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Initial Margin Requirements and Market Efficiency

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Abstract

We examine the association between margin requirements and the market's efficiency in incorporating firm-specific and market-level public news. Combining the Fed's 22 changes in margin requirements with a hand-collected sample of earnings announcements between 1934 and 1975, we show that higher margin requirements induce greater delay in incorporating earnings information into prices. We draw similar conclusions when we analyze the Hou and Moskowitz (2005) price delay measure, as well as indirect measures of leverage constraints over recent years. Further tests suggest that, despite the Fed's expressed intent to curtail excess speculation, higher margin requirements restrict trading by arbitrageurs more than noise traders.

I. Introduction

In the wake of the GameStop trading frenzy in early 2021, several trading platforms and brokerage houses increased their margin requirements to curtail speculative trading, in an effort to mitigate the spike in market volatility. This event ignited renewed interest in the regulation of initial margin requirements as a tool to restrict speculative trading and thereby calm the markets. For example, during the GameStop frenzy, Federal Reserve Chair Jerome Powell was asked whether the Fed would apply Regulation T (Reg T), and adjust initial margin requirements to reduce

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excess speculation.[1] This incident has rekindled debate on the consequences of the Fed's use of initial margin requirements to influence stock market behavior.

The previous literature mainly examines whether the regulation of margin requirements effectively mitigates market volatility.[2] However, changes in margin requirements could also have important implications for the market's ability to incorporate new information into stock prices. Although it seems clear that higher initial margin requirements restrict investors' access to capital and thereby dampen trading activity in general, it is not clear ex ante whether they result in greater price efficiency. Ultimately, this issue depends on how margin regulation affects the relative trading activity of informed versus uninformed investors. On the one hand, to the extent that higher margin requirements force uninformed noise traders to remain on the sidelines, prices are more likely to reveal the opinions of informed traders and thus reflect improved efficiency. On the other hand, higher margin requirements also restrict the borrowing of rational investors, limit outside capital available to arbitrageurs, prevent the beliefs of informed traders from being fully reflected in prices, and thereby may adversely affect market efficiency. Overall, whether higher margin requirements strengthen or weaken market efficiency is an empirical question, which has not been addressed in the prior literature.

This study fills this gap by analyzing how margin requirements affect the markets' response to both firm-specific and market-wide public news. Recent work on investor borrowing restrictions typically relies on indirect measures that attempt to capture variation in the shadow cost of capital constraints.[3] Instead, we analyze a direct measure of investor borrowing constraints: changes in the initial margin requirement mandated by the Federal Reserve. Over the period, 1934–1974, the Fed adjusted the minimum level of initial margin required for U.S. investors 22 times, by varying Reg T. These changes provide a historical record of variation in these direct restrictions to investor borrowing, and a rare opportunity to analyze how variation in margin requirements affect market efficiency. While Reg T is only one among many sources of the constraints that investors face, it provides a unique source of plausibly exogenous variation in leverage constraints during the sample period that we study.

We begin our analysis by investigating how these changes in margin requirements are related to the market's initial reaction and subsequent drift in the return on a hedge portfolio based on the firm's earnings surprise, proxied by standardized unexpected earnings (SUE). Earnings announcements offer an ideal setting to examine how margin regulation affects market efficiency. These compelled information disclosure events generally elicit a dramatic market response, whereby firms with a larger positive (negative) earnings surprise tend to have larger positive (negative) abnormal returns immediately. However, these initial returns are

[1] www.bloomberg.com/opinion/articles/2021-01-27/fed-meeting-powell-refuses-to-bite-on-gamestop-or-tapering.

[2] While the Fed has not changed initial margin requirements since 1974, this debate regularly flares up during market crises. According to Hardouvelis (1990), higher margin requirements reduce stock market volatility. In contrast, other studies claim that there is no clear evidence that margin regulation mitigates volatility (see, e.g., Hsieh and Miller (1990), Kupiec (1997)).

[3] For example, see Hu, Pan, and Wang (2013), Boguth and Simutin (2018), Assness, Frazzini, Gormsen, and Pedersen (2020), Lu and Qin (2020), and Guest, Kothari, and So (2023).

consistently followed by post-earnings announcement drift (PEAD) in the same direction, for several months. According to Fama (1998), PEAD represents the greatest challenge to market efficiency. Thus, our analysis of how margin requirements affect the market's underreaction to earnings news should provide valuable insights regarding their impact on price efficiency.[4]

One impediment to this analysis is that data on earnings announcements are not readily available during the period that margin requirements were changed 22 times. We resolve this problem by hand-collecting earnings announcement data for all firms with earnings releases published in the Digest of Earnings Reports section of the daily *Wall Street Journal* (WSJ) over the years, 1934–1971, until Compustat data became widely available. We then append this sample with Compustat data on earnings announcements for the years 1972–1975. This exercise generates a total of 79,062 earnings announcements during the 42-year period that spans the Fed's 22 changes in margin requirements, 1934–1975.

Figure 1 provides a first glance at our main results, debuting novel evidence that higher margin requirements reduce market efficiency for our unique sample of earnings announcements that extend back to 1934, prior to Ball and Brown (1968). This figure plots daily movements in the mean CAR(0,+t) for the SUE hedge portfolio over days t = 0, …, +61, as a percentage of the mean total 62-day announcement return, CAR(0,+61), under low- versus high-margin regimes. The dashed *orange* (or solid *blue*) line tracks the proportion of the total mean 62-day announcement return that is realized each day from the announcement up to day t; for the subset of announcements that occurs when margin requirements are *low* (or *high*). This figure offers compelling evidence of a significant decline in market efficiency when margin requirements are *high*, embodied in greater underreaction to earnings news (i.e., the *blue* line reveals a smaller initial response followed by larger post-announcement drift).[5]

We examine the robustness of these results by using regression to control for other firm attributes that also predict returns. This analysis corroborates our main finding that higher margin requirements are associated with greater underreaction to earnings news. Further tests establish that this outcome cannot be explained by changes in risk, credit market conditions, stock market conditions, or investor sentiment that may coincide with the Fed's changes in margin policy.

We further explore two alternative economic channels that may help to explain our main finding that higher margin requirements are associated with less efficient

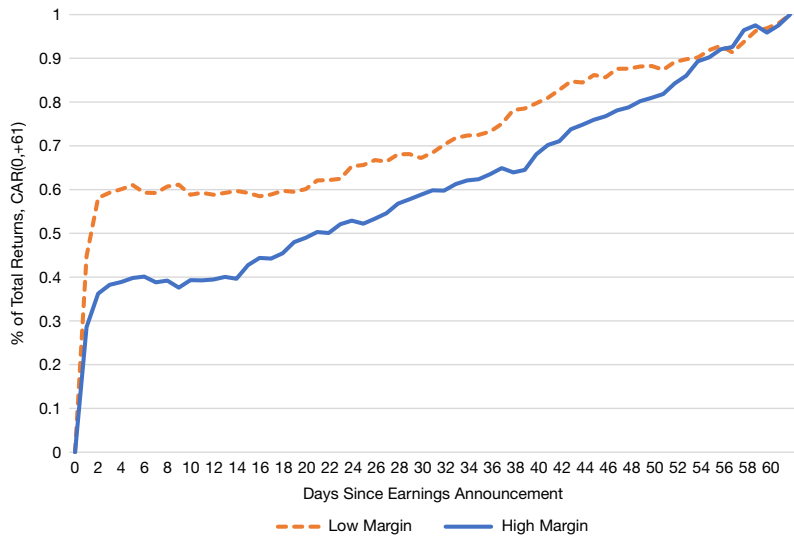
[4]This anomalous market underreaction to firm-level earnings news was originally documented by Ball and Brown (1968) for a small sample of 261 firms over the years, 1957–1965. While the magnitude of PEAD has declined over the years since Ball and Brown (1968), it continues to survive despite all the attention it has received in the literature (McLean and Pontiff (2016), Linnainmaa and Roberts (2018), and Wahal (2019)). Other major contributions to the literature on PEAD include Foster, Olsen, and Shevlin (1984), Bernard and Thomas (1989), (1990), and Ball and Bartov (1996). Sojka (2018) provides an excellent survey.

[5]In Panel A of Table A8 in the Supplementary Material, we document that the mean initial 2-day SUE hedge portfolio return (CAR(0,+1)) is 3.70% during low-margin regimes, but it declines significantly to 3.17% during high-margin regimes (difference of mean CAR(0,+1)'s = 0.53%, t-ratio = 2.07). In contrast, the average 60-day PEAD (CAR(+2,+61)) accumulates to just 3.48% when margin requirements are low, but this post-announcement drift increases to 5.37% during high-margin regimes (difference in mean CAR(+2,+61)'s = −1.89%, t-ratio = −2.27).

FIGURE 1

Path of Mean Daily Cumulative SUE Hedge Portfolio Returns, CAR(0,+*t*); *t* = 0, …, +61, as a Percentage of Total Announcement Return, CAR(0,+61), Under Low- Versus High-Margin Regimes

Figure 1 plots the path of mean daily cumulative abnormal returns following earnings announcements, as a percentage of total returns over the 62-day period, CAR(0,+61), under high- versus low-margin regimes, respectively. First, for every earnings announcement in our sample, we calculate the abnormal return each day over the period, (0,+61), computed as the difference between the daily return for each stock and the CRSP value-weighted market return. Second, we focus on the subsets of announcements in the top or bottom SUE decile each quarter, which occur during high- versus low-margin regimes. In particular, we compute the average daily abnormal return on each day of the announcement period, (0,+61), for the top and bottom SUE decile portfolios, over the subsets of announcements that occur when margin requirements are high (above 75%) versus low (below 55%). This computation yields a different set of 62 mean daily abnormal returns over the window covering days (0,+61), for portfolios of stocks in the top or bottom SUE deciles, which apply to the two subsets of announcements that occur during either high- or low-margin regimes. Third, for these two subsets of announcements during high- versus low-margin regimes, we construct the high minus low mean daily SUE hedge portfolio return, and we compound this return from day 0 to day +*t*, to obtain CAR(0,+*t*); *t* = 0, …, +61. Fourth, for these two subsets of announcements, we scale this mean daily cumulative SUE hedge portfolio return, CAR(0,+*t*), by the total mean return compounded over the entire 62-day period, CAR (0,+61). Finally, we plot the resulting path of this proportion of the total mean SUE hedge portfolio return earned each day, CAR (0,+*t*)/CAR(0,+61), *t* = 0, …, +61, which applies to earnings announcements that occur during regimes with high versus low margin requirements. The solid *blue* (dashed *orange*) line tracks the proportion of total mean announcement returns that is realized each day from the announcement up to day *t*; *t* = 0, …, +61, for the subset of earnings announcements that occurs when margin requirements are high (low).



markets: *leverage constraints* versus *excess speculation.* We begin by considering the *leverage constraints channel*, which focuses on whether margin regulation limits the trading activity of informed investors more or less than that of uninformed investors, and thus reduces or enhances market efficiency. We find that higher margin requirements are associated with less efficient markets, in the form of a smaller initial response to earnings news and larger PEAD. We infer that higher margin requirements limit the activity of arbitrageurs to a greater extent than they constrain noise trading. As a result, informed investors are prevented from incorporating earnings news into prices in a timely fashion, and thereby counteracting the tendency for uninformed investors to underreact to this information.

Next, consider the alternative *excess speculation channel* to explain our main findings. The most common reason the Fed offers for increasing margin

requirements during our sample period is excess speculation.[6] Thus, periods of higher margin requirements may tend to have an abundance of uninformed speculative traders in the market, and a concomitant tendency for more mispricing and less market efficiency. As a result, higher margin requirements may be associated with greater underreaction to earnings news simply because they are associated with excess speculation in the market, rather than by limiting the arbitrage activity of informed investors.

