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Flying under the radar: The effects of short-sale disclosure rules on investor behavior and stock prices☆

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ABSTRACT

We study how disclosure requirements for large short positions affect investor behavior and security prices. Short positions accumulate just below the applicable disclosure threshold as certain investors never disclose any of their positions. Further tests suggest that this secrecy is part of investors' general policy of avoiding disclosure to protect their unique, profitable investment strategies against reverse engineering by competitors. No evidence supports the notion that short sellers avoid disclosure because of potential adverse effects on securities' lending fees, risk of recall, or short squeezes. Finally, the evasive behavior by short sellers in response to transparency regulations hampers price discovery.

1. Introduction

Disclosure requirements for investors' holdings are a prevalent feature of financial market regulation. Since enactment of the Securities Act of 1933 and the Securities Exchange Act of 1934, significant efforts have been made to increase the transparency of investors' long positions.[1]

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[1] In the United States, several disclosure rules apply to long positions. Anyone who acquires beneficial ownership of more than 5% of a voting

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Less regulatory attention has centered on their short positions. This asymmetry of disclosure requirements has been debated extensively, especially in the aftermath of the 2007–2009 global financial crisis, and regulators worldwide have contemplated new transparency measures for short positions. Proponents of short-selling disclosure rules argue that greater transparency levels the playing field for investors, exposes potentially abusive short selling, and helps improve price discovery in the market (Nasdaq, 2015; NYSE, 2015). Critics worry that the timely publication of short positions can pose a threat to proprietary investment strategies, in that investors would reduce their short-selling activities to protect private information and engage less in arbitrage trading, thereby hampering price discovery (SEC, 2014). This debate continues in the United States, but the European Union (EU) in 2012 adopted a uniform rule, requiring investors to publish any net short position that reaches a threshold of 0.5% of the shorted stocks' issued share capital one day after that position occurs.[2] These disclosures provide information to the market, beyond stock-level short-selling measures, such as short interest. The disclosures contain the name and identifier of the shorted stock, the identity of the short seller, and the date and magnitude of the position.

A key question in this regard is whether investors trade strategically around the disclosure threshold and, if so, to what extent their behavior affects stock prices. To address these issues, we exploit a unique setting created by the EU's short-selling regulation, in which we can observe public positions above the disclosure threshold as well as confidential positions below the threshold. The regulation requires a two-tier reporting system for short positions in shares. First, investors must file a confidential notification with the regulator if their short position reaches 0.2% of the shorted stocks' issued share capital. Second, the short position must be publicly disclosed if it reaches 0.5% of the issued share capital. For our analysis, we obtain both confidential and public short-sale notifications covering the German stock market, offering a rare glimpse behind the veil of the disclosure threshold.

How disclosure requirements for short positions affect investors' behavior is not clear a priori. On the one hand, investors could prefer strategically to disclose positions to induce other investors to sell the target stock. Such strategic disclosures can help activist short sellers reduce noise trader risk, making prices converge faster to their fundamental value (Kovbasyuk and Pagano, 2015; Ljungqvist and Qian, 2016; Zhao, 2018). They also could be used as devices to coordinate predatory short selling and manipulate stock prices (Goldstein and Guembel, 2008; Brunnermeier and Oehmke, 2014). For shorting activists, who target individual companies on a case-by-case basis, disclosing a profitable position should be advantageous for two reasons: It increases their profits as it gives them a larger stake, and copycat investors could even help with arbitrage.

On the other hand, investors could prefer to hide their positions below the disclosure threshold to protect their proprietary trading strategy from reverse engineering by competitors. Other investors can use statistical techniques to past disclosures to infer the investor's underlying trading strategy. Having identified the strategy, they can then employ it even before the original investor and thus can arbitrage away the prospective gains (Wermers, 2001; AIMA/MFA, 2013). Thus, if an investor possesses a lucrative proprietary trading strategy that extends beyond the single position, hiding individual positions can be advantageous as it maintains the long-term profits of the underlying strategy.

Another reason for hiding short positions is that disclosure could make them more costly or difficult to maintain and close. Increased shorting demand induced by copycat investors shadowing disclosed positions could result in higher security lending fees, increased costliness of crowded trades, or even stock recalls. Noting these reasons for and against disclosing a short position, ultimately, how investors behave around a disclosure threshold remains an empirical question.

Our empirical findings provide strong evidence that a significant share of positions accumulate just below the disclosure threshold. For investors who have to make a disclosure decision about a specific stock for the first time, we estimate an excess mass of 92.8% relative to the counterfactual distribution. We also explore which trading strategies could generate such bunching just below the disclosure threshold. Contrary to some potential alternative explanations, we find no evidence that short sellers remain below the threshold, waiting for a favorable moment to establish a large position. Instead, bunching occurs because certain short positions never exceed the disclosure threshold. Studying the performance of those positions, we find that stocks with secretive short positions exhibit stronger negative returns than stocks with non-secretive positions. This finding suggests that position concealment is associated with the possession of superior information.

We shed light on why these informed short sellers remain below the radar, despite the fact that larger positions would presumably result in even higher profits. Our findings are most consistent with the hypothesis that secretive investors hide positions from competitors to protect their investment strategies from reverse engineering. Investors seem to adopt a general rule of never disclosing a short position. Most secretive positions are taken by investors who never disclose any position throughout the entire sample period. Also, in line with the notion that these investors are seeking to protect their investment strategy, they are similarly secretive about their long positions. Secretive short positions tend to be held by private funds

class of a publicly traded company must file a Form 13D or 13G with the Securities and Exchange Commission (SEC). Institutional investment managers of a certain size must report quarterly holdings in 13F filings. Mutual funds also must regularly report portfolio holdings to their shareholders (SEC Forms N-CSR and N-Q.).

[2] Among EU countries, Spain and the United Kingdom implemented short-sale disclosure rules 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 Wall Street Reform and Consumer Protection Act required the SEC to conduct a study of the feasibility, benefits, and costs of the real-time disclosures of shorting. However, the real-time disclosure of shorting was not adopted (SEC, 2014). This debate has resurfaced though, and both the NYSE and Nasdaq have filed rulemaking petitions for short-sale disclosures with the SEC (petition numbers 4–689, October 7, 2015, and 4–691, December 7, 2015; see https://www.sec.gov/rules/petitions.shtml).

that seek exemption from disclosing their 13F holdings reports and by investors for whom we cannot find any public filings in the comprehensive FactSet (formerly LionShares) ownership database.

In addition, we link the disclosure avoidance in short positions to hedge funds' investment approaches and the distinctiveness of their investment strategies. The majority of secretive positions are held by equity long-short and market-neutral hedge funds, which are arguably more likely to follow a rule-based approach to investment. Under the hypothesis that short sellers avoid disclosure to protect their strategies from reverse engineering, we expect secretive investors to follow an investment strategy that is distinct from that of their peers. Consistent with this hypothesis, the Sun et al. (2012) strategy distinctiveness index of secretive investors is significantly higher than that of non-secretive investors. Moreover, the unique strategies of these secretive investors are successful. Secretive investors rank higher in performance tables than non-secretive investors. Lastly, secretive hedge funds exhibit a higher flow-performance sensitivity than their non-secretive counterparts, suggesting that they would lose more in terms of net flows if their profitable strategies were reverse engineered by competitors.

We also consider the possibility that short sellers are concerned about maintaining and closing their positions following disclosure. Having studied a wide range of stock-level characteristics, we find no evidence of this being the case. Positions just below and just above the disclosure threshold do not differ with respect to the securities lending fee, supply of stocks to borrow, inventory concentration, stock liquidity, days to cover, or the ex ante risk of rising securities lending fees.

Finally, we investigate how evasive behavior by investors at the disclosure threshold affects asset prices. If this threshold discourages informed investors from increasing their positions further, negative information could be incorporated more slowly into prices. We thus study stock returns when a secretive investor is likely constrained by the threshold. When secretive investors are just below the threshold, we find subsequent negative risk-adjusted returns of around 6 basis points (bps) per day. To confirm that the return predictability results from disclosure avoidance, we perform two placebo tests, which provide two important findings. First, return predictability does not occur if we choose various hypothetical publication thresholds above and below the true one. Second, among secretive positions, subsequent negative returns occur mainly when the position is just below the publication threshold.

Our findings contribute to the long-standing debate about the effects of information disclosure in financial markets. Conventional wisdom suggests that disclosure improves market quality, yet some theories suggest that it can have damaging welfare implications, such as crowding out the acquisition of private information (Verrecchia, 1982; Diamond, 1985), reducing risk-sharing opportunities (Hirshleifer, 1971), or causing investors to attach too much importance to public signals (Morris and Shin, 2002). In this context, our study provides evidence of another unintended consequence: Position disclosure rules discourage informed market participants from fully exploiting their information, which reduces price discovery in the market. This mechanism is closely related to the literature on the trade-off between insider regulation and market quality (Leland, 1992; DeMarzo et al., 1998; Huddart et al., 2001). Two features make the disclosure rule that we are studying particularly interesting for generating a better understanding of holder disclosure and the informational content of stock prices. First, this rule provides granular updates of investors' short positions because disclosure is determined by the magnitude of the position, not by specific time periods (e.g., every quarter end). Highly relevant and timely information is thus conveyed to other market participants. Second, the rule applies to short sellers, who are typically perceived as informed investors.[3] Changes in their behavior can thus significantly affect the ability of financial markets to produce and aggregate private information in the price discovery process.

Empirical studies of mandatory disclosure focus mainly on the long side of investors' portfolios (Agarwal et al., 2013b; Aragon et al., 2013; Frank et al., 2004; Verbeek and Wang, 2013). For example, Agarwal, Jiang, Tang, Yang (2013b) find that hedge funds delay disclosure for some of their long holdings. We complement their findings with similar yet distinct results for stocks on the short side. On both sides, secretive behavior is associated with informed trading. However, secrecy in short positions originates from certain investors avoiding publication entirely, not delaying their crossing of the disclosure threshold. Moreover, the underlying motives differ. Delaying disclosure serves to minimize the costs of being front-run in individual positions. Our findings suggest that avoiding disclosure altogether is motivated by investors' concerns about potential reverse engineering of their underlying trading strategy.

Our study adds to the literature on limits to arbitrage (e.g., Shleifer and Vishny, 1997; Gromb and Vayanos, 2002) and on short-sale constraints in particular. Frictions in the securities lending market are a widely studied source of short-sale constraints (Jones and Lamont, 2002; Asquith et al., 2005; Nagel, 2005; Cohen et al., 2007; Prado et al., 2016). In this respect, we show that the requirements for timely disclosure also constitute a sizable impediment for many short sellers, particularly well-informed investors. Short sellers' disclosure avoidance is unrelated to previously shown frictions in the securities lending market, such as insufficient lendable supply, concentrated ownership structure, the risk of increasing lending fees, or crowded trades (Cohen et al., 2007; Engelberg et al., 2018b; Hong et al., 2015; Kaplan et al., 2013; Prado et al., 2016).

Finally, this paper advances analyses of the effects of short-sale regulations (Diether et al., 2009; Battalio and Schultz, 2011; Grundy et al., 2012; Boehmer et al.,

[3] For example, the model by Diamond and Verrecchia (1987) predicts that short sellers are more likely to be informed because shorting is costly. A robust finding of the empirical literature is that short sales are followed by negative returns, suggesting that short sellers are generally informed (e.g., Seneca, 1967; Aitken et al., 1998; Asquith et al., 2005; Boehmer et al., 2008; Diether et al., 2009). For a recent survey on this topic, see Reed (2013).

2013; Beber and Pagano, 2013; Fang et al., 2016). The consequences of short-sale bans following the financial crisis of 2007–2009 have generated a great deal of interest among researchers. Boehmer et al. (2013) and Beber and Pagano (2013) show how market quality deteriorated following short-sale bans. Duong et al. (2015) and Jones et al. (2016) study the effects of short-sale disclosure rules. Jones et al. (2016), the paper closest to ours, use the staggered introduction of disclosure regimes in Europe and show a reduction in short-selling activity and price efficiency. Their evidence indicates that investors' behavior changed in response to greater transparency. We corroborate their findings and also show that informed short sellers in particular avoid disclosure. The unique setting in our study enables us to identify the efforts that investors make to avoid crossing the disclosure threshold and to shed new light on the underlying reasons for this behavior. Finally, we establish a direct link between investors' disclosure avoidance and slower price discovery for stocks affected.

This paper is organized as follows. Section 2 provides a summary of the institutional background and disclosure requirements of short positions in the EU. In Section 3, we describe our data sources and present summary statistics. Section 4 provides evidence that short positions accumulate below the disclosure threshold. Section 5 studies the performance of short positions that never cross the threshold. Section 6 examines the rationale behind short sellers' disclosure avoidance. Section 7 analyzes the implications of this behavior for price discovery. Section 8 discusses the robustness of our findings. Section 9 concludes.

2. Institutional background and theory

In this section, we provide a summary of the institutional background of the EU regulation on short selling and disclosure requirements of individual short positions. We also discuss arguments both for and against publicizing a short position that guide our empirical analysis.

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 and requires investors to report and disclose any short positions of a certain size. The regulation brought into force 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% threshold 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, notifications must be updated when values fall below the relevant thresholds.

The notification and disclosure rules apply to all stocks for which the principal trading venue is in the EU. 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, or BaFin), and short positions are published on the Internet platform of the Federal Gazette (Bundesanzeiger).[4] Short positions must 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. Table 1 provides an example of a public short position disclosure series, from the point when it crosses the 0.5% disclosure threshold to the point where it falls below it. The regulator receives confidential short position notifications in the same manner, but at a threshold of 0.2%.

