Efficient Governance, Inefficient Markets: Short Selling with Takeover Risk

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We hypothesize that takeover risk creates significant limits to short selling. A target firm's stock price often increases substantially upon a takeover announcement, resulting in trading losses to short sellers. Therefore, short sellers should require higher rates of return when takeover likelihood is higher. Consistent with this prediction, the return predictability of monthly short interest increases with industry-level takeover activities and decreases with the implementation of takeover defenses. The risk of activist intervention also creates similar limits to short arbitrage. Our results suggest that efficient markets for corporate control may have unintended effects in creating stock market inefficiencies.

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On August 7, 2018, Tesla's CEO and founder, Elon Musk, announced that he had secured private outside funding to buy the company at $420 per share. In 24 hours, Tesla's stock price went from $343.84 to $369.09. Three days later, a short seller named Kalman Isaacs filed a lawsuit against Musk, claiming that the announcements were false and designed to hurt investors holding short positions in Tesla. Isaacs further claimed that he had to buy 3,000 shares of Tesla at inflated prices to cover his short positions.[1] This example illustrates a distinct type of risk faced by short sellers: that a potential takeover bid can result in substantial trading losses.

Our study investigates whether the likelihood of a takeover bid creates significant limits to informed short-selling activities. Takeover targets generally experience large positive returns upon the announcement of a takeover bid (Lang, Stulz, and Walkling (1989), Servaes (1991)). This is because acquirers expect to increase target firms' post-acquisition values by improving governance, identifying synergies, etc. and are thus willing to offer significant premiums over current market prices (e.g., Schwert (1996), Schwert (2000), Devos, Kadapakkam, and Krishnamurthy (2009), Hoberg and Phillips (2010), Erel, Liao, and Weisbach (2012), and Erel, Jang, and Weisbach (2015)). Therefore, an increase in the likelihood that a firm becomes a takeover target poses a significant risk to informed short sellers who take under-diversified positions in order to exploit an arbitrage opportunity (Shleifer and Vishny (1997), Wurgler and Zhuravskaya (2002)).[2]

[1] https://www.cnbc.com/2018/08/11/lawsuits-accuse-teslas-musk-of-fraud-over-going-private-proposal.html

[2] The recent takeover of Kite Pharma by Gilead Sciences illustrates the adverse effect of a takeover on short sellers' profits. As of August 15, 2017, Kite Pharma had an outstanding short interest of 8.1 million shares (14.2% of shares outstanding) as investors questioned the prospects of its new technology, CART therapy. On August 28, Gilead Sciences announced the acquisition of Kite Pharma for $11.9 billion. Gilead agreed to pay $180 per share, which represented a 29% premium over the market price. Wedbush biotechnology analyst David Nierengarten admitted that he was wrong on the price forecast, commenting that "the hazard of having an underperform rating on a company that's about to launch is that it can get acquired before the launch."

If informed short sellers anticipate the risk of a potential takeover *ex ante*, they demand higher returns to their arbitrage positions for bearing this risk (Shleifer and Vishny (1997), De Long et al. (1990)). Higher takeover probability should therefore lead to more negative future stock returns for firms with large amounts of short interest (e.g., Engelberg, Reed, and Ringgenberg (2018)). Our evidence supports this prediction. We document a stronger negative relation between short interest and future stock returns in portfolios with the highest *ex-ante* takeover risk, as measured by the number of recent takeover attempts in the same industry.

We show that the economic effect of takeover risk on the return predictability of short interest is comparable to that of other factors that limit arbitrage activities, such as idiosyncratic risk (Pontiff (2006)), institutional ownership (Asquith, Pathak, and Ritter (2005)), size, and stock illiquidity (Brunnermeier and Pedersen (2009)). Our results are also robust to controlling for other types of short-selling constraints, such as the availability of lendable shares and stock borrowing costs. Importantly, we find that the effect of takeover risk on the return predictability of short interest is stronger when the constraints from the stock lending markets are less binding, and when short sellers have longer trading horizons. Consistent with the intuition that takeover risk induces market inefficiencies by limiting informed short selling, we find that a mispricing-based trading strategy is more profitable when takeover risk is higher (Stambaugh, Yu, and Yuan (2015)). Furthermore, traded options exhibit stronger put-call disparity with high short interest in the presence of higher takeover risk (Ofek, Richardson, and Whitelaw (2004), Muravyev, Pearson, and Pollet (2018)).

Although we explore the effect of takeover risk on short sellers, we note that heavy short selling may create downward price pressure, which itself may increase the probability of a takeover attempt. Edmans, Goldstein, and Jiang (2015) formalize this intuition, and theoretically show that when real decision makers such as firm's managers or activist investors learn from stock prices, they can make better-informed decisions and improve real efficiency. Although these corrective actions can improve firms' fundamental values, they also reduce the trading profits of short sellers who convey this negative information via their trades. In our context, the role of market-based corrective action falls to the potential acquirer. Even without this information feedback loop between short sellers and firm's managers or activists, the increase in the likelihood of a takeover attempt and the decrease in short interest could instead be driven by positive fundamental information about the firm. In other words, it is possible that the relation between short selling and takeover risk is endogenously determined. In that case, we must identify exogenous variation in takeover likelihood in order to establish a plausibly causal relation between takeover risk and limits to short arbitrage.

We address this potential endogeneity in our empirical tests in two ways. First, we use the passage of business combination laws to generate staggered, state-level variation in *ex-ante* takeover risk. Second, we consider exogenous firm-level variation in takeover risk using instrumented measures of firms' anti-takeover defenses developed in Gompers, Ishii, and Metrick (2003) and Karpoff, Schonlau, and Wehrly (2017). The results of these better-identified tests continue to suggest that increases in takeover risk generate limits to short arbitrage.

Our hypothesis is generalizable beyond takeovers to other corporate events that cause unexpected positive price shocks. For example, Gantchev, Gredil, and Jotikasthira (2017) consider hedge fund activism to be a more recent substitute mechanism for the market for corporate control. Such activities by large investors result in price jumps similar to M&A bids. We build on their argument and consider whether the potential for shareholder activism affects short sellers in a similar way as takeover threats. Consistent with this intuition, we indeed document that a higher probability of shareholder activism generates more predictability between short interest and future stock returns. This result suggests that other corporate governance actions such as shareholder activism also represent potential limits to short sellers' arbitrage opportunities, consistent with the general theme of this article.

Our study contributes to the extensive literature on the limits to arbitrage (see Gromb and Vayanos (2010) for a survey). Theoretical studies argue that risk exposure due to potential changes in firms' fundamentals (Shleifer and Vishny (1990), Campbell and Kyle (1993)) and noise trading (De Long et al. (1990)) create significant holding costs for arbitrageurs (Pontiff (2006)). Limits to arbitrage due to risk exposure have been empirically examined in various contexts of market inefficiency, such as the closed-end fund discount (Pontiff (1996)), long-term seasoned equity offering returns (Pontiff and Schill (2001)), merger arbitrage (Mitchell and Pulvino (2001)), and situations where a firm's value is less than the sum of its subsidiaries' values (Mitchell, Pulvino, and Stafford (2002)).[3] Our findings contribute to this literature by identifying the threat of a potential takeover as a specific source of risk that causally limits informed short selling.

The empirical literature on short-selling constraints generally documents that short interest can predict stock returns. This return predictability manifests in both cross-sectional and time-series data.[4] Much of the extant literature focuses on transaction costs created by the stock lending market or short-selling regulations (Gromb and Vayanos (2010), Reed (2013)). For example, Jones and Lamont (2002) show that stocks that are expensive to short have lower subsequent returns. Nagel (2005) and Asquith, Pathak, and Ritter (2005) show that institutional ownership, as a proxy

[3] More recent studies show that individual short sellers can mitigate limits to arbitrage by publicly revealing their information and attract other investors to follow, for example through short campaigns (Kovbasyuk and Pagano (2015), Ljungqvist and Qian (2016)).
[4] See, for example, Figlewski (1981), Boehme, Danielsen, and Sorescu (2006), Boehmer, Jones, and Zhang (2013), Chen and Singal (2003), Asquith, Pathak, and Ritter (2005), and Boehmer, Huszar, and Jordan (2010) for evidence on the cross-sectional return predictability of short interest. See Seneca (1967) and Rapach, Ringgenberg, and Zhou (2016) for the time-series return predictability of aggregate short interest.

for the supply of lendable shares, is related to short-selling constraints. Engelberg, Reed, and Ringgenberg (2018) document that the risk of future variation in stock borrowing costs constrains short sellers. Boehmer, Jones, and Zhang (2013), Boehmer and Wu (2013), Lin and Lu (2016), and Chu, Hirshleifer, and Ma (2017) examine the effect of short-selling restrictions on market efficiency. In contrast to these studies, the friction that we investigate arises naturally from the market for corporate control. Hence, informed short selling may be limited even without short selling regulations or frictions in the stock lending market. Interestingly, takeover markets themselves are considered important governance mechanisms in corporate finance and are generally viewed as improving economic efficiency (Jensen and Ruback (1983), Bertrand and Mullainathan (2003), Gompers, Ishii, and Metrick (2003), and Bebchuk, Cohen, and Ferrell (2009)). However, by showing that active takeover markets also generate limits to arbitrage for short sellers, our evidence suggests that efficient markets for corporate control also have an unintended effect in inducing stock market inefficiencies.

Finally, our paper also contributes to the literature on the role of activists in firm's governance (e.g., Boyson and Mooradian (2011), Brav et al. (2008), and Brav, Jiang and Kim (2015b)).[5] Gantchev, Gredil, and Jotikasthira (2017) suggest that the threat of hedge fund activism affects real firm's decisions and can thereby substitute for the threat of a hostile takeover as a governance mechanism. We contribute to this literature by showing that the risk of shareholder activism limits short sellers' arbitrage opportunities in similar ways as the takeover market.

[5] See Brav, Jiang, and Kim (2015a) for a survey.

I. Hypothesis Development and Empirical Identification

A. Hypothesis Development

We next develop hypotheses about the role of takeover risk in creating limits to short arbitrage and about the effect of takeover risk on the relation between a stock's short interest and future returns. We also provide an illustrative model based on the work of Wurgler and Zhuravskaya (2002) and Gromb and Vayanos (2010) in Appendix C.

Consider a short-selling arbitrageur who takes an under-diversified position to exploit a potential mispricing opportunity. The arbitrageur bears the risk that the price will deviate further from the expected value either due to changes in fundamentals or noise trading (De Long et al. (1990), Shleifer and Vishny (1990), Campbell and Kyle (1993), Shleifer and Vishny (1997), Pontiff (2006)). To the extent that this risk cannot be fully hedged, short sellers will not bear this risk unless the expected arbitrage return is sufficiently high (Wurgler and Zhuravskaya (2002)). Consistent with the risk-return tradeoff in short arbitrage, the extant literature documents that monthly short interest negatively predicts future stock returns (e.g., Figlewski (1981), Boehme, Danielsen, and Sorescu (2006), Chen and Singal (2003), Asquith, Pathak, and Ritter (2005), and Boehmer, Huszar, and Jordan (2010)).

We argue that the likelihood of a takeover represents a source of arbitrage risk for informed short sellers. A takeover attempt is often accompanied by a substantial price jump in the target stock price around the announcement, because acquirers typically pay significant premia to obtain control of target firms (e.g., Barclay and Holderness (1989)). Following a takeover attempt, short sellers may even have to cover their positions in response to the price jump and realize trading losses (Hong, Kubik, and Fishman (2012)). Given the *ex-post* potential losses when a takeover attempt induces a short squeeze, a rational short seller demands a higher *ex-ante* return in exchange for this increased risk. Thus, we hypothesize that the relation between monthly short interest, which reflects informed short sellers' positions, and future stock returns is more negative when takeover risk is higher.

H1: Ex-ante takeover risk enhances the negative relation between monthly short interests and future stock returns.

B. Identification Strategy

Our study focuses on how changes in takeover probability cause short sellers to demand higher expected returns for their trades (and therefore more negative stock returns). Using traditional asset pricing methodologies, we first document a cross-sectional relation among takeover risk, short interest, and future stock returns that is consistent with our hypothesis.

We then recognize that this relation could be endogenously determined. For example, the model in Edmans, Goldstein, and Jiang (2015) shows that short sellers could reveal information via their trades. Therefore, by observing short sellers' behavior, managers can take corrective actions if they believe that short sellers identify areas for improvement. Similarly, in our setting, outsiders can make takeover bids by observing information revealed by short sellers' trades. Even if potential acquirers do not directly learn from short sellers' trades, the increase in takeover likelihood and the decline in short interest could be driven by positive information about the firm's fundamentals which acquirers and short sellers independently discover. In sum, the main concern is that the link between short selling and takeovers may be endogenously determined, either through reverse causality (short selling triggering takeover attempts) or a spurious correlation relating to the firm's economic fundamentals.

We recognize this concern and attempt to generate exogenous variation in takeover risk orthogonal to a firm's fundamentals. We use a variety of estimation strategies described in detail in Section III.D, including staggered changes in state-level takeover laws, and instrumented G-Index.

II. Data and Summary Statistics

A. Data

Our study utilizes several standard finance databases. We extract stock price information from CRSP and accounting and short interest data from Compustat. We collect data on takeover attempts for majority ownership of U.S. firms from 1984 to 2015 from the Securities Data Company (SDC).

