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Abstract

There has been intense regulatory and media concern about manipulative distortions associated with naked shorting. However, naked short sales are functionally indistinguishable from covered short sales at the time of trade, and they should arguably have the same beneficial impact on liquidity and pricing efficiency as has been documented for short-selling in general. We investigate the impact of naked shorting on market quality, and find that naked shorting leads to a significant reduction in positive pricing errors, pricing error volatility, returns volatility, bid-ask spreads, and order imbalances. This is qualitatively similar to what we find for covered shorting. Consistent with this, we find that the July/August 2008 SEC ban on naked short-selling reduced liquidity and pricing efficiency. We also investigate naked shorting around the demise of financial firms hardest hit by the 2008 financial crisis and find no evidence that their price-declines were caused by naked shorting. We also find that naked shorting intensifies *after* rather than *before* credit downgrade announcements or large price declines. In general, naked short sellers respond to public news and price declines rather than trigger them. Finally, we find that manipulative naked shorting during our 2008 financial crisis sample period was not different from pre-crisis 2007 levels, and significantly lower than what it was prior to Regulation SHO. Overall, our empirical results are in sharp contrast with the negative pre-conceptions that appear to exist among media commentators and regulators in relation to naked shorting. While we recognize that naked shorting does raise serious concerns about fairness, and there is arguably the possibility that it can create potentially severe distortions, we do not find any evidence whatsoever that, overall, naked short-sellers manipulatively engineered price declines, or otherwise contributed adversely to creating market distortions, even in the extreme situation of the 2008 financial crisis. Instead, the gently regulated naked shorting that existed after Regulation SHO up to mid-2008 was net beneficial for liquidity and pricing efficiency.

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Naked Short Selling: The Emperor's New Clothes?

1. Brief Background and Motivation

Naked shorting harms the market and market participants… -- Harvey Pitt, former Chairman of the Security and Exchange Commission.

A lot of those companies are gone. A lot of them died. This was a fatal attack. Now, some of them were weak when they were attacked. Some of them would have failed anyway. Others wouldn't have. Again, it's not up to the naked short sellers to decide. It's up to the investors that play by the rules. -- Robert Shapiro, former Under Secretary of Commerce.

Short selling is the sale of a stock not owned by the seller. Generally, the stock is borrowed, or adequate borrowing arrangements are made, to ensure availability for delivery at settlement. Such short selling is "covered shorting"; on the other hand, "naked short selling" or "naked shorting" is a short sale in which the seller does not arrange to borrow, or even intend to borrow the securities to deliver to the buyer within the standard three-day settlement period. As a result, the seller fails to deliver securities to the buyer when delivery is due (known as a "failure to deliver" or "FTD").[2,3]

Regulators have often sought to restrict naked short selling, citing potentially negative effects on financial markets, even though the *Depository Trust and Clearing Corporation* (DTCC) electronic system of a voluntary pool of lenders mitigates such disruptions, and makes naked shorting costly.[4] The Securities and Exchange Commission (SEC), through Regulation SHO, imposed major restrictions on naked short selling since January 2005. Also, in the wake of the heavy and rapid falls in the prices of financial sector stocks during the current financial crisis, and public concerns of manipulative "bear raids" by naked short-sellers, US regulators banned naked short selling for select financial institutions between July 21 and August 12, 2008, stating that "false rumors can lead to a loss of confidence [and] panic selling, which may be further exacerbated by 'naked' short selling," and as a result, "the prices of securities may artificially and unnecessarily decline well below the price level that would have resulted from the normal price discovery process."[5] The SEC has since further tightened rules on naked short selling in September 2008 and imposed, in July 2009, a virtual ban on naked short selling, by

[2] Our definition of "naked short sale" follows from the SEC Division of Market Regulation note "Key Points about Regulation SHO", http://www.sec.gov/spotlight/keyregshoissues.htm.
[3] The label "fail to deliver" can be misleading. The great majority of FTDs are, in fact, delays of delivery. Boni (2006) documents that, for listed stocks, most fails are short-lived: the median age of fails is only 2.9 days.
[4] Culp and Heaton (2007) provide an excellent overview of the DTCC system in this context.
[5] Security Exchange Act of 1934, Release No. 58166 / July 15, 2008.

requiring borrowing arrangements prior to any short sale.[6] In a similar spirit, restrictive regulations on shorting were enacted by Britain's Financial Services Authority (FSA) and also in many other countries.[7]

Contemporaneously, there has been a surge of discussion in the media about the impact of naked shorting. Over 4,600 printed articles have appeared in English-language magazines and newspapers discussing naked shorting over a 2 year period.[8] Other evidence of the current views against naked shorting include at least three investor associations lobbying for restrictions on naked shorting,[9] various lawsuits by investor groups alleging stock price manipulation linked to naked shorting,[10] and multiple lawsuits against the DTCC for allegedly facilitating naked short selling. Several senior managers of major companies ostensibly targeted by naked short sellers have also been very vocal in their opposition to naked shorting, claiming that naked shorting led to their stock prices being artificially depressed.[11] As a result, the SEC has received over 5,000 complaints alleging stock price manipulation through naked short selling between January 2007 and June 2008.[12]

It is important to note that both covered and naked short sales are generally transacted without actual prior or contemporaneous borrowing of shares, since, as argued by Geczy, et al, (2002), it is not economically rational for short-sellers to pay extra borrowing fees by borrowing prior to the actual due date of delivery (which is three days *after* the trade).[13] Hence, the distinction between a covered and a naked short sale becomes functionally relevant only on the date of delivery when the naked short seller fails to deliver the security to the buyer. Ordinarily,

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[6] The intensity of the regulation of covered and naked short sales is currently at the center of a heated regulatory debate. We hence believe that an examination of the impact of covered and naked short selling is extremely timely.

[7] The list of countries which have recently imposed new restrictions on either short selling or naked short selling includes Spain, Portugal, France, Italy, Greece, Germany, Luxemburg, Russia, South Korea, Singapore, Hong Kong and Taiwan ("Regulating Short Selling", *Financial Times,* September 23, 2008).

[8] We used the *Factiva Database* to search for the term 'naked short selling', restricting our search to publications in English over the period 8/10/2006-8/10/2008.

[9] *The Movement for Market Reform*, the *National Coalition Against Naked Short Selling* (NCANS) and the *Coalition for the Reform of Regulation SHO*.

[10] *The Biovail lawsuit* against Stephen Cohen, Gradient, and a host of others; *the Overstock lawsuit* against Rocker Partners, Gradient, and a host of others; and *The NFI lawsuit* brought by NFI shareholders against *Bank of America* (the Specialist) and the Prime Brokers.

[11] Patrick Byrne, CEO of Overstock.com, has been very vocal in this regard and has been lobbying for new regulations against naked short selling, while the corporation itself has initiated lawsuits against both naked short sellers and financial institutions accused of facilitating naked short selling (http://www.overstock.com/naked-short-selling.html). More recently, Bear Stearns CEO Alan Schwartz, Morgan Stanly CEO John Mack and Lehman Brothers CEO Richard Fuld have all blamed naked short sellers for price declines of their stock.

[12] "Naked short sales provoke complaints", *The Wall Street Journal Asia* (March 20, 2009). In this context, for example, in 2003, the SEC settled a case against parties accused of manipulating stocks through naked short selling: SEC v. *Rhino Advisors Inc.* and Thomas Badian, Feb. 26, 2003.

[13] Prior to July 2009, the "locate" requirement did not obligate a broker to identify a specific bloc of shares prior to a trade. It only obligated a broker-dealer to have, before executing a short sale order, reasonable grounds to believe that the security can be borrowed for timely delivery, and could potentially be fulfilled just by using published lists of easy-to-borrow securities.

the DTCC system triggers immediate delivery to the buyer through borrowing from a voluntary pool of lenders, and even when the pool is empty, the buyer, by holding the selling price of the stock as collateral and also maintaining an exposure to the security, effectively becomes the lender of the security to the naked shorter. Accordingly, Culp and Heaton (2007) argue that, except for this nuance of a change in roles, covered and naked short sales are functionally indistinguishable. Hence, both covered and naked short-selling should arguably contribute to the price discovery process by enabling value-traders to more quickly and easily bring the prices of overpriced securities in line with their "true value", as argued by Miller (1977) and Diamond and Verrecchia (1987), among others. And second, financial intermediaries and other liquidity suppliers should be able to provide liquidity more effectively and expeditiously in the presence of both covered and naked short-selling. While one would expect naked shorting to be at least as beneficial as covered shorting in this context, the SEC has, potentially because of the fear of *manipulative* naked shorting, *relaxed* covered-shorting restrictions by removal of the uptick rule, but *increased* naked-shorting restrictions first through the "locate" and "close-out" requirements under Regulation SHO, and then through subsequent various restrictions and bans specifically on naked shorting. [14]

There is a significant body of literature focusing on the impact on market quality of short selling. This literature finds that short-selling is beneficial both for pricing efficiency and liquidity.[15] However, this literature does not distinguish between covered and naked short-selling.[16] In particular, in spite of the extensive concern on this issue among regulators and market participants, extant research provides virtually no evidence specifically on the effect of naked shorting on liquidity, price distortions and pricing efficiency, and the extent to which the effects of naked shorting exist after controlling for covered-shorting. In fact, serious concerns have been voiced that severe restrictions have been placed on naked short-selling when the regulators have not produced any evidence linking naked short selling to market manipulation so far."[17] Our study fills this void in existing literature.

Using data on fails to deliver for the first half of 2007,[18] we estimate that naked shorting has affected about 91% of NYSE securities, about 71% of NASDAQ securities and about 60%

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[14] The "locate" requirement is discussed in a preceding footnote. The "close-out" requirement imposes additional delivery obligations on broker-dealers for "threshold" securities with a relatively high number of FTDs.

[15] See footnote 18 later.

[16] That said, in the remainder of the paper, given that less than 3% of shorted shares are naked shorts, we sometimes loosely interpret the literature on short selling in general as indicating also the evidence on covered short selling, even though no extant empirical evidence exists distinguishing between covered and naked short selling.

[17] For example, "Naked Fear", *The Economist* (July 24, 2008).

[18] Data on fails to deliver has recently been made public by the SEC under the Freedom of Information Act, and is available at http://www.sec.gov/foia/docs/failsdata-archive.htm

of AMEX and ARCA securities. Using a random sample of 375 NYSE securities and a vector autoregressive model to control for endogenous interrelationships between market quality metrics, we find that an increase in naked short selling leads to significantly smaller pricing errors, significantly lower pricing error volatility, significantly reduced stock price volatility and significantly lower order imbalances. An increase in naked short selling equivalent to 10 basis points of the number of outstanding shares leads to approximately a 3% reduction in spreads, a 8% reduction in order imbalances, a 29% reduction in the magnitude of positive pricing errors, a 37% decline in pricing error volatility and a 5% reduction in stock price volatility. These results are consistent with market makers employing naked short selling to provide liquidity when it is otherwise scarce and value arbitrageurs enhancing pricing efficiency through naked short selling. As we are more likely to find negative effects associated with naked short selling when it is most intense, we also focus on a sample of the most naked shorted securities. Even in this sample, we find a positive impact on market quality. And importantly, consistent with our expectations, we find that the market impact of covered and naked short selling is very similar in all samples.

Since naked short sellers have been widely alleged in the media to have contributed to the financial crisis by precipitating *manipulative* price declines of financial firms in 2008, we analyze a few high-profile individual cases of financial firms that experienced dramatic stock price declines. In particular, we analyze naked short selling in *Bear Stearns Companies Inc.* (hereafter Bear Stearns), *Lehman Brothers Holdings Inc.* (hereafter Lehman), *Merrill Lynch & Co. Inc.* (hereafter Merrill), and *American Insurance Group* (hereafter AIG). We find that., most of the time, naked short selling was too low to reasonably "cause" significant stock price distortions, and when naked shorting did become abnormally heavy, it was *after* dramatic price declines, *not before*, indicating that naked short sellers were *responding to* public domain information about the firms, rather than being responsible for triggering the observed precipitous price decline. We further analyze how naked short selling changes around public news of credit rating downgrades, and again find that naked short selling increases *after* rather than before the credit downgrade announcement. Similarly, we analyze naked short selling around large stock price declines and find that naked short selling increases on days following the largest negative returns, again consistent with naked short sellers *responding to* public information, rather than being responsible for triggering price declines.

We also analyze the market impact of the SEC naked short selling ban for 19 financial securities between July 15 and August 12, 2008. For the period during which the ban was enacted, we find significantly higher absolute pricing errors and significantly lower trading volumes, indicating that the naked short selling ban hampered price discovery and reduced liquidity. Returns, albeit negative, were not significantly affected, indicating that the ban failed to slow the price decline of the related securities.

Finally, we examine changes in the impact of *manipulative* naked shorting, in contrast to naked shorting that improves pricing efficiency or liquidity. We find that negative pricing errors and negative order imbalances mean-revert at a significantly faster rate after Regulation SHO, indicating a lower impact of manipulative naked short selling after Regulation SHO; and more importantly, this reduced impact of *manipulative* naked shorting has continued through the 2008 financial crisis.

The remainder of the paper is structured as follows. Section 2 briefly reviews extant research on naked short selling. Section 3 develops our hypotheses. Section 4 defines the measures and variables we use for naked and covered shorting, pricing efficiency, and liquidity. Section 5 documents our empirical methods and results: provides salient descriptive statistics; investigates the impact of naked shorting on market quality; analyzes the role of naked short sellers around major economic events over the financial crisis period, e.g., the demise of Bear Stearns and Lehman, the near-demise of Merrill and AIG, around credit rating downgrade announcements and around large stock price drops; examines the impact of the ban on naked short selling of select financial securities in July and August 2008, and analyzes changes in the impact of manipulative naked short-selling in the context of Regulation SHO and the 2008 financial crisis. Section 6 presents concluding remarks.

2. Extant Research on Naked Short-Selling

But there is hardly unanimity in the investment community or the financial media on either the prevalence, or the dangers, of "naked" short selling…. Despite its assertions regarding the potential of danger of "naked" short selling and the growing interest in the subject, the Report can cite to no bona fide studies or empirical data regarding the practice's market impact – Division of Enforcement, Securities and Exchange Commission.

A large body of existing research has examined the relation between short selling and market quality.[19] The literature focusing specifically on naked short selling is much less

[19] Diamond and Verrecchia (1987) conclude, on the basis of their theoretical model, that short-selling constraints do not bias prices upwards, but reduce the speed of adjustment of prices to private information, and hence reduce pricing efficiency. Abreu and Brunnermeier (2002, 2003) and Scheinkmann and Xiong (2003) show theoretically

developed. There are two academic "thought-pieces" without any theoretical models or empirical evidence: Christian et al. (2006) provide a descriptive review of naked shorting from a legal perspective; and, Uchimoto et. al. (2005) discuss the impact of naked short selling on ETF trading, conjecturing adverse impacts on capital formation and pricing efficiency, particularly for small and emerging companies. There are also two theoretical papers on naked shorting without any empirical evidence. Finnerty (2005) develops a theoretical model for market equilibrium in the presence of short selling, both covered and naked shorting, and concludes that naked short selling is likely to be used as an instrument for market manipulation. On the other hand, Culp and Heaton (2007) offer a theoretical discussion of the effects of naked shorting on markets, and, in the context of an extensive analysis of the DTCC settlement system, conclude that "naked shorting is not fundamentally different from traditional short selling and is unlikely to have detrimental effects on capital markets."

We are aware of relatively few empirical studies specifically on naked shorting. First, Evans et al. (2008) use data from one market maker to link FTDs to hard-to-borrow situations and examine the possibility of arbitrage based on misalignments between the option and stock markets. Second, Boni (2006) analyzes delivery failures in U.S. equity markets. She finds that, prior to Regulation SHO, most U.S. equity issues, listed and unlisted, experienced at least a small percentage of failures-to-deliver each day. A substantial fraction of issues (42% of listed stocks and 47% of unlisted stocks) had persistent fails of 5 days or more. She conjectures that Regulation SHO would lead to less liquidity, increased price volatility and temporary short squeezes, but does not offer any empirical evidence on the issue.[20] Third, Edwards and Hanley (2008) examine the effect of short selling constraints and of naked short selling on the short-term performance of IPOs, and find that IPOs with greater naked shorting are more accurately priced. Fourth, Boulton and Braga-Alves (2009a) examine the link between naked short selling

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that constraints on short selling are linked to bubbles and excess market volatility. Early studies supporting the view that short selling reduces overpricing and increases market efficiency include Miller (1977) and Harrison and Kreps (1978). Pope and Yadav (1994) find that spot-market short-selling restrictions make index futures more negatively mispriced, leading to a pricing bias. Asquith and Meulbroek (1996), Aitken et al. (1998), Danielsen and Sorescu (2001), Jones and Lamont (2002), Geczy et. al. (2002), Ofek and Richardson (2003) and Reed (2007) provide evidence that stock prices do not fully incorporate information in the presence of short sale constraints. Daouk and Charoenrook (2005) study the effects of changing restrictions on short selling in 111 countries and conclude that allowing short selling improves market quality. Bris et. al. (2007) similarly analyze equity markets around the world and find that prices incorporate negative information faster in markets where short sales are allowed. Diether et al. (2007) show that the temporary suspension of the uptick rule that restricted short-selling did not negatively affect market quality, and recommend that the suspension can be made permanent, and later, the SEC did actually permanently suspend the uptick rule. Boehmer et al. (2008) use proprietary NYSE order data to find that short sellers are, on average, better informed, and contribute to efficient pricing.

