THE JOURNAL OF FINANCE • VOL. XLVIII, NO. 4 • SEPTEMBER 1993

The Irrelevance of Margin: Evidence from the Crash of '87

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ABSTRACT

Following the crash of 1987, one contentious regulatory issue has been whether margin activity exacerbated the decline in equity values. We contrast the crash behavior of NASDAQ securities eligible for margin trading with the behavior of ineligible ones. Consistent with the hypothesis that margin-eligible securities were more frequently subjected to margin calls and forced sales, we find that abnormal volumes were uniformly larger for eligible securities. However, there is no evidence that this activity provoked additional price depreciation. Margin-eligible securities actually fell by one percent *less* than the ineligible securities over the period.

For every problem, there is a solution that is simple, plausible and wrong
H. L. Mencken

THE CAUSES OF THE crash of October 1987 have been discussed by commentators in academia, the government, and the finance industry. Many causes have been suggested for the crash; factors as diverse as the trade deficit, junk bonds, and antitakeover legislation have been blamed for the event that reduced equity values by close to 20 percent in one week. Perhaps the second most frequently indicted culprit, following program trading, is investor leverage facilitated by margin activity. For example, the Report of the Presidential Task Force on Market Mechanisms (the Brady Commission report, p. 65) claims that

> It has long been recognized that margin requirements, through leverage, affect the volume of speculative activity. Controlling speculative behavior is one approach to inhibiting overvaluation in stocks and reducing the potential for a precipitate price decline fueled by involuntary selling.

Not surprisingly, there have been numerous calls for increased margin restrictions in cash and derivative security markets. Under close regulatory and governmental scrutiny, the S & P 500 futures-hedging margin was raised four times to a level three times above its precrash amount (Kupiec (1989)) and margin levels on options doubled to roughly 20 percent. Similar pres-

* Seguin is from the University of Michigan and Jarrell is from the University of Rochester. This research was performed while the first author was the T. Boone Pickens Jr. Research Fellow at the Bradley Policy Research Center, University of Rochester. We thank Hank Bessembinder, Peter Carr, Tony Greig, Ming-chi Hu, Shing-yang Hu, Margaret Monroe, James T. Moser, Andrei Shleifer, Doug Skinner, René Stulz, two anonymous referees, and participants at the 1991 W. E. A. Annual Meetings for their creative input.

sures were brought to bear on the cash markets. Numerous commentators, including politicians and two ex-chairmen of the Securities and Exchange Commission, called for higher initial margin restrictions.[1]

Garbade (1982) has labelled the link between margin, leverage, and rapid price movements as "pyramiding/de-pyramiding." The pyramiding process is triggered by a rise in share value and an increase in shareholder wealth. Increased wealth allows investors to purchase more securities on margin, with the increase in demand leading to further price appreciation. This activity, in turn, leads to further margin purchases, and so on.

Panic or forced selling due to de-pyramiding (hereafter we use the terms de-pyramiding and forced sales interchangeably) is triggered by a large, rapid decline in share value (like those of October 19) that generates margin calls. In the two days following such a decline, leveraged speculators subjected to margin calls attempt to raise the necessary cash and flood the market with margined securities. This exaggerates the fall in price, leading to another round of price declines. The process iterates. Garbade (1982, p. 320), however, points out that this scenario is inconsistent with the body of empirical evidence showing that, in the absence of new information, large amounts of a stock can be bought or sold with little price pressure.

The events surrounding the crash of '87 seem perfectly suited for generating forced sales. Stock prices increased throughout the decade, and contemporaneous statistics indicate that the amount of margin debt outstanding had reached an all-time high of $44 billion. When sudden price declines materialized, the large amounts of margin outstanding and rapid price declines led to a record number of margin calls.[2]

In this study, we empirically evaluate the applicability and validity of forced sales hypotheses by examining volume and price behavior of National Association of Securities Dealers Automated Quotation (NASDAQ) stocks on eight days surrounding the crash. Unfortunately, while aggregate margin figures are available, it is impossible to disaggregate the total by security. A customer's margin limit is determined by the total market value of margin-eligible securities in the portfolio. If this borrowing potential is not fully employed, it is difficult to apportion borrowing to each of the securities in the portfolio.

Since 1968, a subset of NASDAQ securities has been ineligible for margin activity. By contrasting the volume and return behavior of margin-eligible and ineligible securities during the crash, we estimate the impact of eligibility. Consistent with the hypothesis that margin-eligible securities were more frequently subjected to margin calls and forced sales, we find that abnormal

[1] See, for example, "Calming the Markets" by John Shad, *The Washington Post*, July 25, 1988. Further, in the wake of the extended bull market in Japan, comparable arguments and pressures have recently been focused on the regulation of margin there. See, for example, "High Times on the Margin," *The Economist*, April 25, 1992.

