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Published in:
Journal of Finance

DOI:
10.1111/jofi.12616

Published: 01/06/2018

Document Version
Peer reviewed version

Please cite the original version:
Jylhä, P. (2018). Margin Requirements and the Security Market Line. *Journal of Finance*, *73*(3), 1281-1321. https://doi.org/10.1111/jofi.12616

Margin Requirements and the Security Market Line

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June 12, 2017

Journal of Finance, forthcoming

Abstract

Between the years 1934 and 1974, the Federal Reserve changed the initial margin requirement for the U.S. stock market 22 times. I use this variation to show that investors leverage constraints affect the pricing of risk. Consistent with the theoretical predictions of Frazzini and Pedersen (2014), I find that tighter leverage constraints result in a flatter relation between betas and expected returns. My results provide strong empirical support for the idea that constraints faced by investors may, at least partially, help explain the empirical failure of the capital asset pricing model.

JEL Classification: G12, G14, N22.
Keywords: Leverage constraints, Security market line, Margin regulation.

*Aalto University School of Business, petri.jylha@aalto.fi. I thank Kenneth Singleton (the editor), two anonymous referees, Stéphane Chrétien, Stefanos Delikouras, Darrell Duffie, Samuli Knüpfer, Ralph Koijen, Ľuboš Pástor, Lasse Pedersen, Joshua Pollet, Oleg Rytchkov, Mungo Wilson, and the participants at American Economic Association 2015, European Summer Symposium in Financial Markets 2016, Financial Intermediation Research Society 2014, Western Finance Association 2016, Aalto University, Copenhagen Business School, Imperial College London, Luxembourg School of Finance, and Manchester Business School for helpful comments.

One of the first and most persistent anomalous findings in finance is that the return difference between high and low beta stocks is significantly smaller than predicted by the capital asset pricing model (CAPM) of Sharpe (1964), Lintner (1965), and Mossin (1966). An early explanation for this empirical flatness of the security market line, originally documented by Black, Jensen, and Scholes (1972), is given by Black (1972) who shows that investors' inability to borrow at the risk-free rate results in a lower cross-sectional price of risk than in the unconstrained CAPM. However, Black's version of the CAPM is unrealistic, as in the real world investors are able to borrow, just not in infinite amounts as is assumed in the CAPM. This idea is further developed by Frazzini and Pedersen (2014) who present a model where investors face a limit on their leverage. In their model, the slope of the security market line, the return difference between high and low beta stocks, depends on the tightness of the investors' leverage constraints: a tighter leverage constraint results in a flatter security market line.

Despite the theoretical and intuitive appeal, convincing empirical evidence of leverage constraints affecting the security market line is lacking. This is partially driven by the difficulty of locating an appropriate measure of the tightness of these constraints. A commonly used measure in the funding constraints literature is the spread between Eurodollar and Treasury bill rates, also known as the TED spread. Such an interest rate spread, however, is endogenous to the investors' portfolio choice problem, and does not directly measure the constraint on maximum leverage, but can rather be seen as a proxy for the cost of that leverage. Also, the empirical evidence in Cohen, Polk, and Vuolteenaho (2005) and Frazzini and Pedersen (2014) shows that a higher interest rate spread—typically used in the literature to indicate a tighter funding constraint—does not result in a flatter security market line as the theory would predict.

In this paper, I use a direct measure of investors' leverage constraints and provide strong and robust empirical evidence in support of the theoretical prediction that tighter leverage constraints result in a flatter security market line. My measure of leverage constrains is based on the active management of the minimum initial margin requirement by the Federal Reserve. Pursuant to the Securities Exchange Act of 1934, the Federal Reserve, in its Regulation T, sets the minimum level of initial margin required when purchasing common stock on credit on U.S. stock exchanges.[1] Between October 1934 and January 1974, this margin requirement was changed 22 times and ranged between 40% and 100%. This frequent and sizable variation in a federally mandated leverage constraint provides an excellent setting for testing whether such constraints affect asset prices.

The main results of this paper are as follows. First, I show that the margin requirement

[1]The initial margin requirement dictates the minimum value of collateral needed when purchasing stock. For example, a 40% initial margin requirement means that an investor can borrow up to 60% of the cost of a new stock purchase.

significantly affects investors leverage but is largely uncorrelated with other prevailing and future financial market and macroeconomic conditions. These findings establish that the federally set margin requirement is a useful measure of investors' leverage constraints and not merely a proxy for the overall state of the economy.

Second, and most importantly, I find that the slope of the security market line is negatively dependent on the prevailing margin requirement. Similarly, the intercept of the beta–return relation is positively dependent on the margin requirement. These findings are in accordance with the theoretical prediction of Black (1972) and Frazzini and Pedersen (2014). Figure 1 provides a simple illustration of these main results. It depicts the security market lines for three sub-samples of data: periods of low, medium, and high initial margin requirement. The difference between the security market lines during low and high margin requirement is striking. When the margin requirement is low (between 40% and 55%) the empirical security market line runs very near its CAPM prediction. During periods of high (75%-100%) initial margin requirement, the empirical security market line differs significantly from that predicted by the CAPM, and actually has a negative slope. This graph provides a simple but powerful summary of the main result of this paper.

[Figure 1 here]

Third, using different test assets, control variables, and estimation techniques, I show that the results are very robust. In all specifications, the effects of leverage constraints on the security market line have the predicted sign, and are statistically significant. In the most interesting specification, one that is closely related to the analysis of Frazzini and Pedersen (2014), I include the difference between investors' borrowing and lending rates, a measure of the cost of leverage, as an additional explanatory variable. The results confirm what is discussed above: the interest rate spread does not explain the slope of the security market line, nor does it affect the explanatory power of the margin requirement.

These results are somewhat at odds with those reported by Frazzini and Pedersen (2014). They use the empirically documented flatness of the security market line to motivate a trading strategy of betting against beta, which delivers high and consistent risk-adjusted returns across asset classes. To connect the profitability of this strategy to leverage constraints, they regress the betting against beta returns on their proxy of such constraints: the aforementioned TED spread. As the theory predicts that a tighter leverage constraint results in a flatter security market line, which in turn results in higher betting against beta returns, one would expect the strategy returns to be positively correlated with the TED spread. This, however, is not the case. The authors find a strong negative correlation between the strategy returns and the TED spread, which would imply that the security market line is, indeed, steeper during more binding leverage constraints, not flatter as is predicted by their model.[2] My results clearly show that tighter leverage constraints result in a flatter security market line, consistent with the theoretical model of Frazzini and Pedersen (2014).

In an interesting recent paper, Bali, Brown, Murray, and Tang (2016) argue that the security market line flatness is driven by investors' demand for lottery-like stocks rather than by leverage constraints. They arrive at this conclusion by showing that the betting against beta returns disappear after controlling for lottery demand, measured by the average of the five highest daily returns of the stock during the previous month. My results provide an alternative vantage point to this discussion. Margin requirements should have little to do with investors' lottery preferences but are a key contributor to leverage constraints. Hence, the finding that a higher margin requirement results in a flatter security market line provides strong evidence in support of the leverage constraint explanation.[3]

This work is related to a stream of empirical papers examining the factors that affect the shape of the security market line. Cohen, Polk, and Vuolteenaho (2005) test whether investors suffer from "money illusion" ((Modigliani and Cohn, 1979)) by examining the effect of inflation on the security market line. Consistent with the Modigliani-Cohn hypothesis, they find a negative relation between the level of inflation and the slope of the security market line. The empirical design of this paper closely follows that of Cohen, Polk, and Vuolteenaho (2005). Hong and Sraer (2016) show that aggregate disagreement affects both the slope and concavity of the beta-expected return relation, and Antoniou, Doukas, and Subrahmanyam (2016) find that the security market line is flatter during periods of high investor sentiment. Huang, Lou, and Polk (2014) construct a measure of speculative capital committed to betting against beta, and show that when this measure is high, the security market line tends to have a low, or even negative, slope.[4] Savor and Wilson (2014), in turn, show that the security market line is much steeper on macroeconomic announcement days than on non-announcement days.

In providing empirical support for a constrained version of the CAPM, this paper also connects to the recent literature that shows non-return-based evidence in support of a single-factor model. Barber, Huang, and Odean (2016) and Berk and van Binsbergen (2016) find that mutual fund flows are best explained using the single factor CAPM rather than a more sophisticated model or more

[2] Cohen, Polk, and Vuolteenaho (2005) also show that a higher interest rate spread does not produce a flatter security market line.

[3] It should also be noted that investors' lottery demand spikes in January (Doran, Jiang, and Peterson, 2012), and stocks with strong lottery characteristics—such as high maximum daily return (Bali, Cakici, and Whitelaw, 2011) or high idiosyncratic volatility (Ang, Hodrick, Xing, and Zhang, 2006)—tend to have very high January returns. If lottery demand fully explained the security market line flatness, the betting against beta returns should be very low in January when investors flock to buy high beta stocks. Empirically, this is not the case, and the average January return of the strategy does not differ from the average of the other months.

[4] In the regressions below, I control for these and other potential explanations for security market line flatness and show that my results are robust to the inclusion of additional control variables.

factors. The results in this paper show that the empirical rejection of the unconstrained CAPM in return-based tests is, at least, partially due to leverage constraints faced by investors.

Finally, this paper relates to the literature examining the effects of the federal margin regulation on stock market volatility and on the use of credit to purchase securities. Starting from Moore (1966) and Officer (1973), the nearly unanimous conclusion in the literature is that margin regulation has no impact on market volatility (see Ferris and Chance, 1988, Kupiec, 1989, Schwert, 1989, and Hsieh and Miller, 1990). Kupiec (1997) provides an extensive review of this literature. Moore (1966) and Hsieh and Miller (1990) report that an increase in the margin requirement leads to a decrease in the amount of margin credit. To my knowledge, this is the first paper to study the asset pricing implications of the Regulation T margin requirements.

The rest of the paper is organized as follows. Section I provides a theoretical motivation for the paper, and Section II describes the margin regulation in the U.S. stock market. Section III introduces the estimation of the security market line, Section IV presents the empirical results, and Section V concludes.

I. Asset Pricing with Margin Constraints

The idea that portfolio constraints affect the equilibrium relation between risk and expected return is not new. Black (1972) shows that in a model with no risk-free borrowing, the security market line is flatter than in the CAPM. A more realistic assumption, however, would be that at least some investors can borrow, but their maximum level of leverage is exogenously restricted. This is the key assumption in the model of Frazzini and Pedersen (2014) which also serves as the main theoretical motivation for this paper. Their model features overlapping generations of investors who face a realistic margin constraint: an investor's total investment in risky securities cannot exceed the fraction $1/m$ of her total wealth. Frazzini and Pedersen (2014) consider a model where the margin requirement, m, can vary across investors. Here, I focus on a simplified case where all investors are subject to the same m. This framework is also consistent with the empirical setup of the paper, which uses a marketwide margin requirement as a measure of leverage constraints.

If $m = 0$, the portfolio constraint will never bind and the model reduces to the CAPM, whereas $m = 1$ implies that the investor cannot borrow in the risk-free assets, as in Black (1972). If $m > 1$, the investors are forced to hold part of their wealth in the risk-free asset. The most interesting, and realistic, case is $0 < m < 1$, which implies that the investors can use leverage, but face a margin requirement that limits the maximum amount of leverage. A margin requirement of $m \times 100\%$ means that the investor's own capital must make up at least $m \times 100\%$ of her total investment in risky securities. Hence, her total investment is limited to $1/m$ times her total wealth and the m in the model is equivalent to a real world margin requirement. For example, if the margin requirement is $m = 40\%$, an investor with \$1 to invest can deposit the \$1 on a margin account and borrow up to \$1.5 and invest the total amount in risky securities. Now, the margin (\$1) equals 40% of the total invested amount (\$2.5) and the investor's investment in risky assets is $1/0.4 = 2.5$ times her wealth.

Intuitively, the margin requirement will affect asset prices in the following manner. In an unconstrained CAPM world (where $m = 0$ and $1/m = \infty$), an investor with very low risk aversion borrows heavily in the risk-free asset and invests in the market portfolio of risky assets. However, in the constrained world, she is not able to do so, as the maximum amount of leverage is limited by the margin requirement. As she is no longer able to achieve her desired risk level by leveraging her investment, she does so by investing in a portfolio with beta greater than one, not the market portfolio. Such behavior by constrained investors seeking higher portfolio risk creates higher demand for high beta stocks than in the unconstrained CAPM case. In equilibrium, this results in higher prices and lower expected returns for high beta stocks. Similarly, in the constrained case, the demand for low beta stocks will be lower and their expected return higher than in the unconstrained case. This makes the security market line flatter in the presence of leverage constraints.