[20] Merrick, Naik and Yadav (2005) provide evidence that suggests that the "right to fail" provides an important release valve for settlement related pressures and limits the damage a potential squeezer can cause. This generates another perspective on the potential problems that can arise from restricting naked short selling.

and market returns in the extreme situation of the security being on the threshold list,[21] and conclude that naked short-sellers are uninformed since increased naked shorting is followed by positive abnormal returns. However, their specific finding likely reflects their choice of returns' horizon, since the wider empirical findings of Bardong, et al. (2009) show that the informational advantage of short-sellers is over longer horizons.[22] And finally, in well-executed research undertaken contemporaneously with this study, Boulton and Braga-Alves (2009b) and Kolasinski, et al. (2009) investigate the issue of market quality around the naked short-selling ban in July/August 2008 and document results that are consistent with the results we report on that specific issue in this paper. That said, Boulton and Braga-Alves (2009b) do not investigate deviations from an informationally efficient price (as we do in this study); and the focus of Kolasinski, et al. (2009) is on the difference between short-selling bans and short-selling restrictions, not necessarily on naked shorting. Apart from these two relatively narrowly focused contemporaneously undertaken studies, we are not aware of *any* empirical research that examines the link between *naked* shorting and market quality issues: we fill this gap in the literature with a comprehensive investigation in the present paper.

3. Development of Hypotheses

3.1 Naked Short Selling and Pricing Efficiency

Fails to deliver in the US equity market have exacerbated the sharp declines in share prices of financials. -- Helen Avery, Euromoney.

False rumors …. may be further exacerbated by "naked" short selling…. [and if] significant financial institutions are involved, this chain of events can threaten disruption of our markets. -- Securities and Exchange Commission.

While the large body of literature that has examined the relationship between short sales and pricing efficiency has sometimes documented contrasting results, a growing consensus has emerged that short sellers enhance price efficiency. Two recent studies are especially relevant here. First, Diether et al. (2007) use the recently available data on daily short sales to find that short sellers correct overreaction in stock prices. Second, Boehmer et al. (2008) use proprietary NYSE order data to find that short sellers, especially institutional short sellers, act as value arbitragers and correct overpriced securities to bring about permanent price effects and hence

[21] While this provides a strong focus on securities that have heavy naked shorting, it also potentially leads to confounding effects due to signaling and close-out requirements, particularly in the absence of controls for endogenous relationships (similar to those we have in this paper).

[22] Bardong, et al. (2009) analyze the informational advantage of NYSE short-sellers over different horizons using spectral analysis and other methods, and find that the informational advantage of short-sellers (relative to regular buys and sales) is not over intra-day intervals but over longer multi-day horizons.

contribute to efficient pricing. There is no empirical evidence specifically in regard to naked short selling. However, as argued in the introductory section, covered and naked short sales are functionally indistinguishable given that neither the covered nor the naked short-seller has borrowed the security at the time of the trade, and even if the DTCC system does not trigger immediate delivery to the buyer through borrowing from a voluntary pool of lenders, the buyer effectively becomes the lender of the security to the naked shorter (on day t+3). In view of this functional similarity, and the strong consensus of an improvement in pricing efficiency associated with short selling in general, we hypothesize that:

H1: Naked short selling improves pricing efficiency.

To test Hypothesis *H1,* we empirically investigate several aspects of pricing efficiency.

1. First, naked short sellers will contribute to pricing efficiency if they enter the market when securities are over-priced: then, their trades will arguably reduce the positive pricing errors of these overpriced securities. Hence, we test whether naked short-selling leads to a reduction in positive pricing errors.
2. Second, a reduction in positive pricing errors should make the market more informationally efficient, and such a market should display a lower dispersion of pricing errors (Hasbrouck, 1993). Hence, we test whether naked short-selling leads to a reduction in the volatility of pricing errors.
3. Third, higher pricing efficiency should translate into more orderly markets, and hence we test whether naked short-selling leads to a reduction in stock price volatility.
4. Finally, if naked short-selling contributes to pricing efficiency, we should observe that the SEC ban on naked short selling introduced in the wake of the 2008 financial crisis leads to a reduction in pricing efficiency. Accordingly, we test whether the July/August 2008 SEC ban on naked short selling lead to a higher volatility of pricing errors, higher spreads and lower trading volume.

3.2 Naked Short Selling and Liquidity

The Commission has repeatedly stressed the fact that the practice [of naked short-selling] can provide needed market liquidity in certain circumstances .... – Division of Enforcement, Securities and Exchange Commission.

As per the SEC, naked short selling can often be employed by market makers and other liquidity providers to quickly and efficiently fulfill orders: the SEC website says that "*in certain circumstances, naked short selling contributes to market liquidity. For example, broker-dealers that make a market in a security generally stand ready to buy and sell the security on a regular*

and continuous basis at a publicly quoted price, even when there are no other buyers or sellers. […] Because it may take a market maker considerable time to purchase or arrange to borrow the security, a market maker engaged in bona fide market making, particularly in a fast-moving market, may need to sell the security short without having arranged to borrow shares."[23] Naked short selling is also a mechanism to improve the efficiency of security-lending markets since the option to fail becomes particularly valuable when borrowing is too expensive for covered short sellers, which is exactly when liquidity is most needed (Evans, Geczy, Musto and Reed, 2008).[24] In the context of the above, our second hypothesis is:

H2: Naked short selling improves liquidity.

To test Hypothesis *H2,* we first directly examine if naked short sellers contribute to liquidity by testing whether naked short-selling leads to lower spreads and reduced order imbalances. Second, as for our tests for *H1*, if naked short-selling contributes to liquidity, we should observe that the SEC ban on naked short selling introduced in the wake of the 2008 financial crisis leads to a reduction in liquidity. Accordingly, we test whether the July/August 2008 SEC ban on naked short selling leads to lower trading volumes and higher spreads.

3.3 Manipulative Naked Short Selling and the 2008 Financial Crisis

We have been concerned about 'naked' short selling and, in particular, abusive 'naked' short selling, for some time. -- Security and Exchange Commission.

Illegal naked short selling, according to Robert Shapiro, a former Under Secretary of Commerce, has cost investors $100 billion and driven 1,000 companies into the ground. --Time Magazine.

As highlighted in the introduction and the footnotes therein, the media and the CEOs of affected firms have vociferously and persistently accused naked short-sellers of undertaking "bear raids" and thereby causing stock prices to decline, particularly during the 2008 financial crisis. Regulators have also accused naked short sellers of manipulatively depressing stock prices. Accordingly, we offer additional evidence on the impact of naked short selling on market quality by investigating whether these extensive accusations are consistent with our data. In this context, we hypothesize and test:

H3: Naked short selling contributed adversely to the 2008 financial crisis.

We empirically investigate Hypothesis *H3* in several different ways.

[23] http://www.sec.gov/spotlight/keyregshoissues.htm
[24] We also know from Bardong, et al. (2009) that short-sellers in general are net liquidity suppliers.

1. First, commentators have directly blamed naked short sellers for the price crashes of Bear Stearns, Lehman, AIG and Merrill. Accordingly, we test for the presence of high levels of naked short selling prior to the large price declines in the stock prices of those companies.
2. Second, we note that naked short-sellers are typically thought of as undertaking "bear raids" to trigger downward price spirals specifically with the aim of achieving credit downgrades so as to also profit from potentially simultaneous positions in the CDS market. In this context, we test whether naked short selling intensifies *prior to* credit rating downgrades.
3. Third, in similar spirit, we investigate whether naked short selling intensifies prior to large stock price declines, particularly for securities issued by highly levered firms, as such evidence would also be consistent with "bear raids" aimed at achieving credit downgrades.
4. Finally, we test whether manipulative naked short-selling and its impact increased over the 2008 financial crisis period. In this context, we think of naked short-sellers as having three trading motivations: they could be value arbitrageurs aiming to profit from positive pricing errors; or they could be dealers or other traders aiming to profit from supplying liquidity (by selling when order imbalances are positive and buying when they are negative); or they could be engaged in manipulative naked shorting. The first two motivations lead to beneficial effects on liquidity and pricing efficiency, while the third motivation leads potentially to what has sometimes been labeled as "abusive" naked short-selling. To test *H3*, we test for a significant increase in the manipulative component during the 2008 financial crisis. It is difficult to precisely define the criteria that can be used to identify and classify naked short-selling as potentially manipulative. We define potentially manipulative naked short-sellers from the mind-set used in the financial crisis media coverage of naked short-selling, i.e., the mindset of bear-raids, based on whether naked shorting is undertaken at a time when pricing errors or order-imbalances are negative rather than when they are positive. Accordingly, we do the test in two ways:
    a. If naked shorting is done when pricing errors are positive, it contributes positively to pricing efficiency. If it is done when pricing errors are negative, then it will arguably further amplify negative pricing errors in the next period, and thereby contribute to generating a bear-raid scenario. This implies that, in the presence of greater manipulative naked shorting, we would expect the mean reversion of pricing errors, conditional on the pricing error being negative, to decrease. Hence, we can use the change in mean reversion, conditional on negative pricing errors, to test for a change in the intensity of manipulative naked shorting.

b. If naked shorting is done when order imbalances are positive, naked shorting will arguably have a positive liquidity-related impact. However, following the same mind-set of bear raids, naked short-selling will be potentially manipulative if it is initiated at a time when order-imbalances are negative, since it will cause them to become even more negative. Hence, once again, we can use changes in the mean reversion of order imbalances, conditional on negative order imbalances, to test for changes in manipulative naked shorting.

4. Definitions of Measures and Variables

Table 1 summarizes the measures and variables we use in this paper. The measures and variables related to naked short-selling and pricing error are explained in greater detail in this section. Liquidity measures and other variables in Table 1 are defined and estimated as commonly done in the literature.

Our proxy for naked short selling is based on the outstanding number of fails to deliver (FTDs), daily data on which has been made available by the SEC under the Freedom of Information Act (FOIA) since March 22, 2004.[25] We proxy naked short selling by the *Outstanding Naked Short Ratio* (*ONSR*) defined for each day *t* as the estimated cumulative naked short sales till day *t* scaled by the total number of shares outstanding (obtained from *CRSP*). To measure naked short selling on day *t*, since failure is recorded only on day *t*+3, we calculate the cumulative naked short sales till day *t* by adjusting the outstanding FTDs from the SEC data by adding the naked short sales that have already taken place but have not yet been observed because they will show up only after settlements are duly completed over days *t+1*, *t+2* and *t+3*.[26] Accordingly, for each security *i* and trading day *t:*

$$ONSR_{i,t} = \frac{Outstanding\ FTDs_{i,t} + \sum_{j=1}^{3} NewFails_{i,t+j}}{Shares\ Outstanding_i}$$

[25] The SEC dataset records outstanding fails to deliver only when the latter exceed 10,000 shares. We assume that, when no FTDs are reported, the number of FTDs is equal to zero.

[26] For each day *t*, the difference between cumulative FTDs on day *t* and cumulative FTDs on day *t-1* is equal to the number of new naked shorted shares minus the number of previously outstanding FTDs closed on day *t*. While we do not have data on the number of previously outstanding FTDs settled on a particular day, we approximate it on the basis of the *Office for Economic Analysis* memorandum dated August 21, 2006, "Fails to Deliver Pre- and Post-Regulation SHO" and the assumption of constant settlement rates. Our results are robust to different settlement rate assumptions.

We also compute the *New Naked Short Ratio* on day *t* as the number of new FTDs on day *t* divided by the number of shares traded on day *t*; and the *Naked to All Shorts Ratio* as the *ONSR* divided by the short interest.[27]

In order to control for the effects of covered short selling, we estimate the *Outstanding Covered Short Ratio (OCSR),* the daily number of outstanding covered shorted shares scaled by the number of shares outstanding. The outstanding covered-shorted shares are estimated by subtracting the outstanding naked shorted shares from the contemporaneously outstanding total number of shorted shares estimated using total short-interest data and the total volume of short sales from Regulation SHO data in TAQ.

4.1 FTDs as a Proxy for Naked Short Selling

… the majority of these failures-to-deliver are not the result of honest mistakes or bad processing -- Former SEC commissioner Roel Campos in an interview reported in "Short Sellers Squeezed All Around", The Wall Street Journal (April 7, 2009)

Clearly, our *ONSR* variable is a *proxy* for naked short-selling, not an exact measure. In particular, we can think of three factors that can make our FTD-based proxy potentially imperfect. First, every FTD does not necessarily originate from a naked short sale, since human or mechanical errors or processing delays can result in an FTD. However, we believe such errors and delays should be random and not systematically related to the variables driving any of our hypotheses, and therefore, while they may add noise, they should not affect any of our conclusions.

Second, while every naked short sale does, by definition, result in an FTD at the level of naked short trade, it may not necessarily get reflected in the FTD data provided by the SEC, since these data are constructed by aggregating across brokers (rather than trades) after all trades of a particular broker are netted out. Hence, a failed trade may not show up in the data if the broker is able to do internal offsets of her deliverables with receivables (for other clients) in a manner that allows her to reduce the net FTDs that she reports. However, given that buys must match sells overall across all brokers, a systematic increase on a particular day in the naked short-selling for a particular stock has to be necessarily reflected in the overall FTDs reported collectively by brokers since offsets of this nature at the level of an individual broker cannot fortuitously exist simultaneously for each of the large number of active brokers in the market. Therefore, we again believe that errors due to such fortuitous offsets may add noise but should not systematically affect any of our conclusions since FTDs will continue to proxy for naked

[27] Monthly short interest data were obtained from www.shortsqueeze.com

shorting even if it is not a one-to-one correspondence. And furthermore, irrespective of the naked shorts that get internally absorbed through normal market mechanisms, what are economically relevant from the market quality perspective of this paper are the naked shorts that actually result in FTDs.[28]

Third, Edwards and Hanley (2008) suggest that FTDs "in price supported IPOs may arise from the mechanism of the offering process." Accordingly, to avoid the possibility of IPO-related FTDs, we exclude securities that started trading during our sample interval. In addition, to prevent the possibility of similar FTDs in conjunction with other share issues, we exclude securities for which we observe significant changes in the number of shares outstanding from our sample.

Extant literature provides good support for FTDs being a good proxy for naked short-selling. In particular, Evans et al. (2008) find that the number of FTDs is strongly related to rebate rates, indicating that FTDs originate largely from (naked) short transactions; and Boni (2006) shows that the number of FTDs is related to the number of short sales, and offers evidence that market makers 'strategically' fail to deliver when borrowing costs are high, again pointing to FTDs being governed by (naked) short selling.

Still, to fully reassure ourselves that our FTD-based *ONSR* measure is a good proxy for naked shorting, we undertake our own empirical analysis. First, in Table 2 Panel A, we report the results of running a regression of new FTDs on day t+3 on 'short volume', i.e. the daily trading volume arising from short sales on day t, and 'non-short volume', the daily trading volume arising from regular sales on day t. We find that the number of new FTDs on day t+3 is strongly and significantly related (p-value<<0.01) to 'short volume', and is *not* significantly related to 'non-short' volume.[29] This indicates that failures to deliver are being driven by short-sellers failing to deliver and not by settlement-related delays arising from regular sales failing to deliver. And, since short sales are a sum of covered short sales and naked short sales, and covered short sales should arguably not fail to deliver because of explicit borrowing by the intermediary involved, a significant relationship between FTDs and short-sale volume implies a significant relationship between FTDs and naked short sales. While we appreciate that the regression certainly does not establish an unequivocal one-to-one link between naked shorting and FTDs, it does provide reasonably strong support for FTDs being a proxy for naked shorting.

