Flying Under the Radar: The Effects of Short-Sale Disclosure Rules on Investor Behavior and Stock Prices

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Abstract

This paper analyzes how newly introduced transparency requirements for short positions affect investors' behavior and security prices. Employing a unique data set, which contains both public positions above and confidential positions below the regulatory disclosure threshold, we offer several novel insights. Positions accumulate just below the threshold, indicating that a sizable fraction of short sellers are reluctant to disclose their positions publicly. Furthermore, we provide evidence that the transparency measures effectively represent a short-sale constraint for secretive investors, which results in stocks to be overpriced. Specifically, when this constraint is potentially binding, stocks subsequently exhibit a negative abnormal return of 1.0-1.4% on a monthly basis. Different placebo tests verify that the short-sale constraint originates from the disclosure threshold. Overall, these findings suggest that short sellers' evasive behavior in response to the transparency regulation imposes a negative externality on stock market efficiency.

Keywords: short selling, transparency, investor behavior, stock market efficiency

JEL: G14, G15, G23

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1 Introduction

Disclosure requirements for investors' holdings are a prevalent feature of financial market regulation. Traditionally, various transparency rules have been in place for investors' long positions, but not for their short positions.[1] This asymmetry of publication requirements between long and short positions has been highly debated in the aftermath of the financial crisis, with regulators on both sides of the Atlantic contemplating new transparency measures for short positions. Proponents of short-selling disclosure rules argue that greater transparency would help improve the price discovery process in the market (NYSE, 2015; NASDAQ, 2015). However, opponents often raise the concern that a timely publication of short positions may pose a threat to proprietary investment strategies, especially when the identity of the short seller is revealed. To protect their intellectual property, informed investors may diminish their short-selling activities, which can in fact deteriorate price efficiency (U.S. SEC, 2014). While the debate on more transparency for short sales is still ongoing in the United States, the European Union already adopted a uniform short position disclosure rule in 2012.[2] Specifically, the European regulation requires the publication of investors' net short positions – including derivative equivalents – over a certain threshold one day after the position arises.

In this study, we investigate two key questions related to this new rule: How do short sellers behave around the disclosure threshold; do they, for example, try to stay below the radar? If so, how would such behavior affect the efficiency of stock prices? We address

[1] For example, in the United States, several disclosure rules apply for long positions. First, anyone who acquires beneficial ownership of more than 5% of a voting class of a publicly traded company has to file a 13D or 13G filing with the Securities and Exchange Commission (SEC). Second, institutional investment managers of a certain size must report their quarterly holdings in 13F filings. Mutual funds also must regularly report their portfolio holdings to their shareholders (SEC forms N-CSR and N-Q.)

[2] Among the EU countries, Spain and the United Kingdom had already implemented short-sale disclosures in 2008; France followed in 2011. Japan also introduced disclosure requirements in 2008. In the United States similar measures have been debated. The Dodd-Frank Act required the U.S. Securities and Exchange Commission (SEC) to conduct a study of the feasibility, benefits, and costs of real-time disclosures of shorting. However, the real-time disclosure of shorting was not adopted (U.S. SEC, 2014). Recently, the debate on short-sale disclosure resurfaced, with both large stock exchanges, NSYE and NASDAQ, filing rulemaking petitions for short-sale disclosure with the SEC (petition number: 4-689, October 7, 2015; petition number: 4-691, December 7, 2015, see https://www.sec.gov/rules/petitions.shtml).

these questions by exploiting unique regulatory short-sale notification data, which cover not only *public* positions *above the disclosure threshold* but also *confidential* positions *below the threshold*. Our data originate from the two-tier reporting system pursuant to the EU-wide short-selling regulation: First, investors must notify the regulator if their short position reaches 0.2% of the shorted stocks' issued share capital. Second, the short position must additionally be publicly disclosed if it reaches 0.5% of the issued share capital. Above these thresholds, the short position is updated whenever it falls into a new reporting interval of 0.1% width. These first- and second-tier notifications for the German stock market, as part of the European regulation, offer us a rare glimpse behind the curtain of the public disclosure threshold.

The new rule represents an ideal setting to study how mandatory position disclosure affects investors' behavior, and in turn the informational efficiency of prices. Price discovery is a key function of the financial market: Informed investors try to exploit their private information by trading in the market, and in doing so reveal part of their information to uninformed investors. Through this mechanism the information is eventually incorporated into prices (Glosten and Milgrom, 1985; Kyle, 1985). However, investors also face various disclosure rules pertaining to their holdings, which may convey private information to the market, especially if positions are published in a timely manner. So informed investors have an incentive to avoid disclosure by trading less, which can reduce price efficiency. Early academic literature highlighted this trade-off especially in the context of insider trading (Leland, 1992; DeMarzo, Fishman and Hagerty, 1998; Huddart, Hughes and Levine, 2001). More recently, it has been discussed in connection with hedge fund opacity (Agarwal, Jiang, Tang and Yang, 2013; Easley, O'Hara and Yang, 2014) and mutual funds' portfolio disclosure (Agarwal, Mullally, Tang and Yang, 2015). Two features make the analyzed disclosure rule particularly interesting with regard to informational efficiency. First, the rule applies to short sellers, which are typically perceived as informed investors.[3] Second,

[3]For example, the model by Diamond and Verrecchia (1987) predicts that short sellers are more likely to be informed than uninformed because shorting is costly. A robust finding of the empirical literature

the disclosure rule is highly revealing because positions crossing the disclosure threshold must be publicized as early as the next trading day.

By studying short positions above and below the disclosure threshold, we offer several novel insights. First, we find strong evidence that a considerable fraction of investors avoid crossing the disclosure threshold, resulting in positions to pile up just below the disclosure threshold. Specifically, in the reporting interval just below the disclosure threshold, the probability of increasing a short position is the lowest, and the duration for which such a position is held is the longest, relative to all other reporting intervals. Compared with the neighboring reporting intervals, the duration is 22-55% longer, and the probability of increasing the short position is 20-34% lower. These effects emerge only when investors approach the publication threshold for the first time and from below, not for positions that were already public, suggesting that the observed pattern in the data actually originates from a strategy designed to avoid crossing the disclosure threshold.

There are several potential reasons why short sellers might want to stay below the radar, including the risk of a recall induced by copycat investors, the protection of intellectual property, or institutional and cultural reasons. Studying the determinants of the decision to publish a short position, we find that it is predominantly influenced by investor-specific characteristics. Two variables best predict the likelihood of crossing the publication threshold: Whether the investor is generally secretive about its portfolio, proxied by the existence of any public filing on record; and whether the investor has ever crossed the short position threshold in the past. These findings are broadly in line with intellectual property concerns. At the very least, the results show that the investor's decision to disclose its position is persistent, with investors sticking to their secretive behavior.

We also study how this evasive behavior by investors affects asset prices. If short sellers are reluctant to cross the disclosure threshold, the threshold effectively represents a

is that short sales are followed by negative returns, suggesting that short sellers are generally informed investors (e.g. Seneca, 1967; Aitken, Frino, McCorry and Swan, 1998; Asquith, Pathak and Ritter, 2005; Boehmer, Jones and Zhang, 2008; Diether, Lee and Werner, 2009). For a recent survey on this topic, see Reed (2013).

constraint for them. Theoretical models (e.g., Miller, 1977; Harrison and Kreps, 1978; Duffie, Garleanu and Pedersen, 2002) predict that in the presence of heterogeneous beliefs, binding short-sale constraints result in overpricing. Consistent with the overpricing hypothesis, we find that stocks with likely binding short-sale constraints due to the disclosure rule exhibit subsequent negative abnormal returns of 1% to 1.4% on a monthly basis. This overpricing effect is remarkably high, given that that it is present in highly liquid, large-cap stocks, and considering that the constraint is evoked solely by investors that avoid disclosing their position. To confirm that the overpricing effect is induced by the disclosure threshold, we perform different placebo tests. The overpricing effect is not present when we choose various hypothetical publication thresholds below and above the true one. Moreover, within investor-stock pairs, overpricing only occurs when the position is just below the publication threshold and the constraint is potentially binding.

Additionally, by exploiting our findings about the determinants of reluctance, we can better distinguish truly constrained investors from unconstrained ones. Using the enhanced proxies for short-sale constraints results in an even more pronounced overpricing effect, corroborating the overpricing hypothesis while also validating our findings on the determinants of the reluctance to disclose. Finally, we study the performance of positions held by secretive and non-secretive investors. The results show that secretive investors outperform their peers, which suggests that the concealment of positions is associated with superior information. The fact that secretive investors can generally be characterized as informed investors supports the hypothesis that intellectual property concerns play an important role in the decision not to disclose positions.

These findings contribute to the literature on short-sale constraints and overpricing. Various empirical studies confirm the prediction that binding short-sale constraints lead to overpricing. The literature mainly focuses on frictions in the lending market (e.g. Jones and Lamont, 2002; Asquith et al., 2005; Nagel, 2005; Cohen, Diether and Malloy, 2007;

Prado, Saffi and Sturgess, 2014). Our key contribution to this literature is to show that transparency requirements already constitute a sizable impediment to short selling.

Our paper also relates to the literature on short-sale regulations (e.g. Diether et al., 2009; Boehmer, Jones and Zhang, 2013; Beber and Pagano, 2013; Battalio and Schultz, 2011). The consequences of short-sale bans following the financial crisis of 2007-2008 have attracted great interest among researchers. For instance, Boehmer et al. (2013) and Beber and Pagano (2013) analyze short-sale bans in the United States and internationally, respectively, documenting a deterioration in market quality. However, much less is known about the effects of higher transparency requirements for short sellers. In this context, the recent study by Jones, Reed and Waller (2015) is the closest to ours. They document a reduction in average short interest and the bid-ask spread, as well as an increase in the Hou and Moskowitz (2005) price delay measure after the staggered introduction of short-sale disclosure rules in Europe. Similar findings come from Duong, Huszár and Yamada (2015) for Japan. Our study is, to the best of our knowledge, the first to directly observe short sellers' evasive behavior in response to higher transparency. This behavior has a critical impact on stock prices, which has previously not been documented: Mandatory disclosure represents a short-sale constraint for secretive investors, resulting in stocks being overpriced.

The remainder of this paper is organized as follows: Section 2 provides background information on the short position disclosure regulation and discusses relevant theory. In Section 3, we describe how we construct the sample. Section 4 examines whether investors are reluctant to cross the publication threshold, Section 5 explores the reasons for such reluctance, and Section 6 studies the implications of the disclosure rule on asset prices. Section 7 provides further analyses which corroborate the main results. Section 8 concludes.

2 Background, theory, and testable hypotheses

2.1 Background on the short position disclosure rule

The EU regulation on short selling (No 236/2012) has been in effect since November 1, 2012, requiring investors to report and disclose any short positions of a considerable magnitude. The regulation consists of a two-tier reporting system: First, a net short position must be reported to the regulator if the position reaches 0.2% of the issued share capital of the company shorted and for each 0.1% above that. Second, a net short position must be disclosed to the public if the position reaches 0.5% of the issued share capital of the company shorted and for each 0.1% above that. Also, positions have to be reported or disclosed when they fall below the relevant thresholds.

The disclosure and notification rules apply to all stocks admitted to trading at trading venues in EU countries if the principal venue is located in the EU and not in a third country. Short positions are reported separately for each country on the websites of the national authorities. In Germany, the national authority for reporting short positions is the Federal Financial Supervisory Authority (Bundesanstalt für Finanzdienstleistungsaufsicht, BaFin), and short positions are published on the Internet platform of the Federal Gazette (Bundesanzeiger).[4] Short positions have to be reported or disclosed by 3:30 p.m. (local time) on the next trading day after they arise. Disclosures contain the name of the investor, the date of the short position, the International Securities Identification Number (ISIN), and the name of the shorted stock, as well as the magnitude of the position reported as a percentage of the issued share capital.