Formally, the relation between expected excess return and beta, or the security market line, under margin constraints is given by

$$E\left(r_s^e\right) = \psi\, m + \beta_s \left[E\left(r_M^e\right) - \psi\, m\right], \tag{1}$$

where ψ is the average shadow price of the margin constraint in the investors' portfolio optimization problem.[5] In the absence of a margin requirement, when $m = 0$, the security market line in reduces to its CAPM form. As $\psi \geq 0$, it is straightforward to see from Equation (1) that, other things being equal, a higher margin requirement results in a higher intercept and a lower slope of the security market line. Below I use time-variation in federally mandated minimum initial margin requirement, a direct measure of m in the model, to show that this prediction holds empirically.

Frazzini and Pedersen (2014) use this model mainly to motivate a betting against beta (BAB) trading strategy that goes long a portfolio of low beta assets and shorts high beta assets. The long and short legs are weighted by the reciprocals of their betas to make the resulting portfolio ex ante beta neutral. In their empirical work, Frazzini and Pedersen show that such a strategy yields positive risk-adjusted returns in a number of asset markets.

To connect the profitability of the trading strategy to the leverage constraints, the authors regress the BAB strategy returns on the Treasury-over-Eurodollar spread (TED spread). The

[5]The appendix provides the derivation of the security market line.

TED spread is often used in the literature as a measure of leverage constraints.[6] As the BAB returns are higher when the security market line is flatter, which according to the theory is a result of tighter leverage constraints, one should expect to find a positive correlation between the TED spread and the profitability of betting against beta. This, however, is not what Frazzini and Pedersen (2014) find. On the contrary, they find a negative and statistically very significant correlation between the lagged level of the TED spread and the BAB returns, which seems to be in direct contrast with the theoretical prediction. They also find a negative and significant correlation between the contemporaneous change in the TED spread and the BAB returns. They interpret these findings as both explanatory variables being proxies for the change in funding conditions, that is, a higher lagged level of and a contemporaneous increase in the TED spread imply tightening leverage constraints. This may be a reasonable interpretation of the change in the TED spread, but not necessarily so for the level of the spread, as it is commonly used as a measure of funding conditions, not a measure of change in funding conditions.[7]

The TED spread, however, is not an optimal measure for the exogenously imposed leverage constraint, which is the key ingredient of the theoretical model. First, rather than the maximum limit on investors' leverage, the TED spread is more likely to measure the costs for investors from obtaining the leverage. Frazzini and Pedersen (2014) implicitly posit that higher and increasing funding costs will lead a broker to increase the margin requirements it has set for its customers. A more plausible conjecture would be that the broker increases the interest rate it charges on margin lending rather than lower the amount it lends. Hence, the TED spread is more plausibly a proxy for the spread between the borrowing and lending rates faced by the investors. However, in the model, borrowing carries the same interest rate as lending, but leverage is capped. What affects the security market line in the model is hence the constraint on maximum leverage, not the cost of obtaining that leverage.[8]

Second, as a difference between two yields, the TED spread itself is derived from asset prices

[6] Papers using the TED spread as a measure of leverage constraints include Asness, Moskowitz, and Pedersen (2013), Moskowitz, Ooi, and Pedersen (2012), Cornett, McNutt, Strahan, and Tehranian (2011), Ranaldo and Söderlind (2010), Gârleanu and Pedersen (2011), Brunnermeier, Nagel, and Pedersen (2009), and Brunnermeier and Pedersen (2009).

[7] In unreported analyses, I find that the lagged level and the contemporaneous change of the TED spread do have an effect on the margin credit extended to their customers by NYSE brokers and dealers. In a regression of the changes in margin credit on the lagged TED spread and the contemporaneous change in the spread, both variables have statistically significantly negative coefficients, consistent with the conjecture of Frazzini and Pedersen (2014). The negative effect of the lagged TED spread on changes in margin credit is, however, mainly due to the high spread and contraction in credit during the financial crisis of 2007-2008. In the case of the negative contemporaneous relation between changes in the TED spread and margin credit, the direction of causality and the potential role of omitted confounding variables remain open questions.

[8] In section IV.C, I show that the relation between my measure of leverage constraints and the security market line is robust to including a direct measure of investors' leverage cost as a control variable.

and is hence an outcome of the investors' portfolio choice problem. Thus, for example, changes in investors' risk preferences or expectations could simultaneously affect both the TED spread and the shape of the security market line, without any mechanism involving leverage constraints. This is especially critical when contemporaneous changes in the TED spread are used to explain asset returns. Third, Nagel (2016) shows that the TED spread measures the liquidity premium in Treasury bills, which has little to do directly with the limit on investor's maximum leverage. In this paper, I study the relation between leverage constraints and the security market line using a direct measure of the constraint that is not based on asset prices, but on the minimum margin requirements set by the Federal Reserve.

II. Margin Regulation in the U.S. Stock Market

A. History of Margin Regulation

The Federal Reserve's control over margin requirements is based on the Securities Exchange Act of 1934. The Act bestows the responsibility for regulating the amount of credit that can be used for purchasing and carrying securities on the Board of Governors of the Federal Reserve System.[9] This move reflected the widely held view that unregulated stock market credit had resulted in excessive leverage which fueled the stock market boom in the 1920's, and that the subsequent margin calls had exacerbated the market crash in 1929 (Hsieh and Miller, 1990). There was also a concern that loans extended to investors could crowd out loans to businesses and farmers.

Pursuant to the Securities Exchange Act, the Fed Board regulates margin borrowing by setting a minimum level for the initial margin that the lenders must require. The margin requirements are set in Regulation T, which governs the lending by brokers and dealers.[10] Analogous to the m in the model presented above, an initial margin corresponds to the amount of cash, or other collateral, investors must put down when purchasing stocks. For example, a 45% initial margin requirement means that investors can borrow up to 55% of the cost of a new investment in stock. Hence, a higher margin requirement directly translates into a tighter borrowing constraint. The Fed Board does not regulate the maintenance margin which dictates the minimum amount of collateral required at every point in time to carry the position. Also, the lenders are naturally allowed to require higher initial margins than what is set in the federal regulation.

Importantly from an econometrician's point of view, the initial margin requirement in Regu-

[9]In line with common conventions, I use the terms "Fed Board" and "Board" instead of the formal "Board of Governors of the Federal Reserve System."

[10]Regulations U and X, and formerly G, apply similar margin requirements to borrowing from banks and other non-broker-dealer lenders.

lation T has not remained constant since its inception. Following the guidelines set forth in the Securities Exchange Act, the Fed Board changed the requirement 22 times between 1934 and 1974. The margin requirement has remained unchanged at 50% since January 1974. Table I and Figure 2 present the time series of the margin requirement changes and level.[11] As is evident, the initial margin requirement shows frequent and substantial variation over time. At its lowest, the initial margin requirement was 40%, implying that for every $1 of capital an investor could purchase up to $2.5 worth of stocks. At its highest, the requirement was 100%, from January 1946 to January 1947, completely forbidding new borrowing for purchasing stocks. This range of variation indicates that the changes in Regulation T significantly altered the leverage constraints faced by investors.

[Table I and Figure 2 here]

During the sample period of this paper (from October 1934 to September 1975) stocks in the U.S. were predominantly held by households. The average level of household ownership of stocks between 1945 and 1975 was 84.7% while domestic institutions—mainly private pension funds, insurance companies, and mutual funds—held 12.8% and foreigners only 2.5% of US stocks.[12] For comparison, the same figures for 2015 are 37.3%, 46.7%, and 16.0%, respectively. The high household ownership of stocks makes the Regulation T initial margin a highly relevant leverage constraint for the whole market during the sample period, as households do not face other exogenous leverage constraints like many institutional investors do.

Today, the overall picture of investors' leverage constraints is complicated by, for example, access to derivatives, regulations that apply only to some market participants (such as limits on mutual funds' use of leverage in the Investment Advisers Act of 1940), the use of offshore or joint back office arrangements to circumvent the Regulation T margins (especially in the case of hedge funds), and the use of portfolio margining which allows for lower margin requirements especially in portfolios that hold derivatives. These complications, however, either did not exist or did not have a sizable impact during the sample period used in this paper. Mutual funds were relatively small, holding, on average, only 3.2% of the stocks, compared to 20.5% in 2015. Portfolio margining was introduced in 2005, joint back office arrangements in 1998, and any offshore accounts were marginal as they are included in the 2.5% average foreign ownership. Simply put, during the sample period,

[11] Between October 1, 1934 and March 31, 1936, the margin requirement was dependent on the stock's price development over the preceding 3-year period in a counter-cyclical manner. Hence, for this period, the minimum margin requirement was a range rather than a single number. In accordance with the previous literature and the Federal Reserve and the NYSE statistics, I use the highest value of the range for this time period. The counter-cyclical margin requirement was abandoned in March 1936 due to it being unnecessarily complicated for lenders to manage. Since April 1, 1936, the margin requirement has been expressed as a single number.

[12] This data is from Table L.223 of the flow of funds accounts and begins in 1945. The data is available online at https://www.federalreserve.gov/releases/z1/current/data.htm.

investors' leverage constraints were more straightforward than presently and were predominantly dictated by the initial margin requirement in Regulation T.

It is important to note that the purpose of this paper is not to argue that the Regulation T initial margin requirement is the only relevant leverage constraint faced by investors. Rather, the purpose is to use the variation in the Regulation T margin requirements to identify the effect of leverage constraints on the pricing of risk. In today's financial markets, with different investors facing very different leverage constraints, such identification would be very difficult, if not impossible.

Consistent with the theories of Black (1972) and Frazzini and Pedersen (2014), Section IV below shows empirically that a higher level of the initial margin requirement results in a flatter security market line. However, before using the changes in the minimum initial margin requirements to identify the effects of leverage constraints on asset prices, it is important to understand the reasons behind the margin requirement changes themselves. Specifically, the margin requirement should have two particular empirical properties in order to be a useful measure of the leverage constraints faced by investors. First, the changes in the margin requirement should not reflect strongly such economic or market conditions that also affect the investors' expectations or preferences, and hence the security market line. The potential concern here could be that any correlation between the margin requirement and the security market line could merely be a reflection of the former being a proxy for prevailing economic or market conditions. Second, the margin requirement should have a significant impact on the investors' ability to obtain leverage. To show that these two conditions hold, subsection B shows that the changes in the margin requirement do not depend heavily on the past market and macroeconomic variables, and subsection C shows that changes in the margin requirement forecast the future development of margin credit, but no other market or economic variables.

B. Determinants of Margin Regulation Changes

To understand the relation between the margin requirement and economic and market conditions, it is useful to start from the reasons provided for changing the margin requirement. According to Section 7 of the Securities Exchange Act of 1934, the Federal Reserve should "from time to time" adjust the margin requirements "for the purpose of preventing the excessive use of credit for the purchase and carrying of securities." The same section states that higher margin requirements should be prescribed when "necessary or appropriate to prevent the excessive use of credit to finance transactions in securities" but provides no indication regarding what level of credit should be considered excessive, or what are the potential adverse effects of excessive credit. Lower margin requirements should be prescribed when "necessary or appropriate for the accommodation of commerce and industry, having due regard to the general credit situation of the country."

To better understand the motivations behind each of the 22 margin requirement changes over the 41 year period, I review the Records of Policy Actions provided in the annual reports of the Fed Board.[13] These records provide detailed descriptions of and rationales for various policy actions, including changes to the margin requirements. Broadly, the reasons provided for the margin requirement changes can be grouped as relating to either the changes in stock market credit, the changes in market prices of stocks, the levels of speculative activity, or the overall inflationary pressure. Table 1 lists the reasons provided for each margin requirement change by the Board.

Developments in stock market credit are mentioned as a reason 21 out of the 22 times the Fed Board changed the minimum initial margin requirement in Regulation T. This is not surprising, given the explicit focus on excessive use of credit in the Securities Exchange Act. Indeed, a strict reading of the Act would imply that the Board only has a mandate to increase the margin requirement to prevent margin credit growing to excessive levels, not for any other reason. However, market returns are used by the Board in 12 cases to justify the margin changes in a counter-cyclical manner: higher margins are applied following increases in stock prices. The Board also mentions changes in speculative activity as a partial reason for 10 margin requirement changes.[14] Interestingly, the Board never gives any indication of how it measures speculative activity or why that activity should be curbed by higher margin requirements. Finally, overall inflationary pressure in the economy is cited as a reason for changing margin requirements in five cases.