[28] We are grateful to Stewart Mayhew of the SEC for highlighting this aspect to us.

[29] We use the Regulation SHO TAQ database for the first half of 2007 to obtain the total daily number of shares traded and the total daily number of shares shorted, and thereby infer the 'non-short' daily trading volume arising from regular sales.

Finally, and importantly, we examine time-series changes in *ONSR* during a period in which we have good economic reason to independently expect those changes to be driven *only* by naked short-selling. From this perspective, we note that we can *a priori* expect naked short sales to fall significantly during the SEC ban on naked short selling of the stocks of 19 publicly traded financial institutions from July 21 to August 12, 2008.[30] During this ban period, the SEC order required that "no person may effect a short sale in these securities using the means or instrumentalities of interstate commerce unless such person or its agent has borrowed or arranged to borrow the security or otherwise has the security available to borrow in its inventory prior to effecting such short sale."[31] Accordingly, we employ event study methodology to investigate the variation in FTDs around the SEC ban period from July 21 to August 12, 2008. We obtain data from CRSP for 17 of the 19 affected securities.[32] We construct a matched sample as follows. We start from the universe of firms listed on CRSP as of January 1, 2008. For each one of our target securities, we identify common equity of the firm sharing the same 4-digit SIC code with the closest market capitalization to that of our targets (as of January 1, 2008). Then, for each of the 34 securities (the 17 affected securities and the 17 unique matches) and for each day in the interval January 1 to August 12, 2008, we compute the *Outstanding Naked Short Ratio* (*ONSR*). We then compute *Mean ONSR* for both event and control samples over a pre-ban period (January 1 to July 20, 2008), for each week in the ban period (July 21 to August 12, 2008), and for the three-week period following the ban (August 13 to September 2, 2008), finishing well before the tumultuous period starting in the second week of September 2008. We report these results in Table 2, Panel B.

Importantly, for the sample of securities that are affected by the ban, we find an extremely significant and monotonic *reduction* in *Mean ONSR* of more than 40% over the first week of the ban, more than 93% by the second week of the ban, and more than 96% by the third week of the ban. In contrast, *Mean ONSR* increased over the same period for control firms.[33] And, as soon as the naked shorting ban ends, *Mean ONSR* again increases monotonically and very significantly to several multiples of its end-of-ban value. In fact, in the second and the third

[30] The stocks were *BNP Paribas Securities Corp., Bank of America Corporation, Barclays, Citigroup Inc., Credit Suisse Group, Daiwa Securities Group Inc., Deutsche Bank Group AG, Allianz SE, Goldman, Sachs Group Inc, Royal Bank ADS, HSBC Holdings PLC ADS, J. P. Morgan Chase & Co., Lehman Brothers Holdings Inc., Merrill Lynch & Co., Inc., Mizuho Financial Group, Inc., Morgan Stanley, UBS AG, Freddie Mac,* and *Fannie Mae*.

[31] See Security and Exchange Commission Release No. 58166, July 15th, 2008.

[32] BNP Paribas Securities Corp. and Daiwa Securities Group Inc. trade over the counter, and the CRSP database does not include over the counter securities.

[33] While we do not formally investigate this increase, it would appear reasonable for both covered and naked short selling to increase over July and August 2008 for financial firms, due to news of deteriorating financial performance and liquidity. Arguably, with a ban in a selected subset of these securities, there can potentially an abnormal increase in naked short-selling in securities not affected by the ban.

weeks of the ban period, *Mean ONSR* is statistically indistinguishable from zero for the sample of securities that are affected by the ban. We believe that *Mean ONSR* took a few days to reduce to virtually zero in the ban period because it is derived from a measure of outstanding rather than new FTDs, and some time is required for the old outstanding fails to clear (Boni, 2006). The difference between *Mean ONSR* for the event and control firms is positive and significant prior to the ban, negative and significant during the ban, and again positive and significant after the ban is lifted. Assuming that the SEC ban was effective in curtailing naked shorting, our results clearly indicate that the vast majority of FTDs (> 95%) originate from naked short selling, and at the very least, FTDs provide an excellent basis for a proxy for naked short-selling.[34]

4.2 Pricing Error

In order to examine the effect of naked short selling on pricing efficiency, we construct, for each sample security, a daily estimate of the information-efficient "random-walk" price in the spirit of Hasbrouck (1993), and regard this as our estimate of the "true" or "fundamental" price of the security. The "pricing error" on the day is then the difference between the observed price that day and this "true" or "fundamental" price. The information-efficient "random-walk" price of a security is a latent stochastic variable; hence, we employ a Kalman-filter methodology as in Hamilton (1985) to estimate it. The procedure relies on establishing two equations: one to dictate the evolution of the latent variable (*transition equation*) and the other to relate the observed and the latent variables (*measurement equation*). Next, the *Expectation Maximization* (EM) algorithm[35] is employed to estimate the latent variable based on data relating to the observed variable. Hamilton (1985) employs such an approach to estimate expected quarterly inflation, the latent variable, based on observed actual inflation. In the same way, we utilize the observed daily stock prices to infer the unobserved "true" or "fundamental price", and hence the pricing error. [36] The estimation model is outlined below.

In accordance with Hasbrouck (1993), we assume that the logarithm of the stock's underlying or information-efficient value, $F(t)$, follows a random walk with a drift, μ, and a white noise innovation, $\varepsilon(t)$, with mean zero and variance σ_{ε}^{2}.

[34] The Office for Economic Analysis (OEA) has similarly analyzed the number of FTDs around the same event and reported results consistent with our findings. See OEA Memoranda "Impact of Recent SHO Rule Changes on Fails to Deliver" (November 26, 2008), "Impact of Recent SHO Rule Changes on Fails to Deliver" (March 20, 2009) and "Impact of Recent SHO Rule Changes on Fails to Deliver" (April 16, 2009).
[35] The EM algorithm is an efficient iterative procedure, put forth by Dempster, Laird and Rubin (1977), to compute the Maximum Likelihood (ML) estimate in the presence of hidden data.
[36] For a similar application of this algorithm, see Dong, et al. (2008).

$$F(t) = \mu + F(t-1) + \varepsilon(t), \quad \varepsilon \sim N(0, \sigma_\varepsilon^2)$$

The pricing error *Y(t)* is assumed to follow a mean-reverting process around zero. α is the rate of mean-reversion in pricing errors, i.e., the proportion of pricing error that is corrected over one time period. α is expected to range between 0 and 1, with pricing errors corrected fully when α is equal to one and not corrected at all when α is equal to zero.

$$\Delta Y(t) = -\alpha Y(t-1) + \phi(t), \quad \phi \sim N(0, \sigma_\phi^2)$$

$S(t)$ is the observed log of stock price and is defined as the sum of the fundamental price and pricing error. $S(t) = F(t) + Y(t)$

Combining these equations, we get:

$$S(t) = \mu + (1-\alpha)S(t-1) + \alpha F(t-1) + \theta(t), \quad \theta(t) = \phi(t) + \varepsilon(t)$$

The above equations are written in state-space form as follows:

Measurement Equation:

$$[S(t)] = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} S(t) \\ F(t) \\ \varepsilon(t) \end{bmatrix}$$

Transition Equation:

$$\begin{bmatrix} S(t) \\ F(t) \\ \varepsilon(t) \end{bmatrix} = \begin{bmatrix} (1-\alpha) & \alpha & \mu \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} S(t-1) \\ F(t-1) \\ 1 \end{bmatrix} + \begin{bmatrix} \theta(t) \\ \varepsilon(t) \\ 0 \end{bmatrix}$$

From this state-space representation, all four unknown parameters α, μ, σ_ε^2 and σ_θ^2 can be estimated from observed market prices with the Kalman-filter smooth-estimation procedure.[37]

We accordingly calculate daily estimates of the *Pricing Error* for each day and each sample security, using daily returns data from the CRSP database. We also calculate the other pricing-error related variables from the *Pricing Error* as defined in Table 1.

5. Empirical Results

5.1 Data and Samples

For 4,672 NYSE, AMEX, NASDAQ or ARCA securities the number of outstanding FTDs exceeds 10,000 shares during at least one day over our 2007 sample period, and those

[37] In unreported results, we test the accuracy of our algorithm by simulating multiple datasets with varying mean-reversion parameters. We then apply our algorithm to estimate the fundamental price. We find that the algorithm produces unbiased estimates of the fundamental price.

constitute our sample of what we hereafter refer to as "securities with naked shorts." That includes about 91% of NYSE-listed securities, 61% of AMEX securities, 71% of NASDAQ securities, and 60% of ARCA securities.

Our naked shorting measures are based on SEC FOIA data as described in Section 4.1 and are available from late March 2004 to end-2008. Our market quality measures are based on NYSE TAQ data. To control for covered shorting, we use short interest data purchased from www.shortsqueeze.com and available only after December 2006, and TAQ short sales data released after Regulation SHO and not available after June, 2007, and furthermore, available only for securities whose primary exchange is the NYSE. Accordingly, we confine ourselves hereafter to NYSE-listed securities, and our inferences relating to the impact of naked shorting on pricing efficiency and liquidity are first based on the 6-month time period January to June 2007, where we are able to fully control for covered short sales. We obtain the number of shares outstanding from CRSP and institutional shareholding data from CDA Spectrum.

Since the computation of market quality measures is very resource intensive, we select a random subset of securities for in-depth analysis based only on common shares of US-listed securities (CRSP share codes 10 and 11) for which we have complete data across the various databases we use and which are listed on the NYSE. We first focus on securities which are listed on the NYSE during the entire interval January 1, 2006 and July 1, 2007.[38] We further require that the number of shares outstanding over the period January 1, 2006 to July 1, 2007 does not vary by more than 10% of its original value, to further eliminate the potential for confounding effects on market quality due to share issuance or repurchases and to eliminate the possibility that FTDs that are unrelated to naked short selling might be occurring around share issuances (similarly to what documented by Edwards and Hanley, 2008, around IPOs).[39] We rank each security by the average *Outstanding Naked Short Ratio* (*ONSR*) computed over the interval of interest and allocate securities to quintiles 1 (lowest *Mean ONSR*) through 5 (highest *Mean ONSR*). We similarly rank each security by the average *Outstanding Covered Short Ratio* (*OCSR*) over the interval and allocate securities to quintiles 1 (lowest *Mean OCSR*) through 5 (highest *Mean OCSR*). By proceeding this way, we have all securities sorted into 25 groups. We then pick 15 securities, at random, from each one of those groups. Accordingly, our first sample covers the first half of 2007 and contains 375 securities. We call this the '2007 Overall

[38] We restrict our sample to securities that have been trading for at least one year prior to our period of interest for two reasons. One, our sample does not contain recent IPOs, as Edwards ad Hanley (2008) document unusual volumes of FTDs around IPOs. Two, having one year of trading data prior to the time period we investigate allows us to use the algorithm described in section 4.2 to compute pricing errors.

[39] In unreported analysis, we re-sample without this last constraint and find that our results are robust.

Sample'.[40] In order to provide insight into the impact of naked shorting when such naked shorting is particularly heavy, we also focus on the subset of securities in the 5th *ONSR* quintile. Accordingly, we analyze a subset of the 2007 Overall Sample containing the 75 securities from the 5th *ONSR* quintile. We call this the '2007 Most Naked-Shorted Sample'.

Data on covered shorting is not available for any period not covered by our '2007 Overall Sample' above. Hence, in order to investigate naked short-selling during the 2008 financial crisis period, we construct *single-sorted* samples based only on naked shorting. Our 2008 'financial crisis' sample covers the period January to June 2008 and is labeled as the '2008 Most Naked Shorted Sample'. It is constructed as follows: we sample our population (NYSE common stock traded over the entire time interval) by sorting only on *ONSR*; we rank each security by the average *ONSR* over the interval and allocate those with any FTDs to deciles 1 (lowest average *ONSR*) through 10 (highest average *ONSR*). The securities in decile 10 constitute the 2008 sample. We restrict the period to be up to June 2008 so as to stop well before the extraordinary periods of the naked short-selling ban, with the ban period analyzed separately. For comparability, we also construct an analogous '2007 Single-Sorted Most Naked Short Sample',[41] and we also construct a 'pre-SHO' benchmark sample based on the period April to October 2004, and label this as the '2004 Most Naked Shorted Sample'. We choose a pre-Regulation-SHO sample as benchmark since this part of the paper focuses on manipulative naked shorting, and Regulation-SHO was specifically intended to curb manipulative naked shorting. If Regulation SHO has been effective, we would expect that the impact of manipulative naked shorting would gradually have declined after Regulation SHO to new (significantly lower) levels by 2007, and not increased in 2008, leaving only the potentially beneficial of effects of naked shorting on liquidity and pricing efficiency post-SHO.

5.2 Preliminary Descriptive Analysis

Table 3A reports descriptive statistics on the distribution of *Outstanding Naked Short Ratio* and *New Naked Short Ratio* for our various samples and periods. In addition, given regulatory and media concern about naked shorting of financial stocks in 2008, the table separately reports descriptive statistics for the subset of financial stocks (SIC codes 60 and 61).

Pre-SHO, over the second half of 2004, across the universe of NYSE-listed stocks, outstanding naked shorted shares are, on average, about 0.09% of overall shares outstanding,

[40] We thank an anonymous referee for suggesting a double-sort on covered and naked short sales.
[41] We explicitly add 'Single-sorted" in the name since our general analyses of pricing efficiency and liquidity are based on a 2007 sample that is constructed by double-sorting on both naked and covered shorting.

and the 99th percentile of the distribution is 1.07%; with new naked short sales accounting for about 3.12% of overall trading volume but increasing to as high as 41.22% for the 99th percentile. For our 2007 sample period, across the universe of NYSE-listed stocks, outstanding naked shorted shares are significantly lower: about 0.06% on average of overall shares outstanding with the 99th percentile of the distribution being 0.75%; new naked short sales accounting for 1.24% of overall trading volume, and increase only as high as 11.58% for the 99th percentile. The decline in 2007, compared to 2004, is consistent with the introduction of Regulation SHO in January 2005.

Equally predictably, naked short selling did intensify during the financial crisis of 2008. Both outstanding and new naked shorts are higher in the first half of 2008 (*Mean ONSR* 0.11% in the first half of 2008,), but decline further in the latter half of 2008 (*Mean ONSR* 0.08%). This latter decrease is not surprising given the increased restrictions on both covered and naked shorting over that period. Overall averages of naked short selling measures for financial stocks, those most hit by the 2008 financial crisis, are particularly high during the first half of 2008 (*Mean ONSR* 0.28%), compared to 2004 and 2007 (*Mean ONSR* 0.07% in both periods), and decline over the second half of the year (*Mean ONSR* 0.17%), again presumably due to short selling restrictions.

Table 3B presents descriptive statistics that shed light on the nature of securities that have relatively higher levels of naked shorting within our '2007 Overall Sample'. We present the averages and the standard deviations of firm-size, turnover, bid-offer spread, volatility and level of institutional ownership for the overall sample, for the 1st quintile (lowest naked short selling intensity) and for the 5th quintile (highest naked short selling intensity). We further conduct a test for the differences in means between the 1st and 5th quintiles, and present related t-values. The table shows that naked short-selling is *significantly* greater for relatively smaller firms, for less liquid firms (with lower turnover and higher spreads), for more volatile firms, and for firms with lower institutional ownership. Specifically, *Mean Institutional Ownership* declines from approximately 75% in the 1st quintile to 49% in the 5th, and *Mean Market Value* declines from USD 11.4 billion in the 1st quintile to USD 2.3 billion in the 5th quintile. As institutional shareholding and firm size have often been used as proxies for the ease of shorting, for example by Geczy, Musto and Reed (2002), our results are consistent with naked short selling increasing when short selling becomes more difficult or expensive.

5.4 Naked Short-Selling and Market Quality

In this section, we test Hypotheses *H1* and *H2* by investigating in two ways the relationship between naked short-selling and measures of pricing efficiency and liquidity. First, we test formally for causality while controlling for endogenous interrelationships using vector autoregressive (VAR) modeling frameworks. Second, we examine the effect on market quality of the one-time SEC ban on naked short-selling in July/August 2008.

5.4.1. Causality and Endogenous Relationships

5.4.1.1 Modeling Framework

We test for causality while controlling for endogenous interrelationships using three vector autoregressive (VAR) models, with additional exogenous variable(s) added as controls. The system of equations underlying each of these models is formally specified in Table 4.

