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The costs and benefits of short sale disclosure

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ABSTRACT

In this study, we examine the impact of a market-wide mandatory disclosure policy on short selling on the Tokyo Stock Exchange. We find that average short selling slightly declined while investors' shorting strategies changed significantly in response to the disclosure. Previously highly shorted stocks were shorted less and shorting activity shifted toward smaller and riskier stocks, suggesting that retail investors became the more likely short sellers. Short sales became more trend-chasing, prices became less informative, and short-term price volatility increased. Overall, the pricing efficiency benefits of short selling declined after the mandatory disclosure policy.

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1. Introduction

During the Global Financial Crisis (GFC) of 2007 to 2009, short sellers were blamed for increasing price volatility, intensifying price drops, and distressing share prices (Culp and Heaton, 2008; SEC, 2008). Numerous exchanges deemed short sale practices to be too aggressive resulting in temporary or permanent bans on naked shorting and mandated reporting for large short sales in an effort to curb them.¹ After the collapse of Lehman Brothers, such measures were mostly aimed at stabilizing volatile financial stocks, so the initial reporting requirement of large short positions focused on those stocks. For example, following European exchange disclo-

tures of large short financial stock positions, permanent price effects suggest increased information from large shorts improved pricing efficiency (Jones et al., 2013).

However, the reporting requirements have spread worldwide and across different asset classes since the financial crisis. More recently, in 2012, the European Securities and Market Authority (ESMA) introduced a standardized, market-wide reporting and disclosure procedure for short sellers in all EU markets, covering stocks and treasuries. The standardization likely benefits all market participants in terms of reducing the administrative burden of dealing with different disclosure requirements across the member states. Although markets worldwide have implemented similar disclosure policies for large short positions, no studies have examined the impact of such policies. To our knowledge, our study is the first to analyze the impact of market-wide short sale disclosure policy. We provide new insights into the impact of short sale disclosure on shorting activity, stock returns, and market quality, which are major concerns for regulators. Thus, our study contributes to the regulatory debate on the costs and benefits of mandatory disclosure policies.

We study a well-developed market, the Tokyo Stock Exchange (TSE), around the GFC, during which the Financial Services Agency of the Japanese government implemented a mandatory disclosure

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¹ Following the collapse of Lehman Brothers, regulators introduced disclosure measures on large short sales in Australia (Sept. 2008), Belgium (Sept. 2008), France (Sept. 2008), Germany (Sept. 2008), Greece (Sept. 2008), Hungary (Sept. 2008), India (Oct. 2008), Ireland (Sept. 2008), Japan (Nov. 2008), the Netherlands (Oct. 2009), Portugal (Sept. 2008), Spain (Sept. 2008), United Arab Emirates (Oct. 2008), and the United Kingdom (Sept. 2008). For a full review of disclosure regimes, see Gruenewald et al. (2010).

of large positions for all listed stocks on its exchange. The mandatory disclosure policy (hereafter MDP) requires traders to report within 24 h to the exchange all short positions in excess of 0.25% of the shares outstanding. The information is then publicly disseminated within 24 h.² Since short sellers may behave differently when providing information to regulators than they would when disclosing information to the public, it would be difficult to distinguish between the two behaviors. Thus, the Japanese MDP is especially suited for examining the impact of public disclosure on market quality. Specifically, we examine shorting demand and the role of short selling on pricing efficiency for TSE stocks from July 2006 to July 2010, focusing on changes after November 7, 2008, when the MDP was introduced.

Although regulators hope to support stock prices, curtail volatility, and improve overall pricing efficiency with disclosure, its impact is *a priori* unclear because of possible market participants' strategic reactions. Mandatory reporting is required only above a specific threshold, so the policy mostly affects active institutional traders.³ Consequently, institutional investors worldwide protested that the disclosure policy would add additional reporting costs, reveal trade secrets, and allow other investors to free-ride on private information. Industry studies questioned the benefits of mandated reporting by showing that disclosure policies constrain liquidity and increase volatility (e.g., Oliver Wyman Financial Services, 2011). They also suggested that short sellers stay below the reporting requirements or divert investments to other markets because institutional traders face direct administrative costs of reporting and indirect costs from revealing private information.

Moreover, short sellers are generally considered to be relatively informed investors (Diamond and Verrecchia, 1987) whose trades are widely viewed as beneficial for price discovery and market efficiency (Boehmer and Wu, 2013). Mandatory disclosure of large positions is expected to affect the behavior of both informed and uninformed investors: retail or noise traders can obtain valuable information from the disclosure of large institutional short positions and trade on such information, while informed short sellers (e.g., hedge funds) may attempt to disguise their positions by changing their trading strategies or moving to a less transparent market (Easley et al., 2014). Therefore, policies that reduce or affect short sellers' behavior call for regulatory and academic attention.

We document a large drop in the aggregate shorting activity at the onset of the GFC, likely as a result of the increased risk aversion in the market. While we find evidence of some recovery in the shorting volume, the aggregate level remains still significantly lower during the MDP period compared to the pre-crisis period. To better understand the MDP implications, we examine short selling changes by comparing stocks in the cross-section before and after the introduction of the MDP. Specifically, after the MDP, although shorting demand declined for heavily shorted stocks, it increased for riskier and poorly performing stocks. These suggest that short seller composition might have shifted from institutional investors to retail investors because of the disclosure, consistent with theoretical predictions (Easley et al., 2014). Informed investors are naturally averse to transparent markets (Fishman and Hagerty, 1995; Madhavan, 1995), so institutional investors might

have reduced their trades, while small, uninformed investors might have increased their trades since they can trade on the disclosed information.

We also examine the pricing efficiency of short sales around the MDP implementation and find that pricing efficiency deteriorated after the MDP was introduced. Although previous studies documented contrarian trading behavior of short sellers, we report that short sellers showed more trend-chasing after the MDP introduction. We also find that price volatility increased for large and heavily shorted stocks, which are more likely to cross the threshold level for the disclosure requirement. In sum, our study highlights that the MDP might have indirect costs that negatively impact market quality, which concerns both institutional investors and policymakers.

During the GFC, the Financial Services Agency also banned naked short sales on November 4, 2008, just 4 days before the MDP implementation. In line with theoretical predictions (Diamond and Verrecchia, 1987), if a ban on short sales increased short selling cost, we would expect a higher concentration of informed short sellers after the ban because a higher cost would discourage uninformed traders and in turn should improve market quality. Although we find increased lending fees for large and highly shorted stocks, contrary to Diamond and Verrecchia's (1987) prediction we document deteriorating market quality for these stocks. Therefore, our results imply that the MDP's impact on market quality dominates the ban on naked short sales. We also find that average lending fees decreased after the ban, so our overall results suggest that the ban might have failed to have a market-wide effect on short selling during the period.

The rest of this paper is organized as follows. In Section 2, we discuss the relevant literature and the development of our research hypotheses. In Section 3, we describe our data and present the empirical analyses on the role of disclosure policy in relation to short selling and pricing efficiency. We draw conclusions in Section 4.

2. Literature review and hypotheses development

We contribute to the literature on market transparency in relation to short selling. Previous literature on market disclosure shows that strategic trading behaviors of both informed and uninformed traders in response to disclosure are important in determining market quality. On the other hand, studies on short selling have suggested that short sellers are relatively informed institutional investors who make markets more efficient (Diamond and Verrecchia, 1987; Boehmer and Wu, 2013). In this section, we summarize the relevant literature and present our research hypotheses for the impact of the MDP. As our sample covers the GFC, a naked short sale ban, and an MDP, we also discuss implications of these different and economically important overlapping events in the context of the Japanese stock market.

2.1. Short selling and pricing efficiency

Short sellers are generally viewed as informed traders because the higher costs and risks of shorting likely discourage uninformed traders from active shorting (Diamond and Verrecchia, 1987). Empirical evidence has consistently shown that short sellers fore-run important firm announcements such as analyst downgrades, earnings revisions, insider trading, and disclosures of aggressive accounting practices (e.g., Chakrabarty and Shkilko, 2013; Christophe et al., 2010). Ample evidence shows that short sellers are either informed traders or efficient information processors able to identify and load on overvalued stocks while identifying and avoiding undervalued ones (e.g., Blau et al., 2012; Boehmer et al.,

² In early 2013, Japan's Financial Services Agency (FSA) announced changes to these short sale reporting requirements. Short sellers must now report all net short positions in excess of 0.2% of shares outstanding, but only positions in excess of 0.5% are disclosed to the public, as with the new European ESMA reporting. The series of measures that the FSA implemented in 2008 during the financial crisis were temporary. In 2013, the FSA revised the temporary measures to permanent status, in line with similar measures in other countries.

³ Most countries require short sellers to report their short exposure once it exceeds a certain threshold. Originally, in 2008, Ireland, the Netherlands, and Japan introduced similar thresholds, requiring short sellers (both individuals and institutions) to report aggregate short positions that are greater than 0.25% of the total shares outstanding.

2010; Boehmer et al., 2008; Desai et al., 2002; Engelberg et al., 2012). Therefore, restrictions on short selling harm the market (e.g., Marsh and Payne, 2012) because short sales tend to provide liquidity and improve pricing efficiency by providing new information and making price adjustments occur more rapidly (e.g., Boehmer and Kelley, 2009; Boehmer and Wu, 2013; Bris et al., 2007; Diether et al., 2008; Saffi and Sigurdsson, 2011).

2.2. Market transparency and disclosure

Market transparency reduces adverse selection costs: uninformed traders face lower trading costs and can trade on better terms against informed traders. Liquidity apparently improves when regulatory changes make size and direction of order flows in the market more transparent (e.g., Pagano and Roell, 1996). Improved transparency also increases the price revision risk of inventory, which can offset the benefits of reduced adverse selection costs (Naik et al., 1999). Relevant empirical studies (e.g., Gemmill, 1996; Madhavan et al., 2005) find that increasing market transparency increases trading costs but has a mixed impact on liquidity. One notable study found that more transparent limit-order books improve both pricing efficiency and liquidity, but quote depths decline as traders try to limit trade exposure (Boehmer et al., 2005).

In examining market transparency impacts, it is particularly important to understand the reactions of both informed and uninformed traders. Theoretically, informed investors prefer no disclosure (Fishman and Hagerty, 1995; Madhavan, 1995). They are likely to migrate to more opaque markets or abstain from trading to keep their trade secrets or information advantages (Easley et al., 2014). Moreover, if uninformed traders prefer trading in more transparent markets to avoid adverse selection costs, increased transparency could invite more uninformed traders, which in turn could make asset prices less informative (e.g., Chowdhry and Nanda, 1991). Informed and uninformed investors often trade in more transparent electronic markets rather than in dealer markets because the former reveal more private information (Barclay et al., 2003).⁴

A few theoretical models show that uninformed investors might also avoid markets that are more transparent. For example, if investors have different abilities to process fundamental information about firms, markets that are more transparent will amplify adverse selection since investors less able to process information will leave the market altogether if it becomes transparent beyond a critical level (Di Maggio and Pagano, 2014). Transparent markets give uninformed investors fewer profit opportunities because they trade with informed investors at wider bid-ask spreads, resulting in less-liquid markets (Fishman and Hagerty, 1995).