We perform several additional tests to distinguish between these two alternative channels. First, we consider how margin requirements affect the overall availability of capital. Jylhä (2018) shows that these historical changes in margin requirements *were significantly influenced by* changes in the availability of margin credit. At the same time, these changes in margin policy also *significantly influenced* investors' access to capital during this period, implying that margin requirements represented a binding capital constraint for investors. Importantly, Jylhä (2018) establishes that the influence of margin requirements on risk-taking behavior (his main finding) is not due to the potential simultaneous effects of the availability of margin credit, as well as other financial market or macroeconomic conditions that could be associated with the Fed's policy. Hence, margin requirements satisfy the conditions necessary to serve as an effective instrument to capture leverage constraints in Jylhä's (2018) setting. We similarly show that the influence of margin constraints on PEAD (our main finding) is not due to macroeconomic or financial market conditions at the time, and we thus establish the usefulness of this instrument in our setting. This analysis establishes that these changes in margin requirements represent plausibly exogenous shocks that affected investors' access to leverage during our sample period.[7]

Second, if the Fed tended to increase margin requirements following a perceived rise in speculation in the market, then the level of overall speculation should be high during the periods just before the Fed raised margin requirements. In turn, if our main results are driven by the excess speculation channel, rather than by higher margin requirements per se, then there should be greater underreaction to earnings news during these brief periods just before the Fed increased margin requirements. However, we find no significant difference in the initial reaction to earnings news or PEAD for the subset of earnings announcements made just before these policy changes. Instead, we find that higher margin requirements are similarly associated with greater underreaction to earnings news for the main sample, after we separately control for these periods of excess speculation. This evidence suggests that our main findings are driven by changes in margin requirements over time, and the associated reduction in arbitrage activity, rather than by periodically high levels of excess speculation just before the Fed increased margin requirements.

[6]Section A.1 of the Supplementary Material provides quotes from the WSJ during our sample period, which document that excess speculation was regularly cited as a key rationale for the Fed to raise margin requirements. See also Jylhä (2018), who provides a breakdown of the Fed's expressed reasons behind each change in margin requirements.

[7]Jylhä (2018) provides an exhaustive analysis of these historical changes in margin requirements that supports the usefulness of this policy instrument. We reproduce this analysis in Tables A3 to A5 in the Supplementary Material.

Third, we show that, while a larger positive or negative earnings surprise is generally associated with greater abnormal trading activity around earnings announcements, this typical volume response is significantly attenuated when margin requirements are higher. This outcome supports the constrained volume response predicted by the leverage constraints channel, while it is contrary to an exacerbated response in volume implied by the excess speculation channel.

Fourth, risk-averse arbitrageurs who are unable to hedge idiosyncratic volatility (IVOL) have an incentive to avoid trading on PEAD for stocks with high IVOL, since this activity entails greater arbitrage risk. Thus, according to the leverage constraints channel, higher margin should be associated with even greater underreaction to earnings news for stocks with more arbitrage risk, such as those with high IVOL. In support of this conjecture, we find that higher margin requirements are indeed associated with greater underreaction for stocks with high IVOL.

Next, we note that, while margin requirements offer the most direct measure of capital constraints imposed at the Federal level, these constraints have not varied since 1974. Thus, we also analyze six alternative indirect measures of capital constraints that have been extensively used in the literature, relying on more recent earnings announcement data since 1974.[8] For the first five of these six indirect measures of capital constraints, the results reinforce our analysis of margin requirements over the earlier period, 1934–1974. This evidence further corroborates our main conclusion that tighter leverage constraints are associated with reduced market efficiency, because they limit arbitrage capital more than noise trading, and thereby keep informed investors from eliminating the tendency for uninformed investors to underreact to earnings news.

On the other hand, the sixth indirect measure of capital scarcity from Hu, Pan, and Wang (2013) yields contrasting evidence, suggesting that greater capital scarcity is actually associated with enhanced market efficiency (i.e., less underreaction to earnings news). This contrasting evidence is in line with the intriguing results of Guest, Kothari, and So (2023) who argue that, in times of scarce capital, informed investors flee to firms with stronger earnings. The resulting fund flows could push prices down (up) for stocks with a negative (positive) surprise, making the market react more quickly to earnings news and thus enhancing market efficiency. However, this sixth capital scarcity measure of Hu, Pan, and Wang (2013) is based on discontinuities in the yield curve that reflect illiquidity. These discontinuities are profoundly affected by periods of severe market distress, which cluster around economic recessions. When we exclude recessions from the analysis, the formerly contrasting results for this sixth indirect measure reverse in sign and become consistent with our main results.[9] Together, this evidence suggests that the confounding effects of recessions that pertain to the capital scarcity measure of Hu, Pan,

[8]These indirect measures are the TED spread, the Feds Fund rate, the mutual fund beta measure from Boguth and Simutin (2018), the shadow cost of leverage constructed by Lu and Qin (2020), the margin debt measure of Assness, Frazzini, Gormsen, and Pedersen (2020), and the capital scarcity measure of Hu, Pan, and Wang (2013).

[9]While Guest, Kothari, and So (2023) show that their intriguing results remain when they exclude the few liquidity crises from the sample, they do not document the robustness of their results when all NBER recessions are excluded.

and Wang (2013) appear to be driving the contrasting results of Guest, Kothari, and So (2023).

Finally, we examine how margin requirements are associated with an alternative proxy for market efficiency, the price delay measure of Hou and Moskowitz (2005). While PEAD reflects the market's tendency to underreact to firm-specific news, the Hou and Moskowitz (2005) price delay measure captures the market's overall efficiency in incorporating market-wide information into stock prices. Hence, this measure enables us to further examine the relation between margin constraints and this broader dimension of price efficiency during our sample period. We find that higher margin requirements are also associated with greater price delay, and thus less efficient markets. This analysis provides yet more corroboration for our main results and conclusions that higher margin requirements adversely affect overall market efficiency.

II. Literature Review

This article contributes to several strands of literature. First, we expand prior work that investigates whether margin policy affects stock market conditions. Unlike the vast literature that analyzes the relation between margin constraints and market volatility, we examine the influence of margin policy on price efficiency embodied in the market's underreaction to new information. While the existing literature is inconclusive regarding the impact of margin requirements on volatility, we document a robust adverse impact of tighter margin policy on market efficiency.[10]

From this body of work, perhaps the closest article to ours is Jylhä (2018), who examines how the Fed's changes in margin requirements during our sample period affect investors' risk taking behavior. However, Jylhä (2018) does not explore how the consequent changes in risk taking are associated with market mispricing or price efficiency. To the best of our knowledge, our study is the first to document that higher margin requirements amplify the market's underreaction to new information. This evidence indicates that the use of higher margin requirements to curb overall excess speculation and market volatility may have unintended consequences, including an adverse impact on price efficiency.

Second, our battery of tests suggests that higher margin requirements weaken market efficiency by limiting arbitrage activity to a greater extent than noise trading, and thus preventing informed investors from helping prices adjust to earnings news in a timely fashion. This analysis builds upon the literature that examines investor underreaction to earnings announcements, by emphasizing the importance of leverage constraints as another important economic channel that helps to explain the failure of arbitrageurs to eliminate PEAD. In related work, Mendenhall (2004) shows that firm attributes associated with arbitrage risk extend the delayed response

[10]Brunnermeier and Pedersen (2009), Wang (2016), Kondor and Vayanos (2019), and Glebkin, Gondhi, and Kuong (2021) predict that higher margin should increase market volatility, while Rychkov (2014) predicts the opposite. Empirically, Hardouvelis (1990), Kahraman and Tookes (2017), and Hitzemann et al (2021) find a positive impact of funding constraints on overall volatility or liquidity, while Kupiec (1997) and Jylhä (2018) conclude there is no clear effect. On the other hand, Balthrop (2019) finds that increasing margin causes a decline in market volatility.

of investors to earnings surprises. In addition, Sadka (2006) and Ng et al. (2008) examine how limits to arbitrage in the form of transaction costs and liquidity risk exacerbate PEAD. Mitchell, Pedersen, and Pulvino (2007) and Mitchell and Pulvino (2012) show that how forced liquidations by hedge funds during crisis periods limit their arbitrage capacity and lead to price inefficiencies. Chordia, Subrahmanyam, and Tong (2014) further show that greater liquidity and trading activity attenuate PEAD, while Cao and Narayanamoorthy (2012) show that earnings volatility plays a significant role behind PEAD. Finally, Chung and Hrazdil (2011) construct a firm-specific measure of market efficiency and show that PEAD appears more in firms with lower efficiency.

We note that the various proxies for limits to arbitrage analyzed in the previous literature suffer from shortcomings, since they relate to firm attributes that reflect the firm's information environment, liquidity, and risk. As a result, these proxies do not necessarily isolate the behavior associated with limiting investors' access to capital. In contrast, our focus on initial margin requirements as a direct limit to investor borrowing is unique to the literature on PEAD. Furthermore, while the aforementioned studies focus on the cross-sectional behavior of PEAD, we also examine how time-series variation in the nature of market efficiency embodied in PEAD is associated with variation in the Fed's margin policy over time.

III. Initial Margin Requirements, Data on Earnings Announcements, and Variables

A. Initial Margin Requirements

When investors buy stocks, they are allowed to borrow up to a proportion, m, of their total purchase. This restriction translates into maximum leverage of $1/m - 1$ for the investor. For example, since 1974, the maximum initial margin allowed has been $m = 50\%$ of the purchase. This regulation translates into maximum leverage of $1/0.50–1 = 1.00$, implying that an investor can borrow no more than 100% of their initial amount invested (or 50% of the total purchase).

The responsibility for regulating margin requirements is bestowed upon the Fed in Section 7(a) of the Securities Exchange Act of 1934, by varying Reg T. This regulation governs the extension of credit by securities brokers and dealers in the U.S., and its best-known function is the control of initial margin requirements for stocks bought on margin. While the Fed has not deemed it necessary to adjust the margin requirement since 1974, despite periodic episodes of extreme price volatility, Reg T gives the Fed authority to alter this percentage when it deems appropriate.[11] In accord with this regulation, between 1934 and 1974, the Fed adjusted the minimum level of initial margin required for U.S. investors 22 times. This variation in margin requirements resulted in extended periods during which it was either more or less difficult for investors to borrow in order to finance their investments.

[11] See https://en.wikipedia.org/wiki/Regulation_T.

B. Data on Earnings Announcements

1. Wall Street Data Since 1934

During our sample period from 1934 to 1975, the WSJ regularly published earnings figures released by firms on the previous day, in a table with the heading "Current Earnings Reports" (see Figure 2). Our measure of SUE requires eight previous quarterly observations on these earnings announcements. Since the Fed set margin requirements for the first time in Oct. 1934, we begin collecting earnings announcement data from the WSJ in 1930.[12] We use the ProQuest search engine to download these daily earnings reports for the period between June 1930 and Dec. 1971, from the digital archive containing PDF files of the WSJ. For the later period between 1972 and 1975, we use Compustat data on earnings announcements.[13]

The example in Figure 2 is indicative of the quality of the PDF files available, which varies considerably over the sample period. In many cases, the ProQuest search engine cannot detect the earnings report in the WSJ, even though the table heading and keywords match. Thus, we manually check each daily WSJ with a missing earnings report to ensure that our coverage is complete. Our search successfully downloaded 11,579 daily earnings reports containing 109,344 earnings announcements between 1930 and 1971. We hand-collect the earnings data from these reports, and combine these announcements with those reported in Compustat from 1972 to 1975.

For each earnings announcement, our primary variables of interest from Figure 2 include the company name, earnings announcement date (day 0 = WSJ publication date), period end date, and net income for the current quarter as well as the same quarter in the previous year. In these WSJ earnings reports, losses are not recorded as negative numbers. Instead, there is a symbol beside the earnings number that points to a footnote if that number represents a net loss. We check all footnotes in each earnings report to ensure that losses are recorded properly. In cases where we cannot read the company name or the reported earnings numbers from the PDF files, we exclude these observations from our final sample of announcements.

