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# **Which financial stocks did short sellers target in the subprime crisis?**



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# **Which Financial Stocks did Short Sellers Target in the Subprime Crisis?**

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## **Abstract**

Tracing the SEC ban on the short selling of financial stocks in September 2008, this paper investigates whether such selling activity before the 2008 short ban reflected financial companies' risk exposures in the subprime crisis. The evidence suggests that short sellers sold short stocks that had the greatest asset and insolvency risk exposures, and that the short selling of financial firms' stocks was not significantly greater than that of non-financial firms. When the short ban was in effect, the market quality of financial stocks without subprime asset exposure had deteriorated to a larger degree than that of financial companies with subprime asset exposure. The findings imply that such a regulation may mute the market disciplining effects of investors and may also serve as a counterweight to any perceived macro or systemic risk reduction benefits resulting from such a ban.

**Keywords:** short selling, subprime assets, financial crisis, short-sale ban, CDS spread

**JEL Classifications:** G01, G14, G18, G28, G33

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## 1. Introduction

Short sellers such as hedge funds were accused of using short sale strategies to push down the prices of financial company equities below their fundamental values during the 2007–2009 crisis. Indeed, a sequence of actions taken by the SEC seems to be consistent with this belief. On 15 July 2008, the SEC issued an emergency rule to limit certain types of short selling,<sup>1</sup> namely, the “naked” short selling of 19 major financial firms. On 17 September 2008, the SEC announced that this rule was to be extended to all publicly traded financial firms. On 18 September 2008, the SEC announced a ban effective immediately on all types of short selling of the stocks of 797 public financial companies, which continued until 8 October 2008. At the time, the SEC’s Chairman, Christopher Cox, claimed that this short selling ban was an effort “to combat market manipulation that threatens investors and capital markets.”<sup>2</sup> Within a week, the prohibition on short selling had spread to markets overseas, including the United Kingdom, Australia, Taiwan, and the Netherlands.<sup>3</sup>

The 2008 short ban triggered significant controversy. A number of hedge fund managers and other investors actively opposed the ban, arguing that regulators were actually punishing short sellers for the mistakes made by financial companies that had exposed themselves to risky

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<sup>1</sup> See SEC Press Release 2008-143 on 15 July 2008.

<sup>2</sup> See SEC Press Release 2008-211 on 19 September 2008.

<sup>3</sup> According to a recent BBC news article from 12 August 2011, the European Securities and Marketing Authority (ESMA) issued a statement that France, Italy, Spain, and Belgium were set to ban short selling on select stocks, including large banks and insurers such as BNP Paribas, Crédit Agricole, and Natixis.

asset investments, such as subprime mortgage-backed securities and other credit derivatives. Richard Baker, head of the Managed Funds Association, a hedge fund lobbying group, argued that hedge funds short because they identify fundamental problems with a company. “If in fact a company does fail, it will have nothing to do with the fact that someone on the outside noticed these deficiencies.”<sup>4</sup> Additionally, financial economics researchers commonly believe that short sellers are active, rational, and even informed traders that help facilitate the price discovery process (Boehmer and Wu, 2013) and keep price in line with the fundamental or intrinsic values (e.g., Dechow, Hutton, Meulbroek and Sloan, 2001). Short-sale constrained stocks, on the other hand, may be traded at a price above their fundamental values, and therefore may underperform in the future (e.g., Miller, 1977; Boehme, Danielsen, and Sorescu, 2006; Asquith, Pathak and Ritter, 2005).

This paper investigates whether investors rationally anticipated and traded on certain types of fundamental information that affected future returns, and we are specifically interested in over-investment in risky assets and overall insolvency risk exposure. Given the controversies regarding the short ban, this is an important research question for both researchers and regulators. First, financial institutions’ excessive exposure to risky assets—specifically subprime assets—is believed to have been one of the major causes of the 2007-2009 crisis. The question of whether and how these types of risk exposures affected short selling activity remains unanswered in the literature. Second, if companies with greater exposure to risky assets were actually sold short to a greater degree, then opposition to the SEC’s ban on short selling would have been reasonable. Indeed, as has been shown in a more general context, short selling activity enhances

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<sup>4</sup>See *The Wall Street Journal Article*, “SEC Issues Temporary Ban Against Short Selling,” by Kara Scannell, Deborah Solomon, Craig Karmin, and Gregory Zuckerman on 19 September 2008.

the informational efficiency of asset prices (e.g., Boehmer, Jones and Zhang, 2008; Boehmer and Wu, 2013). That is informed traders inject additional information (and potentially more accurate information) into the marketplace by short selling.<sup>5</sup> Thus, banning short selling could have had unfavorable informational consequences. Stock prices, for instance, might no longer be an accurate reflection of the full information set in the marketplace, especially with regard to a financial company's investment in subprime assets. Such "inefficiency" effects may be perceived as offsets to any potential macro policy or systemic risk reduction benefits from such a ban.

There have been a number of papers that investigate the impact of the short ban on different markets. For example, Boehmer, Jones, and Zhang (2013) show that the ban lowered market quality as measured by spreads, price impact, and intraday volatility for affected stocks. Gagnon and Witmer (2009) have demonstrated—via a natural experiment crafted around cross-listed stocks between the Canadian and U.S. markets—that the 2008 short selling ban actually caused stock prices to trade above their fundamental values. Beber and Pagano (2013) find that short bans around the world during the 2007-2009 crisis were detrimental for liquidity, slowed price discovery, and failed to support prices. Kolasinski, Reed, and Thornock (2013) find that short bans result in more informed trading. Battalio and Schulz (2011) and Grundy, Lim, and Verwijmeren (2012) focus on the impact on the option market. Danciuilezcu (2009) and Choi, Getmansky, Henderson and Tookes (2010) examine the impact on the bond market.<sup>6</sup> However, the heterogeneity of market quality deterioration within stocks affected by the short ban has been

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<sup>5</sup> See Desai, Ramesh, Thiagarajan, and Balachandran (2002), Asquith et al. (2005), and Diether, Lee, and Werner (2009), for example.

<sup>6</sup> Gruenewald et al. (2009) find that around 80% of the worldwide market capitalization was under some form of shorting restriction in December 2008. Beber and Pagano (2013) examine short sale bans internationally. They find significant declines in market quality in countries that enacted a full or partial ban on short selling. Kolasinski et al. (2010) show empirical evidence consistent with the notion that the short sale ban increased the proportion of informed short sellers. Battalio and Schulz (2011) show that the short sale ban has unintended consequences in the option market.

relatively under-researched. This paper further investigates whether financial firms with greater subprime asset exposure experienced a higher or lower degree of market quality deterioration when the ban became effective.

This paper complements the existing literature by answering the important question of which type of financial stocks were more likely to be short sold during the subprime crisis. Our results underscore the important role of short sellers in incorporating financial companies' subprime exposures into their stock prices, and in monitoring and disciplining the targeted companies by discouraging incautious, value-destroying investments.<sup>7</sup> Lorenzo Di Mattia, the manager of the hedge fund Sibilla Global Fund, argued at the time of the ban: "Funny they don't understand that it is because there is short selling that the market didn't crash. If there were no shorts in this market, there would be only sellers."<sup>8</sup> Moreover, banning short selling limits investors' hedges against their market risks, as short selling financial company stocks with significant exposure to risky assets might be viewed as a crucial "self-rescue" strategy for some institutional investors.<sup>9</sup>

To address these research questions, we conduct three different sets of tests. First, we examine whether short sellers actually differentiated between financial companies with substantial exposure to subprime and related assets and financial companies with little exposure over the period prior to the SEC's short sale ban. To examine the extent to which financial firms were exposed to risky asset investments, we use a unique data set of subprime activity at the

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<sup>7</sup> Balasubramanian and Cyree (2008) show evidence that the short selling of bank stocks can provide a signal about the future performance of the banks.

<sup>8</sup> See the article in *Dow Jones Newswires*: "UPDATE: Short Selling Limit May Have Unintended Consequences," by Rob Curran, 15 July 15 2008.

<sup>9</sup> Brunnermeier (2009) mentions a Wall Street saying: "If you can't sell what you want to sell, sell what you can sell."

financial company level by collecting subprime-asset-related accounting information from financial company annual reports during the year prior to the 18 September 2008 short selling ban. Since there is on average three month lag between a company's financial statement filing date and its fiscal year end date (following Compustat's definition of the fiscal year end date), our sample of financial report filings during the year prior to September 2008 covers the 2007 *fiscal year*. Thus, for example, the 2007 fiscal year end for Meta Financial Group Inc. of NASDAQ was 30 September 2007; however, the filing date for its fiscal year-end report was approximately three months later, on 11 January 2008. Thus, Meta's financial reporting disclosure at the time of the 18 September 2008 ban would not have included fiscal year 2008 data, since this had been unavailable until December 2008. It should also be noted that prior to 2009, the subprime asset holdings of financial companies were primarily reported in footnotes to annual financial statements. We compare short selling activities between financial stocks with subprime assets and those without subprime assets over the window  $(-10, +10)$  and  $(-10, -1)$  surrounding the 2007 financial report filing date.

Second, we examine credit default swap (CDS) spreads as an alternative but broader measure of a financial company's insolvency risk exposure. Acharya and Johnson (2007) argue that CDS spreads may contain private information such as bank lenders' assessment of the underlying companies' prospects.<sup>10</sup> If short sellers are rational, we might expect that companies with greater risk exposure (measured by their risky asset exposures and CDS spreads) were sold short more. Thus, in our analysis, we investigate how Lagged Daily CDS Spreads affected short volumes over two periods: the windows surrounding the 2007 financial report filing dates, and the one-year period preceding the 2008 short sale ban (from 18 September 2007 to 17 September

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<sup>10</sup> Acharya and Johnson (2007) provide evidence that CDS spread changes predict stock returns of the borrowing companies.



2008). We also compare short volumes on financial companies' stocks with those on non-financial companies' stocks after we match the two groups on size and CDS spreads.

Third, we investigate the changes in Daily Bid/Ask Spreads of stock prices before and after the short ban went into effect on 19 September 2008. More importantly, we utilize a difference-in-difference approach to compare the changes in bid/ask spreads between financial companies with subprime assets and those without subprime assets.

Importantly, in this paper we only focus on whether short selling activity was a reaction toward financial companies' subprime and insolvency risk exposures. We do not directly examine whether the short sale ban was an attempt by regulators to restore investor confidence or to prevent the financial market meltdown during the peak of the financial crisis. Our results show that the greater a financial company's exposure to risky assets, the greater the short selling activity of its equity around the filing date of its 2007 annual report. Our results suggest that short sellers were playing a crucial role in incorporating some important pieces of fundamental information into stock prices during the period leading up the September 2008 short ban.<sup>11</sup>

Our results using CDS spreads provide further confirmation that short selling prior to the ban reflected financial companies' asset risk exposures. We find that short volume was positively correlated to Lagged Daily CDS Spreads and change in average CDS spreads, both of which can be viewed as reflecting a financial company's overall default or insolvency risk. As a robustness test, we also investigate whether the 19 major financial firms that went on the naked short selling

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<sup>11</sup> It is difficult to entirely rule out manipulative behavior of short sellers. We simply argue that the monitoring and disciplining role of short sellers helps in determining credit quality, as their participation in trading and price discovery helps to set prices that reflect their fundamental values. In such a scenario, the banning of short selling may at least have some downside.

list on 15 July 2008—before the more general and comprehensive September ban—were driving our results. In all tests, our results stay qualitatively the same as those in the broader sample. Since the short selling ban was imposed only on financial companies, we also test whether there was any abnormally high short selling activity on financial stocks in comparison to non-financial stocks. We match these financial firms with non-financial firms based on two dimensions: credit risk exposure and firm size. We find that there was no significant difference between short selling activities for financial and non-financial firms prior to the 2008 short selling ban. These results suggest that short selling activities were not excessive for financial firms relative to non-financial firms prior to the imposition of the ban.

In sum, our results suggest that short sellers differentiated between those financial companies with substantial asset and insolvency risk exposure and those with little exposure. Our results are economically significant as well. For example, over the window  $(-10, +10)$  surrounding the filing date of financial companies' 2007 annual reports, the average abnormal short volume of the group with subprime assets more than tripled the average of the group without subprime assets. Over the one year period before the short ban, the tercile group with the highest changes in CDS spreads (worst deterioration in credit quality) had 10 times as much abnormal trading volume as the tercile group with the lowest changes in CDS spreads.