To quantify the relation between the change in the minimum initial margin requirement and the prevailing market and economic conditions, I regress the former on a number of measures of the latter and report the results in Table II. In the first column of the table, the dependent variable is simply the change in the margin requirement in month t. The second and third columns present the results of a multinomial logit regression for an increase and decrease of the margin requirement. The explanatory variables are motivated by the above analysis of the Fed Board's reasons for changing the margin requirement. These are the change in the logarithm of the margin credit from month $t-13$ to $t-1$, the stock market returns from month $t-13$ to $t-1$ and from month $t-37$ to $t-13$, the volatility and skewness of the daily stock market returns measured from month $t-13$ to $t-1$, the value-weighted average daily turnover of the NYSE listed stocks over the period from month $t-13$ to $t-1$, the price-to-dividend ratio of the S&P Composite Index in month $t-1$, and the changes in the logarithms of the consumer price index, the M1 money supply, and the industrial

[13] All the annual reports of the Board of Governors of the Federal Reserve System are available online at https://fraser.stlouisfed.org/title/117.

[14] References to price developments and market activity in the decisions to change the margin requirement caused occasional disputes among the Board, with governors dissenting from decisions and the legal counsel advising the Board to adhere to the standards of the Securities Exchange Act (Meltzer, 2003).

production from month $t-13$ to $t-1$.[15] The explanatory variables are standardized for ease of comparability.

[Table II here]

Three important conclusions arise from the results in Table II. First, the changes in the margin requirement are significantly positively affected by the changes in margin credit. This is consistent with the requirement of the Securities Exchange Act that the Fed Board uses the margin requirement to prevent excessive use of margin credit, as well as the fact that almost every change to Regulation T was motivated by the preceding developments in the amount of credit. In column 1, the coefficient of the credit change is 0.007, implying that a one-standard deviation change in stock market credit (24%) results in, on average, a 0.7% increase in the margin requirement. This corresponds to 17% of the standard deviation of margin requirement changes (3.9%). In the multinomial logit model, the change in margin credit also has a statistically significant effect on the probability of a margin increase. However, the credit growth does not significantly affect the probability of margin decreases, even though it has the predicted negative sign.

[Figure 3 here]

Figure 3 further exhibits the relation between changes in margin credit and the Fed Board's decisions to change the minimum initial margin requirement. The figure plots the average cumulative change in margin credit 12 months before and after margin requirement increases (solid line) and decreases (dashed line). In the 12 months leading up to an increase in the margin, the amount of credit grows by 33.9% on average, whereas an average margin decrease is preceded by a 12.6% decrease in credit. Following the margin changes, the trend in credit growth strongly reverts. The effects of margin changes on future developments in credit, and other market and macroeconomic variables, are studied further in subsection C below.

Second, also past returns affect the Fed Board's decisions to change the margin requirement. In the OLS model (the first column), the market return measured over the previous 12 months has a

[15] The data on margin credit is collected from Federal Reserve Board (1976a,b) and the NYSE Facts and Figures database. The margin credit time series is constructed by chaining the following time series: "customers' debit balances (net)" in Table 143 in Federal Reserve Board (1976a) from October 1934 to December 1941,"customer credit, net debit balances with NYSE firms" in Table 12.23 in Federal Reserve Board (1976b) from January 1938 to December 1967, and "margin debt" from NYSE Facts and Figures online database (http://www.nyxdata.com/nysedata/asp/factbook/main.asp) from January 1959 to September 1975. These three data sources partially overlap each other, allowing me to check that the data is consistent across the sources. Stock return and volume data is from CRSP. The price-to-dividend ratio for the S&P Composite Index is from Robert Shiller's website (http://www.econ.yale.edu/ shiller/data.htm). The macroeconomic data is from the Fred database maintained by the Federal Reserve Bank of St. Louis (https://research.stlouisfed.org/fred2/).

positive and statistically significant effect on the margin changes. This implies that the Board has practiced a counter-cyclical policy where margins are increased as a response to increasing stock prices. Third, no other variable (with the exception of the growth in industrial production) affects the Board's decisions to change the margin requirement.

Overall, these results indicate that the margin requirement is not merely a projection of prevailing financial market and macroeconomic conditions. However, in the empirical analysis below, these market and macro variables are included as controls when studying the effect of margin requirements on the security market line.

C. Effects of Margin Regulation Changes

As mentioned above, for it to be a useful measure of investors' leverage constraints, the federally mandated margin requirements should affect investors' ability to borrow to finance their stock purchases. Given that the explicit goal of margin regulation is to control the amount of credit, it is not surprising that Hsieh and Miller (1990) find that an increase in the Regulation T margin requirement results in a decrease in margin credit. The first and fifth columns of Table III confirm their finding, reporting the results of regressing the change in margin credit on the lagged change in the margin requirement:

$$\Delta credit_{t:t+k} = a + b\,\Delta margin_{t-1:t} + e. \tag{2}$$

[Table III here]

The b coefficient in this regression is negative and statistically significant both for $k = 1$ and $k = 12$. This implies that, consistent with the spirit of the Securities Exchange Act and the findings of Hsieh and Miller (1990), an increase in margin requirements lowers the amount of credit used to purchase and carry stocks both in the short and the long term. This effect is also visible in Figure 3, where margin increases (decreases) are followed by an average 1.7% decrease (3.8% increase) in credit over the next month, and 14.6% decrease (16.8% increase) over the next year. In addition to statistical significance, these results are also economically large.

The strong relation between margin requirement and credit is also echoed in the contemporary commentary of the Fed Board's decisions to alter Regulation T. For example, the Board commented on its February 1953 action to decrease the margin by: "Stock market credit expanded immediately following the relaxation of margin requirements and stabilized thereafter. Such credit has not been large in amount for more than two decades."[16] The July 1945 decision to increase the margin was

[16] *Annual Report of The Board of Governors of the Federal Reserve System*, 1953.

later called "an important factor in restraining increase in credit."[17]

This result confirms that the federal margin regulation is a useful measure of leverage constraints, as it significantly affects the availability of leverage for investors. A finding of no relation between the margin requirement and margin credit would imply that the leverage constraint does not bind for sufficiently many investors for the regulation to have significant impact. However, the result here shows that the leverage constraint does bind, and the changes in the margin requirement affect investors' access to credit.

One potential concern regarding the use of the Regulation T margin requirement as a measure of leverage constraints is that, as an initial margin requirement, it only affects new levered purchases of stocks, not existing positions. Consequently, the effects of Regulation T may take time to materialize. However, it should be noted that Regulation T contains a component—the so called retention requirement—which makes the initial margin requirement changes also affect existing positions. To understand the retention requirement, it is useful to note that there are three types of margin accounts. Accounts whose equity ratio is above the initial margin are known as unrestricted accounts. More stocks can be purchased into an unrestricted account using the buying power of the excess equity until the account's equity ratio is equal to the Regulation T initial margin. An account whose equity value is below the maintenance margin receives a margin call, and has to be refinanced so that the equity ratio is at least equal to the Regulation T margin. Between these two are the so called restricted accounts. The equity ratio of a restricted account is higher than the maintenance margin, but lower than the initial margin.

The retention requirement affects these restricted accounts. The retention requirement stipulates that whenever stocks are sold from a restricted account, a certain fraction of the proceeds must be used to pay back the margin debt. The retention requirement was included in Regulation T on March 21, 1938, and is still in place. Until June 15, 1959, the retention requirement was equal to the initial margin requirement. This implies that if the initial margin was 60%, a holder of a restricted account had to spend at least 60% of any sales proceeds to pay back her margin debt. After June 1959, the retention requirement has been set separately by the Board. The retention requirement makes initial margin changes affect existing accounts in two ways. First, increasing the initial margin also increases the fraction that holders of restricted accounts must use to pay back their debt, directly affecting the portfolio leverage. Second, increasing the initial margin makes new accounts restricted, as the equity ratio cutoff for restricted accounts is increased. Due to these mechanisms, the changes in Regulation T initial margins affect not only new levered purchases, but also a part of the existing levered portfolios.

As the Regulation T margin requirement is offered here as an alternative to using an interest

[17] *Annual Report of The Board of Governors of the Federal Reserve System*, 1945.

rate spread as a measure of leverage constraints, it is useful to compare the effects of these two leverage constraint measures on margin credit. As mentioned above, studies focusing on more recent data typically use the TED spread as a proxy for the cost of leverage. Nowadays brokers finance their positions primarily through repos and commercial paper issues (Adrian, Etula, and Shin, 2015) for which the TED spread is a reasonable measure of interest rate spread over the risk-free rate. However, the Eurodollar market became central for the interbank lending only after the sample period used in this paper (October 1934 to September 1975). Also, data on the Eurodollar rate does not extend back beyond the mid-1980's. Hence, it is impossible to include the Regulation T margin requirement changes and the TED spread changes in the same regression.

During the period when the Fed Board actively managed the Regulation T margin requirement, brokers obtained financing primarily from commercial banks in the form of call loans (Rappoport and White, 1993). The benchmark rate on these loans was the brokers' call money rate. This call money rate was the interest rate paid by the brokers for their funding. Hence, the spread between the call money rate and the Treasury bill rate, dubbed here "call spread", provides provides the counterpart of the TED spread for the 1934 to 1975 time period.[18] To study the effect of the cost of leverage on margin credit, I include the change in the call spread as an explanatory variable in Equation (2).

Columns 2 and 6 of Table III show that the changes in the call spread do not significantly predict changes in margin credit. The coefficients of the spread have the predicted negative sign but lack statistical significance. In regressions where both the margin requirement changes and call spread changes are used to predict future margin credit changes (columns 3, 4, 7, and 8), only the margin requirement has a statistically significant effect. This result holds for forecasting one month or one year ahead, and when additional control variables are included in the regression. These results confirm the conjecture above that the margin requirement is a more appropriate measure of leverage constraints than the interest rate spreads.

In addition to its effect on margin credit, another important empirical feature of margin regulation is that it does not affect the riskiness of stocks. A number of authors have studied the effects of the margin requirement on stock market volatility. Initially, Moore (1966), Officer (1973), and Ferris and Chance (1988) find no evidence that the Fed Board's margin regulation would have an effect on stock market volatility. The 1987 stock market crash reinvigorated the discussion whether the Federal Reserve should again take a more active stance in managing the margin requirement. This discussion was further fueled by the finding of Hardouvelis (1990) that a higher margin re-

[18]The data on the brokers' call money rate is from Table 120 of Federal Reserve Board (1976a) from 1934 to 1941, Table 12.23 of Federal Reserve Board (1976b) from 1942 to 1970, and Survey of Current Business from 1971 to 1975. The Survey of Current Business is a monthly publication by the Bureau of Economic Analysis and is available online at http://www.bea.gov/scb/.

quirement actually does result in a lower stock market volatility. This finding is, however, disputed by a number of authors, including Kupiec (1989), Schwert (1989), and Hsieh and Miller (1990) who attribute the finding of Hardouvelis (1990) to flaws in the tests. An extensive review by Kupiec (1997) concludes that there is no undisputed evidence that margin regulation would affect stock market volatility.

[Table IV here]

To reconfirm this result, I regress the one-month and 12-month changes in the volatility of daily stock market returns on the changes in margin requirements and report the results in Table IV. In line with the consensus of the literature, I find no statistically significant impact of margin requirement changes on stock market volatility in the short or the long term. Also, the skewness of the market returns is unaffected by the margin policy changes.

Theoretically, a higher margin requirement could either increase or decrease stock return volatility. On one hand, a higher margin requirement limits speculators' ability to provide liquidity, and hence increases volatility. This concern was voiced by the Wall Street Journal during the preparation of the Securities Exchange Act: "Rigid fixation of minimum requirements threatens to produce disastrous consequences at a time of crisis. Such requirements are most likely to produce the effect of a series of stop-loss selling orders with the absence of any effective demand to meet them. The result can be easily imagined. The effect of the margin provisions in the bill will tend to accentuate in high degree the extent and the violence of these disturbances and cause large losses to the public."[19] Similar skepticism toward margin regulation was echoed by the chairman of the New York Curb Exchange, Edwin Posner, in January 1947 when he commented that the decrease of the margin requirement from 100% to 75% "will have a beneficial effect on broadening the base of the securities markets introducing stability and narrowing the range within which stock prices move."[20]

On the other hand, a higher margin requirement could reduce unhealthy and excessive speculation and build-up of highly levered positions whose de-leveraging in a market downturn could increase market volatility. By limiting such volatility-increasing activities, a higher margin requirement could reduce volatility. This is the view held by the Fed Board prior to ending the management of margin requirements in 1974. In his statement at a congressional hearing in 1955, the Fed chairman William McChesney Martin Jr. noted, "The task of the Board, as I see it, is to formulate regulations with two principal objectives. One is to permit adequate access to credit

[19] "Public Interest Requires Further Changes in Bill," *Wall Street Journal*, March 23, 1934.

[20] "New York Bankers, Brokers Hail 75% Margins as Step in the Right Direction; Say It Should Be 50%," *Wall Street Journal*, January 18, 1947.

facilities for security markets to perform their basic economic functions. The other is to prevent the use of stock market credit from becoming excessive. The latter helps to minimize the danger of pyramiding credit in a rising market and also reduces the danger of forced sales of securities from undermargined accounts in a falling market."[21] The fact that no empirical relation is discovered between margin requirement and volatility, could be a result of the two opposing effects canceling each other out, or both of the effects being too weak to be detected empirically.