2. CRSP Coverage of Firms with Earnings Announcements

We painstakingly collect this information for all quarterly earnings announcements and merge these data with CRSP using the company name. However, CRSP only covers stocks listed on the NYSE between 1930 and 1962, while the WSJ earnings reports also include stocks listed on the New York Curb Exchange (NYCE, or AMEX after 1953), as well as regional exchanges like the Midwest Stock Exchange in Chicago. When we merge our sample of announcements with CRSP, we lose all non-NYSE observations prior to 1962. As a result, the total number of earnings announcements that match with CRSP drops to 107,144.

Our final sample consists of the subset of these 107,144 announcements that contain non-missing data for all variables required in our analysis, which includes 79,062 quarterly earnings announcements. Panel A of Table A1 in the Supplementary

[12]The WSJ began reporting earnings announcements regularly in a table format in June 1930.

[13]Compustat's coverage of earnings announcement dates does not begin until the second half of 1971. Therefore, we collect WSJ earnings announcement data through 1971 and append this with Compustat data from 1972 to 1975.

FIGURE 2

Current Earnings Report from the *Wall Street Journal*

Figure 2 provides an example of the WSJ earnings report from Apr. 14, 1937.

Current Earnings Reports

Following is Dow-Jones summary of earnings reported by various companies, giving the net income after federal taxes, common share earnings for the period indicated and annual dividend rate on common stocks. When profit is before federal taxes, no calculation of share earnings is made. If stock is listed on the New York Stock Exchange the tape symbol is given in parentheses after name of company:

Tuesday, April 13, 1937:

Company:	Annual dividends	Net income 1937	Net income 1936	Common share earnings 1937	Common share earnings 1936	Surplus after dividends 1937	Surplus after dividends 1936
Allen Industries, Inc.: March 31 quarter	$1.00	$177,496	$162,415	h$.70	h$ 66		
Barker Bros. Corp. (BER): March 31 quarter	f...	173,694	67,814	h.72	h.15		
Bridgeport Machine Co.: March 31 quarter	1 00	‡175,897	‡77,878	....	....		
Cleveland-Cliffs Iron Co.: March 31 quarter	f...	108,499	‡72,180	....	....		
Collins & Aikman Corp. (CK): Year, February 27	w.50	4,991,659	3,974,687	8.15	6.28	$1,775,997	$2,973,911
General Finance Corp.: February 27 quarter	f...	138,742	83,587	h.16	h.12		
Goldblatt Bros., Inc.: x Thirteen months, January 31	2.40	1,947,414	1,114,226	h3.07	h1.86		
Hoe & Co., R.: Six months, March 31	f...	162,695	‡43,518	....	....		
International Great Northern R. R.: Two months, February 28	....	‡494,916	‡479,412	....	....		
Kimberly-Clark Corp. (KMB): March 31 quarter	1.00	‡451,561	‡204,282	.93	.42		
Twelve months, March 31	1.00	‡1,106,763	‡536,655	2.27	1.10		
Nash-Kelvinator Corp. (NSK): February 28 quarter	1.00	709,563	65,731	....	....		
Pacific Finance Corp. of Calif.: March 31 quarter	$1.80	392,759	412,463	.70	.79		
Parker Rust Proof Co. (PRK): March 31 quarter	$1.50	329,850	250,393	.76	.58		
Pittsburgh & West Virginia Ry. (PW): Two months, February 28	f...	101,234	86,463	.33	.18		
Transue & Williams Steel Forging Corp. (TU): March 31 quarter	w.15	‡78,349	‡33,515	....	....		
		1936	1935	1936	1935	1936	1935
American Pneumatic Service Co.: Year, December 31	f...	‡$130,458	‡$210,247	....	....		
Chicago & North Western Rwy. System (NW): Year, December 31	f...	‡9,388,038	‡11,448,639	....	....		
Cleveland Automatic Machine Co.: Year, December 31	f...	31,259	‡13,800	p$1.84	....		
Continental Diamond Fibre Co. (CDF): Year, December 31	k$2.00	506,060	167,677	1.80	$.37	d$317,540	d$311,738
Crowell Publishing Co.: Year, December 31	3.00	2,923,118	2,399,539	3.81	3.13	613,836	1,026,931
Imperial Oil, Ltd.: Year, December 31	k1.25	25,628,285	20,239,550	.95	.93	d5,078,062	d5,467,427
Kansas Gas & Electric Co.: Twelve months, December 31	....	1,357,971	1,063,791	....	....		
Kildun Mining Corp.: Year, December 31	f...	‡90,703	‡17,051	....	....		
Massachusetts Utilities Assoc.: Year, December 31	f...	1,470,741	1,441,868	....	....		
Montana Power Co.: Twelve months, December 31	....	3,306,096	2,608,406	....	....		
Nebraska Power Co.: Twelve months, December 31	....	1,825,026	2,048,966	....	....		
Smith (L. C.) & Corona Typewriters, Inc. (SLT): December 31 quarter	$1.00	279,141	.....	1.86	....		

*Not available. ‡Net loss. ‡Profit before federal income taxes. §Plus extras. d Deficit. f No common dividend. h On shares outstanding at close of respective periods. k Paid in year 1936. p On preferred stock. t Surplus available for common stock, after preferred dividends. w Last dividend declared: period not announced by company. x Thirteen months ended January 31, 1937, compared with year ended December 31, 1936.

Material summarizes the coverage of distinct firms in our final sample relative to the universe of firms in CRSP, for every year in the sample period. The coverage of our sample begins with 37% of the CRSP sample in 1934, and it trends upward over our sample period until reaching 92% of all CRSP firms in 1975. Our final sample of earnings announcements covers 67% of the CRSP universe in the average year.

Panel B of Table A1 in the Supplementary Material presents summary statistics for firm attributes based on our final sample of earnings announcements, as well as the CRSP sample. We present monthly time-series averages of the cross-sectional means across all firms in each sample. Panel B indicates that the average firm in our sample is slightly larger and more liquid than the average CRSP firm. This outcome is likely due to the WSJ not reporting earnings for the smallest companies.[14] The other attributes of firms in our sample are similar to the

[14]Frazzini and Lamont (2007) point to this issue as the reason behind Compustat's low coverage of earnings announcements for small firms, since the WSJ is one of the main sources for Compustat earnings dates.

typical CRSP stock, including share turnover, market beta, IVOL, and book-to-market (BM) ratio.

3. Determining the Earnings Announcement Date

Our choice of the earnings announcement day (0) is the date that the firm's earnings are published in the WSJ (e.g., Apr. 14, 1937, in Figure 2). We refer the reader to Sections A.3. and A.4.c.(ii) of the Supplementary Material, where we justify this choice of day 0 in three ways. First, we document that the WSJ was the dominant source of daily financial news during our sample period. Second, we plot average daily abnormal trading volume over the 11-day window surrounding this earnings announcement date, covering days (−5,+5), and show that the greatest abnormal trading activity occurred on this choice for day 0. Third, we analyze alternative announcement windows that extend back to day −3 prior to the WSJ publication date, and document that our main results and conclusions are unchanged.

Since the WSJ earnings reports provide the net income figures for the most recent quarter, as well as the same quarter in the previous year, investors who read the WSJ at the time could directly compare this earnings performance.[15] Livnat and Mendenhall (2006) note that Compustat updates a firm's recorded quarterly figures over time to reflect restated earnings. Thus, income data used in many recent studies were not the numbers that investors truly had access to at the time of the announcement. As a result, the magnitude of the drift in prior studies could be inflated or understated due to these data errors. Another advantage of our data setting is that we directly analyze the WSJ numbers that were available to investors at the time, on day 0.

C. Control Variables and Descriptive Statistics

All variables are defined in Table A2 in the Supplementary Material. We follow Foster, Olsen, and Shevlin (1984) and measure the earnings surprise as SUE. We sort announcing stocks into deciles (0 to 9) each calendar quarter based on SUE. For each quarter, we then divide this decile rank by nine to obtain the adjusted SUE rank (ADJ_SUE). Note that a 1-unit increase in ADJ_SUE ranges from the decile portfolio with the lowest SUE to that with the highest SUE.

Daily stock return data are from CRSP. We exclude firms with a share price less than $1, and delete announcements appearing more than 90 calendar days after the quarter-end date provided in the WSJ earnings report. We use historical BM data from Kenneth French's library and complement these data with Compustat annual data after 1950.[16] The control variables for our main analysis include the adjusted rank of SUE and its lagged value, the firm's size in month $t-1$, the number of earnings announcements reported on the same day (Hirshleifer, Lim, and Teoh

[15]For other studies that use earnings numbers reported by the WSJ in more recent periods, see Kros (1981) and Chen, DeFond, and Park (2002). See Tetlock (2007) for analysis of the WSJ's "Abreast of the Market" column.

[16]https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.

(2009)), the most recent publicly available BM ratio,[17] the compounded daily returns and standard deviation across returns over the previous 2 weeks (i.e., days $t-11$ to $t-2$), average daily stock illiquidity over month $t-1$, average daily turnover between days $t-11$ and $t-2$, and the firm's market beta estimated over months $t-36$ to $t-1$ (from regressions of the firm's monthly stock return on the CRSP value-weighted market return). In our robustness tests, we consider the effect of market sentiment on our results. We use annual sentiment data for our sample period from Baker and Wurgler ((2006), p. 1672).[18] We also obtain the daily factor portfolio returns (MKTRF, HML, SMB, and UMD) from French's website.

In Panel A of Table 1, we provide summary statistics for the main variables. On the average day, the WSJ earnings report contains 11 quarterly announcements. The typical firm has a market capitalization of $336 million, a beta of 1.27, and a BM ratio of 1.23. The average share turnover for the 10 days before the announcement is 0.12% of shares outstanding, while the average return and volatility over these 10 days are 0.63% and 2.19%, respectively.

There are 22 changes in margin requirements implemented by the Fed during our sample period, which are listed in Panel B of Table 1. For each change, we retrieve the minimum level of margin required from Table 12.22 of the Federal Reserve Board publication (1976b). The mean (median) level of margin requirements over our sample period is 63% (65%) with a standard deviation of 15%. The mean (median) of the 22 *changes* in margin requirements is 18% (20%) with a standard deviation of 6%.

In our robustness tests, we also control for changes in the supply of credit made available by brokers to investors. We collect margin credit data from three sources for various overlapping periods.[19] We use the percentage change in margin credit over the prior 12 months, measured as the change in the natural logarithm of margin credit from month $t-13$ to $t-1$. We also analyze the cost of borrowing (i.e., the call spread), defined as the difference between the broker call money rate and the 3-month Treasury Bill rate. Call money rate data are from the Federal Reserve Board for the years 1934 to 1970 ((1976a), Table 120, for 1934–1941, and (1976b), Table 12.23, for 1942–1970) and the Survey of Current Business from 1971 to 1975.[20] The price-to-dividend ratio for the S&P Composite Index is taken from Robert Shiller's website, and we use the change in this ratio from month $t-1$.[21] Other macroeconomic factors include the change in the natural logarithm of

[17]Book equity data in the Kenneth French website are collected from past Moody's Industrial Manuals, which were published every year in June. If the earnings announcement date is after June, then we divide the current year's book-equity with the previous month's firm size. If the earnings figure is announced on or before June, then we use the previous year's book-equity data and divide this by the previous month's firm size.

[18]Sentiment data are available at https://afajof.org/supplements/.

[19]We combine the following time-series: "debit balances, customers' debit balances (net)" from Table 143 of Federal Reserve Board (1976a) over the period between Jan. 1933 and Dec. 1937, "customer credit, net debit balances with NYSE firms secured by, U.S. government securities, other securities" from Table 12.23 of Federal Reserve Board (1976b) over the period, Jan. 1938 to Dec. 1958, and "margin debt" from the NYSE Facts and Figures database over the period, Jan. 1959 to Sept. 1975. See also Jylhä (2018) for more details.

[20]The survey is available at http://www.bea.gov/scb.

[21]http://www.econ.yale.edu/~shiller/data.htm.

TABLE 1

Summary Statistics and Historical Changes in Margin Requirements

Panel A of Table 1 provides summary statistics for the variables in our main analysis. All variables are defined in Table A2 in the Supplementary Material. The sample period covers Oct. 1934 through Sept. 1975. Panel B lists the dates of the 22 changes in Regulation T minimum margin requirements instituted by the Federal Reserve. The Fed decided to change margin requirements on the decision date, and this decision became effective on the effective date.

