationary process for the trading

⁹Ueda (1993) investigated the effect of commissions on trading volume for the Tokyo Stock Exchange.

volume. Thus, we may first detrend volume and adjust for the day-of-week and January, Golden week, and December monthly effects:

$$V_{i,t} = \sum_{k=1,12} a_k D_{k,t} + \sum_{k=1,3} b_k M_{k,t} + \sum_{k=1,4} c_k W_{k,t} + d_1 t + d_2 B_t(t - 609) + u_{i,t}.$$

We recover the detrended volume series, $u_{i,t}$, for each futures exchange and use it to test spillover effects between (this usage denotes a one to one relationship) the three markets:

$$u_{i,t} = \sum_{k=1,5} \alpha_k u_{c,t-k} + \sum_{k=1,5} \beta_k u_{o,t-k} + \sum_{k=1,5} \gamma_k u_{s,t-k} + \eta_{i,t}, \text{ for } i=c,o,s$$

All estimations are done by using the least square methods and standard errors are adjusted for heteroskedasticity (and autocorrelations of an order of five in the first regressions). The results are shown in panels B and C of Table 6. For each regime change (row) of panel B, the own market effect, which theory predicts will be negative when the margin requirement is raised, is marked with bold letters; and the substitution effect is marked as the first entry of a (- or +) or a (+ or -) indication on the other market with margin changes. Those effects are derived from changes in a margin requirement of each regime of each market.

The own effect is confirmed in seven out of eleven regime changes. Controlling for other factors, it is definitely confirmed that the increase in margin changes on OSE--three times in 1990-91--always lowered trading volumes. Results on the own effects of changes in margin requirement on SIMEX are more mixed. Out of four events of lowering margin requirements on SIMEX, only three resulted in an increase of trading volume.

There is no general conclusion on whether the substitution effect dominates the overall volume effect. (Ambiguous evidence includes (i) the actual sign of change only sometimes matches the first of the theoretical predictions and (ii) a formal test of the absence of spillovers at the bottom of panel B, Table 6, shows that the null hypothesis cannot be rejected). However, when OSE raised the margin requirements three times in 1990-91, the substitution effect was dominant so SIMEX trading volumes increased.

Panel C (right side of Table 6) shows how the relative volume between OSE and SIMEX changed as the own, substitution, and total effects combined. Here again, the actual changes agree with the theoretical prediction eight out of eleven times. Moreover, the panel shows that the increase in margin requirements on OSE (twice) and the decrease in margin requirements on SIMEX (four times) from March 1991 to August 1993 all contributed to the relative decline of the OSE market share against that of SIMEX.

Panel C (left side) examines the spillover to cash markets. The first sign in the theoretical prediction row indicates that the substitution effect (from a futures market to the cash market) is dominant. In general, the substitution of businesses to the cash market was confirmed (in seven out of eleven times). However, for those margin changes on OSE in the

second half of 1991 substitution did not increase but lowered cash trading. All the substitution out of OSE seems to have gone to SIMEX.

In sum, the most significant finding in this subsection is a collection of empirical results that support the view that the opposite movements in margin requirements in OSE and SIMEX from 1991 to 1993 contributed to the decline of trading on OSE and an increase of trading on SIMEX, even controlling for the various factors.

B. Returns Processes

Next, the returns process is estimated for each market to see whether any measurable changes occurred as a result of the changes in margin requirement. Although the change in transactions costs alters the band of prices that are neutral from arbitrage, since the band is not large anyway, we do not expect to find a dramatic difference in the return process between OSE and SIMEX. A more interesting question is whether the difference in the transactions costs is expected to make a difference in the relationship between the cash market and the futures market. After all, the motivation for a higher margin requirement on OSE in 1991 seems to have been an attempt to discourage the short-sell speculation that allegedly affected the cash market.

In order to control for the economic variables such as the day-of-week effects and lagged returns from all the three exchanges, we specify the return process as:

$$R_{i,t} = \sum_{k=1,2} a_k D_{k,t} + b_1 \text{Mon}_t + b_2 \text{Fri}_t + \sum_{k=1,2} c_k R_{c,t-k} + \sum_{k=1,2} d_k R_{o,t-k} + \sum_{k=1,2} f_k R_{s,t-k} + \epsilon_{i,t}$$

for $i = c$ (cash), o (ose), and s (simex), where $R_{i,t}$ is the market return of the i -th market, $D_{k,t}$ is the dummy variable for different event regimes based on margin changes, Mon_t and Fri_t are dummy variables for Monday and Friday, respectively, $R_{c,t}$ is the cash market return, $R_{o,t}$ is the OSE futures market return, and $R_{s,t}$ is the SIMEX futures market return.

Our major concern is the sign and significance of the coefficients on the dummy variables $D_{k,t}$. Leads and lags of returns of the three markets are also examined. The first null hypothesis of interest is that the constant terms of returns (drift of price index) are not significantly different between the before and after change in margins. The margin requirement did not affect returns. The second hypothesis is that there are no significant spillovers from lagged returns of the cash market (that is, $c_k = 0.0$, for all k). The third (and fourth) hypotheses are to test whether there are no spillovers from lagged returns from OSE or SIMEX futures markets. That is, $d_k = 0.0$ ($f_k = 0.0$, respectively), for all of k . To test this,

the least squares estimation with the standard errors being adjusted for heteroskedasticity is used. The order of lagged returns is chosen to be two.¹⁰

Results of the estimations and tests of the null hypotheses mentioned above are shown in Table 7. The test statistics for the regime change due to margin requirements for the three markets are reported in columns three, five, and seven of the table. The tests for the second to the fourth hypotheses for the three markets are presented in the last three rows, which report the Wald test statistics with the p-value in parentheses.

In Table 7 the a_k columns show the estimates of coefficients on the twelve dummies for changes in margins with the heteroskedasticity-consistent standard errors in parenthesis as well as the Wald test statistics and their p-value in parenthesis. First, in only two cases, did changes in margin requirement result in changes in the mean return (a shift in the constant term) of the three markets. The margin requirement decrease of July 30, 1990 in SIMEX lowered returns on all three markets. The margin requirement increase of January 31, 1991 in OSE increased the returns on the three markets. Note that these results are obtained controlling for influences from the past returns. Hence, in general, the change in the margin requirements does not have a systematic impact on the return process of a market. Put differently, an increase in margin requirements may not be able to reverse the downward trend in the cash or futures market. The higher transaction costs induced by the higher margins may not always reduce the futures price as the expected premia (return) increases to compensate such a cost.

Second, from the last three rows (cash market column) in Table 7, we find that futures prices can significantly affect cash market returns, but not vice versa. It suggests that futures prices tend to reveal market-wide information more quickly than the cash markets and thus that futures prices can lead cash prices. In two days the SIMEX returns predicted the cash market returns with a 1 percent significance level, while the OSE returns showed only a 7 percent significance level. The magnitude, however, is not large, so exploiting this information may not result in sure profits.

Third, from the last two rows (of the OSE and SIMEX columns), the lagged spillover futures from SIMEX to OSE are statistically significant with a 1 percent significance level, while from OSE to SIMEX it is statistically significant only at the 7 percent significance level. The two futures markets are mutually linked and a shock in one market in one day quickly spreads to the other market.

¹⁰To check the validity of this choice, we conducted the Wald tests to examine whether inclusions of the lagged returns of orders three and four significantly affected the returns. Although the results are not reported here, no significant effect of lagged spillovers of an order higher than two was detected from any of the three markets.

C. Variance Process

Lastly, the time-varying volatility processes are analyzed, with a GARCH specification. The dummy variables that account for the regime changes, the Monday and Friday effects, and spillovers are introduced as before. The variance process is specified as follows:

$$\begin{aligned} \epsilon_{i,t} | I_{t-1} &\sim N(0, h_{i,t}) \\ h_{i,t} &= \sum_{k=1,12} \alpha_k D_{k,t} + \beta_1 \text{Mon}_t + \beta_2 \text{Fri}_t + \gamma_1 \epsilon_{c,t-1}^2 + \gamma_2 \epsilon_{o,t-1}^2 + \gamma_3 \epsilon_{s,t-1}^2 + \delta h_{i,t-1}, \end{aligned}$$

for $i = c$ (cash), o (OSE), and s (SIMEX) where $\epsilon_{i,t}$ is the innovation, that is the unexpected return, of the OLS regression residual calculated in the returns regressions in the preceding subsection; $D_{k,t}$, Mon_t and Fri_t are the dummy variables as defined in the return process.