During the period in which the short ban was in effect—19 September 2008 to 8 October 2008—we find the bid/ask spreads of stocks widened to a larger degree for financial companies without subprime assets relative to companies with subprime assets. The market quality of affected stocks in general had deteriorated during the ban-in-effect period because of reduced competition among liquidity providers (Boehmer et al., 2013). This “competition effect” predicts

that market quality deterioration should be relatively more profound in the group with subprime exposure, since it had greater short volume prior to the ban. However, market makers arguably faced a relatively more severe adverse selection problem that was created by informed short sellers in companies with subprime assets before the short ban was imposed. The short ban eliminated the adverse selection problem due to short selling activities in all stocks listed by the short ban. Such an alleviation of adverse selection, which tends to narrow the spreads, should be more profound in companies with subprime assets. Our result is more consistent with the “adverse selection effect” rather than the “competition effect.” This finding highlights another possibly unfavorable consequence of the short ban: the relatively more innocent financial companies that had no subprime investments suffered more in market quality deterioration during the ban-in-effect period than those with subprime investments. This paper is directly linked to the literature on the informational role of short sellers. This strand of literature generally links short selling activity with different pieces of information of the target companies, such as earnings surprises (Christophe, Ferri, and Angel, 2004), the ratios of fundamentals to market values (Dechow et al, 2001), and earnings quality (Desai, Krishnamurthy and Venkataraman, 2006). This paper differentiates itself from the existing literature by identifying some specific yet important types of information that drove short selling activity during the 2007-2009 subprime crisis. To the best of our knowledge, this paper is the first to explicitly investigate the effect of subprime exposure and CDS spreads on short volume. Last but not least, even though some previous research has already shown that CDS spreads (Acharya and Johnson, 2007) and short selling activity (e.g., Asquith et al, 2007; Boehmer et al, 2008; Desai et al, 2002) have predictive power over future stock returns, this paper is one of the first to provide direct evidence of an information flow from credit derivative markets to short sellers.

The rest of this paper is organized as follows. In section 2, we discuss related literature and develop our hypotheses. In section 3, we describe our data and variables. In section 4, we present our empirical results. We conclude in section 5.

## **2. Literature and Hypotheses**

Anecdotal evidence and the financial economics literature both generally view short sellers such as hedge funds as sophisticated, rational, and informed market participants that can facilitate the price discovery process. For example, Dechow et al. (2001) find that short sellers target companies with weak fundamentals such as low earnings-to-price ratios, with the expectation that the ratios will mean-revert in the future. Desai et al. (2006) find that short sellers accumulate their short positions several months before earnings restatements, in which case companies publicly recognize and correct material errors in their previous financial reports. Short selling activities also have shown significant predictive power over future stock returns (e.g., Asquith et al., 2005; Boehmer et al., 2008; Christophe et al., 2004). The literature on short selling generally concurs that short sellers help to facilitate price discovery and keep stock prices in line with fundamental values.

On the other hand, it is also commonly believed that excessive investment in subprime related assets by financial companies is one of the major causes, if not the most important cause, of the subprime crisis. Many financial firms, especially banks, incurred significant losses during the financial crisis due to the dramatic rise in mortgage delinquencies, defaults, and foreclosures. Our hand-collected data show that most financial companies unveiled their investment of subprime assets for the very first time in the 2007 financial reports. If short sellers are indeed

rational, we should expect that these sophisticated traders reacted to this newly released information. More specifically, we expect to observe abnormal short volume in the equities of those financial companies with greatest exposure to subprime assets and other risky securities. Thus, our first hypothesis (H1) is:

*Hypothesis 1: Short selling of stocks was greatest for financial companies with the largest exposures to asset risk.*

The credit derivative market (which includes credit default swaps, or CDS) is dominated by informed players such as banks and other financial institutions. Acharya and Johnson (2007) argue that CDS spreads may convey private information such as banks' assessments of the prospects of the underlying companies. They find evidence of an information flow from the credit derivatives market to the stock market. Such an information flow is more profound when the underlying companies experience credit deterioration. Similarly, Henry, Kisgen and Wu (2011) show 40% higher than normal short selling activity in the stocks of companies that are about to be downgraded by credit rating agencies. We investigate how short sellers could trade based on the arrival of new information in an alternative measure of a financial company's risk exposure, namely, CDS spreads. We argue that rational investors should react to the new fundamental information revealed in the movement of CDS spreads.

Consequently, we hypothesize that a company's CDS spreads and/or change in its CDS spreads should be positively correlated with short volume of its equity. This effect should exist around fiscal filing dates or over the period preceding the short sale ban. Thus H2 is:

*Hypothesis 2: Short selling of equity was greatest for financial companies with the largest insolvency risk exposures measured by CDS spreads.*

Boehmer et al. (2013) argue that a shorting ban could cause deterioration in market quality if short sellers are important liquidity providers. This is because banning short selling could reduce competition among liquidity providers and therefore widen the bid-ask spreads. We call this argument the “competition effect.” Our first hypothesis predicts that financial companies with subprime asset exposures had greater short volume than those without such exposure before the short ban. If this prediction is indeed true, then according to this “competition effect” we should expect to observe a greater degree of market quality deterioration in financial firms with subprime exposure.

Alternatively, Diamond and Verrecchia (1987) point out that in comparison to other traders, short sellers are more likely to be informed. Boehmer et al. (2013) also argue that when short selling is restricted, liquidity providers will face less severe adverse selection problems because informed short sellers are restricted from trading. Therefore banning short selling could actually narrow the bid-ask spreads. We call the second argument the “adverse selection effect.” When the short selling ban was in effect, the “competition effect” tended to widen the bid/ask spreads, whereas the “adverse selection effect” would tend to narrow the bid/ask spreads.

During the period preceding the 2008 short ban, there were many rumors and dramatic events associated with financial companies with significant subprime exposure, such as the bankruptcy of Lehman Brothers. Liquidity providers such as market makers could therefore arguably face a greater degree of adverse selection problems in financial stocks with subprime

exposure than those without. When the short sale ban became effective, the adverse selection problem brought by short sellers became trivial in all affected financial stocks. Therefore there should be a greater reduction of adverse selection problems in financial companies with subprime assets.

In other words, the “competition effect” and the “adverse selection effect” have opposite predictions on which type of financial firms should experience a greater degree of market quality deterioration in the ban-in-effect period. Our third hypothesis is therefore a joint test of the two effects:

*Hypothesis 3: The stocks of financial companies with subprime exposure experienced a greater (lesser) degree of market quality deterioration than those without subprime exposure.*

### **3. Data and Sample Construction**

In this section, we discuss the construction of our sample and data sources. Initially our sample consists of the 797 financial companies that were put on the no-short-sale list by the SEC in September 2008. We then hand collect detailed accounting information on financial companies’ exposures to risky assets, primarily subprime mortgage related loans and securities and the filing dates of that information from annual reports (10-K).<sup>12</sup> After removing those observations without 10-K filing records or filing dates for the fiscal year 2007, our sample consists of 536 financial companies from the short sale ban list.

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<sup>12</sup> We obtain the annual financial reports of the financial firms from SEC filings via Edgar-Pro online.

### *3.1. Measure of Exposure to the Subprime Market*

We create a direct measure of exposure to the subprime market that includes a financial company's investments in subprime mortgage loans, as well as its holdings of securities backed by subprime mortgages. A large number of financial companies discuss their total subprime exposures at the beginning of their annual reports, usually in the firm performance review section. In such cases we directly assign those numbers as the total amount of their exposure to the subprime market. In other cases, we looked for subprime investment information in the sections of the annual report with details on (1) the firm's loan portfolio and (2) its investment portfolio holdings.

In the loan portfolio sections of the annual reports, we identify and calculate the total amount of subprime exposure based on the following criteria: (1) the dollar amount of loans explicitly reported as subprime; (2) the dollar amount of loans indicated as being significantly impacted by the mortgage crisis. For firms that clearly state no exposure to subprime lending, a zero is assigned; otherwise, we code them as missing.

In the investment portfolio section of the annual reports, our primary focus is on the dollar amount of investment assets that are backed by subprime mortgages. Most of this information was first reported in fiscal year 2007. Additionally, subprime-related investments were largely undertaken by major banks. Many smaller publicly traded banks were not actively involved in subprime-market-related investments.<sup>13</sup> A firm's exposure to the subprime market is

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<sup>13</sup> In most cases, banks only had limited subprime exposure, which would not have significantly affected their performance, and these data were not separately reported. If so, they are coded as missing since their subprime-related investment activity is not clear.



standardized by its total assets (Subprime/Assets). As a robustness check, we also standardize the subprime assets by the financial firm's market value of equity (Subprime/Mkt Equity) and tangible equity values (Subprime/Tangible Equity).<sup>14</sup> We report summary statistics of subprime exposures together with other annual variables in Panel A of Table I.

Among 536 financial companies that could be identified with the 2007 annual report filing dates via Edgar, 316 report their actual exposure to the subprime market. On average, subprime assets account for 0.9% of total assets, 10.5% of market value of equity, and 10.6% of tangible equity. There is a high degree of dispersion in banks' subprime exposures. For example, the highest subprime-to-market value of equity ratio is 175.3%, whereas the lowest is zero.

### *3.2. An Alternative Measure of Insolvency Risk Exposure*

In addition to the above measure, we obtain CDS spreads on financial company debt from Markit's Credit Default Swap (CDS) database. Markit provides mark-to-market CDS spreads derived from market makers. CDS data are available by entity, term structure, currency, and restructuring clause. The information provided at the contract level includes: the daily CDS spread, credit ratings, credit event types, seniority, and currency. Following Acharya and Johnson (2007), we consider the daily CDS spreads of five-year maturity contracts, which are usually the most liquid contracts, with the U.S. dollar as the underlying currency and restructuring of the debt included as one of the events of default.

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<sup>14</sup> Tangible equity is defined by *Compustat* as the sum of common stocks, retained earnings, capital surplus, self-insurance reserves (when included in the Equity section), and capital stock premium.

In general, the higher a company's CDS spread, the greater the company's perceived default or insolvency risk exposure. The CDS spread data are available from January 2006 to September 2008. We merge the CDS database with our financial company sample by ticker and year and then by name and year (we manually check the merged results to ensure accuracy).

The first period of interest is the (-10, +10) window around the 2007 financial report filing dates of financial companies. We first use 1-day-lagged Daily CDS Spreads as the key measure of default risk explaining daily short selling activities over the period around the 2007 financial report filing dates. Additionally, since our main goal is to capture the arrival of new information conveyed in the 2007 financial reports, we also calculate  $\Delta$  90-day CDS Spread, which is the change in 90-day average CDS spread before and after the filing dates. Daily CDS Spreads over window (-10, +10) and  $\Delta$  90-day CDS Spread are summarized in Panel B of Table I.

The second period of interest is the one year before the 2008 short sale ban from 18 September 2007 to 17 September 2008. Again we use 1-day-lagged Daily CDS Spreads as the key explanatory variable of daily short selling activity over the period. Moreover, we construct two additional variables, One-year CDS Spread and  $\Delta$  One-year CDS Spread. For every firm we calculate the one-year average of the daily CDS spreads for the period from 18 September 2007 to 17 September 2008; we call this variable One-year CDS Spread. Second, we also calculate the change in One-year CDS Spread ( $\Delta$  One-year CDS), which is calculated as the One-year CDS spread discussed above minus the average daily CDS spread over the period from 18 September 2006 to 17 September 2007. Daily CDS Spread over one year before the ban, One-year CDS Spreads, and  $\Delta$  One-year CDS Spread are summarized in Panel C.

In total there are 76 financial firms with available CDS data. We observe an overall deterioration of credit quality among financial companies in both periods of interest. For example, the average  $\Delta$  90-day CDS Spreads in Panel B is 0.46% around the filing dates and the average  $\Delta$  One-year CDS Spreads in Panel C is positive 1.271%. Both numbers are economically significant if we use the average One-year CDS Spread as the benchmark, which is 1.667% as shown in Panel C. In particular,  $\Delta$  90-day CDS spreads and  $\Delta$  One-year CDS Spreads are equivalent to 36% and 76% of the average raw level One-year CDS spread, respectively. The average Daily CDS Spreads over (-10, +10) surrounding the filing dates is 1.958% (Panel B), slightly higher than the average of 1.866% over the one-year period preceding the short ban (Panel C).