The following example illustrates the disclosure rule. In autumn 2015, the hedge fund company Marshall Wace LLP shorted the stock of Deutsche Lufthansa AG considerably, presumably in light of the airline's restructuring plan and labor disputes with its pilots and cabin crews. Marshall Wace's net short position in Lufthansa stock exceeded the

[4]For recent examples of published net short positions in Germany, see: https://www.bundesanzeiger.de/nlp.

publication threshold of 0.5% on October 29, 2015, with a reported value of of 0.59%. On November 2, 2015, the position exceeded the next reporting threshold of 0.6%, with a reported value of 0.61%, and on November 5, 2015, the next threshold of 0.7% was crossed, with a reported value of 0.71%. Thus, short positions are publicly disclosed when each new publication threshold is crossed, until the position falls below the threshold of 0.5%. The regulator receives confidential short position notifications in the same manner, but here the threshold is 0.2%.

After the reporting day, the exact value of a short position is unknown between the two disclosure thresholds until a new threshold is crossed. That is, the reported short position (SP) of 0.61% on November 5, 2015 could range between 0.60% and 0.69% on the next day, since no further information about crossing another threshold became available. Therefore, we sort the positions into short position bins ($SPBIN$) of 10 basis points (bps) each: 0.20-0.29%, 0.30-0.39%, 0.40-0.49%, and so forth. For brevity, we refer to these reporting intervals as the 0.2, 0.3, 0.4, ... reporting bin, interval, or class.

Several features of the regulation and its scope need to be highlighted. First, the disclosure rule applies to all investors, irrespective of whether they are domiciled in the EU or abroad. In fact, a large proportion of the reporting position holders are hedge funds domiciled outside the EU. Second, market making activities are exempted from the EU short-selling regulation with the purpose of ensuring liquidity provision. To meet the conditions for this exemption, institutional investors are required to file a detailed statement on their market making activities in specific securities, which is monitored by the national authorities (ESMA, 2013*b*). According to the list of market makers published by ESMA, mainly banks are using this exemption in our sample (ESMA, 2016). Third, the regulation applies not only to short positions but also to derivative positions, which must be accounted for on a delta-adjusted basis. Thus, reporting requirements cannot be circumvented by substituting short positions with positions in derivatives.

2.2 Short positions: To publish or not to publish

A priori, it is unclear whether investors prefer to publicize their short positions or prefer to keep it secret. Lamont (2012), whose arguments we follow subsequently, states that depending on the situation, a short seller might either publicize its position or try to remain undetected. Publicizing a short position could be helpful if the investor is attempting to convince other investors that a certain stock is overpriced. If other investors agree and follow suit, prices will converge faster to fundamentals, thus reducing borrowing costs for the stock and potential noise trader risk (De Long, Shleifer, Summers and Waldmann, 1990; Shleifer and Vishny, 1997). As a prominent example of this strategy, in November 2012, Bill Ackman, CEO of the hedge fund management company Pershing Square Capital Management LP, announced that the fund had massively shorted Herbalife stock, accusing the company of a pyramid scheme.[5] The Herbalife case received widespread media attention, but such short-sale campaigns are comparatively rare.[6]

At the same time, there are plenty of reasons why short sellers may want to keep their short positions secret. If other investors follow on shorting the stock, existing stock loans may be called back by the lender, or borrowing fees may rise. This effect would be especially pronounced if lending supply for the stock were low. Other reasons may be cultural or institutional, such as a fear of being sued or harassed by the shorted firm (Lamont, 2012). Investors may also be concerned about their intellectual property, which consists of information they have gathered about the shorted company or a proprietary trading strategy.

Given that there are reasons both for and against publicizing a short position, it is unclear whether and how investors would change their behavior in response to a mandatory disclosure threshold. However, the primary concern raised by participants of the survey

[5] See: Alden, W.: "Ackman Outlines Bet Against Herbalife" *The New York Times* (November 20, 2012).

[6] Ljungqvist and Qian (2016) collect 124 short-sale campaigns in the United States employed by 31 individuals or small boutique hedge funds during 2006-2011, finding evidence that such campaigns contribute to the correction of mispricing.

conducted by the European Securities and Markets Authority (ESMA) is that investors would try to avoid a publication by just remaining below the disclosure threshold (ESMA, 2013*a*). Therefore, we pose the question accordingly and ask whether investors as a whole are reluctant to cross the publication threshold. Yet, it is important to note that our proposed empirical framework would also capture the opposite, an "eagerness" to cross the threshold.[7]

2.3 Testing for reluctance to cross the public disclosure threshold

To develop testable hypotheses for detecting reluctance in disclosing short positions, we sketch a stylized portrait of the development of a short position in a certain stock in Figure 1. In the example depicted, the investor aims for a short position in the 0.7 interval. The continuously held short positions are arranged in 10 bps bins because the data are reported in these intervals. In the first case, no disclosure rule is in effect (dashed gray line). As the graph shows, over time, the investor builds up the position, holds the position for a certain period of time, and then covers the position. Next, consider the same investor and stock if a disclosure rule applies for positions above the threshold of 0.5%, and the investor is reluctant to disclose the position. Even though this investor intended to have a short position in the 0.7 bin, the investor remains under the disclosure threshold, as indicated by the solid black line.

This figure helps us to intuitively derive several testable hypotheses for detecting a reluctance to cross the disclosure threshold. First, in the reporting bin just below the publication threshold, the probability of a position increase should be lower than the expected probability of increase. Second, the time spent in the reporting bin just below the publication threshold should be longer than the expected duration. As Figure 1 indicates, the time spent in the intervals above the disclosure threshold collapses for the reluctant

[7]In this paper we focus on short sellers' behavior around the public disclosure threshold of 0.5%. It is possible that the two-tier reporting system impacts the behavior at 0.2%, where positions are reported to the regulator but not to the public. We are unable to investigate this question because the positions below 0.2% are by definition unobservable.

investor to the 0.4 interval.[8] To test both hypotheses we have to specify the expected probability and duration in the 0.4 bin. In our empirical test we draw on a comparison with the neighboring bins, which serve as natural benchmarks.[9]

Lastly, the effects on the probability of a position increase and duration should be particularly pronounced when the investor approaches the threshold from below for the first time. Investors that have already crossed the threshold for a specific stock in the recent past have demonstrated no reluctance in publicizing this particular position. Thus, we expect that these investors are less hindered in crossing the publication threshold in the near future. To capture this difference, we define the following dummy variable for the sequence of position notifications of each investor-stock (i, j) pair:

$$Position\ record\ high_{i,j,t} = \begin{cases} 1 & \text{if } SPBIN_{i,j,t} = \max\limits_{s \leq t} SPBIN_{i,j,s} \\ 0 & \text{if } SPBIN_{i,j,t} < \max\limits_{s \leq t} SPBIN_{i,j,s}, \end{cases} \tag{1}$$

where $SPBIN_{i,j,t}$ denotes the short position bin of investor i in a given stock j on trading day t. The dummy indicates, whether at time t the short position of an investor i in stock j is at its record high or not.

Comparing two exemplary situations of investors just below the publication threshold provides the economic intuition behind this indicator variable. First, imagine an investor with the following history of short position notifications: 0.2, 0.3, 0.4. The running maximum of the position sequence is 0.2, 0.3, 0.4. That is, the past two values and the current value represent a record high for this investor. If the investor increased the position from 0.4 to a value above 0.5, it would be the *first time* it passed the disclosure threshold. Some investors will disclose their positions, reluctant investors would avoid doing so and stay below the threshold. Thus, if a certain share of investors are reluctant to cross the

[8] An additional effect, not present in Figure 1, may be that, due to the constrained short position, the price does not return as fast to its fundamental value as it normally would, resulting in an even longer holding period in the 0.4 interval.

[9] In contrast, if investors as a whole are eager to cross the publication threshold, we would expect a higher probability of increase and shorter duration in the 0.4 bin.

threshold, we expect to find signs of reluctance especially when investors have a position with a record high of 0.4.

Now imagine a different investor with the following history of notifications: 0.2, 0.3, 0.4, 0.5, 0.4. The running maximum of the position sequence is 0.2, 0.3, 0.4, 0.5, 0.5. The past four values represent record highs, but the current position value is below record level. If the investor now increased its position from 0.4 to a value above 0.5, this would be *not the first time* it passed the disclosure threshold. The investor already crossed the disclosure threshold for this stock in the recent past and thereby demonstrated that it is not reluctant to disclose a position in this particular stock. Thus, we expect the share of reluctant investor in the first situation to be higher than in the second situation, because in the latter we condition on investor-stock observations that revealed not to be hindered by the disclosure rule in the past. In a nutshell, we hypothesize stronger signs of reluctance for positions at their record high than for positions below their record high.

2.4 Potential implications of short-sale disclosure rules on stock prices

What are the implications for stock prices if investors avoid crossing the disclosure threshold? In short, the publication threshold may inflict a short-sale constraint on these investors, which could result in overpricing or less informative prices.

Going back to Miller (1977), a large body of theoretical literature has evolved which studies the relationship between short-sale constraints and asset prices.[10] Miller (1977) suggests that short-sale constraints in combination with divergence of opinion result in overvalued stock prices that reflect only the opinion of optimists. Alternatively, in the rational expectations model of Diamond and Verrecchia (1987) investors take short-sale

[10] See Harrison and Kreps (1978), Diamond and Verrecchia (1987), Duffie et al. (2002), Hong and Stein (2003), and Hong, Scheinkman and Xiong (2006).

constraints into account, resulting in unbiased prices in the long run, but prices may converge more slowly.[11]

In the case of a disclosure threshold, overpricing can arise, as long as the constraint imposed by the threshold is binding. Going back to Figure 1, the publication threshold represents a binding constraint for the reluctant investor during the period from t_0 to t_1. During this period, the investor would have a higher short position if the publication requirement were not present. We cannot observe the counterfactual, but the richness of the data enables us to identify stocks for which the short-sale constraint inflicted by the publication threshold is likely to be binding, allowing us to test the overpricing hypothesis. The main idea of our approach is to study short positions that remain just below the publication threshold, never crossing it. We describe the procedure used to identify potentially constrained investors in detail in Section 6.

3 Data and descriptive statistics

We obtain public and confidential short position disclosures from the German Federal Financial Supervisory Authority (BaFin) for November 1, 2012, through March 31, 2015. We merge the short position notifications with stock data from *Thomson Reuters Datastream* and institutional investor data from *FactSet Ownership*, formerly known as *LionShares*. For our analysis, we restrict the sample to common equity traded on the German regulated market. To ensure the quality of the data from Datastream, we apply several standard data filters (see Ince and Porter, 2006; Griffin, Kelly and Nardari, 2010; Karolyi, Lee and Van Dijk, 2012). We start our analysis on November 5, 2012, to account for some delay in the notification of short positions, due to a statutory holiday in some federal states. The Appendix provides further details on the sample construction, and Table A.1 contains a description of the computation of all the variables.

[11] Cornelli and Yilmaz (2015) show that in Diamond and Verrecchia's (1987) rational expectations framework, uncertainty about the number of informed investors in the market can result in long-run prices that do not converge to their fundamental value.

Table 1 provides summary statistics on various stock characteristics for the entire population of stocks in the regulated market and for stocks that have at least one short position notification. Out of all stocks, 19.9% have at least one short position notification. In particular, 8.3% of the sample consists of stocks that have at least one public short position disclosure and 11.6% of stocks have at least one confidential but no public position. In terms of stock characteristics, we observe short position notifications mainly for stocks with a large market capitalization, a low book-to-market ratio, and a high share of institutional investors, as well as stocks that are very liquid, measured by both the Amihud illiquidity ratio and the bid-ask spread. In fact, the vast majority (73.5%) of stocks with short positions are in the highest market capitalization quartile, and almost all stocks with short position notifications (95.8%) appear above the median value of the market capitalization distribution. In economic terms, there are no apparent differences between stocks with public and confidential short positions.

The panel dimension of the analysis in Sections 4 and 5 pertains to the investor-stock level. Table 2 contains summary statistics for the stock and investor characteristics for which we observe a short position of at least 0.2% of issued share capital. As these details indicate, hedge funds constitute the largest investor group, accounting for 66% of the observations whereas banks account for only 2%.[12] The remaining groups of investors are mutual funds and other investment advisors. For 47% of the observations, the investor is domiciled in Europe and only 2% of investors are local (i.e., domiciled in Germany). For 10% of the observations, the investor has no other public record and is thus not present in the *Factset* database. Finally, 23% of the position days are associated with investors that never had a short position in the past.