In VAR Model 1, our VAR variables are changes in *Outstanding Naked Short Ratio*, *Covered Short Ratio*, *Pricing Error*, *Volatility*, *Spread* and *Order Imbalance*. In addition, we add two exogenous variables. In the pricing error equation, we add, as a predictor, an interaction between lagged changes in *Outstanding Naked Short Ratio* and a binary variable set equal to one when lagged pricing error is positive. Accordingly, we are able to separately estimate the impact of naked short selling on pricing error when the pricing error is positive in contrast to when the pricing error is negative. We add one more predictor to the equation in which the change in *Outstanding Naked Short Ratio* is the response variable: a binary variable set equal to one when order imbalance is positive and zero otherwise. This allows us to check whether positive order imbalances lead to a higher incidence of naked short selling.

In VAR Model 2, we replace *Pricing Error* by *Pricing Error Volatility,* or effectively the absolute value of the *Pricing Error*. Hence, in this model, our variables are changes in *Outstanding Naked Short Ratio*, *Covered Short Ratio*, *Pricing Error Volatility*, *Volatility*, *Spread* and *Order Imbalance*. As in Model 1, we add one more predictor to the equation in which the change in *Outstanding Naked Short Ratio* is the response variable: a binary variable set equal to one when lagged order imbalance is positive and zero otherwise.

In VAR Model 3, we replace *Pricing Error* by *Price*. Hence, in this Model 3, our VAR variables are changes in *Outstanding Naked Short Ratio*, *Covered Short Ratio*, *Price*, *Volatility*, *Spread* and *Order Imbalance*. We retain the binary variable set equal to one when order imbalances are positive, as in Models 1 and 2.

We estimate VAR Models 1, 2 and 3 separately for each security. The results we report in Table 4 are based on estimating the models by first standardizing all variables by subtracting the security-specific mean and dividing by the security-specific standard deviation, and then

winsorizing at three standard deviations from the mean.[42] Using the Box-Jenkins procedure, we determine that, for all models, it is most appropriate to use a VAR of order one. In order to draw inferences about the true population parameters, we employ a Fama and MacBeth (1973) procedure.

5.4.1.2 Main Results

We estimate VAR Models 1, 2 and 3 for both our '2007 Overall Sample' and our '2007 Most Naked-Shorted Sample', the two samples in which we can control for covered shorting. We find that the sign and the significance of the various inter-relationships involved are economically reasonable for both samples. For compactness, ease of interpretation, and to preserve the focus on the specific equations of interest to us, we report in Table 4 only those relationships that are relevant to the issues addressed in the paper. In particular, we report, for all three models and for both samples, the effects of both covered and naked short-selling, i.e. how covered and naked short-selling impact each of our explanatory variables after controlling for endogenous interactions. We document several results of considerable economic significance in Table 4 Panels A and B.

First, interestingly, we do *not* find statistically significant evidence of a causal relationship from naked shorting to falling prices or negative returns, neither in the overall sample nor in the sample of the most-naked-shorted securities. On the other hand, we do find that, for the overall sample, covered short selling is followed by significantly lower stock prices in the following period.

Second, there is strong and significant positive feedback between covered shorting and naked shorting. Lagged changes in *OCSR* are positively related to changes in *ONSR* and vice-versa; i.e., an increase in covered shorting is likely to lead to an increase in naked shorting, and vice-versa.

Third, irrespective of the measure used as proxy for pricing efficiency or liquidity, naked short-selling has a significantly beneficial effect on pricing efficiency and liquidity, strongly supporting Hypotheses *H1* and *H2*. In particular, the following conclusions are significant at least at the 5% level of significance in every modeling specification and across both our '2007 Overall Sample' and our '2007 Most Naked-Shorted Sample'.

[42] For robustness, we estimate all three models without standardizing variables, but we run into problems with the convergence of algorithms, likely driven by the extreme differences in magnitude across our variables. For those securities for which we manage to obtain results without standardizing variables, our results are qualitatively similar to those reported.

1. When pricing errors are positive, naked short-selling reduces pricing errors, consistent with an increase in pricing efficiency and with naked short-sellers functioning as value arbitrageurs.
2. When pricing errors are negative, naked short selling increases pricing errors, i.e. drives them towards zero, and hence reduces the magnitude of the pricing errors: again the implication is that naked short selling, on average, improves pricing efficiency.[43]
3. Naked short-selling significantly reduces the volatility of pricing errors, which is also consistent with an increase in pricing efficiency.
4. An increase in naked shorting reduces stock return volatility, again consistent with improved pricing efficiency.
5. An increase in naked shorting reduces spreads, thereby improving liquidity.
6. An increase in naked shorting reduces order-imbalances, again indicating improvement in liquidity.

Finally, apart from the impact on price-levels mentioned above, the direction and significance of all results relating to the impact of naked short-selling are qualitatively similar to the direction and significance of all results relating to the impact of covered short-selling.[44] We discuss this in greater detail in the next section.

5.4.1.3 Naked vs. Covered Short-Selling

Overall, when qualitatively comparing the impact of naked and covered short selling, the direction and significance of our results are qualitatively similar, indicating that the two practices have very similar impacts on markets. That said, we note that the coefficients measuring the impact on market quality in Table 4 Panels A and B are, in most cases, much larger in magnitude for covered short selling than for naked short selling. This is arguably what we should expect given that the vector autoregressive models we employ are based on standardized variables, and the average standard deviation of covered shorting is much greater than that of naked shorting. Hence, a one standard deviation change in covered shorting clearly results in a much greater change in the level of overall short-selling relative to a one standard deviation change in naked shorting, and a greater level of overall short-selling should arguably have a greater beneficial impact on market quality. In this context, we next examine the

[43] We believe this reduction in the magnitude of negative pricing errors is driven by naked short sellers covering their positions and by an overall decrease in the volatility of pricing errors due to more efficient price discovery.
[44] A minor difference is that the impact of covered short selling on spreads, while always negative, is not significant in three of the six sets of results we present, while the impact of naked short selling is consistently significantly negative at the 5% level in all sets of results.

economic significance of the impact of naked and covered shorting by estimating the market-quality impact of a given *amount* of naked and covered shorting in terms of the incremental number of shares sold short (or proportion sold short relative to the total number of outstanding shares).The results are reported in Table 4 Panels C and D for the impact of naked and covered shorting respectively.

Based on the '2007 Overall Sample' ('2007 Most Naked Shorted Sample'), we find that an increase in naked shorting corresponding to 10 basis points of the total number of outstanding shares leads to approximately a 3% (6%) reduction in spreads, a 8% (10%) reduction in order imbalances, a 29% (24%) reduction in the magnitude of positive pricing errors, a 37% (47%) decline in pricing error volatility and a 5% (9%) reduction in stock price volatility.

In comparison, based on the '2007 Overall Sample' ('2007 Most Naked Shorted Sample'), we find that an increase in covered shorting corresponding to the same 10 basis points of the total number of outstanding shares leads only to approximately a 0.4% (0.1%) reduction in spreads, a 1.5% (0.8%) reduction in order imbalances, a 6% (2%) reduction in the magnitude of positive pricing errors, a 7% (4%) decline in pricing error volatility and a 0.9% (0.7%) reduction in stock price volatility.

Clearly, even though naked and covered shorting are indistinguishable at the time of the trade, for a given amount of short-selling, say 10 basis points of the number of outstanding shares of the firm, the beneficial impact on pricing efficiency and liquidity variables is an order of magnitude greater when that 10 basis point equivalent of shorting is done by naked short-sellers than when it is done by covered short-sellers. This is consistent with the conjecture that naked value arbitrageurs or naked liquidity suppliers initiate their positions (and then strategically fail) at times when pricing errors and/or order imbalances are high, since their trading will then trigger a relatively larger reversion back towards zero pricing errors or zero order imbalances. This in turn could well arise rationally because it makes economic sense for naked short-sellers to become active only when covered shorting has become unattractive due to high borrowing costs, and when covered shorting becomes costly, (positive) pricing errors or order imbalances will tend to drift higher than usual before it becomes profitable for covered or naked short-sellers to engage in the value arbitrage or liquidity supply strategies that can push pricing errors or order imbalances to zero. To test this conjecture, we calculate the average pricing error and the average order-imbalance on the day prior to the day on which naked (or covered) shorting is more than one standard deviation away from its average level. Consistent with the above conjecture, we find that the lagged average pricing error (order-imbalance) conditional on the naked short-selling being more than one standard deviation higher than its

average, is 1.47 times (4.83 times) larger than the lagged average pricing error (order-imbalance) conditional on the covered short-selling being more than one standard deviation higher than its average. However, firm conclusions in this regard need richer intra-day data on covered and naked shorting, and we leave further examination of and conclusions on this issue to future research with access to data that is rich enough to enable competing possibilities to be comprehensively tested.

In view of the serious concerns of fairness, possible settlement related disruptions, and the potential for manipulation arguably associated with naked shorting, regulators have good reasons to monitor the impact of naked short selling more closely. However, given that both naked and covered shorting contribute significantly to liquidity and price discovery, and, as we see later in Section 5.5, naked shorting has not had any adverse effects even in the unusual financial crisis period, it is debatable whether we should view naked and covered short-sellers as polar opposites - the "bad guys" and the "good guys" - and have extremely stringent regulation for naked short-sellers.

5.4.1.4 Bottom-line

Irrespective, in conclusion, the bottom-line is that the market-quality impact of both covered and naked shorting is economically significant and qualitatively similar, and in the direction of being clearly beneficial for market quality. Our results in this sub-section, quite unequivocally, also provide strong support to Hypotheses *H1* and *H2*. Naked short-sellers appear to have a considerably positive effect on market quality, first by enhancing pricing efficiency through correction of security overvaluation and reduction of volatility, and second by providing and improving liquidity through reduction of order-imbalances and spreads.

5.4.2 The Market Quality Impact of Restrictions on Naked Short Selling

In this sub-section, we make use of the SEC ban on naked short sales of select financial firms discussed in section 4.1 to investigate the impact of naked short selling restrictions on stock price returns and on various market quality metrics. Given our previous results indicating that naked short selling has positive effects on market quality, we expect deterioration in market quality in the presence of a ban on naked short selling.

For each of the 34 securities (the 17 affected securities and the 17 unique matches identified as in section 4.1) and for each day in the interval January 1, 2008 to September 9, 2008, we compute the *Outstanding Naked Short Ratio*, *Pricing Error Volatility*, *Spread* and *Volume*, as defined in Table 1. We also compute daily *Close-to-Close Returns.* We average each

of these 5 variables to obtain a daily mean for the affected sample (as the average of the daily metrics for the 17 affected securities) and a daily mean for the control sample. We then run 5 separate OLS regressions; in each regression, the response variable is the affected sample mean of either *Outstanding Naked Short Ratio*, *Pricing Error Volatility*, *Volume*, *Spread* or *Close-to-Close Return*, while the explanatory variables include an intercept, the control sample mean of the variable of interest and a binary variable, *Event*, set equal to 1 on all days during which restrictions were in place and equal to 0 on all other days. Our results, presented in Table 5, indicate that the number of naked short shares outstanding declines during the ban, as expected, consistent with the analysis discussed in section 4.1. Yet, we observe significantly lower trading volumes and significantly higher spreads, both significant at the 1% level. Both results are in line with our expectations, indicating that a ban on naked short selling adversely impacts the stock's liquidity.[45] We also document higher pricing error volatility, indicating that restrictions on naked short selling hamper the price discovery process, and thereby adversely affects price efficiency. Our results include a negative, albeit not statistically significant, coefficient on the *Event* binary variable in the *Close-to-Close Return* regression, indicating also that the ban on naked short selling failed to slow the price decline of the affected securities. Overall, the results in this sub-section also provide further strong support to Hypotheses *H1* and *H2*.

5.5 Manipulative Naked Short Selling and the 2008 Financial Crisis

Bear Stearns failed because it went bankrupt. However, the pace of the collapse of the stock price was clearly accelerated by the enormous naked short-sale activity. -- Robert Shapiro, former Under Secretary of Commerce.

Like all the great merchants of the bubble economy, Bear and Lehman were leveraged to the hilt and vulnerable to collapse. Many of the methods that outsiders used to knock them over were mostly legal: credit markers were pulled, rumors were spread through the media, and legitimate short-sellers pressured the stock price down. But when Bear and Lehman made their final leap off the cliff of history, both undeniably got a push — especially in the form of a flat-out counterfeiting scheme called naked short-selling. -- Rolling Stone Magazine.

Fails to deliver in the US equity market have exacerbated the sharp declines in share prices of financials. Although the SEC is clearing up the mess caused by naked short-selling, more drastic measures might be needed to restore confidence. -- Helen Avery, Euromoney.

In the wake of the financial crisis of 2008, the media has consistently pointed an accusing finger at naked short-sellers, blaming them for having caused, or at least accelerated, sharp declines in stock prices, particularly of financial firms. Naked short-sellers have often

[45] Our results are consistent with contemporaneous work of Kolasinksi, et al. (2009). While their main focus is on the different impact of restrictions vs. bans on short selling, they analyze the same event (interpreting it as a temporary short selling restriction) and find that the ban negatively impacted liquidity of the affected securities.

been thought of as villains who deliberately undertake "bear raids" to drive prices down, create conditions that trigger credit downgrades, and profit from the downward price spiral and the eventual collapse of the financial institutions involved. In this context, we test Hypothesis *H3* by specifically examining two questions. First, we analyze whether significant naked short-selling *preceded* (and hence potentially triggered) the price crashes associated with the four major casualties of the 2008 financial crisis, i.e., Bear Stearns, Lehman, AIG and Merrill, and similarly *preceded* credit downgrades and large price decline episodes in other financial firms; or did significant naked short selling take place *after* these price crashes and *in response to* negative public news. Second, while we know from Section 5.2 that naked short-selling increased somewhat over the 2008 financial crisis period, particularly for financial firms, we examine whether potentially *manipulative* naked short-selling also increased over the 2008 financial crisis period, relative to the pre-crisis period or the pre-SHO period.

5.5.1. Bear Stearns

The first large financial casualty of the 2008 financial crisis was Bear Stearns, the fifth largest investment banking firm in the nation at the time of its demise. Figure 1 provides a time-line about the crisis. Outstanding suspicions about liquidity problems at Bear Stearns started being reported in the media from March 10th onwards, and also reports that the company's management was repeatedly denying rumors about such problems. The first major price-crash took place on Friday, March 14th, when the price per share dropped from $57 to $30 after a 9 a.m. announcement that Bear would receive an unprecedented loan from the Federal Reserve System.[46] Two days later, on Sunday March 16th, JP Morgan Chase proposed buying Bear Stearns for $2 per share.[47] When markets opened on March 17th, a second major price crash materialized, and the price dropped to a close of $4.81.

We analyze naked short selling on the days preceding and immediately following the dramatic loss of market value that led to the demise of the firm. We compute *Outstanding Naked Short Ratio* for Bear Stearns on each trading day from January 1 to March 28, 2008. We also compute for the same period, as a control variable, an equal weighted average *Outstanding Naked Short Ratio* for four other financial institutions with the same primary SIC code as Bear Stearns, and with the closest market value as of the end of the fiscal year 2007.[48] We calculate

[46] "Fed Races to Rescue Bear Stearns in Bid to Steady Financial System Storied Firm", *The Wall Street Journal* (March 15, 2008).
[47] "JP Morgan Chase to Acquire Bear Stearns", *J.P. Morgan News Release* (March 16,2008).
[48] The four control stocks are: *Raymond James Financial Corporation, Ameritrade Holdings Corporation, Ameriprise Financial Inc.* and *Charles Schwab Corporation*.

the difference and test for its statistical significance each day.[49] Our results are presented in Table 6A.

Even though negative media attention had already started on March 10th, Table 6 Panel A and Figure 1 show that, up to March 11th, abnormal naked short selling (i.e. our difference metric above) was statistically insignificant or significantly negative. While naked short selling did increase significantly on March 12th and 13th, the increase was still relatively tiny from an economic perspective since it was tiny relative to the total number of shares outstanding, tiny relative to the typical overall short volume, and tiny relative to what took place on or after March 14th: the outstanding naked shorted shares were only 1.06% of shares outstanding until market close on March 13th. Naked shorting increased to 2.24% (t-stat. 20.7) on March 14th, but increased massively only on March 17th, reaching 12.18% (t-stat. 137.3). Importantly, given that the Fed announcement was at the start of trading on March 14th, even the (relatively small) increase in naked shorting on March 14th was clearly *subsequent to* the public release of tangibly negative news in the form of the announcement and the consequent immediate precipitous price-drop. By the time naked short selling really spiked on March 17th, the company was already in an open distress sale. Yet, the company's management appeared to happily reinforce rumors that the price collapse happened because of naked-shorting.[50] However, the evidence clearly shows that abnormal incidence of naked short selling did not precede the price decline but followed it; and the decline in stock price was triggered by other well-identified negative economic events.