Based on our specification, the two-stage estimation yields the consistent estimators although it is not efficient. The first-stage estimation uses the least square method to estimate the returns regressions. The second-stage estimation applies the maximum likelihood method to estimate the conditional variance process of return innovations from the least square regressions in the first stage. The standard errors are robust to the density function. The Wald tests for the four hypotheses, like those in the returns processes, are conducted in the variance processes again.

Table 8 presents the maximum likelihood estimates of coefficients on the variance processes as well as the Wald test statistics for testing equal volatility before and after each change in margin requirements. The results in Table 8 show several interesting points. First, a relationship between the change in margin requirements and the subsequent volatility cannot be established. This is demonstrated by no pattern in coefficients on the regime dummy variables in relation with an increase or a decrease in margin requirements, and, more formally, by the Wald test of no change across regimes is generally not rejected. This finding is indeed consistent with many studies in the existing literature on the futures market (e.g., Hsieh and Miller (1990)), although it may be in contrast to a popular belief that an increase in margin requirements will drive uninformed traders (or speculators) out of the market, so that volatility can be reduced. It is also observed in our estimations that an increase in margin requirements in the futures market does not necessarily lead to a reduction in volatility of cash market returns.

Second, a high value (about 0.8 or higher) of coefficient of the lagged conditional variance, δ , shows that once volatility becomes higher, it tends to stay that way for a while. The volatility clustering is quite common in many asset prices; it is in fact a core of the GARCH specification.

Third, for the cash market (Tokyo), conditional volatility (of date t), innovations in OSE and SIMEX as well as the cash market of date $t-1$ are important. This is shown by rejection of the null hypothesis in the last three rows in the cash market column of Table 8.

Larger surprises (innovations) in Tokyo and OSE lead to higher conditional volatility. However, innovations in SIMEX seem to reduce conditional volatility in the cash market. This is counter-intuitive, and no explanation can be offered. For OSE conditional volatility, innovations in the cash market as well as its own market are important (as shown by the rejection of the null hypothesis in the second and third to last rows of the OSE column of Table 8), and for SIMEX conditional volatility and OSE innovations are important. Taking the above relationship together, the following picture emerges. Surprise movements in OSE futures prices on day t do affect conditional volatility of all three markets on day $t+1$.

In sum, although the relationship between volatility and margin requirement changes was not established, the estimated volatility process seems to shed new light on the volatility spillover relationship between the cash and two futures markets. Surprise movements in OSE are important to conditional volatility in all three markets.

VI. RACE TO THE CENTER

Let us consider policy implications of the findings above. Four questions are of particular interest: Is it possible for a futures exchange to gain business from a competing futures exchange or cash market by lowering margin requirements? Do higher margin requirements lower price volatility? Were the margin requirements on OSE and SIMEX changed as they should have been? Should the margin requirement be coordinated between the related (competing futures and cash) markets.

The first two questions were already answered above. It was shown in Sections IV and V.A that lowering margin requirements in one market does increase trading volumes on that market, sometimes at the expense of a competing futures exchange. In Section V.C, the volatility processes with a GARCH specification show that volatility does not seem to be affected in any systematic way by changes in margin requirement.

In the rest of this section, we examine the third question concerning the appropriateness of margins in OSE and SIMEX. From the point of view of setting a margin requirement, the increases in margins on OSE and the decreases of margin requirements on SIMEX in 1991 are intriguing. Although this paper does not formally examine the issue, whether the margin should have been increased (as OSE did) or decreased (as SIMEX did) in 1991 can be discussed by looking at Table 8, with the aid of Figure 3. The focus of Section V.C was how the changes in margin requirement are followed by a change in volatility. However, from a viewpoint of setting the level of the margin requirement, the table and figure should be interpreted in reverse: whether changes in the margin requirement are preceded by changes in volatility. From a policy point of view, lowering the margin requirement should be preceded by a period of lower volatility.

Looking through Table 8 (and also recalling Table 2 and Figure 3), an increase (decrease) in margin requirement in general is preceded by higher (lower, respectively) volatility. The first increase in margin requirement by SIMEX in late January 1990 followed a

sharp increase in volatility (combined with a decline in cash prices), although this margin requirement was lowered slightly in July 1990 as volatility came down in the second quarter. However, the sharp rise of volatility (combined with a sharp decline in cash prices) in August 1990 prompted OSE to raise its margin requirement in late August. OSE again raised the margin requirement in January 1991, despite declining volatility. The March and May decreases of SIMEX margins are quite consistent with the declining volatility in the preceding months. A slight increase in volatility in June 1991 immediately prompted OSE to increase its margin requirement. Although volatility fluctuated up and down without a trend in the second half of 1991, a slight increase in December 1991 also led OSE to increase its margin requirement again. The sharp increase in volatility of March and April 1992 in turn prompted SIMEX to increase its margin requirement, while a trend reduction in volatility in the second half of 1992 and early 1993 resulted in reductions in the margin requirement on SIMEX in June and August 1993.

In sum, each change of margin requirement seems to be consistent with the movement of volatility preceding the margin change (historical shown in Figure 3 and conditional shown in Table 8). The only deviation seems to be the increases of the OSE margin requirement in January 1991 (despite the fact that volatility had been coming down) and December 1991 (after only one month of rising volatility, which did not exceed the levels of the previous months).¹¹ If anything, the changes in SIMEX are more consistent with the ups and downs of volatility. There is no evidence to support the argument that SIMEX lowered its margin requirement solely to attract business, compromising risk management. On the other hand OSE raised its margin requirement when volatility increased, but failed to lower it when volatility came down, and thus stood to lose trade to SIMEX.

Let us comment on the fourth question raised at the beginning of this section, regarding coordinated margin requirements in related competing futures and cash markets. Although we do not discover any sign of too low margins for the sake of attracting business in the episodes of Nikkei 225 futures from 1988 to 1993, the race to become a financial center has intensified in the rest of the world. In theory, aggressive setting of margin requirements and commissions could be a problem. Or put differently, any mistake in risk management or too high transaction costs would discourage investors from being in a particular financial center, especially when there is an alternative. If competitive reduction in the margin requirement is a problem, then coordination between the exchanges may be needed in setting a common formula to calculate the appropriate margin requirement as a function of market volatility. Estrella (1988) has called for a consistent setting of margins across all related markets.

¹¹Moreover, there is more anecdotal evidence that the increase in margins on OSE in 1991 was motivated more by a questionable attempt to reduce volatility, or even as a futile attempt to stop the decline in the cash market, and not motivated from the standpoint of managing default risk. The loss in trading volume was an unfortunate by-product from the OSE marketing point of view.

However, there is an argument against such coordination. As capital bases and portfolio characteristics of members of a futures exchange are different, resilience to shocks varies among members. The futures exchange may want to set the margin requirement so that a rare, but conceivable large shock would protect the exchange and other members from a failure of one or a few members. As groups of members are typically different for different exchanges, each exchange may want to set its own standard. Moreover, setting a common formula may result in too high a margin requirement, by setting the standard for the weakest member of the most fragile market, which is counterproductive to market development.

Hence, there is no straightforward method to recommend for resolving the question of coordination between the exchanges on margin requirements. As futures exchanges have their own incentives, which sometimes conflict with each other, an international body, such as the International Organization of Securities Commissions (IOSCO), may be in a good position to set a guideline when to change margin requirement.

VII. BARINGS

Data used in this paper stop in January 1994, just before the Barings problem shook the market. Therefore, the analysis in this paper is free from the extreme turmoil and of this rare market event, which would have produced a problem in the estimations due to outliers. However, we would like to make some observations as to how the Barings incident may be understood in the framework adopted in this paper.

Although we did not uncover any evidence that margin requirements were used as a tool in the competition for business, the relationship between SIMEX and OSE seems to be nothing but competitive. It seems that the Tokyo regulators had become resentful that SIMEX listed futures products without coordination with the Japanese regulators, while SIMEX held to the principle of free market competition. SIMEX was rightly suspicious about the call from Tokyo to coordinate on the margin requirement; TSE was motivated more by concern about the level of the cash market rather than the risk management of the futures market. As a result, communication between OSE and SIMEX was not ideal. (See International Monetary Fund (1995).) The collapse of the Barings group in February 1994 came on the heels of such competitive zeal between the two exchanges.

It is clear that the immediate reason for the Barings collapse in February 1994 was the massive speculative position that Nick Leeson (the responsible Barings official) took in the Nikkei 225 futures at SIMEX, equivalent almost to the entire capital of the parent bank in London. However, why such a large position escaped detection, or was detected but permitted to go on, is a puzzling story. The pieces that solve the puzzle include the lack of internal risk management at Barings, a lack of adequate supervision by the Bank of England,

and the lack of communication between SIMEX and OSE.¹² (See International Monetary Fund (1995), Leeson (1996), Fay (1996), U.K. Board of Bank Supervision (1995), Singapore Counsel to the Inspectors (1995).)

