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10 The Price, Volatility, Volume, and Liquidity Effects of Changes in Federal Reserve Margin Requirements on Both Marginable and Nonmarginable OTC Stocks

Stephen W. Pruitt and K. S. Maurice Tse

10.1 Introduction

In a recent article, Hsieh and Miller (1990) analyze the relationship between official Federal Reserve margin requirements and the variability of the market factor over the time period from October 1934 to December 1987. While detecting the expected negative relation between changing margin levels and the total amount of outstanding margin credit, the authors conclude that the earlier findings of Hardouvelis (1988, 1990)—findings purporting to document a definite negative correlation between margin levels and stock price volatility—are the result of substantial autocorrelation problems inherent in Hardouvelis's tests. Following correction of these problems, Hsieh and Miller state that "[t]he data thus offer no support for the view . . . that Federal Reserve margin requirements are an effective tool for dampening stock market volatility" (28).

While the findings of Hsieh and Miller (1990) provide definitive answers to many questions concerning the magnitude and direction of changes in Federal Reserve margin levels and stock market linkages for *marginable* equity securities, the extent to which changes in margin levels affect marginable stocks *relative to their nonmarginable counterparts* remains unknown. Clearly, the S&P Composite index represents the only well-diversified daily market proxy available for the study of all twenty-one changes in Federal Reserve margin levels mandated since the passage of the Securities Exchange Act of 1934. Unfortunately, since all the securities included in this index over the 1937 to 1974 interval were listed on either the New York or American Stock Ex-

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changes, they were also all subject to the full range of margin borrowing constraints imposed by changes in margin levels. Thus, index-based margin studies such as those of Hsieh and Miller (1990) and others have *necessarily compared the performance of the same market index over two different intervals of calendar time.* Given the precepts of market efficiency and the consequent poor forecasting performance of state-of-the-art return generating models, it is clear that the most appropriate test of the effectiveness of changes in stock market margin requirements at reducing "undesirable" security market perturbations would be between *otherwise identical securities* differing only with respect to the presence or absence of Federal Reserve margin requirements. Indeed, in the absence of such a test, it is virtually impossible to distinguish, at the time of the announcement of a change in Federal Reserve margin levels, those adjustments in security market behavior resulting from *information effects only* from those changes resulting from shifts in *binding borrowing constraints* on equity investors. Fortunately, a 1969 amendment to the Securities Exchange Act of 1934 allows for the development of margin-change tests that, while failing to meet the strictest requirements of a pure empirical duality, are based on pairs of over-the-counter (OTC) firms similar in many important respects while differing in marginability status. Accordingly, this study presents the results of tests of the price, volatility, volume, and liquidity differences registered by both marginable and nonmarginable OTC stocks in response to the 1970, 1971, 1972, and 1974 changes in Federal Reserve margin requirements.

10.2 Margin Requirements and OTC Firms

The Securities Exchange Act of 1934 completely prohibited securities brokers and dealers from extending margin credit for the purchase of OTC stocks. The apparent purpose of this restriction was to eliminate the possibility that unsophisticated investors could become too deeply entangled in margin borrowing on smaller, potentially lower quality securities. Interestingly, although brokers and dealers were prohibited from extending margin loans on OTC stocks, commercial banks were not subject to margin restrictions. Rather, these institutions could freely lend against OTC equities to any levels they chose.

In July 1969, the Securities Exchange Act of 1934 was amended to allow, for the first time, securities dealers and brokers to extend margin credit on certain unlisted (OTC) equity securities. According to official Federal Reserve memorandums, the change in the law was effected at the request of numerous security dealers in an attempt to provide a more level playing field for the merging OTC equity market and to help improve the efficiency of the market. In addition to allowing brokers and dealers the ability to extend margin credit, the amendment (P.L. 90-437) also limited the margin lending powers of commercial banks to levels identical to those granted brokers and dealers. The reg-

ulatory requirements of both sets of changes are embodied in regulations T and U (as amended) of the Securities Exchange Act of 1934.

The actual criteria for determining exactly which, if any, OTC securities could be margined was left to the discretion of the Federal Reserve. Initial margin eligibility requirements consisted of ten factors, including criteria concerning corporate age (three years) and time of public trading (six months), market value ($10,000,000), capital surplus ($5,000,000), average share price ($10.00), and the number of active market makers (five).[1] Although the margin-list requirements remained largely unchanged over the years encompassing the current study's tests (1970–74), several changes since that time have occurred, the most important of which automatically extends margin status to any firm listed on the National Association of Securities Dealers' (NASD) National Market System.[2] Maintenance criteria separate and distinct from the requirements established for initial marginability were first established in 1972. Although, currently, notification of margin status occurs at the time of publication of the Federal Reserve's *Official List of OTC Margin Stocks* in the *Federal Register,* in the early years of the OTC margin program, stocks were added to the list (or deleted) in the interim between publications as deemed appropriate by the board.[3] Over the 1970–74 time period, a total of seven separate OTC margin lists were released by the Federal Reserve. Given its importance in the development of the data employed in the empirical tests, the chronology of changes in both the Federal Reserve's margin requirements and the date of first publication of the Federal Reserve's OTC margin lists from July 8, 1969, to September 29, 1975, is summarized in table 10.1.

10.3 Previous Results

As noted in the introduction, previous empirical literature on the efficacy of Federal Reserve margin regulation has typically been conducted by comparing the price and volatility changes of a general market index (such as the S&P Composite index) concomitant with changes in margin levels. While differing in their various methodologies, studies by Hsieh and Miller (1990), Ferris and Chance (1988), and Hardouvelis (1988, 1990) all follow this general procedure, albeit with occasionally divergent results. While both Hsieh and Miller and Ferris and Chance join earlier researchers such as Largay and West (1973), Grube, Joy, and Panton (1979), and the Board of Governors of the Federal

1. Board of Governors of the Federal Reserve System, Official Office Correspondence, March 1, 1976.

2. All OTC firms traded on the NASD's National Market System became eligible for margin lending on March 2, 1984 (Board of Governors of the Federal Reserve System, Official Office Correspondence, March 2, 1984).

3. Board of Governors of the Federal Reserve System, *Official List of OTC Margin Stocks,* various issues.

Table 10.1 **Chronology of Margin Changes and the Release Dates of the Federal Reserve Board's Official List of Marginable OTC Equities**

Date	Item
7/8/69	First Federal Reserve OTC margin list released
5/6/70	Federal Reserve reduces margin requirement by 15%
7/20/70	Second Federal Reserve OTC margin list released
7/12/71	Third Federal Reserve OTC margin list released
12/6/71	Federal Reserve reduces margin requirement by 10%
5/15/72	Fourth Federal Reserve OTC margin list released
11/24/72	Federal Reserve increases margin requirement by 10%
9/4/73	Fifth Federal Reserve OTC margin list released
1/3/74	Federal Reserve reduces margin requirement by 15%
7/29/74	Sixth Federal Reserve OTC margin list released
9/29/75	Seventh Federal Reserve OTC margin list released

Reserve System's own staff analysis (1984) in maintaining that changes in margin levels are associated with only trivial changes in security market behavior, Hardouvelis's investigation, as noted in the introduction, suggests otherwise.[4]

In work more closely related to the present study, researchers such as Grube, Joy, and Howe (1987), Grube and Joy (1988), Seguin (1990), and Wolfe, Klein, and Bowyer (1992) examine the price, volume, volatility, and liquidity effects of additions to and deletions from the Federal Reserve's list of marginable OTC securities following passage of the 1969 amendment to the Securities Exchange Act of 1934. The findings of each of these studies are summarized below.

Grube, Joy, and Howe (1987) perform an event-time analysis of the price impact of additions and deletions of selected OTC firms to the Federal Reserve Board's *Official List of OTC Margin Stocks.* Using ninety firms collected from three listing dates, weekly data, and two separate return generating models, the authors identify significant price increases in the week of margin eligibility but not in the week of delisting. Taken separately, the positive price listing results point toward either an implied Federal Reserve "endorsement" effect or a credit convenience effect, while the delisting results seemingly indicate no effect at all. However, as Grube, Joy, and Howe note, when the two sets of results are integrated and the regulation T "grandfather clause" is acknowledged, the

4. Additional empirical work on the effectiveness of Federal Reserve margin requirements has been conducted by Moore (1966), Friend (1976), Officer (1973), Luckett (1982), and Pruitt (1993). In general, both Moore and Officer suggest "that not one of the aims of the legislation establishing margin requirements has been accomplished" (Moore 1966, 158), while Friend, Luckett, and Pruitt conclude that "the margin requirement is an effective regulatory tool" (Luckett 1982, 783). Studies of exchange-specific 100 percent margins by Largay (1973) and Eckardt and Rogoff (1976) have generally concluded that the banning of credit transactions in individual security issues is associated with a moderation of "speculative" activity in these stocks.

empirical results indicate that significant short-term stock price changes accompany Fed credit regulatory activities.[5]

In a companion study, Grube and Joy (1988) analyze the volatility effects of additions to the OTC margin list. Again using ninety firms and weekly price data, Grube and Joy fail to support the hypothesis that additions to the OTC margin list result in reductions in overall return volatility. Rather, the authors note that the Federal Reserve appears to select OTC stocks for inclusion on the broker loan list after they experience a decline in relative return variance.

Seguin (1990) employs daily return data for approximately 2,400 firms added to the OTC margin list from 1976 to 1987 to test the hypothesis that margin trading leads to destabilizing price and volatility effects. Noting that stock trading volumes increase by about 15 percent, overall price volatility declines by about 2 percent and stock prices increase by about 2 percent upon margin listing. Seguin concludes that, if there is an OTC margin effect, "it is value" (120).

Wolfe, Klein, and Bowyer (1992) perform an analysis similar to that conducted by Seguin (1990), with the exception that Wolfe, Klein, and Bowyer examine price effects across firms of differing market value. Those authors interpret that their findings of no excess returns upon listing for stocks in the largest market value portfolio, but highly significant abnormal returns for smaller firms, are consistent with "the Federal Reserve endorsement theory since, under the credit convenience theory, positive excess returns should be realized without regard to the market value of the [listed] company" (94). This hypothesis is also consistent with the lack of any price effects at the time of delisting, since the process employed by the Federal Reserve for deleting a stock from the list is quite protracted.[6] In contrast to the findings of Seguin (1990), Wolfe, Klein, and Bowyer are unable to document any statistically significant volume changes in the newly marginable firms. In addition, no statistically significant net changes in the average bid-ask spread are observed following margin listing.

While the studies of Grube, Joy, and Howe (1987), Grube and Joy (1988), Seguin (1990), and Wolfe, Klein, and Bowyer (1992) represent important con-

5. The regulation T "grandfather clause" states that any security removed from the OTC margin list can, at the discretion of the broker, continue to qualify for preexisting broker loans. This fact suggests that strong credit-motivated selling pressure need not arise for newly delisted OTC stocks.

6. The process involved in removing a stock from the OTC margin list begins when the Federal Reserve sends a registered letter to the firm stating that the firm is under review. This letter must be sent at least one month, and usually is sent more than one month, before the effective date of delisting. Since the *Federal Register* is the official organ employed in the notification of delisting, and since, over the time period encompassed by the Wolfe, Klein, and Bowyer (1992) study (1985–87), changes to the margin list were published once per quarter, the notification letter could be out as long as three months before official publication in the *Federal Register.* Not surprisingly, firms subject to delisting also have the right to appeal the Federal Reserve's ruling, a process that, if followed, further increases the lag from first notification to final delisting.

tributions to the literature, none of these efforts deals directly with the impact of *changes* in margin levels on OTC firms. In fact, being concerned solely with the valuation effects of additions to (and deletions from) the Federal Reserve's OTC margin lists, these studies are inherently incapable of differentiating between those security market responses resulting from the information effects associated with margin listing (e.g., the Federal Reserve "endorsement effect") and those effects resulting from changes in binding borrowing constraints on equity investors due to changes in margin.