Even in this extreme scenario, often cited as a glaring example of the negative role of naked short sellers in financial markets, we fail to find any evidence of naked short sellers engaging in manipulative "bear-raid" type activity. Rather, they appeared to be following strategies *in response to* public information. The decline in stock price appears motivated by unrelated and clearly identifiable factors; and consistent with our previous results, naked short sellers appear to be facilitating price discovery, rather than increasing pricing errors. Overall, we find no support for Hypothesis *H3*.

5.5.2 Lehman.

The second notable casualty of the financial crisis of 2008 was Lehman. To investigate the link between naked short selling and the stock price crash, we employ the same method we used for Bear Stearns. We analyze naked short selling on the days surrounding the dramatic loss

[49] We construct a t-statistic for the difference in means as follows: we compute the mean and standard error of this difference over the time interval January 1 to February 15, 2008; we subtract this historic mean from the daily difference and then divide the resulting number by the historic estimate of the standard deviation of the difference.
[50] "Short Sellers Aren't Jackals, They're Bears, Fleckenstein Says", *Bloomberg.com* (October 29, 2008).

of market value of the firm on September 9, 2008. We identify four other financial institutions (having the same primary SIC code as Lehman) with the closest market value as of the end of the fiscal year 2007. We then compute daily an equal weighted average *Outstanding Naked Short Ratio* for those benchmark institutions and subtract it from the *Outstanding Naked Short Ratio* of Lehman, and test for the statistical significance of the difference.[51] Our results are presented in Table 6B. In Figure 2A we present a graphical summary of the relationship between *Outstanding Naked Short Ratio* and stock price for the period spanning January 2008 to Lehman's bankruptcy on September 15, 2008. We offer a closer look at the period surrounding Lehman's bankruptcy in Figure 2B.

Aside from a spike in naked short selling on August 25th, our results indicate abnormally low naked short selling in the days leading to September 9th, with abnormal *Outstanding Naked Short Ratio* at only around 0.01%. While the intensity of naked short selling increases on September 9th, abnormal *Outstanding Naked Short Ratio* was still less than 0.2%. It was only *after* September 10th, well after widespread coverage of negative news about Lehman and the associated price crash, that abnormal *Outstanding Naked Short Ratio* increased dramatically, breaching 3% on September 11th and 8% on September 17th.

Our *Outstanding Naked Short Ratio* plots reveal that naked short selling of Lehman's stock intensified after September 9, 2008, just prior to the firm's bankruptcy. But we should note that, by September 9th, the firm's stock price had already lost approximately 87% of its value as of the beginning of the year. The biggest single-day price drop, about 45%, occurred on September 9th, following news that talks with the *Korea Development Bank*, previously rumored to be considering a 25% stake in Lehman, had failed. While *Outstanding Naked Short Ratio* increases on that day, outstanding naked short shares still represent less than 0.16% of shares outstanding. On September 11th, as shareholders rejected a rescue plan by management, the stock price fell by an additional 42% and *Outstanding Naked Short Ratio* further increased to 3.29%. Over the following days, talks of a possible acquisition by Bank of America and Barclays failed, triggering further declines in stock price and an increase in *Outstanding Naked Short Ratio* to 4.86%; and on September 15th, Lehman announced its bankruptcy.[52]

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[51] We construct a t-statistic for difference in means as follows: we compute the mean and standard error of this difference over a period starting on January 1st, 2008 and ending 20 trading days prior to September 9th, 2008; we subtract this historic mean from the daily difference and then divide the resulting number by the historic estimate of the standard deviation of the difference.

[52] A recent article "Naked Short Sales Hint Fraud in Bringing Down Lehman", *Bloomberg* (March 19, 2009), notes that a rumor about Barclays Plc buying Lehman for a 25% discount to market value was responsible for a 11% fall in Lehman's stock price on June 30th. We find that *Outstanding Naked Short Ratio* spikes to 6 bps (from 0.06 bps) on June 27. The irregular spike in *Outstanding Naked Short Ratio* on the day preceding the rumor is suspicious, and

In sum, our analysis shows that, first of all, the incidence of naked short selling, even at its peak, was too low to justify the decline in price that took place. Second, our analysis indicates that naked short selling intensified *not before but after* the stock had lost most of its value and in reaction to negative news about the company, which is inconsistent with stock price manipulation. Again, we find no support for Hypothesis *H3*.

5.5.3 Merrill

We analyze the relationship between *Outstanding Naked Short Ratio* and the stock price for Merrill in Figure 4. We note that the stock price decline of Merrill Lynch was fairly gradual through the year and was not accompanied by any significant increase in the intensity of naked short selling. The *Outstanding Naked Short Ratio* reached its highest value on October 14, 2008, at 0.18%, and that is economically minuscule. Given that naked shorting remained so extremely small all through the period, we do not engage in any formal statistical testing. There is clearly no evidence of naked-shorting linked manipulation, or any support for Hypothesis *H3*.

5.5.4 AIG

We analyze the relationship between *Outstanding Naked Short Ratio* and the stock price for AIG in Figure 5. The company lost about 40% of its market value by the end of August 2008, amid piling losses on its CDS portfolios. The largest single-day price drop was observed on September 15, 2008. On that day, Standard & Poor's cut AIG's credit rating due to "the combination of reduced flexibility in meeting additional collateral needs and concerns over increasing residential mortgage-related losses." Following the announcement, the company's stock price dropped by about 60%. Yet, the intensity of naked short selling remained low, with *Outstanding Naked Short Ratio* reaching its year high at 0.32% on September 29, 2008. Once again, given that naked shorting remains so small all through the period, we do not engage in any formal statistical testing. There is again clearly no evidence of naked-shorting linked manipulation, or any support for Hypothesis *H3*.

5.5.5. Naked Short Selling and Credit Rating Downgrades

Naked short-sellers have been alleged to engage in (manipulative) naked short selling by creating conditions that trigger credit downgrades specifically to profit not just from the downward price spiral but also from linked credit default swap positions on the associated stock.

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does hint towards a manipulative trading strategy, but is still relatively miniscule, and certainly not enough to bring down Lehman.

In this context, we examine naked short selling around credit rating downgrades for a sample of the most affected financial securities. As our sample of financial firms, we use the 17 securities (as in section 4.1) for which the SEC had issued an emergency order temporarily banning naked short selling in mid-2008.[53] To that list, we add Bear Stearns that had not been included in the SEC emergency order temporarily banning naked short selling, but was clearly affected by the crisis. Also, we exclude Lehman, as its credit rating downgrade was soon followed by a bankruptcy. For this sample of companies, we identify 21 long term issuer downgrades by S&P over the year 2008.

For each downgrade, we compute *Outstanding Naked Short Ratio (ONSR)* for the security of interest for 40 trading days preceding and following the announcement. We then compute average *ONSR* for each day in the event day calendar, where day 0 is the day of the downgrade. We compute abnormal daily *ONSR* by subtracting the average *ONSR* computed over 100 trading days ending 20 days prior to the credit rating downgrade. We report results for various event windows. We compute *Cumulative Abnormal ONSR* as the sum of daily *ONSR* for all days in the event window. The *Mean Cumulative Abnormal ONSR* is the cross-sectional average of the security-specific *Cumulative Abnormal ONSR*. The *t*-statistic for significance of the mean is computed making use of the historic estimate of the standard error adjusted for date clustering (and computed over the estimation period of 100 trading days ending 20 days prior to the credit rating downgrade). The results are reported in Table 7A.

If it were true that naked short-sellers were manipulatively creating conditions that triggered the downgrade, we would expect to find abnormally high naked short selling in the days preceding the credit rating downgrade. However, what we do find is the polar opposite: naked short selling is actually abnormally low in the days preceding the credit rating downgrade. Naked short selling becomes abnormally high only in the days following the downgrade. This abnormal naked shorting is sustained for approximately one month following the rating downgrade. This evidence is again consistent with naked short sellers *reacting* to negative news regarding the company, rather than engaging in naked shorting with a manipulative intent, and is hence inconsistent with our hypothesis *H3*.

5.5.6. Naked Short Selling and Large Price Drops

[53] 19 securities were affected by the ban, but we have data for only 17 of these securities, as previously discussed.

Similar to our analysis of naked short selling around credit rating downgrades, we analyze whether naked short selling intensifies prior to large price drops.[54]

We start with a sample including all NYSE common stocks of US-based firms (CRSP share codes 10 and 11) included in the CRSP and TAQ databases over the interval January 1, 2008 to July 20, 2008,[55] with no large changes (>10%) in the number of shares outstanding during the same period. For each security, we standardize daily returns by subtracting the mean and dividing by the standard deviation. Our "event" days of large abnormal negative stock price returns are the 83 security-days for which the standardized return is smaller than -2.

For each security-day in the interval between day -20 and day +20 (where day 0 is the previously-identified day with the large negative abnormal return), we compute daily *Abnormal ONSR*, by subtracting *Mean ONSR*, estimated over a split interval containing the 50 trading days ending 21 trading days prior to the identified event date and the 50 trading days starting 21 trading days after the identified event date. We obtain *Mean Abnormal ONSR* by averaging *Abnormal ONSR* across securities. We then cumulate *Mean Abnormal ONSR* over various event-windows in the interval between day -20 and day +20 and test for significance using a Brown-Warner (1980, 1985) adjustment in the computation of standard errors, to account for the clustering of event dates. As indicated by the results presented in Table 7B, *Mean Cumulative Abnormal ONSR* is significantly negative at the 1% level over the 20, 10 and 5 day windows preceding the event date. *Mean Abnormal ONSR* is positive but statistically insignificant on the event date. In contrast, *Mean Cumulative Abnormal ONSR* is positive and statistically significant over the 5, 10 and 20 day intervals following the event date. Clearly, once again, it is clear that naked shorting does not precede large price drops but follows them.

To further investigate whether naked short sellers specifically target companies with a view to triggering credit rating downgrades, we investigate whether there is greater evidence of manipulative short selling among securities of highly levered firms, as those would be more vulnerable to credit downgrades. Accordingly, we obtain *Total Assets* and *Long Term Debt* as of the end of the fiscal year 2006 from the Compustat database and compute *Leverage* as the ratio of *Long Term Debt* to *Total Assets*. We then rank securities on *Leverage* and assign those with leverage below the sample median to a 'low leverage' group and those with leverage above the

[54] We thank Matthew Spiegel, our editor, for this suggestion.

[55] We aim at investigating the role of naked short sellers during the financial crisis, hence we focus on the year 2008. We restrict our analysis to the period ending July 20, 2008, as the SEC introduced various restrictions on both covered and naked short selling over the subsequent period, hence making it difficult to draw inferences regarding the relationship between naked short selling and stock returns. In unreported results, we find that including the subsequent period (until December 31, 2008) yields qualitatively similar results, with no evidence of intense naked short selling prior to the largest stock price declines.

sample median to a 'high leverage' group. We then repeat our analysis on these two subsets and present results in Table 7B. The results for the two subsets do not differ qualitatively from those of the overall sample (except for a lack of significance of the abnormal return on the 20-day post-event window for the low leverage sample). Overall, our results that naked short sellers do not intensify their activity prior to the largest stock price declines, specifically hold also for the subset of high leverage firms, which are the ones that are most likely to be targeted by potential manipulators. Again, the proposition that naked short sellers are manipulatively causing those price declines is not supported by these results.

As an alternative testing methodology, we compute, for each day in the interval January 1, 2008 to July 20, 2008, the proportion of firms in our sample with a large stock price drop (where a large stock price drop is identified as above). For each day, we also compute *Mean ONSR* across all securities in the sample. We then test for Granger causality with the optimal lag structure of the underlying model chosen on the basis of the Akaike Information Criterion. At the 1% level of significance, we reject the null hypothesis that large drops in stock returns do not cause naked shorting, while we fail to reject the null hypothesis that naked shorting does not cause large drops in stock returns. In Table 7C, we once more segment our sample by leverage and find qualitatively identical results for the high and low leverage subset of our sample. The results for the high leverage sample are virtually identical to those for the overall population. For the low leverage sample, we fail to reject either null hypothesis. These results are again consistent with naked short sellers acting in response to large price declines, rather than causing those price declines. Given that naked shorting does not trigger price falls even for the high leverage firms, our evidence is again *not* consistent with a scenario in which naked short sellers manipulatively trigger adverse reactions in regard to the firm's debt, and hence *not* consistent with Hypothesis *H3*.

5.5.7 Manipulative Naked Short Selling

In this section, we test Hypothesis *H3* by testing whether manipulative naked short-selling and its impact increased during the 2008 financial crisis period. In this context, as discussed in more detail in Section 3.3 above, we think of naked short-sellers as being either value arbitrageurs (aiming to profit from positive pricing errors), or liquidity suppliers (aiming to profit by shorting when order imbalances are positive), or potentially manipulative naked short-sellers; and we think of potentially manipulative naked short-sellers from the mind-set used in the financial crisis media coverage of naked short-selling, i.e., the mindset of bear-raids, based on whether naked shorting is undertaken at a time when pricing errors or order-imbalances

are negative rather than when they are positive. If naked shorting is done when pricing errors (or order-imbalances) are positive, it contributes positively to pricing efficiency (or liquidity). If it is done when pricing errors (or order-imbalances) are negative, then it will arguably make negative pricing errors (or negative order imbalances) even more negative in the next period, and thereby contribute to generating a bear-raid scenario. This implies that, in the presence of greater manipulative naked shorting, we would expect a decrease in the mean reversion of pricing errors, *conditional on the pricing error being negative in the previous period*, and/or a decrease in the mean reversion of order-imbalances, *conditional on the order-imbalance being negative in the previous period.* Hence, we use the change in mean reversion in pricing errors (or order imbalances) at time *t*, conditional on negative pricing errors (or negative order imbalances) at time *t-1*, to test for a change in the intensity of *manipulative* naked shorting.

Accordingly, for each security in our '2008 Most Naked Shorted Sample', our '2007 Single-Sorted Most Naked Shorted Sample', and our '2004 Most Naked Shorted Sample' we estimate separately the mean reversion of pricing error conditional on the previous period pricing error being positive or being negative; and the mean reversion of order-imbalances conditional on the previous period order-imbalance being positive or being negative. We test whether the 2004, 2007 and 2008 conditional coefficients of mean reversion are different from each other using two-sample t-tests. Our results are in Table 8.

First, while there are significant differences between 2008 and the pre-SHO 2004 period, as there are between the (first half of) 2007 and the pre-SHO 2004 period, *none* of the mean reversion coefficients for the 2008 financial crisis period are significantly different from what they were in the first half of 2007. Second, there are no significant differences in the mean reversion coefficient for positive pricing errors between 2008 (or 2007) and 2004, indicating no change in the beneficial contribution of naked shorting to pricing efficiency. However, manipulative naked shorting, as proxied by the mean reversion coefficient for negative pricing errors, is significantly higher in the pre-SHO 2004 period relative to either 2007 or the 2008 financial crisis period. Third, relative to 2004, the mean reversion coefficient for positive order imbalances are significantly higher in both 2008 and 2007, indicating that the beneficial contribution of naked shorting to liquidity has increased in 2008 and 2007 from what it was pre-SHO. And importantly, manipulative naked shorting, as proxied by the mean reversion coefficient for negative order imbalances, is again significantly higher in the pre-SHO 2004 period relative to either 2007 or the 2008 financial crisis period.

The bottom-line is that, howsoever we measure it, manipulative naked shorting did *not* increase from the first half of 2007 to the 2008 financial crisis period; and the manipulative

naked shorting during the 2008 financial crisis period was significantly lower than what it was in the pre-SHO 2004 period. Clearly and unequivocally, we again find no support for Hypothesis *H3*.

6. Conclusions

We document that naked short selling affects the vast majority of NYSE securities. We analyze the impact of naked short selling on market quality and find that this impact is very similar to that of covered short selling, and overall, very positive for both pricing efficiency and liquidity. On average, naked short sellers function effectively as liquidity providers who reduce order imbalances, and as value arbitrageurs who stabilize markets and reduce the mispricing of overvalued securities. An increase in naked short selling of 10 basis points leads to approximately a 3% reduction in spreads, a 8% reduction in order imbalances, a 29% reduction in the magnitude of positive pricing errors, a 37% decline in pricing error volatility and a 5% reduction in stock price volatility.