Figure 2(a) shows the frequency distribution of days with an open short position notification over the different disclosure bins. Recall that short positions are reported to the regulator when greater or equal to 0.2% of total shares outstanding, and they

[12] As mentioned in Section 2.1, banks predominantly use the exemption rule for market makers, which most likely explains their low share in our sample.

are disclosed to the public when greater or equal to 0.5%. As can be seen from the graph, publicly disclosed short positions are only the tip of the iceberg. The majority of short positions are not disclosed: 79% of days with an open short position fall below the publication threshold.

4 Do investors avoid crossing the disclosure threshold?

Looking at the overall distribution in Figure 2(a), it is hard to determine whether investors are reluctant to publicize their short positions. To uncover a potential accumulation of days with open short position below the disclosure threshold, we therefore split the sample into positions at their historic high and positions below their historic high (see Section 2.3). This sample split exploits the fact that the reluctance to cross the threshold should be particularly pronounced for investors who approach the threshold from below for the first time. Figure 2(b) shows the frequency of days with open short positions for the two subsamples, revealing initial evidence of a reluctance to disclose short positions. Positions which are at their record high amass below the disclosure threshold. The relative frequency in the 0.4 bin is 17.0%, nearly reaching the frequency of the previous bin. Positions which are below their record high instead decline fairly geometrically with increasing disclosure bins. Their relative frequency in the 0.4 bin is 8.6%, about half the relative frequency of positions at their record high.

Overall, Figure 2(b) yields first, descriptive evidence of investors being reluctant to cross the disclosure threshold. In the following, we take a more rigorous approach to test the reluctance hypothesis. First, we study the probability of increasing a short position across reporting intervals. Second, we investigate the duration spent in each reporting interval.

4.1 Probability of short position increase

Table 3 shows the probability of increasing a short position, conditional on currently having a short position in a specific reporting interval. Looking first at the overall sample, we find that this probability rises with the value of the current reporting interval. Beyond this general pattern, we observe an unusual value for the 0.4 reporting interval. The bin just below the publication threshold exhibits the lowest probability of all reporting intervals with a probability of 0.354, significantly different from all other bins except the lowest. Relative to the neighboring intervals, we find that the probability of a position increase is 3.7 percentage points lower than the probability in the next lower bin and 5.4 percentage points lower than in the next higher bin. Thus, just below the publication threshold, we find the lowest likelihood of increasing a short position, which suggests there are investors that are reluctant to cross the publication threshold.

To determine if this effect is really due to a reluctance to pass the publication threshold, we split the sample into positions at and positions below their record level. As discussed previously, the reluctance to pass the disclosure threshold should particularly be present for positions at their record high, but less pronounced for positions below their record high. The second panel shows the probability of increasing a short position only for positions at their historic high. For this subsample, the reluctance effect of the 0.4 bin is much more pronounced than it was in the overall sample. The probability of increasing a short position takes a minimal value of 0.338 for the 0.4 class, which is significantly lower than all reporting intervals except for the lowest. To gauge the economic significance of this reluctance effect, we compare this probability with the neighboring reporting intervals, just below and just above. In the 0.3 bin, the probability of increasing a short position is 0.423, equivalent to a difference of -0.085; in the 0.5 bin, it is 0.514, amounting to a difference of -0.176. In relative terms, in the bin just below the disclosure threshold it is 20% and 34% less likely to increase a short position than in the two neighboring intervals.

Positions that are below their maximum serve as a comparison. If the low probability of increasing a short position is truly due to a reluctance to reveal one's position, we should observe little to no effect for these positions. The right-hand side panel of Table 3 supports this notion: For positions below their maximum, we find nothing extraordinary about the 0.4 reporting interval. The probability of increasing the position is even the second largest, not statistically significant when compared to the class below, and significantly higher than the class above.

4.2 Duration in reporting interval

The second testable hypothesis pertains to the duration spent in the position reporting intervals. If investors are reluctant to publicize their position, they are forced to stay just below the publication threshold of 0.5%, which should result in an unusually long duration in the 0.4 bin. We test this hypothesis in Table 4, which shows the average duration in each reporting interval in trading days. The durations in the bins are prone to severe outliers, so we winsorize the upper tail at 1% before reporting the mean durations in Panel A. As an alternative, we report the median durations in Panel B.

In general, the duration in each 10 bps interval declines with the size of the position. For example, the mean duration for the overall sample in Panel A declines from 18.3 days (lowest class) to 12.6 days for all positions greater than or equal to 1.0% (highest class). Again, we observe an unusual value for the 0.4 bin: The duration in this class, just below the disclosure threshold, is the highest of *all* classes, at 20.6 days. The difference in mean duration is statistically significant when compared with *all* other reporting intervals. As in our previous analysis, we exploit the fact that reluctance to pass the disclosure threshold should be present particularly for positions which approach the threshold from below for the first time. With the sample split, we discover that the pattern of the overall sample is driven entirely by the positions at their record high, for which the maximum duration of 26.0 days is reached in the 0.4 bin, significantly higher than any other class. For positions

below their record high, we find no unusual value for the class just below the publication threshold; instead, the durations decline fairly monotonically with the position value. The same pattern can be observed for median durations: For positions at their record high, the median duration is 10 days for the reporting class just below the publication threshold, significantly higher than any other reporting class. For positions below their record level, on the contrary, durations decline monotonically.

To illustrate the economic magnitude of the duration effect, it is again useful to compare the maximum duration of the 0.4 class with its neighboring classes. The mean duration of 26.0 days is 22% higher than the next lower class (21.3 days), and 55% higher than the next higher class (16.7 days). Taking medians, the results are much alike: The median duration of 10 days is 25% higher than the next lower class (8 days), and 43% higher than the next higher class (7 days).

In summary, investors spend an abnormally long time in the reporting class just below the publication threshold, which is significantly longer than in any other reporting interval. The likelihood of increasing the short position is also the lowest in the reporting class just below the publication threshold. The economic magnitude of these effects is substantial: Compared with the neighboring bins, the duration is 22-55% longer, and the probability of a short position increase is 20-34% lower. These combined results suggest that a considerable share of investors are reluctant to cross the publication threshold.[13]

5 Which characteristics influence the likelihood of crossing the public disclosure threshold?

In the previous section, we uncovered a sizable reluctance to cross the publication threshold. As discussed in Section 2, there are different potential motivations for being secretive about

[13]It is worth noting that these results describe the aggregate behavior of investors around the disclosure threshold. The results are not at odds with the possible existence of individual short-sale campaigns as for example documented by Ljungqvist and Qian (2016).

one's short position, such as borrowing costs, recall risk, cultural or institutional reasons, or the protection of intellectual property. The purpose of this section is to examine these mutually non-exclusive explanations.

Following the discussion in the previous section, we characterize investors' decisions to increase their short positions empirically. In a standard binary outcome model, we construct a dependent variable equal to 1 if a short position increases from one to another bin on two consecutive trading days, and zero otherwise: $y_{i,j,t} = \mathbb{1}\left(SPBIN_{i,j,t} > SPBIN_{i,j,t-1}\right)$. We examine $Pr\left(y_{i,j,t} = 1 | \mathbf{x}_{i,j,t-1}\right)$ for a vector of predictors $\mathbf{x}_{i,j,t-1}$ which we discuss in detail subsequently. We specify the following model:

$$\begin{aligned} y_{i,j,t} \;=\; & \alpha + \beta_0 \; \textit{Just below threshold}_{i,j,t-1} + \gamma_0 \; SPBIN_{i,j,t-1} + \delta' x_{i,j,t-1} \\ & \beta_1' \; \textit{Just below threshold}_{i,j,t-1} \times x_{i,j,t-1} + \gamma_1' SPBIN_{i,j,t-1} \times x_{i,j,t-1} + u_{i,j,t}, \end{aligned} \tag{2}$$

where *Just below threshold* is a dummy variable, indicating the reporting bin just below the publication threshold ($SPBIN = 0.4$). We also control for the size of the position by including the short position bin ($SPBIN$). The vector x describes various stock-specific and investor-specific characteristics that may relate to the likelihood of increasing a short position, as well as variables describing the shorting behavior of other investors.[14] To avoid reverse causality, we lag the stock-specific variables by 20 trading days when estimating the regression model. We are particularly interested in variables that influence the decision to increase a short position, given that the position is close to, but below the publication threshold. To this end, we include interactions of covariates mentioned previously with the *Just below threshold* dummy. Therefore, β_0 represents the baseline reluctance effect, and $\beta_0 + \beta_1' x$ measures the overall reluctance effect, acknowledging that it may depend on observed stock and investor characteristics. Lastly, we also control for the interactions of the explanatory variables with the position size $SPBIN$ and incorporate week fixed effects.

[14] Details about the definitions of each variable and the underlying data sources are in Table A.1 in the Appendix.

To facilitate a straightforward interpretation of the various interaction terms, we adopt a linear probability model instead of the non-linear logit or probit model.[15] Standard errors are clustered on the investor-stock and time level (Petersen, 2009; Thompson, 2011).

Before studying the determinants of reluctance, we first note the results of the benchmark model in Table 5. Model 1 shows a negative coefficient of -0.68 for the *Just below threshold* dummy and a positive coefficient for $SPBIN$. These estimates imply that in the bin just below the publication threshold, the probability of increasing one's position is 37.6% lower than expected, assuming a linear relationship between position size and the probability of an increase. Model 1 captures a reluctance to disclose one's position in a very parsimonious specification, representing the essence of our previous findings.[16]

Model 2 includes additional covariates related to the likelihood of a short position increase. Consistent with the idea that it is difficult to establish the same relative position in larger stocks, market capitalization relates negatively to the probability of an increase. Furthermore, a short seller may be concerned about illiquidity: If stocks are traded less frequently, investors may find it more difficult to cover their position when closing the position or when stocks are recalled. Illiquiditiy measures, the bid-ask spread and the Amihud illiquidity ratio, show the expected negative sign, which is significant for the latter. Moreover, a large supply of stocks to borrow, as suggested by the share of institutional owners (D'Avolio, 2002; Asquith et al., 2005; Nagel, 2005), relates positively to short position increases. As described on page 7, the reported net short positions also include equivalent derivative positions, which are accounted for on a delta-adjusted basis. Thus, derivatives constitute a second channel through which a regulatory net short positions

[15] Assuming the model is correctly specified, both the linear probability model and the logit or probit model provide consistent estimates of the marginal effects, though the logit may be more efficient. The linear probability model allows assessing the contribution of an interaction term to the overall marginal effect in a straightforward manner.

[16] The expected probability can be calculated as follows: $0.84 + 2.42 \times 0.4 = 1.81$. Alternatively, we could include dummy variables for each bin and then compare the 0.4 bin with its neighboring bins. These results yield comparable results. The probability in the 0.4 bin is 0.55 percentage points (pps) lower than in the 0.3 bin (probability: 1.67 pps), and 1.19 pps lower than in the 0.5 bin (probability 2.32 pps), which reflects reductions in likelihood by 33% and 53%, respectively. The estimated coefficient of Model 1 lies within these lower and upper bounds.

can be established. It is not observed through which channel the position is created. However, if futures or listed options for an underlying stock exist, it is presumably easier to establish and increase a net short position. Consistent with this notion, the dummy indicating the existence of futures or listed options yields a positive coefficient. Turning to investor-specific variables, we find that hedge funds and institutions domiciled in Europe are more likely to increase their positions. Finally, short interest, serving as a proxy for overall bad news associated with the stock, is positively associated with the likelihood of a short position increase.

The effect of the covariates may also depend on the level of the short position. Therefore, in Model 3 we additionally include interaction terms with $SPBIN$. Two interesting results emerge: It turns out that the larger the original short position, the greater is the negative impact of illiquidity on the likelihood of increasing the position even further. This effect is present for both the Amihud ratio and the bid-ask spread. Moreover, hedge funds and European investors are more likely to increase their positions further, given that they already hold a large position. Overall, after controlling for a plethora of stock- and investor-specific variables, as well as their interaction with position size, we observe a significantly lower probability of increase just below the publication threshold. Notably, this reluctance effect is of comparable magnitude across all three specifications.