2.3. Hypotheses development

As mandatory disclosure makes the short selling of informed investors publicly available, they may change their trading strategies or move to less-transparent markets to prevent uninformed investors from free-riding on disclosed information (Fishman and Hagerty, 1995; Madhavan, 1995). Hedge funds might even withdraw completely from stock markets for fear of revealing their strategies (Easley et al., 2014). Therefore, disclosure is likely to cause large institutional short sellers to reduce their positions. Similarly, some uninformed investors may decrease their trades if they have inferior information processing abilities (Di Maggio and Pagano, 2014) or have fewer profit opportunities in more

transparent markets (Fishman and Hagerty, 1995). However, some uninformed investors may trade more heavily because more-transparent markets have lower adverse selection costs (Chowdhry and Nanda, 1991). Overall, although the impact on aggregate short positions can be ambiguous, the disclosure is likely to affect the composition of short sellers.

We attempt to disentangle the effect of the MDP on institutional and retail traders by distinguishing between different types of stocks in the cross section. Boehmer et al. (2010) show that shorting is more prevalent in portfolios of US stocks that contain larger and more liquid stocks. Au et al. (2009) also find that short sellers shy away from high idiosyncratic risk stocks. In the Japanese context, institutional traders prefer large, liquid stocks while individual investors prefer small stocks that are likely to be less liquid (Jiang and Yamada, 2011). Foreign institutional traders also generate a significant fraction of the trading volume in Japan (Jiang and Yamada, 2011), so we assume that institutional short sellers prefer large, liquid stocks with low transaction costs. Although the regulatory disclosure requirement is likely to affect institutions and result in less trading, the expected effect for retail traders is not as clear. On the one hand, retail investor shorting is expected to decrease if the increased risk aversion after the financial crisis dominates. On the other hand, because short selling has greater transparency, retail investors may be encouraged to trade because they feel that they have more information now available in the market. Those observations prompted our first general hypothesis and extension:

H1. Short sale volume decreases after the Lehman collapse and remains depressed after the introduction of the MDP.

H1B. Short sale volume particularly decreases for institutional shorts because of the higher direct and indirect costs of shorting for institutions after the MDP introduction. Specifically, shorting decreases in stocks typically preferred by institutions, such as larger, liquid stocks.

If short sellers are informed traders and can detect under- or over-pricing of shares, they will buy when prices are falling and sell when prices are rising. Consistent with this prediction, they are predominantly contrarian traders (Diether et al., 2008). If the disclosure of large positions attracts uninformed follow-on short sellers (Jones et al., 2013), the aggregate trading pattern is expected to become less contrarian (or have more momentum). A noisy rational expectations model shows that less-informed investors tend to exhibit momentum trading patterns, or increase sells (buys) as price levels decrease (increase), since they trade by learning from information revealed in prices (Brennan and Cao, 1997). While our first hypotheses (H1 and H1B) address the change in shorting volume, Hypotheses 2 and 3 address the change in the impact of short selling.

Specifically, we analyze how the reduced institutional short selling alters the composition of short traders and its pricing efficiency implications. We examine two aspects of pricing efficiency, the informativeness of short selling and the short term price volatility. If the disclosure simply provides more information, it may improve market quality, as the policymakers intended. However, if more-transparent markets cause informed investors to reduce trade (Easley et al., 2014) and uninformed investors to increase trade (Chowdhry and Nanda, 1991), disclosure deteriorates pricing efficiency and increases short term volatility. Moreover, this effect should be more pronounced among stocks typically preferred by relatively informed institutional traders, such as large stocks or stocks with high intensity of aggregate short selling. Thus, our second and third hypotheses are defined as:

⁴ Accounting studies find opposite evidence. When SOX was introduced, firms with negative information such as bad growth prospects or disadvantageous financial information preferred to hide and delist (e.g., Marosi and Massoud, 2007).

H2. The informativeness of short selling (return predictability of shorting demand) declines after the MDP for stocks that are large or heavily shorted by informed institutions.

H3. Lower pricing efficiency and greater volatility indicate market quality deteriorates after the MDP for stocks that are large or heavily shorted by informed institutions.

2.4. Discussion of confounding events: the GFC, the naked ban, and the MDP

Three confounding events occurred during our sample period: (1) the GFC with the collapse of Lehman Brothers on Sept. 15, 2008; (2) the naked short sale ban, implemented on Nov. 4, 2008; and (3) the MDP, implemented on Nov. 8, 2008. Below we discuss briefly the market implications of the three events. Specifically, we present our conjectures regarding how each event influenced shorting activity, the stock lending market, and general stock market quality.

The Lehman collapse was associated with increased worldwide risk aversion and costs of shorting for both traders and securities lenders, which then depressed short selling and market trading volume. When risk aversion increases, rational investors are expected to reduce high-risk and high-cost trades (De Long et al., 1990). At that time, the securities lending business came under attack, and stock owners feared that securities lending companies such as Lehman Brothers might default and fail to return securities on loan to them (Blackrock, 2012). Thus, overall shorting demand should have decreased at the onset of the financial crisis.

To differentiate the disclosure effect from the financial crisis impact, we compare the impacts on shorting demand for large stocks versus small stocks and stocks with high volatility versus low volatility to differentiate between riskier and less-risky short trades. In particular, if increased risk aversion drives the decline in short selling during and after the financial crisis, we should observe a decline in short sales for small, illiquid, and risky (high volatility) stocks. In contrast, in response to the MDP, we should observe a decline in short sales for large, liquid, or highly shorted stocks. Furthermore, if disclosure attracts more uninformed investors, the increased retail participation might increase the short selling demand for smaller and riskier stocks. Thus we should be able to identify the different short sale responses between the MDP and the financial crisis by comparing the responses on large and small stocks.

The impact of naked short sale bans and outright bans have been examined in the United States (Boehmer et al., 2013) and worldwide (e.g., Beber and Pagano, 2013), but research has provided little insight into how bans differ from disclosure policies in their impacts. An extensive international study showed that market quality declines with total or naked short sale bans (Beber and Pagano, 2013). Although a total ban might be expected to reduce overall market quality, a naked ban might have different implications. As the ban increases short sale costs, those who participate in short trades might have better information to justify higher trading costs (Diamond and Verrecchia, 1987). Thus, market quality is expected to improve after the ban on naked short sales, particularly for heavily shorted stocks since we expect higher concentration of informed traders for these stocks.

Although the MDP and naked short sales bans might have opposite effects on market quality, we could not isolate the two effects because the Japanese Financial Services Agency implemented the two policies almost concurrently. However, we can use the dynamics of lending fees to examine the impact of the

ban on naked shorts since the locate requirement in borrowing shares is believed to make short selling more costly (e.g., Duffie et al., 2002). The high utilization rates and increase in loan demand trigger higher fees because loan supply is generally inelastic in the short term. Although higher fees are likely to reduce overall short sales, it is ambiguous how they affect highly shorted stocks, such as stocks preferred by institutional traders, or smaller, less-liquid stocks which traders prefer to short naked due to the higher borrowing and search costs (e.g., D'Avolio, 2002; Autore et al., 2011).⁵ Nevertheless, the requirement of borrowing shares may have little impact for retail traders in Japan since they have access to easy and cheap stock borrowing from a centralized lending facility managed by the Japan Securities Finance Co. (Hirose et al., 2009; Huszar and Porras Prado, 2013).⁶ According to the TSE, about 55% of individual investors' sell trades were actually short sale trades, amounting to about 39% of total trades during our sample period.

Taken together, the three events have different implications for short selling and market quality. To compare the impact of these events, we do a side-by-side summary of the return and pricing efficiency implications of each event in Appendix I.

3. Empirical analyses

3.1. Data

We construct a daily stock return database for stocks from the first section of the TSE from July 2006 to July 2010, complemented with short sale, trading, and financial information. While numerous exchanges have introduced short sale ban to protect the market, the Financial Services Agency in Japan was rather cautious in its intervention. In Appendix II, we provide a summary of relevant regulatory market announcements about the naked short sale ban and disclosure requirement to familiarize the reader with the market events leading up to the mandatory disclosure.

We obtain securities lending information from Data Explorers (now Markit Securities), and use the total number of shares currently on loan as a proxy for shorting demand, following other studies (e.g., Gagnon, 2013; Saffi and Sigurdsson, 2011). We use days-to-cover ratio (DTCR) as a measure of shorting demand, computed as the ratio of total number of shares on loan (outstanding short positions) to daily trading volume.⁷ From the first section of the TSE, we exclude 10 stocks that lack information from Data Explorers on securities lending or short selling.

Overall our sample provides a balance representation of the Japanese stocks (see Appendix III for the breakdown of our sample by industry). The three main industries, representing over one third of our sample, are electronics, services and wholesale trade industries. We also exclude financial stocks from our analyses because we have no balance sheet data for non-industrial firms. However, as a robustness check, we examine the stock lending and lending fee patterns for financial firms and find their patterns comparable with those for industrial firms (these unreported results are available upon request). We obtain daily stock prices (e.g., close, high, and low prices), trading volumes, and daily returns from Factset. We also obtain from Factset annual financial statements on total market capitalization, number of shares outstanding, book-to-market ratio, and institutional ownership.

⁵ If the ban on naked short sales forces the short sellers to borrow shares, our measure of shorting demand that uses loaned shares might increase.

⁶ <http://www.jsf.co.jp/>

⁷ The days-to-cover ratio measures the number of days it would take to unwind the total short positions given the current trading volume. Professionals know the measure well, and the *Wall Street Journal* regularly publishes it for the most shorted stocks.

3.2. Summary statistics and trend in short selling

Fig. 1 shows the time-series of the average shorting demand (DTCR) and the lending fees from 2006 to 2010 based on all stocks (excluding financial stocks) listed on the first section of the TSE. Although our measure might capture more than short sales, if shares are borrowed for other reasons (e.g., voting or trade funding), shares on loan mainly represent short selling since it is the main reason for stock borrowing. More importantly, our data capture only “legal” shorts (i.e., when shares are loaned). Our data include some observations where shorting demand is extremely high. We manually examined these cases and confirmed that certain events, such as negative earnings news, might have caused extreme short selling. For robustness, we also either remove or winsorize these observations; the results are similar to those in the main analysis that includes all observations. We could not control for all negative earnings events because analyst information was only available for about a third of our sample.

The top graph in Fig. 1 shows the time series of average and median DTCRs, which both slightly decrease after the Lehman Brothers collapse but increase after the MDP introduction, although it does not recover to the highest levels before the GFC. More importantly, the lending fees in the bottom graph of Fig. 1 reach the lowest levels after the MDP introduction, suggesting that the ban on naked shorting might not have driven up the demand for stock lending. Although we observe a significant jump in lending fees immediately after the Lehman Brothers collapse, the fee increase is likely due to temporary market “chaos” when lenders were unclear about the risk of prime broker default and the resulting non-recoverability of loaned shares (Financial Stability Board, 2012).