### *3.3. Short Selling Volume and Trading Volume*

Similar to Daily CDS spreads, we are interested in short selling activities over the (-10, +10) window around the 2007 financial reports filing date, and the one year period preceding the short ban. According to the Regulation SHO (REGSHO) rule adopted by the SEC in mid-2004, all self-regulatory organizations (SROs) had to report tick data on short sales, including information on ticker name, short sale volume, short sale price, and listing exchange. This SEC reporting requirement was removed on 6 July 2007; SROs are no longer required to publicly report their short sale data after July 6 2007.<sup>15</sup> Since our period of study is after the end of the REGSHO period, we build our short sales database from other sources. For the period from 1 July 2007 to 18 September 2008, we were able to obtain short sale data from commercial databases for NYSE, proprietary sources for NASDAQ, and public databases for NYSE-ARCA,

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<sup>15</sup> This SEC REGSHO rule of public reporting of short selling activities by SROs resumed again in July 2009.

which continued to provide the data publicly after the REGSHO period.<sup>16</sup> Checked against the REGSHO short sale database, these three short sale data sources cover 78.5% of the total short selling activities that were publicly reported under REGSHO. In total, this combined short sale database covers 600 of the 797 financial companies covered by the ban.

Asquith et al. (2005) discuss in detail when it is more appropriate to scale short interest by stock (outstanding share) versus flow (trading volume). Using volume of trading as a scaling measure is more appropriate if the purpose of the research question is to measure whether short selling is “indicative of future buying pressure as short sellers cover their positions.” The use of outstanding shares as a scaling measure is more appropriate if the investigation of short selling reflects the information of informed investors. Consistent with this argument, short interest as a proportion of shares outstanding is used in Dechow et al. (2001), Desai et al. (2002), Asquith et al. (2005), Desai et al. (2006), and Henry et al. (2011). This paper, however, focuses on short volume rather than short interest. We use short volume as a proportion of shares outstanding, Short Volume (%), as the key dependent variable of this paper.

Additionally, we follow the approach in Garfinkel and Sokobin (2006), Chen and Sami (2008), and Connolly and Stivers (2005) to create a demeaned or abnormal Short Volume (%). We subtract the gross Short Volume (%) by the contemporaneous median Short Volume (%) of all publicly traded companies, financial and non-financial, on the same stock exchange of the financial firm on the short ban list. For example, Sterling Bancorp is listed on NYSE, and 79,093 shares of Sterling Bancorp, or 0.42% of its shares outstanding, were short sold on 8 May 2007. On the same day the median Short Volume (%) of all companies listed on NYSE was 0.12%.

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<sup>16</sup> We thank Frank Hatheway, Chief Economist at NASDAQ OMX, for providing the proprietary daily short selling data for the period post REGSHO.

Therefore, the demeaned or Abnormal Short Volume (%) of Sterling Bancorp is 0.30%. In multivariate analysis, we regress this daily Abnormal Short Volume (%) on firm characteristics such as firm size, subprime exposure, CDS spreads, and daily demeaned total trading volume.

This approach is similar to the market-adjusted excess stock returns. We adopt this approach mainly for two reasons. First, it can eliminate the overall market trend of short selling behavior on the stock exchange and on the same day, such that we focus only on the cross-sectional differences of short volume. Second, we investigate short selling not only over the (-10, +10) window surrounding the filing dates, but also over the one full year preceding the effectiveness of the short selling ban. This approach can therefore avoid the difficulty of choosing and justifying an arbitrary estimation window in an event study style approach.

As a robustness check, we adopt an alternative method to define Abnormal Short Volume (%). In particular, we define the period from 18 September 2006 to 17 September 2007 as the “normal” period or estimation window. We then use the average of a company’s short volume as a percentage of shares outstanding over this window as its own benchmark to demean the gross Short Volume (%). We use this alternative measure of abnormal short volume to repeat our analysis and our results remain robust.<sup>17</sup>

In our multivariate analysis we also control for total trading volume as percentage of shares outstanding, or Trading Volume (%). Similar to Short Volume (%), we also demean the Trading Volume (%) by its contemporaneous stock exchange median. The daily short volume

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<sup>17</sup> We also follow Christophe et al. (2004) to create another alternative measure of abnormal short volume, ABSS, which is defined as the ratio of daily short volume to average short volume over the period from 18 September 2006 to 17 September 2007 minus 1. Most of our results are robust to this alternative measure.

and trading volume are over the window (-10, +10) surrounding the filing date and are summarized in Panel B of Table I. Daily Short Volume accounts for on average 0.19% of shares outstanding. The mean and median of Abnormal Short Volume (%) are 0.081% and -0.002%, respectively. On the other hand, total trading volume accounts for 0.621% of shares outstanding. Similarly, in Panel C of Table I we report the summary statistics of Daily Short Volume (%), Daily Abnormal Short Volume (%), Daily Trading Volume (%), and Daily Abnormal Trading Volume (%) over one year preceding the short sale ban.

### *3.4. Market Quality Measures*

Our last hypothesis predicts that firms with subprime exposures should have experienced a higher degree of deterioration in market quality when the 2008 short selling ban went into effect. To test this hypothesis we construct a very simple measure of market quality, Daily Bid/Ask Spreads, which is the difference between closing bid and closing ask scaled by the closing price. We include Daily Bid/Ask Spreads from 18 August 2008 to 8 October 2008, which covers the period one month before the effectiveness of the short ban until the end of the short ban. The statistics of Daily Bid/Ask Spreads are summarized in Panel D of Table I.

### *3.5. Other Control Variables*

We merge our sample of financial companies with Compustat data and calculate different measures of financial firm characteristics and performance. Log (Assets) refers to the natural logarithm of a financial company's total assets (in millions of dollars) at the 2007 fiscal year end. Book/Market is the ratio of book value of equity to market value of equity also measured at the

2007 fiscal year end. Institutional Ownership is the aggregate percentage of shares outstanding held by institutional investors. We acquire the Institutional Ownership information from Thomason Financial's 13 F database, which is reported on a quarterly base. We take the average institutional ownership in the 2007 fiscal year. Amihud's Ratio is defined as the average ratio of absolute value of daily stock return to daily total trading volume over the fiscal year 2007. Higher Amihud's Ratio means lower liquidity. Idiosyncratic Risk refers to the root mean square of error estimated based on the Fama-French three factor model over the fiscal year 2007. Option Dummy refers to a binary variable indicating whether a financial company's equity has associated options traded within three months before and after the filing dates of its 2007 annual reports, according to the OptionMetrics database. The reason for adding an option indicator is that a long position in a put option of a stock can be viewed as an alternative bearish investment strategy to taking a short position in the firm's equity. Additionally, we merge our database with the Compustat/Bank database to acquire the Tier-1 (CAPR1), Tier-2 (CAPR2), and total risk-based capital ratios for banks and bank holding companies at the 2007 fiscal year end.<sup>18</sup> Return on assets, or ROA, is the net income before extraordinary items in the fiscal year 2007 divided by total assets. The summary statistics of these control variables are included in Panel E of Table I.

*<Insert Table I>*

The average Log (Assets) of our sample of financial companies is 7.881, corresponding to 2.65 billion in dollar terms. The average Book/Market ratio is 0.867, and institutional investors on average hold 39.5% of shares outstanding. The majority of these financial

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<sup>18</sup> The number of observations of the capital ratios is smaller than any other control variable because some of the financial companies are not banks or bank holding companies and are therefore are not required to report the capital ratios.

companies remained profitable in the fiscal year 2007, since the median and mean ROA are 0.81% and 1.23%, respectively.

#### **4. Empirical Results**

In this section, we discuss our empirical results as related to Hypotheses 1-3. We first make a comparison of firm characteristics for financial companies with subprime exposures versus those without subprime exposures. Then we examine how financial companies' subprime exposures and CDS spreads affect short selling activity. Last, we examine whether financial companies' subprime exposures affect the degree of deterioration in market quality when the short ban is in effect.

##### *4.1. Comparison of Firm Characteristics for Financial Companies with Subprime Exposures Versus Those without Subprime Exposure*

We separate the 316 companies that report their subprime exposure in their 2007 financial reports into two groups. Group 1 contains 192 firms that claimed to have no subprime exposure, whereas Group 2 contains 124 companies that reported positive subprime assets. We summarize firm characteristics of Group 1 and Group 2 and t-test of mean differences between the two groups in Table II.

*<Insert Table II>*



On average, Group 2 companies (with subprime assets) tend to be larger and more liquid (lower Amihud's ratio), and have greater Institutional Ownership than Group 1 companies (no subprime assets). More importantly, the financial companies with subprime assets had higher default risk (One-year CDS Spread), and experienced a larger degree of deterioration in credit quality ( $\Delta$  One-year CDS Spread) over the one year period before the 2008 short selling ban. These results are consistent with the consensus among finance practitioners and researchers that financial companies' excessive investments in subprime loans and subprime-related assets were a major cause of the soaring insolvency risk during the crisis. On the other hand, the two groups were not significantly different from each other in terms of Book/Market ratio, capital ratios and profitability (ROA).

#### *4.2. Results for Testing H1: Short Selling of Stocks Was Greatest for Financial Companies with the Largest Exposures to Asset Risk.*

We use univariate analysis as well as multivariate regressions to test H1. For the univariate analysis, we use the raw and abnormal short volume as discussed above. Around the fiscal 2007 financial report filing date, we compute the average Daily Short Volume (%) of a financial firm's equity for two event windows (-10, +10) and (-10, -1). As discussed in section 1, the fiscal year 2007 was chosen because the financial report filing dates of 2007 fall into the period right before the 2008 short selling ban, and because most financial companies started to record their subprime exposure in that year. As mentioned earlier, we separate the observations into two groups based on whether or not the financial firms reported positive subprime assets holdings. We test whether the mean difference between the short selling of Group 1 (zero reported subprime asset holdings) and Group 2 (positive reported subprime asset holdings) is

significantly different from zero. We plot the average Daily Short Volume (%) of financial companies with subprime assets and those without subprime assets in Figure I.

*<Insert Figure I>*

The univariate results for testing H1 are presented in Table III and those for the multivariate tests are presented in Table IV. Table III shows the average Daily Short Volume (%) and average Daily Abnormal Short Volume (%) for window (-10, 10) in Panel A and for window (-10, -1) in Panel B. Both groups show significantly positive Daily Abnormal Short Volume (%) over both windows. Consistent with Hypothesis 1, both average Daily Short Volume (%) and average Daily Abnormal Short Volume (%) are statistically significantly higher for Group 2 (firms with positive holdings of subprime assets). Our results are also economically meaningful. For example, for window (-10, 10), Group 2 has an average raw Short Volume (%) of 0.26%, which is double the average of Group 1 at 0.127%. The average Daily Abnormal Short Volume (%) of Group 1 is 0.120%, tripling the 0.038% Group 1 average. The differences between two groups are all statistically significant at 1% level. Our results over window (-10,-1) prior to the filing dates are qualitatively similar.

In Panel C of Table III, we compare the mean short selling of financial firms with exposure to the subprime market and financial firms without subprime assets over the first quarter of 2007 when the Case-Shiller Home Price Index showed the first year-over-year decline in nationwide house prices since 1991. The group of financial firms with exposure to the subprime market had significantly higher average Daily Short Volume (%) and Daily Abnormal Short Volume (%) over the first quarter of 2007 than those without exposure. Additionally, in

Figure I we plot the mean Short Volume (%) of financial firms with subprime assets and the ones without subprime assets. All the results provided in Table III and the patterns shown in Figure I are consistent with our first hypothesis that financial companies with subprime assets experienced greater short volume either in the raw measure or in the demeaned, abnormal measure.

*<Insert Table III>*

Table IV reports our multivariate analysis of short selling activity, measured as the Daily Abnormal Short Volume (%) over two event windows, (-10, +10).<sup>19</sup> We present our OLS regression results in four models based on alternative specifications of explanatory variables. Our base measure for subprime asset exposure is Subprime/Assets. In regression Model I, we only control for Log (Assets) and Option Dummy, the coefficient of which is significantly positive. That means “optionable” financial stocks received relatively higher Abnormal Short Volume (%), ceteris paribus. One possible interpretation is short sellers are more willing to take positions if they can create a hedged short position via the option market. Larger stocks tend to have higher short volume. More importantly, Subprime/Assets has a statistically significant coefficient of 1.44, which implies that a 1% increase in this variable will cause 1.44 bps of increase in Daily Abnormal Short Volume (%). Put differently, one standard deviation of increase in Subprime/Assets will cause a 0.08% increase in Daily Abnormal Short Volume (%). In comparison, the average Daily Abnormal Short Volume (%) over the same period is 0.081%. Therefore, our results are also economically significant.

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<sup>19</sup> We also conduct our analysis over window (-10, -1) and the results are qualitatively similar.