Consistent with naked shorting having a beneficial impact on pricing efficiency and liquidity, we also find that the SEC ban on naked short selling in 19 financial securities between July 15 and August 12, 2008 led to higher absolute pricing errors, higher spreads and lower trading volumes, thereby adversely affecting the price discovery process and negatively impacting liquidity.

We analyze naked shorting in Bear Stearns, Lehman, Merrill and AIG around the days surrounding their dramatic declines in market value, and find that abnormal naked short-selling in these flagship victims of the 2008 financial crisis took place *after* and *not* before their major stock price declines and associated negative news; and hence their fate or demise was not triggered by naked short sellers. We also analyze naked short selling around credit rating downgrades of financial firms in 2008, and again find that abnormal naked short-selling takes place only in response to these downgrade announcements, and not prior to them.. Similarly, we analyze naked short selling around the steepest stock price declines of financial firms during our 2008 financial crisis sample-period, and find yet again that abnormal naked short-selling follows not precedes price declines, and that the direction of significant causality is from steep price falls to naked short-selling, not vice-versa. Overall, our results clearly indicate that, contrary to media perceptions, naked short sellers did not precipitate the collapse of major financial firms in 2008, nor did they trigger credit rating downgrades or large stock price declines of financial firms.

Finally, we analyze a proxy for the impact of manipulative naked shorting during the 2008 financial crisis, and compare it to the pre-crisis first half of 2007, and a 2004 period prior

to Regulation SHO. We find that manipulative naked shorting did not increase from the first half of 2007 to the 2008 financial crisis period, and that manipulative naked shorting during the 2008 financial crisis period (or pre-crisis in 2007) was in fact significantly lower than what it was in 2004, prior to Regulation SHO. It appears that the impact of manipulative naked shorting was successfully reduced by Regulation SHO, and this reduction continued through the 2008 financial crisis.

Our results are in sharp contrast with the extremely negative pre-conceptions that appear to exist among media commentators and some market regulators in relation to naked short-selling. While we recognize that naked shorting certainly raises serious issues of fairness, that unregulated naked shorting could arguably be potentially manipulative, and that the associated settlement failures could perhaps be disruptive to the smooth functioning of financial markets; what we actually find is that there is no evidence that indicates that naked short-sellers manipulatively precipitated price declines, or otherwise contributed adversely to any market distortions, even in the extreme situation of the 2008 financial crisis. Instead, the gently regulated naked shorting that existed after Regulation SHO up to mid-2008 appears to have been net beneficial for pricing efficiency and market liquidity.

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Table 1 - Variable Definitions

Table 1 defines the variables used in our analysis. All variables are daily, unless otherwise specified.

Short Selling	
Outstanding Naked Short Ratio (ONSR)	Ratio of estimated outstanding fails to deliver over total shares outstanding.
New Naked Short Ratio (NNSR)	Ratio of estimated number of shares that failed to deliver over trading volume, in shares.
Naked to All Shorts Ratio	Ratio of *ONSR* over the total number of outstanding shorted shares.
New FTD	Estimated number of shares that fail to deliver on a particular day.
Short Ratio	Ratio of the total number of shorted shares (both covered and naked) over shares outstanding.
Outstanding Covered Short Ratio (OCSR)	Ratio of the estimated number of outstanding covered-shorted shares over shares outstanding.
Short Volume	Number of shares sold short.
Non-Short Volume	Number of traded shares minus number of shares sold short.
Pricing Error	
Pricing Error (PE)	The non-random walk component of a daily return series estimated using a Kalman filter methodology.
Negative Pricing Error (Negative PE)	A binary variable set equal to 1 if *PE* is negative and to zero otherwise
Positive Pricing Error (Positive PE)	A binary variable set equal to 1 if *PE* is positive and to zero otherwise.
Pricing Error Volatility (PE Volatility)	The absolute value of the pricing error.
Liquidity Related Metrics	
Order Imbalance (OIB)	The difference between the market value of shares traded in buyer initiated trades and the market value of shares traded in seller initiated trades, divided by total daily dollar trading volume.
Positive OIB	A binary variable set equal to 1 if *OIB* is positive and to zero otherwise
Spread	The difference between the last bid and the last ask of the day, divided by the average of the last bid and last ask of the day
Volume	Daily number of shares traded.
Other	
Return	The daily average of the 5-minute stock price return.
Volatility	The standard error of the 5-minute stock price return.
Share Turnover	Daily trading volume, in number of shares, divided by total shares outstanding.
Institutional Ownership	The ratio of shares held by institutional investors over total shares outstanding.
Market Value	The number of shares outstanding multiplies by the closing price for the day.

Table 2 – FTD's as a Proxy for Naked Short Selling

Panel A: New Fails to Deliver and Short Trading Volume

Panel A presents results of a regression of *New FTD* on *Short Volume* and *Non-Short Volume*, using a sample of 368 NYSE securities between January and June 2007, where all variables in this Table are as defined in Table 1. We construct the sample as follows: *ONSR* and *OCSR* are computed for all NYSE common stock of US-based firms (CRSP share codes 10 and 11) included in the CRSP and TAQ databases over the entire interval January 1, 2007 to June 30, 2007, and with no large changes (>10%) in the number of shares outstanding during the first half of 2007. We rank each security by *Mean ONSR* and by the *Mean OCSR,* and allocate securities on that basis to quintiles 1 (lowest) through 5 (highest). We accordingly sort all securities into 25 groups. We then pick 15 securities at random from each one of those groups to construct our '2007 Overall Sample' containing 375 securities. Reported results are for 368 securities, as data for 7 securities are incomplete. The model is estimated with security based fixed effects but the fixed effects regression coefficients are not reported for brevity. "*", "**", and "***" indicate significance at the 10%, 5% and 1% level respectively.

$$New\,FTD_{i,t+3} = \alpha_i + \beta_1 Short\,Volume_{i,t} + \beta_2 Non\,Short\,Volume_{i,t} + \varepsilon_{i,t}$$

	Parameter Estimate	T-stat	
Intercept	4421.31	0.75	
Short Volume	0.02	13.17	***
Non-Short Volume	<0.01	-0.20	
R-squared	6.06%		

Panel B: Outstanding Naked Short Ratio (*ONSR*) in different Naked Short Selling Regimes

Panel B presents the behavior of *ONSR* during different naked short selling regimes in 2008. "Event Securities" are the sample of 17 stocks that were subject to increased restrictions on naked short selling between July 21, 2008 and August 12, 2008 , the "Ban Period" (the ban affected 19 securities, but we found data for 17 of these). "Control Securities" are the sample of 17 market capitalization and industry matched stocks that were not subject to increased restrictions on naked short selling during the "Ban Period". The "Pre-Ban Period" refers to the interval January 1, 2008 to July 20, 2008. The "Post-Ban Period" refers to the interval August 13th, 2008 to September 2, 2008. *ONSR* is computed for the Event and Control stocks on a daily basis over the interval January 1, 2008 to August 12, 2008. Reported t-values are for a test of whether *ONSR* has changed significantly in relation to the pre-ban period. "*", "**", and "***" indicate significance at the 10%, 5% and 1% level respectively.

	Event Securities		Control Securities		Event-Control	
	Mean	t value	Mean	t value	Mean	T value
Pre Ban	0.106%		0.015%		0.091%	12.58 ***
Ban, 1st Week	0.063%		0.054%		0.010%	1.34
Change from Pre Ban	-0.043%	-5.75 ***	0.039%	39.75 ***	-0.081%	-11.24 ***
Ban, 2nd Week	0.007%		0.024%		-0.017%	-2.38 **
Change from Pre Ban	-0.099%	-13.39 ***	0.009%	9.44 ***	-0.108%	-14.96 ***
Ban, 3rd Week	0.004%		0.014%		-0.009%	-1.30
Change from Pre Ban	-0.102%	-13.73 ***	-0.001%	-1.16	-0.100%	-13.88 ***
Post Ban	0.028%		0.006%		0.023%	3.12 ***
Change from Ban (3rd Week)	0.024%	3.21 ***	-0.008%	-1.14	0.032%	4.42 ***

Table 3A - Summary Statistics of the Incidence of Naked Shorting.
This table presents the mean, median, 90th percentile (*P90*) and the 99th percentile (*P99*) of the *Outstanding Naked Short Ratio (O* defined as in Table 1. The metrics are computed daily for all NYSE common stock of US-based firms (CRSP share codes 10 databases over the relevant timeframe of interest and with no large changes (>10%) in the number of shares outstanding during tha a subset of this sample including only financial firms (SIC codes 60 and 61).

	Outstanding Naked Short Ratio				
	Mean	Median	P90	P99	Mea
July 2004 to December 2004	0.09%	0.01%	0.09%	1.07%	3.12
January 2007 to June 2007	0.06%	0.01%	0.11%	0.75%	1.24
January 2008 to June 2008	0.11%	0.02%	0.24%	1.35%	2.12
July 2008 to December 2008	0.08%	0.02%	0.17%	0.94%	2.08
Financial Companies (SIC: 60 and 61), July 2004 to December 2004	0.07%	0.01%	0.08%	2.85%	1.51
Financial Companies (SIC: 60 and 61), January 2007 to June 2007	0.07%	0.01%	0.13%	1.80%	0.85
Financial Companies (SIC: 60 and 61), January 2008 to June 2008	0.28%	0.04%	0.41%	6.56%	1.81
Financial Companies (SIC: 60 and 61), July 2008 to December 2008	0.17%	0.04%	0.24%	6.83%	0.94

Table 3B – Means by *Outstanding Naked Short Ratio* quintiles.
The *Outstanding Naked Short Ratio* (*ONSR*) and the *Outstanding Covered Short Ratio* (*OCSR*) are as defined in Table 1. The samp computed for all NYSE common stock of US-based firms (CRSP share codes 10 and 11) included in the CRSP and TAQ database June 30, 2007, and with no large changes (>10%) in the number of shares outstanding during the first half of 2007. We rank each *OCSR,* and allocate securities on that basis to quintiles 1 (lowest) through 5 (highest). We accordingly sort all securities into 25 gr from each one of those groups to construct our '2007 Overall Sample' containing 375 securities. Daily statistics are computed by over quintiles and for the entire sample. This table reports these cross-sectional statistics for the sample, quintiles 1 and 5, alon means across quintiles 1 and 5. "*", "**", and "***" indicate significance at the 10%, 5% and 1% level respectively.

Variables	Sample Mean	Sample STD	Quintile 1 Mean	Quintile 5 Mean	Quintile 5 - Quintile 1
Share Turnover	0.49%	0.34%	0.36%	0.61%	0.25%
Spread	0.13%	0.12%	0.13%	0.19%	0.06%
Volatility	0.15%	0.05%	0.14%	0.17%	0.03%
Institutional Ownership	66.79%	31.91%	74.78%	48.97%	-25.81%
***Market Value* (US$ M)**	$7,971	$22,781	$11,400	$2,300	($9,100)

Table 4 - Summary Results, Impact of Naked and Covered Short Selling

This table provides results for the estimation of three vector autoregressive models of order one: VAR with *Pricing Error* (Model 1), VAR with *Pricing Error Volatility* (Model 2) and VAR with *Price* (Model 3). The *Outstanding Naked Short Ratio* (*ONSR*), the *Outstanding Covered Short Ratio* (*OCSR*) and all other variables are as defined in Table 1. The sample is built as follows: *ONSR* and *OCSR* are computed for all NYSE common stock of US-based firms (CRSP share codes 10 and 11) included in the CRSP and TAQ databases over the entire interval January 1, 2007 to June 30, 2007, and with no large changes (>10%) in the number of shares outstanding during the first half of 2007. We rank each security by *Mean ONSR* and by the *Mean OCSR,* and allocate securities on that basis to quintiles 1 (lowest) through 5 (highest). We accordingly sort all securities into 25 groups. We then pick 15 securities at random from each one of those groups to construct our '2007 Overall Sample' containing 375 securities. We also analyze the '2007 Most Naked Shorted Sample', a subset of the 2007 Overall Sample containing the 75 securities from the 5th *ONSR* quintile. All variables are standardized and winsorized, hence parameter estimates are in units of standard deviations of response variables. Reported results are for 342 out of 375 securities in the '2007 Overall Sample' and 73 out of 75 securities in the '2007 Most Naked Shorted Sample' due to problems with the convergence of our estimation algorithms. The VAR equations are as follows:

Model 1 (with Pricing Error)

$$\Delta \mathbf{Y}_{i,\mathbf{t}} = \mathbf{c}_i + \boldsymbol{\varphi}_i \Delta \mathbf{Y}_{i,\mathbf{t-1}} + \boldsymbol{\psi}_i \mathbf{X}_{i,\mathbf{t}} + \boldsymbol{\varepsilon}_{i,\mathbf{t}} \qquad \Delta \mathbf{Y}_{i,\mathbf{t}} = \mathbf{Y}_{i,\mathbf{t}} - \mathbf{Y}_{i,\mathbf{t-1}} \qquad \boldsymbol{\varepsilon}_{i,t} \sim \text{i.i.d.} N(\mathbf{0}, \boldsymbol{\Omega}_1)$$

$$\mathbf{Y}_{\mathbf{i,t}} = \begin{pmatrix} ONSR_{i,t} \\ OCSR_{i,t} \\ PE_{i,t} \\ Volatility_{i,t} \\ Spread_{i,t} \\ OIB_{i,t} \end{pmatrix} \qquad \boldsymbol{\psi}_i \mathbf{X}_{\mathbf{i,t}} = \begin{pmatrix} \psi_{i,1,1} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \psi_{i,3,3} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} Positive\ OIB_{i,,t-1} \\ 0 \\ Positive\ PE_{i,t-1} * \Delta ONSR_{i,t-1} \\ 0 \\ 0 \\ 0 \end{pmatrix}$$

Model 2 (with Pricing Error Volatility)

$$\Delta \mathbf{M}_{i,\mathbf{t}} = \mathbf{c}_i + \boldsymbol{\theta}_i \Delta \mathbf{M}_{i,\mathbf{t-1}} + \boldsymbol{\eta}_i \mathbf{N}_{i,\mathbf{t}} + \boldsymbol{\xi}_{i,\mathbf{t}} \qquad \Delta \mathbf{M}_{i,\mathbf{t}} = \mathbf{M}_{i,\mathbf{t}} - \mathbf{M}_{i,\mathbf{t-1}} \qquad \boldsymbol{\xi}_{i,t} \sim \text{i.i.d.} N(\mathbf{0}, \boldsymbol{\Omega}_2)$$

$$\mathbf{M}_{\mathbf{i,t}} = \begin{pmatrix} ONSR_{i,t} \\ OCSR_{i,t} \\ PE\ \ Volatility_{i,t} \\ Volatility_{i,t} \\ Spread_{i,t} \\ OIB_{i,t} \end{pmatrix} \qquad \boldsymbol{\eta}_i \mathbf{N}_{\mathbf{i,t}} = \begin{pmatrix} \eta_{i,1,1} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} Positive\ OIB_{i,t-1} \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}$$

Model 3 (with Prices)

$$\Delta \mathbf{S}_{\mathbf{i,t}} = \mathbf{c}_{\mathbf{i}} + \boldsymbol{\gamma}_{\mathbf{i}} \Delta \mathbf{S}_{\mathbf{i,t-1}} + \boldsymbol{\tau}_{\mathbf{i}} \mathbf{T}_{\mathbf{i,t}} + \boldsymbol{\pi}_{\mathbf{i,t}} \qquad \Delta \mathbf{S}_{\mathbf{i,t}} = \mathbf{S}_{\mathbf{i,t}} - \mathbf{S}_{\mathbf{i,t-1}} \qquad \pi_{i,t} \sim \text{i.i.d} N(\mathbf{0}, \boldsymbol{\Omega}_3)$$

$$\mathbf{S}_{\mathbf{i,t}} = \begin{pmatrix} ONSR_{i,t} \\ OCSR_{i,t} \\ Prices_{i,t} \\ Volatility_{i,t} \\ Spread_{i,t} \\ OIB_{i,t} \end{pmatrix} \qquad \boldsymbol{\tau}_{\mathbf{i}} \mathbf{T}_{\mathbf{i,t}} = \begin{pmatrix} \tau_{i,1,1} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} Positive\ OIB_{i,,t-1} \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}$$

Table 4 Panels A and B are extracts of estimates of the parameters in Models 1, 2 and 3 above and report results pertaining to the
Reported parameter estimates are weighted averages of parameter estimates by security; the weights are inversely proportional to t
and they are scaled so that they add to 1. Significance is tested employing a Fama and MacBeth (1973) procedure. The t-statistics
"*", "**", and "***" indicate significance at the 10%, 5% and 1% level respectively.