[2] See "Margin Debt's Pros and Cons," *The New York Times*, October 24, 1987. Exact figures on the number of margin calls are not available, but Shearson Lehman Brothers, for example, estimate that they made 12,000 calls.

volumes over the period were uniformly larger for margin-eligible securities. However, there is no evidence that these larger flows contributed to additional price depreciation. Both time series and cross-sectional analyses indicate that the price behavior of the two groups is virtually indistinguishable. The cross-sectional analysis indicates that the margin-eligible securities actually fell by one percent *less* than the ineligible securities over the period.

The negligible incremental effect of volumes on prices during this period is consistent with numerous models. For example, Madhavan and Smidt (1991) argue that "depth," the amount of volume required to move price by one unit (Kyle (1985)), varies with the informativeness of trading. If market makers correctly interpret volume attributable to forced sales as uninformative (or "noise") trading, then observed volume streams associated with margin-eligible securities should be offset by greater depth.

In the following section, we provide background on margin eligibility and describe the sample composition. Volume data is investigated in Section II, where we confirm that volumes associated with eligible stocks were larger throughout the crash period. In Section III, a model based on Madhavan and Smidt (1991) is developed to generate explicit hypotheses concerning the effect of these higher volumes on observed price changes. Also, the returns to two portfolios—one composed of margin-eligible, the other composed of ineligible securities—are contrasted using time series analysis. Cross-sectional analysis with one observation per firm is conducted in Section IV. The implications of these findings for current policy debates are presented in the conclusion.

I. Background

A. Regulation

The Securities Exchange Act of 1934 allowed margin trading for exchange-listed securities only. Brokers were forbidden from lending funds for the purchase of over-the-counter (OTC) securities, but loans from commercial banks were unrestricted. The Over the Counter Market Act of 1968 allowed margin trading on some OTC securities.

The 1968 Act stipulated initial eligibility criteria for OTC issues: a minimum price of $5 per share and $5 million in either capital plus surplus (book value) or the market value of equity. Between one and four times a year, officers at the Fed review their databases and attempt to identify those issues that recently satisfied eligibility criteria. Discussions with officials at the Fed indicate that these officials rely exclusively on these criteria and do not exercise any discretion in their selection. Though the Fed is not successful in adding issues as soon as they are eligible, Seguin (1990) reports that a newly eligible issue would almost certainly appear on one of the next two updates to the Fed OTC List.

With the 1968 Act, loans by both brokers and commercial banks became subject to margin constraints for eligible issues. However, this Act did not

change the rules for stocks ineligible for margin trading. In 1972, continued listing requirements were established. The Fed would "de-list" (remove from the list of margin-eligible securities) any issue with a share price below $3 or equity value below $2.5 million.

Margin eligibility rules were amended in 1982; market value constraints were removed, and both initial and continued listing criteria were eased. Both the price requirement (which remained at $5) and the book value requirement (lowered to $4 million) became binding. Continued listing requirements were also lowered: the price constraint was lowered from $3 to $2 and the book value constraint was lowered from $2.5 million to $1 million. The stated goal of these amendments was to make eligibility criteria more comparable with the listing requirements of the American Stock Exchange (AMEX). The Fed also began updating the list of eligible securities four times a year, and instituted a policy of announcing changes to the list two weeks before the effective date. Since 1984, automatic margin eligibility has been extended to any firm joining the National Market System (NMS).

B. Effects of Margin Eligibility

Grube, Joy, and Howe (1987) and Seguin (1990) examine the effects of margin eligibility on firm value.[3] Both studies document statistically significant increases in equity value at the announcement that a firm will become margin eligible. This finding is consistent with the joint hypothesis that margin eligibility enhances liquidity by reducing the cost of taking a levered position, and that enhanced liquidity increases prices by decreasing required rates of returns.

Seguin (1990) also examines the effect of margin eligibility on volatility. Comparing the volatility of returns of individual securities in a period before margin trading is allowed to the volatility in a period after margin trading is allowed, he finds that all point estimates of volatility *decline* once margin trading is introduced. Seguin also documents a 30 percent increase in volume. The volume increase and volatility decrease are consistent with the hypothesis that reducing traders' wealth constraints enhances liquidity and market depth.

C. Empirical Benefits of Employing the Crash

One problem inherent in all studies of changes in margin regulation is that conclusions concerning the frequency of forced sales may reflect a lack of power. First, hypotheses based on margin calls and forced sales are pertinent only during periods of distress, which typically occur infrequently. Second, even if the price of an individual stock declines, this stock may represent a small fraction of every individual's portfolio, so few margin calls are trig-

[3] For an exhaustive literature review, see Chance (1990).

gered. Finally, even if margin calls are triggered, investors may choose to liquidate stocks other than the triggering stock.