We start with U.S. common stocks traded on the NYSE, AMEX, or NASDAQ exchanges from 1985 to 2015, and we require that both CRSP and Compustat cover each stock.[6] We exclude stocks below five dollars per share at the portfolio formation date to reduce the concern that small and illiquid stocks drive our results. To ensure that our analysis captures the *ex-ante* threat of a potential acquisition, we exclude stocks that have been takeover targets within the past 12 months. After merging data from the above sources, we have an unbalanced panel dataset with 675,773 firm-month observations for 7,844 companies that we use for our main analysis. We use different sample periods when conducting tests using state antitakeover laws, G-index, stock lending data, and shareholder activism, due to the availability of those variables. We provide detailed discussions of the samples in the corresponding sections.

[6] We begin our stock price data in 1985 because we lag our takeover data.

B. Variable Definitions

B.1 Takeover Intensity

We measure the potential takeover threat for each firm using the number of takeover attempts within the firm's industry over the past six months. We motivate the use of industry-level takeover risk by the well-established observation that merger waves typically cluster within industries (Mitchell and Mulherin (1996), Harford (2005)). For each stock-month, we count the number of announcements of takeover attempts (i.e. including both completed and unsuccessful attempts) that target private and public firms in the same 2-digit SIC industry over the previous six months. We follow Edmans, Goldstein, and Jiang (2012) and exclude acquisitions of partial stakes, minority squeeze-outs, buybacks, recapitalizations, and exchange offers. Additionally, we only retain bids where the acquirers had a stake of under 50% before the acquisition attempt and are bidding for a final ownership over 50%. We standardize the number of takeover announcements by the number of stocks in the same 2-digit SIC industry. For our regression analysis, we create a binary variable that equals one if the takeover intensity ratio is in the top tercile at the portfolio formation date. Consistent coverage of M&A activity in SDC begins in 1984, so we are able to use this variable for portfolio sorting starting in January 1985.[7]

B.2 Short Interest

We collect short interest data for individual stocks from Compustat. Historically, U.S. exchanges compile short interest in each stock as of the 15th of each month and publicly report the data four business days later. After September 2007, Compustat reports short interest data twice per month. We only retain the mid-month short interest throughout the sample to ensure that the

[7] In an unreported test, we find that our industry-level takeover risk measure is significantly related to higher firm-level takeover likelihood in the subsequent quarter. This result supports the validity of our industry-level takeover risk measure.

short interest we use is publicly observable to investors as of the end of each month. Compustat reports historical short interest data back to 1973, which allows us to conduct our analysis using a relatively long time series. Following the extant literature (e.g., Asquith, Pathak, and Ritter (2005) and Rapach, Ringgenberg, and Zhou (2016)), we calculate the short interest ratio (*SR*) as the ratio of the number of shares sold short to the total number of shares outstanding. For Figure 1 we compute the daily short ratio (*DAILY SR*) by dividing the daily short interest variable provided by Markit (*ShortLoanQuantity*) by the total shares outstanding (from CRSP).

B.3 Stock lending utilization and borrowing cost

We collect data on lendable shares utilization and stock borrowing cost from the Markit Securities Finance Buyside Analytics database. Markit collects detailed data on stock lending from their client hedge funds. We use three variables from their database: *UTILIZATION* is the ratio of shares on loan to the number of lendable shares; Daily Cost of Borrowing Score (*DCBS*) is a score from 1 to 10 constructed by Markit using their proprietary information; and *SHORT TENURE*, the weighted average of the number of days from start date to present for all transactions. The data on *UTILIZATION* and *DCBS* are available beginning in 2002.

B.4 Control Variables

Following the extant literature, we include the following control variables (all defined in Appendix A). We control for firm characteristics by using the book-to-market ratio (*BM*), market capitalization (*ME*), idiosyncratic volatility (*IVOL*), institutional ownership (*IO*). We further include variables that have historically explained returns, such as lagged monthly stock returns to measure short-term reversal (*REV*), and the compounded 11-month stock return to measure momentum (*MOM*). We also examine stock illiquidity (*ILLIQ*) as an additional proxy variable measuring limits to arbitrage.

B.5 Put-call Disparity

We collect data on listed options from the OptionMetrics database. For each stock-date, we extract put-call pairs with time to maturity between 30 and 180 days, bid-ask spreads within 50%, and absolute value of the natural log of the options' moneyness within 20%. We extract information on strike prices, bid and ask prices, expiration date, and implied volatility. Our final sample consists of 10,978,250 put-call pairs from 1996 to 2015. We follow Ofek, Richardson, and Whitelaw (2004) and compute put-call disparity as the natural logarithm of the ratio of the actual stock price to the option implied stock price based on the put-call parity: $S* = PV(K) + (C - EEP_c) - (P - EEP_p)$, where *EEP* is the early exercise premium for American options, estimated using Cox, Ross, and Rubenstein's (1979) binomial option pricing model with implied volatility from OptionMetrics. PV(*K*) is the present value of strike price. *C* and *P* are market prices for the call option and put option, respectively.

C. Summary Statistics

Table I reports the summary statistics of the variables used in our data analysis. The short interest ratio (*SR*) has a mean of 3.4% and standard deviation of 4.6%, consistent with summary statistics reported in other recent studies (e.g., Li and Zhu (2017)). Based on the stock lending data reported by Markit, on average 17.7% of the lendable shares are shorted, with a standard deviation of 20%. Further, more than 75% of the observations have the lowest score of stock borrowing (*DCBS*) based on Markit's estimate, indicating that most stocks in our sample are relatively inexpensive to borrow.

Finally, our intuition requires short sellers to hold positions long enough for expected takeovers to affect them. In other words, we expect compensation for longer-run takeover risk to be less relevant for short-term traders. Table I shows that, on average, short sellers hold their positions for 83 days. The data therefore suggests that the average short seller in our sample is an investor with longer-term exposure. This is also in line with the observation by Karpoff and Lou (2010) that short sellers on average detect corporate financial misconducts 19 months ahead of public revelation.

III. Short Interest, Takeover Intensity, and Predictability of Stock Returns

A. Testing the Underlying Assumptions

Our hypothesis is that takeover risk represents a limit to short selling because a takeover attempt can cause substantial losses to short sellers. To verify the underlying assumptions of our hypothesis, we first examine whether short sellers scale back their short positions in reaction to takeover announcements. We use daily data on stock returns and short selling activities and regress *DAILY SR* on binary variables for each day of the [-10, +10] window around the M&A announcements. We also include day-of-the-week fixed effects and the interaction between firm and year fixed effects to control for seasonality and time-varying firm characteristics, respectively. The standard errors are clustered by both firm and year. We plot the coefficient estimates and the corresponding 95% confidence intervals for the day dummies in Figure 1. We note a significant drop in short interest after the announcement. This evidence suggests that short sellers try to close their positions after the M&A bid, likely because of the typical post-bid positive price shock to the target firm (Lang, Stulz, and Walkling (1989), Servaes (1991)).

Our hypothesis also assumes that short sellers update their priors about takeover likelihoods by observing takeover activities in the industry. To test this underlying assumption, we regress *DAILY SR* on binary variables that take a value of 1 when a matched peer firm is the target of a takeover attempt from day *t*-5 to *t*+5.[8] Table B1 of Appendix B reports the results. In column 1, we document that short interest begins to decline from day *t*+1 to *t*+4 after peers' takeover news. In contrast, in column 2 we find that there is no significant change in daily lendable share supply during the same period, indicating that the reduction in short selling is not driven by supply-side constraints. These results are consistent with the intuition that short sellers respond to takeover attempts against peer firms in the same 2-SIC industry by scaling back their short positions, indicating that they are cognizant of potential takeover risks.

B. Industry Takeover Intensity, Short Interest, and the Cross-section of Future Stock Returns

Next, we investigate our main hypothesis that short interest should more strongly predict future stock returns when takeover risk is higher *ex ante*. We start this analysis by creating 30 portfolios by first sorting stocks into terciles of takeover intensity and then, within each tercile, further sorting stocks into deciles of short ratio. For each portfolio, we follow Engelberg, Reed, and Ringgenberg (2018) and compute the equal-weighted average monthly returns and Carhart (1997) four-factor alphas one month ahead of *TAKEOVER* and *SR*.

We present these results in Table II. As predicted, and consistent with existing studies such as Figlewski (1981), Boehme, Danielsen, and Sorescu (2006), and Asquith, Pathak, and Ritter (2005), portfolios in the bottom decile of *SR* significantly outperform portfolios in the top decile of *SR* in most cases. Further, consistent with our intuition that takeover risk limits short selling *ex ante*, the highest tercile of takeover intensity displays stronger outperformance (underperformance) for stocks with low (high) short interest, resulting in a significantly higher return in the long-short portfolio. Specifically, in the top tercile of takeover intensity, the long-short portfolio based on *SR* generates an average of 83 basis-point return and 106 basis-point

[8] We identify takeover announcements of peers that are in the same 2-SIC industry and matched by size (two groups), book-to-market (three groups), and momentum (three groups).

Carhart alpha per month, whereas in the bottom tercile of takeover intensity the long-short portfolio produces only a 26 basis-point return and 60 basis-point Carhart alpha per month. The difference in performance is statistically significant at the 1% level in both cases. Consistent with our hypothesis, Table II documents that the return predictability generated by short interest is stronger when the firm's takeover risk is higher. In turn, this suggests that the likelihood of a takeover bid represents an implicit limit to arbitrage opportunities.[9]

We perform several robustness tests and report the results in Appendix B. First, in Table B2, we show that our main result on takeover risk and return predictability of short interest is robust to alternative asset-pricing models, such as Fama and French (2016 and 2017) five-factor model, Carhart (1997) four-factor model plus Pástor and Stambaugh (2003) liquidity factor, 2-digit SIC code industry-adjusted returns, and Hou, Xue, and Zhang's (2015) Q-factor alphas. Second, in Table B3 we show that this result holds using alternative sorting methods, such as five-by-five and five-by-ten.[10] Finally, in Table B4 we examine the persistence of the return predictability of short interest and find that the predictive power of short interest remains significant up to three months in the future.

As documented by other existing studies (e.g., Engelberg, Reed, and Ringgenberg (2018)), we expect that the return predictability of short interest will manifest more frequently in small stocks. Short selling large stocks is less costly because they are typically more liquid and have a larger supply of lendable shares by institutional investors. Importantly, our proposed mechanism should also apply more to small stocks because large firms are less likely to become takeover

[9] Interestingly, we also note that stocks in the bottom decile of short ratio exhibit significantly positive abnormal returns in the month following portfolio formation, particularly in the highest tercile of takeover intensity. This result is consistent with Boehmer, Huszar, and Jordan (2010), who document a positive abnormal return in stocks with low short interest, and interpret this result as evidence that short sellers not only identify overvalued stocks to short sell, but also identify undervalued stocks to avoid.

[10] We measure our takeover intensity variable at the industry level and thus it does not provide sufficient variation for forming decile portfolios.

targets (Comment and Schwert (1995)). In order to test this conjecture and properly account for size differences, we follow Engelberg, Reed, and Ringgenberg (2018) by partitioning the sample into small and large stocks based on the 50th percentile of NYSE size breakpoints (Fama and French (2008)), and by using value-weighted portfolio returns. We perform the three-by-ten portfolio sort separately among small and large stocks and estimate the value-weighted performance of these portfolios. Consistent with existing studies, our results in Panel A of Table III show that the return predictability of short interest generally exists in the sample of smaller firms. Moreover, the differential performance between the top/bottom takeover-intensity terciles is statistically significant among small stocks. In Panel B, where we present the performance of value-weighted portfolios among large stocks, we still observe a greater positive (negative) performance of lightly (heavily) shorted stocks in the industries with higher takeover likelihood, although now the difference in performance between high/low takeover-intensity tercile is not statistically significant. Since smaller firms are more likely affected by takeover risk, our remaining analyses focus on the performance of equal-weighted portfolios.

Next, we investigate the role of takeover likelihood as a limit to short sellers' arbitrage opportunities in a multivariate setting. Panel A of Table IV reports the estimates of Fama-MacBeth (1973) regressions of the following model:

$$\begin{aligned} \mathrm{Ret}_{i,t+1} = {} & \alpha + \beta_1 \mathrm{SR}_{i,t} + \beta_2 \mathrm{HIGH\ TAKEOVER}_{i,t} + \beta_3 \mathrm{SR}_{i,t} \times \mathrm{HIGH\ TAKEOVER}_{i,t} + \\ & \beta_4 \mathrm{LnBM}_{i,t} + \beta_5 \mathrm{Ln}\mathit{ME}_{i,t} + \beta_6 \mathrm{REV}_{i,t} + \beta_7 \mathrm{MOM}_{i,t} + \beta_8 \mathrm{IVOL}_{i,t} + \beta_9 \mathrm{IO}_{i,t} + \varepsilon_{i,t} \end{aligned} \tag{1}$$

For each firm *i* at month *t*, *SR* is the short interest ratio, *HIGH TAKEOVER* an indicator variable equal to one if *TAKEOVER* is in the top tercile for that month, *BM* the book-to-market ratio, *ME* the market capitalization, *REV* the short-term reversal, *MOM* the momentum, *IVOL* the idiosyncratic volatility, and *IO* the stock institutional ownership (all variables are defined in Appendix A). If a higher threat of a takeover attempt constrains short sellers and generates stronger return predictability, we expect subsequent returns to be lower for stocks that have high short interest and are also in the highest tercile of *TAKEOVER*. Thus, we expect a negative coefficient on the interaction term β_3.