After the reporting day, the exact value of a short position between the two disclosure thresholds is unknown until a new threshold is crossed. Thus, in the example in Table 1, the reported short position of 0.61% on November 2, 2015 could have ranged from 0.60% to 0.69% on the following day. We therefore sort the positions into short position bins of 10 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, and so on, reporting bin.[5]

Several features of the regulation and its scope are worth highlighting. First, the disclosure rule applies to all investors, whether domiciled in the EU or abroad. The majority of those disclosing investors are hedge funds domiciled outside the EU. Second, the regulation applies to both short and 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. Third, the reported net short positions are calculated by netting all long, short, and delta-adjusted derivative positions in the respective stock. A short position established to hedge an exposure that originates from a derivative position in the same underlying stock thus does not have to be reported or disclosed, as long as the overall shorting exposure is below the applicable threshold. Fourth, to ensure provision of liquidity, market-making activities are exempted from the EU short-selling regulation.[6]

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

[5] We measure short positions in intervals, because the reporting rule creates a distorted view of how the positions are distributed within a reporting interval. If a position enters the 0.4 reporting bin from below, it is more likely to have a low instead of a high second digit on that day. If the 0.4 bin is entered from above, the position is more likely to have a high instead of a low second digit on that day. This reporting rule mechanically creates a U-shaped distribution of positions within a reporting corridor. For a more detailed discussion, see the Online Appendix.

[6] Exemptions include market making in a specific stock and its related derivatives. To meet the conditions for the market-making exemption, institutional investors must file detailed statements about their market-making activities in specific securities (ESMA, 2013). The statement includes a description of the main duties and activities and a copy of the contractual market-making agreement. The hurdle for claiming market making is therefore high. Accordingly, broker-dealers and banks mainly are exempted from filing short position notifications (see https://www.esma.europa.eu/sites/default/files/library/list_of_market_makers_and_primary_dealers.pdf). This is also reflected in our data set, consisting mostly of hedge funds and asset managers who do not qualify for the market-maker exemption. These investors cannot sidestep the regulation simply by claiming market making. That said, among market makers it remains a challenge to separate market making from propri-

Table 1
Example of a public short position disclosure.
This table shows an example development of public position disclosures according to the European Union (EU) Short Selling Regulation (Regulation EU No 236/2012), from the point when the 0.5% disclosure threshold is crossed until the position size decreases below it [source: Internet platform of the German Federal Gazette (Bundesanzeiger)]. The net short position must be disclosed to the public if the position reaches (or falls below) 0.5% of the issued share capital of the company shorted and for each 0.1% above that. When a position crosses the relevant disclosure thresholds (0.5%, 0.6%, 0.7%, etc.), the exact value of the short position on that day is reported. After the reporting day, the exact value of a short position between the two disclosure thresholds is unknown until a new threshold is crossed. If a position finally falls below the disclosure threshold of 0.5%, its last value also has to be reported (in this example, 0.44% on January 1, 2016). The regulator receives confidential short position notifications in the same manner, but here the threshold is 0.2%.

Date	Position holder	Issuer	ISIN	Position size
October 29, 2015	Marshall Wace LLP	Deutsche Lufthansa AG	DE0008232125	0.59%
November 2, 2015	Marshall Wace LLP	Deutsche Lufthansa AG	DE0008232125	0.61%
November 5, 2015	Marshall Wace LLP	Deutsche Lufthansa AG	DE0008232125	0.71%
November 25, 2015	Marshall Wace LLP	Deutsche Lufthansa AG	DE0008232125	0.84%
November 30, 2015	Marshall Wace LLP	Deutsche Lufthansa AG	DE0008232125	0.91%
December 8, 2015	Marshall Wace LLP	Deutsche Lufthansa AG	DE0008232125	0.89%
December 14, 2015	Marshall Wace LLP	Deutsche Lufthansa AG	DE0008232125	0.78%
December 17, 2015	Marshall Wace LLP	Deutsche Lufthansa AG	DE0008232125	0.69%
November 22, 2015	Marshall Wace LLP	Deutsche Lufthansa AG	DE0008232125	0.59%
January 22, 2016	Marshall Wace LLP	Deutsche Lufthansa AG	DE0008232125	0.44%

2.2. Short positions: to publish or not to publish

Whether investors prefer to publicize their short positions or keep them secret is not clear a priori. Lamont (2012) states that, depending on the situation, short sellers could either publicize their positions or try to remain undetected. Publicizing a short position could be helpful if the investor is seeking to overcome conventional limits to arbitrage and attempting to convince other investors that a certain stock is overpriced (e.g., Kovbasyuk and Pagano, 2015). If those other investors agree and follow suit, prices converge faster to fundamentals, thus reducing noise trader risk (De Long et al., 1990; Shleifer and Vishny, 1997). Ljungqvist and Qian (2016) provide evidence that short-sale campaigns can help to correct mispricing, especially in cases of questionable governance and accounting practices. Zhao (2018) shows that activist short sellers tend to target firms associated with information uncertainty. Activist short sellers could therefore welcome the new EU Short Selling Regulation and use the disclosure threshold as a device to publish their positions strategically. Instead of overcoming limits to arbitrage and noise trader risk, position disclosure could facilitate the coordination of predatory short-selling strategies to manipulate stock prices (Goldstein and Guembel, 2008; Brunnermeier and Oehmke, 2014). This short-selling strategy differs in the underlying motive but would similarly result in a preference for disclosing short positions.

Short sellers also could want to keep their short positions secret and thus avoid the publication threshold. Through nondisclosure, they can protect their proprietary trading strategy from reverse engineering by competitors. According to Wermers (2001, p.7), "reverse engineering occurs when an outside investor applies statistical techniques to data on publicly reported holdings to infer the stock-picking strategies, strategic choices, or even the holdings of specific securities." Importantly, reverse engineering of strategies goes beyond the pure mimicking of a fund's holdings. Even though it is more difficult to implement than simply shadowing positions, reverse engineering has the advantage that once competitors determine the strategy, they can implement it without delay (Wermers, 2001). Competitors can employ the profitable strategy even shortly before the original investor acts, arbitraging away the prospective gains. Anecdotal evidence demonstrates that hedge funds do worry about reverse engineering of investment strategies in relation to their short position disclosures (AIMA/MFA, 2013). This stands in contrast to shorting activists, who target individual companies on a case-by-case basis, where disclosure of a position is likely to be beneficial. The short seller increases profits by establishing a larger position, and copycat investors can even help with arbitrage. However, if an investor has a lucrative proprietary trading strategy that extends beyond a single position, hiding individual positions can be advantageous as it maintains the long-term profits of the underlying strategy.

Second, short sellers could worry that maintaining and closing their position would become more expensive due to disclosures. If other investors follow suit and short a stock, lending fees can rise. In extreme cases, the lender could even recall existing stock loans, causing unexpected short squeezes. Short squeezes can also result from actions by issuers and large long-side investors, taken in response to a high short interest or disclosures by particular short sellers (Lamont, 2012).

Third, short sellers could be concerned that position disclosure would harm their relationship with the management of shorted companies. This motive applies mainly to traditional asset managers and bank holding companies, which are keen to maintain long-term business relationships with clients. Considering these arguments both for and against publicizing a short position, it is ultimately an empirical question which strategic behavior predominates around the disclosure threshold.[7]

etary trading. Consequently, our paper does not speak to short selling by market makers who intend to engage in proprietary trading but focuses instead on short selling by asset managers.

[7] We acknowledge that preferences for both hiding and publicizing short positions could exist in parallel and vary across investors. With

Table 2
Summary statistics: comparison of stocks with and without short position notifications.

This table shows selected characteristics of stocks with and without short position notifications. 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 they must be publicly disclosed if the position is greater than or equal to 0.5%. Column 1 shows the results for stocks without a short position notification; Column 2 for stocks that have at least one public or confidential short position notification; Column 3 for stocks for which the largest short position is a public short position; and Column 4 for stocks for which the largest position is a confidential but not a public short position. The table presents the percentage share of each group in the German market, as well as the median values of selected stock characteristics for each group. Columns 5 and 6 report tests for differences in medians across groups. The tests are based on a quantile regression with standard errors clustered at the stock level (Parente and Santos Silva, 2016). The sample consists of common equity in the German regulated stock market from November 5, 2012 until March 31, 2015, excluding stocks with a previous day's share price of below 0.1 euro. For details of how the stock characteristics were calculated, see Table A.1.

	(1)	(2)	(3)	(4)	(5)	(6)
	Stocks without short position notifications	Stocks with short position notifications				
Characteristic		All	Public	Confidential		
Share of stocks in regulated market	78.04 %	21.96%	9.05%	12.91%		
Median values					*p*-value (1)=(2)	*p*-value (3)=(4)
Market value (millions of US dollars)	73.7	2,247.7	2,010.7	2,422.4	(0.000)	(0.356)
Book-to-market ratio	0.66	0.51	0.54	0.50	(0.000)	(0.278)
Daily turnover (percent)	0.07	0.32	0.37	0.29	(0.000)	(0.034)
Amihud illiquidity	1.024	0.003	0.003	0.004	(0.000)	(0.927)
Bid–ask spread (percent)	3.51	0.65	0.65	0.65	(0.000)	(0.967)
Return volatility (percent)	2.50	1.93	2.11	1.82	(0.000)	(0.010)
Institutional ownership (percent)	1.76	29.67	30.39	29.30	(0.000)	(0.443)
Share of lendable stocks (percent)	0.50	13.46	12.77	14.17	(0.000)	(0.472)
Indicative fee (per annum percent)	1.50	0.50	0.50	0.50	(0.121)	(1.000)

3. Data and descriptive statistics

To study the effects of mandatory disclosure for short positions, 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 daily stock data from Thomson Reuters Datastream, equity lending data from Markit, and institutional investor data from FactSet Ownership and Refinitiv Eikon. Our other data sources are Trading Adviser Selection System (TASS), or Lipper TASS, and Bloomberg Markets ranking tables for hedge fund performance and flow information, Securities Data Company (SDC) Platinum for information on mergers and acquisitions, and Deutsche Gesellschaft für Ad-hoc Publizität (DGAP) for announcements by German companies. 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 (Ince and Porter, 2006; Griffin et al., 2010; Karolyi et al., 2012). When studying characteristics from the two hedge fund data sources, we confine our short position sample to funds included in Lipper TASS or Bloomberg Markets. We start the analysis on November 5, 2012 to allow for some delay in the notification of short positions, due to a statutory holiday in some federal states. The Appendix provides further details about how the sample was constructed. Table A.1 contains a description and the sources of all the variables used in the analyses.

Table 2 reports the median values of various stock characteristics for the entire universe of stocks in the German regulated market. We first distinguish between stocks with no short position notification (78.0%) and those with at least one short position notification (22.0%). We observe short position notifications mainly for stocks with large market capitalization, low book-to-market ratios, and a high ownership share of institutional investors, as well as for stocks that are very liquid, measured by both the Amihud (2002) illiquidity ratio and the bid-ask spread. The vast majority (73.5%) of stocks with short positions are in the highest quartile of market capitalization, and almost all stocks with short position notifications (95.8%) appear above the median value of the market capitalization distribution (see the Online Appendix). Data from the lending market show a similar picture. Stocks in our sample are easy and cheap to borrow, as indicated by the larger proportion of actively lendable stocks and lower lending fees relative to the overall German stock universe.

Among stocks with short position notifications (confidential or public), we distinguish between two disjoint groups: stocks with at least one public short position (a notification in the 0.5 bin and above), and stocks for which we observe no public positions. These two groups of stocks are similar across many characteristics. Other than turnover and return volatility, the characteristics do not differ significantly in economic and statistical terms. Stocks with public, and thus larger, short positions tend to be slightly more volatile and are traded more actively.

The analyses in this paper pertain to the investor stock day dimension of our data set. For all short positions of at least 0.2% of issued share capital, Table 3 reports the summary statistics of the stock and investor characteristics we use in our empirical analysis. We highlight the most interesting here. Hedge funds constitute the largest investor group, accounting for 76% of observations,

this study, though, we test for a dominant strategic behavior around the threshold and shed light on investors' motives.

Table 3
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 cover the number of observations (*N*), mean, standard deviation, and the 25th, 50th, and 75th percentiles. The sample consists of common equity in the German regulated stock market from November 5, 2012 until March 31, 2015. For details of how the stock characteristics were calculated, see Table A.1.