Panel A - Impact of Naked Short Selling

				Response - Change		
Sample	*ONSR*	*OCSR*	*PE*	*PE* (incremental effect when lag *PE* > 0)	*PE Volatility*	*Price*
A: 2007 Overall	0.017	0.035	0.071	-0.163		
342 Securities	*2.41***	*8.59****	*2.24***	*-4.43****		
B: 2007 Most Naked Shorted	0.073	0.067	0.279	-0.488		
73 Securities	*3.31****	*4.84****	*2.54***	*-3.98****		
A: 2007 Overall	0.024	0.036			-0.149	
342 Securities	*3.54****	*8.75****			*-6.70****	
B: 2007 Most Naked Shorted	0.079	0.071			-0.391	
73 Securities	*3.60****	*4.94****			*-4.89****	
A: 2007 Overall	0.021	0.034				0.000
342 Securities	*3.02****	*8.59****				*0.10*
B: 2007 Most Naked Shorted	0.079	0.062				0.014
73 Securities	*3.56****	*4.31****				*1.17*

Panel B - Impact of Covered Short Selling

				Response - Change		
Sample	*ONSR*	*OCSR*	*PE*	*PE* (incremental effect when lag *PE* > 0)	*PE Volatility*	*Price*
A: 2007 Overall	0.140	0.328	0.800	-1.598		
342 Securities	*5.17****	*30.20****	*7.96****	*-10.09****		
B: 2007 Most Naked Shorted	0.156	0.251	0.759	-1.354		
73 Securities	*3.18****	*10.35****	*3.75****	*-4.88****		
A: 2007 Overall	0.139	0.352			-1.106	
342 Securities	*5.13****	*34.84****			*-17.34****	
B: 2007 Most Naked Shorted	0.162	0.260			-1.097	
73 Securities	*3.23****	*11.38****			*-7.15****	
A: 2007 Overall	0.149	0.352				-0.040
342 Securities	*5.38****	*34.11****				*-2.12***
B: 2007 Most Naked Shorted	0.155	0.247				0.015
73 Securities	*3.18****	*9.95****				*0.48*

Table 4 Panels C and D present the effect on the market quality metrics included in Models 1, 2 and 3 of an increase in *Ou* *Outstanding Covered Short Ratio* (*OCSR*) equivalent to 10 basis points of the number of outstanding shares. We report the impact the mean of the response variable. Percentages presented in bold are significant at 10% or lower.

Panel C: Impact of a Change in *Outstanding Naked Short Ratio* **(*ONSR)* equal to 10 Basis Points of the number of outstandin**

	Overall sample			Most Naked Shorted	
Response Variable	Model 1 (PE)	Model 2 (PE Volatility)	Model 3 (Price)	Model 1 (PE)	Model 2 (PE Volatility)
Positive PE	**-23.0%**			**-19.1%**	
PE Volatility		**-29.3%**			**-36.9%**
Price			0.0%		
Volatility	**-4.3%**	**-4.4%**	**-4.2%**	**-7.1%**	**-7.4%**
Spread	**-2.4%**	**-2.5%**	**-2.4%**	**-4.8%**	**-4.7%**
OIB	**-6.7%**	**-6.8%**	**-5.9%**	**-8.3%**	**-8.8%**

Panel D: Impact of a Change in *Outstanding Covered Short Ratio* **(*OCSR)* equal to 10 Basis Points of the number of outstandi**

	Overall sample			Most Naked Shorted	
Response Variable	Model 1 (PE)	Model 2 (PE Volatility)	Model 3 (Price)	Model 1 (PE)	Model 2 (PE Volatility)
Positive PE	**-6.1%**			**-2.0%**	
PE Volatility		**-6.6%**			**-3.8%**
Price			**-0.2%**		
Volatility	**-0.9%**	**-0.9%**	**-0.9%**	**-0.7%**	**-0.7%**
Spread	**-0.4%**	**-0.4%**	**-0.3%**	-0.1%	-0.1%
OIB	**-1.4%**	**-1.6%**	**-1.4%**	**-0.8%**	**-0.8%**

Table 5 –The Impact of Restrictions on Naked Short Selling imposed by the SEC between July 21st, 2008 and August 12th,

The following table presents parameter estimates and related t-statistics (in italics, grey font) from 5 OLS regressions, one for eac
Volume, *Spread* and *Close-to-Close Return*. All variables are computed daily over the interval January 1, 2008 to September 9, 20
response variable is the mean value of the k^{th} variable of interest for the sample of the 17 stocks that were subject to restrictions
securities, but we found data for 17 of these). Explanatory variables include, in each regression, an intercept, the mean value o
sample, *Control*, and a binary variable, *Event*, equal to 1 between July 21st, 2008 and August 12th, 2008. All variables are defined
to-Close Return; *Close-to-Close Return* is computed as the difference between the day's adjusted close price (as reported by CR
price, divided by the previous day's adjusted close price. "*", "**", and "***" indicate significance at the 10%, 5% and 1% level
is as follows:

$$Response\,Variable_{k,t} = \alpha_k + \beta_{1,k} Event + \beta_{2,k} Control\,Variable_{k,t} + \varepsilon_{k,t}$$

Response	Predictor					
	Event	*Intercept*	*Control - ONSR*	*Control - PE Volatility*	*Control - Volume*	*Contro Spread*
ONSR	-0.001 *-4.83****	0.0007 *7.30****	2.0136 *4.07****			
PE Volatility	0.0743 *4.99****	0.1972 *20.02****		0.6247 *0.98*		
Volume	-0.0078 *-2.76****	-0.008 *-3.00****			2.885 *12.86****	
Spread	0.0001 *0.5*	0.0009 *5.62****				0.277 *0.005*
Close-to-Close Return	-0.0063 *-1.59*	-0.0018 *-1.42*				

Table 6A – Behavior of the Outstanding Naked Short Ratio (*ONSR*) of Bear Stearns Companies (Ticker: BSC) during Mar

ONSR is computed as the ratio of our estimate of outstanding fails to deliver and shares outstanding. *Index ONSR* is calculated
common stock of 4 firms with the same primary SIC code as Bear Stearns Companies ("Bear Stearns") and with the market capital
of the fiscal year 2007. We construct a t-statistic using the mean and standard error of the *ONSR* difference over the time interval
"**", and "***" indicate significance at the 10%, 5% and 1% level respectively.

Date	*BSC Stock Price*	*BSC ONSR*	*Index ONSR*	*Difference in ONSR*	t-stat	
3/3/2008	77.32	0.30%	<0.01	0.30%	-1.24	
3/4/2008	77.17	0.14%	<0.01	0.14%	-3.16	***
3/5/2008	75.78	0.14%	0.02%	0.12%	-3.20	***
3/6/2008	69.9	0.24%	0.02%	0.22%	-2.11	***
3/7/2008	70.08	0.12%	0.02%	0.10%	-3.32	***
3/10/2008	62.3	0.12%	0.02%	0.10%	-3.32	***
3/11/2008	62.97	0.28%	<0.01	0.28%	-1.39	
3/12/2008	61.58	1.16%	0.06%	1.10%	8.36	***
3/13/2008	57	1.06%	0.06%	1.00%	7.18	***
3/14/2008	30	2.24%	0.08%	2.16%	20.71	***
3/17/2008	4.81	12.18%	0.08%	12.10%	137.34	***
3/18/2008	5.91	11.74%	0.04%	11.70%	132.93	***
3/19/2008	5.33	11.74%	0.04%	11.70%	132.70	***
3/20/2008	5.96	11.68%	0.08%	11.60%	131.66	***
3/24/2008	11.25	12.26%	0.04%	12.22%	139.00	***
3/25/2008	10.94	14.38%	0.08%	14.30%	163.23	***
3/26/2008	11.21	10.92%	0.08%	10.84%	122.81	***
3/27/2008	11.23	11.68%	0.06%	11.62%	131.82	***
3/28/2008	10.78	12.36%	0.06%	12.30%	139.76	***
3/29/2008	10.49	12.36%	0.06%	12.30%	139.76	***

Table 6B – Behavior of the Outstanding Naked Short Ratio (*ONSR*) of Lehman Brothers Holdings Inc. (Ticker: LEH) in Au

ONSR is computed as the ratio of our estimate of outstanding fails to deliver and shares outstanding. *Index ONSR* is calculated
common stock of 4 firms with the same primary SIC code as Lehman Brothers Holdings Inc. ("Lehman") and with the market cap
of the fiscal year 2007. We construct a t-statistic as using the mean and standard error of the *ONSR* difference over the time inter
trading days prior to September 9, 2008. "*", "**", and "***" indicate significance at the 10%, 5% and 1% level respectively.

Date	*LEH Stock Price*	*LEH ONSR*	*Index ONSR*	*Difference in ONSR*	t-stat	
8/25/2008	13.45	0.31%	<0.01	0.31%	13.98	***
8/26/2008	14.03	0.16%	<0.01	0.16%	5.30	***
8/27/2008	14.78	0.16%	<0.01	0.16%	5.08	***
8/28/2008	15.87	0.02%	<0.01	0.02%	-3.49	***
8/29/2008	16.09	0.02%	<0.01	0.02%	-3.66	***
9/2/2008	16.13	0.02%	<0.01	0.02%	-3.43	***
9/3/2008	16.94	0.02%	<0.01	0.02%	-3.24	***
9/4/2008	15.17	0.01%	<0.01	0.01%	-4.08	***
9/5/2008	16.20	0.01%	0.02%	-0.01%	-4.75	***
9/8/2008	14.15	0.01%	0.02%	-0.01%	-4.46	***
9/9/2008	7.79	0.16%	0.03%	0.13%	3.47	***
9/10/2008	7.25	0.85%	0.04%	0.81%	43.46	***
9/11/2008	4.22	3.29%	0.04%	3.25%	185.67	***
9/12/2008	3.65	4.86%	0.03%	4.83%	277.32	***
9/15/2008	0.21	4.86%	0.05%	4.81%	276.59	***
9/16/2008	0.30	5.21%	0.16%	5.05%	290.37	***
9/17/2008	0.13	8.16%	0.18%	7.98%	461.09	***
9/18/2008						
9/19/2008			DELISTED			
9/22/2008						
9/23/2008						

Table 7A – Naked Short Selling around Credit Rating Downgrades

We analyze long-term issuer credit rating downgrades by S&P over the year 2008 for 17 financial firms: Bank of America Corp Inc., Citigroup Inc., Credit Suisse Group, Deutsche Bank Group AG, Allianz SE, Goldman, Sachs Group Inc, Royal Bank ADS Chase & Co., Merrill Lynch & Co., Inc., Mizuho Financial Group, Inc., Morgan Stanley, UBS AG, Freddie Mac, and Fannie common stock (when the primary exchange is not in the US, we use the corresponding ADR). In all, we identify 21 downg downgrade. We compute abnormal daily *ONSR* by subtracting the *Mean ONSR* from daily *ONSR*. *Mean ONSR* is computed over 1 credit rating downgrade. We report results for various event windows. *Cumulative Abnormal ONSR* is the sum of daily *ONSR* for a for significance of the mean is computed making use of the historic estimate of the standard error (computed over the estimation prior to the credit rating downgrade), adjusted for date clustering. "*", "**", and "***" indicate significance at the 10%, 5% and 1

Event Window	*N*	*Mean Cumulative Abnormal ONSR*	t-stat	
(-20,-1)	21	-0.36%	-1.93	*
(-10,-1)	21	-0.27%	-2.03	**
(-5,-1)	21	-0.15%	-1.64	
(0,0)	21	-0.02%	-0.57	
(+1,+5)	21	0.32%	3.44	***
(+1,+10)	21	0.57%	4.25	***
(+1,+20)	21	0.67%	3.56	***

Table 7B – Naked Short Selling around Large Drops in Returns

The sample includes all NYSE common stock of US-based firms (CRSP share codes 10 and 11) included in the CRSP and TAQ d
2008 to July 20, 2008, with no large changes (>10%) in the number of shares outstanding during the same period. For each securit
period and estimate the mean and standard deviation of the daily stock price return. We standardize daily returns by subtractir
standard deviation of the security return. We identify days with large abnormal negative stock price returns as security-days for w
We obtain a sample of 83 security-days with extreme negative return and we refer to those as 'event days'. For each security-day i
(where day 0 is the 'event day'), we compute daily *Abnormal ONSR*, by subtracting *Mean ONSR*, estimated over a split interva
trading days prior to the identified event date and the 50 trading days starting 21 trading days after the identified event date. We c
Abnormal ONSR across securities. We then cumulate *Mean Abnormal ONSR* over various event windows. We compute *Leverag*
Asset, rank securities on *Leverage* and assign those with leverage below the sample median to a 'low leverage' group and those w
'high leverage' group. We test for significance using a Brown-Warner (1980, 1985) adjustment in the computation of standard er
dates. "*", "**", and "***" indicate significance at the 10%, 5% and 1% level respectively.

Event Window	All Companies				High Leverage Companies				Low
	N	*Mean Cumulative Abnormal ONSR*	t-stat		*N*	*Mean Cumulative Abnormal ONSR*	t-stat		*N*	*Cu Abno*
(-20,-1)	83	-1.90%	-7.59	***	41	-2.48%	-7.37	***	42	
(-10,-1)	83	-1.25%	-7.08	***	41	-1.70%	-7.13	***	42	
(-5,-1)	83	-0.79%	-6.33	***	41	-1.20%	-7.12	***	42	
(0,0)	84	0.03%	0.52		42	0.01%	0.15		42	
(+1,+5)	85	0.35%	2.81	***	43	0.34%	2.05	**	42	
(+1,+10)	85	0.79%	4.50	***	43	0.95%	4.00	***	42	
(+1,+20)	85	0.78%	3.12	***	43	1.08%	3.20	***	42	

Table 7C – Naked Short Selling around Large Drops in Returns: Granger Causality Tests

The sample includes all NYSE common stock of US-based firms (CRSP share codes 10 and 11) included in the CRSP and TAQ d
2008 to July 20, 2008, with no large changes (>10%) in the number of shares outstanding during the same period. For each securit
period and estimate the mean and standard deviation of the daily stock price return. We standardize daily returns by subtractir
standard deviation of the security return. We identify days with large abnormal negative stock price returns as security-days for w
We obtain a sample of 83 security-days with extreme negative return and we refer to those as 'event days'. We compute, for each
1, 2008, the proportion of firms in our sample with a large stock price drops (as described). For each day, we also compute the mea
We then test for Granger causality with the optimal lag structure of the underlying model chosen on the basis of the Akaike Infor
the ratio of *Long Term Debt* to *Total Asset,* rank securities on *Leverage* and assign those with leverage below the sample media
leverage above the sample median to a 'high leverage' group and repeat our analysis for each of the two groups. "*", "**", and '
and 1% level respectively.