The results in Table IV are consistent with this hypothesis. The coefficient on the interaction term *SR* × *HIGH TAKEOVER* is significantly negative in all specifications, implying that short selling activities more strongly predict future stock returns when firms face higher takeover threats. The effect of takeover risk on return predictability is also economically significant. For example, based on the estimates in column 4, a ten percentage-point increase in short ratio for firms with lower takeover risk implies a 32 basis points reduction in stock return the following month. By contrast, for firms facing the top-tercile level of takeover risk, a ten-percentage point increase in short ratio implies an 80 basis points decrease in returns in the following month. Thus, the magnitude of the effect of the short ratio on the next month's stock return more than doubles in industries with top-tercile level of takeover risk.

In Panel B of Table IV, we re-estimate the models in Panel A but control for several other factors known to limit arbitrage activities in the extant literature (see, e.g., Asquith, Pathak, and Ritter (2005), Duan, Hu, and McLean (2010)). We include the interaction between *SR* and binary variables that indicate firms with top-tercile levels of idiosyncratic volatility (*IVOL*), institutional ownership (*IO*), market capitalization (*ME*), and illiquidity (*ILLIQ*). All control variables from Panel A are included in the regression but omitted from the table for brevity. Our results are consistent with the extant literature in that all four proxies for limits to arbitrage are related to greater return predictability of short interest. Importantly, the coefficient on *SR* × *HIGH*

TAKEOVER remains significant after the inclusion of the other factors known to generate limits to arbitrage. Further, the economic effect of takeover risk on the return predictability of short interest is comparable to that of other proxies of limits to arbitrage. This result suggests that takeover risk generates limits to short selling activities even in the presence of other factors known to limit arbitrage opportunities.

C. Supply-Side Constraints and Short Tenure

High stock borrowing costs can also create frictions for short sellers (see, e.g., Beneish, Lee, and Nichols (2015), and Porras Prado, Saffi, and Sturgess (2016)). A concern in the above tests may be that stocks in high takeover intensity industries are also more difficult to borrow. Therefore, rather than the proposed takeover channel, a spurious correlation created by known short selling constraints such as low supply of lendable shares or high borrowing costs could be generating the return predictability that we document. To address this concern, we re-estimate Model 4 from Panel A of Table IV for subsamples of stocks characterized by high and low availability of lendable shares and stock borrowing costs. We define a stock as easy to lend if *UTILIZATION*, the ratio of shares on loan to the number of lendable shares, is above the median, and measure stock borrowing cost by *DCBS*, a score of lending cost created by Markit (*DCBS*=1 is the lowest score). Note that our Markit data begins in 2002, resulting in a shorter time period for these tests.

Estimates in Table V show that our results hold for the subsample of stocks that are easier to borrow (columns 1 and 3), as the coefficient for the interaction term *SR* × *HIGH TAKEOVER* is significantly negative in both cases. On the other hand, when it is difficult or expensive to borrow a stock (columns 2 and 4), the coefficient on the interaction term between *SR* × *HIGH TAKEOVER* is not significantly different from zero. Moreover, for this subsample we find that both the coefficients on the interaction terms *SR* × *UTILIZATION* and *SR* × *DCBS* are negative, although none of the coefficients are significant. These results suggest that takeover risk creates significant limits to short selling activities only when supply-side constraints are not binding.

In sum, the results in Table V suggest that takeover risk limits short sellers in a different way than low stock supply or high borrowing costs. Although our results are consistent with the extant evidence suggesting an important role of lending frictions in the stock lending markets, we also find that takeover risk appears to limit short sellers even in cases where stock lending frictions are low.

Next, we investigate whether a short seller's exposure to takeover risk is affected by her time horizon. The longer a short seller holds her short position, the longer she is exposed to the risk of a takeover attempt. Therefore, we expect the effect of takeover risk on short interest return predictability to be stronger when short sellers hold their positions for a longer time. We test this intuition by estimating the baseline model (Model 4 from Panel A of Table IV) on two subsamples of shorted stocks with *SHORT TENURE* above and below the median, respectively. Consistent with our intuition, Table VI shows that the negative effect of short ratio on future monthly stock returns is more negative for firms in the highest tercile of takeover risk only for firm in the high short tenure subsample. In the next section, we further focus on the empirical identification of our proposed hypothesis.

D. Identifying the Causal Effect of Takeover Risk on the Limits to Short Arbitrage

D.1 Implementation of Antitakeover Legislation

Our above tests use recent industry-level takeover activity to proxy for a short seller's *ex-ante* risk of future takeover. Although industry merger waves are likely beyond the control of any single firm or investor, we cannot interpret our tests as causal because they cannot rule out a spurious correlation between unobservable industry characteristics and other limits to short arbitrage. Additionally, short selling may create an endogenous feedback loop that triggers corrective actives, such as takeovers (Edmans, Goldstein, and Jiang (2012, 2015)). In addition to the cross-sectional splits based on supply-side constraints in Table V, we further consider two identification strategies to exploit plausibly exogenous variation in ex-ante takeover risk.

We first use the introduction of state-level antitakeover laws in the U.S. as an exogenous shock to a given firm's likelihood of receiving a takeover bid in its state of incorporation.[11] Specifically, our difference-in-differences methodology identifies changes in a firms' takeover risk following the introduction of these laws, which should affect short sellers' required returns from shorting those firms' shares. Given that antitakeover laws make takeovers more difficult, they reduce the likelihood that a firm with high short interest will become the target of a takeover[12]. We therefore expect return predictability associated with short interest to decrease following the passage of an antitakeover law. We estimate the following difference-in-differences model:[13]

$$\begin{aligned} Ret_{i,t+1} = \alpha + \beta_1 SR_{i,t} + \beta_2 BC_{i,t} + \beta_3 SR_{i,t} * BC_{i,t} + \\ \beta_4 LnBM_{i,t} + \beta_5 LnME_{i,t} + \beta_6 REV_{i,t} + \beta_7 MOM_{i,t} + \beta_8 IVOL_{i,t} + \beta_9 IO_{i,t} + \varepsilon_{i,t} \end{aligned} \tag{2}$$

For each firm *i* in month *t*, BC_t *is* a binary variable that equals one for stock-month observations if the state where the firm is incorporated has passed business combination laws. We focus on the implementation of business combination laws, which appear to be the most restrictive type of antitakeover laws based on the corporate governance literature (e.g. Bertrand and Mullainathan (2003)). Business combination laws impose a three-to-five year moratorium on M&A transactions

[11] See Karpoff and Wittry (2018) for a comprehensive list of papers using the introduction of antitakeover laws as a natural experiment.
[12] Further, the introduction of state-level antitakeover laws is unlikely to be driven by short sellers' incentives.
[13] We do not estimate the difference-in-differences regressions using the Fama-Macbeth method because the binary variable *BC* captures time-series variations in takeover risk.

between the firm and the large shareholders who obtain more than a specified percentage of shares. This moratorium imposes costs on acquirers as it impedes them from using the target's assets to repay the debt raised for the acquisition. We predict that the coefficient on the interaction term *SR* × *BC* is positive if antitakeover laws reduce limits to short arbitrage and hence the return predictability of short interest. Since we do not use the *TAKEOVER* measure in this test (and therefore do not use SDC data), we can extend our sample prior to 1984. We follow the methodology of Bertrand and Mullainathan (2003) and estimate Equation (3) using stock-month observations from 1976 to 1995.[14]

Table VII reports the estimates of the difference-in-differences model. The coefficient on the interaction term *SR* × *BC* is significantly positive in all models. Hence, we continue to document that takeover risk constrains short sellers, as antitakeover legislation that reduces takeover risk also reduces the return predictability of short interest. In column 5, we also include industry and year-month fixed effects, thereby controlling for time-invariant, unobserved characteristics at the industry level as well as time trends in short selling. In this model, we continue to document significantly lower return predictability of short interest after the passage of business combination laws.

In order to identify the timing of the effect of business combination laws on short selling activities, we further decompose the *BC* indicator variable into six dummy variables in column 6. BC_{-3}, BC_{-2}, BC_{-1}, and BC_1 indicate observations that are three, two, and one years prior to and one year after the passage of the BC laws, respectively. BC_0 and BC_{2+} indicate all the observations in the year of and at least two years after the passage of the BC laws. The estimates show that, in the

[14] We follow the corporate governance literature (e.g., Bertrand and Mullainathan (2003), Karpoff and Wittry (2018)) and use observations from 1976 to 1995 because most business combination laws became effective between 1980 and 1990.

year prior to the passage, the return predictability of short interest is stronger. Importantly, the relation between short interest and future stock return significantly weakens only two years after the passage of business combination laws. This is consistent with business combination laws reducing limits to short arbitrage.

Our identification strategy relies on two important assumptions. The first assumption is the relevance assumption. Specifically, we require that antitakeover laws impose meaningful changes to the likelihood of takeover. Karpoff and Wittry (2018) argue that other pre-existing antitakeover laws may affect both the likelihood of BC law adoption and the marginal effect of BC laws on takeover likelihoods, confounding our empirical inference. We address this concern and attempt to improve the accuracy of our estimates by following Karpoff and Wittry (2018) and interacting *SR* with dummy variables for other antitakeover laws, including first generation antitakeover laws, poison pill laws, control share acquisition laws, directors' duties laws, and fair price laws. We present these results in Appendix B (Table B5). We continue to document a statistically significant effect of BC laws. Therefore, the reduction in takeover risk and the associated lower return predictability of short interest appears to be largely driven by the introduction of business combination laws.

The second assumption behind our identification strategy is that the passage of antitakeover laws is exogenous to short selling activities in the market. Since firms generally do not have incentives to encourage short selling, we believe it is unlikely that limits to short arbitrage causally induce the passage of business combination laws through firm lobbying. In order to address this concern empirically, we follow Karpoff and Wittry (2018) and re-estimate the regression model in Table VII after excluding from the sample firms that lobbied for the passage of business combination laws. We report these results in Table B6 of Appendix B. They are largely consistent with our earlier results. Overall, the evidence in Table VII is consistent with our main hypothesis that the risk of takeover attempts limits short sellers' arbitrage activities.

D.2 Instrumented G-Index as a Measure of Firm-level Takeover Defenses

Having used industry-level takeover activity as well as state-level shocks to identify variation in takeover risk, we next consider a firm-level measure of takeover probability. We focus on the index of antitakeover defenses in a firm's corporate charter developed by Gompers, Ishii, and Metrick (2003), the G-Index. We collect the G-Index of U.S. public firms from 1991 to 2006 from Andrew Metrick's website and examine whether firms with stronger antitakeover defenses exhibit lower short-selling frictions and hence lower return predictability of short interest.[15]

The raw G-Index potentially contains an endogenous component since firms might incorporate more takeover defenses in their charters when the likelihood of receiving takeover bids is higher *ex ante*. We therefore follow Karpoff, Schonlau, and Wehrly (2017) and use two types of instruments for the G-Index: geography-based instruments and IPO-cohort-based instruments. The geography-based instruments are defined as the average G-Index of neighboring firms within a 100-mile radius. This instrument is designed to capture the influence of local peers through shared legal services or through social interactions. The IPO-cohort instruments are defined as the average G-Index for firms that went public within one year of the focus firms. We motivate this set of instruments using previous studies showing that a firm's choice of takeover defenses is sticky over time and to a large extent influenced by the year it went public (e.g., Daines and Klausner (2001), Field and Karpoff (2002)). Additionally, these geography-based instruments and cohort-based takeover defenses are unlikely to be correlated with stock returns other than through takeover

[15] The data on takeover provision after 2006 are collected by RiskMetrics. As noted by Karpoff, Schonlau, and Wehrly (2017), there have been significant changes to the format and scope of the data compared to the IRRC version before 2006. To ensure consistency of the variable, we only use the G-index based on the IRRC data which ends in 2006. We thank Andrew Metrick for making this data available.

probabilities, thereby satisfying the exclusion restriction. We further follow Karpoff, Schonlau, and Wehrly (2017) by making two adjustments to both instruments in order to strengthen the exclusion condition. First, we exclude firms in the same industry from the peer group. Second, we calculate the instruments based on the peer firms' average G-Index as of: 1. five years before the analysis ("5yr"); 2. 1990, which is as the earliest data reported by IRRC ("static-1990"); and 3. the earliest year before 1990 that are either reported by IRRC or Cremers and Ferrell (2014). By using a lagged value and excluding firms in the same industry from the instruments, we can separate the effect of the instrument from any confounding local economic factors and industry level shocks. We use the instrumented G- Index (G) in our main regressions and interact this variable with SR. We present the results in Table VIII.

