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Investor Behavior Surrounding Trading Halts: Short Sales, Predation and Contagion Effects

Mary Celeste Funck

INVESTOR BEHAVIOR SURROUNDING TRADING HALTS:

SHORT SALES, PREDATION AND CONTAGION EFFECTS

DISSERTATION

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MARY C. FUNCK

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ABSTRACT

This dissertation is comprised of three essays that focus on the interaction between exchange-mandated trading halts and short selling activity in the financial markets. In the first essay, the behavior of short sellers is examined surrounding interruptions in trading to determine if informed short sellers alter their trading patterns prior to and/or following a trading halt. This investigation also addresses the impact of short sales on market quality for halted stocks surrounding periods of interrupted trading, by examining returns, price volatility, and spreads.

The second essay investigates if a short-selling contagion effect exists for contemporaries of firms experiencing a trading halt. Although trading suspensions represent a firm-specific event, they may be viewed as 'contagious' in the sense that they possess information relevant to other firms in the same industry. The potential for an intra-industry effect supports an examination into whether shorting levels vary significantly for organizations that are informationally related to a firm experiencing a trading halt. The impact of short sales on the market quality of these contemporary firms is also determined by examining returns, price volatility, and spreads surrounding interruptions in trading for an industry member.

Market activity surrounding trading halts is examined in the third essay to determine if predatory trading occurs. This research establishes if predatory behavior is present surrounding interruptions in trading or alternatively, if trading halts eliminates the opportunity for predation. This investigation also determines if documented changes in market quality for halted firms are linked to predatory trading.

LIST OF ABBREVIATIONS AND SYMBOLS

ADF	National Association of Securities Dealers Alternative Display Facility
AMEX	American Stock Exchange
ARCA	Archipelago
CHX	Chicago Stock Exchange
CRSP	Center for Research in Security Prices
NASDAQ	National Association of Securities Dealers
NYSE	New York Stock Exchange
TAQ	Trades and Quotes
WRDS	Wharton Research Data Services

TABLE OF CONTENTS

LIST OF TABLES

ESSAY 1

ESSAY 2

LIST OF FIGURES

ESSAY 1

ESSAY 2

ESSAY 3

ESSAY 1:

DOES SHORT-SELLER INFORMATIVENESS EXTEND TO TRADING HALTS?

INTRODUCTION

We examine short selling activity surrounding trading halts to determine whether informed short sellers alter their trading patterns prior to and/or following a trading halt by changing the number, size, and/or total volume of short transactions they execute on halted stocks. We also study the impact of short sales on market quality for halted stocks surrounding periods of interrupted trading by examining their returns, price volatility and spreads.

Our investigation contributes to microstructure literature by addressing the impact of short sales and trading halts together. We determine how these two trading mechanisms interact and whether short sellers appreciably affect market quality and contribute to the impact on security prices for firms experiencing a trading halt. Trading halts occur frequently in current financial markets. Documenting the presence and the impact of short selling surrounding interruptions in trading has important implications for individuals and institutions trading in the markets and for those providing regulatory oversight.

TRADING INTERRUPTIONS

Major financial markets throughout the world have regulations that suspend trading under specific, pre-specified circumstances. Kim and Yang (2004) categorize these trading interruptions as either 1) price limits, which are triggered when security prices impede upon boundaries established by market regulators, 2) firm-specific trading halts that are implemented to stop trading on an individual security for a predetermined period or 3) market-wide circuit

breakers that halt trading on the entire market when a designated index breaches a pre-specified level.

Firm specific trading halts can be further classified according to their underlying cause; they can be either news-related or they can occur due to order imbalances. An order imbalance trading halt is instigated when an exchange specialist observes a large imbalance between buy and sell orders. A news-related trading halt is triggered by exchange officials when an information release is expected to have or demonstrates a significant impact on security prices.