10.4 Data and Empirical Methodology

10.4.1 Data

As stated above, the purpose of this study is to establish a controlled experiment capable of distinguishing between adjustments in security-market behavior resulting from *information effects only* and those changes due to *shifts in margin-imposed binding constraints* on equity investors. As such, all of the tests presented in section 10.5 are based upon specially matched OTC security pairs constructed from the seven OTC margin lists noted in table 10.1. The purpose of the matched pairings is to create the most homogeneous samples possible for study of the effects of changes in Federal Reserve margin levels on both marginable (experiment) and nonmarginable (control) OTC firms. Since over the 1970–74 time interval each of these listings warn that "[s]tocks will be added to the List, or deleted, in the interim between publications as deemed appropriate by the Board," extreme care is taken to ensure that firms placed in either the marginable or nonmarginable portfolios for each margin change are categorized properly. Thus, a stock is considered for inclusion in the marginable firm portfolio for a given margin change only if it appeared on those OTC margin listings published both before and after the change.[7] Similarly, a stock is considered for inclusion in the nonmarginable portfolio only when its first appearance on the OTC margin list occurs on the second OTC firm margin listing following the margin change.

For example, firms included on *both* the OTC margin lists released on July 8, 1969, and July 20, 1970, are considered eligible for inclusion in the marginable firm portfolio for the 15 percent margin decrease announced on May 6, 1970. Similarly, firms are considered eligible for the nonmarginable portfolio only when first included on the OTC firm margin list released on July 12, 1971. In addition to ensuring that each included firm is indeed either marginable or nonmarginable as of the date of a given margin change, this procedure eliminates the possibility that a firm's margin status might have changed

7. Otherwise apparently eligible OTC firms reported in the *Federal Register* as having been removed from the Federal Reserve's *Official List of OTC Margin Stocks* are also eliminated during the construction of the marginable firm portfolios.

over the parameter estimation intervals required by the conducted tests.[8] This latter point is particularly critical, given the parameter estimation biases that might result from the price, volume, and volatility effects associated with OTC firm additions to the list of marginable securities. (See, e.g., Seguin [1990]; and Wolfe, Klein, and Bowyer [1992].)

Since the Center for Research in Security Prices (CRSP) OTC daily data tape begins in 1976, and since the last change in Federal Reserve margin levels occurred in 1974, all of the data employed in the present study are necessarily collected by hand from various quarterly issues of the *ISL OTC Stock Price Guide*.[9] Because of the desire to employ daily data in the analysis and the extremely high opportunity costs associated with hand collection, a total of 20 marginable and 20 nonmarginable firms are included in each of the OTC firm pair groupings employed in the empirical tests for each of the four post-1969 amendment margin changes. For each of these 160 firms, closing bid and ask prices are collected over event days $t = -126$ to $+25$, relative to the day 0 margin change date. Additionally, since daily trading volume data are included in the ISL OTC guides beginning in 1972, volume data for the 40 matched pairs (80 firms) employed in tests of the 1972 and 1974 margin changes also are collected over event days $t = -126$ to $+25$. Combining these two security series results in a final data set exceeding sixty thousand individually hand-collected points.

The actual mechanics for determining which firms are included in the analysis is straightforward. Following the determination of which firms are potentially available for inclusion in both the marginable and nonmarginable portfolios for each of the four margin changes, subsets of these firms are then matched on the basis of four-digit industrial SIC codes. Since the set of potential nonmarginable firms is typically much smaller than the set of available marginable firms, in approximately 70 percent of all cases more than one (and as many as six) four-digit SIC code–matched marginable firm are available for pairing with each nonmarginable firm. In these instances, additional matching criteria based on both similarities in market value and debt/equity ratios are employed to complete the margin pairings. While the market value matching criterion requires no justification here, debt/equity ratios are included in the matching process as an attempt to control for the plausible possibility that some investors might view margin and corporate borrowing as substitutes in

8. The OTC marginable/nonmarginable inclusion criteria for the 1971, 1972, and 1974 margin changes are as follows: 1971 marginable, included on the 7/20/70, 7/12/71, and 5/15/72 margin lists; 1971 nonmarginable, included on the 9/4/73 margin list, but not on the 7/12/71 or 5/15/72 list; 1972 marginable, included on the 5/15/72 and 9/4/73 margin lists; 1972, nonmarginable, included on the 1/3/74 list, but not on the 5/15/72 or 9/4/73 list; 1974 marginable, included on the 9/4/73, 7/29/74, and 9/29/75 margin lists; and 1974 nonmarginable, included on the 9/29/75 list, but not on the 9/4/73 or 7/29/74 list.

9. Unfortunately, attempts to employ an optical scanner in the collection of the data proved unsuccessful.

the sense of the "homemade leverage" arguments proposed by Modigliani and Miller (1958) and others.[10]

10.4.2 Empirical Methodology

The purpose of this study is to determine whether the security-market responses observed previously in response to changes in Federal Reserve margin requirements are due to information effects only or to changes in margin-imposed binding constraints upon investors. The information effects hypothesis suggests that security-market responses to margin changes result from innovations in expectations concerning either the condition of the stock market or the economy as a whole, and that changes in margin levels serve essentially as a signaling mechanism employed by the Federal Reserve in the dissemination of relevant information to the marketplace. In this case, most securities, regardless of their relative accessibility of margin credit, should react in roughly the same magnitude and direction to a given change in margin requirements.[11] Conversely, the binding constraint hypothesis suggests that security-market reactions to changes in margin requirements should differ across issues, particularly with respect to cross-sectional differences in the availability of margin loans, as margin traders adjust their portfolios in response to changes in the lending environment. Accordingly, the standardized abnormal returns differences methodology developed below is designed to detect deviations in *relative* price performance between the marginable and nonmarginable portfolios described above in response to a change in Federal Reserve margin requirements.

Returns for each marginable or nonmarginable firm i for each event day t, $t = -125 \ldots +25$, follow Seguin (1990) and are calculated as

$$(1) \qquad r_{it} = \ln\left(\frac{(A_{it} + B_{it})/2 + D_{it}}{(A_{it-1} + B_{it-1})/2}\right),$$

where A_{it} and A_{it-1} and B_{it} and B_{it-1} are the ask and bid prices for security i at time t and $t - 1$, respectively, and D_{it} is any cash dividend or other cash distribution accruing to stockholders of firm i at time t. All return calculations are corrected for both stock dividends and stock splits, if any.

Returns for the twenty marginable and nonmarginable firms for each margin change are combined into equally weighted portfolio indexes as

$$(2) \qquad R_{MAR,t} = (1/20)\sum_{i=1}^{20} r_{it} \qquad \text{and} \qquad R_{NMR,t} = (1/20)\sum_{i=1}^{20} r_{it},$$

where $R_{MAR,t}$ and $R_{NMR,t}$ are the mean returns for the marginable and nonmarginable firm OTC indexes for all 151 event days t, respectively.

10. Lists of the firms included in the marginable and nonmarginable portfolios are available from the authors upon request.

11. Obviously, certain countercyclical issues might well be expected to react in a direction opposite to that of the market factor as a whole to any given margin change.

Abnormal returns for each OTC index $j(j = 2)$ for each event day t are calculated via the market model and are defined as

$$AR_{jt} = R_{jt} - (\hat{\alpha}_j + \hat{\beta}_j R_{mt}), \qquad t = -25 \ldots +25, \tag{3}$$

where R_{mt} is the daily return of the CRSP value-weighted market index and $\hat{\alpha}_j$ and $\hat{\beta}_j$ are Scholes-Williams (1977) intercept and slope coefficients estimated over event days $t = -100$ to -26, relative to the day 0 margin change announcement, and are defined as[12]

$$\hat{\alpha}_j = \frac{1}{98} \sum_{t=-125}^{-26} R_{jt} - \hat{\beta}_j \frac{1}{98} \sum_{t=-125}^{-26} R_{mt} \tag{4}$$

and

$$\hat{\beta}_j = (\beta_j^- + \beta_j + \beta_j^+)/(1 + 2\rho_m), \tag{5}$$

where ρ_m is the estimated first-order autocorrelation coefficient of the market index over the period $t = -125$ to -26, and the individual β terms are ordinary least squares coefficients estimated from the following three regressions:

$$R_{jt} = \alpha_j^- + \beta_j^- R_{mt-1} + \varepsilon_{jt}, \qquad t = -124, \ldots, -26; \tag{6}$$

$$R_{jt} = \alpha_j + \beta_j R_{mt} + \varepsilon_{jt}, \qquad t = -124, \ldots 26; \tag{7}$$

$$R_{jt} = \alpha_j^+ + \beta_j^+ R_{mt+1} + \varepsilon_{jt}, \qquad t = -125, \ldots, -27. \tag{8}$$

The abnormal returns difference for each event day t, ARD_t, is simply the arithmetic difference between the abnormal returns for each of the two OTC indexes ($AR_{MAR,t}$ and $AR_{NMR,t}$) for each event day t and is defined as

$$ARD_t = AR_{MAR,t} - AR_{NMR,t} \tag{9}$$

Note that, by employing a time series of paired abnormal return differences, any marketwide cross-sectional dependencies of the abnormal returns are effectively purged. The cumulative abnormal returns difference for the interval from T_1 to T_2, $CARD_{T_1T_2}$ is defined as

$$CARD_{T_1T_2} = \sum_{t=1}^{N} ARD_t, \tag{10}$$

where $N = T_2 - T_1 + 1$.

Standardized abnormal return differences for each event day t, $SARD_t$, are calculated by dividing the abnormal return differences for each event day t in the event interval by the square root of the variance of the ARD_t over the 125-day estimation interval. Mathematically,

12. As expected, given the results of Brown and Warner (1985), alternative abnormal return calculation methods such as the ordinary least squares market model and the market-adjusted returns model produce no substantive differences in the results achieved. Further, the results prove similarly insensitive to alternative market indexes such as the CRSP value-weighted index and the S&P 500 index.

$$SARD_t = ARD_t / (s^2_{ARD})^{1/2}, \tag{11}$$

where s^2_{ARD} is defined as

$$s^2_{ARD} = \frac{1}{124} \sum_{t=-125}^{-26} (AR_{MAR,t} - AR_{NMR,t} - \overline{MARD})^2, \tag{12}$$

and where

$$\overline{MARD} = \frac{1}{125} \sum_{t=-125}^{-26} (AR_{MAR,t} - AR_{NMR,t}). \tag{13}$$

The cumulative standardized abnormal return difference from T_1 to T_2, $CSARD_{T_1T_2}$, is defined as

$$CSARD_{T_1T_2} = \sum_{t=T_1}^{T_2} \frac{SARD_t}{\sqrt{T_2 - T_1 + 1}}. \tag{14}$$

This test statistic is assumed distributed asymptotically unit normal (t) and is employed to determine the significance of each event interval tested for each margin change pair.

10.5 Empirical Results

10.5.1 Price Tests

Tables 10.2–10.5 document the daily and cumulative abnormal return differences and their associated daily test statistics (t) between the marginable and nonmarginable OTC firm samples for the 1970, 1971, 1972, and 1974 margin changes, respectively, for event days $t = -25$ to $+25$ relative to the day 0 announcement of each Federal Reserve margin change. Recall, due to the mechanics of the abnormal portfolio return equation (9), a positive abnormal return value for a given even day indicates that the price performance of the marginable OTC firm portfolio exceeded that of the nonmarginable OTC firm portfolio after adjusting for all market movements. In addition to portfolio-specific return data, tables 10.2–10.5 also reproduce the daily and cumulative returns of the CRSP equally weighted index for each event day.