Columns 1 and 2 report the first-stage regressions of G and $SR \times G$ on the five-year lagged geographic- and IPO-based instruments for G. The instruments appear to satisfy the relevance condition, as they are significantly correlated with the firms' G-Index. The first-stage F statistics for the weak instrument tests are also greater than the rule of thumb critical value of 10, as suggested by Staiger and Stock (1997). We present the second-stage regression in Model 3. Here the coefficient on the interaction term $SR \times G$ is significantly positive, consistent with our main hypothesis. Specifically, the relation between short interest and future stock returns is significantly weaker when (instrumented) takeover defenses are stronger. We estimate the same system in models 4-6 and models 7-9 using the static-1990 and pre-1990 versions of the instrument, respectively. We note that the latter two sets of instruments are weaker, possibly due to the longer time lag between the instruments and the endogenous variable. However, the second-stage coefficient on $SR \times G$ remains significantly positive.

These results suggest that making takeovers more difficult or costly partially alleviates risks for short sellers. This intuition is consistent with our primary hypothesis – that takeover risk creates frictions for short sellers. In other words, when a takeover is less likely, it becomes safer to short sell stocks. When short sellers demand less compensation for arbitrage risk, the return predictability of short interest decreases. On the other hand, when takeovers are more likely, short sellers refrain from trading on negative information unless the return is sufficiently large, and hence current short interest better predicts future returns.[16]

IV. Takeover Intensity, Short Interest, and Stock Mispricing

In order to further investigate the role of takeovers as an implicit limit to short selling arbitrage, we examine the relation between takeover risk and stock mispricing. We first form long-short portfolios using the mispricing factor developed by Stambaugh, Yu, and Yuan (2012, 2015), which is a composite score based on a broad set of anomaly variables, including *Net Stock Issues*, *Composite Equity Issues*, *Accruals*, *Net Operating Assets*, *Asset Growth*, *Investment to Assets*, *Distress*, *O-score*, *Momentum*, *Gross Profitability*, and *Return on Assets*, that are related to mispricing due to market sentiment. We create 30 portfolios by first sorting stocks into terciles of takeover intensity and then, within each tercile, further sorting stocks into deciles by the mispricing factor. Since the momentum factor is included in the composite score, for this test we compute the alpha of each portfolio using a three-factor model rather than the four-factor model used to his point. Thus, for each portfolio, we follow Stambaugh, Yu, and Yuan (2012) and Chu, Hirshleifer, and Ma (2017) and compute the average monthly return and the Fama-French three-factor alpha.

[16] We note that although our setting is different from the critiques of Karpoff, Schonlau, and Wehrly (2017) and Karpoff and Wittry (2018), we believe that their instruments are still appropriate in our setting. Specifically, we only require that such endogeneity corrections to takeover probability are unrelated to subsequent short selling behavior.

Results in Table IX show that returns and alphas for the long-short portfolio based on mispricing factor are larger in the high takeover risk subsample. Although the difference is not significant for monthly raw returns, it is significant at the 5% level using the Fama-French three-factor alpha. Takeover risk, therefore, appears to increase the profitability of mispricing-based trading strategies. This result is consistent with Chu, Hirshleifer, and Ma (2017), supporting the intuition that a higher likelihood of a takeover bid limits short sellers' arbitrage activities.

Ofek, Richardson, and Whitelaw (2004) show that short sale constraints are related to violations of put-call parity. They argue that deviations from put-call parity are greater among options with longer time to maturity because the short-selling risk increases with the holding period. Consistent with this idea, Engelberg, Reed, and Ringgenberg (2018) show that short-selling risk, as measured by loan fee variance, increases put-call disparity in long-term options. We follow Ofek, Richardson, and Whitelaw (2004) and Engelberg, Reed, and Ringgenberg (2018) to examine whether takeover risk and short selling activity are related to violations of put-call parity. We collect 10,978,250 put-call pairs from 1996 to 2015 with a time to maturity between 30 and 180 days, bid-ask spreads within 50%, and absolute value of log moneyness within 20% from OptionMetrics. For each put-call pair, we compute put-call disparity as the natural logarithm of the ratio of the actual stock price to the option implied stock price (ln(S/S*)) based on put-call parity. We then estimate the following model:

$$ln\frac{S}{S^*} = \alpha + \beta_1 SR_t \times HIGH\ TAKEOVER_t \times MONTHS_t + \beta_2 SR_t \times HIGH\ TAKEOVER_t + \beta_3 SR_t \times MONTHS_t + \beta_4 HIGH\ TAKEOVER_t \times MONTHS_t + \beta_5 SR_t + \beta_6 HIGH\ TAKEOVER_t + \beta_7 MONTHS_t + \beta_8 OPTION\ BID - ASK\ SPREAD_t + \beta_9 STOCK\ BID - ASK\ SPREAD_t + \varphi_j + \gamma_t + \varepsilon_t \quad (3)$$

where *MONTHS* is the number of months to maturity for the put-call pairs, *OPTION BID-ASK SPREAD* is the average bid-ask spread divided by the average of bid and ask prices for the put-call pairs, and *STOCK BID-ASK SPREAD* is the bid-ask spread of the underlying stocks divided by the average of bid and ask prices. We also control for fixed effects for each 2-digit SIC industry (φ_j) and each year-month (γ_t). If takeover risk limits short selling and such limits increase with the trading horizon, then stocks with higher short interest should exhibit greater put-call disparity for long-term options if they are in industries with higher takeover risk. Thus, we expect the coefficient for the triple interaction term *SR* × *HIGH TAKEOVER* × *MONTHS* to be significantly positive. Our estimates in Table X support the above prediction, as *SR* × *HIGH TAKEOVER* × *MONTHS* has a coefficient that is significantly positive at the 1% level. In columns 2 and 3, we again control for short-sale constraints due to lendable shares supply and stock borrowing cost. In column 2 (3), we include *UTILIZATION* (*DCBS*) and its interaction with short ratio. The interaction terms *UTILIZATION* × *SR* and *DCBS* × *SR* are significantly positive. Consistent with Ofek, Richardson, and Whitelaw (2004), this result suggests that higher short interest is related to higher put-call disparity when the supply of lendable shares is limited and costly. Importantly, after controlling for the availability and cost of lendable shares, we still document a significantly positive coefficient for the triple interaction term *SR* × *HIGH TAKEOVER* × *MONTHS*, suggesting that takeover risk induces greater mispricing in high short-interest stocks.

Overall, we document that takeover risk is related to greater mispricing, defined using the profitability of a mispricing-based trading strategy and the put-call disparity. These results are consistent with the intuition that takeover risk limits the arbitrage activities of short sellers.

V. Activism Risk and Limits to Short Arbitrage

For our final set of empirical tests, we note that our hypothesis also applies to other corporate governance events that cause unexpected positive price shocks that potentially squeeze short sellers' positions. Recent studies in the corporate governance literature consider the role of activist blockholders as an additional governance mechanism, specifically as a substitute for takeover attempts (e.g., Brav et al. (2008), Becht, Franks, Mayer, and Rossi (2009), Brav, Jiang, and Kim (2015b), Cohn, Towner, and Virani (2017)). Similar to bidders in the takeover market, activists often target poorly governed and/or undervalued firms with the intent of adding value. Shareholder activism also increases a firm's likelihood of receiving a takeover offer (Boyson, Gantchev, and Shivdasani (2017)). Given that activists' intervention also leads to positive announcement returns (Brav et al. (2008), Klein and Zur (2009)), our hypotheses relating to takeover risk should likewise hold for activism risk. We consider this additional channel and present the results.

We begin by defining the activism intensity for each industry. We use 13-D filings extracted from the SEC's EDGAR website for the period 2000-2015, which must be filed when a blockholder acquires more than 5% of the voting stock with the intention of taking an activist position in the firm (Brav et al. (2008), Gantchev and Jotikasthira (2017)).[17] We define *ACTIVISM* using the number of 13-D filings for each 2-digit SIC industry over the previous six months, divided by the number of public firms in the same industry. This is similar to *TAKEOVER* in our earlier Tables II and IV, and consistent with other existing studies that measure activism threat at the industry level (e.g., Gantchev, Gredil, and Jotikasthira (2017)).

We then perform a three-by-ten sequential sort based on *ACTIVISM* and *SR* and report the equal-weighted portfolio returns in Table XI. We document similar results as those for takeover

[17] We thank Jonathan Cohn, Mitch Towner, and Aazam Virani for making this data available.

risk. Specifically, both the return and the alpha of the long-short portfolios are significantly higher for stocks in the highest tercile of *ACTIVISM*. In other words, return predictability for short interest appears stronger when the risk of an activist blockholder campaign is higher.[18]

Next, we investigate the effect of shareholder activism on return predictability in a multivariate framework with Fama-MacBeth regressions. We define *HIGH ACTIVISM* as a binary variable that equals one if the 2-digit SIC industry is in top tercile of *ACTIVISM* at the portfolio formation date. Similar to the results reported in Table IV, we expect a significantly negative coefficient on *HIGH ACTIVISM* × *SR*. We report the results in Table XII: in all four models the coefficient on the interaction term *HIGH ACTIVISM* × *SR* is negative and significant, which suggests that the risk of shareholder activism leads to more predictable returns in a similar way as takeover risk. Either action may increase share prices *ex post*, reducing short sellers' profits. In sum, the results in Tables XI and XII are consistent with the paper's main theme that the risk of a price jump due to market-based governance mechanisms limits short sellers' arbitrage opportunities.

VI. Conclusion

We hypothesize that the risk of a takeover bid represents an implicit limit to short sellers' arbitrage activities. The empirical results support our hypothesis, as we find that the return predictability associated with short interest is higher when takeover risk is higher, consistent with the intuition that takeover risk represents a limit to informed short selling. After investigating this effect in univariate and multivariate frameworks, we use additional identification strategies

[18] An alternative explanation for this result is that the supply of lendable shares is lower when an activist invests in the firm. Porras Prado, Saffi, and Sturgess (2016) suggest that activist investors might be less willing to lend shares in order to maintain the ability to influence the firm's management through the proxy voting process.

designed to assuage potential concerns that an omitted factor could drive these results. In addition to using historical industry-level takeover activity to proxy for takeover risk, our empirical methodology also utilizes staggered, state-level variation in business combination laws that exogenously change firms' takeover risk. These results suggest that exogenous reductions in takeover risk also reduce the return predictability of short interest. We find similar results using firm-level variation in takeover risk. Further tests indicate that higher takeover risk appears related to more mispricing, which is consistent with the intuition that takeover risk represents a limit to short sellers' arbitrage opportunities. Finally, we show that the risk of shareholders' activism plays a similar role as takeover risk, and also limits short sellers' arbitrage activities.

We note that the majority of the literature considers short-selling constraints in the context of regulations or market frictions such as limited supply of lendable shares and high stock borrowing costs. In contrast, the short selling constraint documented here can arise naturally from competitive markets for corporate control, rather than short-selling regulations or frictions in the stock lending markets. Our results are surprising because takeovers are considered important mechanisms for disciplining managers and improving corporate governance. In contrast, our evidence suggests that efficient markets for corporate control also have the unintended effect of inducing stock market inefficiencies via limiting arbitrage opportunities for short sellers.

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Figure I

Short Selling Around Acquisition Announcements

The figure presents coefficient estimates from a regression estimating changes in short selling activity around takeover announcements. The sample consists of stock-day observations from 2007 to 2015. The dependent variable is *DAILY SR*, measured as daily number of shares on loan divided by the number of shares. The independent variables are binary variables indicating days around takeover announcements. We also include firm×quarter fixed effects and day-of-the-week fixed effects to control for time varying firm characteristics and seasonality. The vertical lines indicate the 95% confidence intervals, with standard errors adjusted for firm clustering and year-quarter clustering.

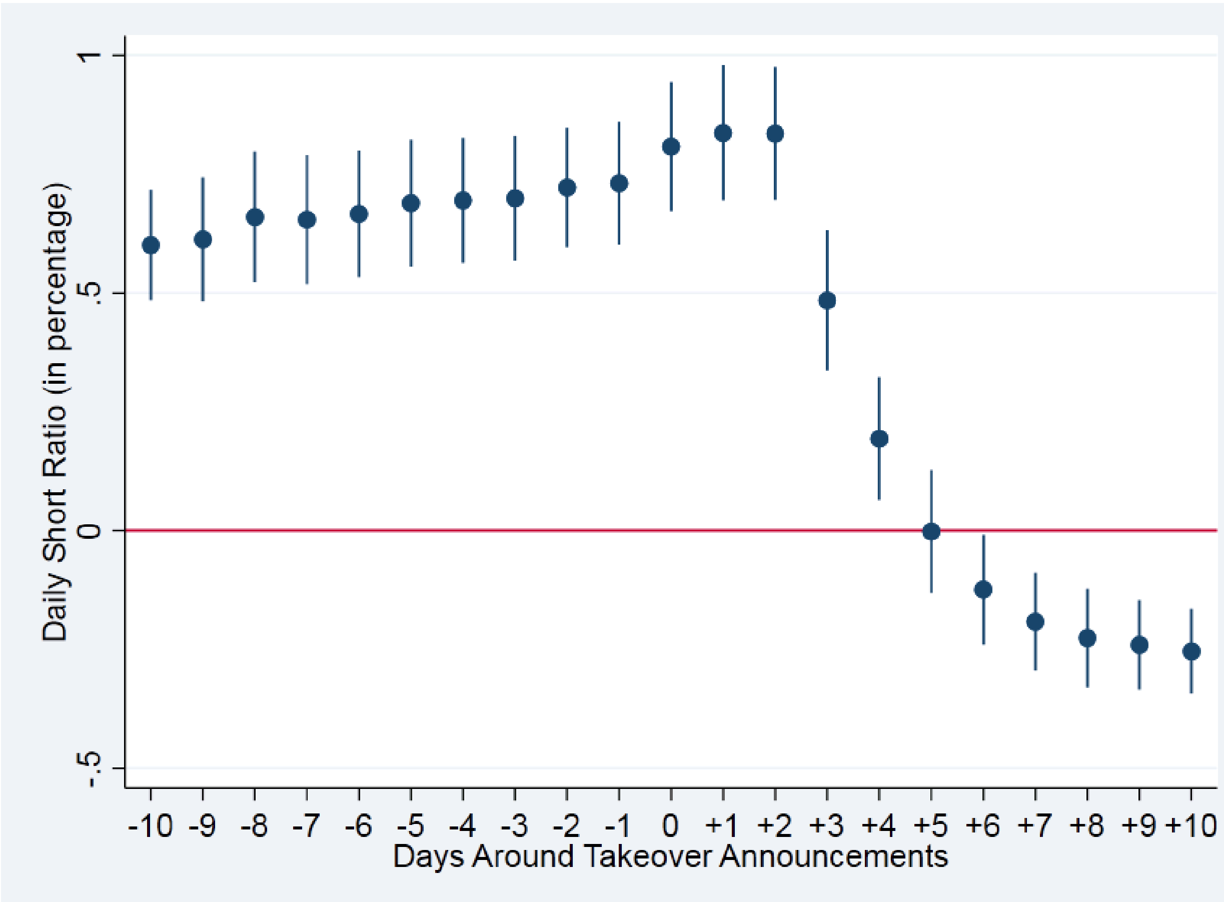


Table I

Summary Statistics

Panel A presents summary statistics of the variables used in our baseline tests. Panel B presents the average stock characteristics for each takeover intensity tercile. We winsorize all variables at the 1st and 99th percentiles. All variables are defined in Appendix A.