The Japanese side might wonder: Wasn't it the lower transactions costs that encouraged speculative activities, by taking large exposed positions on SIMEX rather than in OSE?¹³ Isn't the margin supposed to be set to prevent large-scale speculative activities such as the Barings collapse?

SIMEX would most likely respond to these questions by saying that the Barings incident ironically proved that the margin requirement worked exactly the way it was supposed to. The losses incurred by the exchange in taking over and liquidating the Barings position were reportedly less than the margins that the Barings had put up at SIMEX (and also at OSE). The risk management at the Barings group was flawed and caused the collapse of the firm, but the margin requirement and its rate worked well and prevented the exchange from suffering any financial losses.

Still, the importance of communications between the futures exchanges and the regulators was recognized. The Windsor declaration and subsequent Memorandum of Understandings of March 1996 provide the framework for pledging the exchange of

¹²The lack of communication between the exchanges contributed to the collapse of Barings in the following way. Leeson seemed to have responded to internal (Barings) and SIMEX inquiries about the extended position by suggesting--falsely as it turned out -- that the large open positions in SIMEX had been arbitrated (by opposite open positions) in OSE (competing futures) and TSE (cash market). This could have been checked and proved wrong if the communication between SIMEX and OSE had taken place. Of course, this was not the only, or probably not even the most immediate, trigger that should have alerted the Barings management, the regulators, and the exchanges, but still it was a missed chance.

¹³Fay (1996) examined various records and official statements on the case of the Barings collapse and wrote a book from the journalist's point of view. In explaining how the stage was set for Nick Leeson's speculative activities, Fay writes: "A small group of Barings traders in Tokyo were still engaged in proprietary trading. ... Since agency business was in decline, they turned to proprietary trading. ... After the collapse of the stock market in Tokyo in 1990, the only way of making big money there was by trading, and the Barings people became good at it. ... In 1993, it became clear to traders in Tokyo that [cash-futures] arbitrage could be executed more cheaply in Singapore than in Osaka. Margin requirements on SIMEX were 15 percent of a contract's face value, compared with 30 percent on the Osaka stock exchange. Profits would, therefore, be increased by trading through Singapore. Tokyo began asking the Singapore office to execute Nikkei 225 trades on SIMEX early in 1993, and the trader who assumed the role as Tokyo's man on SIMEX was Nick Leeson." (Fay, 1996, pp. 105-106)

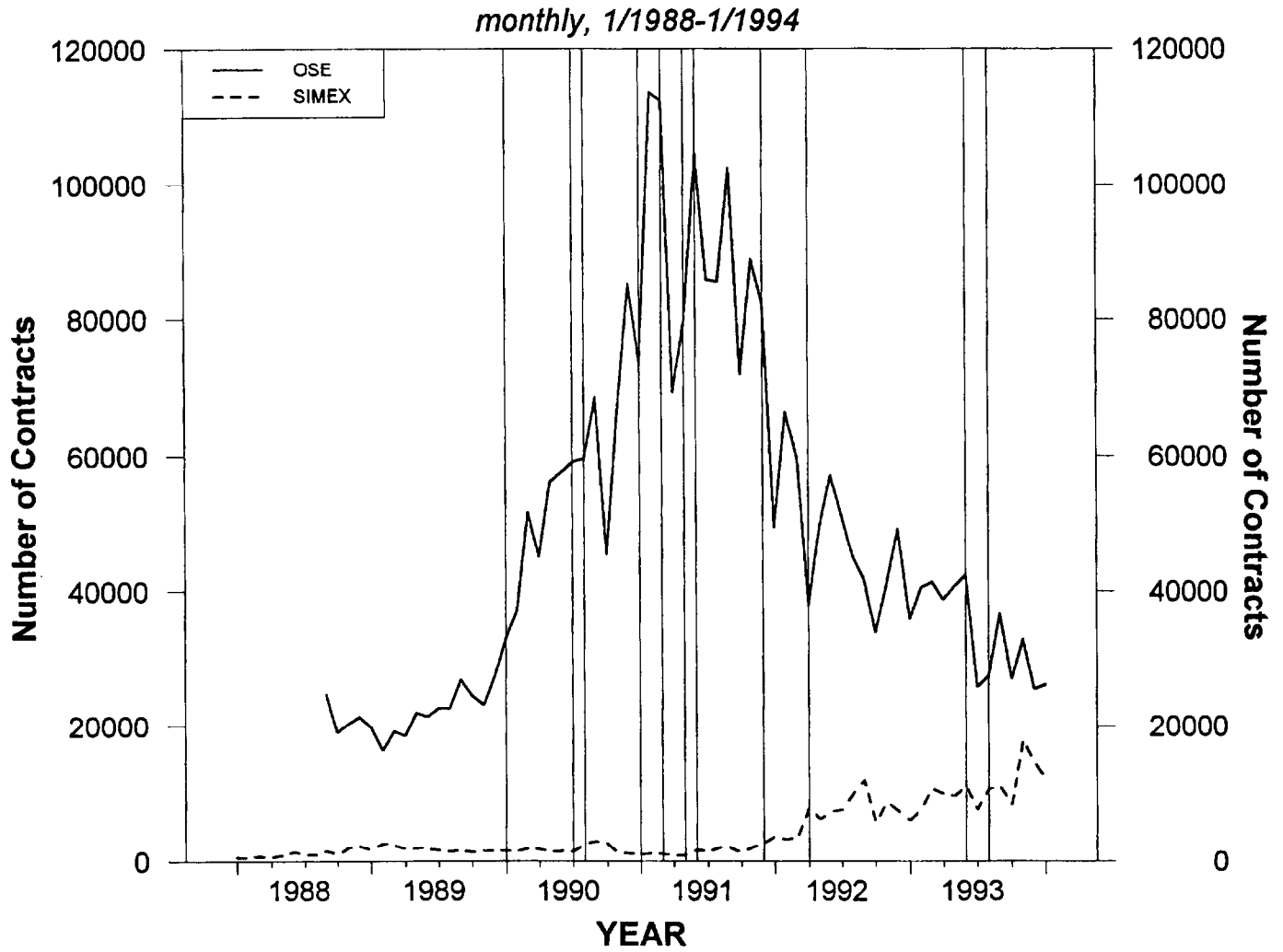
information between the major futures exchanges and market regulators, and is a step in the right direction.

VIII. CONCLUSIONS

This paper examined the effects of changes in margin requirements on trading volume, returns, and volatility. Several notable findings were obtained. First, an increase in the margins requirement in one market (say, OSE) had decreased its own trading volume, but often increased the trading volume of the other market (say, SIMEX), thus resulting in a loss of its (OSE) market share. The substitution effect (changing location of trade) seems to dominate the effect of a market-wide reduction in trade in the competing market. Evidence supports a view that the opposite movements in margin requirements on OSE and SIMEX from 1991 to 1993 contributed to the decline in trading on OSE and increased trading at SIMEX, even controlling for the various factors. One might think that setting a low margin requirement is potentially a strong weapon for attracting business and becoming a financial center. However, a closer look at the timing of margin changes suggests that changes in margin requirement on SIMEX were consistent with changes in volatility, namely higher volatility prompted an increase in margin requirement, while lower volatility prompted a decrease in margin requirement. The changes in margin requirement on OSE are somehow more one-sided; although the margin requirement was raised when there was a slight sign of increased volatility (or even of declining volatility on one occasion), the margin requirement was never lowered even in the phase of declining volatility.