As illustrated in table 10.2, the lack of any positive, statistically significant abnormal returns around the time of the 15 percent decrease in Federal Reserve margin levels enacted on May 6, 1970, strongly suggests that the performance of the nonmarginable OTC firm portfolio mirrored its marginable OTC firm counterpart. While the abnormal return for event day +3 is positive and statistically significant, it seems extremely unlikely that this finding—occurring as it does a full three days after the margin change—is the result of a margin-induced change in binding borrowing constraints on OTC firm investors. The insignificant rise in the cumulative abnormal returns over event days +1 to +25 ($CARD = 3.29$ percent, $CSARD = 1.79$) further underscores the lack of

Table 10.2 **Price Differences between the Marginable and Nonmarginable OTC Firm Portfolios for the 1970 Margin Decrease**

Event Day	CRSP Index	Σ CRSP Index	MAR − NMR (ARD_t)	Test Statistics ($SARD_t$)	$CARD_{T_1T_2}$
−25	−.0002420	−.0002420	−.0117487	−1.4091150	−.0117487
−15	−.0086740	−.0395400	.0071752	.8605785	−.0266280
−5	−.0144620	−.1280480	−.0128349	−1.5393910	−.0096200
−4	.0208060	−.1072420	.0074914	.8985030	−.0021286
−3	−.0034220	−.1106640	−.0183067	−2.1956680	−.0204353
−2	−.0011080	−.1117720	−.0073447	−.8809080	−.0277800
−1	−.0255220	−.1372940	.0056639	.6793163	−.0221161
0	−.0109500	−.1482440	.0066261	.7947207	−.0154900
1	.0121670	−.1360770	−.0044613	−.5350790	−.0199513
2	.0063200	−.1297570	.0044212	.5302695	−.0155301
3	−.0050870	−.1348440	.0203159	2.4366470	.0047858
4	−.0107460	−.1455900	−.0044089	−.5287942	.0003769
5	−.0089880	−.1545780	.0098005	1.1754520	.0101774
15	−.0133190	−.2794580	−.0024386	−.2924805	.0673350
25	.0003140	−.1711940	.0092849	1.1136120	.0174969

Notes: This table documents the daily (ARD_t) and cumulative ($CARD$) abnormal return differences and associated daily abnormal return test statistics ($SARD_t$) between a portfolio of marginable and nonmarginable OTC firms around the 15 percent decrease in Federal Reserve margin requirements enacted on May 6, 1970. Daily and cumulative changes in the CRSP equally weighted index also are presented.

Table 10.3 **Price Differences between the Marginable and Nonmarginable OTC Firm Portfolios for the 1971 Margin Decrease**

Event Day	CRSP Index	Σ CRSP Index	MAR − NMR (ARD_t)	Test Statistics ($SARD_t$)	$CARD_{T_1T_2}$
−25	.0013600	.0013600	.0169072	2.1402440	.0169072
−15	−.0135690	−.0153110	.0116321	1.4724870	−.0206326
−5	.0183380	−.0195630	.0068407	.8659500	−.0095260
−4	.0181610	−.0014020	.0072385	.9163035	−.0022876
−3	.0073560	.0059540	.0207235	2.6233470	.0184359
−2	.0174890	.0234430	.0062550	.7918085	.0246909
−1	.0029870	.0264300	−.0029344	−.3714570	.0217566
0	.0119510	.0383810	−.0150132	−1.9004880	.0067434
1	−.0043440	.0340370	−.0218976	−2.7719800	−.0151543
2	.0046030	.0386400	−.0053207	−.6735385	−.0204750
3	.0016230	.0402630	−.0046687	−.5910037	−.0251437
4	.0002580	.0405210	−.0085862	−1.0869100	−.0337299
5	.0082160	.0487370	−.0024231	−.3067365	−.0361530
15	.0016790	.0805470	−.0081754	−1.0349050	−.0356022
25	−.0001820	.1094550	.0017698	.2240416	−.0159524

Notes: This table documents the daily (ARD_t) and cumulative ($CARD$) abnormal return differences and associated daily abnormal return test statistics ($SARD_t$) between a portfolio of marginable and nonmarginable OTC firms around the 10 percent decrease in Federal Reserve margin requirements enacted on December 6, 1971. Daily and cumulative changes in the CRSP equally weighted index also are presented.

Table 10.4 **Price Differences between the Marginable and Nonmarginable OTC Firm Portfolios for the 1972 Margin Increase**

Event Day	CRSP Index	Σ CRSP Index	MAR − NMR (ARD_t)	Test Statistics ($SARD_t$)	$CARD_{T_1T_2}$
−25	.0059850	.0059850	.0014315	.5734817	.0014315
−15	.0087990	.0426000	.0016413	.6575332	−.0167560
−5	−.0031780	.0707950	.0022984	.9207926	−.0026486
−4	.0052010	.0759960	.0015898	.6369066	−.0010588
−3	.0033340	.0793300	−.0026210	−1.0500270	−.0036798
−2	.0002530	.0795830	.0002736	.1096371	−.0034062
−1	.0047300	.0843130	.0004294	.1720352	−.0029767
0	.0060940	.0904070	−.0010509	−.4210181	−.0040277
1	.0029690	.0933760	−.0010552	−.4227587	−.0050830
2	−.0034770	.0898990	−.0011348	−.4546217	−.0062178
3	−.0015240	.0883750	.0000427	.0171417	−.0061750
4	.0004780	.0888530	−.0012381	−.4959964	−.0074131
5	.0026640	.0915170	.0021748	.8712687	−.0052382
15	−.0030690	.1034480	−.0001277	−.0511793	−.0104012
25	.0091340	.1120880	−.0055319	−2.2161370	−.0162990

Notes: This table documents the daily (ARD_t) and cumulative ($CARD$) abnormal return differences and associated daily abnormal return test statistics ($SARD_t$) between a portfolio of marginable and nonmarginable OTC firms around the 10 percent increase in Federal Reserve margin requirements enacted on November 24, 1972. Daily and cumulative changes in the CRSP equally weighted index also are presented.

Table 10.5 **Price Differences between the Marginable and Nonmarginable OTC Firm Portfolios for the 1974 Margin Decrease**

Event Day	CRSP Index	Σ CRSP Index	MAR − NMR (ARD_t)	Test Statistics ($SARD_t$)	$CARD_{T_1T_2}$
−25	−.0292590	−.0292590	.0156217	1.0332130	.0156217
−15	.0154200	−.0153360	.0265804	1.7580200	.0301715
−5	−.0056990	−.0691410	−.0007229	−.0478155	.0571953
−4	.0281460	−.0409950	−.0308005	−2.0371380	.0263948
−3	.0206470	−.0203480	−.0056012	−.3704586	.0207936
−2	−.0011290	−.0214770	−.0110722	−.7323141	.0097214
−1	.0019370	−.0195400	−.0072027	−.4763867	.0025187
0	.0033430	−.0161970	−.0439908	−2.9095390	−.0414721
1	.0238500	.0076530	−.0244960	−1.6201560	−.0659681
2	−.0050550	.0025980	−.0226153	−1.4957680	−.0885834
3	−.0057600	−.0031620	−.0066456	−.4395393	−.0952290
4	−.0181950	−.0213570	.0193431	1.2793460	−.0758859
5	−.0278670	−.0492240	−.0094121	−.6225135	−.0852980
15	.0054740	−.0133790	−.0074288	−.4913417	−.0909986
25	.0030280	−.0477420	.0019639	.1298889	−.1136665

Notes: This table documents the daily (ARD_t) and cumulative ($CARD$) abnormal return differences and associated daily abnormal return test statistics ($SARD_t$) between a portfolio of marginable and nonmarginable OTC firms around the 15 percent decrease in Federal Reserve margin requirements enacted on January 3, 1974. Daily and cumulative changes in the CRSP equally weighted index also are presented.

a significant margin-change differential between the marginable and nonmarginable portfolios.

Clearly, the lack of a positive, statistically significant rise in the prices of the marginable OTC firm sample relative to their nonmarginable counterparts suggests that any pricing revaluations in response to the 1970 margin change were due to *information effects only* and *not* due to changes in margin-imposed binding constraints on equity investors, at least over the short run. The consistent downward trend in the level of the CRSP index over event days $t = -25$ to -1 is consistent with the hypothesis that the Federal Reserve reduces margin requirements in response to declining equity price levels.

Table 10.3 summarizes the findings for the 10 percent decrease in margin levels announced on December 6, 1971. Whereas the test statistics for the abnormal returns associated with event days 0 and $+1$ indicate a definite margin-change differential between the two OTC firm portfolios, the direction of the difference (negative) is exactly the opposite of the a priori hypothesis that reductions in margin levels should result in price increases in marginable OTC firms vis-à-vis their nonmarginable counterparts. As was the case with the 1970 margin change, the cumulative abnormal return levels registered over event days $t = +1$ to $+25$ are similarly inconsistent with an identifiable margin-change performance differential between the two OTC firm portfolios ($CARD = -2.27$ percent, $CSARD = -1.57$).

The abnormal returns associated with the 10 percent increase in margin requirements mandated on November 24, 1972, are summarized in table 10.4. As before, there is absolutely no evidence presented in table 10.4 that would suggest an identifiable differential response between the marginable and nonmarginable OTC firm portfolios. Indeed, none of the eleven event days immediately surrounding the day 0 announcement of the increase even approach significance at conventional statistical levels. Again, the lack of a consistent trend in the postannouncement abnormal returns over event days $t = +1$ to $+ 25$ ($CARD = -1.23$ percent, $CSARD = -0.98$) underscores the inherent price performance similarity of the two portfolios. Similar to the case of the 1970 margin decrease, the substantial cumulative return increase registered by the CRSP index prior to the announcement of the 1972 margin increase is consistent with the hypothesis that changes in equity levels are an important input into the Federal Reserve's margin-change decision calculus.

In a perhaps initially surprising result, the abnormal return performance of the nonmarginable OTC firms substantially and statistically exceeded the performance of their marginable counterparts at the time of the announcement of the final change in Federal Reserve margin levels announced on January 3, 1974 (table 10.5). Indeed, given the hypothesis that changes in margin levels are associated with changes in binding constraints on equity investors, the abnormal return performance of the marginable firms would, if anything, be expected to exceed that of the nonmarginable firms. However, the fact that this margin change occurred on the second trading day of the year, combined with the fact that the average asset levels of the firms in the marginable firm portfo-

lio exceeded that of the nonmarginable portfolio, suggests that the previously described inverse correlation between stock returns and firm size around the turn of the year (see, e.g., Keim [1983]) may well lie at the root of this empirical finding. Over the entire twenty-five-day postevent period, the cumulative abnormal return performance of the nonmarginable firm portfolio exceeded that of the marginable firms by over 7 percent ($CARD = -7.21$ percent, $CSARD = -2.96$).

Overall, the pricing results clearly refute the hypothesis that changes in margin requirements are associated with changes in binding constraints on security investors. Rather, the results for the marginable and nonmarginable firm pairs for the 1970, 1971, 1972, and 1974 margin changes provide the strongest empirical evidence to date that the pricing dynamics observed by previous researchers in response to changes in margin levels are due strictly to information effects common to all equity securities.

10.5.2 Volatility Tests

Table 10.6 presents a preliminary comparison of differences in volatilities between the marginable and nonmarginable OTC firm portfolios before and after each margin change. Comparisons of the cross-sectional variances are made between the two samples by means of an F-test. Volatility differences (at

Table 10.6 **Across-Sample Comparisons of Means and Variances for the Marginable and Nonmarginable OTC Firm Portfolios**

	1970		1971		1972		1974	
	MAR	NMR	MAR	NMR	MAR	NMR	MAR	NMR
Preannouncement Comparisons								
Mean	0.0108	−0.0098	0.0004	−0.0004	0.0022	0.0013	−0.0009	−0.0021
Variance	0.0025	0.0025	0.0003	0.0001	7.6E-5	4.6E-5	0.0005	0.0004
Observations	25	25	25	25	25	25	25	25
Degrees of freedom	24	24	24	24	24	24	24	24
F-statistic	1.0076		2.0619		1.6318		1.3967	
$p(F < f)$	0.4928		0.0413		0.1187		0.2095	
F critical	1.9838		1.9838		1.9838		1.9838	
Postannouncement Comparisons								
Mean	−0.0021	−0.0031	0.0039	0.0048	0.0022	0.0018	−0.0028	0.0017
Variance	0.0006	0.0009	0.0001	4.0E-5	7.1E-5	0.0001	0.0002	0.0002
Observations	25	25	25	25	25	25	25	25
Degrees of freedom	24	24	24	24	24	24	24	24
F-statistic	1.5933		2.9084		1.7248		1.1615	
$p(F < f)$	0.1305		0.0057		0.0945		0.3584	
F critical	1.9838		1.9838		1.9838		1.9838	

Note: This table presents preliminary comparisons of the differences in volatility for the marginable (MAR) and nonmarginable (NMR) OTC firm portfolios in the pre-margin-announcement period and the post-margin-announcement period for the 1970, 1971, 1972, and 1974 changes in Federal Reserve margin levels.

the 5 percent level) between the marginable and nonmarginable firms in the preannouncement period (event days $t = -25$ to -1) are evident only for the 1971 margin change. This result also holds for the F-tests of the differences in volatility between the two samples over the postannouncement period ($t = +1$ to $+25$ event days). While the statistically significant differences between the volatility of the marginable and nonmarginable OTC firm portfolios both before and after the 1971 margin change are interesting, far more important from a policy perspective are questions concerning changes in the variances of the marginable firms *relative to* their nonmarginable counterparts following the announcement of changes in Federal Reserve margin levels.