			Standard	Percentile		
Variable	N	Mean	Deviation	25th	50th	75th
Panel A: Investor characteristics						
Dummy: Hedge fund (percent)	278,649	76.22				
Dummy: US holder (percent)	278,649	45.35				
Dummy: European holder (percent)	278,649	47.41				
Dummy: Tax haven (percent)	278,649	6.14				
Dummy: No Factset entry (percent)	278,649	9.73				
Dummy: Private fund (percent)	217,036	8.36				
Total assets (billions of US dollars)	206,823	78.40	232.68	0.76	4.37	30.47
Dummy: Long-short hedge fund (percent)	43,703	38.60				
Dummy: Market-neutral hedge fund (percent)	43,703	4.64				
Bloomberg rank (1–100)	49,531	47.96	28.55	23.00	45.33	75.00
TASS percentile rank (0–100)	43,113	45.14	24.14	18.73	44.16	65.65
TASS percentile rank within style (0–100)	43,113	50.56	19.60	39.27	51.53	62.79
Strategy Distinctiveness Index^{VW} (0–2)	30,659	0.58	0.26	0.33	0.62	0.83
Strategy Distinctiveness Index^{EW} (0–2)	30,659	0.60	0.24	0.50	0.61	0.80
Flow-performance sensitivity (raw returns)	38,886	0.64	1.82	−0.63	0.15	1.11
Flow-performance sensitivity (CAPM α)	34,656	0.69	1.73	−0.35	0.02	0.92
Panel B: Stock characteristics						
Market capitalization	278,649	5.44	11.87	0.85	2.11	5.34
Book-to-market ratio	276,147	0.89	3.21	0.37	0.55	0.86
Turnover	273,536	0.50	0.31	0.26	0.43	0.71
Amihud illiquidity	273,536	0.07	1.01	0.00	0.00	0.01
Bid-ask spread	276,860	0.73	0.50	0.42	0.64	0.89
Return volatility	276,860	2.25	0.92	1.71	2.08	2.61
Institutional ownership (percent)	278,344	26.05	13.59	16.50	23.51	34.66
Number of institutional investors	278,344	425.40	467.32	116.00	265.00	537.00
Block holder ($\geq$ 3%) ownership (percent)	278,344	3.84	5.70	0.00	0.00	5.55
Number of block holders ($\geq$ 3%)	278,344	0.86	1.19	0.00	0.00	1.00
Largest five institutional ownership (percent)	278,344	9.57	5.12	6.15	8.79	12.06
Passive investors' ownership (percent)	278,344	3.31	2.77	1.41	2.34	4.94
Short interest (percent)	278,570	4.35	3.65	1.60	3.32	6.22
Fraction of lendable stocks (percent)	278,630	16.11	8.06	9.89	15.70	21.49
Inventory concentration (HHI, 0–100)	278,630	15.08	9.03	10.51	12.44	16.18
Lender concentration (HHI, 0–100)	278,630	21.34	13.80	13.21	17.21	24.06
Utilization (percent)	278,630	33.30	29.58	9.00	22.96	50.18
Indicative fee (percent)	278,543	2.04	5.71	0.50	0.50	1.00
Dummy: "On special" (percent)	278,649	24.56				
Standard deviation of fee (percent)	276,720	0.81	2.01	0.06	0.11	1.07
Standard deviation of utilization (percent)	276,720	12.86	8.45	7.61	10.01	16.90
Fee tail risk (percent)	276,720	3.87	9.13	0.64	0.84	4.70
Utilization tail risk (percent)	276,720	55.87	30.04	29.96	47.53	89.19
Price Squeeze Indicator, (DIPS, 0–100)	278,339	28.46	4.94	25.45	26.93	29.75
Days to cover (DTC)	275,174	13.17	14.45	4.22	8.60	16.59
Dummy: Futures or listed options (percent)	278,649	38.39				
Dummy: M&A acquiring company (percent)	278,649	1.38				
Dummy: Convertible bonds (percent)	278,649	34.74				
Convertible bonds equity risk hedge ratio	81,823	0.25	0.22	0.06	0.21	0.39

followed by mutual funds and other investment advisors. With respect to the location of the investors, US and European institutions account for almost the entire sample, in approximately equal proportions. For just under 10% of the observations, we cannot find any public filings in the comprehensive FactSet ownership database about investors' (long) holdings. A similar but distinct investor group of private funds includes investors who filed Form D with the Securities and Exchange Commission (SEC) and sought private placements under Regulation D.[8] Those

[8] Regulation D includes three SEC rules (Rules 504, 505, and 506) that institutional investors can draw on to sell securities in unregistered offerings. Each rule has specific requirements that the fund must meet. While Rule 504 merely restricts the amount of securities offered to $1 million, the other two rules are more stringent and require the funds' shareholders to be wealthy individual investors or trusts directed by specialist managers. A more detailed description of the requirements is provided in the investor bulletin

Table 4
Duration in reporting bins.
This table shows the average time spent in each reporting bin. Short positions are reported in bins of 10 basis points (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. Reporting bins greater than or equal to 1.0% are summarized in one group. The rows in the table, indexed by k, correspond to the resulting nine bins. The table reports the mean number of trading days spent in each reporting bin. In addition, it displays the difference in mean duration between the 0.4 bin and other bins and the corresponding p-values. The results refer to the overall sample and two subsamples, one containing short positions at their record high and the other short positions below their record high. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

			Overall			Positions at their record high			Positions below their record high		
	k	Bin	Mean duration	Difference Row 3 - k	p-value	Mean duration	Difference Row 3 - k	p-value	Mean duration	Difference Row 3 - k	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)

investors, which account for 8% of our observations, are exempted from registering their securities and usually do not have to file reports with the SEC. Therefore, our data set not only offers a rare glimpse into the short-selling behavior of investors, but it also allows us to analyze investor groups that have not previously been studied, due to their generally secretive behavior.

We plot the frequency distribution of days with an open short position notification over the different reporting bins in Fig. 1, Panel A. The distribution of short positions is skewed, and publicly disclosed short positions represent only the tip of the iceberg. Namely, 79% of observations with an open short position fall below the publication threshold.

4. Strategic behavior around the disclosure threshold

In this section, we study whether short sellers behave strategically around the disclosure threshold.

4.1. Testing for bunching around the disclosure threshold

To analyze strategic behavior around the disclosure threshold, we start with the intuition that strategic considerations should be particularly influential when the short seller faces the initial decision to disclose a position. We therefore split the sample into positions above and below their historic high and define a dummy variable for the sequence of position notifications of each investor-stock (i, j) pair:

$$Position\ record\ high_{i,j,t} = \begin{cases} 1 & \text{if } bin_{i,j,t} = \max\limits_{s \le t} bin_{i,j,s} \\ 0 & \text{if } bin_{i,j,t} < \max\limits_{s \le t} bin_{i,j,s}, \end{cases} \quad (1)$$

where $bin_{i,j,t}$ denotes the short position's reporting bin for investor i in a given stock j on trading day t. The economic intuition is as follows: Consider a short seller with a position in the 0.4 bin in a specific stock. This position is at its record high. The investor thus approaches the threshold from below for the first time and faces a strategic decision on whether to disclose or not. Another investor has a short position in the 0.4 bin in a specific stock, but the position is below its record high. The position has been higher in the past and thus has been public. In the second situation, information about this particular position already has been revealed recently, so crossing the disclosure threshold again is less of a strategic issue.

Fig. 1, Panel B, depicts the frequency of days with open short positions for the two subsamples. Positions at their record high, for which we expect strategic behavior, accumulate below the disclosure threshold. This accumulation suggests that a considerable number of positions remain below the radar. The relative frequency in the 0.4 bin is 17.0%, almost equal to the frequency of the next lower bin. Positions that are below their record high instead decline fairly geometrically with increasing reporting bins. Their relative frequency in the 0.4 bin is 8.6%, about half the frequency of positions at their record high.

To estimate a counterfactual distribution for positions at the record high, we adapt the bunching estimator proposed by Chetty et al. (2011) to our setting. We fit a polynomial regression to the observed frequency distribution, omitting the 0.4 bin. In Fig. 1, Panel B, we observe an economically sizable excess mass just below the disclosure threshold, which is equivalent to 92.8% of the counterfactual distribution. With a bootstrapped standard error of 3.7 and the corresponding t-statistic of 24.9, we reject the null hypothesis that no excess mass is below the disclosure threshold. The economic magnitude of bunching is substantial. The excess mass below the

available at https://www.investor.gov/additional-resources/news-alerts/alerts-bulletins/investor-bulletin-private-placements-under.

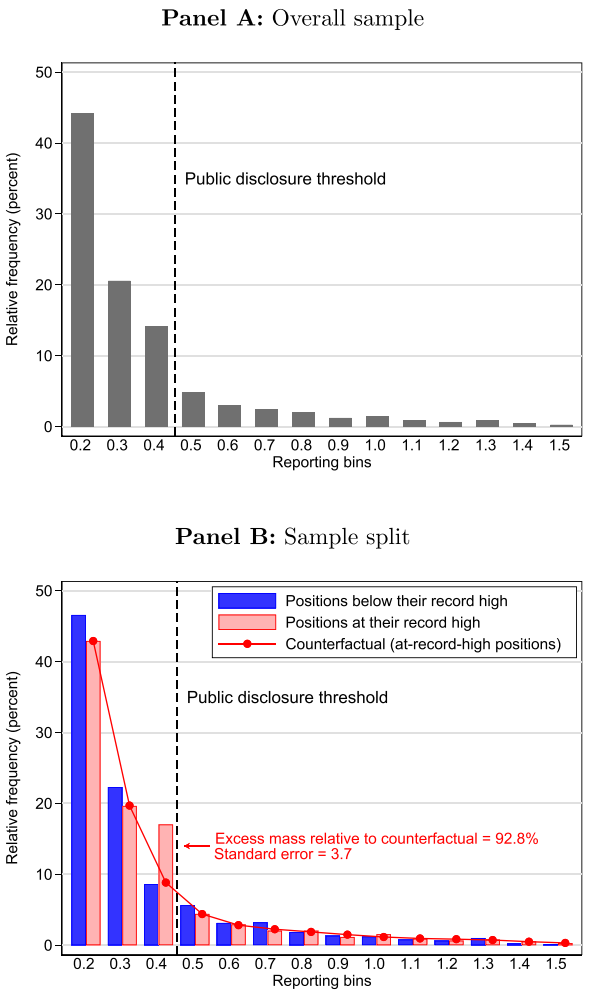

Fig. 1. Distribution of open short positions. This figure shows the distribution of days with open short positions (investor-stock-day observations) across reporting bins. Reporting bins are in 10 basis points steps, starting from 0.2%. Positions above 0.2% but below 0.5% are reported to the regulator but not disclosed to the public. Positions of 0.5% and higher are disclosed to the public. Reporting bins greater than 1.5% are truncated for readability. Panel A shows the relative frequency of days with an open position for each bin for the overall sample. Panel B reports the relative frequency separately for short positions at their record high and below their record high. The figure also shows the counterfactual distribution for record-high positions using the bunching estimator approach proposed by Chetty et al. (2011), implemented with a polynomial regression of sixth order. The excess mass in the 0.4 bin relative to the counterfactual distribution is 92.8% with a bootstrapped standard error of 3.7. The sample contains all German domestic equity in the regulated market from November 5, 2012 to March 31, 2015.

disclosure threshold corresponds to 25.2% of all public short positions in our sample.[9]

This bunching could emerge from two trading patterns. First, short sellers can prefer to wait below the threshold for a favorable time to ultimately cross it. Second, they could avoid disclosure entirely and never cross the threshold for a particular position. We explore which of these two trading strategies drives the bunching of positions below the disclosure threshold.

4.2. Time spent just below the disclosure threshold

The first analysis seeks to determine how long investors spend in the reporting bins, especially the one just below the disclosure threshold. Table 4 shows the average duration in trading days in each reporting bin.[10] In general, the average time spent in each of the bins declines as the position grows in size, from 18.3 days in the lowest bin to 12.6 days in the highest. We observe an unusual value for the 0.4 bin: The duration in this bin, just below the disclosure threshold, is the longest of all the bins, at 20.6 days. The difference in mean duration is statistically significant compared with all the other reporting bins. This evidence suggests that short sellers spend an unusually long time just below the disclosure threshold.

For a more powerful test, we split the sample into positions that are at their record level and those that are below it. The strategic behavior associated with the disclosure threshold should be particularly pronounced when positions are at their record high but less so when they are below it. This sample split shows that the long time spend by investors just below the disclosure threshold is entirely driven by positions at their record high. Here the longest period of time (26.0 days) is spent in the 0.4 bin. The economic magnitude is sizable, relative to neighboring bins. The mean duration in the 0.4 bin is 22% higher than that for the next lowest bin (21.3 days) and 55% higher than for the next highest bin (16.7 days).

4.3. Position increases beyond the disclosure threshold

Investors spend more time just below the disclosure threshold, but do they do so simply because they are hesitant and will eventually cross the threshold or are they avoiding disclosure altogether? To identify which of these possible explanations apply, for each reporting bin, we study whether investors' next position change is an increase or decrease. The rationale behind it is that fewer increases from the 0.4 bin suggest that investors avoid disclosing some positions entirely. We deliberately leave aside the time dimension by looking at the event "next position change is an increase," instead of the event "increase on the next day." While a reduced occurrence of the former would suggest absolute disclosure avoidance, a reduced occurrence of the latter would be ambiguous. It could constitute absolute avoidance or hesitance, or both.

Table 5 contains the results. In the overall sample, the 0.4 bin exhibits the lowest relative frequency that the next position change represents an increase. The difference is significantly lower than all other bins, except when

[9] The excess mass for record-high positions is 8.2 percentage points. These record-high positions account for 64.8% of all positions, so the overall excess mass in the 0.4 bin is approximately 5.3 percentage points. Relating this value to the share of public short positions (21.1%) yields a fraction of 25.2%.

[10] The durations in the bins are prone to outliers, so we winsorize the upper tail at 99% before reporting the mean. The results are qualitatively the same without winsorization. The results are also robust to using the median value of duration, as detailed in the Online Appendix.

Table 5
Frequency of position increases.
This table shows the relative frequency with which the next position change is an increase, conditional on currently having a position in a specific reporting bin. Short positions are reported in bins of 10 basis points (bps), starting from 0.2% of the 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 above are disclosed to the public. Reporting bins greater than or equal to 1.0% are summarized in one group. The rows in the table, indexed by k, correspond to the resulting nine bins. The table reports the relative frequency of increase in each reporting bin. In addition, it displays the difference in relative frequency between the 0.4 bin and other bins and the corresponding p-values. The results refer to the overall sample and two subsamples, reflecting a split of the sample into short positions at their record high and positions below their record high. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

			Overall			Positions at their record high			Positions below their record high		
	k	Bin	Relative frequency of increase	Difference Row 3 - k	p-value	Relative frequency of increase	Difference Row 3 - k	p-value	Relative frequency of increase	Difference Row 3 - k	p-value
undisclosed	(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)

compared with the 0.2 bin. When we again split the sample into positions at and below their record level, we find that the avoidance effect in the 0.4 bin is driven by former positions. The frequency of increasing an at-the-record-high short position takes a minimal value of 33.8% for the 0.4 bin. The differences in frequency to the 0.3 and 0.5 bins are 8.5 and 17.6 percentage points, respectively. In relative terms, in the 0.4 bin, it is 20% and 34% less likely to increase a short position than it would be in its two neighboring bins. Overall, bunching below the disclosure threshold reflects a substantial share of positions that do not increase beyond the disclosure threshold.