In regression Model II, we include the Bank Dummy variable that equals 1 if the financial firm is a bank based on its Compustat identification and 0 otherwise. This may reflect the greater ex-ante propensity of regulators to support banks in financial distress compared to non-bank financial firms. Moreover, since well-capitalized banks are generally perceived to be less risky, we include a variable that measures the interaction between the Bank Dummy variable and its Tier-1 capital ratio (CAPR1). In Model III we introduce additional control variables commonly used in the short selling literature,<sup>20</sup> including the Book/Market ratio, Institutional Ownership, Amihud's Ratio, Idiosyncratic Risk, and ROA. Our results show that firms with greater firm-level volatility or Idiosyncratic Risk received higher Abnormal Short Volume (%). Consistent with Asquith et al. (2005), we find greater Institutional Ownership is associated with higher short selling. This is because institutional investors such as mutual funds are the main lenders of short sold shares. It should be relatively easier for short sellers to locate and borrow shares when Institutional Ownership is larger. ROA and Book/Market ratio, on the other hand, do not provide significant explanatory power over short selling activity.

In Model IV, we further include Filing Date Dummy to indicate the 2007 financial report filing dates, and Post Filing Date Dummy, which equals 1 for the days after the filing date and 0 otherwise. We also control for Abnormal Trading Volume (%). Interestingly, the Post Filing Date Dummy has a significantly positive coefficient, which means that short selling activity was more profound after the filing date. These results suggest that short sellers played an important role in keeping stock price in line by reacting to the information regarding financial companies' subprime exposures as revealed in the 2007 reports.

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<sup>20</sup> E.g., Wu and Zhang (2011).

<Insert Table IV>

Our results hold when we use alternative scaling factors for subprime assets and when we exclude the 19 financial firms that went on the original naked short sale ban list (in unreported tables available upon request) or exclude the Large and Complex Financial Institutions covered by the U.S. Supervisory Capital Assessment Program (SCAP) conducted in the spring of 2009. In an unreported table we repeat our analysis in Table IV over window (-10, -1) and the results are qualitatively similar. In summary, our results provide support for our Hypothesis 1: *short selling of stocks was greatest for financial companies with the largest exposures to subprime mortgage assets.*

One possible explanation of our finding is that most financial companies unveiled their exposure to subprime assets for the first time in the 2007 financial reports. Investors commonly believed that exposure to subprime assets was at least one of the major reasons for the failure of many financial institutions. Therefore, rational investors such as short sellers should have reacted in accordance with this specific type of newly released information, either for the purpose of making profits from the stock price movements or as an effort to avoid losses.

Our results are weaker, however, when we change the scaling measure for our dependent variable (short volume) from share outstanding to daily trading volume. This is mostly due to the fact that when short selling increases it increases the volume of trading since it is part of the trading volume. Another possible interpretation is that rational investors could not only short but could also sell their long positions if they expect the ascending subprime risk exposure would negatively affect stock prices. In such a case, both short volume and total trading volume could

have increased together. This directly reduces the variability of scaled short selling. Therefore our results become weaker or even disappear if we use trading volume as a scaling variable. Additionally, in general, the size of the firm is positively related to shares outstanding, trading volume, and shorting of these stocks. For these reasons to show the variability of short selling we opt to scale it by outstanding shares since it will allow us to fix the denominator and focus more on time series and cross sectional variation of short selling.

#### *4.3. Comparison of Firm Characteristics for Financial Companies with Non-Financial Companies*

The SEC allegation of abusive short selling on financial firm equity prior to the short-sale ban raises an important question: what was the level of short selling for financial versus non-financial firms prior to the short-sale ban? The two groups of companies, however, could have quite different firm characteristics, such as size and default risk levels, both of which might be correlated with short selling volume. Therefore, before we formally compare short selling between the two groups, we first make a comparison of firm characteristics. In total we have 76 financial companies and 720 non-financial companies that could be merged with the CDS database. Some variables used in the previous analysis, such as Bank Dummy and capital ratios, are not applicable to non-financial companies. As a result, we report Leverage ratio, which is the sum of long-term debt and long-term debt in current liabilities divided by total assets. The summary statistics of firm characteristic variables of the two groups are reported in Table V.

*<Insert Table V>*

As can be seen in Table V, relative to non-financial companies, financial companies tend to be larger and less profitable, and have higher Book/Market ratios, which can be interpreted as indicating lower growth and/or higher risk levels. Meanwhile financial companies had higher leverage and lower idiosyncratic risk levels, both of which are not surprising given their larger size and nature of the business. Interestingly, financial companies had higher default risk over the one year period preceding the short ban. This finding implies that we need to match financial and non-financial companies on size and credit risk before we can formally compare the short selling activities between the two groups.

#### *4.4. Results for Testing H2: Short Selling of Equity Was Greatest for Financial Companies with the Largest Insolvency Risk Exposures Measured by CDS Spreads.*

Our results for Hypothesis 2 are presented in Tables VI and VII. In Table VI, we present our univariate tests. In Panel A, we summarize the univariate analysis of short selling activities over windows (-10, +10) and (-10, -1) using two alternative measures of short selling activities: average Daily Short Volume (%) and Average Abnormal Daily Short Volume (%). Not all companies have CDS information. For example, only 58 companies on the short sale ban list could be identified with One-year CDS Spreads information, and meanwhile, Short Volume (%) is not missing. The observations are sorted into three groups according  $\Delta$  90-Day CDS Spreads around the filing dates. Group 1 and Group 3 contain firm observations with lowest and highest  $\Delta$  90-day CDS Spreads, respectively. Our results provide strong support for our Hypothesis 2. For example, Group 3 has an average Daily Short Volume (%) of 0.641%, more than doubling the Group 1 average of 0.284%. The difference of Abnormal Short Volume (%) is even more striking. Group 3's average Abnormal Short Volume (%) is 0.420%, fivefold of the Group 1's

average 0.083%. The differences between Group 1 and 3 are both qualitatively and economically significant. Our results show a clear correlation between changes in CDS spreads around financial report filing dates and short selling activity.

In Panel B, we report univariate tests of short selling activity over the period from 18 September 2007 to 17 September 2008 based on sorting by One-year CDS Spreads. The difference in short selling between group 1 (the lowest One-year CDS) and group 3 (the highest One-year CDS) were negative and significant at the 1% level. In Panel C we sort the sample by  $\Delta$  One-year CDS spreads and repeat a similar analysis. The results are again economically significant. For example, the average Abnormal Daily Short Volume (%) of Group 3 is 0.478%, almost as 10 times much as the Group 1 average, which is 0.049%. Our univariate results provide preliminary support to our second hypothesis. Short volumes were higher in companies with greatest deterioration in credit quality not only over the window surrounding the financial report filing date, but also over the one-year period preceding the short sale ban.

*<Insert Table VI>*

The 2008 short selling ban affected only 797 financial companies, rather than all publically traded stocks. We are curious to know whether short selling on financial stocks was different if we benchmark them against non-financial companies. Therefore, we first provide a simple plot (Figure II, Panel A) that compares the average Daily Short Volume (%) for financial firms versus (unmatched) non-financial firms for one year prior to the SEC short sale ban (for the period from 18 September 2007 to 17 September 2008). During this period, on average there



were 582 financial firms and 5,288 non-financial firms with short sales data.<sup>21</sup> Interestingly, as can be seen in Figure I, Panel A, the average daily short selling of financial firms was not very different than that of non-financial firms. In fact, over the one year period it was mostly lower for financial firms.

*<Insert Figure II>*

Moreover, to improve the financial versus non-financial firm short selling comparison, we matched financial firms with non-financial firms based on two dimensions: their CDS spreads and asset size. First, for each financial company, we look for the non-financial companies whose size (total assets) were within  $\pm 5\%$  of the financial company's size.<sup>22</sup> Then among candidate matching companies, we choose the one with One-Year CDS Spread closest to the financial company's CDS spread. Figure II, Panel B, presents average daily short selling for the financial versus matched non-financial firms for the one year period prior to the 2008 short selling ban. There were 53 matched pairs of financial firms and non-financial with CDS, short volume, and Compustat data available. As can be seen in Panel B of Figure II, short selling for financial and their matched non-financial firms were of very similar magnitudes and followed a similar pattern throughout the sample period. In Table VI, Panel D, we conduct t-tests for differences in both the average Daily Short Volume (%) and the average Daily Abnormal Short Volume (%) for financial firms versus their matched non-financial firms one year prior to the 2008 short selling ban. As can be seen from the results in Panel D, both Daily Short Volume (%)

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<sup>21</sup> The availability of short selling data varies from day to day.

<sup>22</sup> Our results remain robust if we use alternative size difference thresholds, including 50%, 40%, 30%, or 20%. We also conduct a propensity matching method to the robustness of our results. We first run a logit regression with Financial Company Dummy (1 for financial companies and 0 otherwise) as the dependent variable. Then for each financial company we choose nearest neighbor in calculated propensity score within caliper of 0.1. This matching process results in 27 pairs of matched treatment and matching observations.

and Abnormal Short Volume (%) of equity are insignificantly different from financial firms. This finding implies that financial companies do not experience higher than normal short selling activity if we use non-financial companies as the benchmark. Our results also indicate that short selling appears to be related to fundamental information regarding the value of the firm regardless of the firm's industry.

Table VII reports a multivariate analysis of CDS spreads and short volume around the filing date of their pre-ban annual reports. We analyze the Daily Abnormal Short Volume (%) over windows (-10, +10). Our key variable is Lagged Daily CDS Spread around the filing date. We report our results for Models I to IV based on introducing alternative control variables in a similar way as in Table IV. In Model I, we simply control for Log (Assets) and Option Dummy. The coefficient on Lagged Daily CDS Spread is 9.401, statistically significant at 1%. Such results imply that a 1% increase in the previous day's CDS spread will cause Abnormal Short Volume (%) to increase by 0.094%. This result is economically significant, since 0.094% of increase in Abnormal Short Volume is equivalent to 49% of average Daily raw Short Volume (%), and 103% of the average Daily Abnormal Short Volume (%) over the same window. Alternatively, one standard deviation of change in last day's CDS spread will cause today's Abnormal Short Volume (%) to increase by 0.254%, equivalent to 133% of average Daily raw Short Volume (%) and 313% of Average Daily Abnormal Short Volume (%) over the same period. Therefore the results are economically significant as well. In Model II we add Bank Dummy and its interaction with CAPR1, both of which do not provide significant explanatory power. In Model III, we further control for Amihud's Ratio, Institutional Ownership, Book/Market, and ROA. In both Model II and III the coefficient on Lagged Daily CDS Spread remain significant at 1%. In Model IV, we control for Abnormal Trading Volume (%), Filing

Date Dummy, and Post Filing Date Dummy. Our results remain robust to these additional control variables.<sup>23</sup> The negative coefficient on Amihud's Ratio becomes statistically significant in Model IV, implying that higher liquidity is associated with higher Abnormal Short Volume (%). In Model V, we conduct a robustness analysis using an alternative measure of CDS spread, namely,  $\Delta$  90-day CDS Spread around the 2007 financial report filing dates. We argue that this alternative measure should capture the new fundamental information revealed in the financial reports that caused changes in credit quality. The coefficient on  $\Delta$  90-day CDS Spread is statistically significant at 5%. Our results in Table VII provide evidence of an information flow from the credit derivatives market to the stock market via short selling activity when new information such subprime exposure was released in the 2007 financial reports.

*<Insert Table VII>*

In an unreported panel of the table, we re-estimate our regressions over window (-10, -1). Our results remain qualitatively similar in Model I, II, and III. The coefficient on Lagged Daily CDS Spread and  $\Delta$  90-day CDS Spread become insignificant in Model IV and V, respectively, after controlling for Abnormal Trading Volume (%). However, if we drop ROA and Book/Market (the two variables that are highly correlated with CDS spreads) from the two regressions, then the coefficient on Lagged CDS Spread remain statistically significant at 1% level in both regressions even over window (-10, -1).

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<sup>23</sup> In an unreported regression we include both Subprime/Assets and Lagged Daily CDS Spreads as two major explanatory variables. Interestingly, the coefficient on Lagged Daily CDS Spread remains statistically significant, but not on Subprime/Assets. This finding possibly implies that the CDS spread contain not only subprime related information, but also other informational content that may be correlated with future short volume.

In Table VIII, we report the analysis of the Abnormal Short Volume (%) over the period from 18 September 2007 to 17 September 2008. The key explanatory variable in Panel A is Lagged Daily CDS Spread over the same period. We include four different specifications of regressions in Panel A by changing control variables. The coefficients on Lagged Daily CDS Spreads remain statistically significant at 1% or 10%, depending on the regression model chosen.