To investigate relative differences between the marginable and nonmarginable firm samples following the announcement of margin changes, two separate methodologies are employed. The first method, initially developed by Ohlson and Penman (1985) and later replicated by Dubofsky (1991), measures changes in volatility following a specific event via the observation that squared mean daily stock returns are approximately 0.1 percent in order of magnitude compared to expected squared returns. Thus, the null hypothesis that Federal Reserve margin changes have no effect on stock volatilities may be simply restated as $E[R_a^2] - E[R_b^2] = 0$, where R_a and R_b are the returns on security i before and after the margin change, respectively. The statistical approach employed is based on the binomial distribution and assumes simply that, if Federal Reserve margin changes have no effect on security volatility, the percentage of squared returns following a margin change exceeding those prior to the change (p_0), for each portfolio for each of the four margin changes, should be equal to the random chance probability of 0.5. Thus,

$$Z = 2(p_0 - 0.5)\sqrt{n}, \tag{15}$$

where n is the number of return pairs.[13]

The Z-test to determine the statistical significance of the difference in the proportion of the squared returns registered between the marginable and nonmarginable firms for each margin change is given by

$$Z = \frac{p_1 - p_2}{\sqrt{\left(\frac{n_1p_1 + n_2p_2}{n_1 + n_2}\right)\left(1 - \frac{n_1p_1 + n_2p_2}{n_1 + n_2}\right)\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}, \tag{16}$$

where n_1 and p_1 and n_2 and p_2 are the total sample sizes and proportions of squared returns higher following each margin change for the marginable (1) and nonmarginable (2) firm portfolios, respectively.

13. While Ohlson and Penman employ a day-of-the-week matching procedure in their volatility tests, the common events dates of the present study mitigate the need for such an adjustment. Thus, the squared return for the first trading day following the 1970 margin change is paired with the first trading day prior to the margin change for both the marginable and nonmarginable OTC firm portfolios, and so on until all twenty-five event days on each side of each margin change are included in the analysis.

Table 10.7 presents the proportion (p) of cases in which the postannouncement squared daily return exceeds the matched-pair preannouncement squared daily return for both the marginable (MAR) and nonmarginable (NMR) portfolios, respectively, as well as the Z values associated with these proportions (in parentheses). In addition, the table also reports the overall Z value for the difference in the proportions registered by each portfolio for each margin-change announcement.

As reported in table 10.7, while there are clearly significant reductions in volatility for both the marginable and nonmarginable firms in response to the 1971, 1972, and 1974 margin changes, there are no statistically significant differences between the volatility responses of the two portfolios for any of the four tested margin changes. Further, the fact that the postevent returns volatility of the marginable OTC stocks actually fell following the 1971 and 1974 margin decreases further underscores the results of earlier researchers such as Ferris and Chance (1988), who suggest that changes in margin levels and stock return variability are not always inversely correlated.

In an effort to further evaluate whether there is a different margin-induced volatility relationship between the marginable and nonmarginable OTC firms around the time of changes in Federal Reserve margin levels, a two-way ANOVA test also is performed. The model tested is

$$X_{ijk} = \mu + \alpha_i + \beta_j + \gamma_{ij} + \varepsilon_{ijk}, \tag{17}$$

where X_{ijk} is the natural log of the ratio of the postannouncement estimated variance to the preannouncement estimated variance for firm k in sample i =

Table 10.7 **Squared Daily Return Volatility Differences between the Marginable and Nonmarginable OTC Firm Samples around the time of Federal Reserve Margin Changes**

	Total Firms		Matched Pairs		p		
Margin Change	MAR	NMR	MAR	NMR	MAR	NMR	Z^a
1970	20	20	500	500	0.501	0.535	−1.039
					(0.05)	(1.51)	
1971	20	20	500	500	0.434	0.378	1.803
					(−2.95)	(−5.45)	
1972	20	20	500	500	0.424	0.400	0.771
					(−3.40)	(−4.47)	
1974	20	20	500	500	0.386	0.334	1.713
					(−5.10)	(−7.42)	

Notes: This table presents the proportions of cases in which the postmargin squared daily return exceeds the matched premargin squared daily return for the marginable and nonmarginable OTC firm portfolios around the times of the 1970, 1971, 1972, and 1974 margin changes. This proportion is denoted by p for the marginable (MAR) and nonmarginable (NMR) OTC firm samples. The individual margin-change Z-statistic (in parentheses) tests whether $p = .05$.

[a]The Z-statistic test for the difference between the proportions of the marginable and nonmarginable samples.

Table 10.8 **Results for the Two-Way ANOVA Model**

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio	*p* Value	F Critical
Model	46.892	7	6.699	6.91	0.004	3.23
Error	147.420	152	0.970			
Corrected total	194.312	159				
Marginability	0.238	1	0.238	0.24	0.621	3.90
Year	44.581	3	14.860	15.32	0.000	2.66
Interaction	2.072	3	0.691	0.71	0.546	2.66
Model $R^2 = 0.2413$						

Notes: This table presents the results of the following two-way ANOVA model: $X_{ijk} = \mu + \alpha_i + \beta_j + \gamma_{ij} + \varepsilon_{ijk}$, where X_{ijk} is the natural log of the ratio of the postmargin announcement estimated variance to the premargin announcement variance, μ is the overall grand mean (a constant), α_i is the marginability effect, β_j is the year effect, and γ_{ij} is the interaction effect between marginability and year.

marginable, nonmarginable in year j = 1970, 1971, 1972, 1974; μ is the overall grand mean, a constant; α_i is the effect of marginability (MAR − NMR effect); β_j is the effect of year; γ_{ij} is the effect of the interaction between marginability and year; and ε_{ijk} is a normally distributed random error with mean equal to zero, and variance equal for all i, j, and k.

Table 10.8 presents the results of the ANOVA analysis. The null hypothesis of no margin effect on the volatility of the marginable firms relative to their nonmarginable counterparts is that $\alpha_i = 0$. The extremely low significance level of α_i (0.62) indicates clearly the lack of a margin-induced volatility differential between the two samples. The high degree of significance of the time (year) variables underscores the results presented in table 10.7, while the highly significant $F(F = 6.91, p = 0.0045)$ and R^2 values ($R^2 = 0.2413$) confirm the general goodness of fit of the model.

Overall, the results presented in tables 10.6–10.8 offer no support for the view that changes in Federal Reserve margin levels lead to changes in the underlying return volatility of marginable OTC stocks relative to their nonmarginable counterparts. Rather, in every test scenario, the volatility results presented support the discussion of the pricing results discussed above and suggest that any changes in return volatility in response to changes in Federal Reserve margin levels are due only to information effects and *not* to shifts in binding constraints on security investors.

10.5.3 Volume Tests

While early researchers such as Grube, Joy, and Panton (1979) observed statistically significant increases in daily trading volume for the S&P Composite index around the time of announcement of Federal Reserve margin changes, the findings of more recent margin-based experiments employing OTC stocks are contradictory. Specifically, Seguin (1990) documents volume increases of about 15 percent for stocks added to the Federal Reserve's list of marginable

OTC securities. Seguin's findings suggest that in only three of the first hundred postlisting trading days is security trading volume lower than the average of the hundred days just prior to listing. Conversely, Wolfe, Klein, and Bowyer (1992) document that only 48 percent of the firms in their sample experience increases in relative *market-adjusted* trading volumes following placement on the Federal Reserve's OTC margin list.

Despite this discrepancy, given the expected positive relationship between increases in "speculative activity" and trading volume, it is reasonable to posit that, if decreases (increases) in Federal Reserve margin requirements are associated with the loosening (tightening) of a binding constraint on security investors, the average trading volumes of marginable OTC securities should be expected to rise (fall) vis-à-vis their nonmarginable counterparts.

To assess changes in the mean relative percentage trading volumes between the two samples, a paired-differences methodology is employed. In these tests, the percentage change in the mean daily trading volume for the marginable ($DTVMAR_i$) and nonmarginable ($DTVNMR_i$) firms in each OTC firm pair is calculated by taking the natural log of the ratio of the mean daily trading volume for the twenty-five event days before the margin change and the twenty-five event days following the announcement. Thus, $DTVMAR_i = \ln(TVMAR_{ia}/TVMAR_{ib})$, and $DTVNMR_i = \ln(TVNMR_{ia}/TVNMR_{ib})$, where $TVMAR_{ib}$ and $TVNMR_{ib}$ and $TVMAR_{ia}$ and $TVNMR_{ia}$ are, respectively, the mean daily trading volumes for the marginable and nonmarginable firms in each OTC firm pair before and after each margin change.

The net change in the daily percentage trading volume for each firm pair (DTV_i) is calculated by subtracting the mean percentage change in daily trading volume for the nonmarginable firm of each OTC firm pair from that of its matched marginable firm, $DTV_i = DTVMAR_i - DTVNMR_i$. Thus, if the mean daily percentage trading volume for a given marginable firm increased following a given margin change relative to its nonmarginable counterpart, this difference will be positive. The test statistic for the mean difference of the individual OTC pair differences for each of the four margin changes is then calculated via a standard paired differences t-test.

Table 10.9 reports the mean daily trading volumes (in thousands of shares) and the mean percentage change in daily trading volumes for the firms in the marginable and nonmarginable OTC portfolios both before and after the 1972 and 1974 changes in Federal Reserve margin levels. Recall, daily trading volume figures are not reported in the *ISL OTC Stock Price Guide* prior to 1972. Also reported in the table is the mean difference between the changes in percentage trading volumes, the standard error of this difference, and the associated test statistic (t).

As shown in table 10.9, there is no evidence that the 10 percent increase in Federal Reserve margin levels announced on November 24, 1972, led to decreases in the relative mean daily trading volumes for the firms included in the marginable OTC portfolio. Whereas the mean marginable firm trading volume

Table 10.9 **Mean Daily Trading Volume Differences between the Marginable and Nonmarginable OTC Firm Portfolios before and after Federal Reserve Margin Changes**

1972 margin increase	
Marginable firm mean trading volume following change	76.549
Prior to change	77.899
Mean percentage change	−1.748
Nonmarginable firm mean trading volume following change	30.785
Prior to change	33.100
Mean percentage change	−7.251
Mean percentage difference	5.503
Standard error of mean percentage difference	52.409
Test statistic (t) of mean difference	0.105
1974 margin decrease	
Marginable firm mean trading volume following change	86.850
Prior to change	76.150
Mean percentage change	13.101
Nonmarginable firm mean trading volume following change	41.252
Prior to change	48.900
Mean percentage change	−17.006
Mean percentage difference	30.107
Standard error of mean percentage difference	15.600
Test statistic (t) of mean difference	1.930

Notes: This table presents an analysis of the mean changes in daily trading volume (in thousands) for the marginable and nonmarginable OTC firms following the announcement of the 1972 and 1974 changes in Federal Reserve margin requirements. The net percentage change in mean trading volume is equal to the difference between the mean percentage post- and premargin trading volume for the marginable firms, less the difference between the mean post- and premargin percentage trading volume for the nonmarginable firms.

did decrease by just under 2 percent, the mean trading volume of the nonmarginable firms fell by over 7 percent, implying that the mean relative trading volume of the marginable firms increased by approximately 5.5 percent.