Due to the nature of our study, the first two problems are mitigated. The first criticism is not pertinent since we chose the crash of '87 exactly because it is a period of aggregate distress. The overwhelming majority of issues declined in price during this period, and numerous margin calls were, in fact, made. It is conceivable that the third problem is still relevant, and that all margin traders held both eligible and ineligible issues in their portfolio and liquidated roughly equal amounts of eligible and ineligible securities. However, the volume evidence presented in the following section is inconsistent with this possibility.[4]

D. The Sample

The sample of margin-eligible firms is based on the List of Marginable OTC Stocks of August 11, 1987. We amend the list to accommodate listings and delistings from the NMS between August 11 and October 1. We deem all remaining active issues on the Center for Research in Security Prices (CRSP)-NASDAQ tape to be margin-ineligible securities. This yields sets of 1,234 ineligible firms and 2,644 eligible firms that (1) had identifiable CUSIPs, (2) were listed on NASDAQ as of October 1, 1987 and (3) had at least one transaction or change in the reported bid-ask spread during the period from October 14 through October 27.

Throughout this analysis, we examine two event periods. The first is the two-day period beginning October 19, when NASDAQ stocks fell in value by 16 percent. In contrast to the Dow Jones Index, where the price decline was concentrated on Black Monday, NASDAQ prices declined on both Monday and Tuesday. The second event period is an eight-day period beginning October 16. Average daily returns and cumulative returns for the 3,878 sample firms are outlined in the Panel A of Table I for this eight-day period. We chose this larger window for two reasons. First, due to asynchronous trading or delays in the price adjustment process, a longer window may be required to capture the crash for all securities. Second, the five trading days following the Tuesday also are periods of distress: prices fell by a further 8 percent and the absolute price change exceeded 2 percent on four days.

[4] Further, the nature of maintenance requirements reduces the likelihood of this occurring. Maintenance requirements mandate that the amount outstanding in a margin account cannot exceed 75 percent of the market value of stock. For example, if an individual purchased \$1 of stock with 50 percent margined, a margin call would be triggered when the market value fell below \$0.6667. Now suppose an individual purchased \$1 worth of each of two stocks, one of which is eligible and the other is ineligible. Assuming the value of each stock fell to p percent, (fell by $(1 - p)$ percent), where $p < 0.67$, the owner would receive a margin call and would be faced with one of two strategies. The owner could liquidate at least $2/p - 3$ of the eligible stock or $0.5/p - 0.75$ of the ineligible issue. Since this latter amount is one-fourth the former for all p, an investor would have to liquidate four times the amount of eligible securities to meet the margin call.

Table I

Returns and Volumes during the Crash of '87 (October 16th through October 27th)

Panel A depicts returns and cumulative returns to a portfolio strategy in which \$1 is invested in each of the 3,878 securities in the sample at the closing prices (NMS firms) or bid-ask midpoints (non-NMS firms) of October 15 and held without rebalancing. Panel B presents cross-sectional average abnormal volumes for a portfolio of 2,644 margin-eligible issues and a portfolio of 1,234 margin-ineligible issues. For each firm, precrash average volume is estimated over the period -100 to -1, where day 0 is October 16. For each of the eight days considered, we divide daily firm volume by its precrash average yielding a firm specific measure of daily abnormal volume for that firm. Finally, cross-sectional, equally weighted averages are calculated. The final column reports White (1980) heteroskedastic-consistent t-statistics for the test of whether the average adjusted volumes are equal for the eligible and ineligible samples.

Panel A: Daily Returns and Cumulative Returns for the Aggregate Portfolio (in Percentages)

Day	Cumulative Return	Daily Return
October 16	−2.73	−2.73
October 19	−11.17	−8.74
October 20	−19.05	−8.94
October 21	−15.42	5.60
October 22	−18.28	−3.36
October 23	−19.97	−1.98
October 26	−25.66	−7.41
October 27	−27.20	−1.73

Panel B: Average Adjusted Volumes for Eligible and Ineligible Issues

Day	Ineligible	Eligible	t-Statistic for Difference
October 16	1.11	1.29	1.95
October 19	1.47	1.68	2.36
October 20	1.38	1.87	6.68
October 21	1.25	1.97	10.25
October 22	1.39	1.88	5.17
October 23	1.19	1.36	2.13
October 26	1.28	1.70	4.58
October 27	1.25	1.71	5.27