*<Insert Table VIII>*

In Panel B of Table VIII we use Average Daily Abnormal Short Volume (%) over the one year in advance of the short ban as the dependent variable. Therefore each observation in Panel B of Table VIII is one firm. Correspondingly, we use the  $\Delta$  One-year CDS Spread as the major explanatory variable of interest. In Model I we control for Log (Assets) and Option Dummy, neither of which is significant. The coefficient on  $\Delta$  One-year CDS Spread, however, remains significant at 1% in Model I, II, and III. In regression IV, we include both financial and non-financial companies in the sample. Bank Dummy and its interaction with Tier-1 Capital ratio (CAPR1) are no longer applicable in this setting. Instead, we replace them with Financial Companies Dummy, which equals one for financial companies affected by the short ban and zero otherwise, and Leverage ratio, which is defined as the sum of long-term debt plus long-term debt in current liabilities divided by total assets. The purpose of Model IV is to examine whether the financial companies were short sold more than non-financial companies after controlling for firm. Our finding suggests no evidence of higher short volume on financial companies' stocks relative to non-financial companies, since the coefficient on the Financial Companies Dummy is statistically insignificant from zero.

Generally speaking, our finding shows short volume on financial stocks positively correlated to the movement in CDS spreads, which reflects the change in the underlying companies' overall default risk exposures. One possible explanation is that during the 2007-2008 financial crisis the soaring default risk level of financial companies was a major concern for most investors. Therefore, short sellers reacted rationally toward changes in the default risk levels of these financial companies, which may have caused stock price movements.

*4.5. Results for Testing H3: The Stocks of Financial Companies with Subprime Exposure Experienced a Greater (Lesser) Degree of Market Quality Deterioration than Those without Subprime Exposure when the Short Ban Was in Effect.*

In Table IX we report our analysis of change in market quality when the short ban went into effect on 19 September 2008. More specifically, we use a diff-in-diff approach to compare the bid/ask spreads before and during the effective period, and compare the changes in spreads between financial stocks with subprime exposure and those without. The dependent variable in Model I and II is Daily Bid/Ask Spreads from 18 August 2008 to 8 October 2008, from one month before the ban went into effect until the end date of the short ban. One explanatory variable of interest is Ban-in-effect Dummy, which indicates the period from 19 September 2008 to 8 October 2008. The coefficient of Ban-in-effect dummy is 0.026 in Model I, statistically significant at 1%. Our interpretation of this number is that on average the Bid/Ask Spread increased by 2.6% over the ban-in-effect period relative to the one month preceding the effectiveness date. Our results are consistent with Boehmer et al. (2013)'s finding that market quality generally had deteriorated for financial stocks affected by the short ban. Another variable of interest is Subprime Assets Dummy, which equals one for companies with positive subprime

assets in the fiscal year 2007 and 0 for those without subprime assets. The coefficient on Subprime Assets is statistically insignificant.

More importantly, in Model II we add the interaction of Ban-in-effect Dummy and Subprime Assets Dummy. The coefficient on the interaction term captures the diff-in-diff, and is negative and statistically significant. This finding means that even though market quality of financial companies' stocks generally deteriorated, the degree of deterioration for companies with subprime exposure was significantly less severe than companies without subprime exposure. Put differently, financial companies without subprime exposure suffered more from market quality deterioration when the ban was in effect than those with subprime exposure.

*<Insert Table IX>*

There are two possible interpretations for this finding. First, during the crisis, informed traders such as short sellers were likely to target financial companies with subprime exposure. Therefore market makers faced a greater degree of adverse selection problem in such companies. Once informational traders were restricted from short selling, the adverse selection problem caused by short selling activity became trivial in both companies with subprime exposure and those without. Hence the reduction in adverse selection problem was more profound in the companies with the exposure, and therefore market quality deterioration was relatively less severe in those companies. Alternatively, financial companies with exposure to subprime assets were relatively more likely to receive other types of government support that aimed to reduce the volatility of share prices, relative to other financial companies without subprime exposure.

In Model III and IV we repeat the same analysis as in Model I and II but replace Daily Bid/Ask Spreads with Average Daily Bid/Ask Spreads. Each financial company has a pair of average bid/ask spreads, one for the pre-effectiveness period and the other for the ban-in-effect period. The coefficients on the interaction of Bank-in-effect dummy and Subprime exposure dummy remains negative and statistically significant. In unreported tables we also try alternative definitions of pre-ban windows such as 3 months, 6 months, and 1 year preceding the ban-in-effect period, and our results remain qualitatively similar.

## **5. Conclusion**

The results of this paper provide evidence that short sellers clearly differentiated among financial firms according to their assets and insolvency risk exposures. More specifically, the greater a financial firm's exposure to the subprime mortgage market during the financial crisis, the larger the amount of short selling of the equity of that firm around annual financial report filing dates. Using different measures of short selling activity, we also find that the higher the Lagged Daily CDS Spread, One-year CDS Spread,  $\Delta$  One-year CDS Spread, and/or  $\Delta$  90-day CDS Spread, the greater the short selling activity of a financial firm's equity. The evidence presented in this paper also shows that there was no significant difference between the short selling activities for financial and non-financial firms prior to the SEC 2008 short selling ban, after controlling for insolvency risk, firm size, and trading venue.

When the short selling ban went into effect, financial companies without subprime exposure had experienced a greater degree of deterioration in market quality, measured as Daily Bid/Ask Spread, relative to those with subprime exposure. Generally, our results offer support

for the argument that banning short selling may limit the ability of investors to induce market prices that reflect market fundamentals. Accordingly, our findings have important implications regarding the debate over the case for and against limiting short selling. While there may well be valid macro or systemic risk objectives in limiting short selling, our results suggest that such regulations may also mute the disciplining effects of investors on those financial firms with the greatest exposure to insolvency risk.



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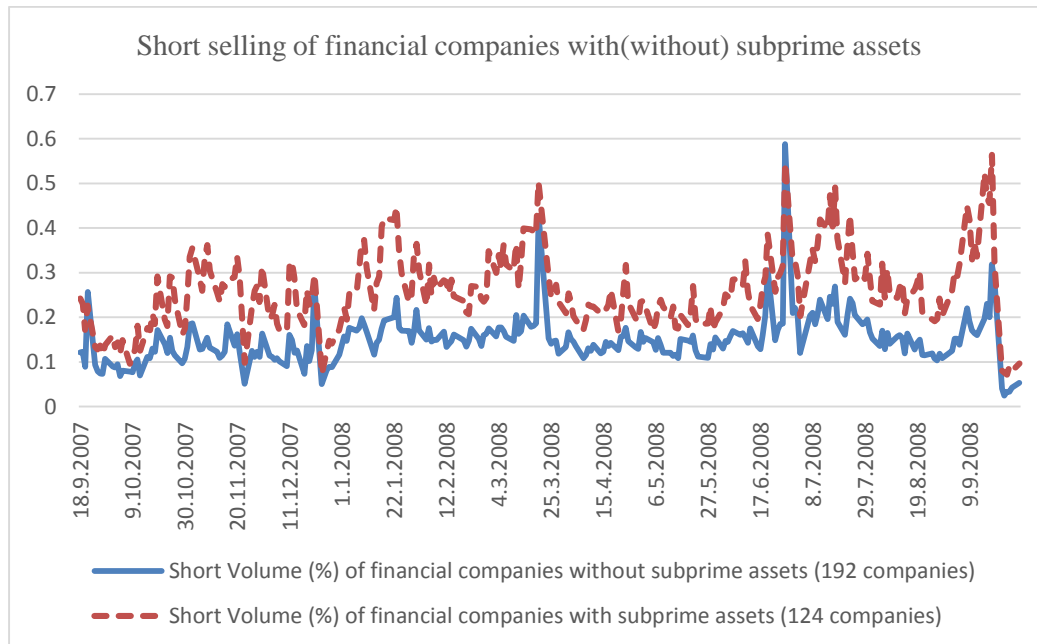
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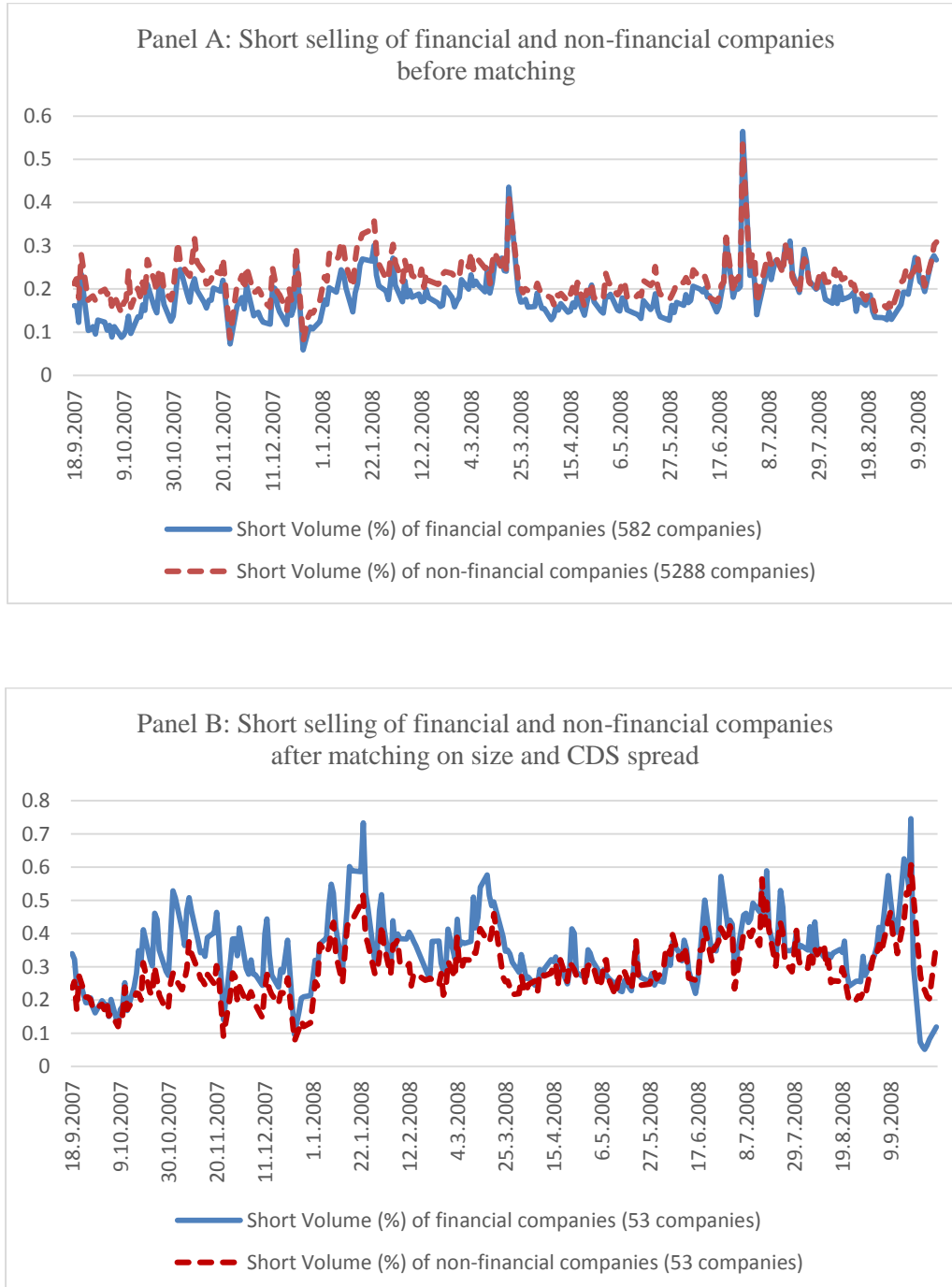
**Figure I: Short Selling Activity of Financial Companies with/without Subprime Assets**

Figure I plots the mean daily Short Volume (%), defined as short volume as a percentage of number of shares outstanding, for financial companies without subprime assets and for those with subprime assets from 18 September 2007 to 17 September 2008.



**Figure II: Short Selling Activity of Financial Companies and Non-Financial Companies**

Panel A of Figure II depicts the average Short Volume (%) of financial companies and non-financial companies. Panel B of Figure II plots the short selling after matching the financial companies with non-financial companies based on Credit Default Swap (CDS) spreads and size. First, for each financial company, we look for the non-financial companies whose size (total assets) are within  $\pm 5\%$  of the financial company's size. Then among candidate matching companies, we choose the one with average CDS spreads closest to the financial company's CDS spread.