In Fig. 2, we examine the cross-sectional differences in shorting demand based on the stock clientele. If the MDP introduction primarily affected institutions, we would expect changes in shorting for stocks that institutions prefer. We sort stocks into quintiles based on their average level of pre-Lehman short selling as measured by the average DTCR from July 2006 to August 2008. The top graph in Fig. 2 shows the DTCR for stocks in the lowest quintile. We find more than a 50% drop (from more than 5 days to less than 2 days) after the collapse but a recovery to pre-crisis levels after the MDP introduction. The bottom graph shows the DTCR during our sample period for stocks with high average pre-Lehman DTCR. We find a significant decline of the DTCR from around 15 days to about 2 days. Although shorting demand (measured by DTCR) recovers after the MDP introduction, both the average and median DTCRs are lower compared with the pre-crisis period. Taken together, Fig. 2 suggests that the MDP introduction affected large short positions of institutional traders such as hedge funds and other institutional investors, who might have withdrawn or drastically reduced their trades. However, the disclosure policy might not have affected retail traders, who are more likely to short with smaller positions. Thus, the policy shifts the composition of shorting demand and average preference toward retail traders.

Table 1 presents descriptive statistics for various firm and stock characteristics and short sale information. We use subsamples based on the level of short selling as measured by average DTCR. First, we find that stocks in the lowest DTCR quintile are smaller in market capitalization, consistent with previous findings using U.S. data (D’Avolio, 2002) and Japanese data (Takahashi, 2010). Second, also consistent with U.S. studies, the table shows that stocks with more shorting have larger market capitalization and

Fig. 1. Time series of shorting demand, measured by DTCR, and stock borrowing fee. Weekly average stock borrowing and shorting characteristics are shown for July 2006 to July 2010. In the top graph, DTCR is the total shares out on loan (proxy for shorting demand) relative to daily trading volume. In the bottom graph, Mean and Median Fee are calculated based on the annualized stock borrowing fee, measured in basis points.

Fig. 2. Time series of shorting demand, measured by DTCR, for previously highly/lightly shorted stocks. Stocks are classified as highly/lightly shorted if they are in the top/bottom quintile of pre-Lehman DTCR, which is the average of the daily DTCR for the period before the Lehman collapse, July 2006–August 2008. Daily DTCR is the total shares out on loan relative to daily trading volume. The top graph shows average daily DTCR for lightly shorted stocks and the bottom graph shows average daily DTCR for highly shorted stocks. The median DTCRs (darker line) are plotted against the right axis.

greater institutional ownership, reflecting that these shares are likely to be readily available for borrowing at lower shorting costs (Porras-Prado et al., 2013).

However, unlike reports in U.S. studies, we report non-monotonic relations between shorting and liquidity. We find that both the lowest and highest DTCR quintile stocks have relatively low average turnovers (mean of 0.32%, for both extreme quintiles) in comparison with stocks from the other quintiles. We also observe a similar non-monotonic pattern with price spreads, where stocks from both the lowest and highest DTCR quintiles exhibit low price spreads (i.e., daily high-low price spread). Third, we find that stocks in the top DTCR quintile have the lowest average returns (−1.7 bps on a daily basis) in comparison with stocks in the other quintiles, although the median returns are very similar across all quintiles. In the last row of Table 1, we find a monotonic relation between lending fees and DTCR, which confirms that lending fees are positively correlated with shorting demand.

In Panel B of Table 1, we compare the summary statistics for subsamples before and after the MDP introduction. We note that daily returns are generally negative before the crisis and positive after the crisis, suggesting that the Japanese market behaved quite differently than the U.S. stock market around the Lehman collapse. Comparing across quintiles, we find that the average short interest ratio (SIR), an alternative measure of shorting demand, and the DTCR are comparable in the two lowest quintiles before and after the disclosure requirement. Thus, stocks lightly shorted before the Lehman collapse experience roughly the same shorting demand. However in quintiles 4 and 5, the average SIR declined significantly from 1.62 (for $Q = 4$) and 2.54 (for $Q = 5$) before the disclosure to 0.76 (for $Q = 4$) and 0.98 (for $Q = 5$) after the disclosure. We observe similar patterns for the DTCR. Consistent with

Fig. 2, Table 1 Panel B suggests that, after the MDP introduction, short demand decreased for previously high-demand stocks.

3.3. Shorting demand around the introduction of MDP

To examine the disclosure's impact on short selling demand before and after the MDP introduction, we conduct regression analysis using our pooled sample. We use a dummy variable, *DisclD*, which takes the value of one after the MDP introduction on November 8, 2008, and zero otherwise. We also interact this disclosure dummy variable with various stock characteristics in order to address cross-sectional differences in terms of the MDP impact. To account for the confounding effect of the financial crisis after the Lehman collapse, we introduce a dummy variable (*Lehman*) that takes the value of one for the days after the collapse on September 15, 2008. Specifically, to test $H1$ we employ the following regression framework to examine the impact of the financial crisis and the disclosure requirement on shorting demand:

$$DTCR_t = \alpha + \beta_1 \times Lehman + \beta_2 \times DisclD + \sum_{j=3}^6 \beta_j Control_j + \varepsilon_t \quad (1)$$

where the dependent variable is the future five-day average DTCR, computed as the ratio of number of total shares on loan relative to daily trading volume. *Controls* include the determinants of short selling demand: past shorting demand ($DTCR_{-5,-1}$), short-term lagged turnover ($Turnover_{-5,-1}$), lagged price spread ($Price-spread_{-5,-1}$), and lagged returns ($LagRet_{-5,-1}$). Firm size ($LogMcap$), market-to-book ratio (*Market-to-book*), and institutional investor ownership (*IO*, in%) are all measured at the end of the previous cal-

Table 1

Summary statistics of highly and lightly shorted stocks from the Tokyo Stock Exchange from July 2006 to July 2010.

	DTCR quintiles										Pooled sample	
	Low		Quintile 2		Medium		Quintile 4		High			
	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median		
Panel A. Pooled summary statistics and by DTCR quintiles												
Logmcap	10.12	9.66	10.96	10.61	10.99	10.82	10.99	10.85	10.89	10.8	10.82	10.60
Market-to-Book	1.34	0.91	1.24	0.99	1.45	1.06	1.60	1.14	1.52	1.12	1.43	1.04
IO (in%)	7.95	5.49	11.24	9.31	11.76	10.06	12.15	9.84	12.42	9.10	11.17	8.67
SIR (in%)	0.12	0.01	0.47	0.20	0.80	0.45	1.21	0.68	1.79	1.06	0.90	0.34
DTCR	0.51	0.09	1.44	0.79	2.43	1.45	4.04	2.61	9.98	5.85	3.76	1.47
Daily Ret (in bp)	−1.11	0.00	−0.26	0.00	−0.91	0.00	−1.10	0.00	−1.70	0.00	0.44	0.24
Turnover (in%)	0.32	0.12	0.51	0.25	0.53	0.29	0.5	0.27	0.32	0.18	2.87	2.52
Pricespread (in%)	2.75	2.22	2.89	2.40	2.99	2.49	2.95	2.44	2.74	2.26	0.65	0.43
Ln(Fee)	0.34	0.00	0.94	0.00	1.18	0.00	1.31	0.00	1.53	0.00	1.06	0.00
Number of Obs	309206		318903		320122		318241		317809		1584281	
	Low DTCR Q = 1		Low DTCR Q = 2		Mid DTCR Q = 3		High DTCR Q = 4		High DTCR Q = 5		Mean	Median
	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median		
Panel B. Subsample (pre-disclosure and post-disclosure) summary statistics												
Pre-disclosure												
Logmcap	10.36	9.85	11.18	10.80	11.23	11.07	11.22	11.03	11.09	11.00		
Market-to-Book	1.68	1.18	1.51	1.23	1.78	1.36	1.88	1.39	1.82	1.35		
IO (in%)	8.06	5.48	11.32	9.29	11.88	10.05	12.46	10.08	12.89	9.62		
SIR (in%)	0.12	0.00	0.57	0.28	1.01	0.66	1.62	1.08	2.54	1.81		
DTCR	0.45	0.03	1.63	0.93	2.94	1.92	4.98	3.45	12.65	8.06		
Daily Ret (in bp)	−8.18	0.00	−6.41	0.00	−8.05	0.00	−7.04	0.00	−6.66	0.00		
Turnover (in%)	0.36	0.14	0.56	0.28	0.55	0.33	0.54	0.30	0.36	0.22		
Pricespread (in%)	2.82	2.24	2.91	2.38	3.00	2.47	2.98	2.43	2.77	2.26		
Ln(Fee)	0.27	0.00	0.96	0.00	1.27	0.00	1.47	0.00	1.83	0.00		
Number of Obs	146525		167427		168486		170701		170109			
Post-disclosure												
Logmcap	9.90	9.43	10.72	10.42	10.74	10.59	10.75	10.57	10.67	10.62		
Market-to-Book	1.02	0.73	0.96	0.80	1.09	0.85	1.29	0.91	1.20	0.92		
IO (in%)	7.80	5.42	11.21	9.56	11.63	10.11	11.81	9.62	11.90	8.32		
SIR (in%)	0.12	0.01	0.36	0.13	0.57	0.25	0.76	0.38	0.98	0.54		
DTCR	0.57	0.17	1.23	0.63	1.88	1.00	3.01	1.71	7.07	3.41		
Daily Ret (in bp)	5.67	0.00	6.32	0.00	6.79	0.00	5.38	0.00	3.84	0.00		
Turnover (in%)	0.28	0.11	0.46	0.22	0.51	0.25	0.45	0.23	0.28	0.15		
Pricespread (in%)	2.70	2.20	2.85	2.41	2.98	2.51	2.91	2.46	2.70	2.25		
Ln(Fee)	0.40	0.00	0.93	0.00	1.07	0.00	1.15	0.00	1.19	0.00		
Number of Obs	154134		156553		156311		156655		155573			

Stocks are reported in 5 quintiles based on their average days-to-cover ratio (*DTCR*) from July 2006 to Oct. 2008, prior to the implementation of the disclosure regime. *DTCR* is the number of total shares out on loan (shorted) relative to the daily trading volume. *Logmcap* is the natural logarithm of the firm's stock market capitalization in million Yen. *Market-to-book* is the firm stock market capitalization relative to the firm book value of equity. *IO* (in%) is the relative number of shares owned by institutions to total shares outstanding in percentage. *Short interest ratio* (*SIR* in%) is the average of the total number of shorted shares outstanding for the specific stock relative to the total number of shares outstanding in percentage. *Ret* (in bp) is daily raw returns in basis points. *Turnover* (in%) is the daily turnover in percentage. *Pricespread* (in%) is the daily price spread, calculated as the difference between the daily high price and daily low price relative to the daily high price, in percentage. *Ln(Fee)* (in bp) is the natural logarithm of 1+ annualized lending fee in basis points.

endar year. Results from regressions using the above framework are reported in Table 2. Models 1 and 2 of Table 2 Panel A are our baseline specifications, showing the average effects of the Lehman collapse and the MDP. We extend our specifications by interacting these dummies with specific stock characteristics in Models 2 to 6 of Panel A and Models 1 to 4 of Panel B. In both panels of Table 2, we alternate between two specifications by controlling for momentum with the continuous lagged returns (*LagRet*_{*t*−5,*t*−1}) in odd-numbered models and with dummy variables for the winner and losers (*Winner*_{*t*−5,*t*−1} and *Loser*_{*t*−5,*t*−1}) in even-numbered models.