II. A Comparison of Volumes

We demonstrate that the volume of margin-eligible securities exceeded ineligible security volume by analyzing volumes for portfolios of eligible and ineligible securities. To measure aggregate portfolio volume, we construct an index of average adjusted volumes. We rejected the alternative of simply totalling volume across all securities since this metric would be dominated by the volumes of very active firms. To construct this index, we first calculate the average daily volume over event days -100 to -1 for each firm, where

day 0 is October 16. Second, for each day, we compute adjusted volume by deflating daily volume by the precrash average, or:

$$v_{jt} = \frac{\text{Volume on day } t \text{ for firm } j}{\text{Average firm } j \text{ volume over days } -100 \text{ to } -1}$$

We then estimate two cross-sectional averages, yielding time series of average adjusted volumes, $\tilde{V}_t = J^{-1} \sum_{j=1}^{J} v_{jt}$. Panel B of Table I displays these cross-sectional averages for the eligible and ineligible portfolios. To determine whether these differences are significant, we calculate t-statistics using White (1980) heteroskedastic-consistent standard errors, which are reported in the third column of Panel B.

Panel B provides circumstantial evidence that forced selling affects volumes of margin-eligible securities more than ineligible securities. First, average adjusted volumes are higher for the eligible securities on each day, with differences ranging from 14 to 58 percent. Further, these differences are uniformly significant with t-statistics ranging from 1.95 to 10.25.

It is possible that the difference in adjusted volume between these two groups is attributable to factors other than margin eligibility. For example, it is possible that investors, concerned about the immediacy and costs of execution during these turbulent market conditions, systematically chose to sell more liquid issues, regardless of their eligibility status. In this case, eligibility may be irrelevant and merely proxying for the degree of liquidity. To investigate this possibility, we estimated cross-sectional regressions, with each firm's average adjusted volume over the crash period as the dependent variable. Independent variables included a dummy variable to indicate whether the issue was margin-eligible, as well as three liquidity related measures, all measured as of October 15: the percent bid-ask spread, the number of active market makers, and the market value of outstanding equity. Regardless of the formulations or transformations used, the coefficient associated with margin eligibility was significantly positive. Estimates of the effect of margin eligibility on volume ran between 20 and 40 percent.

The second observation consistent with the existence of forced sales is that the highest volume days for the eligible securities, October 21 and 22, *follow* the two days with large price drops. This is consistent with the presence of forced selling since investors subjected to margin calls have two trading days to cover the margin call. This pattern does not occur with the ineligible securities. Indeed, October 21, the largest volume day for the eligible issues, is the second lowest volume day for the ineligible securities during the crash period.

This evidence is not definitive proof of the hypothesis that volumes of margin-eligible securities are disproportionally affected by forced selling. Given that data summarizing equity traders' motivations do not exist, we cannot directly measure the number of trades instigated by margin calls. However, the analysis has distinguished a significant difference in volumes between the two eligibility classes during the crash period.

III. Portfolio Returns

In the previous section, we verified the first hypothesis of this study: that trading volumes were statistically significantly greater for margin-eligible securities than for ineligible securities, although there is only circumstantial evidence that this difference is due to forced sales. In this section, we introduce a simple model and generate predictions concerning the effect of additional volume on price changes. We then test these predictions using returns to portfolios of eligible and ineligible securities.

A. A Model of the Volume-Volatility Relation

There are numerous theoretical models of the contemporaneous relation between volume and volatility.[5] A number of these explicitly model Kyle's (1985) concept of depth as the order flow required to move prices by one unit. Madhavan and Smidt (1991) provide a particularly general model since a number of popular models are nested within theirs.

Using their notation, depth is defined as $1/\lambda$, and can be written as:

$$1/\lambda = \frac{\alpha\pi(\sigma_x^2)}{1 - \pi(\sigma_x^2)},$$

where α is related to the intensity of informed trading and governs the informed traders' order flows in response to perceived mispricing. Briefly, when α is large, slight differences between the current price and the beliefs of informed traders lead to large informed trading order flows. The parameter π "summarizes a number of aspects of market quality and information" (Madhavan and Smidt (1991, p. 104)). Most importantly, this parameter is a function of the expected volume of uninformed trading, σ_x^2. The derivative of π with respect to σ_x^2 is positive. Given the functional form above, the derivative of depth $(1/\lambda)$ with respect to the anticipated volume of uninformed trading is also positive. So, an increase in expected uninformed trading enhances depth and reduces the typical unsigned price change associated with a given order flow.[6]

This relation, combined with the volume findings documented above, leads to the second major hypothesis examined in this study. If depth is identical for eligible and ineligible firms, then larger volumes associated with eligible firms should translate into greater price declines. If, however, the market acknowledges that forced sales (which reflect only public information about recent price declines) are typically uninformative, then expectations of the proportion of volume that is informative should decrease. This increases the depth of eligible issues relative to the depth of ineligible issues. Conse-

[5] See Karpoff (1987) for a review.