Panel A. Summary Statistics

Variables	Count	Mean	Median	Std. Dev.	P25	P75
SUE	79,062	0.003	0.001	0.043	−0.004	0.008
#ANN	79,062	11.25	5.00	15.59	2.00	13.00
SIZE (mn)	79,062	335.90	51.42	1,518.21	14.73	198.41
MARKET_BETA	79,062	1.27	1.21	0.58	0.87	1.61
BM	79,062	1.23	0.87	1.99	0.53	1.42
RET [−11, −2] %	79,062	0.63	0.00	7.99	−3.57	4.00
IVOL %	79,062	2.19	1.78	1.58	1.19	2.73
TURNOVER [−11,-2] %	79,062	0.12	0.06	0.23	0.03	0.13
ILLIQUIDITY	79,062	0.05	0.00	0.34	0.00	0.02
MARKET_RETURN [0] %	79,062	0.02	0.04	0.81	−0.36	0.44
AVOL [0,1]	79,062	0.41	0.33	1.63	−0.27	1.07
MARGIN_REQUIREMENTS	23	0.63	0.65	0.15	0.50	0.73
CHANGE_IN_MARGIN	22	0.18	0.20	0.06	0.10	0.24

Panel B. Historical Changes in Margin Requirements

Decision Date	Effective Date	Change	Level
	Oct. 1, 1934		45%
Jan. 24, 1936	Feb. 1, 1936	+10%	55%
Oct. 27, 1937	Nov. 1, 1937	−15%	40%
Feb. 2, 1945	Feb. 5, 1945	+10%	50%
July 3, 1945	July 5, 1945	+25%	75%
Jan. 17, 1946	Jan. 21, 1946	+25%	100%
Jan. 17, 1947	Feb. 1, 1947	−25%	75%
Mar. 28, 1949	Mar. 30, 1949	−25%	50%
Jan. 16, 1951	Jan. 17, 1951	+25%	75%
Feb. 20, 1953	Feb. 20, 1953	−25%	50%
Jan. 4, 1955	Jan. 4, 1955	+10%	60%
Apr. 22, 1955	Apr. 23, 1955	+10%	70%
Jan. 15, 1958	Jan. 16, 1958	−20%	50%
Aug. 4, 1958	Aug. 5, 1958	+20%	70%
Oct. 15, 1958	Oct. 16, 1958	+20%	90%
July 27, 1960	July 28, 1960	−20%	70%
July 9, 1962	July 10, 1962	−20%	50%
Nov. 5, 1963	Nov. 6, 1963	+20%	70%
June 7, 1968	June 8, 1968	+10%	80%
May 5, 1970	May 6, 1970	−15%	65%
Dec. 3, 1971	Dec. 6, 1971	−10%	55%
Nov. 22, 1972	Nov. 24, 1972	+10%	65%
Jan. 2, 1974	Jan. 3, 1974	−15%	50%

industrial production and the money supply (M1) from month $t-13$ to $t-1$. Finally, motivated by Chordia and Shivakumar (2005), we control for the effect of inflation. Data on the CPI, industrial production, and M1 are obtained from the Federal Reserve Bank of St. Louis' Fred database.

IV. Regression Analysis: Margin Requirements and Earnings Announcement Returns

In this section, we estimate a pooled regression model to examine the impact of margin requirements on investors' initial versus subsequent response to earnings news, as follows:

$$
\begin{aligned}
(1)\quad \mathrm{CAR}(a,b)_{it} = {} & \beta_0 + \beta_1\,\mathrm{ADJ\_SUE}_{it} + \beta_2\,\mathrm{MARGIN}_t \\
& + \beta_3\,\mathrm{ADJ\_SUE}_{it} * \mathrm{MARGIN}_t + \beta_4\,\mathrm{LAGGED\_SUE}_{it-1} \\
& + \beta_5 \mathrm{ANN}_{\mathrm{it}} + \beta_6\,\mathrm{RET}[-11,,-2]_{\mathrm{it}} + \beta_7\,\mathrm{BM}_{\mathrm{it}} \\
& + \beta_8\,\mathrm{BETA}_{\mathrm{it}} + \beta_9\,\mathrm{SIZE}_{\mathrm{it}} + \beta_{10}\,\mathrm{IVOL}_{\mathrm{it}} \\
& + \beta_{11}\,\mathrm{TURNOVER}_{it} + \beta_{12}\,\mathrm{ILLIQ}_{it} + \delta_d + \varepsilon_{it}.
\end{aligned}
$$

The dependent variable, $\mathrm{CAR}(a,b)_{i,t}$, is the cumulative abnormal return over days a to b following the announcement (on day 0) for firm i in quarter t. We consider two time frames: the initial 2-day return, CAR(0,+1), and the 60-day PEAD, CAR(+2,+61).[22] All variables are defined in Table A2 in the Supplementary Material. In all pooled regression analysis that follows, we include fixed effects for day-of-the-week (δ_d) (DellaVigna and Pollet (2009)), and we adjust standard errors for heteroscedasticity and cluster by day of the announcement.[23]

In Table 2, we provide the results for two specifications of equation (1). First, consider the evidence in columns 1 and 3, where we estimate an abbreviated version of this model that omits the second and third terms from equation (1), and thus ignores the potential influence of margin requirements on stock returns. In this specification, the relation between earnings news and returns implied by this abbreviated model is given by the partial derivative, $\frac{\partial \mathrm{CAR}(a,b)_{i,t}}{\partial \mathrm{ADJ\_SUE}_{i,t}} = \beta 1$. This derivative shows that a 1-unit increase in ADJ_SUE, from 0 to 1 (which ranges from the bottom decile to the top decile by SUE), is associated with a market response ($\mathrm{CAR}(a,b)_{i,t}$) of β_1 percentage in the firm's stock price, after controlling for the other independent variables.[24]

In column 1 of Table 2, the coefficient of ADJ_SUE (β_1) indicates an initial 2-day market response to earnings news (ranging from the bottom to the top decile of stocks by SUE) of CAR(0,+1) = 3.5% (t-ratio = 58.97), after controlling for other firm attributes. Similarly, column 3 reveals an average 60-day post-announcement drift in response to earnings news (β_1) of CAR(+2,+61) = 4.8% (t-ratio = 24.34), after accounting for other factors. These regression results corroborate the evidence in Figure 1 and Panel A of Table A8 in the Supplementary Material, confirming the existence of both a highly significant initial response and post-announcement drift following earnings announcements, during our early sample period from 1934 to 1975.

[22] We focus on drift that occurs over the next 60 business days following earnings announcements, since longer horizons may encompass the next quarterly announcement and confound our results.

[23] In Section A.4.e of the Supplementary Material, we show that our main results are robust when we conduct a simulation exercise to determine the extent to which our t-statistics may be inflated due to potential clustering of standard errors. We also show that our main results are robust when we examine the possibility that errors are clustered along various dimensions, including the firm, industry, day and quarter of the announcement.

[24] If the regression had no other independent variables, then β_1 could be interpreted as a return to a long–short portfolio that takes positions in all stocks proportional to their ADJ_SUE. In the presence of the control variables, β_1 now represents a return to a portfolio that has unit exposure to ADJ_SUE and 0 exposure to the control variables.

TABLE 2

Regression Analysis: Margin Requirements and Earnings Announcement Returns

Table 2 presents the results from estimating equation (1), as follows:

(1) $$CAR[a,b]_{it} = \beta_0 + \beta_1\ ADJ\_SUE_{i,t} + \beta_2\ MARGIN_t + \beta_3\ ADJ\_SUE_{i,t} * MARGIN_t + CONTROLS + \delta_d + \varepsilon_{it}.$$

The dependent variable is the cumulative abnormal return for stock *i* compounded over two time frames: the initial announcement return on days (0, 1) or the 60-day post-announcement period over days (2, 61) following the earnings announcement in quarter *t* (on day 0). The coefficient of ADJ_SUE reflects the sensitivity of announcement returns to moving from the lowest SUE decile to the highest SUE decile. Control variables are defined in Table A2 in the Supplementary Material, and include the firm's lagged SUE, the number of same-day announcements, the firm's lagged return over days −11 to −2, BM, beta, size, standard deviation of returns over days −11 to −2, turnover for these same days, and illiquidity. We include fixed effects for day-of-the-week. The sample covers Oct. 1934 through Sept. 1975. Standard errors are adjusted for heteroscedasticity and clustered by the day of the announcement. Items of highest relevance are shown in bold. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	Dependent Variable			
	CAR [0, 1]		CAR [2, 61]	
Variables	1	2	3	4
ADJ_SUE (β_1)	**0.035*** (58.97)**	0.046*** (18.08)	**0.048*** (24.34)**	0.010 (1.14)
MARGIN (β_2)		0.006** (2.55)		−0.038*** (−4.18)
ADJ_SUE × MARGIN (β_3)		**−0.018*** (−4.76)**		**0.061*** (4.54)**
LAGGED_SUE	−0.000*** (−4.44)	−0.000*** (−4.65)	−0.001*** (−3.86)	−0.001*** (−3.88)
#ANN	−0.000 (−0.44)	−0.000 (−0.48)	−0.001 (−1.34)	−0.001 (−1.38)
RET [−11, −2]	−0.042*** (−11.73)	−0.043*** (−11.80)	−0.005 (−0.38)	−0.005 (−0.40)
BM	0.003*** (10.51)	0.003*** (10.24)	0.014*** (11.32)	0.013*** (11.42)
BETA	−0.001 (−1.64)	−0.001* (−1.74)	−0.005*** (−3.19)	−0.005*** (−3.14)
SIZE	−0.000 (−0.18)	−0.000 (−0.09)	0.001** (2.12)	0.001** (2.24)
IVOL	0.028 (0.97)	0.027 (0.91)	0.393*** (4.67)	0.385*** (4.61)
TURNOVER	−0.000 (−1.42)	−0.000 (−1.34)	0.000 (1.03)	0.000 (1.19)
ILLIQUIDITY	0.005 (1.06)	0.005 (1.05)	0.017*** (2.98)	0.017*** (2.98)
CONSTANT	−0.018*** (−10.94)	−0.022*** (−9.62)	−0.025*** (−3.82)	−0.001 (−0.12)
No. of obs.	79,062	79,062	79,062	79,062
Adj. R^2	0.066	0.066	0.016	0.016

Consider next the impact of leverage constraints on the market response to earnings news, provided in columns 2 and 4 of Table 2. Here, we include the second and third terms in equation (1) and thereby allow margin requirements to influence the stock return following earnings announcements. In this specification, the coefficient of the interaction term between ADJ_SUE and MARGIN (β_3) reflects the impact of higher margin requirements on the market response to earnings news embodied in β_1. This interaction term is the focus of our analysis.

In column 2 of Table 2, the coefficient of the interaction term is $\beta_3 = -1.8\%$ (*t*-ratio = −4.76), which indicates that higher margin requirements are associated with a significant *decline* in the market's initial 2-day response to earnings news (CAR(0,+1)). In contrast, column 4 documents that $\beta_3 = 6.1\%$ (*t*-ratio = 4.54), which

indicates that higher margin requirements are associated with a significant *increase* in the 60-day post-announcement drift (CAR(+2,+61)). The magnitudes of these coefficients (β_3) reveal the hypothetical impact of higher margin requirements on the initial reaction and subsequent drift following earnings announcements. For example, if margin requirements are raised by 20%, then the market's initial response to earnings surprises is muted by −0.36% (i.e., 20% of $\beta_3 = [0.2] \times [-1.8\%]$) while the subsequent PEAD is amplified by 1.22% (i.e., 20% of $\beta_3 = [0.20] \times [6.1\%]$).[25]

Together, this regression analysis corroborates our previous evidence indicating that investor underreaction to earnings news is significantly exacerbated when margin requirements are higher (see Figure 1 and Panel A of Table A8 in the Supplementary Material). This evidence further establishes that higher margin requirements are associated with a significant decline in price efficiency, after accounting for other factors that influence stock prices.