4.4. Strategic behavior when crossing the disclosure threshold

The evidence thus far indicates that a sizable share of positions do not increase once they reach the 0.4 bin. How do investors behave if they decide to cross the disclosure threshold? They could wait strategically for a favorable time and, after disclosing their position, immediately establish a very large position. If investors hesitate before crossing the threshold, such behavior could contribute to positions bunching below the disclosure threshold.

If investors wait before eventually crossing the disclosure threshold, this behavior would be reflected in a longer duration in the 0.4 bin, compared with neighboring bins. To detect possible hesitance, we repeat our duration analysis with the subsample of positions whose value eventually increases with the next change. The results in Table 6 provide no support for this hypothesis. For positions that eventually increase, the mean duration in the 0.4 bin is only slightly larger than those in neighboring bins, and the differences are economically and statistically insignificant. We also find no significant difference when conditioning on positions at their record high. The slightly longer duration could suggest that investors occasionally wait for a short time before disclosing, but this appears to be a less prevalent strategy. Economically, it is clearly not the main driver of bunching below the threshold.

Next, we investigate whether investors establish a large short position immediately after they cross the disclosure threshold. To do this, we compute the average position change, given that a position increase occurs, and compare the average position increase across the various reporting bins from which they started. The results, shown in Table 7, do not support the large jump hypothesis. That is, when a position's starting point is the 0.4 bin, the average increase in position is 0.114 percentage points, which is not significantly larger than in any other starting bin. We do not find any unusual pattern when confining our sample to positions at their record highs. Overall, the accumulation of short positions just below the disclosure threshold appears to be driven mainly by investors who never cross the threshold, not those who hesitate before making a public disclosure.

4.5. Secrecy at the investor level

Building on our finding that bunching below the disclosure threshold originates from positions that never cross the threshold, we now aim to understand better what drives this behavior. If we observe secrecy in relation to one position held by a particular investor, is that then a characteristic of the investor's overall behavior with regard to disclosing or concealing positions? To answer this question, for each position, i.e., each investor-stock pair (i, j), we first calculate the maximum position value reached:

$$Position\ maximum_{i,j} = \max_{t=1,2,\ldots,T_{i,j}} bin_{i,j,t}, \tag{2}$$

where $T_{i,j}$ is the total number of trading days for the investor-stock pair (i, j). We then calculate the maximum position value reached by each investor across all positions:

$$Investor\ maximum_{i} = \max_{j=1,2,\ldots,S_i} \max_{t=1,2,\ldots,T_{i,j}} bin_{i,j,t}, \tag{3}$$

Table 6
Is there hesitance before crossing the disclosure bin?
This table repeats the duration analysis used in Table 4, conditional on positions that eventually increase with the next change. The rows in the table, indexed by *k*, correspond to nine bins as in Table 4. The table reports the mean number of trading days spent in each disclosure bin. In addition, it displays the difference in mean duration between the 0.4 bin and other bins and the corresponding *p*-values. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

			Overall			Positions at their record high			Positions below their record high		
	k	Bin	Mean duration	Difference Row 3 - *k*	*p*-value	Mean duration	Difference Row 3 - *k*	*p*-value	Mean duration	Difference Row 3 - *k*	*p*-value
undisclosed	(1)	0.2	13.9	−0.2	(0.883)	16.7	−0.3	(0.862)	11.4	−1.2	(0.339)
	(2)	0.3	12.5	1.2	(0.288)	14.5	1.9	(0.300)	10.3	−0.2	(0.901)
	(3)	0.4	13.8			16.4					
disclosed	(4)	0.5	11.8	1.9	(0.209)	13.1	3.3	(0.152)	9.7	0.5	(0.769)
	(5)	0.6	10.0	3.8**	(0.024)	10.8	5.7**	(0.034)	8.9	1.2	(0.439)
	(6)	0.7	10.9	2.9	(0.134)	10.9	5.5*	(0.059)	10.9	−0.7	(0.708)
	(7)	0.8	8.8	4.9**	(0.026)	9.2	7.2**	(0.025)	7.9	2.3	(0.354)
	(8)	0.9	10.9	2.9	(0.242)	9.0	7.5**	(0.033)	15.0	−4.9	(0.121)
	(9)	≥ 1.0	9.6	4.1***	(0.001)	10.0	6.4***	(0.000)	8.7	1.5	(0.324)

Table 7
Average position change when a position increase occurs.
This table shows the average position change for all the reporting bins that were the starting bin for position increases. In addition, it displays the differences in means of Row 3, the 0.4 reporting bin, relative to Row *k*, and the corresponding *p*-values. The table displays position changes for the overall sample and for two subsamples, reflecting a split of the sample into short positions at their record high versus positions below their record high. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

			Overall			Positions at their record high			Positions below their record high		
	k	Starting bin	Mean position change	Difference Row 3 - *k*	*p*-value	Mean position change	Difference Row 3 - *k*	*p*-value	Mean position change	Difference Row 3 - *k*	*p*-value
undisclosed	(1)	0.2	0.111	0.003	(0.394)	0.109	0.007	(0.147)	0.112	−0.001	(0.830)
	(2)	0.3	0.111	0.003	(0.378)	0.112	0.005	(0.331)	0.110	0.001	(0.882)
	(3)	0.4	0.114			0.117			0.111		
disclosed	(4)	0.5	0.121	−0.007*	(0.088)	0.116	0.001	(0.894)	0.130	−0.019***	(0.005)
	(5)	0.6	0.123	−0.009**	(0.037)	0.121	−0.004	(0.503)	0.127	−0.016**	(0.011)
	(6)	0.7	0.122	−0.007	(0.133)	0.124	−0.008	(0.275)	0.117	−0.006	(0.306)
	(7)	0.8	0.126	−0.012**	(0.018)	0.123	−0.006	(0.360)	0.135	−0.024***	(0.004)
	(8)	0.9	0.131	−0.017***	(0.004)	0.121	−0.004	(0.588)	0.156	−0.045***	(0.000)
	(9)	≥ 1.0	0.119	−0.005	(0.368)	0.113	0.003	(0.664)	0.131	−0.020**	(0.023)

where S_i is the total number of stocks in which investor *i* holds short positions.

Fig. 2 shows the frequency of short positions according to the maximum bin reached, as defined in Eq. (2), and reveals two important patterns. First, we find further support for the avoidance effect, in that positions that never cross the disclosure threshold (maximum of 0.4) are the largest group, accounting for 22.8% of all open short position days. Second, many of the positions with a position maximum of 0.4 originate from investors with an overall maximum of 0.4. In other words, positions just below the disclosure threshold largely are held by investors who remain below that threshold for all of their positions, throughout the entire sample period. For positions with other maximum reporting bins, the corresponding share of positions, for which position maximum equals investor maximum, is strikingly lower. This finding suggests that the decision to stay below the radar is investor-specific and that investors stick to their decision to keep their short positions secret. To shed further light on the underlying driver of investors' secretive behavior, we consider the characteristics of positions that reach the reporting bin just below the disclosure threshold but stay below that threshold for the entire period.

5. Performance of secretive positions

In this section, we analyze the trading performance associated with secretive positions. Using the definition from Eq. (2), we compare the returns of positions with similar magnitudes around the disclosure threshold. We form a portfolio of positions with a maximum of 0.4 and compare it with a portfolio of positions with a maximum of 0.5. We refer to those in the first portfolio as secretive positions and those in the second as non-secretive.[11]

We include a stock in one of the two portfolios if the corresponding short position is greater than the 0.2

[11] Not all positions with a maximum of 0.4 are driven by investors' avoidance of disclosure. For some, this value is simply optimal, irrespective of the disclosure threshold. This possibility creates a more conservative test, because it reduces the chances of finding any differences in characteristics between the position groups just below the disclosure threshold and those just above it.

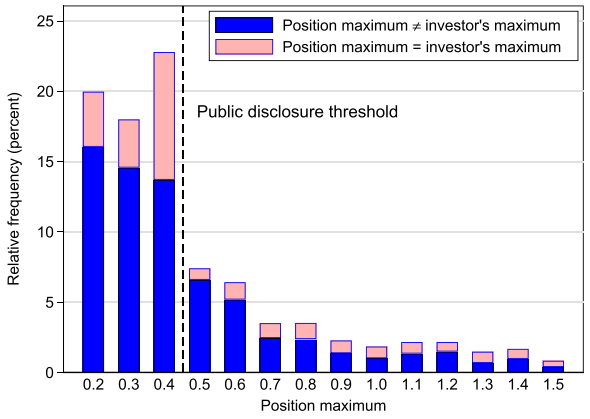

Fig. 2. Distribution of open short positions according to the maximum bin reached. This figure shows the distribution of short position days (investor-stock-day observations) according to the maximum bin reached by the position. Positions that never cross the disclosure threshold and a maximum of 0.4 account for the largest percentage (22.8%) of short position days. The top segment of the bars indicates the share of positions for which the position maximum is also the investor's maximum. Reporting bins greater than 1.5% are truncated for readability. The sample contains all investors with short position notifications in German domestic equity in the regulated market from November 5, 2012 to March 31, 2015.

threshold the day before and exclude it if the position fell below 0.2 the day before. This timing convention is conservative. It assumes that investors are trading at the end of each day. To form the portfolios, we weight the stock by the number of short positions with maximums of 0.4 and 0.5. We estimate the daily risk-adjusted returns (alphas) of the two portfolios with different factor models, including the capital asset pricing model (CAPM) (Sharpe, 1964; Lintner, 1965), Fama and French (1993) three-factor model, and Carhart (1997) four-factor model. To estimate standard errors, we follow Newey and West (1987), and the lag length reflects the findings from the optimal lag-selection algorithm proposed by Newey and West (1994).

The results of the performance comparison are in Table 8, Panel A. Stocks with secretive short positions achieve average negative alphas of -4.12 to -4.74 bps per day, statistically significant across all three factor models. These abnormal returns are also significantly lower, by around 5 bps, than those of stocks with public short positions and a maximum of 0.5. Building on our finding that many secretive positions originate from short sellers that never disclose any positions, we study how stocks perform when both the position and the investor maximum is 0.4. For these positions, alphas increase in absolute terms and range between -4.79 and -5.58 bps per day. For brevity, the remaining analyses in this section rely on the full four-factor Carhart (1997) model, which yields the most conservative alpha estimates.

In addition to using a portfolio approach in which we compute average daily returns, we calculate the return for an entire episode of a short position, following the short seller's position from the moment it moves above the 0.2 threshold up to the point when the position falls below 0.2. This measure directly incorporates position duration and enables us to gauge the practical profitability of shorting strategies. Panel B of Table 8 contains the average alpha for secretive and non-secretive positions. The return difference between them is statistically and economically large, equating to -2.05% and -3.12% per short position episode. The median durations of secretive position episodes and their public benchmarks are 27 and 33 trading days, respectively. The results from both these approaches suggest that secretive positions have an informational advantage compared with non-secretive positions.

We now study the nature of secretive investors' superior performance. We ask whether the abnormal returns shown in Panels A and B of Table 8 come from investors' skill in detecting mispriced stocks. To answer this question, we build on a framework similar to that which Engelberg, Mclean, Pontiff (2018a) use to study the source of stock market anomalies. The intuition behind our test is as follows: If profits from secretive positions are based on shorting stocks that are overpriced, we expect the overpricing to be corrected when public cash flow news arrives. In other words, profits should be particularly high on days with news.

Accordingly, we decompose the performance of secretive positions into days on which firm-specific information was released, including earnings announcements and ad hoc corporate disclosures, versus all remaining days. In addition to regular earnings announcements, publicly traded companies in Germany have a statutory obligation to disclose any facts relating to their company that could affect the stock price immediately. Similar to the US Form 8-K reporting requirement, ad hoc news in Germany refers only to firm-specific information that is relevant to its valuation, not to information about the overall market or certain industries. To estimate the magnitude of each component, we use a regression-based, generalized calendar-time portfolio approach (Hoechle et al., 2016). The regression framework can include multiple explanatory variables, instead of requiring portfolios to be constructed for each variable of interest. In this generalized approach, the Driscoll and Kraay (1998) standard errors are robust to general forms of cross-sectional dependence, autocorrelation, and heteroskedasticity.

In Column 1 of Panel C, Table 8, we show the results obtained when we replicate the calendar-time portfolio approach from Panel A of Table 8.[12] We then decompose the returns into returns generated on days with fundamental news releases and on days without them, as indicated in Columns 2–4 of Panel C. We set the value of the indicators to one for all position days with a fundamental news release. To ensure that we capture price reactions to fundamental news released after trading hours, we also flag the day following an event. This exercise yields two

[12] If we use the excess return for each position day as the dependent variable and the asset-pricing factors as explanatory variables, the Hoechle et al. (2016) estimation procedure yields exactly the same point estimates of alphas and corresponding standard errors as the portfolio approach. Following Hoechle et al. (2016), we estimate a weighted least squares (WLS) regression with observation weights that match the implicit weighting scheme of the calendar-time portfolio approach. This procedure enables us to replicate the results in Panel B of Table 8 and provides a robust decomposition of the return when we include additional explanatory variables.