The fact that the margin regulation does not have an effect on the fundamental riskiness of the stock market is important for the current study. Below, I show that a higher margin requirement results in a flatter security market line. If a higher margin was also associated with a less risky stock market, this finding could be justified by investors requiring a lower risk premium during less risky times. However, as the margin regulation has no impact on the riskiness of the market, the findings below support the hypotheses that leverage constraints faced by investors have an impact on the security market line. Also, I control for contemporaneous market return in all the regressions below. This captures the time variation in the security market line slope resulting from the time variation in the market risk premium.[22]

Finally, Table IV reports the effect of margin requirement changes on other market and macroeconomic variables. The results show that the changes in the margin have no impact on market returns, trading activity, inflation, money growth, or industrial production. The result of no stock price impact is in line with the contemporary commentary of the policy changes. Fed chairman William McChesney Martin Jr. opened his above-mentioned statement in the 1955 congressional hearing with, "Let me say at the outset that this responsibility of the Board of Governors relates to stock market credit and not to the price of stocks." The Wall Street Journal commented the Board's decision on October 15, 1958, to increase the margin by: "The financial community appeared to take the margin increase in stride, saying that it would have only a slight and shortlived effect on stock prices. Edward T. McCormick, president of the American Stock Exchange, said, 'I think the change is completely meaningless. I said at the time of the last increase (August 5) that it would have no impact on the market. I believe that has been proved by subsequent events.'"[23]

Overall, the fact that the margin changes are uncorrelated with future market and macroeconomic conditions is favorable for this study. Below, I show that the security market line slope is significantly correlated with the prevailing margin. Given that the margin is not correlated with

[21] "Statement of Wm, McC. Martin, Jr. Chairman, Board of Governors of the Federal Reserve System, at hearings on the study of the stock market before the Senate Committee on Banking and Currency, Monday, March 14, 1955," available online at https://fraser.stlouisfed.org/title/448.

[22] Table VII shows that adding the contemporaneous market volatility as a control variable does not affect the key results of this paper.

[23] "Stock Margins Hiked to 90% From 70%, High Since '47; Record Stock Market Credit at End of September Cited," *Wall Street Journal*, October 16, 1958.

general economic conditions, the reported results are unlikely to be an outcome of the margin acting as a proxy for market or macroeconomic conditions. However, I include the market and macro variables as controls in the regressions below.

III. Estimating the Security Market Line

The empirical strategy of this paper closely follows the efficient methodology developed by Cohen, Polk, and Vuolteenaho (2005) for a similar setup. I first sort stocks into portfolios based on their historical betas. Then, for every month, I estimate the cross-sectional relation between the portfolios' ex ante betas and realized returns. This yields a monthly series of security market line intercepts and slopes. Finally, in time series, I regress the intercept and the slope on the prevailing initial margin requirement and controls. The results clearly indicate that a high initial margin requirement results in a low security market line slope and a high intercept, consistent with the theoretical predictions of Black (1972) and Frazzini and Pedersen (2014) that leverage constraints flatten the security market line.

As the goal is to study the the relation between CAPM betas and returns, I first construct a set of test assets that has a large spread in terms of betas. For every month, I calculate betas for all the NYSE-listed common stocks of U.S. domiciled corporations in the CRSP file by regressing the stocks' monthly returns in excess of the risk-free rate over the past three years on the value-weighted CRSP index return.[24] I then rank the stocks on the basis of the estimated betas and form 20 equally sized portfolios. The first portfolio contains the five percent of stocks with the lowest betas, and the 20th portfolio contains the five percent of stocks with the highest betas.[25]

Second, I estimate monthly betas for the 20 beta-sorted portfolios by regressing the value-weighted portfolio returns over the past 36 months on the value-weighted CRSP index return. The portfolios provide a set of test assets that has a wide range of postformation betas. The estimated beta of the first portfolio ranges between 0.2 to 1.0 while that of the 20th portfolio takes values between 1.3 to 2.2. The difference between the highest and lowest betas has an average of 1.2, and ranges between 0.6 and 2.2.

Third, I estimate the cross-sectional relation between the ex ante betas and the realized returns

[24] I exclude NASDAQ and Amex listed stocks as data availability on them is limited during the sample period, October 1934 to September 1975. CRSP has data on Amex stocks starting in July 1962 and on NASDAQ stocks starting in December 1972. To avoid any jumps in the number and types of stocks covered, I focus only on the NYSE-listed stocks, for which CRSP data begins in December 1925. Focusing on NYSE has the added benefit of excluding some of the smallest and most illiquid stocks.

[25] In Table VIII, I show that the results reported below are robust to using either 10 or 40 portfolios instead of 20, constructing portfolios with equal market capitalization rather than equal number of stocks, and excluding the smallest 30% of stocks.

each month. I do this by regressing the portfolio excess returns during month t on the portfolio betas estimated using data from month $t-36$ to $t-1$. This way, there is no mechanic connection between the dependent and the independent variables in the regression.[26] These regressions yield monthly time series of security market line slope and intercept coefficients. Namely, every month I run the regression

$$r_t^e = intercept_t + slope_t \, \beta_{t-1} + e_t, \tag{3}$$

where *intercept* and *slope* are the estimated parameters. The estimates of the intercept and the slope can also be seen as excess returns on two portfolios: the intercept represents the return of a portfolio that is a unit investment with a zero ex ante beta, whereas the slope is the return of a zero investment portfolio with unit beta.

[Table V here]

Table V gives the descriptive statistics of the key variables used in this study: the initial margin requirement, the security market line intercept and slope, and the market excess return. A few interesting observations arise from these statistics. First, the average security market line intercept is positive and large, and the average slope (0.2%) is far smaller than the average market excess return (0.7%), indicating that the security market line over the sample period in question is flatter than predicted by the CAPM. Second, the security market line intercept is positively correlated with the initial margin, whereas the slope has a negative correlation with the margin. These univariate results are consistent with the prediction that stricter leverage constraints result in a flatter security market line. Third, the correlation between the margin requirement and the market return is relatively low, so that there should be no concerns of multicollinearity in regressions where both are included as explanatory variables.

IV. Results

A. Margin Requirements and the Security Market Line

To test whether margin constraints have an effect on the relation between betas and expected returns, I regress the time series of the slope and intercept coefficients from Equation (3) on the lagged initial margin requirement. Depending on the specification, I also include the excess return of the CRSP value-weighted index ($r_{M,t}^e$) and other additional controls (X_t) as explanatory variables.

[26] Table VIII shows that the results are robust to using full-sample betas instead of the rolling window betas.

Formally, I run the following two regressions:

$$intercept_t = a_1 + b_1\, margin_{t-1} + c_1\, r^e_{M,t} + d_1\, X_t + u_{1,t} \tag{4}$$

$$slope_t = a_2 + b_2\, margin_{t-1} + c_2\, r^e_{M,t} + d_2\, X_t + u_{2,t}. \tag{5}$$

This pair of equations directly resonates with Equation (1) above. Theoretically, the intercept of the security market line is given by the non-negative shadow price of the leverage constraint times the required margin, and the slope is equal to the expected market return minus the shadow price times the margin. Hence, coefficient b_1 should be non-negative and coefficient b_2 should be non-positive. If b_1 and b_2 are not significantly different from zero, this would imply that the leverage constraint is non-binding and does not affect the cross-sectional pricing of risk. On the other hand, a significantly positive b_1 and a significantly negative b_2 would be direct empirical evidence in support of leverage constraints flattening the security market line as predicted by Black (1972) and Frazzini and Pedersen (2014). The theory also predicts that $b_1 = -b_2$. The results of estimating Equations (4) and (5) are presented in Table VI.

[Table VI here]

The first and fourth columns of Table VI provide the main result of this paper. The coefficient of the lagged initial margin requirement in the intercept regression (b_1, column 1) is equal to 0.024 and is statistically significant with a t-statistic of 2.2. The effect of the initial margin on the security market line slope (b_2, column 4) is statistically significantly negative: -0.053 with a t-statistic equal to -3.7. These findings show that a higher margin requirement results in the security market line having a higher intercept and a lower slope, exactly in line with the theoretical predictions in Equation (1).

The result that a higher margin requirement flattens the security market line could, potentially, be driven by a common factor affecting both the margin levels and the shape of the security market line. More specifically, the margin requirement could reflect general market conditions that also affect the security market line. The most obvious candidate for such a common factor, the contemporaneous market return, is controlled for in the regressions presented in columns 2 and 5 of the table. The market return is not significantly correlated with the security market line intercept, and adding it as an explanatory variable in the intercept regression has no discernible impact on the coefficient of the margin, which remains statistically significant. The market return is, quite naturally, highly correlated with the security market line slope. Adding the market return into the slope equation affects the coefficient of the margin, but it still remains statistically significant negative (t-statistic -2.4).

As the theory predicts that $b_1 = -b_2$, I estimate Equations (4) and (5) jointly in a seemingly unrelated regressions framework and run a Wald test to empirically test the coefficient restriction. The Wald test F-statistic is equal to 0.007 with an associated p-value of 0.93, which implies that the restriction cannot be rejected. This provides further support for the model.[27]

In addition to the market return, other measures of market or macroeconomic conditions could be correlated with the margin requirement and affect the the security market line. To confirm that the main result here is not driven by such an omitted variable, I add a number of control variables that could correlate with both the Federal Reserve's margin policy and investors' preferences or expectations. The control variables are the stock market return over the previous 12 months and over the previous 36 to 12 months, the stock market return standard deviation and skewness over the previous 12 months, the change in margin credit over the previous 12 months, the average monthly turnover of NYSE-listed stocks over the previous 12 months, the price-dividend ratio of the S&P 500 index, and the changes in consumer prices, M1 money supply, and industrial production over the past 12 months. These variables are the same as used above to explain the Fed Board's decisions to change the margin requirement. Also, the previous literature has established that the security market line shape depends on inflation (Cohen, Polk, and Vuolteenaho, 2005), and investor sentiment (Antoniou, Doukas, and Subrahmanyam, 2016), which both might be correlated with the Fed Board's decisions to alter the minimum initial margin requirement.[28]

Columns 3 and 6 of Table VI present the results with the controls in place. Many of the control variables do affect the security market line. For example, high growth in margin credit predicts a flatter security market line. This is consistent with the findings of Antoniou, Doukas, and Subrahmanyam (2016), who document that high investor sentiment results in a flatter beta–return relation. Most importantly, however, the results show that the findings above are not driven by a confounding market or economic factor affecting both the margin requirement and investors' preferences or expectations. Including the controls actually results in a stronger effect of the margin requirement on the security market line. The coefficient of the margin requirement is 0.060 (t-statistic 4.1) in the intercept equation, and -0.064 (t-statistic -4.2) in the slope equation. All the results below are presented with the control variables to ensure robustness.

It is important to note that these results differ from those presented by Frazzini and Pedersen

[27] The F statistics for the Wald tests are very small for all the specifications below, and the restriction is never rejected. This is, to a large extent, driven by the high negative correlation between the estimates of the security market line slope and intercept.

[28] The ideal measure of sentiment would be the Baker and Wurgler (2007) sentiment index. Unfortunately, the monthly data on this index only goes back to 1965. The stock turnover is the only component of the index for which monthly data extends back to the beginning of the sample period used here, 1934. Also, the change in margin credit should capture investor sentiment, as investors are plausibly more likely to lever their portfolios when sentiment is high.

(2014) regarding the relation between leverage constraints and the slope of the security market line. They find that the lagged level of the TED spread has a negative effect on the returns of their betting against beta strategy. A high TED spread is usually considered to be an indication of tighter leverage constraints which, according to the theory, should result in a flatter security market line and higher returns to the strategy. Hence, their results seems to be in contrast with the model predictions. They rationalize this result as the lagged TED spread possibly being a proxy for the change in credit conditions, in which case the negative correlation would be expected. As argued above, the margin requirement is a better and more direct measure of leverage constraints faced by investors than the TED spread, and hence it is not surprising that the results here are more in line with the predictions of the theoretical model.

These results also have direct consequences for the empirical testing of the CAPM. As binding margin constraints make the beta–expected return relation flatter, they will also help to reject the CAPM hypothesis that the security market line has a zero intercept and a slope equal to expected market excess return. Following Cohen, Polk, and Vuolteenaho (2005), one can define the conditional excess slope and intercept of the security market line as

$$\frac{a_2}{c_2} + \frac{b_2}{c_2}\, margin_{t-1} \tag{6}$$

and

$$a_1 - \frac{a_2\, c_1}{c_2} + \left(b_1 - \frac{b_2\, c_1}{c_2}\right) margin_{t-1}, \tag{7}$$

respectively. Using the coefficients in the second and fifth columns of Table VI shows that an initial margin of around 44% would result in the excess slope and intercept being equal to zero. This simple calculation indicates that at relatively low levels of initial margin, the CAPM might not be rejected empirically. The sample period average margin requirement, however, is higher (61%) than the low level required to match the CAPM predictions, and the CAPM is rejected in the data.