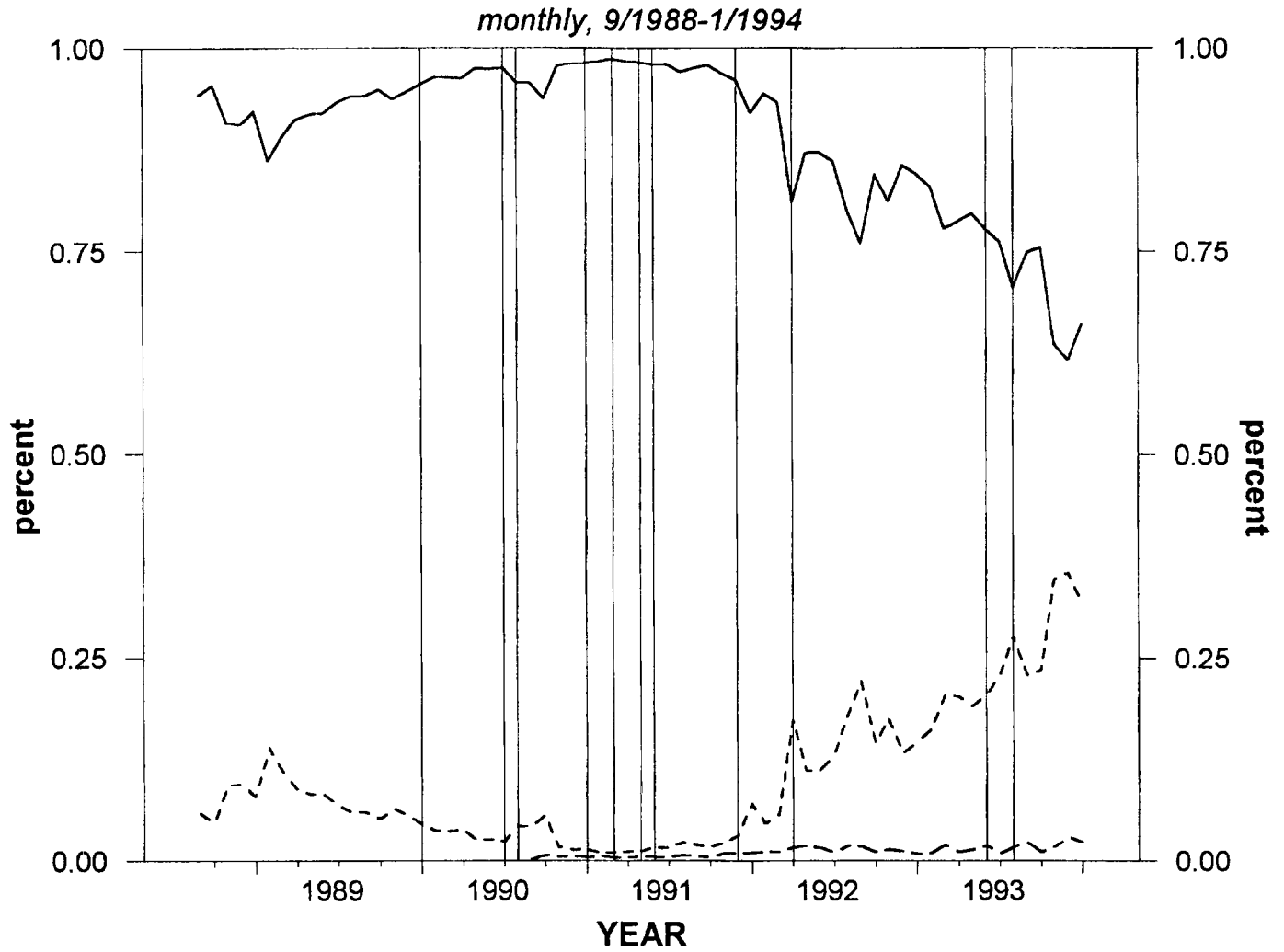
An increase in the margin requirement in one market did not have any significant or systematic effect on the returns or on volatility. One interesting finding is that surprise movements on OSE (innovations in OSE returns) are important in conditional volatility in subsequent days on all three markets. The present paper does not argue for the position that the competing exchanges should adopt a common reserve requirement; it takes the position that coordination between related exchanges is necessary.

Figure 1. OSE and SIMEX: Trading Volumes



Sources: OSE and SIMEX.

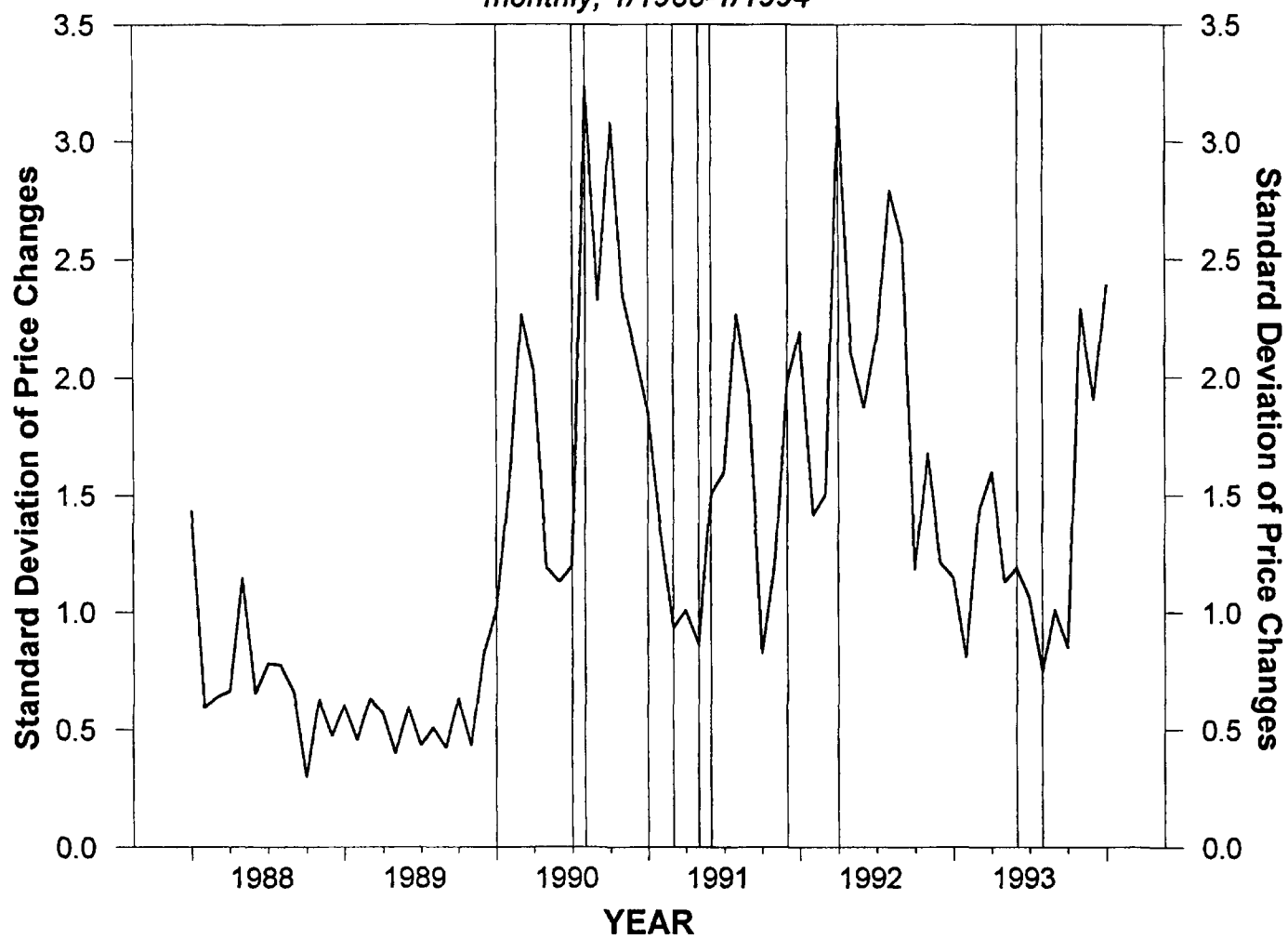
Figure 2. OSE, SIMEX and CME: Market Shares of NK225 Futures



Sources: OSE, SIMEX, and CME.

Figure 3. Price Volatility on SIMEX

monthly, 1/1988-1/1994



Source: SIMEX.

Table 1. OSE, SIMEX, and CME: Summary of the Nikkei 225 Futures Trading

	Osaka (OSE)	Singapore (SIMEX)	Chicago (CME)
First trading	September 3, 1988	September 3, 1986	September 25, 1990
Contract unit	1000 yen x index	500 yen x index	\$5 x index
Price change unit	10 pints = 10,000 yen	5 points = 2,500 yen	5 points = \$25
Price limit	900 points	5 percent for 15 minutes; 10 percent for 15 minutes; and no limit afterward. No limit for last 30 minutes of the day. No limit on the last trading day of the expiring contract month. 1/	900 points
Maturity months	March, June, September, December	March, June, September, December	March, June, September, December
Last trading day of the contract month	Thursday before the second Friday	Third Wednesday	Thursday before the second Friday
Trading hours	9:00 - 11:00 12:30 - 15:10	8:00 - 10:15 11:15 - 14:15	8:00 - 15:15
Trading system	Computer trading	Open outcry	Open outcry

Sources: OSE, SIMEX, and CME.