Having established the general determinants of a short position increase, we examine which factors contribute to the likelihood of crossing the disclosure threshold. To this end, we include interactions with the *Just below threshold* dummy, in addition to the variables and interactions considered in Model 3. Referring to our discussion in Section 2, we hypothesize the following signs of these interaction terms. If investors are concerned about rising borrowing costs or recall risk following a short position disclosure, they should be more reluctant to cross the publication threshold for stocks with low institutional ownership and high illiquidity. If institutional ownership is low, the supply of stocks to borrow is low, which results in higher borrowing fees once possible copycat investors follow.

If illiquidity is high, adverse effects from a recall would be more pronounced, due to the higher price impact when buying stocks back from the market. Cultural and institutional reasons for not disclosing a short position may be reflected in the investor type and origin dummies. Specifically, banks might be more concerned about the reputational costs arising from a public short position, because they maintain other business relationships with companies they could short. Given their business model, hedge funds could be less concerned about possible reputational damages. Cultural reasons, such as the negative and unpatriotic image associated with shorting (Lamont, 2012), might prevent domestic investors more than foreign investors from publicizing their position. Finally, investors may be concerned about revealing their private information or proprietary investment strategies. Because generally both are unobservable, this hypothesis is very challenging to test. To identify this channel, our approach is to include two variables as proxies for operational secrecy: a dummy that indicates whether the investor is generally reluctant to file public disclosures and another dummy that indicates whether the investor has ever had a public short position in the past.

Table 6 reports the results of the full model as in Equation (2). For brevity, we focus on the coefficients of interest: β_0 and β_1.[17] Regarding the stock-specific interactions in Column (1), the coefficients for the liquidity proxies and institutional investors are insignificant, providing no support for the borrowing cost hypothesis. That is, even though liquidity proxies influence the decision to increase a short position in general, they do not appear to determine the decision to publicize a position. Investors in the bin just below the threshold seem less likely to increase their position if the stock price is volatile, yet this effect is only marginally significant in the joint model in Column (4).

Turning to the investor-specific variables in Column (2), we find no significant effect for the investor type and country dummies, providing no support for the institutional or cultural hypotheses. A caveat comes from the relatively few banks and German investors

[17] In the Internet Appendix we show the full list of estimated coefficients for this table.

in the sample, though, so that the power of this test is relatively low. The most important investor-specific determinant is whether the investor has a public record somewhere else. This statistically and economically significant variable is associated with a reduction in probability of 1.59 percentage points. If an investor is generally very secretive about its positions, it is very unlikely that it crosses the publication threshold for short positions. In an alternative specification in Column (3), we include a dummy variable that indicates if an investor ever had a public short position in the past. This variable is an even better predictor of whether the investor is willing to cross the publication threshold. These two variables are clearly related, as the joint model of Column (5) reveals. The coefficients of the two variables slightly decrease when estimating their effect jointly, yet both variables remain economically and statistically significant. The effects of these secrecy proxies are substantial, given that the unconditional probability of increasing the position, is about 2%. These findings are broadly in line with the intellectual property hypothesis. At the very least, they reveal that investors who are generally secretive about their trading behavior in the past, are also reluctant to reveal their short position to the public. In contrast, short interest and whether other investors have a public short position do not seem to determine the decision to cross the publication threshold.

Overall, the results suggest that investor-specific characteristics determine the probability to publicize a short position rather than stock-specific characteristics.[18] In particular, the decision to cross the disclosure threshold appears to be persistent, with investors sticking to their secretive behavior over time.

[18] In a supplementary regression analysis (not shown), we restrict the sample to the 0.4 bin and separately include investor- and stock-specific fixed effects. The investor fixed effects model results in an adjusted R^2 of 4.1%, whereas with stock fixed effects the R^2 is 1.2%, suggesting that investor-specific characteristics are more informative about the decision to cross the disclosure threshold than stock-specific characteristics.

6 Implications for stock prices

6.1 Calendar time portfolio approach

A considerable fraction of investors are reluctant to cross the disclosure threshold; in this section we analyze the effects of their reluctance on asset prices. Following the theoretical arguments of Miller (1977) and others, we expect stocks to be overpriced during the period when these short-sale constraints are binding. In Figure 1, the constraint is binding during t_0 to t_1, such that the investor would have a higher short position if the publication threshold were not present.

The counterfactual is unobservable, so we rely on the following empirical strategy to identify potentially constrained investors:

$$\textit{Potentially constrained}^{\textit{ex-post}}_{i,j,t} = \begin{cases} 1 & \text{if } \left(\max_{s=1,2,\ldots,T_{i,j}} SPBIN_{i,j,s} = 0.4\right) \cap \left(SPBIN_{i,j,t} = 0.4\right) \\ 0 & \text{otherwise.} \end{cases} \tag{3}$$

This approach identifies the necessary conditions for the constraint to be binding. First, constrained investors do not cross the publication threshold, so the maximum bin reached is the 0.4 bin. Thus, for each investor-stock pair, we determine (ex post) the maximum reporting interval reached during the sample period. Second, the constraint is only binding when the position is in the maximum bin of 0.4, just below the threshold. Thus, we flag the investor-stock pair if it has a maximum reporting bin of 0.4 and this maximum has been reached. We denote a stock as potentially short-sale constrained if there is at least one investor for which the publication threshold is potentially binding.

This procedure can only identify situations in which the publication threshold *potentially* inflicts short-sale constraints on investors. However, the measure is diluted by situations in which the constraint is not binding. First, and most importantly, not having crossed the disclosure threshold does not necessarily mean the investor is constrained. Naturally, there are some investors with positions for which the maximum bin of 0.4 is optimal.

These positions are included in our measure, even though these investors are not reluctant. Second, we define an investor as constrained as soon as it reaches the 0.4 bin, not, as depicted in Figure 1, during the period t_0 to t_1, which also may add noise to our measure. Importantly, though, both effects work against finding an overpricing effect.

In addition to the ex-post measure of potentially constrained investors, we also construct an ex-ante measure:

$$\textit{Potentially constrained}^{\textit{ex-ante}}_{i,j,t} = \begin{cases} 1 & \text{if } (\max_{s \leq t} SPBIN_{i,j,s} = 0.4) \cap (SPBIN_{i,j,t} = 0.4) \\ 0 & \text{otherwise} \end{cases} \tag{4}$$

that uses the running maximum bin instead of the ex-post maximum reporting bin. Therefore, a position is characterized as reluctant if it reaches the 0.4 bin and the 0.4 bin is the running maximum. The ex-ante measure of constrained investors is less powerful than the ex-post measure for testing overpricing, because some investors are initially falsely characterized as reluctant. These investors have not crossed the disclosure threshold, up to a certain point in time, but eventually do so. Comparing the ex-ante with the ex-post measure at the investor-stock level, we calculate that 23.4% of the position-days are falsely characterized by the ex-ante measure as constrained.

If the publication threshold represents a short-sale constraint for some investors, we expect these stocks to be overpriced, such that we should observe a lower return thereafter. To test the overpricing hypothesis, we employ a calendar time portfolio approach. In a first step, we form, on a daily basis, an equal-weighted portfolio of stocks for which we observe at least one potentially constrained investor on the previous day.[19] In a second step, we measure the performance of the potentially constrained stocks by running a time-series regression of the portfolio returns on different risk factors. We employ the Capital Asset

[19]For the majority of these stocks (82%) there is only one potentially constrained investor. In 14% there are two, in the remaining 4%, three to a maximum of six potentially constrained investors. The portfolio based on the ex-post measure contains 32 potentially constrained stocks on average, with a median of 31, a minimum of 21, and a maximum of 49 stocks. The number of stocks characterized as potentially constrained by the ex-ante measure is around 19% higher.

Pricing Model (CAPM) by Sharpe (1964) and Lintner (1965), the Fama and French (1993, 1996) three-factor model, and the Carhart (1997) four-factor model. To estimate standard errors, we follow Newey and West (1987), with the lag length selected according to the optimal lag-selection algorithm proposed by Newey and West (1994).

Table 7 shows the results of the calendar time portfolio approach. The ex-post measure for potential short-sale constraints inflicted by the publication threshold (Columns (1)-(3)) reveals a strong, statistically significant underperformance. The underperformance is robust across the CAPM, three-factor model and four-factor model, with daily alpha values ranging between -4.82 and -5.42 bps, which translates into an underperformance of around 1% per month.[20] When comparing Columns (1)-(3) with (4)-(6), it becomes apparent that the performance of the ex-ante measure is slightly lower than the performance of the ex-post measure. This is not surprising owing to the aforementioned lower power of the ex-ante test. Essentially, the ex-ante method misclassifies non-constrained investors as constrained, which adds noise to the measure. Nevertheless, the ex-ante measure of short-sale constraints still yields an economically large and statistically significant level of underperformance, ranging between -4.52 and -5.09 bps per day.

Economically, the overpricing effect inflicted by the publication threshold is substantial, especially considering that these short position notifications almost exclusively take place in highly liquid, large-cap stocks (see Table 1 and Section 3). Recall that the measure for identifying constrained investors is diluted considerably by noise. Thus, the estimated overpricing effect of around 5 bps per day likely represents a lower bound.[21] The magnitude of overpricing due to short-sale constraints is in line with estimates from prior literature. For example, Jones and Lamont (2002) show that stocks that are expensive to short have

[20] In our data, the median time period for which a position is potentially constrained is 16 days, the mean duration is 41 days. To reflect this fact and to make our results comparable with other studies, we express the abnormal return on a monthly basis. The factor loadings (market beta greater than 1 and a positive exposure to SMB and HML) are in line with the results of Jank and Smajlbegovic (2015), who use a comparable sample of European public short-sale disclosures.

[21] In Section 7.1 we also incorporate our findings from the linear probability model to better filter reluctant investors from non-reluctant investors more efficiently.

a monthly abnormal return of around -1%. Cohen et al. (2007) find an underperformance of -3% per month from high short-sale constraints. Lamont (2012) documents a monthly abnormal return of around -2% for firms that induce short-sale constraints by taking anti-shorting actions. Even though the negative abnormal return of our study is in the same ballpark as previous findings, it is also remarkably high, considering that the constraint is merely evoked by investors seeking to avoid disclosing their position.

6.2 Placebo tests

Our finding of abnormal negative returns when short sellers hold positions just below the disclosure threshold is consistent with the notion of short-sale constraints originating from the reluctance of investors. However, to show that the effect is unique to the disclosure threshold and to rule out other potential explanations, we employ several placebo tests.

First, we conduct an analysis similar to the one in Section 6.1 and form calender time portfolios. However, now we choose hypothetical publication thresholds below and above the true one:

$$\text{Placebo}^{A}_{i,j,t} = \begin{cases} 1 & \text{if } \left(\max_{s=1,2,\ldots,T_{i,j}} SPBIN_{i,j,s} = p\right) \cap \left(SPBIN_{i,j,t} = p\right) \\ 0 & \text{otherwise.} \end{cases} \tag{5}$$

where $p = 0.2,\ 0.3,\ 0.5,\ 0.6$. Specifically, we look at positions when they reach their maximum, but with a maximum other than 0.4. As before, we include the stock in the placebo portfolio if at least one investor-stock observation fulfills the condition in Equation (5). With this exercise, we rule out that the negative return reported in the previous section is a finding present when short positions *generally* reach their maximum. If the publication threshold truly constitutes a short-sale constraint, we should find subsequent underperformance only for stocks with investors present in their 0.4 maximum interval, but not for the other intervals. Panel A of Table 8 reports the risk-adjusted average returns for different maximum reporting bins, using the same factor models as in

the previous analysis. Consistent with our hypothesis that binding short-sale constraints are imposed by the publication threshold, we find that stocks with investors in a maximum reporting bin other than 0.4 do not significantly underperform. Even the average return for the closest non-public maximum reporting bin, 0.3, is not significantly negative, and its economic magnitude is only one-fourth of the return associated with the 0.4 bin. These results suggest that the return effect is unique to stocks with investors that hold a position just below the disclosure threshold and cannot be generalized to other positions.