Ho: *ONSR* Does Not Cause Large Drops in Stock Returns		**Ho: Large Drops in Stock Returns Do Not Cause *ONSR***
χ^2		
All Firms		
7.440		24.990 ***
High Leverage Firms		
8.870		25.130 ***
Low Leverage Firms		
7.080		8.140

Table 8 Mean Reversion in Pricing Errors and Order Imbalances

This table presents results of regressions used to estimate the rate of mean reversion of *Pricing Error* conditional on previous perio and the rate of mean reversion of *Order Imbalance* conditional on previous period *Order Imbalance* being positive or negative. W samples covering three sample-periods. We use our '2007 Single Sort Most Naked-Shorted Sample' for a pre-Financial-Crisis Naked-Shorted Sample' for a pre-Regulation-SHO 2004 benchmark period, and our '2008 Most Naked-Shorted Sample' for th samples are as described in Section 5.1. We run the following two OLS regressions for each of the three samples.

$$\Delta Pricing\ Error_{i,t} = \gamma_i + \alpha_{NEG,i} Pricing\ Error_{i,t-1} + \alpha_{INC\_POS,i} Pricing\ Error_{i,t-1} * Positive\ PE_{i,t-1} + \phi_{1,i} \Delta Spread_{i,t}$$

$$\Delta OIB_{i,t} = \gamma_i + \beta_{NEG,i} OIB_{i,t-1} + \beta_{INC\_POS,i} OIB_{i,t-1} * Positive\ OIB_{i,t-1} + \phi_{1,i} \Delta Spread_{i,t} + \phi_{2,i} \Delta Volatility_{i,t} + \varepsilon_{i,t}$$

The regressions are estimated separately for each security *i*. The reported results are average parameter estimates with standard erro in parameter estimates are also reported and tested for being different from zero using a two-sample t-test. "*", "**", and "***" in level respectively. All variables are defined as in Table 1

Parameter		2004	2007	2008	Difference (2007-2004)		Difference
					Estimate	T-Value	Estimate
Coefficient of Mean Reversion for Negative PE	α_{NEG}	0.58 *0.02*	0.64 *0.02*	0.64 *0.03*	0.06	1.76*	0.06
Coefficient of Mean Reversion for Positve PE	$\alpha_{NEG} + \alpha_{INC\_POS}$	0.62 *0.02*	0.65 *0.02*	0.62 *0.03*	0.03	0.64	0.00
Coefficient of Mean Reversion for Negative OIB	β_{NEG}	0.68 *0.06*	0.89 *0.06*	0.81 *0.02*	0.22	2.63***	0.13
Coefficient of Mean Reversion for Positve OIB	$\beta_{NEG} + \beta_{INC\_POS}$	0.71 *0.01*	0.81 *0.01*	0.83 *0.01*	0.09	5.04***	0.12

Figure 1

Plot of *Outstanding Naked Short Ratio* and *Return Index* related to Bear Sterns Companies Inc. common stock (ticker: BSC) agair

1 on the 1st of January, 2008; $Return\ Index_i = \sum_{j=1}^{i}(1 + R_{BSC,j})$. $R_{BSC,j}$ is the observed total return for BSC on day *j*, from the C

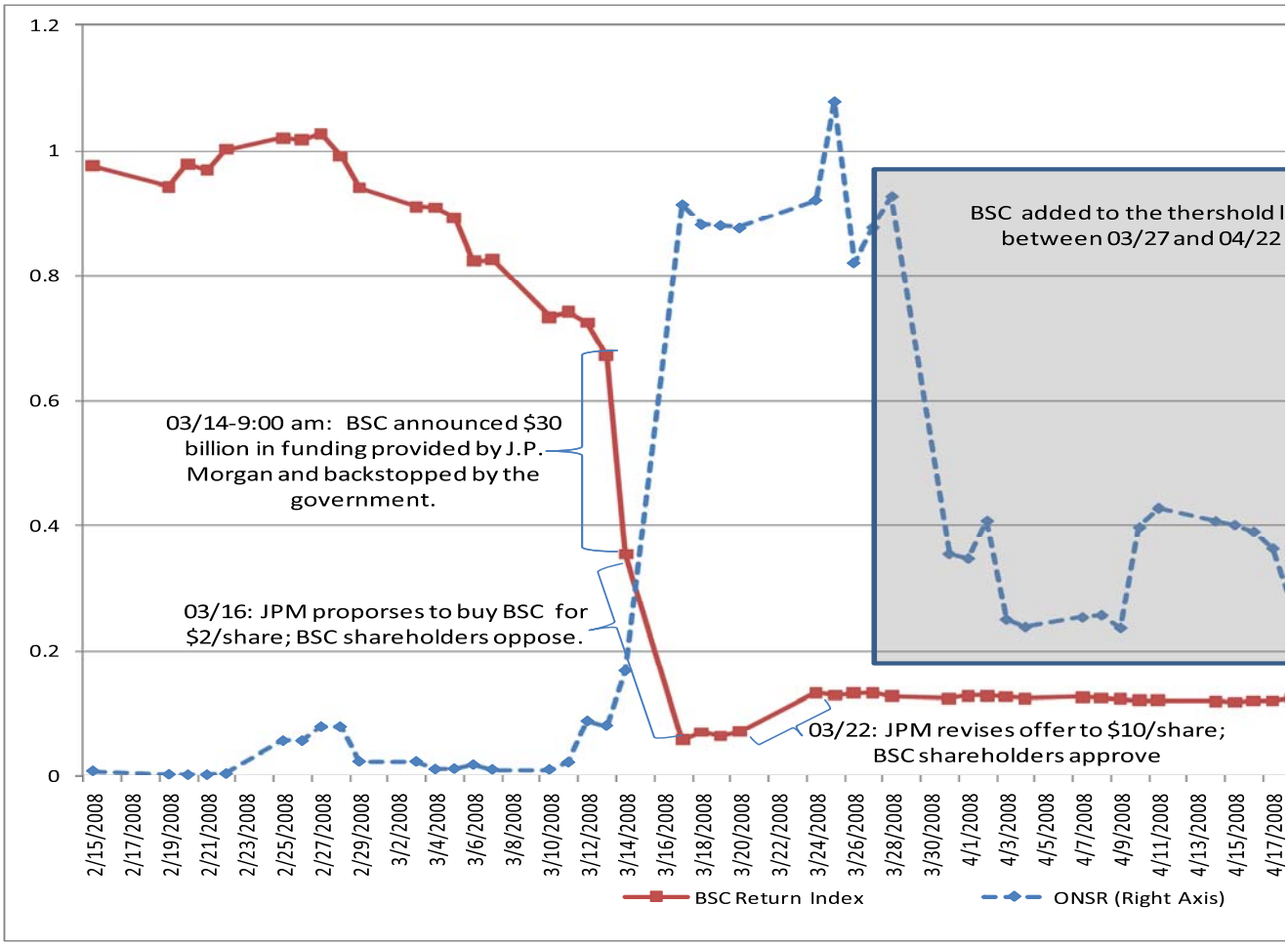

Figure 2A

Plot of *Outstanding Naked Short Ratio* and *Return Index* related to Lehman Brothers Holdings Inc. (ticker: LEH) *over calendar t*

of January, 2008; $Return\ Index_i = \sum_{j=1}^{i}(1 + R_{LEH,j})$. $R_{LEH,j}$ is the observed total return for LEH on day *j*, from the CRSP databas

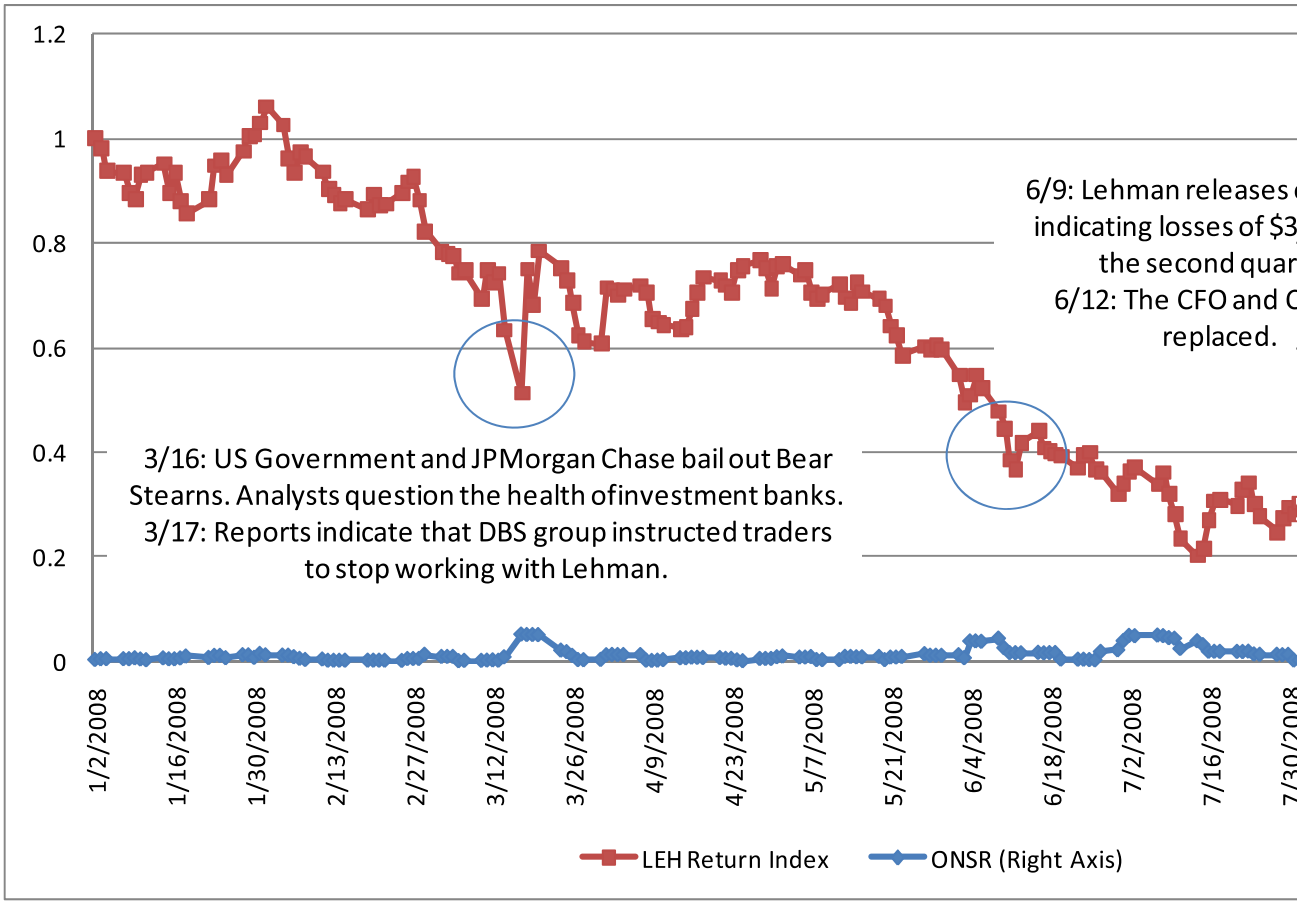

Figure 2B

Plot of *Outstanding Naked Short Ratio* and *Return Index* related to Lehman Brothers Holdings Inc. (ticker: LEH) over calendar tim

January, 2008; $Return\ Index_i = \sum_{j=1}^{i}(1 + R_{LEH,j})$. $R_{LEH,j}$ is the observed total return for LEH on day *j*, from the CRSP database.

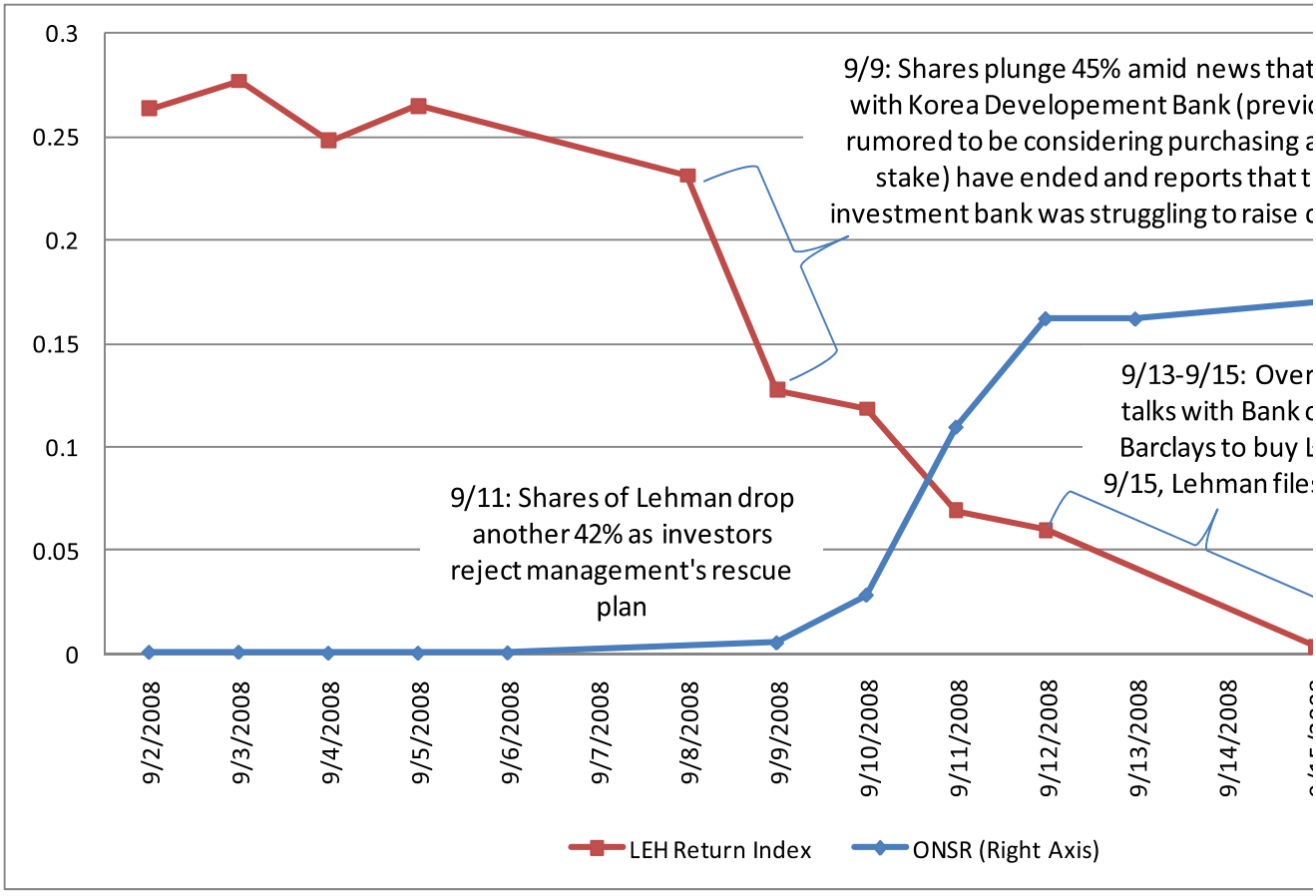

Figure 3

Plot of *Outstanding Naked Short Ratio* and *Return Index* related to Merrill Lynch & Co., Inc. (ticker: MER) *over* calendar time. The *Return Index* is set to 1 on the 1st of January, 2008; $Return\ Index_i = \sum_{j=1}^{i}(1 + R_{MER,j})$.

$R_{MER,j}$ is the observed total return for MER on day *j*, from the CRSP database.

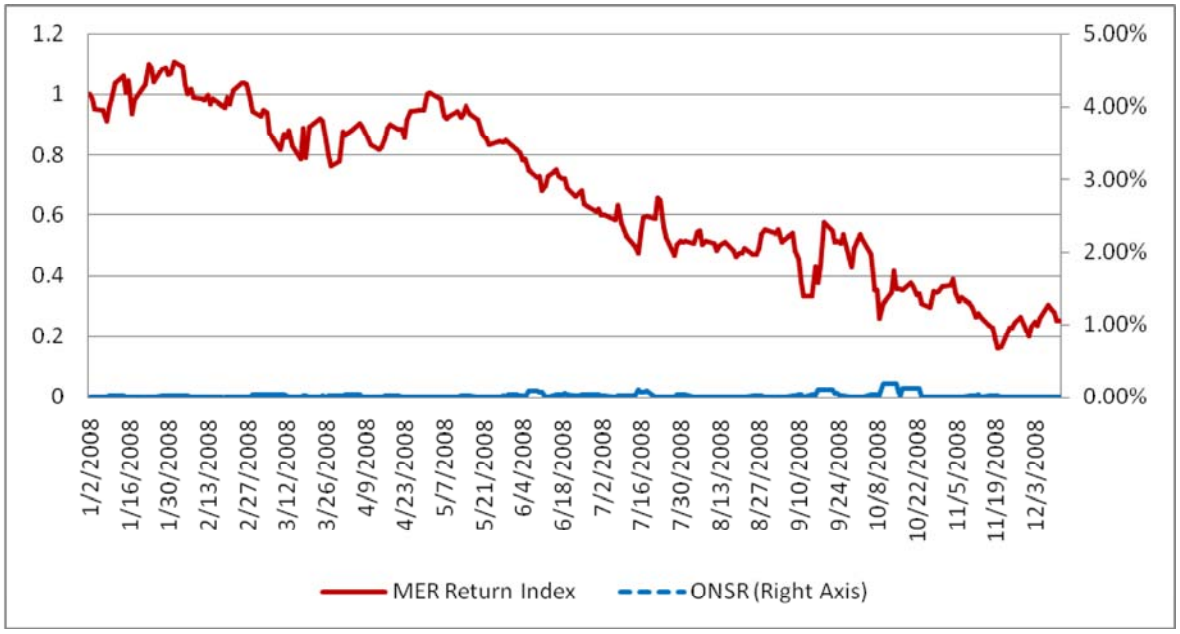

Figure 4

Plot of *Outstanding Naked Short Ratio* and *Return Index* related to American International Group (ticker: AIG) *over* calendartime. The *Return Index* is set to 1 on the 1st of January, 2008; $Return\ Index_i = \sum_{j=1}^{i}(1 + R_{AIG,j})$.

$R_{AIG,j}$ is the observed total return for AIG on day *j*, from the CRSP database.