Table 8
Performance analysis.
Panel A reports the average daily risk-adjusted return [in basis points, (bps)] of stocks associated with short positions with a maximum of 0.4 (secretive positions) and a maximum of 0.5, as well as the difference between them. It also reports the performance of positions that remain below the disclosure threshold and that originate from investors who always have remained just below this threshold (position and investor maximum: 0.4 bin). Stocks are weighted by the number of positions in each group, and the portfolio excess returns are regressed on market excess return (MKTRF), the size (small-minus-big, SMB) and value (high-minus-low, HML) factors, and the momentum factor (winner-minus-loser, WML), depending on the factor model. The alpha estimates are from time series regressions, and the *t*-statistics in the parentheses are computed with Newey-West standard errors, using the optimal lag selection proposed by Newey and West (1994). Panel B reports the average Carhart (1997) risk-adjusted return (percent) for short-selling episodes within each group and the return difference between them. A short-selling episode is defined as being from the day a position reaches the reporting bin 0.2 up to the point when it falls below it again. Panel C reports the average Carhart (1997) risk-adjusted daily return (bps) of stocks associated with secretive positions and also decomposes the average return into returns generated on days when firm-specific fundamental news is released and days when no news is observed. Estimates are from the Hoechle et al. (2016) regression framework, which provides an exact replication of the calendar-time portfolio approach from Panel A. The *t*-statistics, shown in parentheses, are computed with Driscoll and Kraay (1998) standard errors. The estimates in Column 1 correspond to those in Panel A when we use time series regressions with Newey-West standard errors. Columns 2-4 report the average risk-adjusted returns on earnings announcement days, firm-specific ad hoc news days, and days on which no firm-specific news is observed. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Panel A: Performance in bps per day

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Positions max.: 0.4 bin		Positions and investor max.: 0.4 bin		Positions max.: 0.5 bin		Positions max.: Difference in means		Positions and and investor max.: Difference in means	
Model	α	*t*-statistic	α	*t*-statistic	α	*t*-statistic	Δ	*t*-statistic	Δ	*t*-statistic
CAPM	−4.15*	(−1.72)	−4.82	(−1.50)	1.34	(0.57)	−5.49***	(−2.86)	−6.16**	(−2.57)
Fama-French	−4.74***	(−2.66)	−5.58**	(−2.39)	0.68	(0.39)	−5.42***	(−2.89)	−6.27***	(−2.66)
Carhart	−4.12**	(−2.36)	−4.79**	(−2.14)	0.75	(0.41)	−4.87***	(−2.72)	−5.54***	(−2.58)

Panel B: Performance in percent per shorting episode

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Positions max.: 0.4 bin		Positions and investor max.: 0.4 bin		Positions max.: 0.5 bin		Positions max.: Difference in means		Positions and and investor max.: Difference in means	
Model	α	*t*-statistic	α	*t*-statistic	α	*t*-statistic	Δ	*t*-statistic	Δ	*t*-statistic
Carhart	−2.67***	(−5.47)	−3.74***	(−4.34)	−0.62	(−0.66)	−2.05*	(−1.95)	−3.12**	(−2.46)

Panel C: Trading on fundamental news

	(1)	(2)	(3)	(4)
		Days with		
Model	All days	Earnings news	Ad hoc news	No firm news
Carhart	−4.12**	−27.21	−67.84***	−2.15
	(−2.36)	(−1.35)	(−3.31)	(−1.32)
Number of observations	63,390	2,013	1,169	60,390

important findings. First, secretive investors take short positions in stocks for which future negative earnings announcements and corporate ad hoc news are subsequently released. The average daily abnormal return of secretive positions amounts to an economically large -27.21 bps on earnings announcement days and even to -67.84 bps on other days. This reaffirms our previous findings that secretive positions are based on private information that is subsequently released. Second, and possibly more important, although corporate news days represent only 4% of trading days in a year, around 48% of the performance of secretive positions is generated on those days. Thus, trading on mispricing can explain almost half of the profits from secretive positions. The remaining days can even include other types of news that short sellers could trade on but that are not firm-specific, such as macroeconomic or industry news. Such news is not captured in our analysis. Therefore, our estimate represents only the lower bound of profits that can be attributed to overpricing.

6. Understanding investors' avoidance of position disclosure

A considerable number of short sellers avoid passing the publication threshold and, at the same time, appear to possess superior information that enables them to detect overpriced stocks. These findings are at first sight puzzling. Secretive investors could generate higher profits if they increased their position above the disclosure threshold. In addition, copycat investors that follow the disclosed position could even help prices to converge faster to their fundamental value. So the question arises: What are the economic incentives for investors to conceal their positions? We discuss and test two mutually nonexclusive motives for secrecy.

First, short sellers could seek to protect their proprietary trading strategies from reverse engineering by copycat investors. To protect their strategies, informed secretive investors forgo higher profits in single positions

to maintain the long-term profitability of their underlying strategies. Second, investors could be worried about their ability to maintain and close a short position after it becomes public. They could fear that, after disclosure, rising demand for shorting would increase the costs of borrowing securities. In extreme cases, it could trigger a recall of the borrowed securities or a short squeeze. The higher lending fees or short squeezes could be driven by the actions of issuers and large long-side investors, as they attempt to combat the short seller (Lamont, 2012).[13]

6.1. Investor characteristics and general disclosure practices

We explore which specific investor characteristics are associated with avoidance of disclosure. As with the performance analysis, we use the definition from Eq. (2) and compare positions with similar magnitudes around the disclosure threshold. We analyze which characteristics are most closely associated with either secretive or non-secretive positions.

Panel A of Table 9 contains the results for a set of investor characteristics. As a more formal test of the pattern shown in Fig. 2, the first variable indicates whether the position maximum equals the overall maximum reached by the investor. Almost 40% of positions that reach a maximum of 0.4 are held by investors for whom this is also their overall maximum. This share is statistically and economically different from the value in the 0.5 bin, where the corresponding share is only 11%. This result shows that most secretive positions are taken by investors who are always secretive about their positions. Such a trading pattern is in line with the notion that certain investors adopt a policy of never disclosing any short position.

Building on this observation, we analyze whether disclosure avoidance is linked to other measures of investor opaqueness. We start by considering two rough proxies for opaqueness, relating to investor type and domicile. In terms of investor type, hedge funds are generally more opaque than other investors and tend to guard their trading strategies very well. In terms of domicile, the proxy we use is whether the investor is domiciled in a country that is a tax haven. The fact that these countries have few disclosure requirements makes keeping strategies secret easier. The results shown in Panel A of Table 9 indicate that disclosure avoidance is linked to both of these factors. Positions just below the publication threshold are held more by hedge funds and investors domiciled in tax havens than positions just above it. Although it is not directly related to opaqueness, for the sake of completeness, we compare the investors in terms of size. We find some evidence that the size of the fund, as measured by the market capitalization of observable holdings, is slightly smaller for secretive positions than for non-secretive positions, but the difference between the two is only marginally significant at the 10% level.[14]

Next, we analyze whether secrecy in short positions extends to investors' long positions. If protecting their strategies from reverse engineering is an underlying factor in investors' behavior, we would expect them to generally avoid disclosure, be it on the long side or the short side. Investment firms can avoid disclosing long positions by making use of exemptions permitted by different regulations. To determine whether an investor is avoiding long position disclosure, we use the FactSet ownership database (formerly LionShares), which collects data on public disclosures worldwide. We exploit the rich coverage of this database and posit that institutional investors with no public ownership record, and thus no entry in the FactSet database, tend to follow a strategy of opaqueness. As a second proxy, we look at whether the investor is actively seeking exemption from holdings reporting. Even though institutional investment managers who are active in US financial markets are obliged to disclose their quarterly holdings with the SEC through Form 13F, some avoid disclosure as private funds, using an exemption under Regulation D. We therefore search the SEC's Electronic Data Gathering, Analysis, and Retrieval (EDGAR) database for Form D filings and match the variable to our sample using investor names.

The results in Table 9 show that secrecy in short positions is strongly linked to secrecy on the long side. Compared with non-secretive positions, secretive positions are held to a greater extent by investors for whom no public ownership filings are on record. This difference is of a sizable magnitude. For example, investors with no FactSet entry account for 17.61% of all secretive positions and only 2.65% of non-secretive positions. Private funds account for 16.66% of all secretive positions and for only 3.40% of non-secretive positions.

In summary, secretive short positions tend to originate from investors who keep all their short positions secret. Moreover, secrecy for short positions is closely linked to secrecy for long positions. These results are consistent with the notion that short sellers avoid disclosure to protect their proprietary trading strategies from outside investors.

6.2. Trading strategies and relative performance rankings

We now explore how disclosure behavior in relation to short positions is connected to the investors' underlying trading strategies. We first analyze the self-reported primary hedge fund categories provided by Lipper TASS. To merge each category indicator to short position disclosures on fund company level, we use the dominant style category in terms of assets under management (AUM) within a fund company and match institutions by name. Panel B of Table 9 shows that long-short hedge funds account for 54.08% of secretive positions but only for 30.09% of non-secretive positions, with the difference being statistically

[13] Another motive for avoiding disclosure is the fear of harming firm relations. Disclosure avoidance is mainly attributed to private hedge funds (Section 6.1), for which this motive is less relevant than it could be for banks or traditional asset managers.

[14] This result should be interpreted with caution, because information about portfolio assets is not available for all investors. Data on secretive positions are less available than non-secretive positions, as a direct outcome of the opaqueness of these investors.

Table 9
Characteristics of secretive positions.

For each investor-stock pair, we determine the maximum bin reached during the sample period. We compare positions that never have been public but have reached the 0.4 bin at least once (position maximum: 0.4 bin) with those that have just exceeded the public disclosure threshold (position maximum: 0.5 bin). In Panels A and B, we compare the different positions in terms of several investor characteristics, reporting means, the difference in means Δ, and the respective *p*-value, and we also cluster standard errors at the investor-stock level. Here, *N* denotes the number of observations (investor-stock-days) in each group. In Panel C, we report the same statistics using a list of stock characteristics associated with illiquidity, borrowing costs and risks, and other related factors. For details on how the variables were calculated, see Table A.1. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Position max.: 0.4 bin		Position max.: 0.5 bin		Difference in means	
Variable	*N*	Mean	*N*	Mean	Δ	*p*-value
Panel A: General investor characteristics						
Dummy: Investor maximum = position maximum (percent)	63,454	39.94	20,801	10.99	28.95***	(0.000)
Dummy: Hedge fund (percent)	63,454	81.51	20,801	72.80	8.71*	(0.092)
Dummy: Tax haven (percent)	63,454	6.89	20,801	2.17	4.72**	(0.020)
Dummy: No FactSet entry (percent)	63,454	17.61	20,801	2.65	14.96***	(0.000)
Dummy: Private fund (percent)	45,107	16.66	17,897	3.40	13.26***	(0.004)
ln(Total assets)	40,535	22.06	16,536	22.78	−0.72*	(0.095)
Panel B: Trading strategies, relative performance, and flow-performance sensitivity						
Dummy: Long-short hedge fund (percent)	11,610	54.08	4,271	30.09	24.00*	(0.059)
Dummy: Market-neutral hedge fund (percent)	11,610	8.57	4,271	0.19	8.38**	(0.030)
Strategy Distinctiveness Index^{VW}	9,511	0.74	2,483	0.56	0.17***	(0.002)
Strategy Distinctiveness Index^{EW}	9,511	0.72	2,483	0.63	0.09**	(0.030)
Bloomberg rank (1–100)	12,428	44.80	3,929	53.64	−8.84**	(0.032)
TASS percentile rank (0–100)	11,357	38.42	4,271	52.91	−14.48***	(0.006)
TASS percentile rank within style (0–100)	11,357	48.28	4,271	59.51	−11.23***	(0.001)
Flow-performance sensitivity (raw returns)	10,797	1.10	3319	0.18	0.92***	(0.006)
Flow-performance sensitivity (CAPM α)	10,417	1.01	2398	0.33	0.67*	(0.060)
Panel C: Borrowing costs, risk, and other stock characteristics						
ln(Market capitalization)	63,454	7.60	20,801	7.68	−0.08	(0.626)
ln(Turnover)	62,705	−5.55	20,345	−5.47	−0.08	(0.332)
ln(Amihud illiquidity)	62,705	−5.93	20,345	−6.10	0.17	(0.452)
ln(Bid-ask spread)	62,990	−5.06	20,801	−5.14	0.08	(0.176)
ln(Return volatility)	62,990	0.75	20,801	0.70	0.05	(0.155)
Price Squeeze Indicator (DIPS, 0–100)	63,375	28.17	20,792	28.10	0.07	(0.854)
Days to cover (DTC)	63,135	12.60	20,344	12.57	0.02	(0.986)
Institutional ownership (percent)	63,454	25.61	20,801	28.26	−2.65	(0.129)
Number of institutional investors	63,454	418.68	20,801	411.13	7.55	(0.884)
Block holder ($\geq$ 3%) ownership (percent)	63,454	3.92	20,801	4.50	−0.57	(0.425)
Number of block holders ($\geq$ 3%)	63,454	0.86	20,801	1.02	−0.16	(0.296)
Largest five institutional ownership (percent)	63,454	9.61	20,801	10.05	−0.44	(0.500)
Passive investors' ownership (percent)	63,454	3.20	20,801	3.41	−0.21	(0.536)
Fraction of lendable stocks (percent)	63,451	15.95	20,801	16.77	−0.82	(0.365)
Inventory concentration (HHI, 0–100)	63,451	15.20	20,801	14.16	1.04	(0.126)
Lender concentration (HHI, 0–100)	63,451	21.35	20,801	20.82	0.53	(0.665)
Utilization (percent)	63,451	31.68	20,801	28.94	2.74	(0.343)
Indicative fee (percent)	63,439	1.61	20,800	1.30	0.31	(0.139)
Dummy: "On special" (percent)	63,454	23.02	20,801	20.91	2.11	(0.603)
Standard deviation of fee (percent)	62,957	0.69	20,793	0.59	0.10	(0.319)
Standard deviation of utilization (percent)	62,957	12.75	20,793	13.00	−0.25	(0.784)
Fee tail risk (percent)	62,957	3.11	20,793	2.54	0.57	(0.139)
Utilization tail risk (percent)	62,957	53.69	20,793	51.46	2.24	(0.487)
Dummy: Futures or listed options (percent)	63,454	39.94	20,801	34.28	5.66	(0.276)
Dummy: M&A acquiring company (percent)	63,454	1.05	20,801	1.11	−0.06	(0.926)
Dummy: Convertible bonds (percent)	63,454	30.38	20,801	34.57	−4.19	(0.477)
Convertible bonds equity risk hedge ratio	16,478	0.23	6,321	0.25	−0.02	(0.607)

significant. We find a similar pattern for the related but distinct group of funds that follow a market-neutral equity strategy. Hedge funds of this type account for 8.57% of secretive positions but exhibit almost no non-secretive positions. Both long-short and market-neutral hedge funds are arguably more likely to base their trades on specified signals and rules. Hence, the results above are suggestive of secretive investors pursuing rule-based trading strategies.