**Table I: Summary Statistics**

Panel A of Table I reports the summary statistics of subprime exposure variables. First we report financial companies' exposures to subprime assets contained in their annual reports and footnotes for fiscal years of 2007.<sup>24</sup> Subprime/Assets, Subprime/Mkt Equity, and Subprime/Tangible Equity refer to the ratios of the total amount of investments in subprime assets to total assets, market value of common equity, and book value of tangible equity, respectively. In Panel B we report daily Credit Default Swap (CDS) and short volume variables over window (-10,+10) around filing dates (day 0) of the financial companies' 2007 annual reports. In this paper we utilize daily spreads of 5-year senior CDSs with U.S. dollars as the underlying currency and non-restructuring in the documentation clause.  $\Delta$  90-day Average CDS Spread (%) is defined as the change in average daily CDS spreads of a given financial company from the 90 days before the filing dates of its annual financial reports to the 90 days after the filing dates. We report both daily short volume and total trading volume as the percentage of the number of shares outstanding. Additionally, we also calculate the abnormal version of shorting activity and total trading volume by subtracting the contemporaneous median short volume and trading volume of all companies, financial and nonfinancial, on the same stock exchange of the financial firm. In Panel C we report the summary statistics of CDS spreads, short volume, and trading volume variables over the one year preceding the short ban. One-Year Average CDS Spread (%) is the average daily CDS spread over the period from 18 September 2007 to 17 September 2008.  $\Delta$  One-year CDS Spread is the difference between One-year CDS Spread and the average spread over the period from 18 September 2006 to 17 September 2007. Panel D summarizes the Daily Bid/Ask Spread before and during the ban-in-effect period. Panel E reports summary statistics of other annual control variables. In particular, Log (Assets) refers to the natural logarithm of total assets (in million dollars). Book/Market refers to the ratio of book value of equity to market value of equity. Institutional Ownership is the ratio of total number of shares held by institutional investors to number of shares outstanding over a fiscal year. Amihud's Ratio is defined as the average ratio of absolute value of daily stock return to daily total trading volume over a fiscal year. Idiosyncratic Risk refers to the root mean square of error estimated based on the Fama-French three factor model over a fiscal year. Option Dummy is an indicator variable as to whether a financial company's equity has an option trading record in the OptionMetrics database within three months before and after the filing dates of annual reports. CAPR1, CAPR2, and CAPR Combined refer to Tier 1, Tier 2, and combined risk-adjusted capital ratios for the banks and bank holding companies, respectively. ROA is defined as income before extraordinary items divided by total assets. All variables are winsorized at the 2 and 98 percentiles.

| <i>Panel A: Subprime Risk Exposure Variables</i> |     |       |        |       |     |
|--|-----|-------|--------|-------|-----|
| Variables  | N   | Mean  | Median | Max   | Min |
| Subprime/Assets                                  | 316 | 0.009 | 0      | 0.136 | 0   |
| Subprime/Mkt Equity                              | 315 | 0.105 | 0      | 1.753 | 0   |
| Subprime/Tangible Equity                         | 316 | 0.106 | 0      | 1.573 | 0   |

| <i>Panel B: Daily Short Volume, Trading Volume, and CDS Spreads over Window (-10,+10) around the 2007 Financial Report Filing Dates</i> |      |       |        |        |         |
|---|------|-------|--------|--------|---------|
| Daily CDS Spread (%)  | 966  | 1.958 | 1.263  | 9.840  | 0.306   |
| $\Delta$ 90-day Average CDS Spread (%)  | 50   | 0.460 | 0.294  | 3.729  | -0.410  |
| Daily Short Volume (%)  | 8366 | 0.191 | 0.087  | 2.273  | 0.001   |
| Daily Abnormal Short Volume (%)   | 8366 | 0.081 | -0.002 | 2.030  | -0.300  |
| Daily Trading Volume (%)  | 8366 | 0.621 | 0.273  | 84.864 | 3.7E-05 |
| Daily Abnormal Trading Volume (%)   | 8366 | 0.264 | -0.014 | 84.139 | -0.860  |

<sup>24</sup> As mentioned in the introduction, on average there is a three month lag between a company's filing date and its fiscal year end date. Following Compustat's definition of fiscal year end, our financial report filing from September 2007 to September 2008 covers the fiscal year 2007.

*Panel C: Daily Short Volume, Trading Volume, and CDS Spreads over One-year Preceding the Short Sale Ban (September 18 2007 to September 17 2008)*

|  |       |       |       |        |        |
|--|-------|-------|-------|--------|--------|
| One-Year Average CDS Spread (%)          | 76    | 1.667 | 0.913 | 11.642 | 0.164  |
| $\Delta$ One-Year Average CDS Spread (%) | 75    | 1.271 | 0.576 | 10.502 | -0.622 |
| Daily Short Volume (%)                   | 15433 | 0.364 | 0.231 | 3.388  | 0.003  |
| Daily Abnormal Short Volume (%)          | 15433 | 0.198 | 0.061 | 3.064  | -0.275 |
| Daily Trading Volume (%)                 | 15180 | 1.639 | 0.880 | 84.864 | 0.019  |
| Daily Abnormal Trading Volume (%)        | 15180 | 0.987 | 0.217 | 84.139 | -1.070 |
| Daily CDS Spread (%)                     | 12075 | 1.866 | 0.903 | 38.761 | 0.153  |

*Panel D: Daily Bid/Ask Spread from 18 August 2008 to 8 October 2008*

|                          |       |       |       |         |   |
|--------------------------|-------|-------|-------|---------|---|
| Daily Bid/Ask Spread (%) | 11525 | 2.970 | 0.542 | 192.133 | 0 |
|--------------------------|-------|-------|-------|---------|---|

*Panel E: Other Annual Control Variables*

|                         |     |           |        |         |           |
|-------------------------|-----|-----------|--------|---------|-----------|
| Log (Assets)            | 536 | 7.881     | 7.336  | 13.860  | 5.417     |
| Book/Market             | 535 | 0.867     | 0.809  | 1.875   | 0.315     |
| Institutional Ownership | 499 | 39.481    | 33.318 | 100.000 | 0.012     |
| Amihud's Ratio          | 513 | 3.331E-03 | 0.000  | 0.034   | 2.098E-07 |
| Idiosyncratic Risk      | 513 | 1.771     | 1.637  | 3.832   | 0.876     |
| CAPR1                   | 403 | 10.758    | 10.150 | 18.890  | 6.800     |
| CAPR2                   | 403 | 2.795     | 1.300  | 15.020  | 0.610     |
| CAPR - Combined         | 403 | 13.589    | 12.270 | 32.670  | 10.140    |
| Option Dummy            | 536 | 0.265     | 0      | 1       | 0         |
| ROA                     | 536 | 1.23%     | 0.81%  | 34.58%  | -21.64%   |

**Table II: Univariate Analysis of Firm Characteristics Based on Annual Exposures to the Subprime Market**

Table II reports the comparison between financial companies with subprime assets and those without subprime assets in the fiscal year 2007. The categorization of the two groups is based on the subprime exposure self-reported by financial companies in their 2007 annual reports and footnotes. Among the 536 companies on that short ban list and with financial data, 124 companies report that they have subprime assets in the year 2007, and 192 claim to have no subprime exposure. Then we report annual firm characteristics as defined in Table I of each group, and then conduct mean-difference t-tests between the two groups.

| <i>Comparison of Financial Companies with and without Subprime Assets</i> |                                    |        |                                 |        |                   |         |         |
|---|------------------------------------|--------|---------------------------------|--------|-------------------|---------|---------|
| Variables   | Group 1<br>Without Subprime Assets |        | Group 2<br>With Subprime Assets |        | Group 1 – Group 2 |         |         |
|   | N                                  | Mean   | N                               | Mean   | Mean diff.        | t-value | p-value |
| Log (Assets)  | 192                                | 7.601  | 124                             | 9.120  | -1.519***         | -6.08   | <.0001  |
| Book/Market   | 192                                | 0.862  | 124                             | 0.874  | -0.013            | -0.32   | 0.751   |
| Institutional Ownership   | 183                                | 36.947 | 113                             | 54.934 | -17.988***        | -5.29   | <.0001  |
| Amihud's Ratio  | 187                                | 0.004  | 117                             | 0.001  | 0.002***          | 3.05    | 0.0025  |
| Idiosyncratic Risk  | 187                                | 1.739  | 117                             | 1.682  | 0.057             | 0.71    | 0.478   |
| CAPR1   | 161                                | 10.533 | 60                              | 10.506 | 0.027             | 0.06    | 0.955   |
| CAPR2   | 161                                | 2.925  | 60                              | 3.183  | -0.258            | -0.62   | 0.535   |
| CAPR – Combined   | 161                                | 13.489 | 60                              | 13.791 | -0.302            | -0.62   | 0.535   |
| $\Delta$ 90-day Average CDS Spread (%)                                    | 7                                  | 0.312  | 34                              | 0.542  | -0.230            | -1.12   | 0.275   |
| One-Year Average CDS Spread (%)   | 8                                  | 0.728  | 40                              | 1.824  | -1.096**          | -2.66   | 0.011   |
| $\Delta$ One-Year Average CDS Spread (%)                                  | 8                                  | 0.459  | 40                              | 1.489  | -1.030***         | -2.78   | 0.008   |
| Option Dummy  | 192                                | 0.224  | 124                             | 0.468  | -0.244***         | -4.50   | <.0001  |
| ROA   | 192                                | 0.013  | 124                             | 0.010  | 0.002             | 0.55    | 0.5835  |



**Table III: Univariate Analysis of Short Selling Activities Based on Annual Exposures to the Subprime Market**

Table III summarizes the univariate analysis of average daily short selling activities over different windows around the 2007 annual report filing date during the period from 27 June 2008 to 8 September 2008 (ten days before the short sale ban by the SEC). Our results are robust for different window specifications. The results reported here are based on (-10, +10) and (-10, -1) window in Panel A and B, respectively, where day 0 is the filing date of the 2007 annual reports. We also report short selling over the first calendar quarter of 2007 in Panel C. In all panels we compare short selling activity of the companies with subprime assets and the ones without subprime assets. Short selling activity is measured as Short Volume (%) and Abnormal Short Volume (%) as defined in Table 1. t-test of short selling activities within each group and mean difference t-tests between two groups are reported. \*, \*\*, and \*\*\* indicate significance at 10%, 5%, and 1%, respectively. All variables in Table III are winsorized at 2 and 98 percentile.

| <i>Panel A: Short Selling over Window (-10, 10) Around Announcement of Annual Reports</i> |                 |        |                                |           |        |   |           |
|---|-----------------|--------|--------------------------------|-----------|--------|---|-----------|
| Groups  | Subprime/Assets |        | Average Daily Short Volume (%) |           | t-test | Average Daily Abnormal Short Volume (%) |           |
|   | N               | Mean   | Mean                           |           |        | Mean                                    | t-test    |
| 1 (Without Subprime Assets)   | 192             | 0      | 0.127%                         |           |        | 0.038%                                  | *** 3.62  |
| 2 (With Subprime Assets)  | 124             | 0.023  | 0.260%                         |           |        | 0.120%                                  | *** 5.16  |
| 1 – 2   | 316             | -0.023 | -0.134%                        | *** -4.53 |        | -0.081%                                 | *** -3.19 |

| <i>Panel B: Short Selling over Window (-10, -1) around Announcement of Annual Reports</i> |                 |        |                                |           |        |   |           |
|---|-----------------|--------|--------------------------------|-----------|--------|---|-----------|
| Groups  | Subprime/Assets |        | Average Daily Short Volume (%) |           | t-test | Average Daily Abnormal Short Volume (%) |           |
|   | N               | Mean   | Mean                           |           |        | Mean                                    | t-test    |
| 1 (Without Subprime Assets)   | 192             | 0      | 0.117%                         |           |        | 0.031%                                  | *** 2.93  |
| 2 (With Subprime Assets)  | 124             | 0.023  | 0.242%                         |           |        | 0.105%                                  | *** 4.93  |
| 1 – 2   | 316             | -0.023 | -0.126%                        | *** -4.55 |        | -0.074%                                 | *** -3.14 |

| <i>Panel C: Short Selling over First Quarter of 2007</i> |                 |        |                                |           |        |   |           |
|--|-----------------|--------|--------------------------------|-----------|--------|---|-----------|
| Groups   | Subprime/Assets |        | Average Daily Short Volume (%) |           | t-test | Average Daily Abnormal Short Volume (%) |           |
|  | N               | Mean   | Mean                           |           |        | Mean                                    | t-test    |
| 1 (Without Subprime Assets)                              | 188             | 0      | 0.052%                         |           |        | -0.016%                                 | *** -3.56 |
| 2 (With Subprime Assets)                                 | 121             | 0.023  | 0.091%                         |           |        | 0.011%                                  | *** 1.00  |
| 1 - 2  | 309             | -0.023 | -0.039%                        | *** -3.64 |        | -0.027%                                 | *** -2.60 |