In Model 1, the significant negative coefficient associated with the *Lehman* dummy implies that stocks have 0.8642 lower DTCR on average, suggesting lower overall shorting activity due to increased risk aversion. Although the positive coefficient on the *DisclD* dummy suggests that short selling recovered somewhat after the crisis began, the net effect is a decline in total DTCR of approximately 60% of daily trading volume (i.e., $-0.5922 = -0.8642 + 0.2720$). This 60% reduction is economically significant given that the average DTCR is 376% in our sample. Overall, results in Models 1 and 2 show support for our *H1* that overall shorting decreased following the Lehman collapse, despite a slight recovery after the MDP introduction.

We also show that the DTCR is highly persistent because the coefficients for *DTCR*_{*t*−5,*t*−1} are positive and significant in all models. This persistence might be partially explained by the construction of the variable because aggregate shorting (proxied by total number of shares on loan) and daily trading volume are both known to have high persistence. We find that the DTCR is higher in stocks with lower turnover and those with higher short term volatility (i.e., stocks with higher intra-day high-low price spread), implying that short sellers in Japan are targeting riskier stocks on average. Contrary to the U.S. studies (e.g., Boehmer et al., 2010; Desai et al., 2002), we find that short sellers do not target overvalued stocks based on fundamentals since we find an insignificant negative coefficient on the market-to-book ratio. The positive coefficient on *LagRet*_{*t*−5,*t*−1} in Model 1 is consistent with the findings of Diether et al. (2008), stating that short sellers are contrarians. When we break the returns into losers and winners using past five-day returns, we find that short sellers are particularly strong contrarian traders for extreme loser stocks and, to a lesser extent, for extreme winner stocks.

To test *H1B*, which differentiates between the preferences of institutional and retail short selling, we extend the regression model to include stock characteristics in conjunction with the

Table 2

Regression analysis of shorting demand in relation with disclosure policy and Lehman Brothers' collapse.

	DTCR (1)	DTCR (2)	DTCR (3)	DTCR (4)	DTCR (5)	DTCR (6)
Panel A. Future shorting demand in relation with disclosure policy						
Lehman	−0.8642*** [0.0480]	−0.8789*** [0.0488]	−0.5085*** [0.0441]	−0.5241*** [0.0438]	−0.8078*** [0.0517]	−0.8618*** [0.0543]
DisclD	0.2702*** [0.0592]	0.2905*** [0.0583]	0.3414*** [0.0543]	0.3625*** [0.0537]	0.2051*** [0.0611]	0.2175*** [0.0602]
Lehman*HighDTCR _{pre}			−1.7512*** [0.1804]	−1.7518*** [0.1804]		
DisclD*HighDTCR _{pre}			−0.4425*** [0.1042]	−0.4423*** [0.1042]		
Lehman*Loser					−0.1864*** [0.0486]	−0.0517 [0.0500]
DisclD*Loser					0.2192*** [0.0468]	0.2652*** [0.0451]
DTCR _{−5,−1}	0.6886*** [0.0178]	0.6885*** [0.0178]	0.6766*** [0.0172]	0.6765*** [0.0172]	0.6886*** [0.0178]	0.6885*** [0.0178]
LagRet _{−5,−1}	0.0057*** [0.0010]		0.0054*** [0.0010]		0.0059*** [0.0012]	
Winner _{−5,−1}		0.0361** [0.0143]		0.0242* [0.0143]		0.0353** [0.0143]
Loser _{−5,−1}		−0.1077*** [0.0159]		−0.1139*** [0.0159]		−0.2116*** [0.0275]
Turnover _{−5,−1}	−0.1032*** [0.0105]	−0.1009*** [0.0103]	−0.1041*** [0.0103]	−0.1019*** [0.0101]	−0.1031*** [0.0105]	−0.1008*** [0.0103]
Pricespread _{−5,−1}	0.1473*** [0.0129]	0.1487*** [0.0127]	0.1470*** [0.0126]	0.1490*** [0.0124]	0.1473*** [0.0129]	0.1495*** [0.0127]
Logmcap	0.0707 [0.0594]	0.0712 [0.0592]	0.0854 [0.0537]	0.0861 [0.0534]	0.0718 [0.0595]	0.0774 [0.0591]
Market-to-book	−0.0041 [0.0074]	−0.004 [0.0073]	−0.0053 [0.0056]	−0.0051 [0.0055]	−0.0042 [0.0074]	−0.0039 [0.0072]
IO (in%)	0.006 [0.0045]	0.0061 [0.0045]	−0.0003 [0.0043]	−0.0002 [0.0043]	0.006 [0.0045]	0.0063 [0.0045]
MarketRet	0.0224*** [0.0016]	0.0220*** [0.0015]	0.0219*** [0.0015]	0.0215*** [0.0015]	0.0225*** [0.0016]	0.0220*** [0.0015]
Intercept	0.2736 [0.7037]	0.2777 [0.7026]	0.234 [0.6327]	0.2398 [0.6316]	0.2604 [0.7041]	0.2333 [0.7017]
Adj. R-sq	0.624	0.624	0.6267	0.6267	0.624	0.624
Observations	1584281	1584281	1584281	1584281	1584281	1584281
	DTCR (1)		DTCR (2)		DTCR (3)	DTCR (4)
Panel B. Future shorting demand in relation with disclosure policy in conjunction with firm size and volatility						
Lehman	−0.9392*** [0.0525]		−0.7767*** [0.0389]		−0.4246*** [0.0904]	−0.4327*** [0.0898]
DisclD	0.3122*** [0.0630]		0.3827*** [0.0340]		−0.2914*** [0.0851]	−0.2794*** [0.0852]
Lehman*SmallD	0.2706*** [0.0964]		0.1722*** [0.0603]			
DisclD*SmallD	−0.1112* [0.0643]		−0.0667* [0.0386]			
SmallD	−0.0043 [0.1148]		−0.0053 [0.0724]			
Lehman*PriceSpread					−0.0651*** [0.0185]	−0.0660*** [0.0183]
DisclD*PriceSpread					0.1109*** [0.0151]	0.1124*** [0.0152]
DTCR _{−5,−1}	0.6885*** [0.0178]		0.8067*** [0.0071]		0.6883*** [0.0178]	0.6883*** [0.0178]
LagRet _{−5,−1}	0.0056*** [0.0010]				0.0053*** [0.0010]	
Winner _{−5,−1}			−0.0858*** [0.0147]			0.0312** [0.0144]
Loser _{−5,−1}			−0.1529*** [0.0163]			−0.1089*** [0.0156]
Turnover _{−5,−1}	−0.1026*** [0.0104]		−0.0795*** [0.0077]		−0.1049*** [0.0104]	−0.1029*** [0.0103]
Pricespread _{−5,−1}	0.1472*** [0.0130]		0.1165*** [0.0071]		0.1319*** [0.0205]	0.1333*** [0.0201]
LogMcap	0.0979 [0.0633]		0.0817** [0.0380]		0.0851 [0.0592]	0.0861 [0.0589]
Market-to-book	−0.006 [0.0079]		−0.0033 [0.0049]		−0.0047 [0.0075]	−0.0045 [0.0074]
IO (in%)	0.0071 [0.0046]		0.0048* [0.0027]		0.006 [0.0045]	0.0061 [0.0045]

Table 2
(continued).

	DTCR (1)	DTCR (2)	DTCR (3)	DTCR (4)
MarketRet	0.0223*** [0.0015]	0.0033*** [0.0012]	0.0239*** [0.0016]	0.0235*** [0.0016]
Intercept	−0.037 [0.7494]	−0.2488 [0.4342]	0.1585 [0.7113]	0.1595 [0.7095]
Adj. R-sq	0.624	0.5436	0.624	0.624
Observations	1584281	1583851	1584281	1584281

The dependent variable is the average of the next 5-day stock days-to-cover ratio (*DTCR*), where *DTCR* is the total number of stocks borrowed (proxy for shorting) relative to the total daily trading volume. *Lehman* dummy variable takes the value of 1 for days from the Lehman Brothers' collapse, Sept 15, 2008. *DisclD* is a dummy variable that takes the value 1 for days from Nov. 7, 2008, when the disclosure requirement was introduced at the TSE. *HighDTCR_{pre}* variable takes the value of 1 for stocks from the top quintile based on the average *DTCR* from July 2006 to Sept 14, 2008. *Lehman*HighDTCR_{pre}* and *DisclD*HighDTCR_{pre}* are interaction variables of the *HighDTCR_{pre}* variable with the Lehman Brothers' collapse (Lehman) and the disclosure policy introduction (*DisclD*) dummies. *DTCR_{5,-1}* is the average *DTCR* based on the previous 5 days. *LagRet_{5,-1}* is the lagged 5-days cumulative holding period returns in percentage. *Winner_{5,-1}* (*Loser_{5,-1}*) is a dummy variable that takes the value of 1 for stocks with return in the top (bottom) 30th percentile based on the last 5 days cumulative returns. *Lehman*Loser* and *DisclD*Loser* are interaction variables of *Loser_{5,-1}* with *Lehman* and *DisclD* dummies, respectively. *Turnover_{5,-1}* and *Pricespread_{5,-1}* are the average daily turnover in percentage and the average pricespread (highest and lowest price relative to highest price) based on the previous 5 days. *Logmcap* is the natural logarithm of the firm's stock market capitalization in million Yen. *Market-to-book* ratio is the ratio of the market value of equity relative to the book value of equity at the end of the previous fiscal year. *IO* (in%) is the relative number of shares owned by institutions to total shares outstanding in percentage. *MarketRet* is the corresponding 1-day TOPIX 1000 index returns in basis points from January 2006 to July 2010. The coefficient estimates with the corresponding standard errors (in brackets) clustered at firm level are reported. All models include firm fixed (not reported). The 1%, 5%, and 10% levels of statistical significance are denoted with ***, **, and *, respectively.

The dependant variable is the shorting demand as in Panel A. Control variables are defined in Panel A, with the exception of two new interaction variables with a small size dummy (*SmallD*) and the pricespread. *SmallD* takes the value of 1 for stocks from the bottom quintile of stock market capitalization. *Lehman*SmallD* and *DisclD*SmallD* are interaction variables of the *SmallD* variable with the Lehman Brothers' collapse (*Lehman*) and the disclosure policy (*DisclD*) dummies. Similarly, *Lehman*Pricespread* and *DisclD*Pricespread* are interaction variables of the *Pricespread* variable with *Lehman* and *DisclD* dummies. The coefficient estimates with the corresponding standard errors (in brackets) clustered at firm level are reported. All models include firm fixed effect (not reported). The 1%, 5%, and 10% levels of statistical significance are denoted with ***, **, and *, respectively.