1/ Whenever the price moves by 5 percent, in either direction, from the previous day's settlement price, trading within the price limit of 5 percent is allowed for the next 15 minutes. Thereafter, an expanded price limit of 10 percent (above or below the previous day's settlement price) shall apply. Whenever the price moves by 10 percent, in either direction, from the previous day's settlement price, trading within the price limit of 10 percent is allowed for the next 15 minutes. Thereafter, there shall be no price limit for the remainder of the day. No price limit shall be initiated during the last 30 minutes before the close of trading on any day. There shall be no price limits on the last trading day of the expiring contract month.

Table 2. OSE, SIMEX, and CME:
Margin Requirements on Nikkei Futures, OSE Versus SIMEX

	OSE 1/		SIMEX 2/		CME 3/	
	Initial	Additional	Initial	Additional	Initial	Additional
Prior to Jan. 5, 1990	9% (3% cash)		¥1,500,000 (9.8%)	¥1,200,000 (7.8%)	No trade	No trade
Jan. 25, 1990			¥2,000,000 (12.3%)	¥1,600,000 (9.8%)	No trade	No trade
Jul. 30, 1990			¥1,500,000 (12.0%)	¥1,200,000 (9.6%)	No trade	No trade
Aug. 24, 1990	15% (5% cash)				No trade	No trade
Sep. 25, 1990					\$12,000 (10.3%)	\$12,000 (10.3%)
Jan. 31, 1991	20% (7% cash)					
Mar. 28, 1991			¥1,250,000 (9.5%)	¥1,000,000 (7.6%)		
May 17, 1991			¥1,000,000 (8.8%)	¥800,000 (7.0%)		
June 27, 1991	25% (8% cash)					
Dec. 18, 1991	30% (13% cash)					
Apr. 9, 1992			¥1,250,000 (14.2%)	¥1,000,000 (11.3%)		
May 12, 1992					\$6,000 (7.1%)	\$6,000 (7.1%)
Jan. 19, 1993					\$5,000 (5.3%)	\$5,000 (5.3%)
June 8, 1993					\$3,000 (3.1%)	\$3,000 (3.1%)
June 14, 1993			¥1,000,000 (10.0%)	¥800,000 (8%)		

Table 2. OSE, SIMEX, and CME:
Margin Requirements on Nikkei Futures, OSE Versus SIMEX

	OSE 1/		SIMEX 2/		CME 3/	
	Initial	Additional	Initial	Additional	Initial	Additional
Aug. 10, 1993			¥ 812,500 (8.5%)	¥ 650,000 (7.7%)		
Dec. 21, 1993					\$ 3,200 (3.4%)	\$ 3,200 (3.4%)

Sources: OSE, SIMEX, and CME.

1/ The Osaka stock exchange used margin requirements proportional to the contract value. The number in parenthesis indicates the cash requirements on margins.

2/ The Singapore stock exchange used a fixed dollar amount of margin requirements. The number in parenthesis indicates the margin requirements as the average proportion of the margin requirement to the contract value.

3/ The Chicago mercantile exchange used a fixed dollar amount of margin requirements. The number in parenthesis indicates the margin requirements as the average proportion of the margin requirement to the contract value.

Table 3. OSE and SIMEX: Trading Volumes,
25 Trading Days Before and After Margin Requirement Changes

Event	Exchange	Trading Volume 1/ 2/		p-Test	Change	Theory predict change 3/
		Before	After			
SIMEX increased margin 1990, Jan. 25	SIMEX	1,537.9	1,486.7	0.510	-	--
	OSE	31,383.8	39,088.3	0.002	+ *	+ (or-)
	OSE/ SIMEX	20.407	26.291	0.000	+ *	+
SIMEX decreased margin 1990, Jul. 30	SIMEX	1,494.0	2,306.1	0.000	+ *	++
	OSE	57,404.0	61,471.8	0.108	+	- (or+)
	OSE/ SIMEX	38.423	26.656	0.000	- *	-
OSE increased margin 1990, Aug. 24	SIMEX	2,137.7	3,084.2	0.000	+ *	+ (or-)
	OSE	61,595.6	66,490.2	0.107	+	--
	OSE/ SIMEX	28.814	21.559	0.000	- *	-
OSE increased margin 1991, Jan. 31	SIMEX	936.8	1,179.2	0.119	+	++
	OSE	72,680.4	113,915.0	0.000	+ *	- (or+)
	OSE/ SIMEX	77.584	96.607	0.127	+	-
SIMEX decreased margin 1991, Mar. 28	SIMEX	1,218.8	762.7	0.000	- *	++
	OSE	113,241.8	67,841.7	0.000	- *	- (or+)
	OSE/ SIMEX	92.916	88.945	0.694	-	-
SIMEX decreased margin 1991, May 17	SIMEX	816.8	1,542.9	0.000	+ *	+
	OSE	70,302.2	101,440.4	0.000	+ *	- (or+)

Table 3. OSE and SIMEX: Trading Volumes,
25 Trading Days Before and After Margin Requirement Changes

Event	Exchange	Trading Volume 1/ 2/				Theory predict change 3/
		Before	After	p-Test	Change	
	OSE/ SIMEX	86.062	65.747	0.019	- *	-
OSE increased margin 1991, Jun.27	SIMEX	1,546.8	1,378.1	0.269	-	+ (or-)
	OSE	101,856.6	84,220.8	0.000	- *	-
	OSE/ SIMEX	65.849	61.113	0.490	-	-
OSE increased margin 1991, Dec. 18	SIMEX	2,792.7	3,167.3	0.223	+	+ (or-)
	OSE	92,692.4	55,941.4	0.000	- *	-
	OSE/ SIMEX	33.156	17.662	0.000	- *	-
SIMEX increased margin 1992, Apr. 9	SIMEX	4,707.6	6,862.9	0.001	+ *	-
	OSE	53,540.8	42,463.7	0.002	- *	+ (or-)
	OSE/ SIMEX	11.373	6.187	0.000	- *	+
SIMEX decreased margin 1993, Jun. 14	SIMEX	10,556.2	9,125.7	0.065	-	+
	OSE	44,620.6	31,749.7	0.000	- *	- (or+)
	OSE/ SIMEX	4.227	3.479	0.024	- *	-
SIMEX decreased margin 1993, Aug. 10	SIMEX	7,745.2	11,709.5	0.000	+ *	+
	OSE	24,555.0	32,707.1	0.000	+ *	- (or+)
	OSE/ SIMEX	3.170	2.7930	0.115	-	-

Sources: Original data from OSE and SIMEX, and authors' calculations.

1/ Volumes are 25-day averages of before and after the margin requirement changes, controlling for the trend and seasonality.

2/ SIMEX volumes are divided by 2, to adjust for their contract size being half that of OSE.

3/ For cross-market effects the sign of theoretical prediction first indicates the case where the substitution effect is dominant and then cautioned in brackets that it may be reversed when total market effect dominates.

Table 4. OSE and SIMEX:
Price Volatilities, 25 Trading Days Before and After Margin Requirement Changes

Event	Exchange	Price Volatility 1/			
		Before	After	p-Test	Change 2/
SIMEX increased margin 1990, Jan. 25	SIMEX	1.054	1.356	0.450	+
	OSE	1.050	1.211	0.628	+
	OSE/SIMEX	0.997	0.893	0.137	-
SIMEX decreased margin 1990, Jul. 30	SIMEX	1.079	2.870	0.000	+ *
	OSE	1.507	2.544	0.000	+ *
	OSE/SIMEX	0.978	0.887	0.023	+
OSE increased margin 1990, Aug. 24	SIMEX	2.615	2.638	0.965	+
	OSE	2.214	2.709	0.252	+
	OSE/SIMEX	0.847	1.027	0.020	+
OSE increased margin 1991, Jan. 31	SIMEX	2.016	1.193	0.079	-
	OSE	1.737	1.071	0.112	-
	OSE/SIMEX	0.861	0.897	0.691	+
SIMEX decreased margin 1991, Mar. 28	SIMEX	0.956	0.964	0.964	+
	OSE	0.845	0.931	0.533	+
	OSE/SIMEX	0.884	0.966	0.314	+

Table 4. OSE and SIMEX:
Price Volatilities, 25 Trading Days Before and After Margin Requirement Changes

Event	Exchange	Price Volatility 1/			
		Before	After	p-Test	Change 2/
SIMEX decreased margin 1991, May 17	SIMEX	0.854	1.108	0.078	+
	OSE	0.814	1.052	0.078	+
	OSE/SIMEX	0.953	0.950	0.924	-
OSE increased margin 1991, Jun. 27	SIMEX	1.080	1.744	0.040	+ *
	OSE	1.026	1.613	0.029	+ *
	OSE/SIMEX	0.950	0.925	0.637	-
OSE increased margin 1991, Dec. 18	SIMEX	1.734	2.103	0.375	+
	OSE	1.525	2.086	0.190	+
	OSE/SIMEX	0.879	0.992	0.248	+
SIMEX increased margin 1992, Apr. 9	SIMEX	1.745	2.738	0.126	+
	OSE	1.486	2.099	0.166	+
	OSE/SIMEX	0.852	0.767	0.501	-
SIMEX decreased margin 1993, Jun. 14	SIMEX	1.052	1.136	0.674	+
	OSE	0.986	1.162	0.387	+
	OSE/SIMEX	0.937	1.022	0.151	+

Table 4. OSE and SIMEX:
Price Volatilities, 25 Trading Days Before and After Margin Requirement Changes

Event	Exchange	Price Volatility 1/		p-Test	Change 2/
		Before	After		
SIMEX decreased margin 1993, Aug. 10	SIMEX	0.957	0.976	0.930	+
	OSE	0.977	0.992	0.941	+
	OSE/SIMEX	1.022	1.017	0.932	-

Sources: Data from OSE, SIMEX, and authors' calculations.