V. Robustness Tests

A. Controlling for Investor Sentiment

We next examine the robustness of our results during periods of high investor sentiment. If, during our sample period, the Federal Reserve tended to increase (decrease) margin requirements following periods of high (low) sentiment, then higher margin requirements could merely proxy for such periods of high investor sentiment over time, rather than tighter leverage constraints. Since investors may react less to earnings news when sentiment is low, this aspect of investor psychology could be driving our results, rather than margin requirements.[26]

In Table 3, we address this issue by estimating an expanded version of equation (1) that adds a dummy variable for periods of high investor sentiment, as well as its interaction with ADJ_SUE.[27] We also add a triple-interaction term that involves the adjusted rank of SUE, the level of margin requirements, and this sentiment dummy. In this analysis, the sample begins in 1935 rather than 1934 because the Baker–Wurgler Sentiment measure is only available annually beginning in 1934, and we use its lagged annual value to generate our Sentiment dummy.

Once again, the main results in Table 3 are robust to this specification. After accounting for the potential influence of investor sentiment, the coefficient of ADJ_SUE × MARGIN (β_3) still indicates that higher margin requirements are associated with a significantly lower initial response (CAR(0,+1)) followed by a significantly higher PEAD (CAR(+2,+61)). Furthermore, the triple interaction term is not significant, which implies that sentiment does not affect the impact of margin requirements on the market's underreaction to earnings news (i.e., β_3).

The evidence in Table 3 again corroborates our main finding that investor underreaction to earnings surprises is exacerbated when leverage constraints are

[25]A 20% change in margin requirements corresponds to the median size of the Fed's 22 margin policy changes during our sample period (see Panel A of Table 1).

[26]Livnat and Petrovits (2009) and Mian and Sankaraguruswamy (2012) examine how sentiment influences PEAD.

[27]This dummy variable is labeled "SENTIMENT," and is defined in Table A2 in the Supplementary Material.

TABLE 3

Controlling for Investor Sentiment

In Table 3, we estimate an expanded version of equation (1)) that controls for investor sentiment by including a dummy variable for periods of high sentiment (labeled SENTIMENT, defined in Table A2 in the Supplementary Material), along with its interaction with ADJ_SUE. We also add a triple-interaction term that involves the adjusted rank of SUE, the level of margin requirements, and the sentiment dummy. The dependent variable is CAR(0,1) or CAR(2,61). In each model, we include fixed effects for day-of-the-week. The sample begins in 1935, because the Baker–Wurgler Sentiment measure is available annually beginning in 1934, and we use the lagged value to generate our SENTIMENT dummy variable. Standard errors are adjusted for heteroscedasticity and clustered by the day of the earnings announcement. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	Dependent Variable	
	CAR [0, 1]	CAR [2, 61]
Variables	1	2
ADJ_SUE (β_1)	0.050***	0.016
	(13.55)	(1.22)
MARGIN (β_2)	0.010***	−0.004
	(2.97)	(−0.31)
ADJ_SUE × MARGIN (β_3)	**−0.028*** **	**0.053** **
	(−4.59)	**(2.46)**
SENTIMENT	0.001	0.046***
	(0.40)	(3.24)
ADJ_SUE × SENTIMENT	−0.001	−0.011
	(−0.21)	(−0.56)
MARGIN × SENTIMENT	−0.004	−0.065***
	(−0.83)	(−3.11)
ADJ_SUE × MARGIN × SENTIMENT	**0.007**	**0.015**
	(0.88)	**(0.50)**
CONSTANT	−0.023***	−0.019*
	(−8.68)	(−1.82)
Controls	Yes	Yes
No. of obs.	78,846	78,846
Adj. R^2	0.067	0.017

more stringent, after we control for periods of high investor sentiment that may be associated with the Fed's margin policy. This evidence helps to solidify our conclusion that, when leverage constraints are more binding, investors and arbitrageurs are less able to respond to the information in earnings announcements, or to counteract the resulting underreaction.

B. Investor Underreaction, Margin Requirements, and Changes in Risk

In this subsection, we consider the possibility that our evidence suggesting greater underreaction to earnings news when margin requirements are higher may instead be due to changes in risk associated with the firm's earnings release. A firm's exposure to risk (e.g., the firm's return sensitivities to the MKTRF, HML, SMB, or UMD factors) may rise (fall) following the release of bad (good) earnings news (Zolotoy (2011), Hirshleifer and Sheng (2022)). If the Fed's changes in margin policy tend to coincide with changes in these four risk factors, then our results might be driven by changes in risk rather than by changes in margin requirements.[28]

[28]See Ball, Kothari, and Watts (1993), Chordia and Shivakumar (2005), (2006), Sadka (2006), Garfinkel and Sokobin (2006), and Patton and Verardo (2012) for studies that support a risk-based explanation for PEAD.

We follow Hirshleifer and Sheng (2022), and examine the interactive effects of the adjusted SUE decile with the four daily Carhart (1997) factors, as well as margin requirements. In our first specification, we allow the market response to earnings news (β_1) to depend upon these four risk factors, by expanding equation (1) to include each daily factor return and its two-way interaction with ADJ_SUE. In our second specification, we add four triple-interaction terms that involve the adjusted rank of SUE, each daily factor, and the level of margin requirements, as well as all two-way interactions.

If the margin effect documented in Table 2 is driven by changes in risk around the Fed's policy actions, then these four risk factors and their interactions with ADJ_SUE and margin requirements should subsume any influence of margin constraints on the impact of ADJ_SUE. That is, in our first specification, the coefficient of the first interaction term, ADJ_SUE × MARGIN (β_3), should become insignificant when we include the two-way interactions between ADJ_SUE and each daily factor, for our analysis of either CAR(0,+1) or CAR(+2,+61). Furthermore, in our second specification, the coefficients of the triple interaction terms should be significant and negative for the initial reaction, CAR(0,+1), but positive for the delayed reaction, CAR(+2,+61).

However, these potential implications of risk are generally not born out in our analysis. The relevant results are provided in Table 4. First, only the triple interaction involving the market return is significantly negative in column 2 for the initial reaction, CAR(0,+1), and significantly positive in column 4 for the delayed reaction, CAR(+2,+61). Furthermore, when we control for the four factors in either specification, the coefficient of the main interaction term, ADJ_SUE × MARGIN (β_3), remains significantly negative in columns 1 and 2 and significantly positive in columns 3 and 4. Thus, the initial response to earnings surprises (CAR(0,+1)) is still muted, and PEAD (CAR(+2,+61)) is still magnified when margin requirements are higher. This analysis establishes that the impact of margin requirements on investor underreaction to earnings news is not due to possible changes in the firm's exposure to risk that might be associated with the earnings release, or with these changes in the Fed's margin policy.[29]

C. Additional Robustness Tests

Section A.4 of the Supplementary Material presents many additional robustness tests. This analysis uniformly corroborates that our main results and conclusions are unaffected when we account for macroeconomic and credit market conditions, stock market conditions, alternative windows around the announcement, differential behavior for announcements that occur near a change in margin requirements, and alternative schemes for clustered standard errors.

[29]Our analysis in Tables A9 and A10 in the Supplementary Material excludes earnings announcements either before, or both before and after, changes in margin requirements. These results further establish that our main results and conclusions are not driven by potential changes in risk that could manifest around these changes in margin policy.

TABLE 4

Controlling for Changes in the Firm's Exposure to Risk

Table 4 presents the results from two expanded versions of equation (1)). In columns 1 and 3, we add the 4-factor returns from Carhart (1997), along with the interaction between each factor return and ADJ_SUE. In columns 2 and 4, we also add four triple-interaction terms that involve the adjusted rank of SUE, the margin requirement, and each of the 4-factor returns, as well as all two-way interactions. The dependent variable is CAR(0,1) or CAR(2,61). MKTRF, SMB, HML, and UMD are the daily returns to the four Carhart (1997) factors from Kenneth French's website. We also include the other control variables in equation (1)), as well as fixed effects for day-of-the-week. The sample covers Oct. 1934 through Sept. 1975. Standard errors are adjusted for heteroscedasticity and clustered by the day of the earnings announcement. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	Dependent Variable			
	CAR [0, 1]		CAR [2, 61]	
Variables	1	2	3	4
ADJ_SUE (β_1)	0.046***	0.047***	0.010	0.010
	(18.41)	(18.54)	(1.15)	(1.17)
MARGIN (β_2)	0.007***	0.008***	−0.037***	−0.036***
	(3.10)	(3.36)	(−4.04)	(−3.96)
ADJ_SUE × MARGIN (β_3)	**−0.019*** **	**−0.020*** **	**0.061*** **	**0.061*** **
	(−4.94)	**(−5.12)**	**(4.54)**	**(4.56)**
ADJ_SUE × MKTRF	0.332***	1.181***	−0.356	−3.389***
	(4.44)	(3.34)	(−1.43)	(−2.91)
ADJ_SUE × HML	−0.164	−0.668	−0.424	5.199**
	(−1.16)	(−1.16)	(−0.85)	(2.49)
ADJ_SUE × SMB	−0.446***	−0.713	0.764	3.462
	(−2.74)	(−0.96)	(1.46)	(1.41)
ADJ_SUE × UMD	0.427***	−0.338	0.184	−2.094
	(3.74)	(−0.70)	(0.51)	(−1.35)
ADJ_SUE × MARGIN × MKTRF		−1.460***		4.932***
		(−2.62)		(2.71)
ADJ_SUE × MARGIN × HML		0.715		−9.276***
		(0.80)		(−2.82)
ADJ_SUE × MARGIN × SMB		0.606		−5.419
		(0.50)		(−1.36)
ADJ_SUE × MARGIN × UMD		1.386*		3.530
		(1.81)		(1.43)
CONSTANT	−0.023***	−0.023***	−0.002	−0.002
	(−10.08)	(−10.21)	(−0.19)	(−0.26)
4-factor returns + controls	Yes	Yes	Yes	Yes
No. of obs.	79,062	79,062	79,062	79,062
Adj. R^2	0.075	0.075	0.017	0.018

VI. Distinguishing Between the Leverage Constraints and Excess Speculation Channels

We provide strong evidence indicating that periods of higher initial margin requirements are associated with greater underreaction to earnings news, and thus lower market efficiency. Although we have established that this empirical relation is strong and robust, we have not yet pinned down the economic mechanism behind these main results. In this section, we provide several additional tests that attempt to distinguish between the leverage constraints channel versus the excess speculation channel as alternative economic explanations for our results.

A. Margin Requirements and Abnormal Trading Volume Around Earnings Announcements

An abundant literature establishes a strong theoretical and empirical relation between abnormal trading volume and the absolute magnitude of the

earnings surprise, under general conditions.[30] However, the two economic channels, we propose to help understand the impact of margin requirements on market efficiency have opposing predictions for this generally positive response of abnormal trading volume around earnings announcements. According to the leverage constraints channel, higher margin requirements curtail the ability of investors to trade around the earnings release, and thus should mitigate the generally high response in abnormal volume around these events. In contrast, according to the excess speculation channel, higher margin requirements are associated with higher levels of excess speculation, which should further exacerbate the already high abnormal volume response around the earnings release.

We investigate this issue by estimating the following pooled regression model:

$$\begin{aligned}(2)\qquad \mathrm{AVOL}(0,1)_{it} = {} & \beta_0 + \beta_1\ \mathrm{ABS\_SUE}_{it} + \beta_2\ \mathrm{MARGIN}_t \\ & + \beta_3\ \mathrm{ABS\_SUE}_{it} * \mathrm{MARGIN}_t \\ & + \mathrm{CONTROLS} + \delta_d + \varepsilon_{it}.\end{aligned}$$

The dependent variable is abnormal trading volume in the stock of firm *i* on the 2 days around the firm's earnings announcement during quarter *t*, defined in Table A2 in the Supplementary Material. The first independent variable, $\mathrm{ABS\_SUE}_{it}$, is the decile rank of the *absolute* magnitude of the firm's earnings surprise. As discussed previously, prior work establishes that a larger positive or negative earnings surprise is generally associated with greater abnormal volume (i.e., $\beta_1 > 0$). In the context of this study, the leverage constraints channel predicts that higher margin requirements should attenuate this typical volume response to earnings surprises (i.e., $\beta_3 < 0$), while the excess speculation channel predicts the opposite effect (i.e., $\beta_3 > 0$).