Lehman collapse and the introduction of the MDP. Table 1 shows that the most heavily shorted stocks are larger and have greater institutional holding. To show this in our regression analysis of Table 2 Panel A, we index highly shorted stocks (i.e., stocks with *DTCR* from the top quintile) before the Lehman collapse, using the dummy variable *HighDTCR_{pre}*.⁸ Although the disclosure policy is expected to affect informed institutions, the GFC and the increased risk aversion might also impact retail investors. As Table 1 shows, stocks preferred by retail traders (i.e., held by fewer institutional investors) are generally smaller and tend to have lower *DTCR*, as retail investors might not accumulate large positions even if they are active short sellers. In Panel B, we include a dummy variable (*SmallD*) for small stocks (in the bottom quintile of market capitalization) since retail traders tend to prefer smaller and/or riskier stocks. We examine Lehman's collapse and the MDP introduction in conjunction with a trader preference variable (*Traderpref*) in the following regression model. We use the same control variables as in Eq. (1).

$$DTCR_t = \alpha + \beta_1 \times Lehman + \beta_2 \times DisclD + \beta_3 \times DisclD \times Traderpref + \beta_4 \times Lehman \times Traderpref + \sum_{j=5}^8 \beta_j Control_j + \varepsilon_t \quad (1B)$$

In Models 3 and 4 of Table 2 Panel A, we include a control that captures past shorting activity before Lehman's collapse (*HighDTCR_{pre}*) and interact that measure with the *Lehman* and *DisclD* dummies. The objective is to capture which stocks short sellers prefer or target, *a priori*. We find that previously highly shorted stocks are less shorted after the Lehman collapse and even less so after the MDP introduction. This implies that institutions are shorting fewer stocks even after controlling for the crisis, supporting H1.

In Models 5 and 6, we focus on trend-chasing behavior and on the worst-performing stocks (bottom 30th percentile) for the previous week. The negative coefficient on the interaction variable

*Lehman*Loser* shows that shorting activity decreased for the worst-performing stocks, implying that the financial crisis increased risk aversion.

Next, in Panel B of Table 2, we directly examine the effect of risk aversion by testing whether short sellers move away from smaller and riskier stocks. However, if short sellers are more likely to be retail traders with the withdrawal of institutions, as hypothesized in our H1B, we should observe greater preference for smaller and riskier stocks.

In Models 1 and 2, from Panel B of Table 2, the positive coefficient on *Lehman*SmallD*, together with the smaller negative coefficient on *DisclD*SmallD*, suggests that short selling significantly increased for smaller stocks after the Lehman collapse. Although a reversal occurs after the disclosure policy, the net effect is still positive, showing that demand for short selling increased for small stocks. In Models 3 and 4, we focus on the impact of price spread by interacting lagged price spread with *Lehman* and *DisclD* (*Lehman*Pricespread* and *DisclD*Pricespread*). The coefficient for *DisclD*Pricespread* is significant and positive, indicating that shorting increased in stocks with greater price volatility after the disclosure policy. Although the coefficient for *Lehman*Pricespread* is negative, it has smaller magnitude than that of *DisclD*Pricespread*, suggesting an increase in shorting demand for riskier stocks even after controlling for the impact of the crisis.

When taken together, the results from Panels A and B of Table 2 support H1 and H1B, that short selling decreases, especially in the large, liquid, less-risky stocks, which are generally preferred by institutions.⁹ We also find evidence suggesting increases in short demand for small and riskier stocks. Although we find that risk aversion during the GFC gradually decreases shorting demand, the disclosure policy impacts the cross-sectional difference in preferences for shorting demand, implying that increased market transparency shifted the composition of investor types (Easley et al., 2014).

In the next two sections, we study whether short selling changes around the Lehman collapse and whether disclosure policy altered

⁸ In Table 1, we show that the stocks from top *DTCR* quintile have an average 1.79 SIR and 9.98 *DTCR* while, in the pooled sample, the average SIR and *DTCR* are 0.9 and 3.76, respectively. Retail traders are unlikely to achieve more-than-double the shorting activity, so it is logical to assume that stocks from the high *DTCR* quintile attract institutional traders.

⁹ We conduct a robustness check by double clustering standard errors by firm and day. We find the results are quantitatively very similar and are available from the authors on request.

Table 3

Informational role of short selling pre- and post-disclosure.

	Ret _{1,5} Full sample (1)	Ret _{1,5} Full sample (2)	Ret _{1,5} Small stocks (Quintile 1) (3)	Ret _{1,5} Large stocks (Quintile 5) (4)	Ret _{1,5} Low DTCR (Quintile 1) (5)	Ret _{1,5} High DTCR (Quintile 5) (6)
Lehman	−0.2411*** [0.0774]	−0.2227*** [0.0774]	0.0779 [0.1781]	−0.7875*** [0.1601]	−0.0341 [0.1499]	−0.2938 [0.2713]
DisclD	0.0354 [0.0796]	0.0047 [0.0794]	−0.2076 [0.1885]	0.5094*** [0.1650]	−0.1291 [0.1508]	−0.0508 [0.2642]
Lehman*HighDTCR _{−5,−1}	0.0574 [0.1749]	0.0583 [0.1742]	−0.7981 [0.4973]	0.6821 [0.4464]	1.2465 [1.3901]	−0.082 [0.3594]
DisclD*HighDTCR _{−5,−1}	−0.1418 [0.1793]	−0.1425 [0.1785]	0.6517 [0.5183]	−0.7896* [0.4478]	−1.2785 [1.2910]	0.1208 [0.3593]
HighDTCR _{−5,−1}	0.0321 [0.0302]	0.0277 [0.0302]	0.0631 [0.0989]	0.0675 [0.0649]	0.0822 [0.5258]	−0.0373 [0.0523]
LagRet _{−5,−1}	−0.0174*** [0.0024]					
Winner _{−5,−1}		−0.2306*** [0.0149]	−0.3918*** [0.0443]	−0.2355*** [0.0250]	−0.3693*** [0.0378]	−0.1698*** [0.0313]
Loser _{−5,−1}		0.0711*** [0.0151]	0.1424*** [0.0383]	0.1184*** [0.0263]	0.1193*** [0.0393]	0.0176 [0.0347]
Turnover _{−5,−1}	−0.0769*** [0.0185]	−0.0851*** [0.0186]	−0.1249*** [0.0281]	0.0657 [0.0625]	−0.0199 [0.0419]	−0.0632 [0.0610]
Pricespread _{−5,−1}	0.1849*** [0.0116]	0.1912*** [0.0116]	0.1922*** [0.0293]	0.0992*** [0.0214]	0.1880*** [0.0248]	0.2036*** [0.0312]
Logmcap	−0.8485*** [0.0348]	−0.8432*** [0.0347]	−0.9592*** [0.0997]	−0.7431*** [0.0977]	−0.8099*** [0.0899]	−0.9798*** [0.0915]
Market-to-Book	−0.0032 [0.0055]	−0.0032 [0.0054]	−0.0021 [0.0067]	0.0254 [0.0338]	−0.0423* [0.0217]	0.0214 [0.0353]
IO (in%)	−0.0247*** [0.0023]	−0.0248*** [0.0023]	−0.0212* [0.0110]	−0.0193*** [0.0041]	−0.0262*** [0.0059]	−0.0233*** [0.0047]
MarketRet _{1,5}	0.8782*** [0.0084]	0.8795*** [0.0083]	0.8151*** [0.0149]	0.9562*** [0.0210]	0.7963*** [0.0173]	0.7998*** [0.0170]
Intercept	9.1872*** [0.3875]	9.1713*** [0.3863]	8.4611*** [0.9490]	10.1244*** [1.2853]	8.2259*** [0.9302]	10.7755*** [1.0021]
Adj. R-sq	0.2705	0.2706	0.1908	0.3821	0.2505	0.2366
Observations	1584281	1584281	314348	318300	299887	317809

The dependent variable is the 5-day future holding period returns in percentage ($Ret_{1,5}$). Models 1–2 are based on the full sample, while model 3 (4) is based on stocks from the lowest size quintile (highest size quintile). In model 5 (6), the sample includes stocks with DTCR from the lowest (highest quintile) of the distribution based on the average DTCR prior to the Lehman Brothers' collapse. *Lehman* dummy variable takes the value of 1 for days after the Lehman Brothers' collapse, after Sept 15, 2008. *DisclD* is a dummy variable that takes the value of 1 after the implementation of disclosure requirement, after Nov. 7, 2008. *Lehman*HighDTCR_{−5,−1}* and *DisclD*HighDTCR_{−5,−1}* are interaction variables of the *HighDTCR_{−5,−1}* with the Lehman collapse (*Lehman*) and the disclosure policy introduction (*DisclD*) dummies, where *HighDTCR_{−5,−1}* is a dummy variable that takes the value of 1 for stocks from the top quintile of the previous day's DTCR. Control variables are defined in Table 2. The sample period is from Jan. 2006 to July 2010. All models include firm fixed effect (not reported). The 1%, 5%, and 10% levels of statistical significance are denoted with ***, **, and *, respectively.

short selling's role in pricing efficiency. In Panel A of Table 2, we have shown some evidence of more trend trading behavior which suggest less informed trading. In the next sessions, we directly assess the change in the impact of short selling. First, we analyze the change in informativeness of short sales by examining the return predictability of shorts (in Section 3.4), then we evaluate the impact of short selling on short-term volatility (in Section 3.5) after the Lehman collapse and the introduction of the MDP.