1/ Sample standard deviation of 25 trading days before and after the margin changes is used for price volatility. Standard errors for price volatility are adjusted for heteroskedasticity.

2/ "***" shows the statistical significance at 5 percent.

Table 5. OSE and SIMEX:
Mean Returns, 25 Trading Days Before and After Margin Requirement Changes

Event	Exchange	Mean Returns 1/			
		Before	After	p-Test	Change
SIMEX increased margin 1990, Jan. 25	SIMEX	-0.200	-0.421	0.510	-
	OSE	-0.190	-0.421	0.463	+
	OSE/SIMEX	0.949	0.999	0.834	+ *
SIMEX decreased margin 1990, Jul. 30	SIMEX	-0.132	-0.913	0.193	+ *
	OSE	-0.129	-0.905	0.151	+
	OSE/SIMEX	0.982	0.992	0.963	- *
OSE increased margin 1990, Aug. 24	SIMEX	-1.271	-0.619	0.371	+ *
	OSE	-1.286	-0.671	0.369	+
	OSE/SIMEX	1.102	1.083	0.867	- *
OSE increased margin 1991, Jan. 31	SIMEX	-0.239	0.580	0.074	+
	OSE	-0.239	0.579	0.041	+ *
	OSE/SIMEX	0.998	0.998	0.999	+
SIMEX decreased margin 1991, Mar. 28	SIMEX	0.038	-0.002	0.883	- *
	OSE	0.056	-0.003	0.811	- *
	OSE/SIMEX	1.485	2.002	0.997	-
SIMEX decreased margin 1991, May 17	SIMEX	-0.183	-0.314	0.632	+ *
	OSE	-0.187	-0.296	0.676	+ *
	OSE/SIMEX	1.025	0.943	0.612	- *
OSE increased margin 1991, Jun. 27	SIMEX	-0.278	0.074	0.382	-
	OSE	-0.266	0.065	0.378	- *
	OSE/SIMEX	0.956	0.875	0.929	-

Table 5. OSE and SIMEX:
Mean Returns, 25 Trading Days Before and After Margin Requirement Changes

Event	Exchange	Mean Returns 1/			
		Before	After	p-Test	Change
OSE increased margin 1991, Dec. 18	SIMEX	-0.381	-0.072	0.563	+
	OSE	-0.377	-0.075	0.550	- *
	OSE/SIMEX	0.992	1.038	0.974	- *
SIMEX increased margin 1992, Apr. 9	SIMEX	-0.926	0.366	0.042	+ *
	OSE	-0.881	0.258	0.024	- *
	OSE/SIMEX	0.952	0.705	0.645	- *
SIMEX decreased margin 1993, Jun. 14	SIMEX	-0.021	-0.076	0.858	-
	OSE	-0.029	-0.079	0.868	- *
	OSE/SIMEX	1.363	1.040	0.958	- *
SIMEX decreased margin 1993, Aug. 10	SIMEX	0.121	0.011	0.681	+ *
	OSE	0.118	0.010	0.690	+ *
	OSE/SIMEX	0.982	0.908	0.987	-

Sources: Original data from OSE, SIMEX, and authors' calculations.

1/ Mean returns are twenty-day averages of before and after the margin requirement changes.

Table 6. Cash Market, and OSE and SIMEX Futures: Trading Volume Process

A. Test for Unit Root

Model:

$$\Delta V_{i,t} = \sum_{k=1,12} a_k D_{k,t} + \sum_{k=1,3} b_k M_{k,t} + \sum_{k=1,4} c_k W_{k,t} + d_1 t + d_2 B_t(t - 609) + \sum_{k=1,5} \beta_k \Delta V_{i,t-k} + \alpha V_{i,t-1} + u_{i,t}, \text{ for } i = c, o, \text{ and } s$$

where $V_{i,t}$ is the logarithm of the trading volume in the home market, $D_{k,t}$ is the dummy variable for different event regimes based on margin changes, $W_{k,t}$ is a dummy variable for the day of week, $M_{k,t}$ is a dummy variable for January ($k=1$), May ($k=2$), or December ($k=3$), $V_{c,t}$ is the logarithm of the trading volume in the cash market, $V_{o,t}$ is the logarithm of the trading volume in the OSE futures market, $V_{s,t}$ is the logarithm of the trading volume in the SIMEX futures market, and B_t is the dummy variable whose value equals one for t (March 28, 1991, the 609th observation) greater than 609.

<u>Cash Market</u>		<u>OSE Futures</u>		<u>SIMEX Futures</u>	
α	t-stat	α	t-stat	α	t-stat
-0.1611 (0.0214)	-7.5229*	-0.1127 (0.0195)	-5.7875*	-0.1886 (0.0257)	-7.3464*

Notes: The critical values are -3.96, -3.41, and -3.12 for the 1%, 5%, and 10% significance levels, respectively.

B. Volume Process, I

$$V_{i,t} = \sum_{k=1,12} a_k D_{k,t} + \sum_{k=1,3} b_k M_{k,t} + \sum_{k=1,4} c_k W_{k,t} + d_1 t + d_2 B_t(t-609) + u_{i,t}$$

$$u_{i,t} = \sum_{k=1,5} \alpha_k u_{c,t-k} + \sum_{k=1,5} \beta_k u_{o,t-k} + \sum_{k=1,5} \gamma_k u_{s,t-k} + \eta_{i,t}$$

where $V_{i,t}$ is the logarithm of the trading volume in the home market; $D_{k,t}$ is the dummy variable for different event regimes based on margin changes; $W_{k,t}$ is a dummy variable for the day of week, $M_{k,t}$ is a dummy variable for January ($k=1$), May ($k=2$), or December ($k=3$); $u_{c,t}$ is the logarithm of the trading volume in the cash market, $u_{o,t}$ is the logarithm of the trading volume in the OSE futures market, and $u_{s,t}$ is the logarithm of the trading volume in the SIMEX futures market. B_t is the dummy variable for a structural break.

Event dummy variable a_k	<u>OSE Futures</u>			<u>SIMEX Futures</u>		
	Coeff. (standard errors)	(Actual vs. predict. change)	Wald Test for $a_{k-1}=a_k$ (prob.)	Coeff. (standard errors)	(Actual vs. predict. change)	Wald test for $a_{k-1}=a_k$ (prob.)
Prior to margins change 9/3/88 - 1/25/90	9.5143* (0.2021)			7.2956* (0.2096)		
SIMEX increased margins on 1/25/90	9.6876* (0.4662)	(+, + or -)	0.4069 (0.5253)	7.0327* (0.4405)	(-, -)	1.1002 (0.2942)