[6] This conclusion is not specific to the analysis of Madhavan and Smidt. Similar results can be derived using the theoretical frameworks developed by Glosten and Harris (1988) or Foster and Vishwanathan (1990).

quently, higher eligible volumes need not necessarily translate into greater price declines.

B. Testing the Volume-Volatility Relation

We begin the examination of this hypothesis by analyzing returns to three portfolios based on margin eligibility. The first portfolio contains those firms that are margin-eligible as of October 15, while the second contains all ineligible firms. The third portfolio is a subset of the second and is composed of those 681 firms that are not on the list of margin-eligible securities, but satisfy either the Fed's margin eligibility requirements or the NMS's listing requirements.[7] Thus, this third portfolio contains issues that would be eligible save for delays by the National Association of Securities Dealers or the Fed in identifying and adding these firms to either the margin-eligible list or the NMS. Comparisons between portfolios 1 and 3 may be more compelling since member firms are more closely matched along the dimensions of market maker participation, size, bid-ask spread, and volatility. We explicitly accommodate differences along these dimensions in the following section.

To examine excess portfolio returns, we first construct a model of expected returns, conditional on observing the return sequence to some market index. To avoid endogeneity problems, we choose a CRSP New York Stock Exchange/American Stock Exchange (NYSE/AMEX) index, although our reported results are robust to the choice of index.

Analyses of cross-correlations indicate that portfolio and index returns are correlated contemporaneously and with a one-day lag. Consequently, we estimate models of conditional expected returns by regressing portfolio returns on current, one lead, and one lag of the index over days -300 to -1, where -1 is October 15. Since the portfolio residuals from these models are autocorrelated, we allow market model residuals to follow an AR(5) process.

Table II summarizes parameter estimates for the model of conditional returns. The R^2's are uniformly high and all parameter estimates appear consistent with the patterns of cross-correlations.

We employ these models to generate abnormal and cumulative abnormal returns over the crash period. Abnormal returns are defined as the difference between actual returns and expected returns conditional on one lead, one lag, and contemporaneous market returns and on five lags of residuals. The differences in abnormal returns and cumulative abnormal returns between portfolios 1 and 2, and portfolios 1 and 3, are calculated.

Figure 1 charts differences and cumulative differences in abnormal returns between the portfolio of eligible securities and all ineligible securities. Margin-eligible securities outperformed ineligible issues on five of the eight days and by 1.3 percent over the eight-day period. To determine the significance of this increase, the variance and first two autocorrelations of the

[7] See Seguin (1992) for details on current and historical NMS listing requirements.

Table II

Estimates of a Model of Conditional Expected Returns

Conditional expected returns are calculated by regressing portfolio returns on current, one lead and one lag of the CRSP NYSE/AMEX value-weighted index over days -300 to -1, where day -1 is October 15, 1987:

$$R_{pt} = \alpha + \beta_{-1}R_{mt-1} + \beta_0 R_{mt} + \beta_{+1}R_{mt+1} + \sum_{\tau=1}^{5} \gamma_\tau \varepsilon_{pt-\tau} + \varepsilon_{pt}$$

Estimation is performed via weighted least squares, where the weights are inversely proportional to the fitted values from a regression of the absolute value of the return to the index on five lags of the absolute value. The results are robust to the numerous alternative weighting schemes employed. The first two portfolios contain 2,644 margin-eligible issues and 1,234 margin-ineligible issues, respectively. The third portfolio is a subset of the second portfolio and is comprised of those 681 firms that are ineligible for margin trading, but satisfy either the Fed's margin eligibility requirements or the NMS's listing requirements.

Portfolio	N	α	β_{-1}	β_0	β_{+1}	γ_1	γ_2	γ_3	γ_4	γ_5	R^2
Margin eligible	2,644	−0.0001	−0.037	0.753	0.154	−0.107	−0.103	0.076	−0.129	0.046	0.9318
		(−0.50)	(−2.94)	(59.73)	(12.12)	(−1.90)	(−1.83)	(1.35)	(−2.30)	(0.82)	
Margin ineligible	1,234	−0.0002	−0.108	0.528	0.146	−0.181	−0.169	−0.003	−0.163	−0.084	0.8658
		(−0.60)	(−7.53)	(37.80)	(10.19)	(−3.21)	(−3.01)	(−0.06)	(−2.89)	(−1.49)	
Ineligible but satisfies criteria	681	0.0003	−0.107	0.668	0.139	−0.043	−0.233	−0.051	−0.052	−0.028	0.8725
		(0.91)	(−6.52)	(42.16)	(8.48)	(−0.75)	(−4.12)	(−0.88)	(−0.92)	(−0.50)	