Table 10.9 reports the same statistics for the 15 percent decrease in margin levels enacted on January 3, 1974. Similar to the case of the 1972 increase, there is only weak evidence that the 1974 decrease in margin requirements led to higher trading volumes for the marginable OTC firms relative to their nonmarginable counterparts. While the mean daily percentage trading volume of the marginable OTC stocks rose by 13 percent in the postannouncement period relative to preannouncement levels, and the mean daily percentage trading volume of the nonmarginable firms fell by 17 percent over the same time period, the net difference between these two figures is only marginally significant at conventional statistical levels ($t = 1.930$).

10.5.4 Liquidity (Bid-Ask Spread) Tests

In an effort to determine whether changes in margin levels led to changes in the relative liquidity of the marginable OTC stocks vis-à-vis their nonmarginable counterparts, paired difference tests for changes in the mean daily percentage bid-ask spread also are performed via a methodology similar to the paired-volumes tests discussed above. In these tests, the differential change in the percentage bid-ask spread for the marginable and nonmarginable firms in each OTC firm pair is calculated by subtracting the mean percentage bid-ask spread figures for the twenty-five event days before the margin change from those for the twenty-five event days following. The *net* change in the percentage bid-ask spread for each firm pair is then calculated by subtracting the mean percentage change in the bid-ask spread for the nonmarginable firm of each pair from that of its matched marginable firm. As before, if the percentage bid-ask spread for a given marginable firm increased following a given margin change relative to its nonmarginable counterpart, this difference will be positive.

While the null hypothesis of no difference in the mean daily percentage bid-ask spreads between the marginable and nonmarginable OTC firm pairs seems reasonable, there are alternative hypotheses that could, under certain conditions, suggest either an increase or decrease in relative spreads or, conceivably (in the case of exactly counterbalancing effects) lead to no change at all. In a study that presents estimates of two components of the bid-ask spread, Glosten and Harris (1988) suggest that changes in the spread arise from the interplay of the transitory and adverse-selection components. Thus, by extension, the extent to which the relative bid-ask spread of marginable OTC firms is affected by a change in Federal Reserve margin levels is due in part to the degree to which the monopoly profits generated by market makers from liquidity-motivated traders are counterbalanced by the profits earned by informed traders possessing valuable asymmetric information. Since it is reasonable to posit that the quantity of both liquidity- and informationally motivated trades may increase (decrease) following the imposition of lower (higher) margin levels—the former by virtue of increased (decreased) trading activity in general, the latter due to the fact that decreases (increases) in margin levels allow informationally motivated margin traders to assume larger (smaller) positions in marginable stocks—and since changes in the relative proportions of these two types of traders cannot be determined for the sampled stocks over the time periods under study, the magnitude and direction of changes in *relative* bid-ask spreads for marginable firms in response to changes in margin levels cannot, a priori, be determined.

The results of the tests of the mean bid-ask spread differences between the marginable and nonmarginable OTC firm pairs before and after each of the four margin changes are presented in table 10.10. Similar to the price, volatility, and volume tests presented above, there is no consistent pattern evident in

Table 10.10 **Bid-Ask Spread Differences between the Marginable and Nonmarginable OTC Firm Portfolios before and after Federal Reserve Margin Changes**

Margin Change	Premargin Spread		Postmargin Spread		Net Change	Test Statistics
	MAR	NMR	MAR	NMR		
1970	0.05792	0.05017	0.06635	0.06868	−0.01008 (0.00540)	−1.87
1971	0.04620	0.03681	0.04526	0.03478	0.00109 (0.00274)	0.40
1972	0.03525	0.04033	0.03579	0.03816	0.00270 (0.00174)	1.55
1974	0.07389	0.07838	0.06277	0.07310	−0.00585 (0.00653)	−0.90

Notes: This table presents an analysis of the mean changes in the reported closing percentage bid-ask spreads for the marginable and nonmarginable OTC firms following the announcement of changes in Federal Reserve margin requirements. The net change in the mean percentage bid-ask spread is equal to the difference between the mean post- and premargin spreads for the marginable firms, less the difference between the mean post- and premargin spreads for the nonmarginable firms. The standard errors of these net differences are reported in parentheses.

the results. While the 1970 and 1974 margin decreases led to reductions in the bid-ask spread for marginable firms vis-à-vis their nonmarginable counterparts, the 1971 margin decrease led to an increase in the spread, as did the 1972 margin increase. The results remain inconsistent even when measured *gross* of changes in the bid-ask spread of the nonmarginable firm portfolio. In this case, the observed mean bid-ask spread rises following the 1970 and 1972 margin changes and falls after the 1971 and 1974 changes. In no case, however, are the observed differences statistically significant. Indeed, only the relative bid-ask spread reduction associated with the 1970 decrease in margin levels approaches significance at conventional levels.

10.6 Conclusions

Recent empirical work on the efficacy of Federal Reserve margin regulation typically has been conducted by comparing the price and volatility changes of the S&P Composite index concomitant with changes in margin levels. The present study represents a unique departure from this approach by exploiting a 1969 amendment to the Securities Exchange Act of 1934—an amendment that allowed brokers and dealers to extend margin credit for the purchase of selected OTC issues—to create two separate portfolios of OTC firms similar in many important respects (e.g., industry, exchange, size, debt/equity ratio) while differing with respect to the presence or absence of Federal Reserve margin requirements. Prior to this development, it was impossible to distinguish, at the time of the announcement of a change in Federal Reserve margin

levels, those adjustments in security market behavior resulting from information effects only from those changes resulting from shifts in binding borrowing constraints on equity investors. The results of the conducted price, volatility, volume, and liquidity tests of these matched-pair marginable and nonmarginable OTC firms for the 1970, 1971, 1972, and 1974 Federal Reserve margin changes are summarized below.

Market-adjusted price comparisons of the marginable and nonmarginable OTC firm portfolios failed to document statistically significant differences between the two portfolios in a direction consistent with a priori expectations. Indeed, rather than the positive (negative) relative price performance for the marginable firm portfolio that would be consistent with the loosening (tightening) of a binding constraint facing investors in these securities following margin decreases (increases), no statistically significant price reactions were observed following either the 1970 margin decrease or the 1972 margin increase, while negative and statistically significant relative price performance for the marginable firm portfolio was observed following the 1971 and 1974 margin decreases. Thus, the results of the conducted price tests provide the most convincing evidence to date that the security market reactions observed in response to Federal Reserve margin changes are due to information effects only rather than due to changes in margin-imposed binding constraints on security investors.

Tests for changes in overall return variability provide no evidence of a differential effect between the marginable and nonmarginable firm portfolios following the announcement of either margin increases or decreases, rather than the increasing (decreasing) relative variability of the marginal OTC firm portfolio that would be predicted by the binding constraint hypothesis following the announcement of margin decreases (increases). Further, in findings that support the earlier results of both Hsieh and Miller (1990) and Ferris and Chance (1988), there was no consistent pattern in even the gross changes in volatility of the marginable OTC firms independent of the effect of nonmarginable firms, as the volatility of the marginable firms actually fell in the post-event period following both the 1971 and 1974 margin decreases.

Following the pattern established in the price and volatility results discussed above, tests of changes in marginable and nonmarginable OTC firm trading volume fail to yield a picture consistent with the hypothesis that decreases (increases) in Federal Reserve margin levels should be associated with increases (decreases) in trading volume for marginable equity securities. While the trading volume of the marginable firms did fall following the 1972 margin increase, the volume of the nonmarginable firms fell by an even greater amount. Unfortunately, the lack of daily trading volume figures for the 1970 and 1971 margin changes reduces the extent to which solid inferences may be made concerning the direction and magnitude of changes in marginable and nonmarginable OTC firm trading volumes in response to margin changes.

As mentioned in the discussion of the empirical results, shifts in net direc-

tion of the interplay between the transitory and adverse-selection components of the bid-ask spread make it difficult to predict, a priori, the extent to which the relative bid-ask spreads of marginable OTC firms should be affected by a change in Federal Reserve margin levels. Given this caveat, tests of the mean bid-ask spread differences between the marginable and nonmarginable OTC firm pairs before and after each of the four margin changes reveal no consistent pattern in the results. The 1970 and 1974 margin decreases led to reductions in the bid-ask spread for marginable firms vis-à-vis their nonmarginable counterparts, and the 1971 margin decrease and the 1972 margin increase led to an increase in the spread. In no instance are the observed differences statistically significant.

Taken as a whole, the empirical tests presented in this study offer *no support* for the view that Federal Reserve margin requirements function as originally conceived or that changes in margin levels are associated with changes in margin-imposed binding constraints on security investors. Rather, in every test scenario, the findings of the study are consistent with the hypothesis that the price, volatility, volume, and liquidity effects observed in equity securities in response to changes in Federal Reserve margin levels are due to information effects only. As such, the results of the study provide powerful and important new evidence that the findings of Hardouvelis (1988, 1990)—findings purporting to suggest that margin requirements "seem to be an effective regulatory tool" (1990, 736)—do indeed represent a significant overstatement of the strength of the case.

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Comment

A. Craig MacKinlay

Over the years there has been considerable debate concerning the effect of margin requirements for purchasing common equity on the volatility of the stock market. Recently, the debate has been active because of arguments that margins in the stock index futures market should be the same as margins in the cash market. (See Sofianos [1988] for details concerning the margin requirements on equity instruments.) The ultimate question from a policy point of view is whether margin requirements represent an effective tool for the Federal

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Reserve to use to control market volatility. A recent round of the debate is between Hardouvelis (1990) and Hsieh and Miller (1990). Hardouvelis presented evidence that margin requirements influence the volatility of the market and hence can be a useful tool. However, Hsieh and Miller reexamined Hardouvelis's evidence and find that his results can be explained by statistical biases. Based on a combination of this finding and some new analysis, they reject his conclusion. In this paper, Pruitt and Tse begin at this point. They add to the body of evidence by comparing two samples of OTC stocks; one sample is marginable stock and the other sample is nonmarginable. Their results support the conclusion of Hsieh and Miller (and much previous work).

Rather than spend my discussion time on the specifics of the Pruitt and Tse paper, I thought it might be useful to step back and ask a few broad questions about the margin requirements and stock market volatility debate. These questions have not been addressed in previous work. I have divided my thoughts into two categories—theoretical questions and empirical questions, and I will deal with these in turn.

Theoretical Questions

One shortfall on the theoretical side is the apparent lack of theory with specific empirical predictions for the margins and volatility relation. Existing theory argues that low margin requirements lead to speculative excesses. These excesses can introduce the possibility of an initial price drop triggering a pyramiding effect where calls for collateral lead to forced liquidations and further price drops. (See Garbade [1982] for a review of these arguments.) Such theory appears to predict nothing more specific than that lower margin requirements will lead to higher volatility. This has left empiricists with the choice of designing tests that only assume that volatility is a decreasing function of margin requirements or of adding ad hoc structure (which is usually linear in nature—see Officer [1973] for an example). As we shall see in the section on empirical questions, this lack of specificity can make given relations difficult to detect.

Some other questions also come to mind. Why is it that the studies are concerned only with the initial margin requirements and ignore maintenance margins? If one is concerned with forced liquidations, it seems that the maintenance margin is of some relevance. However, the lack of study of the role of the maintenance margin might be explained by the fact that it has not changed in the United States over the time period researchers have drawn upon for their empirical analysis. More generally, one might ask, To what extent are margins binding at all? Potentially investors can effectively avoid any constraint that high margin requirements impose, by the use of bank lending. If this is the case, then looking for a relation is a fool's errand.

Another question is, Where does one expect the effects of margin requirements to appear in terms of volatility changes? Most studies have focused on a broad-based stock market index (often the S&P 500 index) and hence are

looking for marketwide effects. However, if margin accounts are concentrated in a particular segment of the market (e.g., low-capitalization stocks), there may be more fruitful portfolios to examine. Pruitt and Tse deserve credit here. They have gone beyond a broad-based index by using a specific sample of OTC stocks. But such a choice is not without costs, as they have only one margin change to look at. Related to this is the question of how systematic the effects of margin requirements will be. There could be possible benefits from looking at the variances of individual stocks rather than the variance of a portfolio of stocks. One would like to select stocks with a high number of margin purchasers.