Table 6. Cash Market, and OSE and SIMEX Futures: Trading Volume Process

Event dummy variable a_k	OSE Futures			SIMEX Futures		
	Coeff. (standard errors)	(Actual vs. predict. change)	Wald Test for $a_{k-1} = a_k$ (prob.)	Coeff. (standard errors)	(Actual vs. predict. change)	Wald test for $a_{k-1} = a_k$ (prob.)
SIMEX decreased margins on 7/30/90	9.7059* (0.5450)	(+, - or +)	0.0367 (0.8480)	7.2420* (0.5215)	(+, +)	2.7603 (0.0967)
OSE increased margins on 8/24/90	9.6121* (0.6070)	(-, -)	0.9610 (0.3269)	6.9436* (0.5981)	(-, + or -)	2.0567 (0.1515)
OSE increased margins on 1/31/91	9.9712* (0.6955)	(+, -)	9.1594 (0.0025)	6.4417* (0.6558)	(-, + or -)	6.4574 (0.0110)
SIMEX decreased margins on 3/28/91	9.4207* (0.7373)	(-, - or +)	54.7988 (0.0000)	6.0399* (0.6923)	(-, +)	18.3227 (0.0000)
SIMEX decreased margins on 5/17/91	9.7430* (0.7813)	(+, - or +)	12.4724 (0.0004)	6.5486* (0.7341)	(+, +)	12.9118 (0.0003)
OSE increased margins on 6/27/91	9.4969* (0.8889)	(-, -)	2.9664 (0.0850)	6.4765* (0.8164)	(-, + or -)	0.1539 (0.6947)
OSE increased margins on 12/18/91	8.9821* (1.0268)	(-, -)	8.5967 (0.0033)	6.9547* (0.9321)	(+, + or -)	5.5384 (0.0186)
SIMEX increased margins on 4/9/92	8.4894* (1.3155)	(-, + or -)	2.3296 (0.1269)	7.1225* (1.1747)	(+, -)	0.2854 (0.5932)
SIMEX decreased margins on 6/14/93	7.6645* (1.7434)	(-, - or +)	3.2890 (0.0697)	6.4260* (1.5217)	(-, +)	3.1668 (0.0752)
SIMEX decreased margins on 8/10/93	7.7219* (1.7496)	(-, - or +)	0.1325 (0.7159)	6.6668* (1.5486)	(+, +)	2.3470 (0.1255)

Table 6. Cash Market, and OSE and SIMEX Futures: Trading Volume Process

Event dummy variable a_k	OSE Futures			SIMEX Futures		
	Coeff. (standard errors)	(Actual vs. predict. change)	Wald Test for $a_{k-1} = a_k$ (prob.)	Coeff. (standard errors)	(Actual vs. predict. change)	Wald test for $a_{k-1} = a_k$ (prob.)
Trend; d_1 (standard error)	0.0028* (0.0011)					0.0001* (0.0010)
Breaking trend after March 28, 1991: d_2 (standard error)	-0.0016* (0.0009)					0.0025* (0.0010)
Test for no spillovers from cash. $H_0: \alpha_k = 0$ for all k (probability in brackets)	7.2510 (0.2026)					4.6316 (0.4625)
Test for no spillovers from ose. $H_0: \beta_k = 0$ for all k (probability)						6.5744 (0.2543)
Test for no spillovers from SIMEX. $H_0: \gamma_k = 0$ for all k (probability)	2.4729 (0.7806)					
Test of the Own effects at OSE. $H_0: \beta_o = 0$ for all changes at OSE (probability)	152.6366 (0.0000)					
Test of the own effects at SIMEX. $H_0: \gamma_s = 0$ for all changes at SIMEX (probability)						461.5829 (0.0000)

Note: A predicted direction of change for the market which did not change the margin requirement in each event is uncertain. The first sign is for the case that the substitution effect dominates the overall market effect and the second sign is the opposite case.

Table 6. Cash Market, and OSE and SIMEX Futures: Trading Volume Process

C. Volume process, effects on cash market and relative market share of OSE

$$V_{it} = \sum_{k=1,12} a_k D_{kt} + \sum_{k=1,3} b_k M_{kt} + \sum_{k=1,4} c_k W_{kt} + d_1 t + d_2 B_t (t-609) + u_{it}$$

$$u_{it} = \sum_{k=1,5} \alpha_k u_{c,t-k} + \sum_{k=1,5} \beta_k u_{o,t-k} + \sum_{k=1,5} \gamma_k u_{s,t-k} + \eta_{it}$$

where V_{it} is the logarithm of trading volume in the home market; D_{kt} is the dummy variable for different event regimes based on margin changes; W_{kt} is a dummy variable for the day of week, M_{kt} is a dummy variable for January ($k=1$), May ($k=2$), or December ($k=3$); $u_{c,t}$ is the detrended trading volume in the cash market, $u_{o,t}$ is the detrended trading volume in the OSE futures market, and $u_{s,t}$ is the detrended trading volume in the SIMEX futures market. B_t is the dummy variable for a structural break.

Event dummy variable a_k	Cash Market			OSE Volume - SIMEX Volume		
	Coeff. (standard errors)	(actual vs. predicted change)	Wald Test for $a_{k-1} = a_k$ (probability)	Coeff. (standard errors)	(actual vs. predicted change)	Wald test for $a_{k-1} = a_k$ (probability)
Prior to margins change 9/3/88 - 1/25/90	13.6282* (0.2241)			2.2187* (0.1625)		
SIMEX increased margins on 1/25/90	13.0838* (0.5623)	(-, + or -)	2.6516 (0.1034)	2.6548* (0.2623)	(+, +)	12.3500 (0.0004)
SIMEX decreased margins on 7/30/90	12.7276* (0.6610)	(-, - or +)	8.6929 (0.0032)	2.4639* (0.3206)	(-, -)	2.0862 (0.1486)
OSE increased margins on 8/24/90	12.8026* (0.7305)	(+, + or -)	0.4347 (0.5096)	2.6686* (0.3997)	(+, -)	0.7358 (0.3909)
OSE increased margins on 1/31/91	13.2180* (0.8482)	(+, + or -)	5.5858 (0.0181)	3.5596* (0.3841)	(+, -)	16.8533 (0.0000)
SIMEX decreased margins on 3/28/91	12.5070* (0.9054)	(-, - or +)	10.9258 (0.0009)	3.3808* (0.3956)	(-, -)	6.7109 (0.0000)
SIMEX decreased margins on 5/17/91	12.2006* (0.9429)	(-, - or +)	3.1555 (0.0756)	3.1944* (0.4013)	(-, -)	3.7707 (0.0522)
OSE increased margins on 6/27/91	11.9095* (1.0776)	(-, + or -)	2.6054 (0.1065)	3.0203* (0.3935)	(-, -)	2.1837 (0.1395)
OSE increased margins on 12/18/91	11.3227* (1.2406)	(-, + or -)	7.3430 (0.0067)	2.0273* (0.4320)	(-, -)	21.8258 (0.0000)

Table 6. Cash Market, and OSE and SIMEX Futures: Trading Volume Process

Event dummy variable a_k	Cash Market			OSE Volume - SIMEX Volume		
	Coeff. (standard errors)	(actual vs. predicted change)	Wald Test for $a_{k-1}=a_k$ (probability)	Coeff. (standard errors)	(actual vs. predicted change)	Wald test for $a_{k-1}=a_k$ (probability)
SIMEX increased margins on 4/9/92	10.5966* (1.5959)	(-, + or -)	3.4333 (0.0639)	1.3769* (0.4167)	(-, +)	10.5520 (0.0012)
SIMEX decreased margins on 6/14/93	9.4895* (2.0984)	(-, - or +)	4.3277 (0.0375)	1.2385* (0.4441)	(-, -)	1.6392 (0.2004)
SIMEX decreased margins on 8/10/93	9.4372* (2.1105)	(-, - or +)	0.1089 (0.7414)	1.0550* (0.4599)	(-, -)	2.6050 (0.1065)
Trend; d_1 (standard error)			0.0003 (0.0014)			0.0018* (0.0006)
Breaking trend after March 28, 1991: d_2 (standard error)			0.0047* (0.0012)			-0.0041* (0.0008)
Test for no spillovers from cash. $H_0: \alpha_k=0$ for all k. (probability)			266.4017 (0.0000)			6.2942 (0.2786)
Test for no spillovers from OSE. $H_0: \beta_k=0$ for all k. (probability)			8.9977 (0.1092)			359.3295 (0.0000)
Test for no spillovers from SIMEX. $H_0: \gamma_k=0$ for all k. (probability)			5.9759 (0.3086)			490.5756 (0.0000)

Source: Authors' calculations.

Table 7. Cash Market, and OSE and SIMEX Futures: Returns Process

Model:

$$R_{i,t} = \sum_{k=1,12} a_k D_{k,t} + b_1 \text{Mon}_t + b_2 \text{Fri}_t + \sum_{k=1,2} c_k R_{c,t-k} + \sum_{k=1,2} d_k R_{o,t-k} + \sum_{k=1,2} f_k R_{s,t-k} + \epsilon_{i,t}, \text{ for } i=c, o, \text{ and } s$$

where $R_{i,t}$ is the home market return; $D_{k,t}$ is the dummy variables for different event regimes based on margin changes, Mon_t and Fri_t are dummy variables for Monday and Friday, respectively; $R_{c,t}$ is the cash market return, $R_{o,t}$ and $R_{s,t}$ is the OSE and SIMEX futures market return, respectively.