3.4. Information and pricing efficiency of short selling around the introduction of the MDP

To analyze changes in pricing efficiency of short selling in conjunction with the disclosure requirement we examine, following Diether et al. (2008), the relationship between return and short sale demand using the following regression model:

$$\begin{aligned} \text{Return}_{t+i} = & \alpha + \beta_1 \times \text{Lehman} + \beta_2 \times \text{DisclD} + \beta_3 \times \text{Lehman} \\ & \times \text{HighDTCR}_{-5,-1} + \beta_4 \times \text{DisclD} \times \text{HighDTCR}_{-5,-1} \\ & + \sum_{j=5}^8 \beta_j \text{Control}_j + \beta_9 \times \text{MarketRet}_{t+i} + \varepsilon_t \end{aligned} \quad (2)$$

where the dependent variable is the future five-day holding period percentage return. All other firm control variables are the same as in Eq. (1). We again use the two dummy variables, *Lehman* and *DisclD*, and interact each with a measure of high short selling activity in the last five days (*HighDTCR_{−5,−1}*), which is a dummy variable that takes

the value of one for stocks that have the previous five-day average DTCR in the top DTCR quintile.¹⁰

Models 1 and 2 from Table 3 show that, after the Lehman collapse, stocks underperformed on average, even after controlling for market returns. We also find a strong reversal effect; as did Chou et al. (2007), we find significant positive (negative) coefficient on the *Loser* dummy (*Winner* dummy). But more importantly, the coefficient for *HighDTCR_{−5,−1}* is not significant, suggesting that high shorting does not improve return predictability. The lack of informativeness of high shorting is consistent with previous findings of non-robust negative returns associated with high shorting (Boehmer et al., 2010). We find that coefficients on both *Lehman*HighDTCR_{−5,−1}* and *DisclD*HighDTCR_{−5,−1}* are also not significant after the crisis. We examine our sample of stocks in the lowest and highest quintile for size (Models 3 and 4) and for DTCR (Models 5 and 6). Our results are similar to Models 1 and 2, except for large stocks (Model 4) where we find a negative and significant coefficient on *DisclD*HighDTCR_{−5,−1}*. Our result for large stocks (Model 4) counters H3, that the disclosure causes pricing efficiency to deteriorate for stocks preferred by institutions. Although our results for Model 4 show that high shorting predicts negative returns after the disclosure, our results may not imply improved pricing efficiency since prices might overshoot because of less contrarian (or more momentum) traders that increased their trades

¹⁰ In unreported robustness analyses, we examined the future return and high shorting activity using DTCR in the top decile and obtained consistent results.

Table 4

Regression analysis of short term volatility and disclosure policy on short selling.

	Pricespread _{1,5} Full sample (1)	Pricespread _{1,5} Full sample (2)	Pricespread _{1,5} Small stocks (Quintile 1) (3)	Pricespread _{1,5} Large stocks (Quintile 5) (4)	Pricespread _{1,5} Low DTCR (Quintile 1) (5)	Pricespread _{1,5} HighDTCR (Quintile 5) (6)
Lehman	1.4239*** [0.0343]	1.4679*** [0.0349]	1.3902*** [0.0677]	1.5110*** [0.0309]	1.2742*** [0.1197]	1.5905*** [0.0542]
DiscID	–1.5579*** [0.0355]	–1.6091*** [0.0361]	–1.5730*** [0.0806]	–1.6443*** [0.0306]	–1.4205*** [0.1196]	–1.6937*** [0.0569]
Lehman* HighDTCR _{5,-1}	0.0116 [0.0325]	0.0007 [0.0331]	0.2256* [0.1155]	–0.2919*** [0.0685]	–0.0044 [0.2758]	–0.1076* [0.0651]
DiscID*HighDTCR _{5,-1}	0.0374 [0.0333]	0.0519 [0.0339]	–0.0846 [0.1150]	0.3422*** [0.0706]	–0.2021 [0.2361]	0.2056*** [0.0665]
HighDTCR _{5,-1}	0.0141 [0.0110]	0.0163 [0.0110]	–0.0073 [0.0360]	–0.0065 [0.0169]	0.123 [0.1479]	0.0339** [0.0158]
LagRet _{5,-1}	–0.0150*** [0.0005]					
Winner _{5,-1}		–0.0222*** [0.0052]	0.0401*** [0.0148]	–0.0534*** [0.0055]	–0.0089 [0.0187]	–0.0034 [0.0076]
Loser _{5,-1}		0.0794*** [0.0048]	0.0870*** [0.0124]	0.0664*** [0.0067]	0.0466*** [0.0165]	0.0685*** [0.0084]
Turnover _{5,-1}	0.0390*** [0.0065]	0.0279*** [0.0066]	0.0348*** [0.0097]	–0.0299 [0.0326]	0.0221 [0.0220]	0.0221** [0.0103]
Pricespread _{5,-1}	0.5257*** [0.0098]	0.5241*** [0.0100]	0.4550*** [0.0198]	0.5789*** [0.0055]	0.5466*** [0.0399]	0.5156*** [0.0068]
Logmcap	–0.3808*** [0.0210]	–0.3728*** [0.0208]	–0.5361*** [0.0396]	–0.3565*** [0.0256]	–0.4237*** [0.0383]	–0.3564*** [0.0286]
Market-to-Book	0.0113 [0.0133]	0.0111 [0.0131]	–0.0059 [0.0041]	0.0142* [0.0079]	0.0549*** [0.0147]	0.0390*** [0.0091]
IO (in%)	0.0124*** [0.0010]	0.0129*** [0.0010]	0.0079* [0.0040]	0.0158*** [0.0017]	0.0077*** [0.0024]	0.0139*** [0.0018]
MarketRet _{1,5}	–0.0488*** [0.0007]	–0.0471*** [0.0007]	–0.0470*** [0.0018]	–0.0419*** [0.0012]	–0.0423*** [0.0015]	–0.0425*** [0.0014]
Intercept	5.3079*** [0.2110]	5.2137*** [0.2095]	6.3785*** [0.3968]	5.5650*** [0.3408]	5.3962*** [0.3576]	4.9499*** [0.3121]
Adj. R-sq	0.5979	0.5954	0.6078	0.6365	0.6562	0.5847
Observations	1584281	1584281	314348	318300	299887	317809

The dependent variable is the 5-day future average Pricespread in percentage ($Pricespread_{1,5}$), where the price spread is the difference of the high price and low price relative to the daily high price. Models 1–2 are based on the full sample, while model 3 (4) is based on stocks from the lowest size quintile (highest size quintile). In model 5 (6), the sample includes stocks with DTCR from the lowest (highest quintile) of the distribution based on the average DTCR prior to the Lehman collapse. *Lehman* dummy variable takes the value of 1 for days after the Lehman Brothers' collapse, after Sept 15, 2008. *DiscID* is a dummy variable that takes the value of 1 after the implementation of disclosure requirement, after Nov. 7, 2008. *Lehman*HighDTCR_{5,-1}* and *DiscID*HighDTCR_{5,-1}* are interaction variables of the *HighDTCR_{5,-1}* with the Lehman collapse (Lehman) and the disclosure policy introduction (*DiscID*) dummies where *HighDTCR_{5,-1}* is a dummy variable that takes the value of 1 for stocks from the top quintile of the previous 5 days DTCR. Control variables are defined in Table 2. The sample period is from Jan. 2006 to July 2010. The coefficient estimates with the corresponding standard errors (in brackets) clustered at firm level are reported. All models include firm fixed effect (not reported). The 1%, 5%, and 10% levels of statistical significance are denoted with ***, **, and *, respectively.

after the MDP introduction (see Models 5 and 6 in Table 2 Panel A). On the other hand, if the ban on naked shorts had a dominant impact, we can expect market quality to improve: the concentration of informed investors would increase because the ban would mean higher short selling costs, which could be consistent with the negative and significant coefficient on *DiscID*HighDTCR_{5,-1}*. To explore further whether the MDP introduction reduced pricing efficiency, we examine whether price volatility increased after the introduction of the MDP in the next section.

3.5. Relationship between short selling and short term volatility around introduction of the MDP

In this section, we consider the pricing efficiency role of short selling by examining the future short-term volatility of stocks in response to high short selling around the Lehman collapse and the introduction of the MDP. The model below (Eq. (3)) tests *H3* as to whether short term volatility increased after the MDP introduction, controlling for the effect of the crisis.

$$\begin{aligned}
 Pricespread_{t+i} = & \alpha + \beta_1 \times Lehman + \beta_2 \times DiscID \\
 & + \beta_3 \times Lehman \times HighDTCR_{5,-1} \\
 & + \beta_4 \times DiscID \times HighDTCR_{5,-1} + \sum_{j=5}^8 \beta_j Control_j \\
 & + \beta_9 \times MarketRet_{t+i} + \varepsilon_t
 \end{aligned} \quad (3)$$

Our dependent variable is the future five-day average *Price-spread*, a percentage difference between the daily high and low price relative to the daily high price (adopted from Diether et al., 2008); this dependent variable measures short-term volatility and captures information uncertainty about the stock. Other explanatory variables are defined similarly to Eq. (1). In addition to running the regression on the full sample, we also show results for subsamples of stocks based on size and level of shorting in Models 3 through 6.

The overall positive coefficient on the *Lehman* dummy variable in Models 1 through 6 of Table 4 suggests more market volatility after the Lehman collapse. The increase in overall price spread fully reversed after the MDP was introduced since the coefficients for *DiscID* are significantly negative and greater than those on the *Lehman* dummy.

In Models 3 and 4, we find that the crisis and the MDP have different impacts on the volatility for large and small stocks. In Model 3, we find a positive and significant coefficient on *Lehman*HighDTCR_{5,-1}* for small stocks, which shows that short-term volatility increased for actively shorted small stocks, while Model 4 shows volatility decreased for large, highly shorted stocks. The coefficient on *DiscID*HighDTCR_{5,-1}* for large stocks (Model 4) is positive and significant, which implies that volatility of stocks preferred by institutional investors increased after the disclosure; this result shows deteriorating market quality and supports *H3*. Consistent with the results for large stocks (Model 4), results for highly

Table 5

Regression analysis of shorting demand around 4-week window around Lehman Brothers' collapse and the introduction of the disclosure policy.