Empirical Questions

My empirical questions follow from the issues presented in the theoretical questions. In this section I would like to address the likelihood of statistically detecting a margin requirements and volatility relation if one did exist. While my priors are that none exists, I also suspect that, if one does exist, it will be difficult to find. The subsequent analysis draws heavily on the basic framework of Hsieh and Miller (1990). Using the history of margin changes from 1934 to the present, they consider changes both individually and in aggregate. They find that, in aggregate, the test they use to detect volatility effects has high power, given a "strong negative relation." I believe further analysis is warranted for two reasons. Most important, I find the relation they pose is so strong that it is economically unrealistic. For example, with their alternative relation, when the margin requirements are reduced from 100 percent to 75 percent, the variance of returns increases by 900 percent. Also, they present tests using individual changes and do not report on the power of such tests.

Miller and Hsieh base their analysis on the Levene test. This test is useful because it does not require strong distributional assumptions. However, there is a potential loss of power with this test because it does not incorporate the direction of the volatility change when margins change. To investigate this possibility, a one-sided F-test is also included.

In order to answer the posed question one needs to specify possible alternative margin requirements and volatility relations. This is done using the linear relation proposed by Hsieh and Miller (1990). They use standard deviation of return (σ) to measure volatility and percent initial margin (M) to measure margin requirements. The relation they consider is

$$\sigma = \alpha - \beta M. \tag{1}$$

Hsieh and Miller calibrate their model using a monthly interval. The relation is completely specified by assigning values to α and β. Five cases are considered, the null hypothesis (alternative 0) and alternatives 1 to 4. The parameter β is selected to control the strength of the relation. It ranges from 0.000 (null hypothesis) to 0.319 (alternative 4). Alternative 4 is the alternative used by Hsieh and Miller (1990). Given β, the parameter α is selected so that the annu-

alized standard deviation is 23.1 percent when the margin requirement is 40 percent. The range of parameters is reported in table 10C.1, and the relations are plotted in figure 10C.1. Also reported in table 10C.1 for each alternative is the standard deviation of return when M is 100 percent. This value ranges from 4.0 percent for the Hsieh-Miller alternative to 23.1 percent for the null hypothesis.

I begin with the consideration of detecting volatility effects given a single margin change. Hsieh and Miller consider this using the Levene test statistic.[1] Define r_{ij} as the jth observation of margin requirement regime i. Consider G regimes and N observations per regime.[2] To construct the statistic, we need the absolute deviations from the mean within each regime. Define z_{ij} as the mean absolute deviation for observation j, regime i. Then

$$z_{ij} = |r_{ij} - \bar{r}_i|, \tag{2}$$

where

$$\bar{r}_i = \frac{1}{N}\sum_{j=1}^{N} r_{ij}. \tag{3}$$

Let L be the Levene test statistic; then

$$L = \left[\frac{GN(N-1)}{(G-1)}\right]\left[\frac{\sum_{i=1}^{G}(\bar{z}_i - \bar{z})^2}{\sum_{i=1}^{G}\sum_{j=1}^{N}(z_{ij} - \bar{z}_i)^2}\right], \tag{4}$$

where

$$\bar{z}_i = \frac{1}{N}\sum_{j=1}^{N} z_{ij} \tag{5}$$

and

$$\bar{z} = \frac{1}{G}\sum_{i=1}^{G} \bar{z}_i. \tag{6}$$

Under the null hypothesis that the returns are independently and identically distributed, L is distributed $F[G-1, G(N-1)]$ asymptotically.[3] In the case of a single change in margin requirement, $G = 2$.

For comparison, the usual F-test using the ratio of the variances of returns on each side of the margin requirements change is presented. Let Q be the test statistic. Then

1. Hsieh and Miller use a slight variation of the Levene test statistic because they want to allow for heteroskedasticity in the data that is unrelated to margin changes. In the analysis of this paper, because all returns are simulated to be homoskedastic except for the volatility changes due to margin changes, the usual Levene test is reported. This difference is likely to bias the results in this paper toward overstating the power relative to the test used by Hsieh and Miller.

2. Because the null distribution is known only asymptotically, for all results presented the null critical values are determined by simulation.

3. In general N can vary across regimes. See Hsieh and Miller (1990).

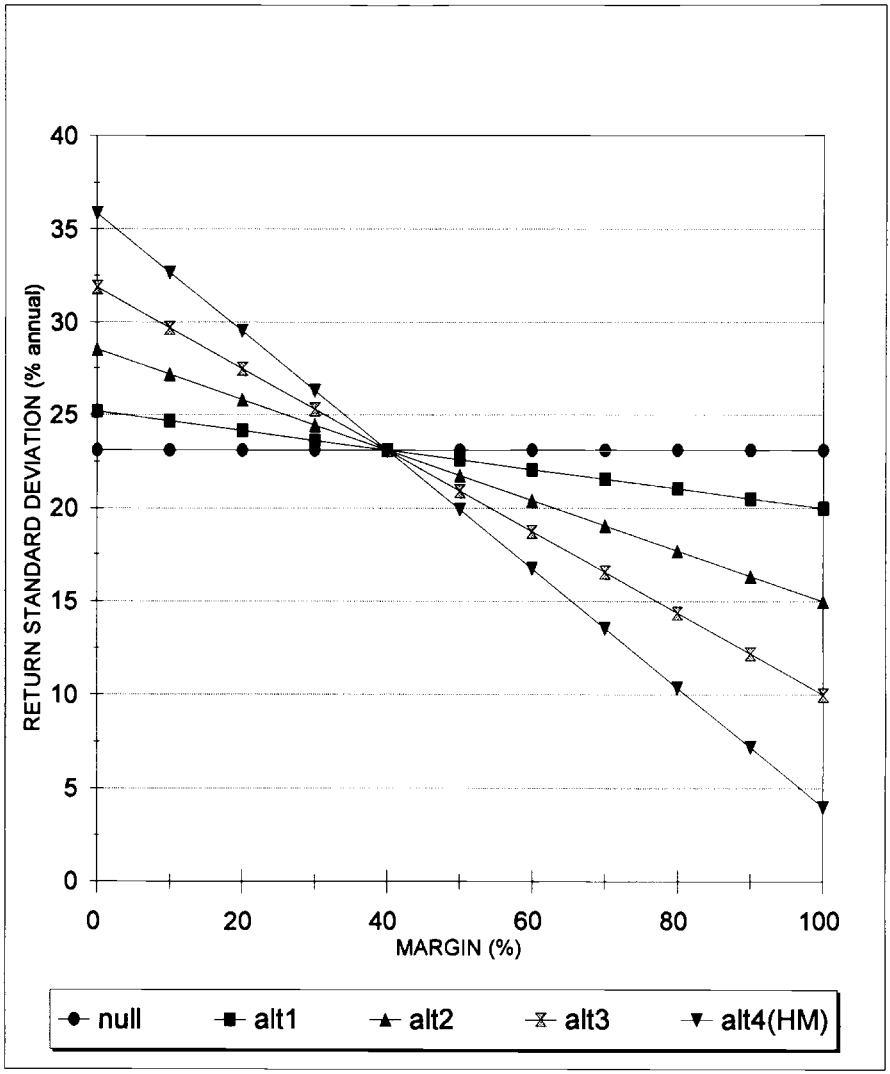

Fig. 10C.1 Margins and volatility relation

$$Q = \frac{\hat{\sigma}_A^2}{\hat{\sigma}_B^2}, \tag{7}$$

where $\hat{\sigma}_A^2$ and $\hat{\sigma}_B^2$ are the usual maximum likelihood estimators of the variance for regimes A and B, respectively. A and B are adjacent regimes, with regime A being the one with lower margins. This definition of regimes captures the one-sided nature of the hypothesis. Under the null hypothesis the distribution of Q is $F[N-1, N-1]$.

Table 10C.1 **Parameters for Alternative Models of Volatility and Margin Requirements**

Alternative	α	β	$\sigma[M = 100]$
0	23.1	0.000	23.1
1	25.2	0.052	20.0
2	28.6	0.136	15.0
3	31.9	0.219	10.0
4	35.9	0.319	4.0

Notes: A linear relation between annual standard deviation and margin requirements is assumed. The model is $\sigma = \alpha - \beta M$, where σ is the annual standard deviation, M is the margin requirement, and α and β are the model parameters. β is increased to strengthen the relation, and α is selected so that at $M = 40$ percent the standard deviation is 23.1 percent.

The individual change analysis is presented for the four alternatives previously described. The number of observations per regime is set to twenty-five. This roughly corresponds to the average number of months per regime since 1934. Three margin changes are considered, 45–55 percent, 50–70 percent, and 75–100 percent. These all represent changes that actually took place. Independent and identically distributed returns are simulated within each regime. The standard deviation of returns for each regime is given by the linear volatility and margins relation. In table 10C.2 the power of the two tests at the 5 percent level of significance is documented for the four alternatives. Although the power of the two tests is similar, throughout the table the (one-sided) F-test does dominate the Levene test. As expected, the power of both tests is lowest for alternative 1 and the 45–55 percent margin change and the highest for alternative 4 and the 75–100 percent margin change. The difference in magnitudes is extreme, however, with the power ranging from the size of the test to almost 1.0. This illustrates the importance of the alternative one has in mind in assessing the usefulness of the tests. The margin change being considered is also important. The power is low for all alternatives when the 45–55 percent change is considered and is only high for the extreme alternatives and extreme margin change. In summary, only when extreme changes in volatility occur would one expect these tests using individual change events to be able to statistically detect the volatility effects.

Next we address the power of the tests if the margin requirements changes are aggregated together. With the Levene statistic this is easily accomplished by setting G to the number of regimes. In the case at hand $G = 23$ since there are twenty-two margin requirements changes over the 1934-to-present sample. To aggregate the F-test, we form a new statistic based on the average of the Q statistic across regime changes. The size of the sample to be averaged is twenty-two. The null hypothesis critical values of this aggregate F-test are determined by simulation.

The power of the aggregate tests are reported in table 10C.3. Results are reported for three significance levels, 1 percent, 5 percent, and 10 percent. In terms of being able to statistically detect volatility effects, the Levene test has

Table 10C.2 **Power of Two Tests at 5 Percent Significance Level for Individual Margin Changes**

	Change A, 45–55%		Change B, 50–70%		Change C, 75–100%	
Alternative	L-test	F-test	L-test	F-test	L-test	F-test
1	0.047	0.053	0.057	0.084	0.062	0.096
2	0.060	0.080	0.102	0.117	0.145	0.277
3	0.079	0.128	0.163	0.219	0.465	0.671
4	0.094	0.179	0.380	0.403	0.999	0.999

Notes: The two tests are the Levene test (L-test) and the F-test. Four alternative hypotheses are considered. See table 10C.1 and figure 10C.1 for details of the alternatives. Each cell is based on one thousand independent replications.

Table 10C.3 **Power of Two Tests at Various Significance Levels for Twenty-three Margin Changes**

	Significance Level					
	1%		5%		10%	
Alternative	L-test	F-test	L-test	F-test	L-test	F-test
1	0.014	0.073	0.081	0.226	0.158	0.351
2	0.160	0.600	0.366	0.835	0.495	0.915
3	0.811	0.999	0.938	1.000	0.973	1.000
4	1.000	1.000	1.000	1.000	1.000	1.000

Notes: The two tests are the Levene test (L-test) and the aggregate F-test. Four alternative hypotheses are considered. See table 10C.1 and figure 10C.1 for details of the alternatives. The twenty-three margin changes are selected to match the actual margin changes that occurred from October 15, 1934, to January 3, 1974. The margin ranges from 40 percent to 100 percent. See table 1 of Hardouvelis (1990) for the margins and change dates. Each cell is based on one thousand independent replications. The finite sample critical values are determined empirically using ten thousand replications.

low power against alternative 1, moderate power against alternative 2, and high power against alternatives 3 and 4. The aggregate F-test displays a similar pattern but in many cases dominates the Levene test substantially. For example, with alternative 2 and a 5 percent significance level, the power of the aggregate F-test is 83.5 percent, whereas the power of the Levene test is only 36.6 percent. Considerable power gains can be achieved by incorporating the inverse nature of the margin change and volatility relation.