Event	Cash Market		OSE Futures		SIMEX Futures	
	a_k	Wald test $a_{k-1} = a_k$ (prob.)	a_k	Waldtest for $a_{k-1} = a_k$ (prob.)	a_k	Wald test for $a_{k-1} = a_k$ (prob.)
Prior to margins change 9/3/88 - 1/25/90	0.1723* (0.0473)		0.1624* (0.0454)		0.1743* (0.0476)	
SIMEX increased margins on 1/25/90	-0.0428 (0.1398)	2.1883 (0.1391)	-0.0512 (0.141)	2.1911 (0.1388)	-0.0529 (0.1474)	2.2597 (0.1327)
SIMEX decreased margins on 7/30/90	-1.1102* (0.4705)	4.7432 (0.0294)	- 1.1475* (0.4575)	5.2531 (0.0219)	- 1.2562* (0.5222)	4.9286 (0.1327)
OSE increased margins on 8/24/90	0.0422 (0.2391)	4.7647 (0.0291)	0.0470 (0.2347)	5.4037 (0.0201)	0.0523 (0.2474)	5.1315 (0.0235)
OSE increased margins on 1/31/91	0.3802* (0.2036)	1.2118 (0.2710)	0.4035* (0.1864)	1.4636 (0.2263)	0.4291* (0.1989)	1.4705 (0.2253)
SIMEX decreased margins on 3/28/91	0.0416 (0.1508)	1.8567 (0.1730)	-0.0109 (0.1647)	2.8913 (0.0891)	-0.0097 (0.1693)	2.9427 (0.0863)
SIMEX decreased margins on 5/17/91	-0.2823 (0.2180)	1.5551 (0.2123)	-0.2419 (0.2046)	0.7939 (0.3729)	-0.2846 (0.2199)	1.0124 (0.3143)
OSE increased margins on 6/27/91	0.0486 (0.1282)	1.7439 (0.1867)	0.0249 (0.1291)	1.2393 (0.2655)	0.0304 (0.1532)	1.3840 (0.2394)
OSE increased margins on 12/18/91	- 0.4347* (0.2178)	3.0135 (0.0825)	-0.3506 (0.2161)	2.2886 (0.1303)	-0.4222 (0.2344)	2.6467 (0.1038)
SIMEX increased margins on 4/9/92	0.1587 (0.1057)	5.1738 (0.0230)	0.1385 (0.1009)	4.3280 (0.0375)	0.1587 (0.1096)	5.2056 (0.0225)

Table 7. Cash Market, and OSE and SIMEX Futures: Returns Process

Event	Cash Market		OSE Futures		SIMEX Futures	
	a_k	Wald test $a_{k,1} = a_k$ (prob.)	a_k	Waldtest for $a_{k,1} = a_k$ (prob.)	a_k	Wald test for $a_{k,1} = a_k$ (prob.)
SIMEX decreased margins on 6/14/93	0.1019 (0.1703)	0.0822 (0.7744)	0.0754 (0.1713)	0.1038 (0.7474)	0.0734 (0.1727)	0.1794 (0.6719)
SIMEX decreased margins on 8/10/93	0.0259 (0.1455)	0.1159 (0.7336)	0.0136 (0.1530)	0.0721 (0.7881)	0.0016 (0.1549)	0.0966 (0.7559)
Test for no spillovers from cash. $H_0: c_1 = c_2 = 0$ (probability)		31.5590 (0.0000)		3.3543 (0.1869)		3.2144 (0.2004)
Test for no spillovers from OSE. $H_0: d_1 = d_2 = 0$ (probability)		4.8236 (0.0896)		5.4915 (0.0642)		5.2498 (0.0724)
Test for no spillovers from SIMEX. $H_0: f_1 = f_2 = 0$ (probability)		11.6468 (0.0030)		13.5997 (0.0011)		3.4797 (0.1755)

Source: Authors' calculations.

Table 8. Cash Market, and OSE and SIMEX Futures: Return Variance Process

Model:

$$\epsilon_{i,t} | I_{t-1} \sim N(0, h_{i,t})$$

$$h_{i,t} = \sum_{k=1,12} \alpha_k D_{k,t} + \beta_1 \text{Mon}_t + \beta_2 \text{Fri}_t + \gamma_1 \epsilon_{c,t-1}^2 + \gamma_2 \epsilon_{o,t-1}^2 + \gamma_3 \epsilon_{s,t-1}^2 + \delta h_{i,t-1}, \text{ for } i = c, o, \text{ and } s$$

where $\epsilon_{i,t}$ is the innovation (the OLS regression residual) from the home market return, $D_{k,t}$ is the dummy variable for different event regimes based on margin changes, Mon_t is a dummy variable for Monday, Fri_t is a dummy variable, $\epsilon_{c,t}$ is the cash market return, $R_{o,t}$ is the innovation from the OSE futures market return, and $\epsilon_{s,t}$ is the innovation from the SIMEX futures market return.

Event dummy variable α_k	Cash Market		OSE Futures		SIMEX Futures	
	Coeff. (standard errors)	Wald Test for $\alpha_{k-1} = \alpha_k$ (prob.)	Coeff. (standard errors)	Wald Test for $\alpha_{k-1} = \alpha_k$ (prob.)	Coeff. (standard errors)	Test for equal α_{k-1} and α_k
Prior to margins change 9/3/88 - 1/25/90	-0.0205 (0.0203)		-0.0276 (0.0187)		-0.0538 (0.0148)	
SIMEX increased margins on 1/25/90	0.1085 (0.0924)	2.4014 (0.1212)	0.0998 (0.0730)	3.6984 (0.0545)	0.0569 (0.0747)	2.5303 (0.1117)
SIMEX decreased margins on 7/30/90	0.6503* (0.3370)	2.7213 (0.0990)	0.6089* (0.2821)	3.4993 (0.0614)	0.7472* (0.2915)	6.1346 (0.0133)
OSE increased margins on 8/24/90	0.4854* (0.2817)	0.1876 (0.6649)	0.3626* (0.1952)	0.7095 (0.3996)	0.3227* (0.1984)	2.0554 (0.1517)
OSE increased margins on 1/31/91	0.1172 (0.1233)	1.9331 (0.1644)	0.0816 (0.0971)	2.3676 (0.1239)	0.0142 (0.0696)	2.9228 (0.0873)
SIMEX decreased margins on 3/28/91	0.0248 (0.0741)	0.4622 (0.4966)	0.0161 (0.0580)	0.3712 (0.5424)	-0.0090 (0.0561)	0.0734 (0.7865)
SIMEX decreased margins on 5/17/91	0.1608* (0.0986)	1.3106 (0.2523)	0.1602 (0.1061)	1.4356 (0.2308)	0.1224 (0.1008)	1.2833 (0.2573)
OSE increased margins on 6/27/91	0.1778* (0.0954)	0.0231 (0.8791)	0.0976* (0.0604)	0.3563 (0.5506)	0.1499 (0.0978)	0.0467 (0.8289)

Table 8. Cash Market, and OSE and SIMEX Futures: Return Variance Process

Event dummy variable α_k	Cash Market		OSE Futures		SIMEX Futures	
	Coeff. (standard errors)	Wald Test for $\alpha_{k-1} = \alpha_k$ (prob.)	Coeff. (standard errors)	Wald Test for $\alpha_{k-1} = \alpha_k$ (prob.)	Coeff. (standard errors)	Test for equal α_{k-1} and α_k
OSE increased margins on 12/18/91	0.2799* (0.1491)	0.5846 (0.4445)	0.1832 (0.1118)	0.7718 (0.3797)	0.2241* (0.1348)	0.2623 (0.6086)
SIMEX increased margins on 4/9/92	0.2013* (0.1167)	0.4070 (0.5235)	0.1470* (0.0786)	0.1514 (0.6972)	0.1019 (0.0822)	1.2550 (0.2626)
SIMEX decreased margins on 6/14/93	0.0812 (0.1075)	0.9239 (0.3365)	0.0584 (0.0858)	0.9425 (0.3316)	0.0109 (0.0772)	0.9791 (0.3224)
SIMEX decreased margins on 8/10/93	0.1085* (0.0644)	0.0644 (0.7997)	0.1370* (0.0615)	0.7383 (0.3902)	0.0818 (0.0598)	0.6690 (0.4134)
Coefficient of lagged conditional variance: δ	0.7811* (0.0469)		0.8096* (0.0368)		0.8504* (0.0325)	
Coefficient of cash market return innovation: γ_1 (standard error)	0.1378* (0.0424)		0.0547* (0.0309)		0.0361 (0.0285)	
Coefficient of OSE futures return innovation: γ_2 (standard error)	0.0610* (0.0353)		0.0855* (0.0371)		0.0684* (0.0433)	
Coefficient of SIMEX futures return innovation: γ_3 (standard error)	-0.0558* (0.0186)		-0.0254 (0.0192)		-0.0115 (0.0366)	

Source: Authors' calculations.

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