In the next step, we analyze the return of positions with a maximum bin of 0.4 but during the period below the maximum bin:

$$\text{Placebo}^{B}_{i,j,t} = \begin{cases} 1 & \text{if } \left(\max_{s=1,2,\ldots,T_{i,j}} SPBIN_{i,j,s} = 0.4\right) \cap \left(SPBIN_{i,j,t} < 0.4\right) \\ 0 & \text{otherwise.} \end{cases} \tag{6}$$

Comparing the return of the same short position inside and outside the maximum interval, we are able to control for any investor-stock-specific unobservable factors. In other words, if the negative abnormal return in the maximum bin of 0.4 is a result of overpricing due to reluctance, we would expect that there is no negative return below the maximum bin of 0.4, when the short-sale constraint is not binding. The shaded column in Panel B of Table 8 shows that for positions with a maximum interval of 0.4, the average risk-adjusted return generated below this maximum interval is not statistically different from zero. Moreover, in Panel C, we compute the difference between the return generated inside and outside the maximum bin. The return during the time just below the publication threshold is significantly lower relative to the time when the investor is not reluctant. This result is in line with the overpricing hypothesis and holds across all factor models.

What does the pattern look like for positions with other maxima? Interestingly, *none* of the other maximum reporting bins show a pattern similar to the interval just below the disclosure threshold. Namely, only for positions with a maximum of 0.4 we do observe that the return in the maximum bin is negative *and* significantly lower than the return of the

same positions below the maximum bin. For all other bins, the average daily return below the maximum interval is even more negative than the return in the maximum bin. Overall, the stark contrast between the results associated with the bin just below the publication threshold and all other intervals is difficult to reconcile with any explanation other than overpricing originating from investors' reluctance to cross the publication threshold.

7 Further Analyses

7.1 Regression approach and refined measures of short-sale constraints

As discussed in Section 6.1, our proposed measure is only a noisy proxy for the short-sale constraints evoked by the disclosure rule. The measure of potential short-sale constraints captures some investors constrained by the threshold. But it also captures unconstrained investors, for which the position in the 0.4 maximum bin is actually optimal. In this section, we seek a means to filter out truly reluctant investors from non-reluctant investors. To this end, we exploit our findings from the linear probability model about which characteristics influence investors not to cross the publication threshold.

The main findings from the linear probability model of Section 5 is that the two investor-specific secrecy proxies mainly determine whether an investor is reluctant to cross the publication threshold. Using these insights, we construct two refined proxies for short-sale constraints. First, we compute our potentially constrained measure as before, see Equations (3) and (4). Then, we also condition on (a.) positions of investors without a public record elsewhere, and (b.) positions of investors who never crossed the publication threshold in the past. If the two variables are truly related to reluctance, they should better filter out reluctant from non-reluctant positions which, in turn, should result in a more pronounced overpricing effect.

We test this hypothesis using a Fama and MacBeth (1973) cross-sectional predictive regression, which at the same time serves as a robustness check to the calendar time

portfolio approach. For each trading day, we perform a cross-sectional regression of the next day's returns on different measures for short-sale constraints and various control variables related to the cross-section of returns. To account for systematic risk and the well-known size, value, short-term reversal, and momentum effects in returns (Banz, 1981; DeBondt and Thaler, 1985; Jegadeesh, 1990; Lehmann, 1990; Jegadeesh and Titman, 1993), we include the stocks' beta, log market capitalization, log book-to-market ratio, and past return over different horizons as control variables. To isolate the short-sale constraint of the publication rule, we also control for the short interest of the stock, which prior literature has related to stock returns (e.g., Senchack and Starks, 1993; Desai, Ramesh, Thiagarajan and Balachandran, 2002; Asquith et al., 2005). Furthermore, we control for institutional ownership in the stock, which serves as a proxy for the supply of shares to borrow (D'Avolio, 2002; Asquith et al., 2005; Nagel, 2005).

Table 9 displays the average coefficient estimates and standard errors, following the procedure of Fama and MacBeth (1973). Columns (1) and (2) provide the results of the previously used 0.4 maximum bin dummy, serving as our benchmark model. Stocks for which the short-sale constraint inflicted by the threshold is likely to be binding underperform in the following by 7.33 to 7.67 bps per day. These results are even more pronounced than those of the calendar time portfolio approach (around 5 bps per day). The control variables exhibit the expected signs. The market capitalization coefficient is negative and the book-to-market coefficient is positive. At a daily frequency, short-term reversal effects are strong and the momentum effect (return from t-20 to t-249) is positive but insignificant. Beta, short interest and institutional ownership are insignificant in our sample.

Next, we turn to the refined measures of binding short-sale constraints. In Columns (3) and (4), we focus on positions in the 0.4 bin that also originate from investors without any public record. As hypothesized, the underperformance of these stocks is greater, ranging between -22.91 and -30.07 bps per day (ex-ante and ex-post measures). Positions in the 0.4

bin that originate from investors that have never had a public short position notification are in Columns (5) and (6). This refined measure yields a more pronounced underperformance than the benchmark, ranging between -10.02 and -11.04 bps per day (ex-ante and ex-post measures). Together, these results confirm the notion that the original measure represents merely a conservative lower bound of the overvaluation effects inflicted by the transparency requirement. The results also provide a good consistency check regarding the determinants of investors' decisions to disclose their short positions.

7.2 Are secretive investors better informed?

The results so far show that the choice to disclose or not to disclose short positions is persistent, with investors sticking to their decision. Secretive investors may be concerned about protecting their private information or their proprietary investment strategies. In the following, we explore this intellectual property hypothesis by comparing the ex-post shorting performance of secretive investors with that of non-secretive investors. If non-disclosure is generally associated with superior information, secretive investors should perform better on average than non-secretive investors.

For our test we first split the sample of investors into secretive and non-secretive investors. We define investors as secretive if they never had a public short position in our sample, but reached the 0.4 bin at least once, i.e. these investors stayed just below the radar. Investors are defined as non-secretive if they had a public short position at least once in our sample. In the second step, we compare the two investor groups' performance in short positions that were never public or constrained by the disclosure threshold. That is, we only look at the performance of short positions with a maximum value of 0.2 or 0.3. This procedure ensures that we compare short positions of a similar magnitude. Secretive investors, as defined above, do not have any public positions, so we focus on the confidential positions. Moreover, to prevent positions constrained by the disclosure threshold from driving our results, we omit positions with a maximum value of 0.4.

To compare their performance, we form two equal-weighted portfolios of stocks originating from secretive and non-secretive investors. A stock is included in the portfolio if the respective investor established a short position greater than 0.20% the day before, and the stock is excluded from the portfolio if the investor's position fell below 0.20% the day before. This conservative timing convention assumes that investors trade at the end of each day. Finally, to estimate abnormal returns of the two portfolios, we employ various factor models, which are discussed in detail in Section 6.1.

The results of the performance comparison are shown in Table 10. As can be seen from Panel A, short positions of secretive investors have a negative alpha of -4 to -5 bps per day, which is statistically significant for the Fama-French and Carhart models. In contrast, short positions of non-secretive investors have a negative alpha of around -1 bp per day, which is not significantly different from zero. Accordingly, secretive investors on average outperform their peers by around 3 to 4 bps per day. The outperformance is robust across all factor models and statistically significant at the 5% (CAPM and Fama-French model) and 10% level (Carhart model). In Panels B and C, we split the sample in positions with a maximum value of 0.3 and 0.2. The outperformance of secretive investors is particularly strong for larger short positions, with a return differential of -6 to -7 bps per day, as shown in Panel B. Although it is less pronounced, a similar pattern emerges for the smaller positions shown in Panel C. Secretive investors have a negative alpha, while non-secretive investors actually have a positive alpha. The difference is not statistically significant, but economically sizable, ranging between -2 and -3 bps.

Overall, the results show that positions of secretive investors outperform those of non-secretive investors, which suggests that the concealment of positions is associated with superior information. This finding provides additional support for the hypothesis that intellectual property concerns play an important role in the decision not to disclose short positions.

7.3 Additional robustness checks

In this section we briefly summarize various robustness checks to our analysis. For a detailed description of all additional tests and their results, we refer the reader to the Internet Appendix.

First, we conduct different sensitivity analyses related to the existence of investors' reluctance to cross the disclosure threshold. In Section 4 we document that reluctance is particularly pronounced when investors approach the publication threshold from below *and* for the first time. Specifically, we rely on a sample split of positions at their record high vs. positions below their record high. In the Internet Appendix we show that an alternative sample split, in which positions are simply divided into previously increased and previously decreased, yields comparable results. This measure is much simpler but noisier given that it solely relies on investors last change of the position instead of the entire position history.

One potential concern with the results in Section 4 is that the reduced probability of increase in the bin just below the publication threshold stems from changes in stock or investor characteristics that coincide with its phase in that bin. To rule out such confounding effects, we conduct panel regressions with progressively saturated fixed effects in spirit of Jiménez, Ongena, Peydró and Saurina (2014). Even in our most saturated specification when we control for time-varying observed or unobserved investor *and* stock characteristics, we document significant reluctance to cross the publication threshold of similar if not stronger economic magnitude.

When studying determinants of both position increase and of reluctance in Section 5, we choose a linear probability model because of simplicity. In additional analyses, we show that the marginal effects of logit or probit models are very similar to those of the linear model.

We also conduct a series of sensitivity analyses related to the overpricing effect from Section 6. First, we apply several modifications to our calendar-time portfolio approach.

The overpricing effect is comparable when excluding penny stocks, requiring at least five trading days in the 0.4 bin, weighting the stocks by the number of potentially constrained short sellers, and also when using European instead of German factor portfolios. Second, the finding of overpriced stocks when short sellers are potentially reluctant to pass the publication threshold holds when including various additional stock- and investor-specific controls in the Fama and MacBeth (1973) predictive regression. Specifically, in addition to the variables in Table 9, we also control for liquidity, analyst coverage, the existence of a short position held by a secretive investor and industry fixed effects.

8 Conclusion

Using both public and confidential short-sale notifications, we study the effect of a disclosure threshold for short positions on investors' behavior and security prices. We document that a considerable fraction of short sellers are reluctant to cross the disclosure threshold, effectively representing a short-sale constraint for these investors. When the short-sale constraint imposed by the disclosure threshold is potentially binding, stocks subsequently exhibit a negative abnormal return, consistent with the notion of overpricing. These findings suggest that short sellers' evasive behavior in response to the transparency regulation imposes a negative externality on the informational efficiency of stock prices.

The documented effect originates from investors' reluctance to cross the publication threshold. Additionally, in the spirit of Grossman and Stiglitz (1980), the short-sale disclosure rule may also diminish the incentive to collect and process information in the first place. As a consequence, overall shorting activity may decrease, presumably resulting in an even greater reduction of stock price efficiency.

Our insights contribute to the ongoing policy debate on the requirement and design of short-sale disclosure rules. The EU short-sale transparency regulation is characterized by a public disclosure threshold of 0.5% of the stocks' market capitalization and a very timely publication delay period of one day. Regulators are also discussing different reporting

regimes, with alternative thresholds, longer delay periods, or different regimes altogether. The strong evidence of investors' reluctance to reveal their short positions is of great importance for defining future transparency requirements. Thus, our findings advocate a better understanding of the incentives and consequences of disclosure requirements, both in theoretical and empirical work. To what degree modified disclosure rules help to attenuate the information-revealing effects of disclosure remains an open question for future research.

Appendix: Sample construction

We obtain public and confidential short-sale notifications from the German Federal Financial Supervisory Authority (BaFin). BaFin's notification data include the position holder's name, address and country, the name and ISIN code of the stock shorted, the net short position in number of equivalent shares and as a percentage of share issued capital, and the position and reporting date. To construct a panel of investors' short positions in different stocks we first account for the ISIN changes of the stocks. Next, we convert the original short-sale notifications into reporting intervals of 10 basis points by rounding down to the first decimal place, as we described in Section 2.1. We delete duplicate notifications (same information in all variables). For a few days, we find multiple short-sale positions for the same investor-stock pair. For these days, we keep the most recent one (identified by the reporting date), which is likely to represent corrections of the previous values. We omit some stale positions, which seem to occur disproportionably in the first days after the regulation was put in place. We define a stale position as a position which has been reported only once, has never changed, and is still open after 600 days.[22] From the notifications, we construct a large daily panel of investors' short positions in different stocks. Finally, we identify trading days from the official trading calendar of Frankfurt Stock Exchange.