The results from estimating equation (2) are presented in Table 5. Consistent with prior work on abnormal volume around earnings announcements, we find that a larger positive or negative earnings surprise is generally associated with greater abnormal volume around the earnings release ($\beta_1 = 0.068$, *t*-ratio = 6.18). However, this volume response is significantly attenuated when margin requirements are higher ($\beta_3 = -0.040$, *t*-ratio = −2.43). This evidence reinforces the view that more binding leverage constraints impede the ability of investors to trade on earnings news, and thus provides support for the leverage constraints channel (and against the excess speculation channel), as an explanation for our main results.

[30]For theory and evidence regarding the behavior of abnormal volume around earnings announcements, see Bamber (1987), Morse (1981), Ziebart (1990), Atiase and Bamber (1994), Kim and Verrecchia (1994), Bamber, Barron, and Stober (1997), Landsman and Maydew (2002), Garfinkel and Sokobin (2006), Berkman et al. (2009), Bamber, Barron, and Stevens (2010), and Akbas (2016). We plot daily abnormal volume around earnings announcements in Figure A1 in the Supplementary Material, and discuss this behavior in Section A.3.b of the Supplementary Material. Panel B of Figure A.1 in the Supplementary Material shows that periods of high margin requirements are associated with lower abnormal volume around earnings announcements.

TABLE 5

Margin Requirements and Abnormal Volume Around Earnings Announcements

Table 5 presents the results from estimating equation (2), as follows:

$$AVOL(0,1)_{it} = \beta_0 + \beta_1 ABS\_SUE_{it} + \beta_2 MARGIN_t + \beta_3 ABS\_SUE_{it} * MARGIN_t + CONTROLS + \delta_d + \varepsilon_{it}. \quad (2)$$

This model relates the firm's abnormal trading volume on days 0 and +1 around the earnings announcement to the decile rank of the absolute value of the earnings surprise (ABS_SUE), as well as the level of margin requirements (MARGIN) and their interaction (ABS_SUE × MARGIN), along with the other control variables from equation (1). We also include fixed effects for day-of-the-week. The sample period covers Oct. 1934 through Sept. 1975. Standard errors are adjusted for heteroscedasticity and clustered by the day of the earnings announcement. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	AVOL [0, 1]
Variables	1
ABS_SUE (β_1)	**0.068*** (6.18)**
MARGIN (β_2)	0.101 (0.99)
ABS_SUE × MARGIN (β_3)	**−0.040** (−2.43)**
CONSTANT	1.765*** (17.94)
Controls	Yes
No. of obs.	79,062
Adj. R^2	0.045

B. Periods of Excess Speculation just Before the Fed Increased Margin Requirements

One of the most standard and important reasons that the Federal Reserve cites for increasing margin requirements during our sample period is to curb excess speculation in the marketplace. The Federal Reserve Board mentions "speculation" as the motivation for 10 of their 22 changes in margin requirements during this period, 9 of which are increases. Put another way, for 9 of the 12 increases in margin requirements during our sample period, speculation is mentioned by the Fed as a key reason for the change.[31]

This historical record suggests that the periods just prior to the Fed's 12 increases in margin requirements were typically characterized by abnormally high speculation, while having relatively low margin requirements. Therefore, these periods provide a unique testing opportunity to allow the data to differentiate between the implications of the leverage constraints channel versus the excess speculation channel. If our main results are driven by excess speculation just prior to the Fed's 12 increases in margin requirements, then we should expect less efficient markets during these periods of high speculation (i.e., there should be a smaller initial response to earnings news, CAR(0,+1), and larger PEAD, CAR (+2,+61)). On the other hand, according to the leverage constraints channel, the relatively low margin requirements during these periods should *not* be accompanied

[31]Section A.1 of the Supplementary Material provides several quotes from the WSJ, which document that excess speculation was perceived as a common rationale for the Fed to raise margin requirements. See also Jylhä (2018) for a breakdown of the reasons behind each change in margin requirements discussed by the Federal Reserve.

by less efficient markets (i.e., there should *not* be a significantly smaller CAR(0,+1) or a significantly larger CAR(+2,+61)).

We empirically address this issue by separately accounting for the periods just before the Fed increased margin requirements, when excess speculation was perceived to be the greatest. We accomplish this task by estimating an expanded version of equation (1) that includes a dummy variable labeled "BEFORE_INCREASE," which takes a value of 1 for all earnings announcements made within the 60-day periods before each of the 12 times the Fed increased margin requirements during our sample period. We also include the interaction term between this dummy variable and ADJ_SUE. We estimate two versions of this model, one that omits the two independent variables that capture the influence of margin requirements (i.e., MARGIN and ADJ_SUE × MARGIN), and another model that includes these two independent variables.

The results appear in Table 6. The left side provides the evidence when the dependent variable is CAR(0,+1), whereas the right side presents the results for CAR(+2,+61). Similar to our analysis in Table 2, when we omit the influence of margin requirements in columns 1 and 3 of Table 6, the coefficient of ADJ_SUE (β_1) indicates the market response to the earnings surprise embodied in SUE. Once again, in Table 6 this coefficient indicates a significant initial response to earnings

TABLE 6

The Potential Impact of Excess Speculation on the Market Response to Earnings News During the Periods just Before the Federal Reserve Increased Margin Requirements

In Table 6, we estimate an expanded version of equation (1) that separately accounts for earnings announcements that were made during periods just before the Federal Reserve increased margin requirements, when they often stated that they were especially concerned about a high level of market speculation. This expanded model includes a dummy variable labeled "BEFORE_INCREASE," which is assigned a value of 1 for any earnings announcements made within 60 days before the Fed increased margin requirements, along with its interaction with ADJ_SUE. We estimate two versions of this model, one that omits the two independent variables that capture the influence of margin requirements (MARGIN and ADJ_SUE × MARGIN), and another version that includes these two independent variables. The left side of this table provides the results when the dependent variable is CAR(0,1), while the right side gives the results for (CAR(2,61)). In each model estimated, we include fixed effects for day-of-the-week. The sample period covers Oct. 1934 through Sept. 1975. Standard errors are adjusted for heteroscedasticity and clustered by the day of the earnings announcement. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	Dependent Variable:			
	CAR [0,1]		CAR [2,61]	
Variables	1	2	3	4
ADJ_SUE (β_1)	**0.035*** (58.22)**	**0.046*** (17.88)**	**0.048*** (23.67)**	**0.009 (0.99)**
MARGIN (β_2)		0.007*** (2.83)		−0.039*** (−4.19)
ADJ_SUE × MARGIN (β_3)		**−0.018*** (−4.66)**		**0.062*** (4.62)**
BEFORE_INCREASE (β_4)	0.002 (1.11)	0.002 (1.27)	−0.007 (−1.22)	−0.009 (−1.48)
ADJ_SUE × BEFORE_INCREASE (β_5)	**0.001 (0.44)**	**0.000 (0.18)**	**0.007 (0.86)**	**0.010 (1.15)**
CONSTANT	−0.017*** (−10.23)	−0.021*** (−9.18)	−0.022*** (−3.52)	0.002 (0.21)
Controls	Yes	Yes	Yes	Yes
No. of obs.	79,062	79,062	79,062	79,062
Adj. R^2	0.065	0.066	0.016	0.016

news in column 1 (i.e., $\beta_1 = 3.5\%$, *t*-ratio = 58.22) and significant PEAD in column 3 (i.e., $\beta_1 = 4.8\%$, *t*-ratio = 23.67).

Next, when we account for the influence of margin requirements in columns 2 and 4 of Table 6, the coefficient of the interaction term, ADJ_SUE × MARGIN (β_3), reveals the influence of margin requirements on the market's initial response to earnings news (CAR(0,+1)) and PEAD (CAR(+2,+61). The coefficient of this interaction (β_3) is virtually unchanged from the evidence in Table 2, again revealing a significantly negative impact on CAR(0,+1) in column 2, and a significantly positive impact on CAR(+2,+61) in column 4. This evidence indicates that our main results for β_3 are robust when we incorporate the two variables, BEFORE_INCREASE and BEFORE_INCREASE × ADJ_SUE, to separately account for periods just before the Fed increased margin requirements, when excess speculation was arguably perceived as the greatest.[32]

Additional new insights from Table 6 are provided by the coefficient of the interaction term, ADJ_SUE × BEFORE_INCREASE (i.e., β_5). Similar to β_3, this new interaction coefficient (β_5) reveals any possible systematic change in the response to earnings news that might characterize the periods just before the Fed increased margin requirements, when excess speculation was perceived as the highest. However, in all four columns of Table 6, this coefficient (β_5) is small and insignificant, indicating that there is no significant change in the market's response to earnings news (i.e., CAR(0,+1) or CAR(+2,+61)) during these periods just before the Federal Reserve's 12 increases in margin requirements. We conclude that the apparently high excess speculation just before the Fed increased margin requirements cannot explain our main findings. This evidence is contrary to the predictions of the excess speculation channel, but remains consistent with the implications of the leverage constraints channel.[33]

C. Six Alternative Indirect Measures of Leverage Constraints, Including Data Since 1974

The 22 changes in margin requirements mandated by the Fed between 1934 and 1974 provide a historical record of variation in this direct measure of constraints on investor borrowing over this period. However, the Fed has not altered margin requirements since 1974. Thus, it is not clear whether more recent and ongoing

[32]The dummy variable, "BEFORE_INCREASE," identifies 3,300 earnings announcements made within 60 days before the Fed increased margin requirements, which represent 4.2% of the sample. We have also analyzed the alternative subsets of announcements made within the 45 days or 90 days before the Fed increased margin requirements, as alternative definitions of "BEFORE_INCREASE." There are 2,661 (or 4,857) such earnings announcements, which represent 3.37% (or 6.14%) of the sample, made within the 45 (or 90) days before the Fed increased margin requirements. This extended analysis is provided in Table A11 in the Supplementary Material, and reveals that our main results continue to be robust.

[33]In Table A9 in the Supplementary Material, we re-estimate equation (1) after excluding announcements made in the 60 days before or after the Fed changed margin requirements, with robust results. In Table A10 in the Supplementary Material, we repeat this analysis after deleting announcements made in the 45, 60, or 90 days before the Fed increased margin requirements. Once again, our main results remain robust when we exclude these periods of perceived excess speculation.

time-series variation in other indirect constraints on investor borrowing may have affected market efficiency since 1974.

In this section, we shed additional light on this issue by analyzing variation in six alternative indirect measures of capital constraints that have been extensively used in the literature, encompassing more recent data since 1974. These six measures are the TED spread, the Feds Fund rate, the mutual fund beta measure from Boguth and Simutin (2018), the shadow cost of leverage from Lu and Qin (2020), the margin debt from Assness, Frazzini, Gormsen, and Pedersen (2020), and the capital scarcity measure of Hu, Pan, and Wang (2013).[34]

While higher margin requirements may conceivably operate through either economic channel posed previously, these six indirect measures of capital constraints mainly reflect investor borrowing costs. Thus, it would be difficult to argue that these indirect measures simply capture excess speculation in the market, as in the case of margin requirements. Hence, analysis of these indirect measures using more recent data sheds new light on the impact of leverage constraints on price efficiency, by further distinguishing between these two alternative economic channels.