Panel A						
	N	Mean	P25	P50	P75	SD
TAKEOVER	675,773	0.832	0.369	0.569	1.000	0.942
SR	675,773	0.034	0.004	0.017	0.045	0.046
REV	675,740	0.014	-0.045	0.009	0.068	0.111
MOM	670,452	0.175	-0.088	0.109	0.339	0.451
LnBM	675,773	-0.682	-1.115	-0.604	-0.177	0.758
LnME	675,773	13.510	12.265	13.451	14.681	1.778
IVOL	674,442	0.020	0.011	0.017	0.024	0.012
IO	675,773	0.559	0.336	0.583	0.791	0.287
LnILLIQ	675,725	-4.934	-6.950	-5.194	-3.141	2.789
UTILIZATION	322,838	0.171	0.028	0.093	0.244	0.200
DCBS	316,940	1.248	1.000	1.000	1.000	1.007
SHORT TENURE	286,454	82.579	37.823	66.444	105.872	67.545
ACTIVISM	675,773	0.053	0.000	0.045	0.080	0.064
PUT-CALL DISPARITY	10,978,250	0.377	0.006	0.191	0.577	0.628
OPTION BID-ASK SPREAD	10,978,250	0.077	0.034	0.060	0.103	0.058
STOCK BID-ASK SPREAD	10,978,250	0.033	0.018	0.027	0.041	0.023

Panel B								
Takeover Tercile	(Average) Number of Stocks	*TAKEOVER*	Ln*BM*	Ln*ME*	*IVOL*	*IO*	*SR*	*SR* (std)
1	647	0.309	-0.626	13.255	0.020	0.497	0.030	0.043
2	646	0.619	-0.635	13.661	0.019	0.574	0.035	0.046
3	647	1.588	-0.787	13.535	0.021	0.580	0.037	0.047

Table II
Two-way Sorts on Takeover Intensity and Stock Short Ratio

This table reports equal-weighted monthly average returns and Carhart (1997) four-factor alphas (in percentages) sorted by takeover intensity and stock's short ratio. The sample runs from January 1985 to December 2015. At the beginning of each month, we first sort all the stocks into terciles based on takeover intensity at the 2-digit SIC industry level, and within each tercile we sort the stocks further into deciles based on their short ratios in the past month. The time-series average of portfolio size is 64 stocks. All variables are defined in Appendix A. We report Newey-West adjusted *t*-statistics in parentheses. For the long-short portfolios, we use *, ** and *** to indicate significance better than 10%, 5%, and 1% respectively.

Takeover	Returns (EW) Short Ratio Deciles				Carhart four-factor Alphas (EW) Short Ratio Deciles			
Terciles	1	5	10	1-10	1	5	10	1-10
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	0.98	1.08	0.73	0.26	0.21	0.05	-0.39	0.60***
	(4.30)	(4.60)	(2.35)	(1.29)	(1.55)	(0.44)	(-2.65)	(3.21)
2	1.29	1.21	0.69	0.60***	0.40	0.16	-0.42	0.81***
	(5.22)	(5.32)	(2.16)	(3.81)	(2.87)	(1.43)	(-2.74)	(4.71)
3	1.37	1.21	0.54	0.83***	0.44	0.14	-0.62	1.06***
	(5.17)	(4.78)	(1.62)	(4.84)	(3.31)	(1.27)	(-4.05)	(5.75)
3-1	0.39***	0.13	-0.18	0.57***	0.23	0.10	-0.23	0.46***
	(2.78)	(1.14)	(-1.05)	(3.82)	(1.59)	(0.77)	(-1.30)	(2.92)

Table III

Two-way Sorts on Takeover Intensity and Stock Short Ratio: Subsample by Size

This table reports value-weighted monthly average returns and Carhart (1997) four-factor alphas (in percentages) sorted by takeover intensity and stock's short ratio. The sample runs from January 1985 to December 2015. In Panels A and B, we partition the sample into small stocks and large stocks based on the 50th percentile of NYSE size breakpoints. At the beginning of each month, we first sort all the stocks into terciles based on takeover intensity at the 2-digit SIC industry level, and within each tercile we sort the stocks further into deciles based on their short ratios in the past month. The time-series average of portfolio size for small (large) stocks is 41 (23). All variables are defined in Appendix A. We report Newey-West adjusted *t*-statistics in parentheses. For the long-short portfolios, we use *, ** and *** to indicate significance better than 10%, 5%, and 1% respectively.

Panel A: Value-weighted portfolios of small stocks								
Takeover	Returns Short Ratio Deciles				Carhart four-factor Alphas Short Ratio Deciles			
Terciles	1	5	10	1-10	1	5	10	1-10
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	0.95	1.37	0.76	0.19	0.09	0.32	-0.36	0.46*
	(3.82)	(4.52)	(2.54)	(0.68)	(0.50)	(1.54)	(-1.92)	(1.85)
2	1.25	1.24	0.64	0.62***	0.31	0.18	-0.49	0.80***
	(4.90)	(4.63)	(1.75)	(2.93)	(2.09)	(1.09)	(-2.09)	(4.02)
3	1.40	1.27	0.44	0.95***	0.46	0.17	-0.73	1.19***
	(4.35)	(4.73)	(1.27)	(4.12)	(2.12)	(1.41)	(-3.97)	(4.27)
3-1	0.45*	-0.10	-0.32	0.77***	0.36	-0.15	-0.37	0.73**
	(1.79)	(-0.39)	(-1.25)	(2.85)	(1.36)	(-0.65)	(-1.42)	(2.48)

Panel B: Value-weighted portfolios of large stocks								
Takeover	Returns Short Ratio Deciles				Carhart four-factor Alphas Short Ratio Deciles			
Terciles	1	5	10	1-10	1	5	10	1-10
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	0.76	1.11	0.95	-0.19	-0.26	0.11	-0.02	-0.23
	(2.61)	(5.23)	(2.75)	(-0.67)	(-1.67)	(1.02)	(-0.13)	(-0.90)
2	0.89	0.91	0.95	-0.06	-0.11	-0.04	-0.16	0.05
	(3.77)	(3.82)	(2.87)	(-0.33)	(-0.79)	(-0.28)	(-0.95)	(0.26)
3	1.00	0.98	0.90	0.10	-0.06	-0.03	-0.22	0.16
	(4.24)	(3.39)	(2.70)	(0.42)	(-0.50)	(-0.22)	(-1.27)	(0.81)
3-1	0.23	-0.13	-0.06	0.29	0.20	-0.15	-0.20	0.40
	(1.33)	(-0.69)	(-0.25)	(1.00)	(0.92)	(-0.77)	(-0.90)	(1.24)

Table IV

Fama-MacBeth Regressions on Takeover Intensity, Short Ratio, and the Cross-section of Stock Returns

Panel A reports the estimates from the Fama and MacBeth (1973) regression of monthly stock returns for the period from January 1985 to December 2015. Panel B re-estimates the model in Panel A including alternative measures of limits to arbitrage. Control variables are included in the regression but omitted from panel B for brevity. All variables are defined in Appendix A. We report Newey-West adjusted *t*-statistics in parentheses. ***, **, and * represent significance levels of 1%, 5%, and 10%, respectively.

Panel A – Baseline Model				
	(1)	(2)	(3)	(4)
SR	-0.034**	-0.034**	-0.026*	-0.032**
	(-2.18)	(-2.38)	(-1.96)	(-2.53)
SR × *HIGH TAKEOVER*	-0.047***	-0.047***	-0.049***	-0.048***
	(-2.66)	(-2.73)	(-2.88)	(-2.83)
HIGH TAKEOVER	0.002**	0.001*	0.001*	0.001*
	(2.01)	(1.68)	(1.94)	(1.74)
Ln*BM*	0.001**	0.001**	0.001*	0.001*
	(2.14)	(2.11)	(1.76)	(1.67)
Ln*ME*	0.000	0.000	-0.000	-0.001*
	(0.82)	(0.35)	(-1.01)	(-1.77)
REV		-0.025***	-0.024***	-0.024***
		(-5.58)	(-5.34)	(-5.54)
MOM		0.005**	0.006***	0.006***
		(2.36)	(2.69)	(2.77)
IVOL			-0.173***	-0.172***
			(-3.59)	(-3.53)
IO				0.004**
				(2.24)
R^2	0.023	0.042	0.048	0.052
N	675,773	670,420	669,115	669,115

(Continued)

Table IV (continued)

Panel B – Additional proxies for limits to arbitrage					
	(1)	(2)	(3)	(4)	(5)
SR	-0.018	-0.018	-0.016	-0.036**	-0.006
	(-1.20)	(-1.12)	(-0.98)	(-2.55)	(-0.36)
HIGH TAKEOVER	0.001	0.001*	0.001*	0.001*	0.001*
	(1.60)	(1.85)	(1.85)	(1.90)	(1.90)
SR × HIGH TAKEOVER	-0.044**	-0.047***	-0.047***	-0.051***	-0.045**
	(-2.56)	(-2.63)	(-2.74)	(-2.94)	(-2.36)
HIGH IVOL	-0.001				-0.001
	(-1.22)				(-1.37)
SR × HIGH IVOL	-0.038***				-0.031**
	(-2.87)				(-1.99)
LOW IO		-0.001			-0.001
		(-1.10)			(-0.79)
SR × LOW IO		-0.054**			-0.053**
		(-2.58)			(-2.42)
LOW ME			0.002**		0.001
			(2.00)		(0.95)
SR × LOW ME			-0.048***		-0.040*
			(-3.06)		(-1.90)
HIGH ILLIQ				-0.001	-0.003***
				(-1.51)	(-3.16)
SR × HIGH ILLIQ				-0.026	0.027
				(-1.17)	(0.94)
R^2	0.050	0.053	0.051	0.055	0.054
N	669,115	669,115	669,115	669,111	669,111
Control Variables	Yes	Yes	Yes	Yes	Yes

Table V

Fama-McBeth Regression: Controlling for Stock Lending Characteristics

This table reports the estimates from the Fama and MacBeth (1973) regression of monthly stock returns for the period from January 1985 to December 2015. In Columns 1 and 2, we split the sample into two groups where *UTILIZATION* is below (Low) and above (High) the median. In Columns 3 and 4, we split the sample based on the cost of lending as measured by DCBS index reported by Markit. All variables are defined in Appendix A. We report Newey-West adjusted *t*-statistics in parentheses. ***, **, and * represent significance levels of 1%, 5%, and 10%, respectively.