We merge the BaFin panel of short positions with stock-level data (static characteristics and time-series data, such as price, return, and market value data) from *Thomson Reuters Datastream* using current ISIN codes. We only consider domestic common equity in the regulated market. Thus, we keep stocks categorized by *Datastream* as domiciled in Germany (variable GEOG = 30), equity (variable TYPE = EQ) and major issuance (variable MAJOR = Y). Moreover, we exclude preferred stocks, depositary receipts, real estate investment trusts, and stocks with other special features by screening the stocks' names. We filter out all stock day observations of delisted stocks, which are not trading

[22] Other cut-off points, such as 500 or 250 days, lead to similar results.

any more (variable $P\#T$ = missing value). We only keep shares admitted to trading on the German regulated market, using the information provided by the MiFID database of ESMA.[23]

Noting Ince and Porter's (2006) concerns about return data from *Datastream*, we apply the following filters for daily return data, as proposed by Karolyi et al. (2012) and Griffin et al. (2010): The return ($r_t = (RI_t/R_{t-1}) - 1$, where RI is the dollar return index) is set to missing if the current or lagged total return index (RI) is below 0.01. If r_t or $r_{t-1} > 100\%$ and $(1 + r_{t-1})(1 + r_t) - 1 < 20\%$, then both r_t and r_{t-1} are set to missing. Moreover, any return greater than 200% is set to missing.

To gather additional information on the position holders, we manually research the corresponding unique investor identification number from *FactSet*, using the position holder's name, address, and country information from the BaFin notification data. For the identified investors, we then obtain investor characteristics such as the investor type.

We obtain the risk-free rate (RF), the market excess return (MKTRF), and the returns on the factor portfolios small-minus-big (SMB), high-minus-low (HML), and winner-minus-loser (WML) for the German stock market from Andrea Frazzini's data library, provided through AQR's website.[24]

The detailed computation and data sources of all variables used in the analysis are in Table A.1.

[23] http://mifiddatabase.esma.europa.eu/Index.aspx?sectionlinks_id=14&language=0&pageName=MiFIDLiquidSearch

[24] See: www.aqr.com/library/data-sets/quality-minus-junk-factors-daily/data

Table A.1:
Definitions of variables

Variable:	Description:	Source:
Market capitalization	Market capitalization (in USD million) provided by the Datastream variable MV.	Datastream
Book-to-market ratio	Calculated as $PTBV^{-1}$, where PTBV is the price-to-book value provided by Datastream. The book-to-market ratio is set to missing if it is below 0.	Datastream
Bid-ask spread	$(PA - PB)/P$, expressed in percentage terms, where P is the stock's price, PA is the ask price, and PB is the bid price, all provided by Datastream. We winsorize the bid-ask spread at 1% at the upper tail and then average it over the last 60 trading days, requiring at least 10 valid observations.	Datastream
Amihud illiquidity	$\|r_t\|/(VO \times P) \times 10^6$, where r_t is the return, VO is the number of shares traded (in thousands), and P is the price (Amihud, 2002). We winsorize the Amihud illiquidity ratio at 1% at the upper tail and then average it over the last 60 trading days, requiring at least 10 valid observations.	Datastream
Return volatility	Standard deviation of return r_t computed over the last 60 trading days, requiring at least 10 valid observations.	Datastream
Institutional ownership	Percentage share of institutional investors from the previous quarter provided by Factset (Variable: OS_SEC_PCT_HLD_INST).	Factset
Futures or listed options	Dummy variable that equals 1 if futures or listed options exist for the underlying stock.	Datastream
Hedge fund	Dummy variable that equals 1 if investor is defined by Factset as a hedge fund.	BaFin, Factset
Bank	Dummy variable that equals 1 if investor is a bank.	Own research
European holder	Dummy variable which equals one if investor is domiciled in an European country.	BaFin
German holder	Dummy variable that equals 1 if investor is domiciled in Germany.	BaFin

Continued on next page

Table A.1 – *Continued from previous page*

Variable:	**Description:**	**Source:**
No public filings	Dummy variable that equals 1 if investor is not included in the Factset Ownership database. The ownership information of Factset originates from public filings, so a non-appearance is indicative of no public record.	BaFin, Factset
No public short position	Dummy variable that equals 1 if an investor has never had a public short position in the past. The variable is set to one if the investor has ever had a public short position.	BaFin
Short interest	We aggregate the short positions of all investors for each stock per day to obtain a proxy for the short interest.	BaFin
Disclosure by others	Dummy variable that equals 1 if at least one other investor has a public short position disclosure.	BaFin
Market beta	Slope coefficient of the time series regression of the stock's return the market excess return (MKTRF), with a rolling window of 300 trading days.	Datastream, Frazzini

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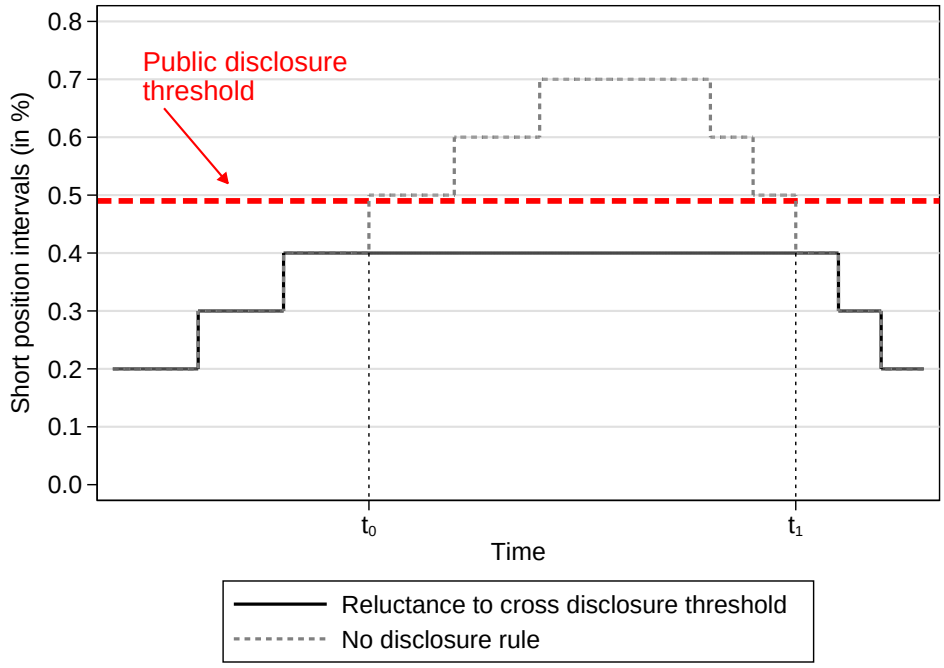
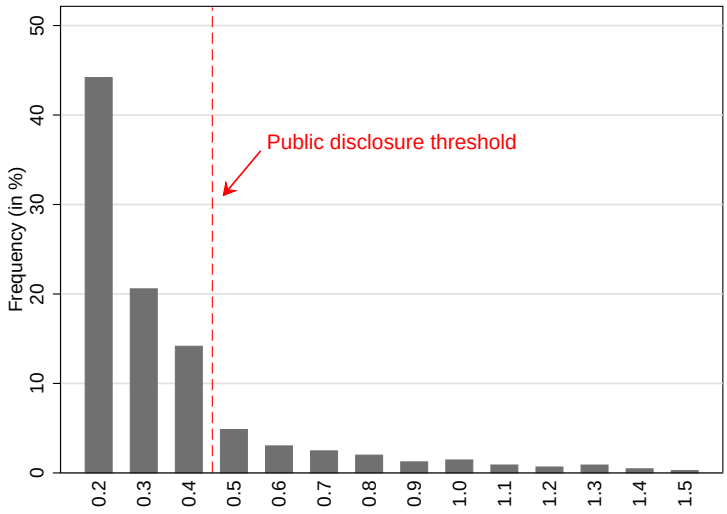


Figure 1:
Stylized development of a short position over time

This figures shows the stylized development of a short position over time. The level of the short position as a percentage of total shares outstanding is grouped into 10 bps bins, because the actual data are reported in these intervals. The 0.2 reporting interval ranges from 0.20 to 0.29%, the 0.3 interval from 0.30 to 0.39%, the 0.4 interval from 0.40 to 0.49%, and so forth. The red, dashed, horizontal line indicates the public disclosure threshold of 0.5%. The gray dashed line shows the development of the short position, if there is no disclosure rule in place. The black solid line shows the development of the short position if a disclosure rule is present and the investor does not want to disclose its position. The time from t_0 to t_1 is the period in which the short-sale constraint inflicted by the publication threshold is binding.

(a) Overall sample



(b) Sample split

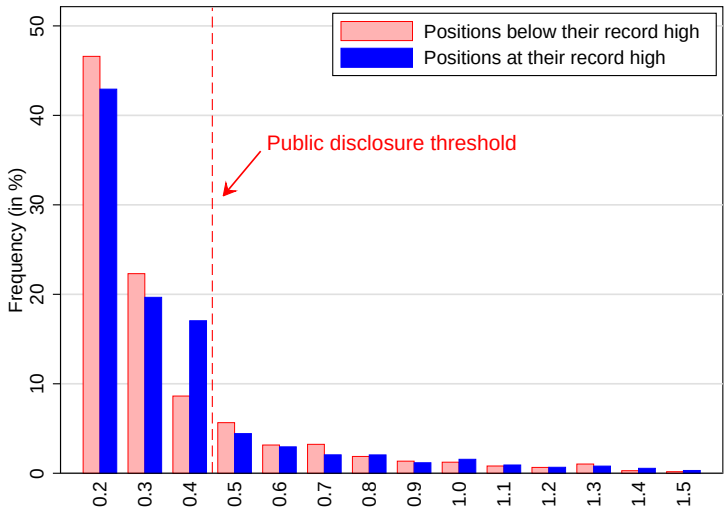


Figure 2:
Distribution of open short positions

This figure displays the distribution of days with open short positions across reporting intervals. Reporting intervals are in 10 bps steps, starting from 0.2%. Positions above 0.2% but below 0.5% are reported to the regulator but not disclosed to the public; positions of 0.50% and higher are disclosed to the public. Figure 2(a) shows the relative frequency of days with an open position for each interval for the overall sample. Figure 2(b) reports the relative frequency separately for short positions at their record high and for positions below their record high. Reporting intervals greater than 1.6% are truncated for readability. The sample contains all German domestic equity in the regulated market from November 5, 2012, to March 31, 2015.

Table 1:
Summary statistics: Stocks with short position notifications vs. all stocks

This table shows summary statistics for the various stock characteristics of stocks with at least one short position notification and for all stocks in the regulated market. Short positions must be reported to the regulator if the position is greater than or equal to 0.2% of the issued share capital of the company shorted and publicly disclosed if the position is greater than or equal to 0.5%. Column (1) contains the summary statistics for the entire population of stocks in the German regulated market, Column (2) reports stocks that have at least one public or confidential short postilion notification, Column (3) includes stocks with at least one public short position, and Column (4) refers to stocks with at least one confidential short position notification. The table reports time-series averages of cross-sectional medians. The sample consists of common equity in the German regulated stock market from November 5, 2012, until March 31, 2015. For details on the calculation of the stock characteristics, see Table A.1.

	(1)	(2)	(3)	(4)
	All stocks	Stocks with short position notifications		
		All	Public	Confidential
Share of stocks		19.9%	8.3%	11.6%
Median values:				
Market value (in USD million)	102.1	2225.3	1986.6	2401.2
Book-to-market ratio	0.65	0.53	0.55	0.52
Institutional ownership (in %)	3.9	29.2	29.8	29.0
Relative bid-ask spread (in %)	3.11	0.65	0.66	0.63
Amihud illiquidity ($\times 10^6$)	2082.7	223.3	223.9	229.4
Return volatility (in %)	2.28	1.81	2.00	1.71

Table 2:
Summary statistics

This table contains summary statistics for the investor-stock panel with open short position notifications above 0.2% of the issued share capital. The summary statistics include the number of observations (N), mean, standard deviation (SD), and the 10th, 25th, 50th, 75th and 90th percentiles. The sample consists of common equity in the German regulated stock market from November 5, 2012, until March 31, 2015. For details on the calculation of the variables, see Table A.1.