In Table 7, we present the results from re-estimating equation (1) when we replace the margin requirement as an independent variable with each of the previous six indirect measures of capital constraints, including data since 1974. Panel A presents six columns of results for the initial reaction to earnings surprises (CAR(0,+1)), while Panel B gives the analogous results for PEAD (CAR(+2,+61)). We begin by concentrating on the first five indirect measures of leverage constraints in each panel of Table 7. Once again, the key variable of interest is the interaction term between each indirect measure and the adjusted rank of SUE. The coefficient of this variable (β_3) is negative in the first five columns in Panel A, whereas it is positive in the first five columns in Panel B, and it is statistically significant in four of these first five columns in each panel. Once again, this evidence indicates that tighter leverage constraints are associated with significantly greater underreaction to earnings news (i.e., a smaller initial reaction, CAR(0,+1) and larger PEAD, CAR(+2,+61)). This analysis further corroborates the results and conclusions from our main analysis of margin requirements over the earlier period covering 1934–1975.

In contrast, the last column in each panel of Table 7 presents contrasting evidence when we analyze the sixth indirect measure of capital scarcity from Hu, Pan, and Wang (2013). In particular, the coefficient of the interaction term between capital scarcity and ADJ_SUE (β_3) in column 6 is now significantly positive in Panel A and significantly negative in Panel B. This contrasting evidence implies that, when this sixth measure indicates greater capital scarcity, prices actually become *more* efficient around earnings announcements, implying *less* underreaction to earnings news (i.e., a larger initial reaction and smaller PEAD).

This analysis corroborates the recent work of Guest, Kothari, and So (2023), who argue that flight to quality earnings during times of greater capital scarcity

[34]Our margin debt measure is the negative value of the margin debt measure from Assness, Frazzini, Gormsen, and Pedersen (2020). This adjustment aligns the interpretation of our margin debt measure with the other five measures of capital constraints (i.e., now a higher value of all six measures indicates more stringent capital constraints).

TABLE 7

Analyzing Indirect Measures of Leverage Constraints During Recent Times

In Table 7, we re-estimate equation (1) six times using data over more recent years, where we replace margin requirements with six alternative indirect measures of leverage constraints. These indirect measures include the TED spread, the Feds Fund rate, the measure of leverage constraints from Boguth and Simutin (2018), the shadow cost of leverage constructed by Lu and Qin (2020), the (negative value of the) margin debt measure of Assness, Frazzini, Gormsen, and Pedersen (2020), and the capital scarcity measure of Hu, Pan, and Wang (2013). The TED spread, the Fed Funds Rate, the shadow cost of leverage from Lu and Qin (2020), and the capital scarcity measure of Hu, Pan, and Wang (2013) are each measured over the 2-day earnings announcement window (TED[0,1], FFR[0,1], PSI[0,1], and CapScarcity[0,1]). The leverage constraint measure from Boguth and Simutin (2018) is their 6-month moving average measure (LCT_{MA6}). Our margin debt measure is the negative value of the measure from Assness, Frazzini, Gormsen, and Pedersen (2020), which aligns the interpretation of this measure with the other five measures (i.e., now a higher value of each measure indicates tighter capital constraints). In this revised version of equation (1), we include each measure separately, along with its respective interaction with the adjusted rank of SUE. In Panel A, the dependent variable is CAR(0,1), whereas in Panel B, the dependent variable is CAR(2,61). We only provide the results for the relevant variables and interaction terms for brevity. In both panels, we also include the other controls in equation (1), as well as fixed effects for day-of-the-week. The sample period corresponding to each measure is given at the bottom of each panel. Standard errors are adjusted for heteroscedasticity and clustered by the day of the earnings announcement. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Panel A. Indirect Measures of Leverage Constraints and CAR [0, 1]

	CAR [0, 1]					
	LCT_{MA6}	PSI [0, 1]	Margin $Debt_t$	TED [0, 1]	FFR [0, 1]	Cap Scarcity [0, 1]
Variables	1	2	3	4	5	6
ADJ_SUE (β_1)	0.090***	0.055***	0.025***	0.047***	0.045***	0.042***
	(12.25)	(55.94)	(26.23)	(52.67)	(87.15)	(38.50)
LEVERAGE_ CONSTRAINTS (β_2)	0.011**	0.0004	0.204***	−0.094**	.00002***	−0.001***
	(2.55)	(1.20)	(7.73)	(−2.01)	(6.61)	(−3.95)
ADJ_SUE × LEVERAGE_ CONSTRAINTS (β_3)	**−0.044*** (−6.49)**	**−0.001** (−2.55)**	**−0.623*** (−15.72)**	**−0.087 (−1.25)**	**−0.0001*** (−15.40)**	**0.001*** (3.81)**
CONSTANT	−0.017***	−0.014***	−0.005***	−0.005***	−0.012***	−0.002
	(−3.65)	(−3.64)	(−3.71)	(−2.73)	(−7.94)	(−0.99)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	393,696	119,877	535,614	392,733	528,327	336,435
Adj. R^2	0.030	0.038	0.032	0.032	0.032	0.032
Sample period	1981–2014	2006–2016	1933–2017	1986–2018	1954–2018	1988–2014

Panel B. Indirect Measures of Leverage Constraints and CAR [2, 61]

	CAR [2, 61]					
	LCT_{MA6}	PSI [0, 1]	Margin $Debt_t$	TED [0, 1]	FFR [0, 1]	Cap Scarcity [0, 1]
Variables	1	2	3	4	5	6
ADJ_SUE (β_1)	−0.053**	0.033***	0.065***	0.039***	0.040***	0.057***
	(−2.18)	(13.44)	(21.66)	(17.41)	(27.90)	(14.36)
LEVERAGE_CONSTRAINTS (β_2)	−0.109***	0.001	−0.424***	−1.146***	−0.0002***	0.004***
	(−6.22)	(0.76)	(−4.06)	(−7.21)	(−14.60)	(3.42)
ADJ_SUE × Leverage CONSTRAINTS (β_3)	**0.095*** (4.21)**	**0.0001 (0.04)**	**0.690*** (5.64)**	**0.508*** (2.69)**	**0.0002*** (11.79)**	**−0.004*** (−2.77)**
CONSTANT	0.136***	0.014	−0.008	0.026***	0.019***	0.019**
	(6.63)	(0.99)	(−1.24)	(3.67)	(3.41)	(2.19)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	393,696	119,877	535,614	392,733	528,327	336,435
Adj. R^2	0.011	0.017	0.012	0.0111	0.013	0.011

reduces investors' delayed reaction to earnings news. According to their argument, investors switch from riskier assets to safer assets when there is greater capital scarcity during periods of intense market stress. As a result of this flight to quality earnings, firms with a positive earnings surprise (i.e., safer assets) realize higher demand from investors facing margin requirements, whereas firms with a negative earnings surprise (i.e., riskier assets) have lower demand. The outcome of this

investor response to periods of intense market stress is a more immediate increase (decrease) in stock prices for firms with a positive (negative) earnings surprise, implying *less* underreaction to earnings news.

In column 6 of Table A14 in the Supplementary Material, we reconcile these seemingly contradictory results for the sixth indirect measure of capital constraints from the last column of Table 7, by showing that the contrary results for β_3 change sign when we exclude NBER recessions from the analysis. The capital scarcity measure used in Guest, Kothari, and So (2023) is highly sensitive to periods of great market stress, such as economic recessions. In recessions, investors' risk preferences are likely to change profoundly, compelling them to flee from risky assets to safe assets. At the same time, investors become more attentive to earnings news during such periods of extreme uncertainty. We conjecture that this change in risk preferences during recessions, along with the increased attention to earnings announcements, may lead to a more timely reaction to new information, which could explain the contrary evidence pointing to less underreaction to earnings news captured by the capital scarcity measure in Table 7.

In Table A14 in the Supplementary Material, we conduct the same analysis from Table 7 after excluding periods of NBER recessions from the analysis. In the sixth column of Table A14 in the Supplementary Material, the coefficient of β_3 for the capital scarcity measure now flips sign and becomes consistent with the evidence for the other five indirect measures of leverage constraints, contained in the first five columns. This analysis shows that the seemingly contradicting result for β_3 in the last column of Table 7 is driven by recessions. Together, the analyses in Table 7 and Table A14 in the Supplementary Material provide compelling new evidence that further corroborates our main results, indicating that greater capital constraints are associated with less efficient markets in recent times, as well as during the earlier period of our study.

VII. The Leverage Constraints Channel: Further Corroborating Evidence

In this section, we present two more tests to further explore the above support for the leverage constraints channel as the mechanism by which margin constraints reduce efficiency.

A. Idiosyncratic Volatility and Arbitrage Risk

Risk-averse arbitrageurs who are unable to hedge idiosyncratic risk take relatively small positions in stocks with high IVOL (Atilgan, Bali, Demirtas, and Gunaydin (2020)). Also, while the Fed sets the minimum margin required through Reg T, brokers may set a more stringent limit for certain stocks, such as those with high IVOL. Thus, informed investors have incentive to avoid trading on PEAD for stocks with high IVOL, since this activity entails greater arbitrage risk. In line with these arguments, Mendenhall (2004) shows that high IVOL amplifies the market's underreaction to earnings surprises (i.e., increases PEAD).

According to the leverage constraints channel, risk-averse arbitrageurs should be even more constrained by high margin requirements when trading high IVOL

stocks around earnings announcements. Thus, when margin requirements are higher, the elevated arbitrage risk associated with high IVOL stocks should further prevent arbitrageurs from weighing in with their beliefs on the announcement date, and thus further amplify PEAD. We investigate this issue by sorting the cross section of earnings announcements each quarter into terciles based on the announcing firm's IVOL. We then re-estimate equation (1) for the subsets of announcements made by firms with either high or low IVOL.

The results are provided in Panel A of Table 8. Once again, the key variable is the interaction term, ADJ_SUE × MARGIN (β_3). First, consider the evidence for β_3 in columns 1 and 3, which reveals how IVOL affects the impact of margin requirements on the market's initial reaction to earnings surprises (CAR(0,+1)) for subsets of firms with high or low IVOL. In column 1, $\beta_3 = -3.3\%$ (t-ratio = −3.98) for the subset of announcements with high IVOL, while column 3 reveals a smaller negative estimate, $\beta_3 = -1.0\%$ (t-ratio = −2.15) for stocks with low IVOL. In untabulated results, we find that these two estimates of β_3 are significantly different across the subsets of announcements with high versus low IVOL (i.e., difference in $\beta_3 = -2.4\%$, t-ratio = −2.50). This outcome indicates that, while higher margin requirements lead to a smaller initial reaction to earnings surprises for stocks with both high and low IVOL, this decline in CAR(0,+1) is significantly larger for stocks with greater arbitrage risk embodied in high IVOL.