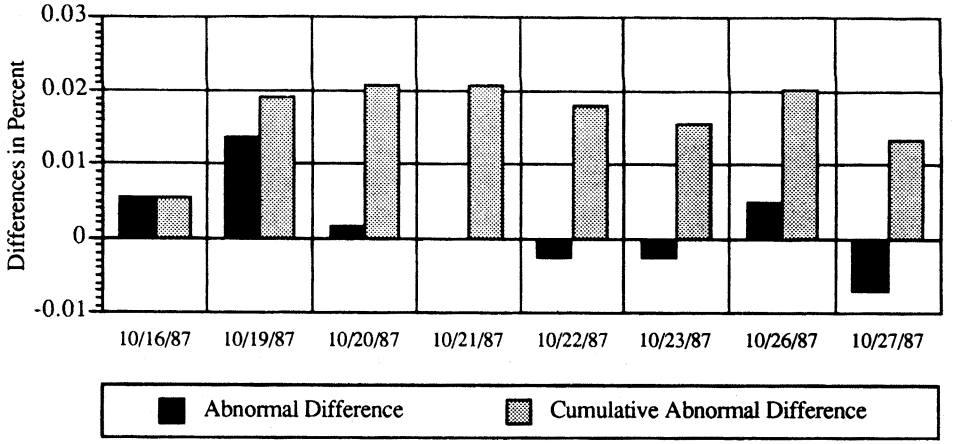

Figure 1. Differences and cumulative differences of abnormal returns to margin-eligible and ineligible security portfolios. For a portfolio of 2,657 margin-eligible securities and a portfolio of 1,387 margin-ineligible securities, abnormal returns are calculated over the eight-trading-day crash period (October 16 through 27, 1987) using a market model that accommodates leads and lags. See Table II for methodological details. This figure plots the differences and cumulative differences between the abnormal returns to the eligible portfolio minus the abnormal returns to the ineligible portfolio.

difference series are estimated and employed in a formula for the standard error of a cumulative difference that accommodates second-order autocorrelation: $\hat{\sigma}\sqrt{n + 2(n-1)\hat{\rho}_1 + 2(n-2)\hat{\rho}_2}$. Autocorrelations beyond lag two are insignificant. Since we calculate standard deviations and autocorrelations from the series of differences, we avoid errors attributable to cross-sectional correlations (Bernard (1987)). Dividing the cumulative difference over this period by the estimated standard error of 0.00657 yields a t-statistic of 2.04.

Conclusions are identical for the comparison of margin-eligible firms with ineligible firms satisfying either NMS listing or Fed eligibility requirements (portfolios 1 and 3). Margin-eligible securities outperformed portfolio 3 ineligible issues on five of the eight days and by 1.49 percent over the eight-day window (t-statistic = 2.03). Margin-eligible securities significantly underperformed the matched ineligible securities on October 21, however. The abnormal difference is -0.53 percent with an associated t-statistic of -1.82. This is consistent with the joint hypothesis that large price declines of the 19th and 20th triggered margin calls that generated forced sales and price depreciation on the 21st. However, the effect of these forced sales on prices is small and temporary. Indeed, over the crash period, a portfolio of eligible securities outperformed one containing ineligible securities.

IV. Analysis of Firm Returns

In this section, we estimate a number of cross-sectional regressions with individual firm returns as dependent variables. Margin-eligible and ineligible

firms differ along a number of factors including industry, liquidity, market value, and typical volume. Since price declines are affected by the interaction of volume shocks and depth, with depth partially determined by these factors, it is important to include these factors in a cross-sectional specification. Then, coefficients associated with margin eligibility are more reliably interpreted as the effect of margin eligibility on return, ceteris paribus.

A. Empirical Methods

We examine returns calculated over two periods. The first period is the full eight-day crash window. Returns calculated over October 19 and 20, the days with the two largest declines, are also analyzed. We regress individual firm returns against a number of independent variables. Margin eligibility is captured by an indicator variable MARDUM that equals one if the firm is margin-eligible and zero otherwise. Firm returns are also related to systematic risk, which requires an estimate of beta. Since firms in this sample are small and suffer from asynchronous trading, we avoid Ordinary Least Squares betas calculated from daily data. Instead, we use 300 daily returns to compute sixty weekly returns. We then regress weekly firm return on weekly returns to the equally weighted NYSE/AMEX index.[8]

We control for differences in depth by using the bid-ask spread, number of active market makers, and market value of equity (firm size), all as of October 15.[9] Our measure of unanticipated volume is $\ln(v_{jt})$, the log of the ratio of volume to the precrash average daily volume defined above. Use of the log transformation is suggested by Ajinkya and Jain (1990).