	Lendable Shares Utilization		Lending Cost (DCBS)	
	Low	High	=1	>1
	(1)	(2)	(3)	(4)
SR	0.074	0.003	-0.021	0.0004
	(1.54)	(0.17)	(-1.42)	(0.01)
HIGH TAKEOVER	0.003**	-0.001	0.001	0.003
	(2.27)	(-0.33)	(1.05)	(0.66)
UTILIZATION	-0.0004***	-0.0001**		
	(-2.66)	(-2.00)		
DCBS				-0.002***
				(-2.93)
SR × *HIGH TAKEOVER*	-0.094**	-0.005	-0.020*	-0.021
	(-2.34)	(-0.47)	(-1.77)	(-1.21)
SR × *UTILIZATION*	-0.001	-0.0002		
	(-0.15)	(-1.00)		
SR × *DCBS*				-0.003
				(-0.53)
Ln*BM*	-0.001	-0.001	-0.001	0.002
	(-0.95)	(-1.18)	(-1.44)	(1.15)
Ln*ME*	-0.001**	-0.0004	-0.001*	-0.0003
	(-2.17)	(-0.80)	(-1.80)	(-0.21)
REV	-0.026***	-0.001	-0.012	0.001
	(-3.80)	(-0.08)	(-1.61)	(0.06)
MOM	0.001	0.002	0.000	0.004
	(0.19)	(0.37)	(0.08)	(0.82)
IVOL	-0.156**	-0.176**	-0.105	-0.440***
	(-2.45)	(-2.27)	(-1.53)	(-5.89)
IO	0.003	0.006***	0.004*	0.010**
	(0.84)	(2.78)	(1.94)	(2.01)
R^2	0.049	0.047	0.044	0.068
N	162,742	157,319	287,883	26,338

Table VI

Fama-McBeth Regressions: Controlling for Short Seller Horizons

This table reports the estimates from the Fama and MacBeth (1973) regression of monthly stock returns for the period from January 1985 to December 2015. In Columns 1 and 2, we split the sample into two groups where *SHORT TENURE* is above or below sample median. All variables are defined in Appendix A. We report Newey-West adjusted *t*-statistics in parentheses. ***, **, and * represent significance levels of 1%, 5%, and 10%, respectively.

	SHORT TENURE	
	Low	High
	(1)	(2)
SR	-0.033	-0.026
	(-1.13)	(-1.59)
SR × *HIGH TAKEOVER*	-0.016	-0.026**
	(-0.84)	(-2.52)
HIGH TAKEOVER	0.000	0.001
	(0.09)	(0.98)
SHORT TENURE	-0.000	0.000
	(-0.48)	(1.22)
Ln*BM*	-0.000	-0.002**
	(-0.06)	(-2.11)
Ln*ME*	-0.001**	-0.000
	(-2.50)	(-1.22)
REV	-0.009	-0.015*
	(-1.11)	(-1.93)
MOM	-0.001	0.002
	(-0.17)	(0.40)
IVOL	-0.225***	-0.143*
	(-3.23)	(-1.77)
IO	0.008***	0.006**
	(2.69)	(2.24)
R^2	0.051	0.045
N	135,887	148,149

Table VII

Business Combination Laws, Short Interest, and Monthly Stock Returns

This table reports estimates from a panel regression of monthly stock returns for the period from January 1976 to December 1995. All variables are defined in Appendix A. We report t-statistics using firm-clustered standard errors in parentheses. ***, **, and * represent significance levels of 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
SR	-0.222***	-0.233***	-0.221***	-0.230***	-0.143***	-0.129***
	(-5.40)	(-5.87)	(-5.63)	(-5.52)	(-4.04)	(-3.12)
SR × *BC*	0.197***	0.211***	0.207***	0.213***	0.121***	
	(4.31)	(4.77)	(4.74)	(4.63)	(3.07)	
BC	-0.001**	-0.001**	-0.001**	-0.002***	0.000	
	(-2.29)	(-2.33)	(-2.26)	(-3.25)	(0.03)	
$SR \times BC_{-3}$						0.054
						(0.50)
$SR \times BC_{-2}$						0.093
						(0.86)
$SR \times BC_{-1}$						-0.167**
						(-2.23)
$SR \times BC_{0}$						-0.106
						(-1.23)
$SR \times BC_{1}$						0.039
						(0.58)
$SR \times BC_{2+}$						0.125***
						(2.80)
Ln*BM*	0.004***	0.004***	0.004***	0.004***	0.004***	0.004***
	(10.83)	(10.45)	(9.78)	(8.60)	(9.39)	(9.47)
Ln*ME*	-0.000**	-0.000**	-0.001***	-0.001***	-0.001***	-0.001***
	(-2.22)	(-2.14)	(-4.20)	(-4.63)	(-4.34)	(-4.40)
REV		0.002	0.003	0.012***	-0.025***	-0.025***
		(0.66)	(1.26)	(4.14)	(-8.90)	(-8.97)
MOM		0.002***	0.002***	0.001	0.009***	0.009***
		(3.09)	(3.13)	(0.96)	(13.83)	(13.68)
IVOL			-0.135***	-0.141***	-0.245***	-0.244***
			(-4.30)	(-4.33)	(-7.71)	(-7.69)
IO				0.009***		
				(7.01)		
BC_{-3}						0.003**
						(2.45)
BC_{-2}						0.000
						(0.19)
BC_{-1}						0.004***
						(2.73)

(Continued)

Table VII (continued)

	(1)	(2)	(3)	(4)	(5)	(6)
BC_0						0.002*
						(1.72)
BC_1						0.004***
						(2.83)
BC_{2+}						-0.000
						(-0.26)
R^2	0.001	0.001	0.002	0.002	0.218	0.218
N	215,046	213,691	213,660	188,453	213,472	213,472
Industry FE					Yes	Yes
Year-month FE					Yes	Yes

Table VIII
IV Regressions: Takeover Defenses, Short Interest, and Stock Returns

This table reports the estimates from a 2SLS regression of monthly stock returns from 1991 to 2006. Columns 1 and 2, 4 and 5, and 7 and 8 report first-stage estimates of *SR* and *G*, while Columns 3, 6, and 9 report second-stage estimates of monthly returns. All variables are defined in Appendix A. We report the *F*-statistic of weak-instrument test for the first-stage models. We also present *t*-statistics using firm-clustered standard errors in parentheses. *, ** and *** indicate significance better than 10%, 5%, and 1% respectively.

Model:				2SLS					
Stage:	1st	1st	2nd	1st	1st	2nd	1st	1st	2nd
Dependent Variable:	*SR* × *G*	*G*	Return	*SR* × *G*	*G*	Return	*SR* × *G*	*G*	Return
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
SR	0.283	-25.475*	-0.395**	2.366	-21.714	-0.399**	5.621***	-31.380**	-0.416**
	(0.18)	(-1.75)	(-2.15)	(1.22)	(-1.19)	(-2.03)	(3.04)	(-2.02)	(-2.09)
SR × *G*			0.039**			0.040*			0.041*
			(1.97)			(1.91)			(1.93)
G			-0.002**			-0.001			-0.002*
			(-2.57)			(-0.97)			(-1.78)
SR × *GEO-5yr*	0.424***	1.335							
	(3.26)	(1.07)							
GEO-5yr	-0.001	0.311***							
	(-0.40)	(3.54)							
SR × *IPO-5yr*	0.565***	1.058							
	(3.74)	(0.94)							
IPO-5yr	0.002	0.604***							
	(0.50)	(7.59)							
SR × *GEO-1990*				0.587***	2.762*				
				(3.81)	(1.90)				
GEO-1990				-0.002	0.286***				
				(-0.85)	(2.59)				
SR × *IPO-1990*				0.162	-0.945				
				(1.07)	(-0.71)				
IPO-1990				-0.001	0.250**				
				(-0.43)	(2.42)				

(Continued)

Table VIII (continued)

Model:				2SLS					
Stage:	1st	1st	2nd	1st	1st	2nd	1st	1st	2nd
Dependent Variable:	*SR* × *G*	*G*	Return	*SR* × *G*	*G*	Return	*SR* × *G*	*G*	Return
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
SR × GEO-pre-1990							0.597***	2.781	
							(2.76)	(1.61)	
SR × IPO-pre-1990							-0.134	0.615	
							(-1.27)	(0.67)	
IPO-pre-1990							-0.002	-0.288***	
							(-0.74)	(-3.83)	
F-stat	34.47	44.25		8.51	9.56		5.66	8.20	
N	110,034	110,034	110,034	144,255	144,255	144,255	144,255	144,255	144,255
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table IX
Takeover Intensity and Mispricing Factor

This table reports equal-weighted monthly average returns and Fama and French (1993) three-factor alphas (in percentages) sorted by takeover intensity and stock's *MISPRICE* (defined as in Stambaugh, Yu, and Yuan, 2015). The sample runs from January 1985 to December 2015. At the beginning of each month, we first sort all the stocks into terciles based on takeover intensity at the 2-digit SIC industry level, and within each tercile we sort the stocks further into deciles based on *MISPRICE* in the past month. The time-series average of portfolio size is 64 stocks. All variables are defined in Appendix A. We report Newey-West adjusted *t*-statistics in parentheses. For the long-short portfolios, we use *, ** and *** to indicate significance better than 10%, 5%, and 1% respectively.

Takeover	Returns (EW) Mispricing Score Deciles				Fama-French three-factor Alphas (EW) Mispricing Score Deciles			
Terciles	1	5	10	1-10	1	5	10	1-10
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	1.71	1.32	0.13	1.58***	0.76	0.37	-0.98	1.73***
	(6.82)	(5.32)	(0.39)	(8.99)	(7.29)	(3.13)	(-6.76)	(9.93)
2	1.56	1.18	-0.06	1.62***	0.64	0.14	-1.27	1.91***
	(6.51)	(4.40)	(-0.17)	(7.09)	(6.06)	(1.55)	(-8.17)	(10.19)
3	1.57	1.21	-0.31	1.87***	0.63	0.13	-1.55	2.18***
	(6.21)	(4.27)	(-0.68)	(6.09)	(6.40)	(1.57)	(-7.57)	(9.03)
3-1	-0.15	-0.11	-0.44*	0.29	-0.13	-0.24*	-0.57**	0.45**
	(-1.41)	(-0.74)	(-1.66)	(1.12)	(-1.22)	(-1.78)	(-2.47)	(1.98)

Table X

Takeover Intensity and Put-Call Disparity

This table reports estimates of OLS regressions of put-call disparity for the period from January 1996 to December 2015. All variables are defined in Appendix A. We report t-statistics with firm-clustered standard error in brackets. ***, **, and * represent significance levels of 1%, 5%, and 10%, respectively.

Dependent Variable:		*PUT-CALL DISPARITY*	
	(1)	(2)	(3)
SR × HIGH TAKEOVER × MONTHS	0.285***	0.301***	0.297***
	(3.19)	(3.17)	(3.11)
SR	1.882***	-3.812***	-0.366**
	(10.29)	(-12.64)	(-2.52)
HIGH TAKEOVER	0.069**	0.090***	0.108***
	(2.30)	(3.11)	(3.96)
MONTHS	0.150***	0.152***	0.150***
	(19.14)	(18.12)	(17.81)
HIGH TAKEOVER × MONTHS	-0.051***	-0.055***	-0.056***
	(-4.91)	(-4.89)	(-4.91)
HIGH TAKEOVER × SR	-0.235	-0.341*	-0.488**
	(-0.90)	(-1.73)	(-2.13)
SR × MONTHS	-0.134**	-0.150**	-0.114*
	(-2.13)	(-2.28)	(-1.76)
OPTION BID-ASK SPREAD	0.501***	0.472***	0.248***
	(5.24)	(5.25)	(3.15)
STOCK BID-ASK SPREAD	-0.989***	-1.006***	-2.054***
	(-3.61)	(-4.70)	(-11.02)
UTILIZATION × SR		0.080***	
		(13.69)	
UTILIZATION		0.003**	
		(2.29)	
DCBS × SR			0.136***
			(2.68)
DCBS			0.278***
			(23.30)
R^2	0.195	0.276	0.387
N	10,978,250	9,835,290	9,804,272
Industry FE	Yes	Yes	Yes
Year-month FE	Yes	Yes	Yes

Table XI
Two-way sorts on Activism Intensity and Stock Short Ratio

This table reports equal-weighted monthly average returns and Carhart (1997) four-factor alphas (in percentages) sorted by 2-SIC level activism intensity and stock's short ratio. The sample runs from January 2001 to December 2015. At the beginning of each month, we first sort all the stocks into terciles based on activism intensity at the 2-SIC industry level in the past 6 months, and within each tercile we sort the stocks further into deciles based on their short ratios in the past month. All variables are defined in Appendix A. We report Newey-West adjusted *t*-statistics in parentheses. For the long-short portfolios, we use *, ** and *** to indicate significance better than 10%, 5%, and 1% respectively.