	Lehman Event, 4-week Sample, 1-29 Sept 2008					
	DTCR (1)	DTCR (2)	DTCR (3)	DTCR (4)	DTCR (5)	DTCR (6)
Panel A. Event study of shorting demand around Lehman Brother's collapse						
Lehman	−0.5865*** [0.1184]	−0.5589*** [0.1229]	−0.6906*** [0.1376]	−0.6949*** [0.1559]	0.1473** [0.0699]	0.1791** [0.0729]
Lehman*HighDTCR _{pre}					−0.2627 [0.2070]	−0.26 [0.2074]
Lehman*Loser			0.2986** [0.1167]	0.4243*** [0.1645]		
HighDTCR _{pre}					1.3059*** [0.2779]	1.3081*** [0.2782]
DTCR _{−5,−1}	0.4201*** [0.0567]	0.4204*** [0.0568]	0.4195*** [0.0568]	0.4192*** [0.0570]	0.7607*** [0.0249]	0.7607*** [0.0249]
LagRet _{−5,−1}	0.0219*** [0.0057]		0.0295*** [0.0059]		0.0246*** [0.0052]	
Winner _{−5,−1}		−0.0234 [0.0840]		−0.0268 [0.0846]		0.0403 [0.0761]
Loser _{−5,−1}		−0.2268*** [0.0673]		−0.4393*** [0.1076]		−0.2650*** [0.0641]
Turnover _{−5,−1}	−0.2806*** [0.0835]	−0.2574*** [0.0814]	−0.2939*** [0.0858]	−0.2674*** [0.0834]	−0.1936*** [0.0503]	−0.1892*** [0.0490]
Pricespread _{−5,−1}	0.2766*** [0.0455]	0.2884*** [0.0444]	0.2747*** [0.0457]	0.2924*** [0.0442]	0.1807*** [0.0255]	0.1926*** [0.0258]
Logmcap					0.1016*** [0.0218]	0.1030*** [0.0220]
Market-to-Book					−0.0827*** [0.0207]	−0.0823*** [0.0206]
IO (in%)					0.006 [0.0038]	0.0061 [0.0038]
MarketRet	−0.0006*** [0.0001]	−0.0007*** [0.0001]	−0.0005*** [0.0001]	−0.0007*** [0.0001]	−0.0001* [0.0001]	−0.0003*** [0.0001]
Intercept	1.9288*** [0.4556]	1.9016*** [0.4709]	1.9624*** [0.4590]	1.9659*** [0.4816]	−1.0567*** [0.2444]	−1.1062*** [0.2427]
Adj. R-sq	0.6689	0.6687	0.669	0.6688	0.6337	0.6336
Observations	27885	27885	27885	27885	27885	27885
Dep Var: 1 day DTCR	Disclosure Event, 4-week Sample, 24 Oct-21 Nov2008					
	DTCR (1)	DTCR (2)	DTCR (3)	DTCR (4)	DTCR (5)	DTCR (6)
Panel B. Event study of shorting demand around introduction of Disclosure Policy						
DisclD	1.0069*** [0.0767]	1.0210*** [0.0770]	0.9500*** [0.0768]	0.9714*** [0.0810]	0.4699*** [0.0380]	0.4618*** [0.0383]
DisclD*HighDTCR _{pre}					1.0213*** [0.1569]	1.0226*** [0.1565]
DisclD*Loser			0.1878** [0.0730]	0.1696* [0.0924]		
HighDTCR _{pre}					0.1459 [0.1135]	0.1550 [0.1131]
DTCR _{−5,−1}	0.4140*** [0.0353]	0.4117*** [0.0351]	0.4152*** [0.0354]	0.4124*** [0.0352]	0.8958*** [0.0164]	0.8942*** [0.0164]
LagRet _{−5,−1}	0.0042** [0.0017]		0.0058*** [0.0016]		0.0106*** [0.0017]	
Winner _{−5,−1}		−0.1952*** [0.0527]		−0.1974*** [0.0527]		−0.1385*** [0.0524]
Loser _{−5,−1}		−0.0437 [0.0501]		−0.1410** [0.0616]		−0.1206*** [0.0466]
Turnover _{−5,−1}	−0.1631*** [0.0526]	−0.1397*** [0.0528]	−0.1568*** [0.0534]	−0.1348** [0.0535]	−0.1283*** [0.0311]	−0.1189*** [0.0308]
Pricespread _{−5,−1}	0.0379* [0.0215]	0.0529** [0.0212]	0.0381* [0.0215]	0.0531** [0.0212]	0.0689*** [0.0122]	0.0813*** [0.0124]
Logmcap					−0.0419*** [0.0123]	−0.0458*** [0.0124]
Market-to-Book					0.0018 [0.0143]	0.0016 [0.0144]
IO (in%)					−0.0014 [0.0021]	−0.0018 [0.0021]
MarketRet	−0.0002*** [0.0000]	−0.0002*** [0.0000]	−0.0002*** [0.0000]	−0.0002*** [0.0000]	−0.0001** [0.0000]	−0.0001*** [0.0000]
Intercept	1.2905*** [0.2032]	1.2628*** [0.2046]	1.2779*** [0.2042]	1.2831*** [0.2026]	0.1024 [0.1422]	0.1619 [0.1440]
Adj. R-sq	0.7015	0.7016	0.7016	0.7016	0.6736	0.6732
Observations	29365	29365	29365	29365	29365	29365

The dependent variable is the daily days-to-cover ratio (*DTCR*), where *DTCR* is the total number of stocks borrowed (proxy for shorting) relative to the daily trading volume. *Lehman* dummy variable takes the value of 1 for days after the Lehman collapse, Sept 15, 2008. *DisclD* is a dummy variable for the disclosure requirement, takes the value of 1 for days from Nov. 7, 2008. *HighDTCR_{pre}* variable takes the value of 1 for stocks from the top quintile based on the average *DTCR* from July 2006 to Sept 14, 2008. *Lehman*HighDTCR_{pre}* and *DisclD*HighDTCR_{pre}* are interaction variables of the *HighDTCR_{pre}* variable with the *Lehman* and the *DisclD* dummies, respectively. *Lehman*Loser* and *DisclD*Loser* are interaction variables of the *Loser* dummy (takes the value of 1 for stocks from the bottom 30th percentile based on the last 5 days cumulative returns) with *Lehman* and *DisclD* dummies. Control variables are defined in Table 2. The sample period is from Jan. 2006 to July 2010. The coefficient estimates with the corresponding standard errors (in brackets) clustered at firm level are reported. All models include firm fixed effect (not reported). The 1%, 5%, and 10% levels of statistical significance are denoted with ***, **, and *, respectively.

Table 6

Lending fee dynamics in conjunction with Lehman Brothers' collapse and the disclosure policy.

	Ln(Fee) Full sample (1)	Ln(Fee) Full sample (2)	Ln(Fee) Small stocks (Quintile 1) (3)	Ln(Fee) Large stocks (Quintile 5) (4)	Ln(Fee) Low DTCR (Quintile 1) (5)	Ln(Fee) HighDTCR (Quintile 5) (6)
Lehman	0.0638** [0.0293]	0.0790*** [0.0294]	0.0913* [0.0479]	−0.2051*** [0.0407]	0.3631*** [0.0583]	−0.1116 [0.0798]
DisclD	−0.3767*** [0.0318]	−0.3899*** [0.0317]	−0.0054 [0.0537]	−0.6575*** [0.0414]	−0.1179* [0.0637]	−0.8157*** [0.0904]
Lehman* HighDTCR _{5,-1}	0.0262 [0.0539]	0.0205 [0.0538]	0.1295 [0.1563]	−0.0149 [0.0850]	0.6625 [0.4138]	0.2271** [0.0940]
DisclD* HighDTCR _{5,-1}	0.1536*** [0.0561]	0.1608*** [0.0560]	0.0413 [0.1430]	0.3171*** [0.0886]	0.3645 [0.4556]	0.5354*** [0.1022]
HighDTCR _{5,-1}	0.5855*** [0.0317]	0.5896*** [0.0316]	0.0552 [0.0490]	0.6433*** [0.0605]	0.0511 [0.1264]	0.3458*** [0.0482]
LagRet _{5,-1}	0.0010** [0.0005]					
Winner _{5,-1}		0.1121*** [0.0056]	0.0454*** [0.0093]	0.0883*** [0.0090]	0.0588*** [0.0107]	0.1507*** [0.0126]
Loser _{5,-1}		0.0268*** [0.0058]	0.0524*** [0.0099]	−0.0262*** [0.0097]	0.0213* [0.0115]	0.0307** [0.0139]
Turnover _{5,-1}	0.1291*** [0.0142]	0.1277*** [0.0140]	0.0881*** [0.0120]	0.1554*** [0.0286]	0.1089** [0.0436]	0.2047*** [0.0413]
Pricespread _{5,-1}	0.1174*** [0.0074]	0.1126*** [0.0073]	0.0630*** [0.0082]	0.1675*** [0.0107]	0.0189 [0.0197]	0.1295*** [0.0122]
Logmcap	−0.0126 [0.0313]	−0.0118 [0.0313]	0.0013 [0.0433]	−0.8750*** [0.0877]	0.0637 [0.0633]	−0.0096 [0.0799]
Market-to-Book	0.0002 [0.0062]	0.0001 [0.0062]	−0.0056** [0.0027]	0.0540* [0.0289]	−0.0280* [0.0166]	0.0722*** [0.0190]
IO (in%)	0.0278*** [0.0023]	0.0280*** [0.0023]	0.0098 [0.0061]	0.0215*** [0.0039]	0.0110** [0.0047]	0.0250*** [0.0042]
MarketRet _{1,5}	−0.0081*** [0.0007]	−0.0079*** [0.0006]	−0.0067*** [0.0014]	−0.0101*** [0.0009]	−0.002 [0.0013]	−0.0100*** [0.0016]
Intercept	1.1640*** [0.3488]	1.1246*** [0.3486]	0.2046 [0.4051]	13.3480*** [1.1327]	−0.3485 [0.6397]	1.6951* [0.8876]
Adj. R-sq	0.3572	0.3578	0.1635	0.3186	0.2734	0.3303
Observations	1584281	1584281	314348	318300	299887	317809

The dependent variable is natural logarithm of 1 plus the 5-day future average lending fees. In models 1–2, we use the full sample, while in model 3 (4), we use only stocks from the lowest size quintile (highest size quintile). In model 5 (6), we use only stocks that have high DTCR from the lowest (highest quintile) of the distribution based on the average DTCR prior to the Lehman Brothers' collapse. *Lehman* dummy variable takes the value of 1 for days after the Lehman collapse, after Sept 15, 2008. *DisclD* is a dummy variable that takes the value of 1 after the implementation of disclosure requirement, after Nov. 7, 2008. *Lehman*HighDTCR_{5,-1}* and *DisclD* HighDTCR_{5,-1}* are interaction variables of the *HighDTCR_{5,-1}* with *Lehman* and *DisclD* dummies, with the *HighDTCR_{5,-1}* is a dummy variable that takes the value of 1 for stocks from the top quintile of the previous 5 days DTCR. Control variables are defined in Table 2. The sample period is from Jan. 2006 to July 2010. The coefficient estimates with the corresponding standard errors (in brackets) clustered at firm level are reported. All models include firm fixed effect (not reported). The 1%, 5%, and 10% levels of statistical significance are denoted with ***, **, and *, respectively.

shorted stocks (Model 6) also show that volatility of stocks with the highest DTCRs increases in response to the MDP, suggesting increased price uncertainty.

Our results suggest that high shorting's informational role deteriorated after the MDP was introduced, particularly for stocks preferred by institutional investors, supporting *H3*. Our results also imply that the ban on naked short sales has no dominant impact on market quality.

3.6. Event study analysis

In this section we adopt an event study methodology to sharpen the analysis regarding the impacts of the Lehman collapse and the introduction of the MDP on shorting demand. Event studies allow us to better isolate the overlapping effects of the crisis from the impact of the MDP introduction. In Table 5 Panel A, we first examine the shorting demand proxied by DTCR in the four weeks surrounding the Lehman collapse. We use the same variables and model specifications as in Table 2.

In Panel A of Table 5, the negative and significant coefficient on the *Lehman* dummy implies that average short selling declines after the event. For all models, the positive and significant coefficient on the lagged *DTCR* variable shows a strong persistence in short selling, while the negative coefficient on *Turnover* and positive coefficient on *Pricespread* imply short sellers preferred illiquid and volatile stocks during the crisis. More importantly, we find an increasing

focus on poorly performing stocks: loser stocks have about a 29.86% higher DTCR immediately after the Lehman collapse, according to the coefficient on *Lehman*Loser* in Model 3. In contrast to prior studies showing that short sellers tend to focus on winners during normal times (e.g., Diether et al., 2008), our results are strikingly different around the crisis event. In Models 5 and 6, the positive and significant coefficients (larger than 1.30) on *HighDTCR_{pre}* and statistically insignificant coefficients on *Lehman*HighDTCR_{pre}* show that short sellers maintained or even increased the demand for heavily shorted stocks. Our overall findings show that short sellers engage in short-term trend-chasing, particularly for poorly performing stocks, and maintain large short positions around the time of the crisis, and thus provide justification for regulations to restrict destabilizing short sales in the crisis environment.