Including firm size is also important in controlling for any day-of-the-week effects. Harris (1986) demonstrates that expected stock returns have a weekly seasonality and that this seasonality varies with firm size. Since margin-eligible firms are, on average, larger than ineligible firms, it is important to

[8] Due to holidays, weekly returns are not Wednesday-to-Wednesday returns, but are the cumulative returns over five successive trading days. Monthly betas are impractical due to the high rate of turnover for NASDAQ firms. A substantial fraction of our sample is lost if we impose a sixty-month selection criterion. Handa, Kothari, and Wasley (1989) compare beta estimates generated from daily and weekly returns and find that weekly betas exhibit larger variations from 1; in their sample, average daily betas for size ranked portfolios vary from 0.86 to 1.10, while weekly betas vary from 0.78 to 1.18. We also considered Scholes-Williams (1977) betas calculated from daily data, but found that weekly betas performed better in out-of-sample forecasting. Throughout, estimation is performed by way of Weighted Least Squares with estimated weekly firm return standard deviations in the precrash period used as weights. Since the dependent variable is an individual stock return, this choice of weight is correct if firm return variances during the crash are proportional to estimates of precrash variances (Schwert and Seguin (1990)). More complicated weighting schemes were employed, but every choice yielded identical results. Further, we report t-statistics based on White (1980) heteroskedastic-consistent standard errors.

[9] We also controlled for industry-specific returns by placing each firm in one of twelve industry groups based on two-digit Standard Industrial Classification codes. We add eleven dummy variables to every cross-sectional formulation reported. The addition of industry variables did not alter any conclusions and the industry variables are omitted from presentation.

accommodate potential differences in expected returns due to the interaction of the day-of-the-week effect and size.

B. Results: The Crash

Table III contains estimates from various specifications with the eight-day crash period return as the independent variable. The first specification contains only estimated betas and a dummy variable (MARGIN) that equals one if the firm is eligible for margin trading and zero otherwise. The coefficient associated with margin eligibility is *positive* and significant. This indicates that over the eight-day crash period, margin-eligible securities outperformed ineligible securities by 0.8 percent. In the second specification, we include three proxies for liquidity and depth: the natural log of size, the number of active market makers, and the bid-ask spread. These variables are insignificant, and their inclusion does not alter the conclusions drawn from the first specification.

Table III

Margin Eligibility and Return Behavior: Cross-Sectional Regressions for Returns for October 16–28

Cross-sectional regressions are estimated with one observation per firm. The first two specifications are estimated using 3,878 firms with at least 150 non-missing returns. The third specification is estimated on 3,757 firms with sufficient return and volume data. Spread is the bid-ask spread divided by the CRSP reported closing price. Estimated Weekly Beta is the slope coefficient from a regression of sixty nonoverlapping, five-day firm returns on the equally-weighted CRSP NYSE/AMEX index. Precrash average volume is the mean daily volume for the one hundred trading days before October 16, 1987. Regressions are estimated in three steps: (1) OLS is estimated, (2) a Glejser regression is estimated with the absolute errors from step (1) as the dependent variable, and the same independent variables, and (3) Weighted Least Squares is estimated with the fitted values from the Glejser as weights. *t*-Statistics in brackets use White (1980) heteroskedastic-consistent standard errors.

Independent Variable	Dependent Variable: Stock Return October 16–28		
Intercept	−0.061	−0.049	−0.049
	[−17.64]	[−4.48]	[−4.47]
Margin Eligible Indicator	0.008	0.009	0.009
(= 1 if eligible)	[2.99]	[2.88]	[2.84]
Estimated Weekly Beta	−0.204	−0.203	−0.203
	[−71.32]	[−66.84]	[−67.24]
Market Value of Equity		−0.001	−0.001
		[−1.35]	[−1.34]
Number of Market Makers on Oct. 15		−0.000	−0.000
		[−0.33]	[−0.32]
Spread as of October 15th		−0.009	−0.009
		[−0.20]	[−0.19]
$\mathrm{Ln}\left\{\frac{\text{Volume}}{\text{precrash average Volume}}\right\}$			0.000
			[0.11]
R^2	0.725	0.725	0.725

In the third specification, we add the log of the measure of abnormal volume over the crash period. This variable is also insignificant indicating that, conditional on the firm's beta and the market movement, price change is unrelated to trading volume. This finding suggests that abnormal volume levels were interpreted by the market as stemming from primarily uninformed trading.

In Table IV, we estimate the same three specifications with the return on the two major crash dates of October 19 and 20 as the dependent variable. The coefficient associated with margin eligibility in the first specification is negative but insignificant. In the second specification, two of the three liquidity variables are significant. However, the signs of these variables indicate that issues with greater depth (larger issues with a large number of market makers and small bid-ask spreads) experienced greater price declines than did less liquid issues. The coefficient associated with abnormal volume is highly significant, indicating that large volumes are associated with larger price declines even after firm-specific variations in depth are accommodated.