				Percentiles:				
Variable	N	Mean	SD	10th	25th	50th	75th	90th
ln(Return volatility)	278,648	0.70	0.38	0.25	0.44	0.68	0.92	1.16
ln(Market value)	278,649	7.63	1.41	5.78	6.74	7.66	8.58	9.26
ln(Amihud illiquidity)	278,624	5.08	1.31	3.23	4.29	5.19	5.94	6.66
ln(Bid-ask spread)	278,648	-0.43	0.53	-1.05	-0.86	-0.40	-0.08	0.21
Institutional ownership	278,475	34.37	17.50	13.08	21.93	31.50	45.81	61.21
Futures or listed options	278,649	0.38						
Hedge fund	278,649	0.66						
Bank	278,649	0.02						
European holder	278,649	0.47						
German holder	278,649	0.02						
No public filings	278,649	0.10						
No public short position	278,649	0.23						
Short interest	278,649	4.07	3.70	0.57	1.37	2.90	5.75	9.41
Disclosure by others	278,649	0.61						

Table 3:
Probability of short position increase

This table shows the estimated probability of increasing a short position, conditional on currently having a position in a specific reporting bin. Short positions are reported in bins of 10 bps, starting from 0.2% of issued share capital of the company shorted. Positions above 0.2% but below 0.5% are reported to the regulator but not disclosed to the public; positions of 0.5% and higher are disclosed to the public. The 0.2 bin denotes the bin ranging from 0.20% to 0.29%, the 0.3 bin from 0.30% to 0.39%, the 0.4 bin from 0.40% to 0.49%, and so forth. Reporting bins greater than or equal to 1.0% are summarized in one group. The table reports the probability of increasing a short position (i.e., changing to a higher reporting bin), given that an investor currently has a position in a specific bin. In addition, it displays the difference in probability of row (3) relative to row (j), the 0.4 reporting bin just below the publication threshold (shaded in gray), and the p-value for the differences in means. The table displays probabilities for the overall sample and for two subsamples, in which we split the sample into short positions at their record high and into positions below their record high. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

				Overall			Positions at their record high			Positions below their record high		
			Bin	Probability of increase	Difference row (3) - (j)	p-value	Probability of increase	Difference row (3) - (j)	p-value	Probability of increase	Difference row (3) - (j)	p-value
undis-	closed	(1)	0.2	0.364	−0.010	(0.469)	0.347	−0.010	(0.581)	0.380	−0.001	(0.947)
		(2)	0.3	0.391	−0.037**	(0.014)	0.423	−0.085***	(0.000)	0.360	0.018	(0.416)
		(3)	0.4	0.354			0.338			0.379		
	disclosed	(4)	0.5	0.408	−0.054***	(0.007)	0.514	−0.176***	(0.000)	0.302	0.076***	(0.009)
		(5)	0.6	0.476	−0.122***	(0.000)	0.562	−0.225***	(0.000)	0.395	−0.017	(0.624)
		(6)	0.7	0.440	−0.086***	(0.001)	0.604	−0.266***	(0.000)	0.308	0.071**	(0.048)
		(7)	0.8	0.449	−0.095***	(0.001)	0.648	−0.310***	(0.000)	0.266	0.113***	(0.006)
		(8)	0.9	0.477	−0.123***	(0.000)	0.702	−0.364***	(0.000)	0.279	0.100**	(0.032)
		(9)	≥1.0	0.474	−0.120***	(0.000)	0.682	−0.345***	(0.000)	0.275	0.103***	(0.000)

Table 4:
Duration within reporting bins

This table shows the average duration spent in each disclosure bin. Short positions are reported in bins of 10 bps, starting from 0.2% of issued share capital of the company shorted. Positions above 0.2% but below 0.5% are reported to the regulator but not disclosed to the public; positions of 0.5% and higher are disclosed to the public. The 0.2 bin denotes the bin ranging from 0.20% to 0.29%, the 0.3 bin from 0.30% to 0.39%, the 0.4 bin from 0.40% to 0.49%, and so forth. Reporting bins greater than or equal to 1.0% are summarized in one group. The table reports the mean and median number of trading days spent in each disclosure bin (Panels A and B, respectively). In addition, it displays the difference in mean (median) duration of row (3) relative to row (j), the 0.4 reporting bin just below the publication threshold (shaded in gray), and the p-value for differences in means (medians). Each panel displays probabilities for the overall sample and for two subsamples, in which we split the sample into short positions at their record high and into positions below their record high. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Mean duration within reporting bin in trading days

			Overall			Positions at their record high			Positions below their record high		
		Bin	Mean duration	Difference row (3) - (j)	p-value	Mean duration	Difference row (3) - (j)	p-value	Mean duration	Difference row (3) - (j)	p-value
undisclosed	(1)	0.2	18.3	2.2**	(0.019)	22.3	3.6**	(0.012)	14.0	−2.4**	(0.039)
	(2)	0.3	17.0	3.6***	(0.000)	21.3	4.6***	(0.002)	12.6	−1.0	(0.376)
	(3)	0.4	20.6			26.0			11.7		
disclosed	(4)	0.5	14.3	6.2***	(0.000)	16.7	9.3***	(0.000)	11.8	−0.1	(0.919)
	(5)	0.6	13.7	6.8***	(0.000)	17.4	8.5***	(0.001)	9.9	1.8	(0.238)
	(6)	0.7	13.3	7.3***	(0.000)	15.8	10.1***	(0.001)	11.2	0.5	(0.772)
	(7)	0.8	13.6	7.0***	(0.001)	17.2	8.8***	(0.008)	10.0	1.6	(0.379)
	(8)	0.9	11.9	8.7***	(0.000)	14.1	11.8***	(0.002)	9.7	2.0	(0.355)
	(9)	≥1.0	12.6	8.0***	(0.000)	16.6	9.4***	(0.000)	8.6	3.1***	(0.004)

Table 4 – Continued

Panel B: Median duration within reporting bin in trading days

				Overall			Positions at their record high			Positions below their record high		
			Bin	Median duration	Difference row (3) - (j)	p-value	Median duration	Difference row (3) - (j)	p-value	Median duration	Difference row (3) - (j)	p-value
undis-	closed	(1)	0.2	6	1***	(0.004)	7	3***	(0.000)	5	0	(0.182)
		(2)	0.3	6	1***	(0.003)	8	2***	(0.007)	5	0	(0.824)
		(3)	0.4	7			10			5		
	disclosed	(4)	0.5	5	2***	(0.000)	7	3***	(0.004)	4	1	(0.364)
		(5)	0.6	5	2***	(0.000)	6	4***	(0.000)	4	1	(0.331)
		(6)	0.7	4	3***	(0.000)	4	6***	(0.000)	4	1	(0.278)
		(7)	0.8	4	3***	(0.000)	5	5***	(0.000)	3	2***	(0.009)
		(8)	0.9	4	3***	(0.000)	5	5***	(0.000)	3	2*	(0.053)
		(9)	≥1.0	4	3***	(0.000)	5	5***	(0.000)	3	2***	(0.000)

Table 5:
Characteristics influencing the probability of increasing a short position

This table shows estimates from the linear probability model

$$\begin{aligned} y_{i,j,t} \quad = \quad & \alpha + \beta_0 \, \textit{Just below threshold}_{i,j,t-1} + \gamma_0 \, SPBIN_{i,j,t-1} + \delta' x_{i,j,t-1} \\ & \gamma_1' SPBIN_{i,j,t-1} \times x_{i,j,t-1} + u_{i,j,t}, \end{aligned}$$

with $y_{i,j,t} = \mathbb{1}\left(SPBIN_{i,j,t} > SPBIN_{i,j,t-1}\right)$, where $SPBIN_{i,j,t-1}$ denotes the short position bin of investor i in a given stock j on trading day t, and $\mathbb{1}(\cdot)$ is the indicator function. Here, *Just below threshold* is a dummy variable indicating whether a short position is located in the reporting bin just below the disclosure threshold ($SPBIN = 0.4$) and $x_{i,j,t-1}$ is a vector of stock- and investor-specific variables. For details on the calculation of these variables, see Table A.1. All specifications include weekly time fixed effects. The unconditional probability of increasing a short position to enter the next bin (estimated by the sample average of $y_{i,j,t}$) is 2.0%. The estimated coefficients are scaled to reflect changes in percentage points. Standard errors are clustered at the investor-stock and time level. The t-statistics are given in parentheses, and *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Variable:	Model 1		Model 2		Model 3	
Just below threshold = 1	−0.68***	(−5.52)	−0.65***	(−5.25)	−0.61***	(−4.93)
Short position bin	2.42***	(6.32)	1.99***	(5.57)	0.03	(0.03)
ln(Market capitalization)			−0.40***	(−5.07)	−0.15	(−0.99)
ln(Return volatility)			0.27	(1.30)	−0.15	(−0.48)
ln(Amihud Illiquidity)			−0.51***	(−6.70)	−0.25**	(−2.04)
ln(Bid-ask spread)			−0.14	(−0.77)	0.53	(1.60)
Institutional Ownership			0.01***	(3.81)	0.00	(0.65)
Futures or listed options = 1			0.56***	(4.07)	0.48**	(2.05)
Hedge Fund = 1			0.23	(1.61)	−0.24	(−0.93)
Bank = 1			−0.14	(−0.34)	−0.64	(−0.97)
European holder = 1			0.41***	(2.70)	−0.48*	(−1.87)
German holder = 1			−0.57	(−1.37)	−0.79	(−1.37)
No public filings = 1			0.33	(1.30)	0.18	(0.28)
Short interest			0.07**	(2.46)	−0.01	(−0.19)
Disclosure by others = 1			−0.04	(−0.27)	0.23	(1.02)
Short position bin × ln(Market capitalization)					−0.62	(−1.50)
Short position bin × ln(Return volatility)					1.45	(1.56)
Short position bin × ln(Amihud Illiquidity)					−0.68**	(−2.05)
Short position bin × ln(Bid-ask spread)					−1.87*	(−1.93)
Short position bin × Institutional ownership					0.03	(1.62)
Short position bin × Futures or listed options = 1					0.25	(0.37)
Short position bin × Hedge fund = 1					1.36*	(1.77)
Short position bin × Bank = 1					1.56	(0.71)
Short position bin × European holder = 1					2.58***	(3.30)
Short position bin × German holder = 1					0.70	(0.36)
Short position bin × No public filings = 1					0.28	(0.14)
Short position bin × Short interest					0.19*	(1.93)
Short position bin × Disclosure by others = 1					−0.71	(−1.05)
Constant	0.84	(1.60)	0.31	(0.54)	0.98	(1.61)
Adjusted R^2 (in %)		0.32		0.61		0.70
Number of observations		278,003		277,722		277,722

Table 6:
Characteristics influencing the probability of passing the disclosure threshold