In Panel B of Table 5, we find that short selling somewhat increased after the disclosure policy, since the coefficient on *DisclD* is positive and significant in Models 1 through 6. This result suggests a recovery in the market from the worldwide shock caused by the Lehman collapse. The positive coefficients in these regressions have to be interpreted as a recovery, not as a general increase in shorting because Table 2 results based on the full sample already show that short selling remained lower after the disclosure, relative to the pre-crisis level. However, it is important to document in this table that by focusing on the events around Lehman collapse and the disclosure policy, the disclosure policy did not have an immediate adverse effect on the market.

The results in Models 5 and 6 also suggest a recovery of shorting demand for previously highly shorted stocks, as implied by the positive and significant coefficient on $DiscI^*HighDTCR_{pre}$. Given that pre-Lehman highly shorted stocks are likely to have more disclosed positions, increased shorting for these stocks could reflect the follow-on shorts immediately after the disclosure (Jones et al., 2013). In Models 3 and 4, the positive and significant coefficient on $DiscI^*Loser$ suggests a strong trend-chasing shorting demand in response to the disclosure. Also, the significant and negative coefficient on the *Winner* dummy further supports our finding that short sellers in Japan follow less-contrarian strategies. In sum, our results in Table 5 Panel B, using an event study, are generally consistent with our earlier results in Table 2.

3.7. The ban on naked shorts and lending fees

Results from Tables 3 and 4 show the reduced informativeness of short selling and increased volatility after the introduction of the MDP and naked shorts ban. While we cannot clearly isolate the impacts of the two policies in our previous results, we provide an auxiliary analysis of lending fees to examine whether the ban on naked short sales had a binding effect. The ban may force some short sellers to borrow shares, which drives up the lending costs and discourages some traders from shorting even if they have material information. To this end, we examine the dynamics of lending fees to assess the effectiveness of the naked shorts ban by regressing the natural log of average lending fee on dummy variables *Lehman* and *DiscID* and other independent variables similar to the previous analyses.

In Models 1 and 2 of Table 6, the positive and significant coefficients on *Lehman* show that lending fees rose after the Lehman collapse, but the negative and significant coefficients on *DiscID* show that lending fees significantly declined since the ban and the MDP were introduced, suggesting that the ban might not have been a binding factor for stock lending on average. However, the positive and significant coefficients on $DiscI^*HighDTCR_{5-1}$ suggest that lending fees became significantly higher for the pre-Lehman highly shorted stocks (Models 1 and 2). Our results from Models 4 and 6 confirm that either large stocks (Model 4) or heavily shorted stocks (Model 6) drive this result. If high lending fees for these stocks reflect greater share borrowing of informed short sellers, we expect market quality to improve because of a greater concentration of informed short sellers. However, market quality deteriorates for these stocks after the disclosure. Although we cannot rule out that the ban on naked shorts affected the fees of large or highly shorted stocks, our overall results suggest that the ban did not have a market-wide impact since average lending fees dropped after it was introduced.

4. Conclusion

In recent years stock exchanges worldwide introduced various disclosure requirements for large short positions to improve transparency and monitoring. More recently ESMA introduced a Europe wide disclosure regime without considering potentially adverse

effect of the disclosure. In this study, we examine the impacts of such a mandatory disclosure policy as was implemented in November 2008 for all listed stocks on the Tokyo Stock Exchange.

We find that short selling is significantly lower during the mandatory disclosure period (MDP) when compared to the normal market conditions, before the Global Financial Crisis. While increased risk aversion following Lehman collapse may have caused the decline in the aggregate levels of shorting, we show that the decline persists during the MDP. We find that stocks which were most heavily shorted in the pre-crisis period were major drivers of the aggregate decline. This suggests that institutional investors may be the type of short sellers who reduced most their short-sale activity following the mandatory disclosure policy. Consistently, we find significant adjustments in shorting preferences before and after the disclosure: short selling increasingly shifted to risky, small, and poorly performing stocks, which are the least preferred by institutional investors. We also find that short sellers exhibit more trend-chasing behavior and that the high shorting demand is associated with increased short-term price volatility.

Taken together, the documented changes in shorting preferences and strategies suggest unlikely alteration in the composition of the participating short sellers. Some informed institutional short sellers could have withdrawn or reduced their short-selling activities because of the direct costs (of reporting information) and the indirect costs (due to higher information disclosure, risk of free-riding from uninformed investors). More importantly, regulators should be aware of changes in the composition of traders and their strategies because these changes likely result in a loss of potential benefits of shorting, such as information provision and pricing efficiency.

5. Uncited reference

FSA (2009).

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Appendix I

Summary of hypotheses for the MDP introduction, the Lehman crisis, and the naked short ban

Implications of market events	Shorting demand (proxied by DTCR and shares outstanding on loan/trading volume)	Future return predictability of shorting demand	Future price volatility in relation to shorting demand
<i>MDP introduction:</i> institutional traders withdraw	Table 2 H1: decrease in shorting demand H1B: decrease in shorting demand after MDP for stocks that are likely preferred by institutions because of	Table 3 H2: decrease in the negative return predictability of shorting demand (i.e., decrease in information content)	Table 4 H3: increase in future price volatility in relation to heavier shorting, as “relatively informed” traders withdraw

Appendix I (continued)

Implications of market events	Shorting demand (proxied by DTCR and shares outstanding on loan/trading volume)	Future return predictability of shorting demand	Future price volatility in relation to shorting demand
	the higher direct and indirect shorting costs		
<i>Lehman crisis</i> : risk aversion increases market-wide	H1: increase in risk aversion after Lehman's collapse causes decrease in shorting H1B: increase in risk aversion reduces short sales for risky stocks (small, volatile stocks)	H2: no change (or increase) in return predictability of shorting demand, as all traders are affected by the increased risk aversion. Composition of traders does not change. If anything, institutions are less likely to be affected, in which case return predictability strengthens	H3: no change (or decrease) in the future volatility impact of shorting demand. Future volatility may decrease because of less shorting, especially by relatively uninformed retail investors, if they are more sensitive to risk aversion
<i>Naked short sale ban</i> : higher shorting costs and increased constraints	H1: increase in securities lending activity H1B: decrease in shorting activity for smaller, illiquid stocks, which are generally associated with higher borrowing costs	H2: increase in negative return predictability of high shorting demand, as high shorting costs are associated with greater concentration of informed traders	H3: decrease in future volatility in relation to shorting demand as price precision increases with more informed trading, in turn a result of higher shorting costs

Appendix II

Japan's Financial Services Agency's Press releases about Disclosure regime and Naked short selling, October 2008.

Financial Services Agency: Press Conference by Shoichi Nakagawa, Minister of Finance and Minister for Financial Services
(Official English Excerpt from Japan FSA' website, October 14, 2008)

"Although information disclosure has until now been required on a monthly basis, it will be required on a daily basis to tighten the regulation on short-selling. In addition, we plan to suspend the sale of stocks the government has bought from banks. This concerns the stockholdings of Banks' Shareholdings Purchase Corporation. I hope that the BOJ (Bank of Japan) will do likewise."

Financial Services Agency: Press Conference by Shoichi Nakagawa, Minister of Finance and Minister for Financial Services
(Official English Excerpt from Japan FSA' website, October 27, 2008)

[Opening Remarks by Minister Nakagawa]

"First, the Prime Minister instructed me to tighten restrictions on short selling of stocks in order to stabilize the stock market, and this will be decided at a cabinet meeting on Friday. We will tighten restrictions as soon as possible, by the first trading day of November - that is, just after the three-day weekend starting on November 1. In addition, we would like to quickly start allowing the flexible application of restrictions regarding banks' stockholdings."

Financial Services Agency: Press Conference by Shoichi Nakagawa, Minister of Finance and Minister for Financial Services
(Official English Excerpt from Japan FSA' website, October 28, 2008)

[Opening Remarks by Minister Nakagawa]

I do not have anything particular to report to you about today's cabinet meeting.

However, I would like to mention one matter. Yesterday, I said that a ban on the naked short selling of stocks (a practice of selling stocks short without borrowing the stocks first) will be introduced on the first trading day of November as a measure to stabilize the stock market. Later, based on an instruction from the Prime Minister, I have made a new decision, which I will now explain to you. We will immediately start investigating the status of the enforcement of the restrictions on short selling to identify illegal activities. The FSA (Financial Services Agency) will cooperate with the Securities and Exchange Surveillance Commission and the TSE (Tokyo Stock Exchange) in doing this. If the investigation finds past cases of illegal activities, we intend to punish the offenders retroactively. **In addition, we will introduce a restriction on naked short selling today, although formal procedures such as a cabinet decision and the issuance of a cabinet order will take some time.** As an emergency step for the interim period, the TSE will request member securities companies to refrain from taking orders related to naked short selling.

Financial Services Agency: Press Conference by Shoichi Nakagawa, Minister of Finance and Minister for Financial Services
(Official English Excerpt from Japan FSA' website, October 31, 2008)

[Opening Remarks by Minister Nakagawa]

I did not make any particular statement at today's cabinet meeting. There was a report regarding statistics such as the effective ratio of job offers to applicants and the unemployment rate.

Today, we will issue a cabinet order regarding the publication of data on short selling positions with a size larger than the prescribed level, which we earlier announced as part of measures to strengthen the financial functions. Although we previously planned to start the publication in mid-November out of consideration for the need for a computer system modification, we will bring forward the start date by one week to November 7, Friday.

Appendix III

Summary information about industry representation in the data

NIKKEI industries	Number of firms	Pct of sample (%)
Air Transportation	3	0.20
Chemicals	114	7.67
Communication Services	16	1.08
Construction	93	6.26
Credit & Leasing	2	0.13
Drugs	34	2.29
Electric & Electronic Equipment	152	10.23
Fish & Marine Products	5	0.34
Foods	61	4.10
Iron & Steel	35	2.36
Machinery	116	7.81
Mining	5	0.34
Motor Vehicles & Auto Parts	50	3.36
Nonferrous Metal & Metal Products	60	4.04
Other Manufacturing	47	3.16
Petroleum	9	0.61
Precision Equipment	31	2.09
Pulp & Paper	11	0.74
Railroad Transportation	19	1.28
Real Estate	12	0.81
Retail Trade	114	7.67
Rubber Products	13	0.87
Sea Transportation	9	0.61
Services	196	13.19
Shipbuilding & Repairing	3	0.20
Stone, Clay & Glass Products	29	1.95
Textile Products	35	2.36
Transportation Equipment	8	0.54
Trucking	17	1.14
Utilities – Electric	11	0.74
Utilities – Gas	6	0.40
Warehousing & Harbor Transportation	18	1.21
Wholesale Trade	152	10.23

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