We then examine the distinctiveness of investors' underlying trading strategies. If disclosure avoidance of short positions is associated with investors guarding their investment strategies against reverse engineering, we would expect the nondisclosure to come from investors with unique, profitable strategies that are worth protecting. The challenge in this context is that the exact strategies of hedge funds are well-guarded secrets. To resolve this issue,

we utilize the strategy distinctiveness index (SDI) developed by Sun et al. (2012). The construction of the measure relies on a model-free approach that does not require information about funds' individual positions but exploits the co-movement between funds' past returns. The SDI quantifies the degree to which a hedge fund follows an investment strategy that is distinct from its peers. The intuition is that only unique strategies can generate superior performance, because any potential profits in well-known and heavily traded strategies are competed away quickly.

Following Sun et al. (2012), we compute a hedge fund's SDI as 1 minus the correlation between the fund's return and that of its peers, based on monthly data for the previous three years. The SDI ranges between 0 and 2 and represents a distance measure. The higher the SDI, the farther a fund is from its peer group and the more distinctive is its strategy. Building on the original paper and previous literature (Brown and Goetzmann, 1997; 2003), we use a statistical clustering approach to group funds into ten categories and determine their peers using three years of past returns. We construct two versions of the SDI measure depending on whether the mean style return is computed with equal-weighted fund returns or by weighting the returns with the value of each fund's AUM. We construct the SDI measure for all hedge funds covered by the Lipper TASS database, excluding fund of funds as suggested by Sun et al. (2012). To merge the strategy distinctiveness of funds with their short position disclosures at the fund company level, we compute the SDI as the AUM-weighted SDI across all the funds within a fund company and match institutions by name. This matching procedure is based on methods advocated in the hedge fund literature (e.g., Agarwal et al., 2013a; 2019).

Regarding the disclosure threshold, we put forward the following hypothesis. If short sellers avoid disclosing their short positions because they fear that competitors will reverse engineer their profitable strategies, those investors will be more likely to follow distinctive investment strategies. The results shown in Panel B of Table 9 support this hypothesis. When fund returns within each style are value weighted, the SDI measure of funds with a secretive short position is 0.74, compared with 0.56 for those with non-secretive short positions. The difference of 0.17 is statistically and economically significant. In our sample, the mean of SDI is 0.58 and its standard deviation is 0.26. We find similar results if we equal-weight instead of value-weight returns within style clusters.

We next examine whether the unique strategies that secretive investors follow are also successful. This exercise complements the performance analysis of short positions (see Table 8) but considers the overall fund performance in relative terms. The remuneration scheme for asset managers reflects a tournament setting, in which compensation depends on performance relative to the other participants (Brown et al., 1996).

To test this link between relative success and the decision to remain below the disclosure threshold, we turn to two hedge fund rankings: Bloomberg Markets' annual performance ranking and our own performance ranking based on the Lipper TASS database. Bloomberg Markets' annual performance ranking for hedge funds managing $1 billion or more in assets is based on a broad database of hedge funds, which represents its main advantage. With this source, we can identify and match only those funds that are ranked in the top one hundred. Therefore, we also construct an annual ranking table using the hedge fund universe of Lipper TASS and rank funds on the basis of their past year's performance. To include a fund in these rankings, we require it to not have a missing AUM value, which gives approximately four thousand to five thousand funds for each year. Compared with the Bloomberg performance table, these rankings go far beyond the top one hundred performers. However, they are based solely on the sample of funds reported by Lipper TASS. We compute the fund company rank as the average AUM-weighted rank across all funds within a fund company and match it to the short positions by institution name.

In Panel B of Table 9, we report the average for the various ranking measures. Notably, secretive short positions are held by investors ranked almost nine positions higher in the Bloomberg rankings than those with short positions that have just crossed the disclosure threshold. With the rankings from the Lipper TASS database, we find similar results. Compared with those with public positions, short sellers with secretive positions have a much better ranking (i.e., a significantly lower percentile rank). This result remains robust if we rank investors' performance within hedge fund style categories. To sum up, the underlying trading strategies of investors who avoid short position disclosure are not just unique but also perform significantly better than those of non-secretive investors.

Next, we look at how investors' disclosure behavior is linked to the potential consequences of their lucrative strategies being competed away by others. In general, funds with the highest rank in terms of past returns receive the largest rewards in terms of future inflows (Agarwal et al., 2004; Baquero and Verbeek, 2009; Sirri and Tufano, 1998). As a direct outcome of this relation, hedge funds with a high flow-performance sensitivity lose more in terms of inflows if their profitable strategies are reverse engineered by competitors and profits are competed away. Hence, these funds have a stronger incentive to hide their strategy. Accordingly, we test whether the flow-performance sensitivity of funds with secretive positions differs from that of non-secretive positions. We estimate for each hedge fund in the Lipper TASS universe the sensitivity of flows to relative past performance, using three years' worth of monthly flow and return data. Building on recent evidence from Agarwal et al. (2018), we employ funds' raw returns and the CAPM alpha as performance measures. Further details on the computation of the flow-performance sensitivity are provided in Table A.1. Irrespective of whether we measure relative performance based on raw returns or CAPM alphas, as reported in Panel B of Table 9, we find strong evidence that the flows of secretive hedge funds tend to be more sensitive to the performance relative to their peers in the control group. Differences in the flow-performance sensitivity for secretive and non-secretive positions are 0.92 and 0.67, respectively, both statistically and economically significant.

Overall, the results presented in Sections 6.1 and 6.2 provide a consistent picture that supports the notion that protecting trading strategies from reverse engineering is an explanation of disclosure avoidance. Secretive investors are mainly long-short hedge funds, pursuing investment strategies that are notably different from those of their peers. These strategies yield a significantly higher performance, as reflected in the funds' rankings. Secretive positions are held by investors with a higher flow-performance sensitivity than their peers. To protect their proprietary trading strategies, these investors thus appear to adopt a policy of disclosing as little information as possible. In line with this explanation, secrecy is characterized by short sellers hiding all their short positions and being equally secretive about their long positions.

6.3. Short-selling costs and the risk of higher lending fees

Other concerns for short sellers are that borrowing cost will rise or that disclosing their short position could even lead to a stock recall, due to increased demand by copycat investors. Issuers and long-side investors could take coordinated action to force stock recalls and cause short squeezes. These explanations suggest that disclosure avoidance relates to the stock-specific risk of rising shorting fees, recalls, short squeezes, or crowded trades.

Panel C of Table 9 reports the average values for a list of stock-specific variables associated with secretive positions, non-secretive positions, and the differences between them. Liquidity is crucial for investors who want to cover their positions at the right time or are forced to do so by a recall. If investors avoid disclosure because they fear a recall induced by publication, avoidance should be more marked for illiquid than for liquid stocks, yet our results show that secretive positions do not differ from non-secretive positions in terms of market capitalization, turnover, bid-ask spread, or the Amihud (2002) illiquidity measure. Secretive positions are slightly more volatile than non-secretive positions, but the magnitude is small and statistically insignificant.

Short sellers could be concerned that exiting a position is more difficult if copycat investors decide to exit at around the same time. Hong et al. (2015) show that investors are generally concerned about the costliness of exiting crowded trades and require a premium to enter such trades. Short sellers prefer stocks that enable them to close or cover their positions quickly, without a large price impact. To test whether the cost of exiting crowded trades is also linked to disclosure avoidance by short sellers, we incorporate two additional variables into our analysis. The first variable is days to cover *(DTC)*, the ratio of short interest to trading volume, as proposed by Hong et al. (2015). These authors show theoretically and empirically that the *DTC* measure relates directly to the costliness and risk of exiting crowded trades. Also, it is a classical risk management tool regularly monitored by short sellers (see, Hong et al., 2015). The second variable is Markit's Data Explorers Increase Price Squeeze indicator *(DIPS)*. The *DIPS* compares securities lending data with cash market data (average trade volume and close price) to determine the risk of a rapid increase in price (i.e., price squeeze). The indicator uses a scale of 0% to 100%. This measure is also available to short sellers through Markit's data feed and serves a similar purpose for short sellers as *DTC*. If short sellers avoid disclosure because they are concerned that copycat investors would increase the cost of exiting crowded trades, we would expect them to particularly avoid disclosure for stocks with high *DTC* or *DIPS* values. Panel C of Table 9 shows that this is not the case. The difference in *DTC* and *DIPS* between secretive and non-secretive positions is economically and statistically insignificant. Thus, the results do not lend support for the crowded trades argument.

Short selling becomes more difficult with an insufficient supply of lendable stocks, especially for stocks with low institutional ownership shares (Nagel, 2005). Prado et al. (2016) highlight the importance of ownership structure, and ownership concentration in particular, for the supply of stocks to borrow. Especially when there are already insufficient shares to borrow, or when stock ownership is concentrated in the hands of a few large investors, copycat activity by other investors can lead to higher lending fees. In addition, a high concentration of ownership facilitates coordinated trading among long-side investors, in an effort to combat short sellers (Lamont, 2012). If secrecy is driven by such motives, we would expect a significantly lower supply and higher concentrations of ownership for positions just below the disclosure threshold. Comparing positions to the left and right of the disclosure threshold provides little support for this hypothesis. Considering institutional ownership and ownership concentration proxies (i.e., ownership share held by block holders, number of block holders, ownership share of the five investors with the largest holdings), we find no significant differences between secretive and non-secretive positions. This also holds if we look at the ownership share of passive investors, the share of lendable stocks, or lender and inventory concentration as reported by Markit.

Short squeezes are likely when the percentage of shares on loan is high, relative to loan supply (utilization). If investors fear short squeezes or rising lending fees after publication, they could avoid disclosure when utilization is high or, by the same argument, when short-selling fees are high. According to Panel C of Table 9, secretive positions are not significantly different from non-secretive positions in terms of the average utilization or lending fees. Moreover, we do not find any difference between the two types of positions in the tail of the fee distribution. The difference in the percentage of stocks trading on special, that is, with a lending fee greater than 100 bps, is statistically indistinguishable from zero.

Investors also require a premium for shorting stocks with volatile fees (D'Avolio, 2002; Engelberg et al., 2018b). Stocks with a high variance in lending fees are associated with higher risk, and publicizing a short position for these stocks could trigger an increase in fees. Following Engelberg, Reed, Ringgenberg (2018b), we calculate different state variables that predict future loan volatility. The proxies include the standard deviation of loan fees and utilization measured over the past year, as well as two tail-risk measures of loan fees and utilization. None of these four short-selling risk proxies differs significantly

for secretive versus non-secretive positions. Finally, under the EU regulations, net short positions include exposures through derivatives. If futures and listed options are available for a certain stock, it would be easier to establish and maintain a short position. However, the existence of futures and listed options does not play a role in disclosures.[15] These combined results thus provide no evidence that stock liquidity, crowded trades, inventory supply, concentration of supply, utilization, lending fees, or short-selling risk are associated with short sellers' decisions to remain below the radar.

6.4. Common arbitrage strategies

Short positions could be hedging elements in arbitrage strategies. We therefore explore disclosure decisions by short sellers in relation to two prominent composite strategies whose popularity has grown rapidly: mergers and acquisitions (M&A) and convertible bond arbitrage. According to Barclay Hedge, the AUM of merger arbitrage hedge funds grew from $11.7 billion at the beginning of 2000 to $65 billion by the end of 2017.[16] The convertible bond market has witnessed a similar increase in importance for the hedge fund industry from 2000 onward (e.g. Choi et al., 2009; Brown et al., 2012; Duca et al., 2012).

To determine how investors following these arbitrage strategies behave around the disclosure threshold, we first compute proxies for M&A and convertible bond arbitrage at the stock level. In the case of a stock merger, the arbitrageur shorts the stock of the acquirer and buys shares in the target company. Accordingly, we compute a dummy variable that equals one for every acquirer stock-day between the M&A announcement day and either the completion or withdrawal day. We focus on non-pure cash M&As for which both the acquirer and the target are publicly traded companies. For convertible bond arbitrage, the arbitrageur buys a company's convertible bond and hedges the equity risky by shorting the equity of that company. Therefore, we compute a dummy variable that equals one if the company issued convertible bonds on a given day. Following Agarwal et al. (2011), we also implement a buy-and-hedge convertible bond strategy and estimate equity hedge ratios for each stock-day.

If such strategies make investors either more or less likely to disclose their positions, we would expect to find significant differences between secretive and public positions with regard to our M&A and convertible bond arbitrage proxies. Panel C of Table 9 shows no significant differences. The proportion of acquiring companies with a listed target is around 1% for both public and secretive short positions. The share of stocks with convertible bonds is slightly higher for public short positions (34.57%) than for secretive positions (30.38%), but the difference is statistically insignificant. We also find little difference in the convertible arbitrage hedge ratio: 0.23 for secretive and 0.25 for public short positions.