One's satisfaction with the performance of the aggregate tests depends heavily on the alternative deemed economically reasonable. If one accepts the linear relation and views alternative 1 as realistic, the tests are not very useful for detecting volatility effects. In contrast, if one deems the Hsieh and Miller (1990) alternative as realistic, the tests are very useful because they have high power.

Conclusion

To summarize, I find the issue of the relation between margin requirements and volatility in need of further theoretical modeling. The current theory lacks specific predictions. This lack of specificity leads to difficulties empirically designing an informative framework for investigation. For plausible scenarios where there is a relation between margin requirements and volatility, with commonly employed tests, one would be unlikely to find such a relation statistically. While Pruitt and Tse have made some progress, I believe there is still more to be done.

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Comment

Paul H. Kupiec

In their paper, Stephen Pruitt and K. S. Maurice Tse (PT) examine the effects of changes in margin requirements on the returns of small capitalization stocks. The distinguishing feature of this study is its use of a "matched-pair" statistical design. The methodology measures the differential impact of a margin rate change on selected characteristics of two stocks that, aside from their marginability status, are close substitutes. This methodology is designed to difference out the background noise that might make an underlying margin-volatility, margin-price, or margin-liquidity effect difficult to detect. PT interpret their statistical results as strong evidence against the hypothesis that federal margin requirements impose binding constraints on investors.

Before discussing the specific methodology and results of the PT paper, I

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first consider the potential importance of these results for the conduct of federal margin policy. The literature investigating the effects of regulation T margin changes on the volatility of returns to broad stock market indexes is extensive.[1] The vast majority of margin-volatility studies conclude that there is no statistically significant relationship between changes in the Federal Reserve's regulation T margin requirement and subsequent changes in the volatility of returns to broad stock market indexes.[2]

Suppose for a moment that PT were to find that their matched-pair statistical design generated results consistent with the hypothesis that higher margins dampen stock price volatility. Would such a finding imply that margin requirements are an effective tool that can be used to control the volatility of the stock market? I would argue not. The stocks included in the PT sample design are among the smallest capitalization stocks investors can trade. If margins affect the volatility of the very smallest stocks, it need not follow that margins must also affect the aggregate volatility of the stock market. It is possible that margins could have effects on the returns of individual stocks, in this case the smallest equity issues, and yet in aggregate have no effect on overall market volatility.

The theoretical results of Kupiec and Sharpe (1991) are useful in explaining how there might be a statistical margin-volatility relationship in some individual stocks' returns and yet be no evidence of an aggregate margin-volatility relationship. Kupiec and Sharpe show that an increase in margin requirements may cause a risky asset's volatility to either increase or decrease. Margin requirements affect volatility by constraining the holdings of investors. If margin requirements keep irrationally optimistic investors from bidding a stock's price above its sustainable long-run equilibrium price, an increase in margin requirements will reduce that asset's price volatility. Alternatively, margin requirements may prohibit rational risk-tolerant investors from purchasing additional shares when new information causes a share's price to fall or prohibit these investors from short-selling sufficient shares to offset the demands of irrationally optimistic traders. In either instance, a higher margin requirement will increase an asset's price volatility by restricting the volatility-attenuating demands of rational investors. Thus, in an economy with heterogeneous investors, an increase in margin requirements might have positive effects on the return volatility of some shares, negative effects on the return volatility of other shares, and, in aggregate, no measurable effect on the return volatility of the overall stock market index.

The upshot of this argument is that the results of a study that measures the effects of margin-requirement changes on the volatility of small capitalization stocks need not have direct implications for the conduct of margin policy. From

1. See, for example, Moore (1966); Largay and West (1973); Hardouvelis (1988, 1990); Kupiec (1989); Salinger (1989); and Hsieh and Miller (1990).

2. Hardouvelis (1988, 1990) are the only studies that find a statistically significant relationship between margin requirements and the volatility of a broad index of stock returns.

an academic perspective, it might be interesting to know whether federal margin policy has an effect on the price volatility and market characteristics of small capitalization stocks, but it would not be appropriate to generalize these results into statements about the effects of margin changes on the equity market in aggregate. If small capitalization issues were affected by margin requirements, however, such a result would be evidence that small capitalization stocks have a different investor clientele than the clientele that typically invests in large capitalization issues. The finding that investors in small firm shares are somehow different from average market investors would be of interest to researchers outside the margin-volatility debate.

The methodological innovation PT bring to the margin-volatility debate is the use of the matched-pair statistical design. PT choose stocks on the Federal Reserve's OTC marginable stock list and then match each stock with a nonmarginable OTC stock in the same four-digit SIC code category. Under the null hypothesis that margin requirements have no effect on investors in these issues, the differences in price changes, volatility changes, volume changes, and bid-ask spread changes for these matched pairs of stocks on dates surrounding changes in margin requirements should not be statistically different from zero.

Notwithstanding PT's discussion of the advantages of the matched-pair design, it is doubtful that this methodology is appropriate for measuring the effects of margin changes on marginable OTC stocks. The problem in applying the matched-pair design is that it is unlikely that there exist nonmarginable OTC stocks that are close matches for stocks on the Federal Reserve's OTC marginable stock list. One firm's shares are included in the Federal Reserve's OTC margin list and another firm's shares are not marginable precisely because the characteristics of these firms are different. As discussed by PT, critical factors used by the Federal Reserve to determine margin eligibility status include minimum capitalization standards, firm age, tenure of listing, average share price, the number of active market makers, and the dispersion of share ownership. Strictly speaking, it is impossible to match a nonmarginable OTC firm with a firm eligible for margin lending unless the Federal Reserve erred in classification. Clearly one or more of the margin eligibility factors differs across the firms in each PT matched pair. The assumption that a four-digit SIC code is a sufficient statistic for the matching criterion is clearly incorrect.

Although it is possible that the differences between marginable and nonmarginable firms in a PT matched pair are minor and have little bearing on the analysis, PT do not report statistics that measure the magnitudes of these differences in firm characteristics. As a consequence, it is unclear exactly how completely the paired firms are matched. This issue is important because firm returns are almost certainly related to firm size in a systematic way, and they may be related to the other characteristics as well.[3] Without statistics that suggest otherwise, the reader must conclude that the PT matching criterion ignores

3. For example, it is well known that returns to shares in an initial public offer differ in systematic ways from the returns to shares of seasoned firms.

these potentially important factors and controls only for an industry factor (and the market-model factor) in the return generating process.

The empirical evidence reported by PT suggests that omitted factors may be compromising the integrity of their reported test statistics. Consider the margin-requirement price-effect tests reported in tables 10.2–10.5. Each table reports the standardized abnormal return estimate difference (*SARD*) and the cumulative *SARD* (*CARD*) estimates for the margin-change event beginning on event day −25.

In the four separate margin-change events examined, PT find significant evidence of a price effect in the +25 day *CARD* statistic only in the 15 percent margin-requirement decrease of January 3, 1974. For this event, PT calculate that marginable OTC firms underperformed nonmarginable firms by an average 7.21 percent in the fifty-one-day event window. PT find this negative differential return effect of a margin reduction counterintuitive and attribute the result (without statistical confirmation) to the so-called small-firm effect. If this explanation is correct, it is clear that the PT matched-pair criterion does not adequately control for a firm size factor.

Determining whether or not an omitted small-firm factor is the source of the significant *CARD* in the 1974 margin-change event is critically important. PT mistakenly assume that any potential margin-price effect is unidirectional. In their view, if investors are constrained by a margin requirement, relaxing the requirement could only lead to a higher share price. PT do not recognize that margin requirements may prohibit investors from short-selling as many shares as they otherwise might desire. Under regulation T, a short sale is treated as a loan and a share purchase. For margin purposes, the transaction is treated as if the owner of the share sells the security to the short seller and provides the short seller financing to purchase the share. Because the financing is collateralized by the share being purchased, the size of the loan to the short seller is limited by the margin requirement. Effectively, if the margin requirement is 50 percent, the short seller must post margin collateral equal to 50 percent of the value of the shares being sold short.[4] The implication is that a reduction in the margin requirement would allow investors to increase short sales that could potentially cause share price declines.

Aside from the 1974 margin-change event, there is other evidence in the individual *SARD* estimates reported in tables 10.2–10.5 that indicate problems with PT's statistical methodology. Under the null hypothesis, individual *SARD* estimates are distributed (asymptotically) as normal zero-one variables. An examination of the individual *SARD* estimates suggests that their empirical distribution does not correspond very closely with this theoretical distribution. Recall that, based upon the fifty-one-day *CARD* statistics, PT conclude that the 1970 (table 10.2) and 1971 (table 10.3) margin decreases had no measurable

4. Since the proceeds of the stock sale are held by the lender and unavailable to the short seller, the margin requirement is effectively 150 percent in this example.

price effect. Despite the overall insignificance of these events, the tables contain many extreme-valued *SARD* estimates. In the eleven days surrounding the 1970 event date alone, two days have *SARD* statistics that exceed the 3 percent two-tailed critical value. The surplus of extreme-valued *SARD*s is even more evident in the results reported in table 10.3. The relative abundance of extreme-valued *SARD*s reported by PT may be an an additional indication of poorly matched firms generating omitted-factor contamination in the test statistics.

After attributing the statistical significance of the 1974 margin change to an omitted small-firm factor, PT conclude, "[T]he pricing results clearly refute the hypothesis that changes in margin requirements are associated with changes in binding constraints on security investors." The methodological problems identified in this discussion suggest otherwise. If the matched-pair statistics are not biased by omitted factors, then the 1974 margin event is statistical evidence that, in some instances, margin requirements do impose binding constraints on investors. If omitted factors bias the event test results, the binding-constraint hypothesis has not been subjected to an accurate test.

Although my priors are consistent with the conclusions of PT, the methodological issues raised in this discussion reduce my confidence in the accuracy of their reported statistics. The potential statistical problems at issue are important, but they may also be relatively easy to address. I encourage the authors to consider these issues in any future revision of this paper.

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Authors' Reply

One of the most interesting aspects of being invited to present a paper at a research conference is the generally high variability in the content of the discussants' comments. In their remarks, Paul Kupiec and Craig MacKinlay offer further empirical evidence in support of this proposition. As the present reply will show, we believe that many of Kupiec's more paper-specific comments are undeservedly critical, while MacKinlay's more generalized comments represent a considerable and insightful research advance.

The basic premise of our paper is a very simple one. Specifically, we believe that the only appropriate test of the effectiveness of changes in stock market margin requirements at reducing "undesirable" security market perturbations is between otherwise identical securities differing only with respect to the presence or absence of Federal Reserve margin requirements. Indeed, since changes in margin requirements are one of only a very few discrete policy tools that the Federal Reserve has at its disposal to influence general economic conditions, it is extremely likely that changes in margin levels will have important signaling ramifications, *independent of any changes in the overall security lending environment.* Thus, without the creation of separate "marginable" and "nonmarginable" stock portfolios, it is impossible to distinguish between those adjustments in security market behavior resulting from *information effects only* (that is, effects that are identical across *all* equity securities) from those changes resulting from *shifts in binding borrowing constraints on equity investors* (that is, effects due to changes in the overall security lending environment). Our study, by exploiting a 1969 amendment to the Securities Exchange Act of 1934—an amendment that allowed, for the first time, securities dealers and brokers to extend margin credit on *selected* (but not all) OTC equities—is the first specifically designed to effectively differentiate between these effects. Such a differential test is extremely important since there is ample evidence that both changes in Federal Reserve margin levels *and* inclusion on the Federal Reserve's OTC margin list are associated with statistically significant changes in security pricing behavior. The findings of the present study illustrate that price changes around changes in Federal Reserve margin levels are the result of information effects only and are not due to changes in binding borrowing constraints on equity investors.