Next, consider the evidence for β_3 across columns 2 and 4 in Panel A of Table 8, which reveals how IVOL affects the relation between margin requirements and the drift following earnings announcements (CAR(+2,+61)). In column 2, $\beta_3 = 10.8\%$ (t-ratio = 3.68) for firms with high IVOL, while column 4 reveals a smaller estimate, $\beta_3 = 2.2\%$ (t-ratio = 1.52), for firms with low IVOL. This result indicates that higher margin requirements lead to significantly larger PEAD for the subset of stocks with high IVOL, but not for stocks with low IVOL. Once again, the

TABLE 8

Margin Requirements, Arbitrage Risk, and Idiosyncratic Volatility

In Table 8, we present results from estimating equation (1) for subsamples of earnings announcements based on the firm's idiosyncratic volatility (IVOL). We first sort the cross section of earnings announcements each quarter into terciles based on the firm's IVOL. We then estimate equation (1) for the subsample of announcements with either high or low IVOL. In this estimation, we also include the other control variables in equation (1), as well as fixed effects for day-of-the-week. The sample period covers Oct. 1934 through Sept. 1975. Standard errors are adjusted for heteroscedasticity and clustered by the day of the earnings announcement. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	High IVOL		Low IVOL	
	CAR [0, 1]	CAR [2, 61]	CAR [0, 1]	CAR [2, 61]
Variables	1	2	3	4
ADJ_SUE (β_1)	0.061***	−0.010	0.033***	0.026***
	(11.07)	(−0.50)	(11.42)	(2.65)
MARGIN (β_2)	0.008	−0.064***	0.007**	−0.009
	(1.55)	(−3.48)	(2.54)	(−0.99)
ADJ_SUE × MARGIN (β_3)	**−0.033*** **	**0.108*** **	**−0.010** **	**0.022**
	(−3.98)	**(3.68)**	**(−2.15)**	**(1.52)**
CONSTANT	−0.027***	0.043**	−0.016***	−0.023***
	(−5.13)	(2.37)	(−5.82)	(−2.63)
Controls	Yes	Yes	Yes	Yes
No. of obs.	26,349	26,349	26,299	26,299
Adj. R^2	0.059	0.019	0.081	0.015

difference between these two coefficients (β_3) is significant across the two subsets of announcements with high versus low IVOL (i.e., the difference in β_3 = 8.5%, *t*-ratio = 2.60). Together, the evidence in Panel A indicates that higher margin requirements lead to greater underreaction (i.e., significantly smaller CAR(0,+1) and larger CAR(+2,+61)) for stocks with greater arbitrage risk embodied in high IVOL. This evidence provides further support for the leverage constraints channel, as opposed to the excess speculation channel.[35]

B. Positive Versus Negative Earnings Surprises

During the majority of our sample period, the initial margin required on stock purchases and short sales was identical. However, while margin requirements affected both long and short positions in the same way, one might expect investor responses to be different for positive versus negative earnings news, due to restrictions on short selling. A significant literature shows that short sellers facilitate price discovery by incorporating negative information contained in earnings news into prices. Therefore, it is crucial to investigate whether the impact of margin requirements is different for investors' response to positive versus negative news.[36]

In Section A.4.f of the Supplementary Material, we account for potentially differential market responses to earnings news that is either large and positive or large and negative, by estimating an expanded version of equation (1). The results appear in Table A13 in the Supplementary Material. This evidence provides further support for our main analysis and conclusions by showing that higher margin requirements attenuate the initial market response to earnings news while exacerbating PEAD, albeit in opposite directions, for subsets of earnings surprises that are large positive versus negative. These results are in line with the view that higher margin requirements limit the ability of arbitrageurs to trade around large earnings surprises that are either positive or negative, and thereby delay the incorporation of both good news and bad news into stock prices.

VIII. Margin Requirements and an Alternative Measure of Market Efficiency

In this section, we analyze the impact of margin requirements on the Hou and Moskowitz (2005) measure of price delay during our sample period. Similar to PEAD, this delay measure reflects the speed of stock price adjustment to the arrival of new information, and thus captures the magnitude of investor underreaction in the market. However, unlike PEAD, this measure reveals the delay in stock price reaction to the arrival of economy-wide information embodied in market returns,

[35]In unreported tests, we also analyze whether the impact of margin requirements on the market's underreaction to earnings news (i.e., β_3) is further exacerbated when the attention of arbitrageurs is limited by a larger number of announcements on the same day (Hirshleifer, Lim, and Teoh (2009)). However, we find no significant difference in the main interaction term (β_3) across subsets of events with a high versus low number of same-day announcements.

[36]See Section A.4.f of the Supplementary Material for more background on short selling activity during our sample period, along with details regarding the margin requirements that pertained to long and short positions at the time.

rather than firm-specific news around earnings announcements. If higher margin requirements are truly associated with less efficient markets, then we would expect a greater delay in the adjustment of stock prices to market-wide information, as well as to earnings news.

This price delay measure is computed each month by estimating the following two regression models on weekly firm-specific returns over the previous 12 months:

$$R_{iT} = \beta_0 + \beta_1 R_{m,T} + \varepsilon_{iT}, \tag{3}$$

$$R_{iT} = \beta_0 + \beta_1 R_{m,T} + \beta_2 R_{m,T-1} + \beta_3 R_{m,T-2} + \beta_4 R_{m,T-3} + \beta_5 R_{m,T-4} + \varepsilon_{iT}, \tag{4}$$

where the dependent variable (R_{iT}) is the weekly return on stock *i* during week *T*, while $R_{m,T}$ is the CRSP value-weighted market return during week *T*. For each firm (*i*) during month (*t*), the Hou and Moskowitz (2005) measure of price delay is one minus the ratio of the R^2 from equation (3)) to the R^2 from equation (4)). A *smaller ratio* of R^2 from equation (3)) relative to that from equation (4)) implies *lower market efficiency*, since it reflects a greater delay for the firm's stock price to fully respond to economy-wide information embodied in the prior 12 months of weekly market returns. Accordingly, a smaller ratio of R^2 from equation (3)) relative to equation (4)) means a *larger Hou and Moskowitz (2005) measure of price delay*, and implies greater underreaction and less efficient markets. We first estimate this price delay measure for each firm (*i*) during every month (*t*). We then compute the value-weighted average of this firm-specific price delay measure across all firms (*i*) during month (*t*), as our alternative measure of overall market efficiency. Finally, we regress this monthly average price delay measure against the average level of margin requirements that prevail during the same 12-month period, as follows:

$$\text{AVERAGE\_PRICE\_DELAY}_t = \alpha_1 + \beta_1 \text{ AVERAGE\_MARGIN}_t + \text{CONTROLS} + \varepsilon_t. \tag{5}$$

Table 9 presents the results from estimating equation (5). As we progress from columns 1–3, we include different subsets of control variables that account for various aspects of macroeconomic and stock market conditions, including inflation, the change in the call spread, credit growth, money supply (M1) growth, industrial production growth, an NBER recession dummy, aggregate volatility, turnover, and illiquidity, past cumulative market returns, and the change in the market's price-to-dividend ratio. All independent variables are defined in Table A2 in the Supplementary Material. The dependent variable is the cross-sectional average price delay measure of Hou and Moskowitz (2005) during month (*t*).

In Table 9, the coefficient of margin requirements (β_1) from equation (5) is significantly positive, indicating that higher margin requirements exacerbate the delay with which firm-specific stock prices respond to market-wide information. These results hold across all three columns, indicating that this evidence remains unchanged when we account for the various aspects of macroeconomic and stock market conditions listed previously that may be associated with the Fed's margin

TABLE 9

Margin Requirements and the Price Delay to Market-Wide Information

Table 9 presents the results from relating the average level of margin requirements over a 12-month period to the average price delay across all stocks measured over the same 12-month period, based on Hou and Moskowitz (2005). Each month (t), for every firm (i), we begin by estimating the following two regression models:

$$R_{iT} = \beta_0 + \beta_1 R_{m,T} + \varepsilon_{iT}, \tag{3}$$

$$R_{iT} = \beta_0 + \beta_1 R_{m,T} + \beta_2 R_{m,T-1} + \beta_3 R_{m,T-2} + \beta_4 R_{m,T-3} + \beta_5 R_{m,T-4} + \varepsilon_{iT}, \tag{4}$$

where the dependent variable, R_{iT}, is the return on stock i during week T, while $R_{m,T}$ is the CRSP value-weighted market return during week T. For month (t), the measure of price delay for each firm (i) is one minus the ratio of the R^2 from equation (3) to the R^2 from equation (4). We then aggregate these firm-specific price delay measures across all stocks (i) during month (t), and relate this average measure of price delay (AVERAGE_PRICE_DELAY) to the average margin requirement over the same time frame covering the previous 12 months, as follows:

$$\text{AVERAGE\_PRICE\_DELAY}_t = \alpha_1 + \beta_1\ \text{AVERAGE\_MARGIN}_t + \text{CONTROLS} + \varepsilon_t. \tag{5}$$

In columns 1–3, we include different subsets of control variables to account for different aspects of macroeconomic and stock market conditions, including inflation, the change in the call spread, credit growth, money supply growth, industrial production growth, an NBER recession dummy, aggregate volatility, turnover, and illiquidity, cumulative market returns, and the change in the market's price-to-dividend ratio (as defined in Table A2 in the Supplementary Material). The dependent variable is the cross-sectional average price delay measure of Hou and Moskowitz (2005) during month (t). The sample period covers Oct. 1934 through Sept. 1975. Robust t-ratios are provided in parentheses beneath the parameter estimates (Newey and West, with 12 monthly lags). *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Variables	1	2	3
MARGIN (β_1)	**0.189****	**0.254*****	**0.200*****
	(2.38)	**(4.21)**	**(3.56)**
INFLATION		−0.306	−0.299
		(−1.10)	(−1.08)
ΔCALL_SPREAD		0.068	0.151
		(0.12)	(0.27)
CREDIT_GROWTH		0.111***	0.077
		(3.92)	(1.59)
M1_GROWTH		−0.062	−0.132
		(−0.54)	(−1.08)
IP_GROWTH		0.054	0.078
		(1.16)	(1.51)
NBER_RECESSION_DUMMY		−0.028*	−0.024
		(−1.91)	(−1.65)
AGGREGATE_VOLATILITY			0.510***
			(3.07)
AGGREGATE_TURNOVER			0.753
			(1.22)
AGGREGATE_ILLIQUIDITY			−0.055
			(−1.33)
PAST_MARKET_RETURNS			0.023
			(0.40)
CHANGE_IN_MARKET_PD			−0.000
			(−0.04)
CONSTANT	0.081*	0.054	0.063
	(1.79)	(1.32)	(1.44)
Adj. R^2	0.130	0.387	0.416

policy. This evidence provides further corroborating support for our main results, reinforcing the conclusion that higher margin requirements are associated with greater underreaction to new information, and thus a reduction in market efficiency.[37]

[37]Our results are robust when we compute the price delay measure for each firm using the R^2 from equations (3) and (4) estimated over the prior 6 months of weekly returns, and then regress the resulting cross-sectional average price delay measure against the average margin requirement over the past

IX. Conclusions

We investigate the association between margin requirements and the degree of stock market efficiency, as measured by the speed of price adjustment to new value-relevant information. In our main analysis, we examine a novel hand-collected sample of earnings announcements over the period, 1934–1975, to explore whether the Fed's 22 changes in the level of margin requirements during this era affect the market's tendency to underreact to earnings news. We show that higher margin requirements are associated with less efficient markets, in the form of a smaller initial reaction to earnings news and greater PEAD.

We conduct a battery of tests to distinguish between two alternative potential explanations for these results, a leverage constraints channel and an excess speculation channel. These tests consistently support the leverage constraints channel, but are contrary to the implications of the excess speculation channel. We conclude that higher margin requirements adversely impact market efficiency by constraining the outside capital available for arbitrageurs to a greater extent than they constrain noise trading activity. As a result, informed investors fail to incorporate earnings news into prices in a timely fashion, and are thus prevented from counteracting the tendency for uninformed investors to underreact to this information.

In addition, we explore how this variation in the level of margin requirements during our sample period affects the Hou and Moskowitz (2005) measure of price delay in the market's adjustment to economy-wide news, and we find similar results and conclusions. We also provide further independent analysis of how six alternative indirect measures of leverage constraints affect PEAD, using data that encompass more recent years, and we verify that our main results are again robust. These additional tests provide compelling independent corroboration of the results from our main analysis that examines the impact of margin requirements on the speed of price adjustment to news.

Our study sheds new light on several aspects of market efficiency that have been heretofore unexplored. This analysis establishes that more binding leverage constraints directly exacerbate the market's underreaction to earnings information, in the form of a smaller initial reaction and larger PEAD. This impact of leverage constraints on the market's delayed response to earnings news is exacerbated when limits to arbitrage are more stringent. Finally, our results and conclusions are robust when we control for changes in risk, sentiment, or macroeconomic and stock market behavior that may simultaneously influence the Fed's margin policy, and they hold up when we analyze alternative indirect measures of capital constraints or broader aspects of price efficiency.

Our findings have implications for the margin-setting actors in the market. Our results indicate that higher margin requirements adversely affect price efficiency by restricting the ability of informed investors to react to public news, and thereby preventing them from helping prices to fully adjust in a timely fashion. Hence, despite the expressed intentions of the Fed to limit the perceived undesirable impacts of excess speculation on some aspects of market behavior, there are

6 months in equation (5). Results are also robust when we estimate an alternative version of this price delay measure using daily returns each month.

unintended consequences when the Fed increases margin requirements, and their ultimate benefit should be weighed against their adverse impact on market efficiency.

Supplementary Material

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