Overall, we find no evidence that investors following an M&A or convertible bond arbitrage strategy have a strong preference for disclosing or hiding their short positions. These results are consistent with our previous findings. The arbitrage strategies are mainly based on public information and a self-evident short-selling arm, so we would not expect investors to protect their position from competitors or disclose it to convince other investors to follow the same strategy.

7. Implications for stock prices

In this section, we analyze the consequences of investors' avoidance behavior for the price discovery process. That is, the publication requirement for short positions represents an impediment that keeps some investors from increasing their position, and the evidence suggests that these secretive investors are informed. According to studies on limits to arbitrage, when informed investors encounter impediments, prices adjust more slowly in response to private information, and return predictability increases due to prices deviating temporarily from their fundamental values (Shleifer and Vishny, 1997; Gromb and Vayanos, 2010).[17] In the rational expectations model of Diamond and Verrecchia (1987), which defines investors as either informed or uninformed and differentiates between unconstrained traders and those who are prohibited from short selling, prices converge more slowly, and adjustment to private information becomes slower as the proportion of prohibited short sellers increases. Jones et al. (2016), using the DeMarzo et al. (1998) framework, argue that when investors confront an impediment to trading (e.g., a disclosure threshold), it reduces price informativeness.[18]

If the publication threshold restricts short selling for informed investors, the price discovery process should be slower if these secretive investors hold positions just below the threshold. Therefore, these stocks should be temporarily mispriced, and return predictability will be particularly pronounced when investors face this friction. Using the

[15] The size of a short position is also determined endogenously by the costs associated with borrowing and short selling the stock: Small positions can be below the radar because the stock is difficult to short (e.g., low supply, high fees, high short-selling risk), irrespective of the publication threshold. Therefore, positions just below the radar should be associated, to some extent, with higher (but not abnormally high) frictions, more so than positions just above the publication threshold. We do not account for this pattern in our tests, because even without adjusting our null hypothesis to a positive value, we do not find economically or statistically significant differences between secretive and non-secretive positions in terms of the borrowing costs hypothesis.

[16] See the Global Hedge Fund Database of Barclay Hedge at https://www.barclayhedge.com/solutions/assets-under-management/hedge-fund-assets-under-management/merger-arbitrage/.

[17] In general, short-selling risks, such as restrictions or costs associated with establishing a short position, hamper efforts to eliminate mispricing, as has been established by theoretical studies (Miller, 1977; Harrison and Kreps, 1978; Diamond and Verrecchia, 1987; Duffie et al., 2002; Hong and Stein, 2003; Hong et al., 2006). Empirical studies mainly use market-wide short-selling restrictions, such as short-selling bans, or else use stock-specific characteristics to test for the slower process of price discovery and return predictability.

[18] DeMarzo et al. (1998) focus on the regulators' optimal policy in insider trading investigations. They argue that investors' welfare-maximizing outcome entails investigations of large insider trading volumes, whereas small trades remain unpunished. The result is to discourage insiders from trading above a certain threshold. Although they focus on corporate insiders, their arguments and findings apply to any group of informed investors.

following empirical approach, we seek to identify periods in which the disclosure threshold could prevent secretive investors from further increasing their positions:

$$\begin{aligned}&\textit{Secretive position}\\&\textit{just below threshold}_{i,j,t}\\&=\begin{cases}1 & \text{if } \left(\textit{Position maximum}_{i,j}=0.4\right)\cap\left(\textit{bin}_{i,j,t}=0.4\right)\\0 & \text{otherwise.}\end{cases}\end{aligned}\tag{4}$$

As indicated in Section 6, as a proxy for secretive positions we use positions that reach the bin just below the threshold but do not cross it during our sample period. The friction is binding only when the position is in the maximum bin of 0.4, just below the threshold. In other words, we flag any investor-stock pair that has a maximum reporting bin of 0.4 and this maximum has been reached. This measure is diluted by noise, because Eq. (4) defines only a necessary, not a sufficient, condition for the friction to be binding. During these position days, we expect price adjustments to negative information to be slower, resulting in temporary overpricing and predictable negative abnormal returns.

7.1. Publication threshold as a friction

To test the hypothesis about return predictability, we employ a calendar-time portfolio approach, as outlined in Section 5. Thus, we form, on a daily basis, a portfolio of stocks for which we observe a secretive position just below the publication threshold on the previous day.[19] We then measure the average risk-adjusted return of the portfolio by running time series regressions of the returns using the risk factor models in Section 5. If the publication threshold represents a friction to secretive investors, those particular stocks should have future negative abnormal returns, due to the slower price adjustment to information.

Column 3 of Panel A, Table 10, contains the average risk-adjusted returns for the portfolio. Stocks for which investors have secretive positions just below the publication threshold exhibit predictability of strong and statistically significant, negative returns. The return predictability is robust across the CAPM, three-factor model, and four-factor model, with daily alpha values ranging from -5.46 to -6.13 bps, which translates into a return of around -1% per month.[20]

Economically, the predictability effect created by the publication threshold is substantial, especially considering that these short-position notifications are nearly always issued for highly liquid, large-cap stocks (Table 2, Section 3). We reiterate that the measure for identifying restricted investors is diluted considerably by noise, so the estimated return effect of around 5 bps per day likely represents a lower bound.

[19] Most of these stocks (82%) have only one secretive investor. For 14% of stocks, we identify two secretive investors, and the remaining 4% have between three and six secretive investors. The portfolio contains 32 distinct stocks on average, with a median of 31, a minimum of 21, and a maximum of 49 stocks.

[20] In our data, the median time period during which a position is restricted is 16 days, and the mean duration is 41 days.

7.2. Placebo tests

Our finding that abnormal negative returns result when secretive short sellers hold positions just below the disclosure threshold is consistent with the notion of slower price discovery and return predictability stemming from publication avoidance by investors, due to short-sale impediments. To confirm that the return predictability effect is unique to positions just below the disclosure threshold, we employ several placebo tests. In an analysis similar to the one detailed in Section 7.1, we form calendar-time portfolios but use hypothetical publication thresholds below and above the true threshold:

$$\begin{aligned}&\text{Placebo}^{A}_{i,j,t}\\&=\begin{cases}1 & \text{if } \left(\textit{Position maximum}_{i,j}=p\right)\cap\left(\textit{bin}_{i,j,t}=p\right)\\0 & \text{otherwise,}\end{cases}\end{aligned}\tag{5}$$

where p is equal to 0.2, 0.3, 0.5, or 0.6. That is, we look at positions when they reach a maximum, but that maximum is other than 0.4. The corresponding stock enters the placebo portfolio if a position fulfills the conditions in Eq. (5). With this exercise, we rule out the possibility that the negative returns we have identified apply more generally, whenever short positions reach their maximum. If the publication threshold truly constitutes a trading friction, we should find the strongest return predictability for stocks with investors in their 0.4 maximum bin.

Columns 1, 2, 4, and 5 in Panel A of Table 10 report the risk-adjusted average returns for the other maximum reporting bins, with the factor models we used in our previous analyses. Consistent with our hypothesis that the publication threshold imposes binding short-sale constraints, stocks with investors that have a maximum reporting bin other than 0.4 are not associated with significant negative future returns. Even the average return for the closest nonpublic maximum reporting bin, 0.3, is not significantly negative, and its economic magnitude is only a quarter of the return associated with the 0.4 bin. The return effect is thus unique to stocks with investors who hold a position just below the disclosure threshold. It cannot be generalized to other positions.

Another potential concern is that the results in Column 3 of Panel A are entirely driven by informed trading in secretive positions, not by the constraint imposed by the threshold. To determine the constraining effect of the threshold, we compare the returns of the same investor-stock pair when the disclosure threshold is binding versus nonbinding. That is, we consider positions with a maximum bin of 0.4, during periods below the maximum, such that

$$\begin{aligned}&\text{Placebo}^{B}_{i,j,t}\\&=\begin{cases}1 & \text{if } \left(\textit{Position maximum}_{i,j}=0.4\right)\cap\left(\textit{bin}_{i,j,t}<0.4\right)\\0 & \text{otherwise.}\end{cases}\end{aligned}\tag{6}$$

If the return just below the disclosure threshold is driven solely by informed trading, we would expect returns to exhibit similar magnitudes inside and outside the maximum bin phase. Again, we include the stock in the placebo portfolio whenever the short position fulfills the conditions in

Table 10
Short sellers' disclosure avoidance and predictability of stock returns.
This table shows the average risk-adjusted returns of different portfolios constructed on the basis of different maximum reporting bins (Column 1–5). For each investor-stock pair, we determine the maximum reporting bin 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 for which we observe a position at its maximum reporting bin. In Panel B, for each maximum bin, we report the average risk-adjusted return of portfolios that contain all stocks for which we observe a position that is outside the maximum reporting bin. In other words, it is the average return of the stocks not generated in the maximum bin phase. We form a position-weighted portfolio of stocks for each test. We then regress the portfolio returns on market excess return (MKTRF), size (small-minus-big, SMB) and value (high-minus-low, HML) factors, and the momentum factor (winner-minus-loser, WML), depending on the factor model. The table reports alphas (in basis points 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, using the optimal lag selection proposed by Newey and West (1994). *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)	(4)	(5)
Panel A: Performance during the maximum bin phase					
	Maximum reporting bin reached				
Model	0.2	0.3	0.4	0.5	0.6
CAPM	0.30	−0.59	−5.46**	6.37	0.80
	(0.14)	(−0.34)	(−2.00)	(1.64)	(0.21)
Fama-French	−0.36	−1.09	−6.13***	6.30*	−0.22
	(−0.21)	(−0.59)	(−2.83)	(1.71)	(−0.05)
Carhart	−0.09	−1.22	−5.66**	6.02	−1.37
	(−0.05)	(−0.87)	(−2.57)	(1.58)	(−0.36)
Panel B: Performance during other bin phases					
CAPM	–	−4.69	−1.70	0.69	−4.83
		(−1.58)	(−0.64)	(0.28)	(−1.50)
Fama-French	–	−5.23**	−2.02	−0.22	−5.62**
		(−2.16)	(−1.01)	(−0.12)	(−2.26)
Carhart	–	−4.67*	−1.43	−0.18	−5.20**
		(−1.86)	(−0.69)	(−0.09)	(−2.09)

Eq. (6). The average risk-adjusted return for this portfolio is shown in the shaded column in Panel B, Table 10. Outside the maximum bin phase, the average alpha is negative but not statistically different from zero. The stock return predictability that arises when a secretive investor is just below the publication threshold thus cannot be explained by informed trading in this particular stock. The findings hold across all factor models and are in line with the hypothesis that the process of price discovery slows down because investors avoid crossing the publication threshold.

In this context, we use the other reporting bins for comparisons. Is predictability generally stronger during the maximum bin phase than in other phases? Notably, none of the other maximum reporting bins exhibits a pattern similar to the one shown by the bin just below the disclosure threshold. Only for positions with a maximum of 0.4 we can observe that the return in the maximum bin is negative and larger in magnitude than the returns of the same positions below the maximum bin. For all other bins, the average return below the maximum bin is even more negative than the return in the maximum bin.

Overall, we find negative risk-adjusted returns for secretive positions when the investor is just below the disclosure threshold. No negative return predictability arises when we choose various hypothetical publication thresholds above and below the true one. Also, within investor-stock pairs, subsequent negative returns occur mainly when the secretive position is just below the publication threshold and the constraint originating from it is binding. Taken together, these results suggest that the evasive behavior by short sellers in response to the disclosure rule leads to slower price discovery.

8. Robustness tests

We briefly summarize the various robustness checks we carried out for our analyses. Detailed descriptions are in the Online Appendix. First, to consider the distribution pattern of reported short positions more closely, we include the second digit after the decimal point and thus gain an intuition of why the frequency of the short positions spikes around the reporting thresholds, resulting in a U-shaped pattern for each reporting bin (see also footnote 5).

Second, using different sensitivity analyses, we consider whether investors avoid crossing the disclosure threshold. In Section 4, we use a sample split into positions at their record high and below it to show how avoidance is particularly pronounced when investors approach the publication threshold from below, and for the first time. In the Online Appendix, we split the sample another way, dividing it simply into previously increased and previously decreased positions, and we achieve comparable results. This measure is simpler but noisier. It is based solely on the investors' last change of the position, instead of on the entire position history. In addition, to rule out alternative mechanisms that could cause bunching below the disclosure threshold, we conduct panel regressions with a battery of control variables associated with short-selling constraints as well as progressively saturated fixed effects specifications in the spirit of Jiménez et al. (2014).

Third, we provide more details on the construction of the strategy distinctiveness index (Sun et al., 2012) and the flow-performance sensitivity of hedge funds. We also examine alterations of these two measures in the comparison analysis of secretive and non-secretive positions of

Table 9. We change the number of peer groups to calculate the distinctiveness of the fund's strategy, and we shorten the estimation window to compute the flow-performance sensitivity.

Fourth, we conduct a series of sensitivity analyses relating to return predictability, as discussed in Section 7. We apply several modifications to our calendar-time portfolio approach. The effects are robust when we exclude penny stocks or require the duration in the 0.4 bin to be at least five trading days before the publication threshold can be defined as binding. It is similarly robust when we weight stocks equally, instead of by the number of positions, and when we use European, not German, risk factors.

9. Conclusion

Using both public and confidential short-sale notifications, we study how a disclosure threshold for short positions affects investors' behavior and security prices. The findings show that a considerable proportion of short sellers seek to avoid crossing the disclosure threshold, in particular those that are well-informed. Apparently, many short sellers perceive additional transparency as sufficiently costly to forgo economically meaningful profits. Our findings are most consistent with the notion that avoiding disclosure of short positions is part of the investors' general policy of secrecy, designed to protect their underlying investment strategy against reverse engineering by copycat investors. Effectively, the disclosure threshold represents a short-sale constraint for these investors. As a consequence, when this constraint imposed by the disclosure threshold is binding, stocks exhibit a negative abnormal return, such that prices appear to adjust more slowly to private information.