Kupiec begins his comments by noting that we "examine the effects of changes in margin requirements on the returns of small capitalization stocks." Yes, the firms included in our sample are relatively small when compared with larger, listed firms. However, the purpose of the study was not to study low-capitalization stocks per se. Our concentration on OTC stocks occurred precisely because these are the only groups of stocks via which an effective control portfolio could be constructed. The fact that the majority of these issues are "small" is an important by-product of the study—not its chief contribution. Further, it should be noted that, by their very construction, marginable and

nonmarginable portfolios included in the tests comprised the largest firms traded on the OTC market.

While it is clearly true that studies examining the volatility changes of the S&P Composite index in response to changes in margin levels generally find no relationship between the two, it is also true (but not generally known) that the S&P Composite index *consisted of only ninety U.S. stocks until March 1957.* The larger S&P 500 index has been employed in margin tests only over the 1957 to 1974 time interval. Almost half (ten of twenty-one) the margin changes have been tested with an index employing only ninety of the largest U.S. firms. It is, therefore, by no means surprising that previous researchers have mined so little from the margin-change vein. It would be surprising only if they hadn't.

In a *direct test* of the relationship between firm size and security responses of NYSE-listed equities to change in margin levels, Pruitt (1993) clearly documents that smaller firms respond to a statistically significantly greater degree to the announcement of margin changes than the S&P Composite index. Given the known inverse relationship between firm size and firm leverage and the "homemade leverage" arguments of Modigliani and Miller (1958), the known inverse relationship between firm size and firm-specific informational asymmetries (e.g., Barry and Brown [1984]), and the known inverse relationship between firm size and institutional ownership (e.g., Pruitt and Wei [1989]), it is clear that individual margin traders must hold a proportionally larger share of the stock of smaller firms. Thus, while it is true that most previous researchers have found no consistent relationship between changes in margin levels and stock return behavior, it is equally clear that these same researchers have examined the very index of securities least likely to illustrate a demonstrable margin effect.

Kupiec's next major point concerns the efficacy of margin changes in a broader context: "Would [finding small firms respond more to margin changes] imply that margin requirements are an effective tool that can be used to control the volatility of the stock market?" We argue that it could. Indeed, a careful reading of the Securities Exchange Act of 1934 makes it clear that one of the three important reasons for the passage of margin regulations in the first place concerned the protection of unsophisticated investors. While one could argue that margin traders are not, by definition, unsophisticated, could the same be said for the nonmargin traders investing in heavily margined securities? We believe that margin regulations were not enacted to protect margin traders. Rather, we believe that they were enacted to keep the trading activities of margin traders from adversely affecting less sophisticated nonmargin traders. To the extent that changes in margin levels are employed by the Federal Reserve to reduce the "undesirable" results of margin trading activity by margin traders in smaller firms, the Federal Reserve will have enhanced the safety of nonmargin traders in these same issues. Thus, a potential and important paradox is resolved. It is indeed quite possible for changes in margin levels to simultane-

ously reduce "undesirable" security return behavior in smaller issues while failing to lead to any measurable effects in a broader market index, such as the S&P Composite.

Kupiec's comments concerning our methodology are more relevant. No, the methodology is not perfect. None ever is. However, given the extremely high costs associated with the hand collection of data, we continue to believe that the methodologies employed in the empirical tests are the best that can reasonably be performed.

Kupiec states that our data-selection criteria "match[es] each [marginable] stock with a nonmarginable OTC stock in the same four-digit SIC code category." This is correct as far as it goes, but it by no means describes all the selection criteria employed. First, we don't simply grab "any" marginable firm included on the Federal Reserve's OTC margin list. Rather, all marginable firms serve as *potential* sample firms only because they are included on the OTC margin list. To actually be included in the study they must then be matched with a nonmarginable OTC firm *that itself is later added to the OTC margin list.* This latter point is especially critical. Although Kupiec is correct in that there may, in general, be quite a few differences between the firms included on the Fed's OTC list and those not included on the list, it almost certainly is true that the underlying differences between firms added to the list between, say, May and November 1972 must be very slight indeed. Again, *all of the firms included in each of the nonmarginable OTC samples as of a given margin change were themselves added to the Fed's OTC list by the time of the next margin change.*

Also ignored in Kupiec's discussion of our research design is the actual matching procedure employed. While we did match on the basis of four-digit SIC codes, this is by no means the only criterion involved in the firm matching. Rather, as is noted in the study, in addition to SIC codes, firms were also matched on the basis of debt/equity ratios as well as total sales. Thus, although it is clear that our marginable/nonmarginable firms are not in point of fact perfect substitutes, they are very closely matched indeed. We are not aware of a more careful matching procedure employed in any research endeavor employing hand-collected data.

In addition to his general and methodological concerns, Kupiec takes exception with our interpretation of the 1974 margin decrease results. In these tests we note that the price changes observed for the nonmarginable sample significantly exceed those registered by the marginable sample. Given that this particular margin change occurred on January 3, 1974, we correctly interpret this differential response as a result of the well-known small-firm effect. Kupiec, on the other hand, suggests that this result may in fact be due to the trading behavior of short sellers taking advantage of the lower margin levels. To test this hypothesis directly, we divided each firm listed on either the New York or the American Stock Exchange into ten market-value deciles as of January 3, 1974. We next calculated the abnormal returns of each of these deciles em-

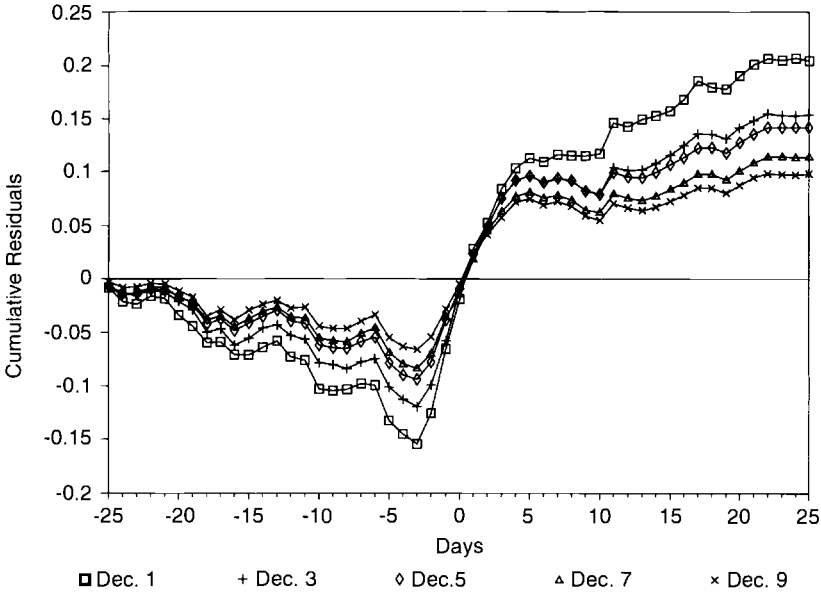

Fig. 10R.1 Unexpected decrease, 1974, deciles 1, 3, 5, 7, 9
Source: Scholes and Williams, Value-Weighted Index.

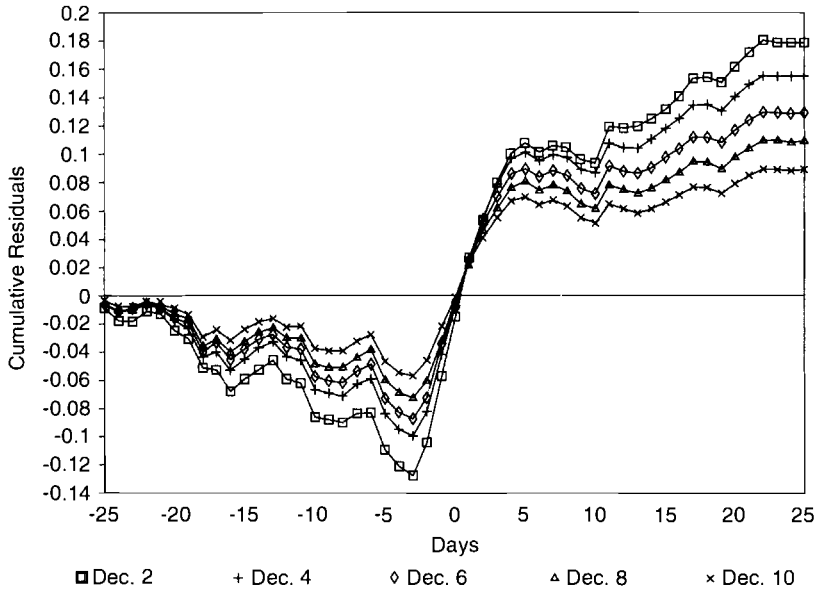

Fig. 10R.2 Unexpected decrease, 1974, deciles 2, 4, 6, 8, 10
Source: Scholes and Williams, Value-Weighted Index.

ploying a standard market-model methodology. Figure 10R.1 plots these results for deciles 1, 3, 5, 7, and 9, while figure 10R.2 provides the same results for size deciles 2, 4, 6, 8, and 10. Even the most casual observer will recognize the obvious relationship between firm size and price performance around the time of this margin change. Thus, it should be quite clear that our January 1974 margin-change results are indeed driven by the small-firm effect. The fact that such a size differential exists at all does support Kupiec's conjecture that our firm-matching procedure is not entirely capable of eliminating *all* nonmargin effects between the two sets of firms. However, the "relative abundance of extreme-valued *SARD*s reported" in our study are almost certainly the result of the fact that the hand collection of our data set limited the size of our marginable and nonmarginable firm portfolios to twenty stocks each.

In sum, we are sympathetic to the wishes of Kupiec with respect to both a larger data set and a more precise marginable/nonmarginable firm-matching criteria. Until finer work on the subject is forthcoming, however, we will continue to maintain that our study represents the best that has yet to be performed on the subject of the price, volatility, volume, and liquidity effects of changes in Federal Reserve margin requirements. But just how good is the best? It is to this issue and, more specifically, MacKinlay's insightful analysis that we address the following brief comments.

MacKinlay attacks the margin-change, security-response question in an entirely new and innovative manner. His comments concern the statistical likelihood of actually detecting a margin-change price volatility relationship should one indeed exist. Drawing heavily on the empirical results presented previously by Hsieh and Miller (1990), MacKinlay establishes numerically that the Levene test employed by these authors is almost incapable of detecting volatility effects in response to margin changes. In other words, the power of their test statistics is quite low. While noting that the F-statistics employed in the present paper are more powerful than the Levene tests, MacKinlay's simulations clearly document that "only when extreme changes in volatility occur would one expect these tests using individual change events to be able to statistically detect the volatility effects." The F-statistics employed in the present study are indeed based upon individual margin changes and, as such, strongly suggest that our failure to document a statistically significant volatility response between the marginable and the nonmarginable portfolios may be due as much (or more) to low statistical power as an inherent inability on the part of margins to influence actual return behavior. Thus, one is forced to conclude that, even if the current study is indeed the best yet performed concerning the margin-change price behavior question, it may not be good enough to finally put it to rest.

While specifically addressed only to our volatility tests, one could ask if similar things could not be said concerning our price, volume, and liquidity tests as well. We believe not. Indeed, detailed simulation studies by Brown and Warner (1985) have fully documented the statistical power of the event

methodologies employed in the present (and similar) studies. While by no means all-powerful, such tests have repeatedly (and accurately) been employed to assess the valuation effects of a variety of economic phenomena. Thus, our failure to identify a statistically significant differential price response between the marginable and nonmarginable OTC stock portfolios around the time of Federal Reserve margin changes is more than likely due to a lack of such a differential effect rather than a paucity of statistical power. Given their basis in such event-type models, we believe that similar things could be said for our volume and liquidity tests as well. Unfortunately, as we note in the study, the lack of a firm unidirectional hypothesis concerning our liquidity tests renders these tests interesting, but largely meaningless.

We agree with MacKinlay that more theoretical work on the relationship between stock prices, volatility, volume, and liquidity is needed. Kupiec's own work on this area is especially interesting in this respect. We continue to believe that our study is the best yet performed. We believe that it addresses and, in some cases, answers several important questions concerning the current status of margin regulation. However, we must agree with MacKinlay when he states in his comments that "there is still more [work] to be done."

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