Activism	Returns (EW) Short Ratio Deciles				Carhart four-factor Alphas (EW) Short Ratio Deciles			
Terciles	1	5	10	1-10	1	5	10	1-10
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	0.87	0.96	0.48	0.39	0.36	0.21	-0.45	0.82***
	(2.14)	(2.73)	(0.83)	(1.12)	(1.46)	(2.67)	(-2.60)	(3.64)
2	1.20	1.06	0.51	0.69***	0.56	0.23	-0.45	1.01***
	(2.82)	(2.56)	(1.04)	(3.05)	(3.22)	(1.75)	(-2.60)	(4.06)
3	1.19	0.88	0.17	1.02***	0.62	0.04	-0.76	1.39***
	(3.18)	(2.15)	(0.31)	(3.30)	(3.51)	(0.33)	(-3.17)	(4.98)
3-1	0.32	-0.08	-0.31	0.63***	0.26	-0.17	-0.31	0.57**
	(1.46)	(-0.54)	(-1.19)	(2.82)	(1.21)	(-1.20)	(-1.06)	(2.45)

Table XII
Fama-MacBeth Regressions: Shareholder Activism, Short Interest, and Stock Returns

This table reports the estimates from the Fama and MacBeth (1973) regression of monthly stock returns. The sample runs from January 2001 to December 2015. All variables are defined in Appendix A. We report Newey-West adjusted *t*-statistics in parentheses. ***, **, and * represent significance levels of 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)	(4)
SR	-0.037**	-0.033**	-0.029*	-0.042***
	(-2.19)	(-2.00)	(-1.94)	(-3.14)
HIGH ACTIVISM	0.002	0.002*	0.002*	0.002*
	(1.58)	(1.78)	(1.92)	(1.81)
SR × *HIGH ACTIVISM*	-0.024**	-0.022*	-0.022**	-0.020*
	(-2.50)	(-1.93)	(-2.10)	(-1.96)
Ln*BM*		0.000	0.000	0.000
		(0.16)	(0.13)	(0.04)
Ln*ME*		-0.000	-0.001*	-0.001***
		(-0.95)	(-1.89)	(-3.13)
REV		-0.023***	-0.022***	-0.023***
		(-3.56)	(-3.38)	(-3.48)
MOM		-0.000	0.001	0.001
		(-0.05)	(0.14)	(0.17)
IVOL			-0.139**	-0.132*
			(-2.03)	(-1.92)
IO				0.006***
				(2.81)
R^2	0.010	0.041	0.046	0.049
N	477,602	441,659	440,385	440,385

Appendix A: Variable Definitions

SR	The number of shares shorted over total shares outstanding (COMPUSTAT)
TAKEOVER	Number of takeover attempts in a 2-SIC industry divided by the number of public firms in the same industry. (SDC)
CAR	Cumulative abnormal returns adjusted by market index.
REV	The short-term reversal measured by lagged monthly stock return.
MOM	The compounded 11-month stock return from month -12 to month -2. (CRSP)
BM	Book value of equity, measured as the value of common stockholders' equity, plus deferred taxes and investment tax credits, minus the book value of preferred stock, divided by market capitalization (CRSP and COMPUSTAT)
ME	Market capitalization in thousands at the end of the June of each year. (CRSP)
IVOL	Idiosyncratic volatility measured following Ang, Hodrick, Xing, and Zhang (2006)
IO	The sum of shares held by institutions from 13F filings in each quarter divided by the total shares outstanding
ILLIQ	The monthly average of absolute daily returns divided by dollar trading volume (Amihud (2002)). In the summary statistics, we report the natural logarithm of *ILLIQ* multiplied by one million. (CRSP)
UTILIZATION	The ratio of shares borrowed to shares made available by Markit lenders.
DCBS	A score of lending cost created by Markit with a scale of 1 to 10.
SHORT TENURE	The weighted average number of days from start date to present for all transactions
BC	Dummy equal to 1 when Business Combination Laws introduced in the state of incorporation.
G	A measure of firm-level number of takeover defenses by Gompers, Ishii, Metrick (2003).
GEO-5yr	Instrument for G-index based on takeover defenses at geographically proximate firms (not in the same industry) five years before the observation. (Karpoff, Schonlau and Wehrly (2017))
IPO-5yr	Instrument for G-index based on takeover defenses at firms that went public within one year of the focus firm (and that are not in the same industry) using data from five years before the observations. (Karpoff, Schonlau and Wehrly (2017))
GEO-1990	Instrument for G-index based on takeover defenses at geographically proximate firms (that are not in the same industry) in the earliest year of available data from IRRC. (Karpoff, Schonlau and Wehrly (2017))
IPO-1990	Instrument for G-index based on takeover defenses at firms that went public within one year of the focus firm (and that are not in the same industry) using data in the earliest year of available data from IRRC. (Karpoff, Schonlau and Wehrly (2017))
GEO-pre-1990	Instrument for G-index based on takeover defenses at geographically proximate firms (that are not in the same industry) in the earliest year of available data from both IRRC and Cremers and Ferrell (2014) data that date back to 1978. (Karpoff, Schonlau and Wehrly (2017))
IPO-pre-1990	Instrument for G-index based on takeover defenses at firms that went public within one year of the focus firm (and that are not in the same industry) using data in the earliest year of available data from both IRRC and Cremers and Ferrell (2014) data that date back to 1978. (Karpoff, Schonlau and Wehrly (2017))
MISPRICE	Composite score based on a set of anomaly variables from Stambaugh, Yu, and Yuan (2012).
PUT-CALL DISPARITY	Natural logarithm of the ratio of the actual stock price to the option implied stock price based on put-call parity. (OptionMetrics)

OPTION BID-ASK SPREAD	The difference between an option's bid and ask prices (OptionMetrics).
STOCK BID-ASK SPREAD	The difference between a stock's bid and ask prices (WRDS)
ACTIVISM	The number of firms in a 2-SIC industry that experienced shareholder activism, as reflected by 13-D filings in the past six months, divided by the number of firms in the same industry.

Appendix B: Additional Results for Robustness

Table B1: Short Sellers' Responses to Peers' Takeover Announcements

The sample consists of stock-day observations from 2007 to 2015. The dependent variable in column 1 is *DAILY SR*, measured as daily number of shares on loan divided by the number of shares. The dependent variable in column 2 is *LENDABLE SHARES SUPPLY*, defined as number of lendable shares divided by number of shares outstanding. The independent variables are binary variables indicating days around peers' takeover announcements. We identify takeover announcements of peers that are in the same 2-SIC industry and matched by size (two groups), book-to-market (three groups), and momentum (three groups). We also include firm×quarter fixed effects and day-of-the-week fixed effects to control for time varying firm characteristics and seasonality. We report standard errors adjusted for firm clustering and year-quarter clustering. We use *, ** and *** to indicate significance better than 10%, 5%, and 1% respectively.

Dependent Variable:	*DAILY SR*	*LENDABLE SHARES SUPPLY*
	(1)	(2)
t-5	-0.012	0.020
	(-1.46)	(0.81)
t-4	-0.011	0.020
	(-1.29)	(0.78)
t-3	-0.011	0.021
	(-1.28)	(0.86)
t-2	-0.016	0.015
	(-1.62)	(0.63)
t-1	-0.010	0.021
	(-1.15)	(1.22)
t 0	-0.012	0.025
	(-1.52)	(1.31)
t+1	-0.013*	0.022
	(-1.73)	(1.17)
t+2	-0.019***	0.009
	(-2.90)	(0.54)
t+3	-0.019**	0.005
	(-2.68)	(0.30)
t+4	-0.017***	-0.000
	(-2.84)	(-0.00)
t+5	-0.010	0.011
	(-1.60)	(0.87)
R^2	0.969	0.992
N	8,049,840	7,974,483
Firm × Quarter FE	Yes	Yes
Day-of-the-week FE	Yes	Yes

Table B2: Alternative Factor Models

This table reports equal-weighted Fama and French (2016 and 2017) five factor alphas, Carhart (1997) four-factor plus Pástor and Stambaugh (2003) liquidity factor alphas (in percentages), 2-SIC industry-adjusted returns, and Hou, Xue, and Zhang's (2015) Q-factor alphas sorted by takeover intensity and stock's short ratio. The sample runs from January 1985 to December 2015. At the beginning of each month, we first sort all the stocks into terciles based on takeover intensity at the 2-digit SIC industry level, and within each tercile we sort the stocks further into deciles based on their short ratios in the past month. The time-series average of portfolio size is 64 stocks. All variables are defined in Appendix A. We report Newey-West adjusted *t*-statistics in parentheses. For the long-short portfolios, we use *, ** and *** to indicate significance better than 10%, 5%, and 1% respectively.

Takeover	Fama-French 5-factor Alpha Short Ratio Deciles				Carhart-Pastor-Stambaugh Alpha Short Ratio Deciles			
Terciles	1	5	10	1-10	1	5	10	1-10
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	0.06	-0.14	-0.55	0.61***	0.24	0.04	-0.42	0.66***
	(0.41)	(-1.51)	(-3.54)	(2.97)	(1.74)	(0.33)	(-2.82)	(3.38)
2	0.12	-0.13	-0.69	0.81***	0.39	0.15	-0.39	0.78***
	(0.85)	(-1.28)	(-4.14)	(4.38)	(2.76)	(1.39)	(-2.72)	(4.57)
3	0.26	-0.12	-0.79	1.05***	0.42	0.11	-0.63	1.06***
	(1.80)	(-1.17)	(-4.82)	(5.79)	(3.15)	(1.06)	(-4.20)	(5.50)
3-1	0.20	0.02	-0.24	0.44***	0.18	0.08	-0.22	0.40**
	(1.53)	(0.19)	(-1.53)	(2.89)	(1.38)	(0.61)	(-1.21)	(2.54)

Takeover	Industry-adjusted Return Short Ratio Deciles				Q-factor Alpha Short Ratio Deciles			
Terciles	1	5	10	1-10	1	5	10	1-10
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	0.03	0.04	-0.32	0.35**	0.00	-0.22	-0.54	0.54***
	(0.15)	(0.21)	(-1.82)	(2.05)	(0.01)	(-1.97)	(-3.03)	(2.64)
2	0.31	0.13	-0.28	0.58***	0.16	-0.11	-0.62	0.78***
	(2.65)	(0.91)	(-1.79)	(3.37)	(0.86)	(-0.77)	(-3.04)	(4.37)
3	0.43	0.21	-0.52	0.95***	0.27	-0.08	-0.72	0.98***
	(2.27)	(0.95)	(-2.85)	(5.87)	(1.31)	(-0.49)	(-3.09)	(5.15)
3-1	0.41**	0.16	-0.20	0.60***	0.27*	0.14	-0.18	0.44***
	(2.49)	(1.08)	(-1.05)	(2.77)	(1.75)	(1.09)	(-0.97)	(2.67)

Table B3: Alternative Sorting Strategies

This table reports equal weighted Carhart (1997) four-factor alphas (in percentages) sorted by takeover intensity and stock's short ratio. The sample runs from January 1985 to December 2015. At the beginning of each month, we first sort all the stocks into quintiles based on takeover intensity at the 2-digit SIC industry level, and within each quintile we sort the stocks further into quintiles (deciles) based on their short ratios in the past month. In columns 1 to 6 (7 to 10), we perform a five-by-five (five-by-ten) sequential sort. All variables are defined in Appendix A. We report Newey-West adjusted *t*-statistics in parentheses. For the long-short portfolios, we use *, ** and *** to indicate significance better than 10%, 5%, and 1% respectively.

	Five-by-five sorting						Five-by-ten sorting			
	Short Ratio Quintiles						Short Ratio Deciles			
Takeover Quintiles	1	2	3	4	5	1-5	1	5	10	1-10
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1	0.36	0.33	0.05	-0.07	-0.17	0.53***	0.34	0.06	-0.24	0.58***
	(2.45)	(1.93)	(0.49)	(-0.73)	(-1.32)	(3.20)	(2.33)	(0.48)	(-1.76)	(3.21)
2	0.24	-0.04	-0.08	-0.11	-0.34	0.57***	0.16	-0.04	-0.37	0.53**
	(1.76)	(-0.31)	(-0.63)	(-0.87)	(-2.07)	(3.41)	(0.90)	(-0.30)	(-1.93)	(2.35)
3	0.37	0.24	0.06	0.09	-0.29	0.66***	0.40	0.08	-0.33	0.74***
	(2.79)	(1.98)	(0.49)	(0.71)	(-2.01)	(4.18)	(2.71)	(0.68)	(-1.85)	(4.01)
4	0.38	0.24	0.07	0.02	-0.37	0.75***	0.36	0.08	-0.52	0.88***
	(2.90)	(1.90)	(0.60)	(0.19)	(-2.08)	(3.74)	(2.34)	(0.60)	(-2.50)	(3.44)
5	0.43	0.25	0.11	-0.00	-0.45	0.88***	0.53	0.14	-0.63	1.15***
	(3.72)	(2.02)	(1.22)	(-0.03)	(-3.48)	(6.59)	(3.40)	(1.15)	(-3.69)	(5.90)
5-1	0.08	-0.08	0.06	0.07	-0.28	0.35**	0.18	0.08	-0.39**	0.57***
	(0.51)	(-0.50)	(0.48)	(0.57)	(-1.60)	(2.14)	(1.13)	(0.56)	(-2.12)	(2.66)

Table B4: The Horizon of Return Predictability of Short Interest

This table reports equal weighted Carhart (1997) four-factor alphas (in percentages) of long-short portfolios sorted by takeover intensity and stock's short ratio in months t+1 to t+6. The sample runs from January 1985 to December 2015. At the beginning of each month, we first sort all the stocks into terciles based on takeover intensity at the 2-digit SIC industry level, and within each tercile we sort the stocks further into deciles based on their short ratios in the past month. We then form the long-short portfolios. All variables are defined in Appendix A. We report Newey-West adjusted *t*-statistics in parentheses. For the long-short portfolios, we use *, ** and *** to indicate significance better than 10%, 5%, and 1% respectively.