The disclosure rule could also have implications beyond the effects shown in this paper. The net welfare effect of short position transparency remains unknown. We do not observe the response of all agents, such as other traders or companies targeted for short sales. In the spirit of Grossman and Stiglitz (1980), the short-sale disclosure rule can reduce the incentive for investors to collect and process information in the first place, leading to even less stock price efficiency. Conversely, improvements in liquidity and financial stability due to greater transparency could have positive effects on the functioning of stock markets (DeMarzo et al., 1998; Jones et al., 2016). Even with these considerations, our results provide new insights on investors' behavior in response to disclosure requirements, thereby contributing to the ongoing debate about the optimal design of disclosure rules.

Appendix A. Sample construction

We obtain public and confidential short-sale notifications from the German Federal Financial Supervisory Authority. Its notification data include the position holder's name, address and country, the name and ISIN code of the stock being shorted, the net short position in number of equivalent shares and as a percentage of share-issued capital, and the 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 bins of 10 bps by rounding down to the first decimal place, as described in Section 2.1. We delete duplicate notifications (i.e., same information in all variables). For a few days, we find multiple short-sale positions for the same investor-stock pair and keep the most recent positions (identified by the reporting date), which likely represent corrections to previous values. We omit some stale positions, which occur disproportionately in the first days after the regulation has been put in place. A stale position is one that has been reported only once, has never changed, and is still open after six hundred days.[21] 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 consider only domestic common equity in the regulated market. Thus, we keep stocks categorized by Datastream as domiciled in Germany ($GEOG = 30$), equity ($TYPE = \text{EQ}$), and major issuance ($MAJOR = \text{Y}$). We exclude preferred stocks, depositary receipts, real estate investment trusts, and stocks with other special features by screening the names of the stocks. We filter out all stock-day observations when a stock is no longer trading ($P\#T =$ missing value). Using the information from the European Securities and Markets Authority (ESMA) Markets in Financial Instruments Directive (MiFID) database, we keep only shares that have been permitted to trade on the German regulated market.

Noting the concerns of Ince and Porter (2006) about return data from Datastream, we apply filters to the daily return data, as proposed by Karolyi et al. (2012) and Griffin et al. (2010). The return [$r_t = (RI_t/RI_{t-1}) - 1$, 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. Any return greater than 200% is also set to missing.

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

Securities lending data come from Markit Securities Finance Buyside Analytics Data Feed ($market\ area =$ DE Equity), merged using the ISIN.

We obtain the risk-free rate (RF), 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 on AQR's website.[22]

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

[21] Other cutoff points, such as five hundred or 250 days, lead to similar results.

[22] www.aqr.com/Insights/Datasets/Quality-Minus-Junk-Factors-Monthly.

Table A.1
Definitions of variables.

Variable	Description	Source
Amihud illiquidity	$\|r\|/(VC \times 1000 \times P) \times 10^6$, where r is the return in US dollars, VC is the consolidated number of shares traded across all German exchanges (in thousands), and P is the price in US dollars (Amihud, 2002). We winsorize the Amihud illiquidity ratio at 1% at the upper tail and then average it over the last 250 trading days, requiring at least one hundred valid observations.	Datastream
Bid-ask spread	$(PA - PB)/P$, expressed in percentage terms, where P is the stock price, PA is the ask price, and PB is the bid price. We winsorize the bid-ask spread at 1% at the upper tail and then average it over the last 250 trading days, requiring at least one hundred valid observations.	Datastream
Block holder ($\geq$ 3%) ownership (percent)	Percentage of shares held by institutional investors with an ownership share above 3% of the stock's shares outstanding.	Eikon
Bloomberg rank (1–100)	Rank of investor in Bloomberg Markets' annual large hedge funds performance ranking, if listed. Otherwise set to missing.	Bloomberg Markets
Book-to-market ratio	Calculated as $PTBV^{-1}$, where *PTBV* is the price-to-book value. The book-to-market ratio is set to missing if it is below zero.	Datastream
Convertible bonds equity risk hedge ratio	Following Agarwal et al. (2011), we implement a buy-and-hedge strategy, in which the arbitrageur is long in a company's convertible bonds and hedges the equity risk by shorting the company's stock. We estimate for each stock i the equity hedge ratio γ_1 from the following regression spanning a 30-day rolling window: $$R^{CB}_{i,t} = \gamma_0 + \gamma_1 R^{EQ}_{i,t} + \epsilon_{i,t},$$ where $R^{CB}_{i,t}$ is the issue-size weighted portfolio return of all convertible bonds of company i and $R_{i,t}$ is the stock return of company i. We require a minimum of 25 days for our estimation.	Eikon
Data Explorers Increase Price Squeeze (DIPS) indicator (0%–100%)	The indicator compares securities lending data with cash market data (average trade volume and close price) to determine the risk of a rapid increase in price (i.e., price squeeze).	Markit
Daily turnover	$VC/NOSH$, expressed in percentage terms, where VC is the consolidated number of shares traded across all German exchanges (in thousands) and $NOSH$ is the companies' shares outstanding (in thousands). We winsorize the bid-ask spread at 1% at the upper tail and then average it over the last 250 trading days, requiring at least one hundred valid observations.	Datastream
Days to cover (DTC)	The ratio of short interest to trading volume (VC), as proposed by Hong et al. (2015). VC is the consolidated number of shares traded across all German exchanges	Markit, Datastream
Dummy: *Ad hoc news*	Event dummy variable that equals one if there is ad hoc news for that specific stock on that day or previous day.	Deutsche Gesellschaft für Ad-hoc Publizität
Dummy: *Convertible bonds*	Dummy variable that equals one if a company issues convertible bonds.	Datastream
Dummy: *European holder*	Dummy variable that equals one if the investor is domiciled in a European country. German Federal Financial Supervisory Authority (BaFIN)	
Dummy: *Earnings announcement*	Event dummy variable that equals one if there is an earnings announcement for that specific stock on that day or the previous day.	Datastream
Dummy: *Futures or listed options*	Dummy variable that equals one if futures or listed options exist for the underlying stock.	Datastream
Dummy:*Hedge fund*	Dummy variable that equals one if the investor is defined by FactSet as a hedge fund or has no entry in FactSet [similar to the selection criterion used by Brunnermeier and Nagel (2004)].	BaFin, FactSet
Dummy: *Long-short hedge fund*	Dummy variable that equals one if the hedge fund company predominantly [in terms of assets under management (AUM)] pursues an equity long-short strategy (primary category).	Trading Advisor Selection System (TASS), or Lipper TASS Hedge Fund Database
Dummy: *Market-neutral hedge fund*	Dummy variable that equals one if the hedge fund company predominantly (in terms of AUM) pursues an equity market-neutral strategy (primary category).	Lipper TASS Hedge Fund Database
Dummy: *M&A acquiring company*	Dummy variable that equals one for every stock-day since the company announced it would be acquiring a publicly listed firm.	Securities Data Company(SDC) Platinum
Dummy: *No FactSet entry*	Dummy variable that equals one if the investor is not included in the FactSet Ownership database. The ownership information in FactSet originates from public filings, so a nonappearance is indicative of no public record.	FactSet
Dummy: *On special*	Dummy variable that equals one if the indicative fee (per annum) to borrow a stock is above 100 basis points (Prado et al., 2016).	Markit

(*continued on next page*)

Table A.1 (*continued*)

Variable	Description	Source
Dummy: *Private fund*	Dummy variable that equals one if the investor files Form D with the Securities and Exchange Commission (SEC) and seeks private placements under Regulation D. Private placements are not subject to some of the laws and regulations designed to protect investors, such as the comprehensive disclosure requirements that apply to registered offerings.	Electronic Data Gathering, Analysis and Retrieval (EDGAR) SEC database
Dummy: *Tax haven*	Dummy variable that equals one if the investor is domiciled in a tax haven as defined by OECD (2000).	BaFin, Organisation for Economic Cooperation and Development (OECD)
Dummy: *US holder*	Dummy variable that equals one if the investor is domiciled in the United States.	BaFin
Fee tail risk	The 99th percentile of a normal distribution using the estimated mean and standard deviation of the indicative fee over the last 250 trading days (Engelberg, Reed, Ringgenberg, 2018b). We require at least one hundred valid observations for mean and standard deviation computation: mean of fee $+ 2.33 \times$ standard deviation of fee.	Markit
Flow-performance sensitivity	We first run the following regression specification, at every year end, using two or three years' worth of monthly return and flow data for each fund: $\text{Flow}_{j,t} = a + \beta_1 \text{Performance Decile}_{j,t-1,t-12} + \beta_2 \text{Performance}_{j,t-1,t-12} + \varepsilon_{j,t}$, where $\text{Flow}_{j,t} = \frac{\text{AUM}_{j,t}}{\text{AUM}_{j,t-1}} - (1 + r_{j,t})$. $\text{Flow}_{j,t}$ refers to the cash flow of fund j in month t in terms of the percentage of the assets under management. $\text{Performance Decile}_{j,t-1,t-12}$ refers to fund's cross-sectional decile ranking based on either raw returns or capital Asset Pricing Model (CAPM) alphas of the past 12 months. The variable takes the value of 10 (1) for the top (bottom) 10 % of the cross-sectional performance distribution. $\text{Performance}_{j,t-1,t-12}$ refers to the corresponding raw values. The flow-performance sensitivity measure comes in four different versions depending on whether we define performance based on raw returns or CAPM alphas and whether we estimate the sensitivity with two or three years of past data. The market beta for each fund is calculated using three years of past return data and updated at the end of every year. In addition, all variables are de-meaned within style-month to account for time-varying differences in hedge fund styles. To merge the flow-performance sensitivity of funds with their short position disclosures at the fund company level, we compute the flow-performance sensitivity of a hedge fund company as the AUM-weighted sensitivity across all funds within a fund company and match institutions by name.	Lipper TASS Hedge Fund Database
Share of lendable stocks	Ratio, expressed in percentage terms, of lendable value to market capitalization of the stock. We use Markit's lendable value adjusted for inventory that is not being actively made available for lending.	Markit
Indicative fee	Expected securities borrowing cost, in percentage-per-year terms, for a hedge fund on a given day, which is derived by Markit.	Markit
Institutional ownership	Percentage of shares held by institutional investors in a stock.	Eikon
Inventory concentration	Herfindahl Hirschman Index (HHI) scaled between 0 and 100 to measure inventory concentration.	Markit
Largest five institutional ownership (percent)	Percentage of shares held by the five institutional investors with the largest ownership share in a stock.	Eikon
Lender concentration	HHI scaled between 0 and 100 to measure lender concentration.	Markit
Market value	Market capitalization (in billions of US dollars) provided by the Datastream variable *MV*.	Datastream
Number of institutional investors	Number of distinct institutional investors with a positive ownership share in a stock.	Eikon
Number of block holders ($\geq$ 3%)	Number of distinct institutional investors with a ownership share above 3% of the stock's shares outstanding.	Eikon
Return volatility	Standard deviation of return computed over the last 250 trading days and requiring at least one hundred valid observations. Expressed in percentage terms.	Datastream
Passive investors' ownership (percent)	Percentage of shares held by passive institutional investors (as defined by Eikon) in a stock.	Eikon
Short interest	Ratio, expressed in percentage terms, of value of securities on loan (with dividend trading and financing trades removed) to market capitalization of the stock.	Markit
Standard deviation of fee	Standard deviation of the indicative fee over the last 250 trading days, requiring at least one hundred valid observations.	Markit
Standard deviation of utilization	Standard deviation of utilization over the last 250 trading days, requiring at least one hundred valid observations.	Markit

(*continued on next page*)

Table A.1 (*continued*)

Variable	Description	Source
Strategy Distinctiveness Index (0–2)	Following Sun et al. (2012), we compute a hedge fund's *strategy distinctiveness index* (SDI) as $$\mathrm{SDI}_j = 1 - corr(r_j, \mu_J)$$ using three years of past monthly data. r_j is fund j's return, μ_J is the mean return of all funds belonging to the same style J, and $j \in J$. Building on the original paper and previous literature (Brown and Goetzmann, 1997; 2003), we use a statistical clustering approach to group funds into style categories and determine their peers using three years of past returns. The formation of style categories is based on the Ward (1963) hierarchical method, in which groups of hedge funds are formed by minimizing the across-fund return variation within the respective clusters. We then construct two versions of the SDI measure, depending on whether the mean style return, μ_J, is computed using equal-weighted fund returns or by weighting the returns according to the value of each fund's assets under management. To combine the SDI of funds with their short position disclosures on fund company level, we compute the SDI of a hedge fund company as the AUM-weighted SDI across all funds within a fund company and match institutions by name.	Lipper TASS Hedge Fund Database
TASS percentile rank (0–100)	Percentile rank based on past year's performance of all funds covered by the Lipper TASS Hedge Fund Database with non-missing AUM.	Lipper TASS Hedge Fund Database
TASS percentile rank within style (0–100)	Percentile rank within each strategy type based on past year's performance of all funds covered by the Lipper TASS Hedge Fund Database with non-missing AUM.	Lipper TASS Hedge Fund Database
Total assets	Market capitalization (in millions of US dollars) of the investor's long holdings, as provided by FactSet.	FactSet
Utilization	Percentage of actively lendable securities in lending programs that are currently out on loan, calculated as the value of assets on loan from lenders divided by the active lendable value.	Markit
Utilization tail risk	The 99th percentile of a normal distribution using the estimated mean and standard deviation of utilization over the last 250 trading days (Engelberg, Reed, Ringgenberg, 2018b). We require at least one hundred valid observations for mean and standard deviation computation and we limit utilization tail risk to 100%: min(mean of utilization + 2.33 × standard deviationof utilization; 100%).	Markit

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