Table IV

Margin Eligibility and Return Behavior: Cross-Sectional Regressions for Returns for October 19–20

Cross-sectional regressions are estimated with one observation per firm. The first two specifications are estimated using 3,878 firms with at least 150 non-missing returns. The third specification is estimated on 3,757 firms with sufficient return and volume data. Spread is the bid-ask spread divided by the CRSP reported closing price. Estimated Weekly Beta is the slope coefficient from a regression of sixty nonoverlapping, five-day firm returns on the equally-weighted CRSP NYSE/AMEX index. Precrash average volume is the mean daily volume for the one hundred trading days before October 16, 1987. Regressions are estimated in three steps: (i) OLS is estimated, (ii) a Glejser regression is estimated with the absolute errors from step (i) as the dependent variable, and the same independent variables, and (iii) Weighted Least Squares is estimated with the fitted values from the Glejser as weights. t-Statistics in brackets use White (1980) heteroskedastic-consistent standard errors.

Independent Variable	Dependent Variable: Return October 19–20		
Intercept	−0.035	−0.011	−0.013
	[−11.63]	[−1.00]	[−1.22]
Margin Eligible Dummy	−0.002	0.006	0.008
(= 1 if eligible)	[−0.50]	[1.68]	[2.22]
Estimated Weekly Beta	−0.124	−0.118	−0.117
	[−50.97]	[−46.54]	[−46.42]
Market Value of Equity		−0.002	−0.002
		[−2.28]	[−1.96]
Number of Market Makers on Oct. 15		−0.002	−0.002
		[−8.04]	[−7.62]
Spread as of October 15th		0.044	−0.038
		[1.07]	[−0.79]
$\mathrm{Ln}\left\{\frac{\text{Volume}}{\text{pre-crash average Volume}}\right\}$			−0.013
			[−9.87]
R^2	0.457	0.467	0.460

The magnitude of the volume coefficient is of interest since it provides evidence on the relevance of trading pressures and represents an estimate of depth (expressed as an elasticity). Since the variable is the log of the ratio of average daily volume over the two-day crash period to average daily volume in the precrash period, a one-unit increase in the variable represents a substantial increase in the number of shares traded. For example, this variable equals one when the ratio of crash volume to average volume is 2.7 and k when the ratio equals e^k. Note, however, that the coefficient is only -0.013. Therefore, a firm experiencing 7.4 *times* its typical daily volume on each of the two crash dates would experience an additional price decline of only 2.6 percent.

V. Conclusions and Implications

The crash of '87 provides an excellent opportunity to examine the effects of leverage and forced sales during periods of volatility. Stock prices had increased throughout the decade, margin credit outstanding had reached an all-time high, and a record number of margin calls were made. Therefore, an analysis of price performance during this period should yield the strongest possible conclusions concerning the link between leverage and volatility.

In this study, we examined the price behavior of NASDAQ stocks in the eight days surrounding the crash and contrasted the behavior of margin-eligible and ineligible securities. Consistent with the popular notion that margin activity fuels forced sales, trading volumes associated with margin-eligible securities were 14 to 40 percent greater than ineligible issue volumes. Further, this difference cannot be explained by differences in size or liquidity.

However, there is no evidence that these larger volumes or margin eligibility itself affected returns during this period. Best estimates show that eligible securities outperformed ineligible securities by 1 or 2 percent. This finding is inconsistent with the hypothesis that margin activity amplifies past price movements. Instead, it suggests that any forced sales were easily absorbed and generated little or no price pressure. Consequently, we conclude that on average, the depth associated with eligible firms was larger than ineligible firm depth and that any forced selling was correctly interpreted by market participants as uninformed trading.

We readily admit that the strength of our conclusions is limited by the availability of data. Ideally, we would prefer to use information on the actual number and timing of forced sales, as well as the amount of margin credit or margin activity by issue. These data are not compiled, however. Consequently, we have used all available data and actively searched for indications of price depreciation due to margin activity and forced sales. Available data indicate that this relation simply did not exist.

The empirical findings presented here are consistent with predictions published by the Federal Reserve Bank (1984) before the crash. That study argues that the existence of multiple available sources of credit makes margin eligibility and levels irrelevant. Restrictions and limits on the use of

one source of credit do not alter agents' equilibrium leverage, but merely encourage substitution into other sources of credit (see Hartzmark (1986) for a review). Under this paradigm, the empirical results presented here indicate that the price changes for stocks financed partially through margin are comparable to those financed entirely by alternate sources. This result is irreconcilable with the belief that the manipulation of margin regulation can inhibit or mitigate the relation between aggregate leverage and precipitate price declines. Consequently, policy propositions based on this logic may not be effective. We would heartily applaud any legislation that successfully reduces excess volatility. However, it is our opinion that although the solution of reducing volatility through higher margin requirements and restrictions is simple and plausible, it is probably wrong.

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