This result raises an interesting question regarding the years after the Fed Board ended active management of the Regulation T margin requirement. The requirement has remained at 50% since 1974. During the period from 1975 to 2012, the security market line has an average monthly slope equal to 0.34%, whereas the average market excess return is 0.58%. Clearly, the 50% margin requirement does not result in the slope being equal to the market excess return in this sample, even though it is not too much higher than the 44% estimated above to result in a zero excess slope. This is most likely driven by the large changes in stock ownership over the past decades. As mentioned above, households, whose only leverage constraint comes from the Regulation T margin requirements, held on average 84.7% of the U.S. stocks during the sample period. This number has decreased to 37.3% in 2015. At the same time, institutions have increased their ownership stake significantly. For example, mutual funds held, on average, 3.2% of the stocks during the sample period, and 20.5% by 2015. Many institutions face leverage constraints beyond those in Regulation T, such as the limits in the Investment Advisers Act of 1940 and internal rules in the case of mutual funds (Almazan, Brown, Carlson, and Chapman, 2004). Such an increase in the importance of leverage-constrained institutions has likely contributed to the flatter security market line in the more recent times, as suggested by Karceski (2002), Buffa, Vayanos, and Woolley (2014), Frazzini and Pedersen (2014), Boguth and Simutin (2016), and Christoffersen and Simutin (2016).[29]

B. Robustness Checks

Tables VII and VIII provide additional robustness checks of the main results by using alternative sets of test assets and by controlling for additional factors. The first candidate for an additional control variable is the contemporaneous market volatility. The lagged change in market volatility is already included in the tests reported in columns 3 and 6 of Table VI. However, one might argue that the margin requirement could affect volatility—even though the empirical evidence in existing literature and Table IV is against this—and that volatility affects the security market line with investors requiring a lower price of risk during periods of lower volatility. This effect of a lower risk premium resulting from lower volatility should already be captured by the contemporaneous market return. The results presented in columns 1 and 4 of Table VII show that the contemporaneous market volatility has some explanatory power over the security market line: higher volatility results in a lower intercept and higher slope of the line. However, since the volatility is uncorrelated with the margin requirement, the key result remains unchanged by the inclusion of volatility as a control: the margin requirement still has a strong impact on the security market line.

[Table VII here]

As the estimates of the security market line intercept and slope can also be interpreted as portfolio returns, it is natural to check that any regularity concerning them does not arise simply from exposures to standard risk factors. To check for this, columns 2 and 5 of Table VII include

[29]Extending the sample period of the regressions reported in Table VI to include the 1975 to 2012 period does not change the results qualitatively or quantitatively. As the margin requirement remained constant for this period, extending the data does not improve the identification of the effect of margin requirements on the security market line. Importantly, however, the margin requirement affects the security market line in a statistically significant way also in the 1934 to 2012 sample.

the size and value factors (Fama and French, 1993) and the momentum factor (Carhart, 1997) as additional controls. Both SMB and HML have a significant positive (negative) correlation with the security market line slope (intercept). This is not surprising, as small and value firms are known to have higher betas than large and growth firms (e.g. Fama and French, 1993, and Novy-Marx, 2016). Importantly, however, the results presented in columns 2 and 5 show that the inclusion of these risk factors does not alter the main result. In the presence of all the controls (columns 3 and 6), the coefficient of the margin requirement is statistically significant positive in the intercept equation, and significant negative in the slope equation. This implies that the main result of the paper is not driven by the security market line being affected by the contemporaneous market volatility or other risk factors.

In Table VIII, I confirm that the main result is also robust to using alternative test assets. So far, the results have been presented with the security market line intercept and slope estimated based on 20 beta-sorted portfolios. In columns 1 and 2, the security market line is estimated from 10 and 40 beta-sorted portfolios, respectively. These changes have no impact on the main result.

[Table VIII here]

A potentially valid concern is that, even though the portfolios are value-weighted, the results could be affected by relatively small stocks. This is especially so given that extreme beta values are more common among smaller stocks. Columns 3 and 4 of Table VIII confirm that the results above are not driven by small stocks. In column 3, I exclude micro-cap stocks–defined as stocks falling in the three smallest size deciles–from the sample and sort the remaining stocks into 20 value-weighted portfolios to estimate the security market line. In column 4, I construct 20 beta-sorted portfolios so that each month each portfolio has the same total market capitalization, rather than the same number of stocks. The key result of the paper remains unchanged using these alternative portfolio construction methods to alleviate the concern that the extreme beta portfolios are populated by very small stocks. The margin requirement has a statistically significant negative (positive) impact on the security market line slope (intercept), and the coefficients of interest are very close to those reported in Table VI above.

To alleviate the potential concern that time variation in the estimation error of betas is correlated with the margin requirement, column 5 presents the basic result with the monthly security market lines estimated using full-sample betas of the portfolios rather than rolling window betas. The results here are very similar to those reported in Table VI confirming that those results are not driven by time variation in beta estimates.

Finally, columns 6 and 7 of Table VIII report the key results using other than beta-sorted portfolios. In column 6, the test assets are the 25 size and book-to-market portfolios of Fama and

French (1993), and in column 7, the test assets comprise 41 industry portfolios. These are those of the 49 Fama and French industry portfolios for which full return history is available for the sample period from October 1934 through September 1975.[30] The main result of the paper also holds for these alternative sets of test assets. Overall, the result that the margin requirement affects the security market line is very robust to using alternative test assets and portfolio construction techniques.

A potential source of concern is that the level of the margin requirement is highly persistent, which could affect the statistical inference. To confirm that the results are not materially affected by this, I perform three alternative tests: cluster the standard errors, simulate the standard errors, and collapse the data so that one margin requirement regime is represented by a single observation.[31] Clustering the standard errors by regime increases the standard error estimates only marginally, and does not affect the inference. In the slope (intercept) equation the clustered t-statistic of the margin requirement is -4.02 (3.94), whereas the un-clustered Newey and West (1987) t-statistic is -4.25 (4.14).

As the second way of confirming that the results are not driven by the persistence of the margin requirement, I simulate a time series of random margin requirements, and use that in the regressions instead of the true margin. The simulated margin requirement (m^s) is generated by the following system:

$$
\begin{aligned}
m_t^s &= m_{t-1}^s + I_t\, x_t && (8)\\
I_t &\sim Bernoulli(p = 22/492) && (9)\\
x_t &\sim Normal(\mu = 0, \sigma = 0.189). && (10)
\end{aligned}
$$

Every month there is a 22/492 probability that the simulated margin requirement changes. This matches the data, as there are 22 margin requirement changes during the 492-month sample period. If a change happens, the size of the change is drawn from a Normal distribution with standard deviation equal to that of the margin requirement changes in the data. This yields a time series that has statistical properties similar to the true margin requirement but, by construction, has no explanatory power over the security market line.

Using this simulated margin requirement, I estimate regressions (4) and (5) using the same controls as in columns 3 and 6 of Table VI. I repeat the simulation and regressions 10,000 times and collect the Newey and West (1987) t-statistics of the simulated margin requirements in the regressions. This gives the distribution of the t-statistics under the null hypothesis of no relation

[30] The data for the size and book-to-market portfolios and industry portfolios are from Kenneth French's website.

[31] By a regime, I refer to the period between two consecutive changes in the margin requirement.

between margin requirements and the security market line. In 14 out of the 10,000 simulations, the absolute value of the t-statistic of the simulated margin requirement in the intercept equation exceeds that reported in column 3 of Table VI. This means that the simulated p-value of the margin requirement coefficient is 0.0014. In the slope equation, the absolute simulated t-statistic exceeds the estimated t-statistic 16 times in 10,000 simulations, resulting in a p-value of 0.0016. These results show that the statistical significance of the margin requirement in explaining the security market line intercept and slope is not a mere artifact of the persistent nature of the margin.

Finally, I collapse the data into 23 observations, one observation for each margin requirement regime, and regress the average security market line slope during the period on the margin requirement. The results are best summarized in Figure 4, which plots the average slope against the margin requirement. The lengths of the margin requirement regimes vary from just two months to 88 months. To illustrate the amount of data each point in the figure is based on, the area of each dot in the plot is proportional to the length of the regimes. It is evident from the figure that there is a negative relation between the margin requirement and the security market line slope. The solid line in the figure plots the OLS fit, whereas the dotted line gives the weighted least squares (WLS) fit using the lengths of the regimes as weights. An OLS (WLS) regression of the average security market line slope on the margin requirement and the average market excess return yields a coefficient of -0.022 (-0.036) with an associated t-statistic of -1.69 (-2.73) for the margin. These coefficients are close to the values reported in Table VI for the monthly regression, and the OLS coefficient is significant at the 10% level, whereas the WLS coefficient, which underweights the observations based only on a few months of data, is significant at the 5% level.[32]

Overall, the checks presented above show that the effect of the margin requirement on the security market line is very robust to various alternative estimation methods and control variables. The next two sections show that the main result of the paper is not driven by investors' costs of obtaining leverage or the short sales constraint implied by Regulation T margin requirements.

C. Cost of Leverage

Besides the limits on borrowing, another leverage-related factor that theoretically results in a flatter beta-return relation is the difference between the lending and borrowing interest rates faced by investors. When the two rates differ, the efficient portfolios involving borrowing lie on a line that is flatter than the line of portfolios involving lending. In this section I confirm that the results above are not driven by correlation between margin requirements and the spread between the borrowing

[32]In a regression of the regime-to-regime change in the security market line slope on the change in margin requirements, the OLS coefficient of the margin requirement change is -0.053 with a t-statistic of -2.45. This result also is in line with those reported using the monthly data in Table VI.

and lending rates.

My measure for the spread is the difference between the so-called brokers' call money rate and the 3-month Treasury bill rate. As discussed above in section II.C, during the sample period, the brokers' call money rate was the benchmark rate on the brokers' primary source of funding. Customers' margin borrowing typically carried an interest rate defined as the brokers' call rate plus a spread (Statman, 1987). Assuming that the customers' spread remained constant, the difference between the brokers' call rate and the 3-month Treasury bill rate provides a good approximation of the time-series variation of the difference between the borrowing and lending rates faced by investors. Table IX presents the results of estimating regression equations (4) and (5) including the spread between brokers' call and Treasury bill rates, call spread, as an explanatory variable. Theoretically, a higher spread should make the security market line flatter, so one would expect a negative (positive) correlation between the call spread and the security market line slope (intercept).

[Table IX here]

The first and third columns of the table provide the results without including the margin requirement as an explanatory variable. The coefficients of call spread has the expected signs—positive in the intercept equation and negative in the slope equation—but are not statistically significant. The second and fourth columns confirm that the results presented above are not driven by a correlation between the margin requirement and the call spread. Including the call spread in the baseline regression (columns 3 and 6 of Table VI) does not alter the coefficient of the margin requirement. This is not surprising, given that the correlation between the margin requirement and the call spread is only 0.02.[33]

D. Short Sales Constraints

In addition to leverage constraints and the cost of leverage, short sales constraints can also result in a flatter security market line (see e.g. Schnabel, 1984, and Hong and Sraer, 2016). Since November 1937, Regulation T also dictates the minimum initial margin on short sales, and since February 1945, the initial margin on short sales has been identical to the margin on stock purchases.[34] In this section, I provide some evidence that the results presented above are not significantly driven by the short sales constraints affecting the security market line.

[33]Cohen, Polk, and Vuolteenaho (2005) also conclude that the variation in the difference between investors' borrowing and lending rates does not appear to explain the variation in the security market line slope. They use interest rates on car loans, personal loans, and credit cards as measures of borrowing rates. The brokers' call rate used here is a more direct measure for the rate paid on margin borrowing.

[34]Prior to November 1937, the initial margin on short sales was defined as "the margin customarily required by the brokers and dealers". Between November 1937 and February 1945, the short sales margin was 50%, whereas the margin requirement on purchases was 40%.

First of all, the short interest remained very low throughout the sample period. The aggregate short interest ratio varied between 0.03% and 0.19% with an average value of 0.08%.[35] There are two reasons why such a low short interest ratio cannot result from the regulation T requirements alone. First of all, margin credit, which faces an identical margin requirement, was on average 1.4% of the total NYSE market capitalization during the sample period, which is 18 times larger than the short interest. Second, the short interest ratio has steadily grown to about 5% in 2015, while the initial margin requirement has remained constant at 50%. However, margin credit relative to market capitalization, on the other hand, does not exhibit such massive growth from its 1934 to 1975 average, being about 2% in 2015. The volume of shorting was also never mentioned by the Fed Board as a motive for altering the margin requirements. All this evidence points to the conclusion that short selling was nowhere near as common a practice as it is today. Hence, it is unlikely that all the results presented above could be driven by short sales constraints imposed by Regulation T alone.