**Table IV: Multivariate Analysis of Short Selling Activities Based on Annual Exposures to the Subprime Markets**

Table IV includes the regression analysis of Daily Abnormal Short Volume (%) over different windows around the filing dates of annual reports for fiscal year 2007. We report the results over window (-10, +10).<sup>25</sup> We use Subprime/Assets as the key measure of exposure to the subprime market.<sup>26</sup> In Model I we only control for Log (Asset) and Option Dummy. In Model II and III we gradually add additional control variables such as Bank dummy and its interaction with CAPR1,<sup>27</sup> Amihud's Ratio, Idiosyncratic risk, Book/Market, Institutional Ownership, and ROA. In Model IV we also add Abnormal Trading Volume (%), Filing Date Dummy (equals to 1 for day 0), and Post Filing Date Dummy, which indicates the window (+1,+10) after filing dates. \*, \*\*, and \*\*\* indicate significance at 10%, 5%, and 1%, respectively.

| <i>Daily Abnormal Short Volume (%) over Window (-10, +10) as Dependent Variable</i> |                       |                       |                       |                       |
|---|-----------------------|-----------------------|-----------------------|-----------------------|
|   | Model I               | Model II              | Model III             | Model IV              |
| Subprime/Assets   | 1.442***<br>[2.754]   | 1.613***<br>[2.886]   | 0.861**<br>[2.097]    | 0.794**<br>[2.130]    |
| Log (Assets)  | 0.044***<br>[4.356]   | 0.043***<br>[4.282]   | 0.037***<br>[3.526]   | 0.032***<br>[3.360]   |
| Option Dummy  | 0.082**<br>[2.434]    | 0.111***<br>[3.396]   | 0.090***<br>[2.915]   | 0.068**<br>[2.426]    |
| Bank  |                       | 0.151***<br>[2.831]   | 0.141***<br>[2.888]   | 0.145***<br>[3.535]   |
| Bank×CAPR1  |                       | -0.007*<br>[-1.786]   | 0.000<br>[0.107]      | -0.001<br>[-0.420]    |
| Amihud's Ratio  |                       |                       | -0.985<br>[-0.868]    | -0.877<br>[-0.946]    |
| Idiosyncratic Risk  |                       |                       | 0.083***<br>[4.059]   | 0.047**<br>[2.441]    |
| Institutional Ownership   |                       |                       | 0.003***<br>[5.797]   | 0.002***<br>[4.394]   |
| Book/Market   |                       |                       | -0.008<br>[-0.258]    | 0.005<br>[0.214]      |
| ROA   |                       |                       | -0.618<br>[-1.442]    | -0.067<br>[-0.208]    |
| Filing Date Dummy   |                       |                       |                       | 0.007<br>[0.872]      |
| Post Filing Date Dummy  |                       |                       |                       | 0.021***<br>[3.160]   |
| Abnormal Trading Volume (%)   |                       |                       |                       | 5.138*<br>[1.944]     |
| Constant  | -0.330***<br>[-4.502] | -0.383***<br>[-5.020] | -0.624***<br>[-5.449] | -0.513***<br>[-4.679] |
| Num. of Observations  | 5,136                 | 5,128                 | 4,885                 | 4,880                 |
| Adjusted R-square   | 0.253                 | 0.278                 | 0.380                 | 0.506                 |

<sup>25</sup> In an unreported panel we repeat a similar analysis over window (-10, -1) and the results remain qualitatively similar.

<sup>26</sup> To check the robustness of our results, we use subprime-to-market equity and subprime-to-tangible equity as alternative measures of subprime exposure, and remove the companies on naked-short-ban list. Our results remain qualitatively similar.

<sup>27</sup> We check the robustness of our results by using the combined capital ratio instead of Tier 1 capital ratio, and the results are qualitatively similar.

**Table V: Univariate Analysis of Firm Characteristics of Financial and Non-Financial Companies**

In this table we compare firm characteristics between financial companies on the short sale ban list and non-financial companies that could be merged with CDS information. The variables reported in Table V are similar to those in Table II, except for some variables that are not applicable to non-financial companies such as Bank Dummy and capital ratios. Instead, we add Leverage ratio, which is defined as the sum of long-term debt and long-term debt in current liabilities divided to total assets. Mean-difference t-tests are conducted between the two groups.

| <i>Comparison between financial and non-financial companies before matching</i> |                      |         |                               |         |                   |         |         |
|---|----------------------|---------|-------------------------------|---------|-------------------|---------|---------|
| Variables   | Group 1<br>Financial |         | Group 2<br>Non-fin. Companies |         | Group 1 – group 2 |         |         |
|   | N                    | Mean    | N                             | Mean    | Mean diff.        | t-value | p-value |
| Log (Assets)  | 76                   | 11.229  | 720                           | 9.142   | 2.087***          | 9.64    | <.0001  |
| Book/Market   | 76                   | 0.775   | 703                           | 0.466   | 0.310***          | 5.56    | <.0001  |
| Institutional Ownership   | 54                   | 71.430  | 587                           | 73.857  | -2.427            | -0.81   | 0.4182  |
| Amihud's Ratio  | 56                   | 3.1E-05 | 665                           | 2.9E-06 | 2.9E-05           | 1.01    | 0.317   |
| Idiosyncratic Risk  | 56                   | 1.454   | 660                           | 1.640   | -0.185*           | -1.75   | 0.086   |
| One-Year Average CDS Spread (%)   | 76                   | 1.635   | 720                           | 2.321   | -0.686**          | -2.47   | 0.015   |
| $\Delta$ One-Year Average CDS Spread (%)  | 75                   | 1.271   | 680                           | 0.999   | 0.272             | 1.05    | 0.296   |
| Option Dummy  | 60                   | 0.883   | 720                           | 0.850   | 0.033             | 0.76    | 0.4498  |
| Leverage  | 76                   | 0.203   | 719                           | 0.336   | -0.133***         | -5.62   | <.0001  |
| ROA   | 76                   | 0.013   | 720                           | 0.042   | -0.029***         | -4.29   | <.0001  |

**Table VI: Univariate Analysis of Short Selling Activities Based on CDS Spreads**

In Panel A we summarize the univariate analysis of short selling activities over windows (-10, +10) and (-10, -1) using our measure of average Daily Short Volume (%), as well as Abnormal Short Volume (%). The observations are sorted into three groups according to  $\Delta 90$ -day CDS Spread, the changes in the average 5-year CDS spreads from the 90 days before the filing of financial reports to the 90 days after. Group 1 and Group 3 contain the observations with the lowest and the highest  $\Delta 90$ -day CDS Spread, respectively. In Panel B, we report the univariate tests for One-year CDS Spread, the one-year average CDS spread over the period from 18 September 2007 to 17 September 2008. In Panel C we analyze the one-year short selling sorted by  $\Delta$  One-year CDS Spread. In Panel D we compare one year average daily short selling between the financial group and the non-financial group after matching. In particular, for each financial company, we look for the non-financial companies whose size (total assets) are within  $\pm 5\%$  of the financial company's size. Then among candidate matching companies, we choose the one with average CDS spreads closest to the financial company's CDS spread. We also conduct t-tests of short selling activities within each group, and mean difference t-tests between group 1 and 3 are reported. \*, \*\*, and \*\*\* indicate significance at 10%, 5%, and 1%, respectively.

| <i>Panel A: Short Selling Around the 2007 Financial Reports Filing Dates</i>  |    |                                 |                             |                                      |           |   |      |         |
|---|----|---------------------------------|-----------------------------|--------------------------------------|-----------|---|------|---------|
| Panel A.1: over window (-10, +10)   |    |                                 |                             |                                      |           |   |      |         |
| Group   | N  | $\Delta 90$ -day CDS Spread (%) | Ave. Daily Short Volume (%) |                                      | t-stats.  | Ave. Daily Abnormal Short Volume (%)          |      | t-stats |
|   |    |                                 | Mean                        | Mean                                 |           | Mean  | Mean |         |
| 1 (Lowest)  | 16 | -0.071                          | -0.071                      | 0.284%                               |           | 0.083%  | *    | 1.8     |
| 2   | 17 | 0.288                           | 0.288                       | 0.312%                               |           | 0.106%  | ***  | 3.03    |
| 3 (Highest)   | 17 | 1.133                           | 1.133                       | 0.641%                               |           | 0.420%  | ***  | 4.43    |
| (1-3)   | 33 | -1.204                          | -1.204                      | -0.357%                              | *** -3.47 | -0.337%                                       | ***  | -3.2    |
| Panel A.2: over window (-10, -1)  |    |                                 |                             |                                      |           |   |      |         |
| Group   | N  | $\Delta 90$ -day CDS Spread (%) | Ave. Daily Short Volume (%) |                                      | t-stats.  | Ave. Daily Abnormal Short Volume (%)          |      | t-stats |
|   |    |                                 | Mean                        | Mean                                 |           | Mean  | Mean |         |
| 1 (Lowest)  | 16 | -0.071                          | -0.071                      | 0.248%                               |           | 0.056%  |      | 1.64    |
| 2   | 17 | 0.288                           | 0.288                       | 0.258%                               |           | 0.068%  | **   | 2.91    |
| 3 (Highest)   | 17 | 1.133                           | 1.133                       | 0.588%                               |           | 0.374%  | ***  | 4.17    |
| (1-3)   | 33 | -1.204                          | -1.204                      | -0.340%                              | *** -3.61 | -0.318%                                       |      | -3.31   |
| <i>Panel B: Short Selling over One-year Preceding the Short Ban (18 September 2007 to 17 September 2008) Sorted by One-year CDS Spreads</i> |    |                                 |                             |                                      |           |   |      |         |
| Group   | N  | One-year CDS Spread (%)         |                             | One-year Ave. Daily Short Volume (%) |           | One-year Ave. Daily Abnormal Short Volume (%) |      | t       |
|   |    | Mean                            | Mean                        | Mean                                 | t         | Mean  | Mean |         |
| 1 (Lowest)  | 19 | 0.441                           | 0.219%                      | 0.219%                               |           | 0.049%  | ***  | 2.89    |
| 2   | 20 | 0.93                            | 0.267%                      | 0.267%                               |           | 0.097%  | **   | 2.47    |
| 3 (Highest)   | 19 | 3.634                           | 0.637%                      | 0.637%                               |           | 0.478%  | ***  | 6.01    |
| (1-3)   | 38 | -3.193                          | -0.418%                     | -0.418%                              | *** -5.16 | -0.428%                                       | ***  | -5.28   |

*Panel C: Short Selling over One-year Preceding the Short Ban (18 September 2007 to 17 September 2008) Sorted by  $\Delta$  One-year CDS Spreads*

| Group       | N  | $\Delta$ One-year CDS Spread (%) | One-year Ave. Daily Short Volume (%) |           | One-year Ave. Daily Abnormal Short Volume (%) |     |       |
|-------------|----|----------------------------------|--------------------------------------|-----------|---|-----|-------|
|             |    | Mean                             | Mean                                 | t         | Mean  |     | t     |
| 1 (lowest)  | 19 | 0.189                            | 0.213%                               |           | 0.044%  | **  | 2.39  |
| 2           | 20 | 0.644                            | 0.271%                               |           | 0.101%  | *** | 2.65  |
| 3 (highest) | 19 | 3.194                            | 0.638%                               |           | 0.478%  | *** | 6.03  |
| (1-3)       | 38 | -3.005                           | -0.424%                              | *** -5.23 | -0.435%                                       | *** | -5.34 |

*Panel D: Comparison of One-year Average Short Selling between Financial and Non-financial Companies*

| Group                  | N  | One-year CDS Spread (%) |  | One-year Ave. Daily Short Volume (%) |      | One-year Ave. Daily Abnormal Short Volume (%) |          |
|------------------------|----|-------------------------|--|--------------------------------------|------|---|----------|
|                        |    | Mean                    |  | Mean                                 | t    | Mean  | t        |
| 1 (Fin. companies)     | 53 | 1.824                   |  | 0.351%                               |      | 0.187%  | *** 5.00 |
| 2 (Non-fin. companies) | 53 | 1.472                   |  | 0.293%                               |      | 0.136%  | *** 3.82 |
| 1-2                    | 53 | 0.352                   |  | 0.059%                               | 1.30 | 0.051%  | 1.11     |

**Table VII: Multivariate Analysis of Short Selling Activities around 2007 Annual Report Filing Dates based on CDS Spread**