This table shows estimates from the linear probability model

$$\begin{aligned} y_{i,j,t} \quad = \quad & \alpha + \beta_0 \; \textit{Just below threshold}_{i,j,t-1} + \gamma_0 \; SPBIN_{i,j,t-1} + \delta' x_{i,j,t-1} \\ & \beta_1' \; \textit{Just below threshold}_{i,j,t-1} \times x_{i,j,t-1} + \gamma_1' SPBIN_{i,j,t-1} \times x_{i,j,t-1} + u_{i,j,t}, \end{aligned}$$

with $y_{i,j,t} = \mathbb{1}\left(SPBIN_{i,j,t} > SPBIN_{i,j,t-1}\right)$, where $SPBIN_{i,j,t-1}$ denotes the short position bin of investor i in a given stock j on trading day t, and $\mathbb{1}(\cdot)$ is the indicator function. This model is therefore an extension of Model 3 in Table 5. Details on the variable definitions and model specifications appear in the notes to Table 5. For brevity, only the coefficients β_0 and β_1 of the interactions $\textit{Just below threshold}_{i,j,t-1} \times x_{i,j,t-1}$ are shown. All specifications include weekly time fixed effects. The unconditional probability of increasing a short position to enter the next bin (estimated by the sample average of $y_{i,j,t}$) is 2.0%. The estimated coefficients are scaled to reflect changes in percentage points. Standard errors are clustered at the investor-stock and time level. The t-statistics are given in parentheses, and *, **, and *** indicate a significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)
Just below threshold = 1	−0.39**	−0.22	−0.43	−0.53**	−0.13
	(−2.38)	(−0.80)	(−1.64)	(−2.53)	(−0.39)
Just below threshold	0.05				0.03
× ln(Market capitalization)	(0.35)				(0.22)
Just below threshold	−0.70**				−0.62*
× ln(Return volatility)	(−2.01)				(−1.69)
Just below threshold	0.08				0.04
× ln(Amihud Illiquidity)	(0.62)				(0.32)
Just below threshold	0.16				0.14
× ln(Bid-ask spread)	(0.49)				(0.41)
Just below threshold	0.00				−0.01
× Institutional ownership	(−0.69)				(−0.69)
Just below threshold	0.00				−0.07
× Futures or listed options = 1	(−0.02)				(−0.29)
Just below threshold		−0.36	0.13		−0.29
× Hedge Fund = 1		(−1.21)	(0.49)		(−0.95)
Just below threshold		−0.33	−0.13		−0.52
× Bank = 1		(−0.49)	(−0.19)		(−0.74)
Just below threshold		0.31	0.37		0.18
× European holder = 1		(1.26)	(1.46)		(0.73)
Just below threshold		−0.26	−0.03		−0.29
× German holder = 1		(−0.20)	(−0.02)		(−0.23)
Just below threshold		−1.59***			−1.05**
× No public filings = 1		(−3.16)			(−2.08)
Just below threshold			−1.66***		−1.46***
× No public short position = 1			(−4.18)		(−3.65)
Just below threshold				−0.02	0.00
× Short interest				(−0.42)	(−0.09)
Just below threshold				0.20	0.25
× Disclosure by others = 1				(0.77)	(0.95)
Adjusted R^2 (in %)	0.78	0.79	0.79	0.77	0.80
Number of observations	277,722	277,722	277,722	277,722	277,722

Table 7:
Calendar time portfolio approach

This table shows the performance of stocks for which there is at least one potentially constrained short seller, due to the publication threshold. For the ex-post measure of constrained investors (left-hand side), we proceed as follows: For each investor-stock pair, we determine the maximum reporting interval reached during the sample period. A potentially constrained investor is present if the maximum reporting bin is the 0.4 bin and the maximum reporting class is reached. For the ex-ante measure of constrained investors (right-hand side), we proceed likewise, but use running maxima instead of ex-post maxima. We form an equal-weighted portfolio of stocks with at least one potentially constrained short seller. After that, we can regress the portfolio excess return on the market excess return (MKTRF), the size (SMB) and value (HML) factors, and the momentum factor (WML). The table reports factor loadings, alphas (in bps per day), and the adjusted R^2 of the time-series regression. The t-statistics are computed with Newey-West standard errors and are shown in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Returns are daily and the sample period is November 5, 2012 to March 31, 2015.

	(1)	(2)	(3)	(4)	(5)	(6)
	Portfolio return: Threshold constraint potentially binding (ex-post measure)			Portfolio return: Threshold constraint potentially binding (ex-ante measure)		
MKTRF	1.08***	1.17***	1.18***	1.08***	1.17***	1.17***
	(25.06)	(29.69)	(29.76)	(26.36)	(29.14)	(29.14)
SMB		0.45***	0.44***		0.45***	0.45***
		(7.79)	(7.46)		(8.67)	(8.16)
HML		0.33***	0.32***		0.32***	0.32***
		(6.14)	(5.97)		(6.34)	(6.27)
WML			-0.03			-0.01
			(-0.59)			(-0.24)
Alpha	-4.82**	-5.42***	-5.17***	-4.52*	-5.09***	-4.99***
	(-1.98)	(-3.02)	(-3.01)	(-1.95)	(-2.83)	(-3.01)
Adjusted R^2 (in %)	69.85	74.18	74.16	72.32	76.76	76.73

Table 8:
Placebo tests

This table shows the performance of different portfolios constructed according to different maximum reporting bins (Column 1 to 5). For each investor-stock pair, we determine the maximum reporting interval reached during the sample period. In Panel A, for each maximum bin, we report the average risk-adjusted return of portfolios that include all stocks with at least one short seller, holding a position at its maximum reporting bin. Therefore, abnormal returns in the gray-shaded Column (3) coincide with the abnormal returns from Table 7. In Panel B, for each maximum bin interval, we report the average risk-adjusted return of portfolios that include all stocks with at least one short seller holding a position that is *not* in the maximum reporting bin. In other words, it is the average return of the stocks not generated in the maximum bin phase. Panel C reports the differences between the two portfolios for each maximum bin definition and factor model. We form an equal-weighted portfolio of stocks for each test. Then, we regress the portfolio returns on the same three factor models as in Table 7. The table reports alphas (in bps per day) of the time-series regression, omitting the factor loadings for the sake of brevity. The t-statistics are computed with Newey-West standard errors and are shown in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)
Panel A: Performance during the maximum bin phase					
	Maximum reporting bin reached				
	0.2	0.3	0.4	0.5	0.6
CAPM	0.46	-1.24	-4.82**	6.27	0.32
	(0.22)	(-0.77)	(-1.98)	(1.64)	(0.09)
Fama-French	-0.13	-1.68	-5.42***	6.17*	-0.70
	(-0.09)	(-1.27)	(-3.02)	(1.70)	(-0.18)
Carhart	-0.00	-1.76	-5.17***	5.85	-1.84
	(-0.00)	(-1.30)	(-3.01)	(1.56)	(-0.48)
Panel B: Performance outside the maximum bin phase					
	Maximum reporting bin reached				
	0.2	0.3	0.4	0.5	0.6
CAPM	–	-5.07*	-1.51	0.02	-5.46
		(-1.89)	(-0.64)	(0.01)	(-1.60)
Fama-French	–	-5.55***	-1.76	-0.66	-6.30**
		(-2.58)	(-1.04)	(-0.38)	(-2.33)
Carhart	–	-5.12**	-1.40	-0.59	-6.00**
		(-2.30)	(-0.78)	(-0.31)	(-2.19)
Panel C: Difference in performance (Panel A - B)					
	Maximum reporting bin reached				
	0.2	0.3	0.4	0.5	0.6
CAPM	–	3.84*	-3.30*	6.25	5.78
		(1.74)	(-1.67)	(1.46)	(1.04)
Fama-French	–	3.86	-3.67*	6.83*	5.60
		(1.52)	(-1.95)	(1.92)	(0.98)
Carhart	–	3.36	-3.77**	6.44	4.16
		(1.51)	(-2.14)	(1.51)	(0.76)

Table 9:
Cross-sectional predictive regression

This table shows the average coefficients and t-statistics from daily cross-sectional regressions to predict stock returns (in bps per day) using the Fama and MacBeth (1973) procedure. Each day, we run a cross-sectional regression of future returns $t+1$ on a measure of short-sale constraint and several control variables, which are observed at time t. The control variables are the market beta, market capitalization, the book-to-market ratio, past returns, short interest, and institutional ownership. Skewed variables are logarithmized and named accordingly. The table reports the time-series average of the cross-sectional regression coefficients, along with their t-statistics and R^2s . The t-statistics are based on the time-series standard deviations of the cross-sectional coefficients using the Newey and West (1987) procedure. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Potentially constrained	-7.33***					
	(-2.67)					
Potentially constrained (ex-ante)		-7.67***				
		(-2.78)				
Potentially constrained			-30.07***			
∩ No public filings			(-3.72)			
Potentially constrained				-22.91***		
∩ No public filings (ex-ante)				(-3.25)		
Potentially constrained					-11.04***	
∩ No public short position					(-2.65)	
Potentially constrained						-10.02***
∩ No public short position (ex-ante)						(-2.63)
Market beta	8.60	8.56	8.96	8.79	8.56	8.72
	(1.44)	(1.43)	(1.50)	(1.47)	(1.43)	(1.46)
ln(Market capitalization)	-2.96***	-2.96***	-3.02***	-2.99***	-2.97***	-2.95***
	(-3.79)	(-3.79)	(-3.87)	(-3.82)	(-3.81)	(-3.76)
ln(Book-to-market)	6.67***	6.67***	6.65***	6.67***	6.63***	6.70***
	(4.15)	(4.15)	(4.14)	(4.15)	(4.12)	(4.17)
Return (t)	-0.22***	-0.22***	-0.22***	-0.22***	-0.22***	-0.22***
	(-28.72)	(-28.71)	(-28.73)	(-28.73)	(-28.71)	(-28.72)
Return (t-1,t-4)	-0.05***	-0.05***	-0.05***	-0.05***	-0.05***	-0.05***
	(-12.57)	(-12.58)	(-12.59)	(-12.59)	(-12.58)	(-12.58)
Return (t-5,t-19)	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***
	(-5.87)	(-5.88)	(-5.93)	(-5.92)	(-5.89)	(-5.89)
Return (t-20, t-249)	0.75	0.77	0.52	0.59	0.65	0.62
	(0.18)	(0.18)	(0.12)	(0.14)	(0.16)	(0.15)
ln(Short interest)	0.21	0.31	0.00	-0.03	0.04	0.15
	(0.33)	(0.46)	(0.00)	(-0.05)	(0.06)	(0.25)
ln(Institutional ownership)	-0.22	-0.22	-0.20	-0.21	-0.21	-0.24
	(-0.37)	(-0.37)	(-0.34)	(-0.36)	(-0.36)	(-0.40)
Constant	26.53***	27.01***	25.67***	25.47***	25.82***	26.19***
	(3.43)	(3.44)	(3.35)	(3.32)	(3.34)	(3.38)
Adjusted R^2 (in %)	12.01	12.01	12.05	12.04	12.01	12.02
Number of observations	294,104	294,104	294,104	294,104	294,104	294,104

Table 10:
Performance comparison: Secretive vs. non-secretive investors

In this table we compare the performance of secretive with that of non-secretive investors. We define secretive investors as investors, which never had a public short position in our sample, but at least once reached the 0.4 bin. Investors are defined as non-secretive, if they at least once had a public short position. In Panel A, we compare the two investor groups' performance in unconstrained non-public positions, i.e. positions with a maximum value of 0.2 or 0.3. In Panel B we only investigate positions with a maximum value of 0.3, in Panel C with a maximum value of 0.2. To measure performance, we form equal-weighted portfolios of stocks originating from the respective investor groups and regress the portfolio returns on the same three factor models as in Table 7. The table reports alphas (in bps per day) of the time-series regression, omitting the factor loadings for the sake of brevity. The t-statistics are computed with Newey-West standard errors and are shown in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	(1) Secretive investors	(2) Non-secretive investors	(3) Difference: (1) - (2)
Panel A: Performance of all unconstrained non-public positions			
CAPM	-4.40	-0.58	-3.83**
	(-1.47)	(-0.33)	(-2.15)
Fama-French	-5.01**	-1.03	-3.98**
	(-2.20)	(-0.83)	(-2.30)
Carhart	-4.38*	-1.21	-3.16*
	(-1.87)	(-0.80)	(-1.92)
Panel B: Performance of positions with a maximum of 0.3			
CAPM	-8.12**	-1.62	-6.50**
	(-2.29)	(-0.87)	(-2.24)
Fama-French	-8.97***	-2.08	-6.89**
	(-2.74)	(-1.54)	(-2.36)
Carhart	-7.70**	-2.06	-5.64*
	(-2.42)	(-1.43)	(-1.88)
Panel C: Performance of positions with a maximum of 0.2			
CAPM	-1.30	1.42	-2.71
	(-0.40)	(0.64)	(-1.33)
Fama-French	-1.89	0.86	-2.76
	(-0.68)	(0.50)	(-1.27)
Carhart	-1.38	0.55	-1.93
	(-0.47)	(0.29)	(-0.99)