The main empirical tests examining the effect of short sales constraints on the above results rely on the role of disagreement. As short sales arise from investors' disagreement about the stock, the stocks that investors disagree about more should be more affected by any constraints on short sales. Hence, a higher initial margin requirement on short sales should affect the beta-expected return relation more for stocks with high disagreement and during times of high aggregate disagreement. I use these predictions in the cross section and the time series to test how strongly the results above are affected by the short sales constraints implied by Regulation T.

First, I divide the sample of stocks into three groups (low, medium, and high) based on measures of disagreement. A natural and commonly used measure would be the dispersion of analyst forecasts. However, the I/B/E/S data on analyst forecasts extends back only to 1982, eight years after the Fed Board last changed the margin requirements in Regulation T. Instead, I use idiosyncratic volatility and share turnover as proxies of disagreement and estimate security market lines monthly for high and low disagreement stocks separately. Diether, Malloy, and Scherbina (2002) show that volatility and turnover are very significantly correlated with analyst forecast dispersion. Table X presents the results of the baseline regression for the two categories, as well as the difference between the coefficients and the p-value of a Wald test of equality of the coefficients.

[Table X here]

If the above-reported relation between the margin requirement and the security market line was driven by the short sales constraint implied by Regulation T, one should expect the effect to be

[35] The data on aggregate short interest is from the NYSE Facts and Figures online database (http://www.nyxdata.com/nysedata/asp/factbook/main.asp).

stronger for high disagreement (high idiosyncratic volatility or high turnover) stocks. Empirically, the effect of the margin requirement on the security market line intercept is actually somewhat weaker, not stronger, for the high disagreement stocks. In the slope equation, the coefficient of the margin requirement is nearly identical for low and high disagreement stocks. None of the differences between the coefficients are statistically significant. Hence, these results do not support the hypothesis that the main results of this paper would be driven by the short sales constraints imposed by Regulation T.

Second, I make use of the result of Hong and Sraer (2016) that short sales constraints make the security market line flatter during periods of high aggregate disagreement. If the relation between the Regulation T margin requirement and the security market line is a result of short sales constraints, the relation should be stronger during periods of high aggregate disagreement. Hong and Sraer (2016) measure disagreement using the analyst forecasts which, again, are not available during the 1934 to 1975 sample period. I use four different measures of aggregate disagreement: average idiosyncratic volatility, cross-sectional standard deviation of monthly stock returns, aggregate share turnover, and aggregate short interest ratio. As noted above, Diether, Malloy, and Scherbina (2002) show that volatility and turnover are positively related to analyst forecast dispersion. Cross-sectional return dispersion and short interest ratio are also natural candidates for disagreement proxies. I augment the baseline regressions, Equations (4) and (5), by including an interaction term between margin requirement and disagreement and present the results in Table XI.

[Table XI here]

Again, if the reported relation between the Regulation T margin requirement and the security market line was driven by the short sales constraint, one should observe this relation to be stronger during periods of high aggregate disagreement. In the results presented in Table XI, this would imply a negative (positive) coefficient for the interaction between margin and disagreement in the slope (intercept) equation. The empirical results do not support the hypothesis that the short sales constraints significantly drive the relation between the margin requirement and the security market line. Though they have the predicted signs, the interaction coefficients are very small and lack any statistical significance.

Overall, Tables X and XI provide evidence that the results presented in this paper are not significantly affected by the short sales constraints imposed by Regulation T. Nonetheless, the possibility of the short sales constraints having some effect cannot be ruled out. However, in light of these results, that effect is likely to be rather minor compared to the effect of the leverage constraint.

V. Conclusions

In this paper, I study the effect of leverage constraints on the relation between CAPM betas and expected returns. Using sizeable variation in the minimum initial margin requirement in the U.S. stock market, I show that during periods of tighter leverage constraints, the empirical security market line has a lower slope and a higher intercept than at times of looser constraints. These results are robust to controlling for additional factors and to using different test assets, portfolio construction rules, and estimation methods. The results provide strong empirical evidence in support of the hypothesis that tighter leverage constraints result in a flatter security market line, as predicted by Black (1972) and Frazzini and Pedersen (2014).

Some of the results presented in the paper, however, indicate that leverage constraints cannot fully explain the empirical flatness of the security market line. In many of the observations in Figure 4, the security market line has a negative slope which is not consistent with model presented in Section I. In the model, investors are risk-averse and have homogeneous beliefs. Hence, in equilibrium, the price of risk, the slope of the security market line, is positive. As leverage constraints alone cannot explain the empirical patterns, other factors must also play a role. Potential other factors affecting the security market line include the unobservability of the true portfolio of risky assets (Roll, 1977), the estimation errors in betas, the interaction of short sales constraints and heterogeneous expectations (e.g., Hong and Sraer, 2016), investor sentiment (Antoniou, Doukas, and Subrahmanyam, 2016), and investors preferences for lottery-like stocks (Bali, Brown, Murray, and Tang, 2016). Many of these features could also be introduced into a model with leverage constraints to simultaneously capture multiple determinants of the security market line.

Appendix

This appendix provides a short derivation of Equation (1), the security market line when all investors face the same margin requirement. The derivation presented here is a simplification of the overlapping generations model presented by Frazzini and Pedersen (2014) and is also closely related to those presented by Aschcraft, Gârleanu, and Pedersen (2010) and Gârleanu and Pedersen (2011).

Securities. There are S risky securities, indexed by s. Security s pays a random periodic dividend $\delta_{s,t}$, has X_s shares outstanding, and trades at the price $P_{s,t}$. The risky payoffs are correlated, with Ω_t representing the covariance matrix of $P_{s,t+1} + \delta_{s,t+1}$. There is also a risk-free security with return r_f.

Investors. Each period I investors, indexed by i, are born with wealth $W_{i,t}$. The investors invest their wealth at birth, and in the next period, they sell their securities to the next generation to finance their final consumption. The portfolio of investor i contains $x_i = (x_{i,1}, \ldots, x_{i,S})$ shares of the risky securities, and the rest of her wealth is invested in the risk-free asset. Investor i has a risk aversion coefficient of γ_i and her expected utility is given by

$$U = x_i' \, E_t \left(P_{t+1} + \delta_{t+1}\right) + (1 + r_f) \left(W_{i,t} - x_i' \, P_t\right) - \frac{\gamma_i}{2} \, x_i' \, \Omega_t \, x_i. \tag{A1}$$

All the investors face an identical margin requirement: the investors are able to borrow at the risk-free rate, but need to post an initial margin of m. This directly results in a constraint on the amount of shares an investor can buy. With wealth $W_{i,t}$, the maximum investment in the risky securities is $W_{i,t}/m$.

Portfolio choice. Given the above, investor i's portfolio choice becomes

$$\begin{aligned} \max \quad & x_i' \left[E_t \left(P_{t+1} + \delta_{t+1}\right) - (1 + r_f) \, P_t\right] - \frac{\gamma_i}{2} \, x_i' \, \Omega_t \, x_i \\ s.t. \quad & m \, x_i' \, P_t \leq W_{i,t}. \end{aligned}$$

The Lagrangian of the portfolio choice program is given by

$$\mathfrak{L} = x_i' \left[E_t \left(P_{t+1} + \delta_{t+1}\right) - (1 + r_f) \, P_t\right] - \frac{\gamma_i}{2} \, x_i' \, \Omega_t \, x_i - \psi_i \left(m \, x_i' \, P_t - W_{i,t}\right), \tag{A2}$$

where ψ_i is the shadow price of investor i's margin constraint. The first order condition for investor i is then

$$\frac{\partial \mathfrak{L}}{\partial x} = E_t \left(P_{t+1} + \delta_{t+1}\right) - (1 + r_f) \, P_t - \gamma_i \, \Omega_t x_i - \psi_i \, m \, P_t = 0 \tag{A3}$$

and her optimal portfolio is given by

$$x_i = \frac{1}{\gamma_i} \Omega_t^{-1} \left[E_t \left(P_{t+1} + \delta_{t+1} \right) - \left(1 + r_f + \psi_i \, m \right) P_t \right]. \tag{A4}$$

Equilibrium. Equilibrium prevails when the market clears and the sum of all investors' positions equals the number of shares outstanding:

$$X = \frac{1}{\gamma} \Omega_t^{-1} \left[E_t \left(P_{t+1} + \delta_{t+1} \right) - \left(1 + r_f + \psi \, m \right) P_t \right], \tag{A5}$$

where $\gamma = \left(\sum_{i=1}^{I} \gamma_i^{-1} \right)^{-1}$ is the aggregate risk aversion and $\psi = \sum_{i=1}^{I} \left(\gamma / \gamma_i \right) \psi_i$ is the weighted average shadow price of the margin constraint. Rearranging the market clearing condition yields the equilibrium prices:

$$P_t = \frac{E_t \left(P_{t+1} + \delta_{t+1} \right) - \gamma \, \Omega_t \, X}{1 + r_f + \psi \, m}. \tag{A6}$$

Price of risk. Focusing on a single risky security s and defining its return as $r_{s,t+1} = \left(P_{s,t+1} + \delta_{s,t+1} \right) / P_{s,t} - 1$, the equilibrium price equation yields the equilibrium expected return as:

$$E_t \left(r_{s,t+1} \right) = r_f + \psi \, m + \gamma \, \frac{1}{P_{s,t}} \, \mathbf{1_s}' \, \Omega_t \, X, \tag{A7}$$

where $\mathbf{1_s}$ is a vector with a one on row s and zeros elsewhere. Defining market portfolio M as the value-weighted average of the risky securities gives $\frac{1}{P_{s,t}} \mathbf{1_s}' \Omega_t = \text{cov}_t \left(r_{s,t+1}, r_{M,t+1} \right) P_t$ resulting in

$$E_t \left(r_{s,t+1} \right) = r_f + \psi \, m + \gamma \, \text{cov}_t \left(r_{s,t+1}, r_{M,t+1} \right) P_t' \, X. \tag{A8}$$

The expected return of the market portfolio is

$$E_t \left(r_{M,t+1} \right) = r_f + \psi \, m + \gamma \, \text{var}_t \left(r_{M,t+1} \right) P_t' \, X \tag{A9}$$

which gives

$$\gamma \, P_t' \, X = \frac{E_t \left(r_{M,t+1} \right) - r_f - \psi \, m}{\text{var}_t \left(r_{M,t+1} \right)}. \tag{A10}$$

Plugging (A10) into (A8) and defining beta in the standard manner as

$$\beta_{s,t} = \frac{\text{cov}_t \left(r_{s,t+1}, r_{M,t+1} \right)}{\text{var}_t \left(r_{M,t+1} \right)} \tag{A11}$$

and excess return as $r^e = r - r_f$ yields the security market line as

$$E_t\left(r^e_{s,t+1}\right) = \psi\, m + \beta_{s,t}\left[E_t\left(r^e_{M,t+1}\right) - \psi\, m\right]. \tag{A12}$$

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Figure 1: Initial margin requirement and security market line.
This graph depicts the empirical relation between beta and average excess return in subsamples with different initial margin requirements. The test assets are ten beta-sorted value-weighted portfolios. The solid line depicts the theoretical security market line predicted by the CAPM, and the dashed line gives the empirical security market line. The top left panel includes those 197 months where the initial margin requirement is between 40% and 55%, the top right panel includes months where the requirement is between 55% and 75% (183 months), and the bottom left panel includes months where the requirement is above 75% (112 months). The bottom right panel presents the security market lines for the full sample of 492 months from 10/1934 to 9/1975.