Table VII shows the relationship between the short selling and CDS spread around the 2007 annual report filing dates. We analyze the Daily Abnormal Short Volume (%) over window  $(-10, +10)^{28}$  around the filing date of annual reports for fiscal year 2007. The key explanatory variables are Daily CDS Spread lagged by 1 day, and  $\Delta$  90-day CDS, which is defined as the change in average CDS spreads of a given financial company from the 90 days before the filing dates of its annual financial reports to the 90 days after the filing dates. In regression I we only control for Log (Assets) and Option Dummy. In Model II to IV we gradually add additional control variables. In Model V we replace Lagged Daily CDS Spread with  $\Delta$  90-day CDS Spread.

| <i>Daily Abnormal Short Volume (%) over Window (-10, +10) as Dependent Variable</i> |                      |                     |                         |                           |                           |
|---|----------------------|---------------------|-------------------------|---------------------------|---------------------------|
|   | Model I              | Model II            | Model III               | Model IV                  | Model V                   |
| Lagged Daily CDS Spread   | 9.401***<br>[5.532]  | 9.167***<br>[5.660] | 10.007***<br>[4.735]    | 5.552**<br>[2.066]        |                           |
| $\Delta$ 90-day CDS   |                      |                     |                         |                           | 11.256**<br>[2.328]       |
| Log (Assets)  | 0.047**<br>[2.118]   | 0.045*<br>[1.703]   | 0.035<br>[1.349]        | 0.026<br>[1.094]          | 0.015<br>[0.584]          |
| Option Dummy  | -0.003<br>[-0.045]   | 0.003<br>[0.042]    | -0.299<br>[-1.429]      | -0.324*<br>[-1.763]       | -0.269<br>[-1.569]        |
| Bank  |                      | 1.001<br>[1.168]    | 0.650<br>[0.830]        | 0.459<br>[0.666]          | 0.462<br>[0.703]          |
| Bank $\times$ CAPRI   |                      | -0.128<br>[-1.181]  | -0.083<br>[-0.863]      | -0.061<br>[-0.730]        | -0.061<br>[-0.756]        |
| Amihud's Ratio  |                      |                     | -61,578.480<br>[-1.656] | -74,400.494**<br>[-2.286] | -75,577.973**<br>[-2.653] |
| Institutional Ownership   |                      |                     | -0.000<br>[-0.140]      | -0.000<br>[-0.386]        | -0.000<br>[-0.323]        |
| Book/Market   |                      |                     | 0.010<br>[0.095]        | 0.115<br>[1.108]          | 0.185*<br>[1.873]         |
| ROA   |                      |                     | -0.213<br>[-0.263]      | -0.386<br>[-0.603]        | -0.895<br>[-1.551]        |
| Filing Date Dummy   |                      |                     |                         | 0.013<br>[0.477]          | 0.009<br>[0.378]          |
| Post Filing Date Dummy  |                      |                     |                         | 0.047**<br>[2.301]        | 0.058**<br>[2.590]        |
| Abnormal Trading Volume (%)   |                      |                     |                         | 2.744<br>[1.637]          | 2.379<br>[1.441]          |
| Constant  | -0.508**<br>[-2.429] | -0.490*<br>[-1.997] | -0.015<br>[-0.049]      | 0.102<br>[0.395]          | 0.160<br>[0.530]          |
| Num of Observations   | 913                  | 913                 | 853                     | 853                       | 903                       |
| Adjusted R <sup>2</sup>   | 0.371                | 0.384               | 0.428                   | 0.498                     | 0.513                     |

<sup>28</sup> In an unreported panel we conduct similar analysis in the window  $(-10, -1)$  right before the filing date of the 2007 annual reports. Our results remain qualitatively similar in most regressions.

**Table VIII: Multivariate Analysis of Short Selling Activities over One Year Preceding the Short Sale Ban  
Based on CDS Spreads**

Table VIII shows the relationship between the short selling and CDS spread over the period 18 September 2007 to 17 September 2008, one year preceding the 2008 short sale ban. In Panel A, we analyze the Daily Abnormal Short Volume (%) and the key explanatory variable is Daily CDS Spread lagged by 1 day. In regression I we only control for Log (Assets) and Option Dummy. In Model II to IV we gradually add additional control variables. In Panel B we report the analysis of Average Daily Abnormal Short Volume (%) over the period from 18 September 2007 to 17 September 2008. The key explanatory variable in Panel B is  $\Delta$  One-year CDS Spread. In Model IV we include both financial and non-financial companies in the sample. Further we control for Leverage, which is defined as long term debt plus long-term debt in current liabilities divided by total assets, as well as Financial Companies Dummy, which equals 1 for financial companies affected by the short ban and 0 for non-financial companies.

| <i>Panel A: Daily Abnormal Short Volume (%) over One Year Preceding the Short Sale Ban</i> |                      |                      |                        |                         |
|--|----------------------|----------------------|------------------------|-------------------------|
|  | Model I              | Model II             | Model III              | Model IV                |
| Lagged Daily CDS Spread  | 8.100***<br>[12.808] | 7.927***<br>[12.000] | 5.535***<br>[4.977]    | 1.425*<br>[1.956]       |
| Log (Assets)   | 0.023<br>[1.205]     | 0.018<br>[0.756]     | 0.012<br>[0.455]       | -0.001<br>[-0.059]      |
| Option Dummy   | 0.092<br>[1.467]     | 0.098<br>[1.505]     | 0.070<br>[1.187]       | 0.050<br>[1.125]        |
| Bank   |                      | 0.715<br>[1.233]     | 0.718<br>[1.219]       | 0.436<br>[1.079]        |
| Bank $\times$ CAPR1  |                      | -0.088<br>[-1.169]   | -0.087<br>[-1.139]     | -0.050<br>[-0.940]      |
| Amihud's Ratio   |                      |                      | -3,749.927<br>[-1.632] | -2,930.083*<br>[-1.702] |
| Institutional Ownership  |                      |                      | 0.001<br>[0.462]       | -0.000<br>[-0.033]      |
| Book/Market  |                      |                      | 0.042<br>[0.432]       | 0.085<br>[1.365]        |
| ROA  |                      |                      | -1.606***<br>[-2.954]  | -1.009***<br>[-3.095]   |
| Abnormal Trading Volume (%)  |                      |                      |                        | 8.087***<br>[6.206]     |
| Constant   | -0.266<br>[-1.362]   | -0.230<br>[-0.970]   | -0.160<br>[-0.557]     | -0.001<br>[-0.004]      |
| Num of Observations  | 12,035               | 12,035               | 10,992                 | 10,992                  |
| Adjusted R <sup>2</sup>  | 0.308                | 0.315                | 0.367                  | 0.660                   |

| <i>Panel B: Average Daily Abnormal Short Volume (%) over One Year Preceding the Short Sale Ban</i> |                          |                       |                        |                           |
|--|--------------------------|-----------------------|------------------------|---------------------------|
|  | Financial Companies only |                       |                        | All companies             |
|  | Model I                  | Model II              | Model III              | Model IV                  |
| ΔOne-year CDS  | 11.822***<br>[13.259]    | 11.690***<br>[13.753] | 9.579***<br>[6.768]    | 0.665<br>[0.484]          |
| Financial Companies Dummy  |                          |                       |                        | -0.017<br>[-0.833]        |
| Log (Assets)   | 0.026<br>[1.634]         | 0.021<br>[0.994]      | 0.028<br>[1.410]       | -0.021***<br>[-4.823]     |
| Option Dummy   | 0.017<br>[0.368]         | 0.022<br>[0.471]      | -0.048<br>[-0.736]     | -0.065*<br>[-1.958]       |
| Bank   |                          | 0.346<br>[0.762]      | 0.205<br>[0.488]       |                           |
| Bank× CAPRI  |                          | -0.040<br>[-0.666]    | -0.016<br>[-0.299]     |                           |
| Amihud's Ratio   |                          |                       | -1,464.016<br>[-0.829] | -2,512.393***<br>[-3.307] |
| Institutional Ownership  |                          |                       | -0.001<br>[-0.759]     | 0.001<br>[1.149]          |
| Book/Market  |                          |                       | 0.063<br>[1.074]       | 0.051**<br>[2.476]        |
| ROA  |                          |                       | 0.801<br>[1.302]       | -0.168<br>[-1.076]        |
| Leverage   |                          |                       |                        | -0.057<br>[-1.572]        |
| One-Year Average Abnormal Trading Volume (%)   |                          |                       | 28.439***<br>[2.948]   | 15.481***<br>[4.815]      |
| Constant   | -0.256<br>[-1.416]       | -0.221<br>[-0.971]    | -0.246<br>[-1.144]     | 0.281***<br>[4.216]       |
| Observations   | 58                       | 58                    | 52                     | 538                       |
| Adjusted R-squared   | 0.670                    | 0.663                 | 0.793                  | 0.768                     |



**Table IX: Impact of Short Sale Ban on Market Quality**

In this table we analyze the impact of the short sale ban on bid/ask spreads, which are defined as the difference between closing ask and bid scaled by closing price, of the financial companies affected by the short ban. In Model I and II the dependent variable is Daily Bid/Ask spread from 18 August 2008 to 8 October 2008, one month in advance of the short sale ban until the end date of the short ban. In Model I the key explanatory variables are the Subprime Assets Dummy, which equals 1 if a financial company has positive subprime assets and 0 otherwise, and the Ban-in-effect Dummy, which indicates the ban effectiveness period from 19 September 2008 to 8 Oct 2008. In Model II we further include the interaction term of the two dummies to capture the “diff-in-diff” effect. In Model III and IV, for each financial company we calculate the Average Daily Bid/Ask spreads over two periods, namely the pre-ban period (from 18 August 2008 to 18 September 2008),<sup>29</sup> and the ban-in-effect period (19 September 2008 to 8 Oct 2008), and repeat the same analysis as in Model I and II.

|  | Daily Bid/Ask Spread  |                       | Average Daily Bid/Ask Spread |                       |
|--|-----------------------|-----------------------|------------------------------|-----------------------|
|  | Model I               | Model II              | Model III                    | Model IV              |
| <i>Ban-in-effect Dummy</i>                                   | 0.026***<br>[10.874]  | 0.029***<br>[9.416]   | 0.026***<br>[10.537]         | 0.030***<br>[8.998]   |
| <i>Subprime Assets Dummy</i>                                 | 0.003<br>[1.096]      | 0.006**<br>[2.580]    | 0.003<br>[1.066]             | 0.008***<br>[3.044]   |
| <i>Ban-in-effect Dummy</i><br>× <i>Subprime Assets Dummy</i> |                       | -0.010**<br>[-2.026]  |                              | -0.010**<br>[-2.084]  |
| <i>Size</i>  | -0.003***<br>[-4.199] | -0.003***<br>[-4.230] | -0.004***<br>[-4.176]        | -0.004***<br>[-4.200] |
| <i>Option Dummy</i>  | 0.002<br>[0.840]      | 0.002<br>[0.840]      | 0.002<br>[0.640]             | 0.002<br>[0.640]      |
| <i>Bank</i>  | 0.017**<br>[2.379]    | 0.017**<br>[2.381]    | 0.020**<br>[2.455]           | 0.020**<br>[2.456]    |
| <i>Bank</i> × <i>CAPRI</i>                                   | -0.001**<br>[-2.042]  | -0.001**<br>[-2.044]  | -0.002**<br>[-2.057]         | -0.002**<br>[-2.056]  |
| <i>Amihud's Ratio</i>  | 2.887***<br>[8.305]   | 2.886***<br>[8.303]   | 3.059***<br>[7.300]          | 3.059***<br>[7.294]   |
| <i>Idiosyncratic Risk</i>                                    | 0.009***<br>[2.679]   | 0.009***<br>[2.675]   | 0.010**<br>[2.436]           | 0.010**<br>[2.431]    |
| <i>Institutional Ownership</i>                               | -0.000***<br>[-4.842] | -0.000***<br>[-4.840] | -0.000***<br>[-4.445]        | -0.000***<br>[-4.439] |
| <i>Book/Market</i>   | 0.015***<br>[3.217]   | 0.015***<br>[3.211]   | 0.018***<br>[2.898]          | 0.018***<br>[2.896]   |
| <i>ROA</i>   | 0.053<br>[1.286]      | 0.052<br>[1.283]      | 0.057<br>[1.249]             | 0.057<br>[1.247]      |
| <i>Constant</i>  | 0.019*<br>[1.693]     | 0.018<br>[1.571]      | 0.019<br>[1.430]             | 0.017<br>[1.274]      |
| Observations   | 10,785                | 10,785                | 584                          | 584                   |
| Adjusted R-squared   | 0.175                 | 0.175                 | 0.557                        | 0.559                 |

<sup>29</sup> Our results are robust to different definitions of pre-ban periods such as 3 months, 6 months, or 1 year before the short sale ban went into effect on 19 September 2008.

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