Takeover Terciles	Long-short Portfolio based on Short Ratio Deciles (1-10)					
	t+1	t+2	t+3	t+4	t+5	t+6
	(1)	(2)	(3)	(4)	(5)	(6)
1	0.60***	0.55***	0.58***	0.62***	0.57***	0.73***
	(3.21)	(3.13)	(2.91)	(3.45)	(3.78)	(3.87)
2	0.81***	0.53***	0.57***	0.80***	0.64**	0.66***
	(4.71)	(2.59)	(2.98)	(4.24)	(3.77)	(3.83)
3	1.06***	0.95***	0.99***	0.97***	0.86***	0.78***
	(5.75)	(4.96)	(5.91)	(5.23)	(4.45)	(3.63)
3-1	0.46***	0.40**	0.40**	0.35	0.28	0.06
	(2.92)	(2.11)	(1.99)	(1.48)	(1.43)	(-.24)

Table B5: State Antitakeover Laws, Short Interest, and Monthly Stock Returns

This table reports the estimates from a panel regression of monthly stock returns on state antitakeover laws other than the Business Combination Law, including the First-generation Law (*FG*), the Poison Pill Law (*PP*), the Control Share Acquisition Law (*CS*), the Directors' Duties Law (*DD*), and the Fair Price Law (*FP*). The sample runs from 1976 to 1995. All other variables are defined in Appendix A. We present *t*-statistics using firm-clustered and time-clustered standard errors in parentheses. *, ** and *** indicate significance better than 10%, 5%, and 1% respectively.

	(1)	(2)	(3)	(4)	(5)
SR	-0.262***	-0.270***	-0.258***	-0.237***	-0.269***
	(-4.75)	(-5.00)	(-4.81)	(-4.28)	(-4.97)
SR × *BC*	0.218***	0.226***	0.222***	0.200***	0.235***
	(3.81)	(4.02)	(3.98)	(3.50)	(4.14)
SR × *FG*	0.062	0.059	0.061	0.018	0.072
	(1.17)	(1.11)	(1.15)	(0.33)	(1.36)
SR × *PP*	0.026	0.036	0.029	0.037	0.021
	(0.32)	(0.44)	(0.37)	(0.47)	(0.25)
SR × *CS*	0.130**	0.106*	0.107*	0.106*	0.104*
	(2.30)	(1.90)	(1.90)	(1.89)	(1.87)
SR × *DD*	-0.044	-0.026	-0.023	-0.005	-0.027
	(-0.51)	(-0.30)	(-0.27)	(-0.06)	(-0.31)
SR × *FP*	-0.046	-0.034	-0.034	-0.028	-0.035
	(-0.67)	(-0.50)	(-0.50)	(-0.41)	(-0.52)
BC	0.004***	0.004***	0.004***	0.004***	0.009***
	(4.91)	(4.94)	(5.11)	(5.35)	(8.47)
FG	0.006***	0.006***	0.006***	0.008***	0.011***
	(8.15)	(8.22)	(8.24)	(9.91)	(10.53)
PP	0.000	0.000	0.000	-0.000	-0.000
	(0.24)	(0.01)	(0.19)	(-0.12)	(-0.10)
CS	-0.000	-0.000	-0.000	-0.000	0.000
	(-0.36)	(-0.03)	(-0.07)	(-0.01)	(0.26)
DD	-0.005***	-0.005***	-0.005***	-0.006***	-0.006***
	(-3.99)	(-4.05)	(-4.23)	(-4.83)	(-4.42)
FP	-0.001*	-0.001*	-0.002*	-0.002*	-0.004***
	(-1.67)	(-1.66)	(-1.90)	(-1.86)	(-3.53)
Ln*BM*	0.004***	0.004***	0.004***	0.004***	0.005***
	(10.85)	(10.48)	(9.81)	(8.41)	(11.14)
Ln*ME*	-0.000**	-0.000*	-0.001***	-0.001***	-0.001***
	(-1.98)	(-1.93)	(-4.09)	(-4.59)	(-3.40)
REV		0.001	0.003	0.011***	0.001
		(0.44)	(1.07)	(3.85)	(0.49)
MOM		0.002***	0.002***	0.000	0.001**
		(2.87)	(2.90)	(0.52)	(2.12)

(Continued)

Table B5 (continued)

	(1)	(2)	(3)	(4)	(5)
IVOL			-0.142***	-0.153***	-0.134***
			(-4.51)	(-4.62)	(-4.07)
IO				0.009***	
				(7.01)	
Adjusted R^2	0.002	0.002	0.002	0.002	0.003
N	215,046	213,691	213,660	188,453	213,473
Industry FE					Yes
Year FE					Yes

Table B6: Excluding Firms Lobbying for Business Combination Laws

This table reports estimates from panel regression of monthly stock returns for the period from January 1976 to December 1995. The independent variables of interest is the interaction between short ratio (*SR*) and a binary variable (*BC*) that equals one if a Business Combination Law is passed in the state of incorporation. We control for a set of stock characteristics including short term reversal measured by lagged monthly return (*REV*), momentum (*MOM*), book-to-market (Ln*BM*), size (Ln*ME*), idiosyncratic volatility (*IVOL*), and institutional ownership (*IO*). We also include 2-SIC industry fixed effects and state of incorporation fixed effects in columns 5 and 7. We present t-statistics using firm-clustered standard errors in brackets. *, ** and *** indicate significance better than 10%, 5%, and 1% respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
SR	-0.221***	-0.232***	-0.220***	-0.228***	-0.142***	-0.127***
	(-5.36)	(-5.84)	(-5.60)	(-5.47)	(-4.02)	(-3.09)
SR × *BC*	0.196***	0.210***	0.207***	0.211***	0.121***	
	(4.28)	(4.74)	(4.71)	(4.59)	(3.08)	
BC	-0.001**	-0.001**	-0.001**	-0.002***	-0.000	
	(-2.22)	(-2.25)	(-2.18)	(-3.10)	(-0.05)	
$SR \times BC_{-3}$						0.051
						(0.48)
$SR \times BC_{-2}$						0.091
						(0.84)
$SR \times BC_{-1}$						-0.167**
						(-2.24)
$SR \times BC_{0}$						-0.107
						(-1.23)
$SR \times BC_{1}$						0.039
						(0.57)
$SR \times BC_{2+}$						0.125***
						(2.80)
Ln*BM*	0.004***	0.004***	0.004***	0.004***	0.004***	0.004***
	(10.67)	(10.29)	(9.62)	(8.48)	(9.23)	(9.32)
Ln*ME*	-0.000**	-0.000**	-0.001***	-0.001***	-0.001***	-0.001***
	(-2.33)	(-2.24)	(-4.27)	(-4.65)	(-4.46)	(-4.53)
REV		0.002	0.004	0.012***	-0.025***	-0.025***
		(0.77)	(1.36)	(4.21)	(-8.79)	(-8.86)
MOM		0.002***	0.002***	0.001	0.009***	0.009***
		(3.18)	(3.22)	(1.07)	(13.84)	(13.69)
IVOL			-0.135***	-0.142***	-0.246***	-0.245***
			(-4.29)	(-4.31)	(-7.68)	(-7.66)
IO				0.009***		
				(6.92)		
BC_{-3}						0.003***
						(2.58)

(Continued)

Table B6 (continued)

	(1)	(2)	(3)	(4)	(5)	(6)
BC_{-2}						0.000
						(0.32)
BC_{-1}						0.004***
						(2.70)
BC_0						0.002
						(1.60)
BC_1						0.004***
						(2.70)
BC_{2+}						-0.000
						(-0.22)
R^2	0.001	0.001	0.002	0.002	0.217	0.217
N	211,379	210,024	209,993	185,429	209,805	209,805
Industry FE					Yes	Yes
Year FE					Yes	Yes

Appendix C – Illustrative Model

This appendix contains an illustrative model based on Wurgler and Zhuravskaya (2002) and Gromb and Vayanos (2010) to generate our testable hypotheses. Assume an economy with two periods, $t = 0$ and t = 1, and one asset in zero net supply. At $t = 0$, there is a positive demand shock for the asset for d fraction of the shares, and the arbitrageur spends x dollars to trade against it. There are two possible realizations of the asset value in $t = 1$. If there is no takeover, the asset value is V. If there is a takeover, the asset value in $t = 1$ is $V(1+k)$, where k represents the premium paid by the acquirer. We assume that the probability of a takeover is $q < 0.5$. Hence $E_0(V) = V(1 + qk)$. The risk-free rate is assumed to be zero. The arbitrageur is a short seller who borrows shares at the risk-free rate, and extracts utility from the gain of the trade.

The arbitrageur spends x dollars to trade the asset at price p at $t = 0$ and closes the position at $t = 1$. Assuming an exponential utility function $(-e^{-aW})$, the arbitrageur's objective is to maximize the following equation with respect to the value of the shares shorted x:

$$E_0(-e^{-aW_1}) = -(1-q)e^{-\frac{ax(V-p)}{p}} - qe^{-\frac{ax[V(1+k)-p]}{p}} \tag{1}$$

The first order condition with respect to x is:

$$\frac{\partial E_0\left(-e^{-aW_1}\right)}{\partial X} = \frac{a(1-q)(V-p)}{p} e^{-\frac{ax(V-p)}{p}} + \frac{aq[V(1+k)-p]}{p} e^{-\frac{ax[V(1+k)-p]}{p}} = 0 \tag{2}$$

Solving Equation (2) gives the optimal x:

$$x = \frac{pln\left\{\frac{q[V(1+k)-p]}{(1-q)(p-V)}\right\}}{akV} \tag{3}$$

Since the asset is in zero net supply, the market clearing condition is that:

$$x + dp = 0 \tag{4}$$

Combining Equations (3) and (4) we find the equilibrium risk-compensation to be:

$$p = V(1 + \frac{kqe^{adkV}}{1-q+qe^{adkV}}) \tag{5}$$

Note that p is bounded by $[V, V(1+k)]$. When there is no chance of a takeover (q = 0) or when the acquirer does not require any premium (k = 0) it is trivial to show that the expected value of the asset is V and that p = V. On the other hand, when takeover likelihood is close to one, or when demand shock and premium approaches arbitrarily large values, the equilibrium price converges to $V(1+k)$.

The first derivative of the price p with respect to the demand shock d is given by the following equation:

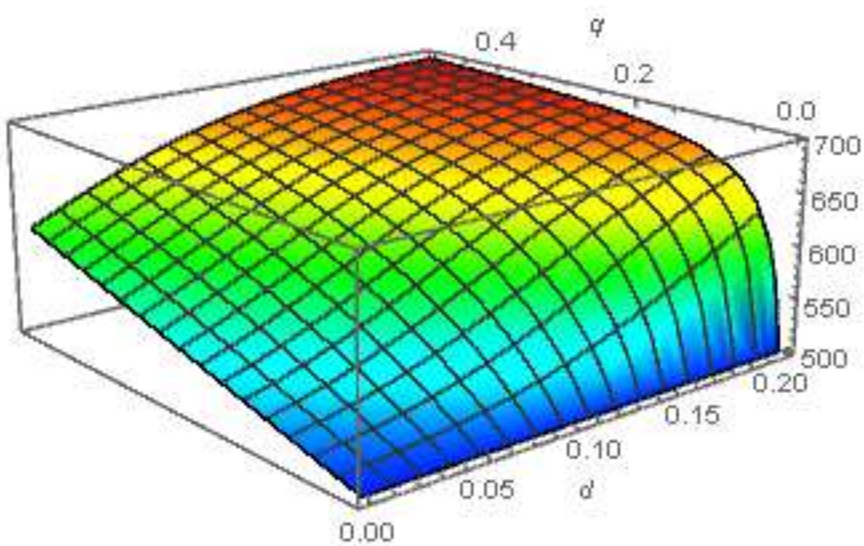
$$\frac{\partial p}{\partial d} = \frac{qV^2k^2(1-q)ae^{adkV}}{\left[1+q\left(e^{adkV}-1\right)\right]^2} > 0 \tag{6}$$

This result suggests that, *ceteris paribus*, the arbitrageur demands a higher expected return if the demand shock is larger. Since the market clearing condition in Equation (4) requires that the dollar amount of shares shorted (x) is equal to the dollar amount of the demand shock (dp), then a higher short interest (which reflects a larger demand shock) implies a more negative expected stock return.

The second derivative of the price *p* with respect to the demand shock *d* and the probability of a takeover *q* is:

$$\frac{\partial^2 p}{\partial d \partial q} = \frac{V^2 k^2 (1-q-qe^{adkV}) a e^{adkV}}{\left[1+q(e^{adkV}-1)\right]^3} > 0 \quad (7)$$

This inequality is true if $q < \frac{1}{1+e^{adkV}}$. Assume an extreme demand shock of *d* = 10%, which is similar to the difference between the top and bottom decile of short interest in our sample, and a takeover premium of 40%, which is close to the average takeover premium observed in the data. Further assume that absolute risk aversion is *a* = 0.1 and the no-takeover asset value *V*=500 ($mil). Then the relation between takeover likelihood, demand shock, and market price is shown in the following graph:



When $q < \frac{1}{1+e^{adkV}} = 11.9\%$, then $\frac{\partial^2 p}{\partial d \partial q} > 0$. This suggests that the sensitivity of the expected stock return to the demand shock increases with takeover risk. To the extent that monthly short interest reflects the informed short sellers' position against demand shocks in equilibrium, a higher short interest should be related to greater negative expected stock return when there is higher takeover risk. As takeover risk goes beyond the threshold given by the level of risk aversion and the takeover premium, the equilibrium price converges to the upper bound ($V(1+k) = 700$) and $\frac{\partial^2 p}{\partial d \partial q}$ turns negative. Given that the unconditional likelihood of a takeover for any firm-quarter (1%) is far below the illustrative threshold, the parameters in the sample will likely lie in the range such that an increase in takeover risk will increase the sensitivity of future stock returns to current short interests.