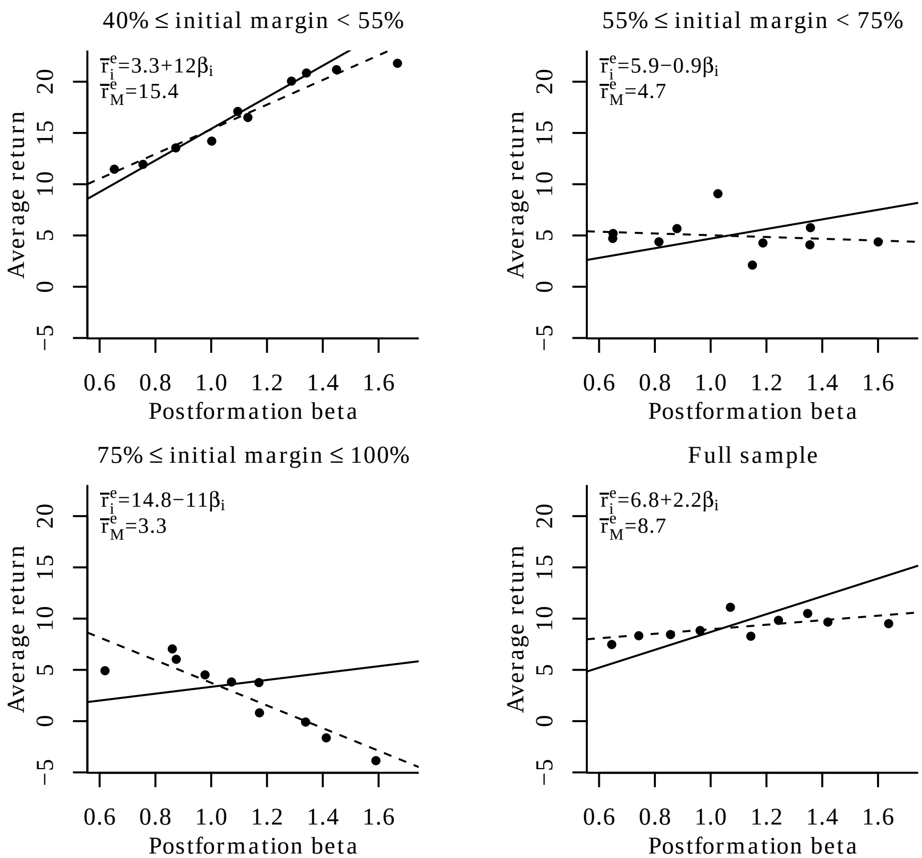

Figure 2: Initial margin requirement.
This graph gives the level of initial margin required on positions in listed U.S. equities. The initial margin requirement is set by the Board of Governors of the Federal Reserve System via Regulation T. The sample period is from 10/1934 to 9/1975.

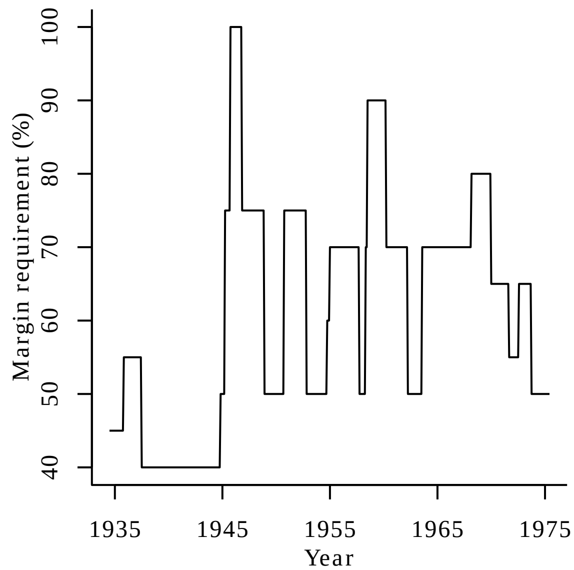

Figure 3: Margin requirement changes and margin credit.
This graph plots the average cumulative change in margin credit 12 months before and after an increase (solid line) or a decrease (dashed line) in the minimum initial margin requirement in Regulation T. Month 0 is the margin change month. There are 12 margin requirement increases and 10 decreases during the sample period from 10/1934 to 9/1975.

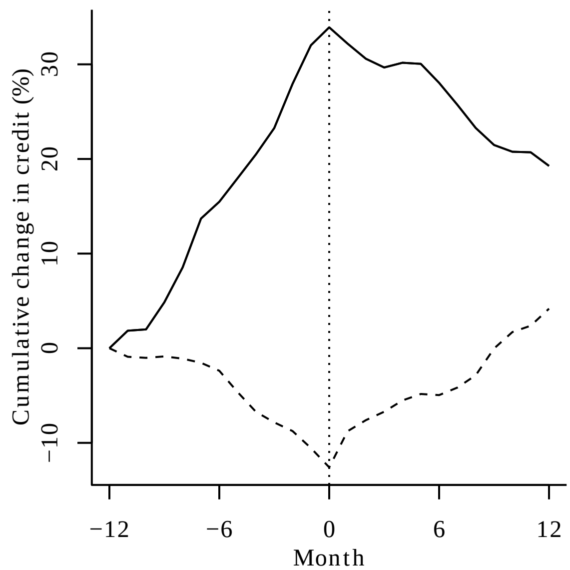

Figure 4: Margin requirement regimes.
The dots in this figure plot the margin requirement and the average security market line slope for the 23 Regulation T margin requirement regimes during the sample period from 10/1934 to 9/1975. The area of the dots is proportional to the length of the regimes. The solid line gives the ordinary least squares fit of the data, whereas the dashed line gives the weighted least squares fit. The cross depicts the margin requirement and average security market line slope for the period from 10/1975 to 12/2012.

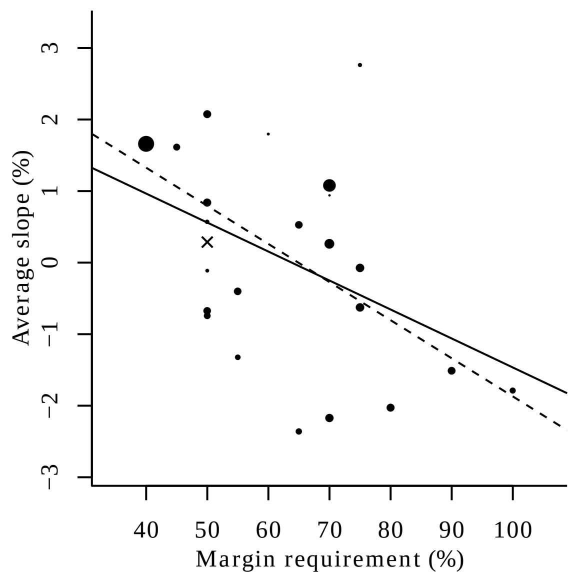

Table I: Margin regulation changes.
This table presents the data on the changes to the minimum margin requirement in the Federal Reserve's Regulation T. The first column gives the date when the new margin requirement was decided by the Fed Board, and the second column gives the date when the new requirement became effective. The following two columns give the change and the new level of the margin requirement. The four last columns indicate what reasons were provided by the Board as justifications for changing the margin requirement. The categories of reasons relate to developments in margin credit, stock prices, stock market activity, and consumer prices. The reasons are collected from the summary minutes of the Fed Board meetings available in the Board's annual reports.

Date		Margin		Reason for change			
Decision	Effective	Change	Level	Credit	Return	Activity	Inflation
	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%	×	×	×	
Jul 3, 1945	Jul 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%	×	×	×	
Jul 27, 1960	Jul 28, 1960	−20%	70%	×	×	×	
Jul 9, 1962	Jul 10, 1962	−20%	50%	×			
Nov 5, 1963	Nov 6, 1963	+20%	70%	×		×	
Jun 7, 1968	Jun 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%	×			

Table II: Determinants of Regulation T changes.
This table presents the results of regressing the change in the Regulation T minimum margin requirement in month t on the lagged financial market and macroeconomic variables. The explanatory variables are the change in the logarithm of the aggregate margin credit from month $t-13$ to month t, the stock market return from month $t-13$ to month t and from month $t-37$ to month $t-13$, the standard deviation and skewness of the daily stock market returns measured over months $t-13$ to $t-1$, the average share turnover measured over months $t-13$ to $t-1$, the stock market price-dividend ratio measured at the end of month $t-1$, and the changes in logarithms of consumer prices, M1 money supply, and industrial production from month $t-13$ to $t-1$. Newey and West (1987) t-statistics with 12 lags are reported in parentheses and the R^2s are adjusted for degrees of freedom. The sample period is 10/1934-9/1975 with 492 monthly observations.

Model	OLS	Multinomial logit	
Dependent variable	Change	Increase	Decrease
	(1)	(2)	(3)
Constant	0.000	**-5.402**	**-4.775**
	(0.07)	(-7.26)	(-6.81)
Credit growth	**0.007**	**1.702**	-0.418
	(2.14)	(4.49)	(-0.49)
Market return 1-12	**0.005**	0.393	**-1.360**
	(2.90)	(0.85)	(-2.25)
Market return 13-36	0.003	**0.713**	-0.057
	(1.25)	(2.19)	(-0.13)
Market volatility	0.004	0.039	-0.662
	(1.78)	(0.06)	(-1.24)
Market skewness	0.002	0.816	-0.138
	(1.36)	(1.85)	(-0.41)
Share turnover	0.002	0.751	0.065
	(1.12)	(1.36)	(0.21)
Market P/D	-0.001	0.044	0.405
	(-0.61)	(0.12)	(0.75)
Inflation	0.001	0.324	0.072
	(0.40)	(0.76)	(0.18)
M1 growth	0.003	0.216	-0.830
	(1.55)	(0.48)	(-1.59)
IP growth	**-0.004**	**-0.604**	0.282
	(-2.24)	(-3.20)	(0.89)
R^2	0.037	0.012	

Table III: Determinants of margin credit changes.
This table presents the results of regressing the change in margin credit on the lagged changes in the Regulation T minimum margin requirement and the call spread. The dependent variable is the change in the logarithm of the aggregate margin credit measured over one month (first four columns) and 12 months (last four columns). The call spread is the difference between the brokers' call rate and the 3-month Treasury bill rate, and proxies for the difference between the investors' borrowing and lending rates. Newey and West (1987) t-statistics with 12 lags are reported in parentheses and the R^2s are adjusted for degrees of freedom. The sample period is 10/1934-9/1975 with 492 monthly observations.

	1 month forward				12 months forward			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	0.003	0.003	0.003	0.003	0.035	0.031	0.035	0.035
	(0.96)	(0.96)	(0.97)	(1.29)	(1.05)	(0.91)	(1.05)	(1.16)
Margin change	**-0.178**		**-0.179**	**-0.232**	**-0.892**		**-0.893**	**-0.714**
	(-2.75)		(-2.82)	(-4.12)	(-2.87)		(-2.88)	(-3.19)
Call spread change		-0.933	-0.997	-0.620		-0.935	-0.674	-1.945
		(-1.51)	(-1.55)	(-0.94)		(-0.29)	(-0.22)	(-0.75)
Controls	No	No	No	Yes	No	No	No	Yes
R^2	0.025	0.001	0.026	0.107	0.019	-0.002	0.017	0.200

Table IV: Effects of margin regulation.
This table presents the results of regressing the change in financial market and macroeconomic variables on the lagged change in the Regulation T minimum margin requirement. The dependent variables are the stock market return, the standard deviation and skewness of the daily stock market returns, the average share turnover, and the changes in the logarithms of consumer prices, M1 money supply, and industrial production. The dependent variables are measured over one month (first three columns) and 12 months (last three columns). Newey and West (1987) t-statistics with 12 lags are reported in parentheses and the R^2s are adjusted for degrees of freedom. The sample period is 10/1934-9/1975 with 492 monthly observations.

	1 month forward			12 months forward		
Dependent variable	Constant	ΔMargin	R^2	Constant	ΔMargin	R^2
Market return	**0.007**	0.065	0.001	**0.093**	0.020	-0.002
	(3.13)	(1.80)		(3.59)	(0.12)	
Market volatility	0.000	0.015	-0.002	0.002	0.477	0.001
	(-0.03)	(0.18)		(0.05)	(1.08)	
Market skewness	0.001	0.578	-0.001	0.014	-1.353	0.001
	(0.11)	(0.45)		(0.13)	(-1.33)	
Share turnover	0.000	-0.006	0.003	-0.002	-0.017	-0.002
	(0.02)	(-1.16)		(-0.12)	(-0.20)	
Inflation	**0.084**	-0.211	0.001	**0.034**	0.060	0.002
	(5.28)	(-1.08)		(6.07)	(0.98)	
M1 growth	**0.408**	-0.363	-0.001	**0.029**	0.000	-0.002
	(6.16)	(-0.62)		(8.52)	(0.02)	
IP growth	**0.077**	-0.227	-0.001	**0.049**	0.039	-0.002
	(3.01)	(-0.29)		(3.15)	(0.29)	

Table V: Descriptive statistics.
This table presents the descriptive statistics for key variables used in the paper. *Margin* is the minimum initial margin requirement set by the Federal Reserve's Regulation T. *Intercept* and *slope* are the monthly security market line intercept and slope, respectively. They are constructed by regressing monthly the cross-section of excess returns of 20 beta-sorted portfolios on the lagged estimated portfolio betas. *Market return* is the excess return of the CRSP value weighted index. The sample period is 10/1934-9/1975 with 492 monthly observations.

	Margin	Intercept	Slope	Market return
Mean	0.613	0.006	0.002	0.007
Standard deviation	0.157	0.041	0.060	0.047
Skewness	0.286	-0.198	0.956	-0.377
Excess kurtosis	-0.691	7.395	6.312	3.570
25%	0.500	-0.014	-0.033	-0.019
Median	0.650	0.007	0.000	0.010
75%	0.700	0.023	0.027	0.031
Correlation with				
Intercept	0.100			
Slope	-0.134	-0.607		
Market return	-0.077	0.107	0.722	

Table VI: Margin regulation and security market line.
This table presents the results of regressing the monthly security market line intercept and slope on the lagged Regulation T minimum initial margin requirement, the contemporaneous market excess return, and controls. The security market line intercept and slope are constructed by regressing monthly the cross-section of excess returns of beta-sorted portfolios on the lagged betas. The control variables are defined in Table II. Newey and West (1987) t-statistics are in parentheses and the R^2s are adjusted for degrees of freedom. The sample period is 10/1934-9/1975 with 492 monthly observations.

Dependent variable	Intercept			Slope		
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	-0.009	-0.012	**-0.032**	**0.035**	0.013	**0.035**
	(-1.27)	(-1.50)	(-3.39)	(3.65)	(1.63)	(3.51)
Margin	**0.024**	**0.027**	**0.060**	**-0.053**	**-0.029**	**-0.064**
	(2.15)	(2.32)	(4.14)	(-3.73)	(-2.42)	(-4.25)
Market return		0.102	0.107		**0.921**	**0.917**
		(0.99)	(1.04)		(8.41)	(8.47)
Market return 1-12			**-0.006**			**0.006**
			(-2.24)			(2.21)
Market return 13-36			0.000			0.001
			(-0.19)			(0.45)
Credit growth			**0.015**			**-0.015**
			(3.91)			(-3.96)
Market volatility			**0.007**			**-0.007**
			(2.92)			(-2.70)
Market skewness			0.004			-0.004
			(1.74)			(-1.77)
Share turnover			**-0.005**			**0.005**
			(-2.37)			(2.34)
Market P/D			0.003			-0.002
			(1.03)			(-0.79)
Inflation			0.003			-0.003
			(1.26)			(-1.20)
M1 growth			**-0.006**			**0.006**
			(-2.77)			(2.82)
IP growth			-0.002			0.002
			(-1.16)			(0.95)
R^2	0.007	0.018	0.059	0.018	0.526	0.544

Table VII: Controlling for additional risk factors.
This table presents the results of regressing the monthly security market line intercept and slope on the lagged Regulation T minimum initial margin requirement, the contemporaneous market excess return, and controls. The security market line intercept and slope are constructed by regressing monthly the cross-section of excess returns of beta-sorted portfolios on the lagged betas. *Market volatility* is the standard deviation of the daily market returns measured over the month, *SMB* and *HML* are the Fama and French (1993) size and value factors, and *UMD* is the momentum factor (Jegadeesh and Titman, 1993). The other control variables are defined in Table II. Newey and West (1987) t-statistics are in parentheses and the R^2s are adjusted for degrees of freedom. The sample period is 10/1934-9/1975 with 492 monthly observations.

Dependent variable	Intercept			Slope		
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	-0.018	**-0.019**	-0.005	0.020	**0.021**	0.008
	(-1.30)	(-2.34)	(-0.52)	(1.42)	(2.51)	(0.74)
Margin	**0.059**	**0.041**	**0.041**	**-0.064**	**-0.044**	**-0.044**
	(4.11)	(3.14)	(3.25)	(-4.22)	(-3.27)	(-3.38)
Market return	0.052	**0.271**	**0.211**	**0.973**	**0.743**	**0.802**
	(0.42)	(3.10)	(2.15)	(7.50)	(8.18)	(7.90)
Market volatility	-0.118		**-0.117**	0.120		**0.115**
	(-1.73)		(-2.84)	(1.71)		(2.78)
SMB		**-0.498**	**-0.519**		**0.517**	**0.538**
		(-4.31)	(-4.36)		(4.46)	(4.51)
HML		**-0.242**	**-0.220**		**0.250**	**0.229**
		(-2.20)	(-2.12)		(2.30)	(2.20)
UMD		-0.032	-0.068		0.014	0.049
		(-0.29)	(-0.67)		(0.12)	(0.46)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.078	0.189	0.207	0.554	0.612	0.620

Table VIII: Alternative test assets.
This table presents the results of regressing the monthly security market line intercept and slope on the lagged Regulation T minimum initial margin requirement, the contemporaneous market excess return, and controls using alternative test assets. Columns 1 and 2 present the results using 10 or 40 beta-sorted portfolios. In column 3 the 20 beta-sorted portfolios are constructed by first excluding from the sample the smallest 30% of stocks each month. In column 4 the 20 beta-sorted portfolios are constructed so that they all have the same total market capitalization each month. In column 5 the portfolio betas are estimated using the full sample of data, rather than a rolling window. In columns 6 and 7 the test assets are the 25 size and book-to-market and the 41 industry portfolios, respectively. The security market line intercept and slope are constructed by regressing monthly the cross-section of excess returns of test assets on the lagged betas. The control variables are defined in Table II. Newey and West (1987) t-statistics are in parentheses and the R^2s are adjusted for degrees of freedom. The sample period is 10/1934-9/1975 with 492 monthly observations.

Dependent variable: Intercept							
	Beta-sorted portfolios					Other portfolios	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
N	10	40	20	20	20	25	41
Constant	**-0.035**	**-0.027**	**-0.030**	**-0.028**	**-0.030**	**-0.032**	**-0.023**
	(-3.49)	(-2.92)	(-3.14)	(-2.78)	(-2.92)	(-2.70)	(-2.82)
Margin	**0.064**	**0.051**	**0.057**	**0.053**	**0.059**	**0.062**	**0.045**
	(4.21)	(3.66)	(3.88)	(3.43)	(3.62)	(3.21)	(3.65)
Market return	0.074	0.149	0.107	0.166	0.010	**0.231**	**0.387**
	(0.69)	(1.51)	(1.04)	(1.63)	(0.08)	(2.10)	(5.74)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.048	0.071	0.060	0.080	0.046	0.047	0.243
Dependent variable: Slope							
	Beta-sorted portfolios					Other portfolios	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
N	10	40	20	20	20	25	41
Constant	**0.037**	**0.030**	**0.031**	**0.027**	**0.030**	**0.039**	**0.028**
	(3.60)	(3.14)	(3.21)	(2.71)	(2.87)	(3.43)	(3.56)
Margin	**-0.068**	**-0.056**	**-0.060**	**-0.052**	**-0.057**	**-0.072**	**-0.052**
	(-4.31)	(-3.87)	(-3.95)	(-3.36)	(-3.58)	(-3.90)	(-4.30)
Market return	**0.948**	**0.878**	**0.912**	**0.837**	**0.990**	**0.791**	**0.636**
	(8.43)	(8.48)	(8.44)	(7.98)	(7.56)	(7.07)	(10.02)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.525	0.561	0.539	0.522	0.556	0.331	0.482

Table IX: Controlling for cost of leverage.
This table presents the results of regressing the monthly security market line intercept and slope on the lagged Regulation T minimum initial margin requirement, investors' cost of leverage, the contemporaneous market excess return, and controls. The security market line intercept and slope are constructed by regressing monthly the cross-section of excess returns of beta-sorted portfolios on the lagged betas. *Call spread* is the difference between the brokers' call rate and the 3-month Treasury bill rate, and proxies for the difference between the investors' borrowing and lending rates. The control variables are defined in Table II. Newey and West (1987) t-statistics are in parentheses and R^2s are adjusted for degrees of freedom. The sample period is 10/1934-9/1975 with 492 monthly observations.

Dependent variable	Intercept		Slope	
	(1)	(2)	(3)	(4)
Constant	0.005	**-0.035**	-0.004	**0.038**
	(1.14)	(-3.46)	(-0.98)	(3.69)
Margin		**0.061**		**-0.066**
		(4.32)		(-4.48)
Call spread	0.011	0.167	-0.054	-0.222
	(0.03)	(0.48)	(-0.14)	(-0.61)
Market return	0.103	0.107	**0.921**	**0.917**
	(0.99)	(1.04)	(8.39)	(8.45)
Controls	Yes	Yes	Yes	Yes
R^2	0.035	0.058	0.531	0.544

Table X: Low and high disagreement stocks.
This table presents the results of regressing the monthly security market line intercept and slope on the lagged Regulation T minimum initial margin requirement, the contemporaneous market excess return, and controls separately for low and high disagreement stocks. Every month stocks are grouped in three categories based on a measure of disagreement. The security market line intercept and slope are constructed by regressing monthly the cross-section of excess returns of beta-sorted portfolios on the lagged betas separately within each of the three disagreement categories. Disagreement is measured by idiosyncratic volatility and share turnover. The control variables are defined in Table II. Columns 3 and 6 provide the Wald test F-statistic and its p-value for the test of the coefficients being equal for the low and high disagreement stocks. In columns 1, 2, 4, and 5, the Newey and West (1987) t-statistics of the coefficients are are reported in parentheses and the R^2s are adjusted for degrees of freedom. The sample period is 10/1934-9/1975 with 492 monthly observations.

Dependent variable: Intercept						
Disagreement	Idiosyncratic volatility			Turnover		
	Low (1)	High (2)	H-L (3)	Low (4)	High (5)	H-L (6)
Constant	**-0.023**	-0.009	0.014	-0.020	-0.005	0.015
	(-2.24)	(-0.57)	(0.48)	(-1.93)	(-0.41)	(0.39)
Margin	**0.044**	0.027	-0.016	**0.039**	0.015	-0.024
	(2.75)	(1.11)	(0.61)	(2.47)	(0.75)	(0.37)
Market return	0.099	**0.290**	0.191	0.161	0.216	0.054
	(0.98)	(2.27)	(0.17)	(1.38)	(1.73)	(0.69)
Controls	Yes	Yes		Yes	Yes	
R^2	0.054	0.033		0.082	0.011	

Dependent variable: Slope						
Disagreement	Idiosyncratic volatility			Turnover		
	Low (1)	High (2)	H-L (3)	Low (4)	High (5)	H-L (6)
Constant	**0.022**	0.022	-0.001	0.018	**0.020**	0.002
	(1.97)	(1.71)	(0.97)	(1.57)	(2.04)	(0.91)
Margin	**-0.043**	**-0.047**	-0.004	**-0.036**	**-0.039**	-0.004
	(-2.42)	(-2.31)	(0.89)	(-1.99)	(-2.52)	(0.88)
Market return	**0.907**	**0.788**	-0.119	**0.825**	**0.852**	0.028
	(8.28)	(6.99)	(0.43)	(6.59)	(7.45)	(0.87)
Controls	Yes	Yes		Yes	Yes	
R^2	0.455	0.314		0.379	0.371	

Table XI: Conditioning on aggregate disagreement.
This table presents the results of regressing the monthly security market line intercept and slope on the lagged Regulation T minimum initial margin requirement, a measure of aggregate disagreement, the interaction of margin and disagreement, the contemporaneous market excess return, and controls. The security market line intercept and slope are constructed by regressing monthly the cross-section of excess returns of beta-sorted portfolios on the lagged betas. The measures of disagreement are average idiosyncratic volatility (IV), cross-sectional standard deviation of stock returns (*Disp*), aggregate share turnover (TO), and aggregate short interest ratio (*Short*). The control variables are defined in Table II. Newey and West (1987) t-statistics are in parentheses and the R^2s are adjusted for degrees of freedom. The sample period is 10/1934-9/1975 with 492 monthly observations.

Dependent variable	Intercept				Slope			
Disagreement	IV (1)	Disp (2)	TO (3)	Short (4)	IV (5)	Disp (6)	TO (7)	Short (8)
Constant	**-0.034**	**-0.031**	**-0.033**	**-0.031**	**0.036**	**0.033**	**0.036**	**0.034**
	(-2.55)	(-2.67)	(-3.18)	(-3.02)	(2.62)	(2.75)	(3.33)	(3.12)
Margin ×	0.003	0.001	0.006	0.002	-0.003	-0.003	-0.008	-0.001
disagreement	(0.14)	(0.07)	(0.36)	(0.13)	(-0.12)	(-0.13)	(-0.47)	(-0.11)
Margin	**0.063**	**0.059**	**0.062**	**0.059**	**-0.066**	**-0.062**	**-0.067**	**-0.063**
	(2.85)	(3.10)	(3.84)	(3.54)	(-2.89)	(-3.17)	(-3.97)	(-3.63)
Disagreement	-0.001	-0.001	-0.003	-0.001	0.001	0.003	0.005	0.001
	(-0.09)	(-0.11)	(-0.33)	(-0.15)	(0.10)	(0.20)	(0.47)	(0.13)
Market return	0.107	0.107	0.107	0.108	**0.917**	**0.917**	**0.917**	**0.916**
	(1.04)	(1.04)	(1.04)	(1.03)	(8.48)	(8.46)	(8.41)	(8.26)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.055	0.055	0.056	0.055	0.543	0.543	0.543	0.543