News-related trading halts, the focus of our investigation, are implemented to ensure that new information is disseminated equally among market participants and to allow participants the time necessary to gauge the impact of the news.[1] Hauser, Kedar-Levy, Pilo, and Shurki (2006 page 83) state, "Trading halts are aimed at reducing information asymmetry by granting investors the opportunity to reassess trades upon arrival of new, substantial information."

The foundation of our investigation into the interaction between short-selling and news-related trading halts relies on previous research findings. These include the informativeness of short sales, the presence of asymmetric information surrounding the declaration of trading halts, and the increase in trading activity by investors prior to interruptions in trading (the magnet effect).

INFORMATIVENESS OF SHORT SELLERS

Research shows that short sellers are informed and it demonstrates that they have the

[1] Trading halt discussion condensed from information contained on NASDAQ website at http://www.nasdaq.com/about/marketwatch_faq.stm and SEC website at http://www.sec.gov/answers/tradinghalt.htm

ability to earn abnormal returns in environments with elevated levels of information asymmetry.[2] The foundation for this view rests upon the work of Miller (1977). He purports that in the presence of short sale constraints, security prices tend to reflect a more optimistic valuation than the average opinion of potential investors and thus prices tend to be biased upward. It follows from Miller's work that short sellers possess superior private information if their absence in the market or their restricted ability to trade leads to overvalued security prices.

The rationale that short sellers are informed can also be justified by the heightened risk-return profile of a short position (potentially unlimited losses) and the additional transaction costs associated with shorting. For instance, Geczy, Musto, and Reed (2002 page 242) state, "… short positions can be expensive or impossible and can be involuntarily terminated." Dechow, Hutton, Meulbroek, and Sloan (2001) purport that short sellers will trade only if they anticipate that their superior knowledge will lead to gains that will compensate them for bearing elevated risk and costs.

Short sellers are cross-sectionally more informed; this allows them to earn abnormal returns by identifying and then short selling overpriced stocks and covering their position when the prices on these securities drop. We suggest that the informational advantage of short sellers extends to trading halts; our research intent is to determine whether short sellers use this advantage to profit in the marketplace surrounding interruptions in trading.

Three empirical studies have particular significance for our investigation of short seller behavior surrounding trading halts. In the first, Cohen, Diether, and Malloy (2007), examine the relation between changes in the supply and demand for shorting and stock prices and find that shorting demand is an important predictor of future stock returns. Particularly important for our

[2] Senchack and Starks (1993); Arnold, Butler, Crack, and Zhang (2005); Chang, Cheng, and Yu (2007); Boehmer, Jones, and Zhang (2008); and Diether, Lee, and Werner (2009B) provide specific examples.

examination of shorting in markets with high asymmetric information, their results are stronger in trading environments with impeded public information flow.

In the second, Christophe, Ferri, and Angel (2004), investigate short-selling activity prior to earnings announcements to determine if it differs from short selling during periods without an imminent announcement. They find evidence of short seller informativeness through a significant negative relation between pre-announcement short selling and post-announcement stock prices. Additionally, they find that short selling does not increase across all firms, which implies that short sellers are acting on firm-specific information. This result is essential to our research – if short sellers' superior information pertains to specific firms, we can link short seller behavior to firm-specific trading halts.

In the third, Angel, Christophe, and Ferri (2003) provide a connection between short seller behavior and volatile trading environments when they find that short selling is highest for high volatility stocks and that as volatility decreases short selling declines monotonically. These researchers suggest that public revelation of the negative information short sellers possess leads to an eventual drop in stock price; high levels of short selling therefore precede future price declines and increased volatility. This research also provides additional support for the notion that short sellers target specific firms during selected intervals when it finds that short sales are concentrated in a relatively small number of stocks on a subset of trading days.

TRADING HALTS AND ASYMMETRIC INFORMATION

Researchers purport that trading halts customarily occur in environments with high levels of asymmetric information. For example, Spiegel and Subrahmanyam (2000) suggest that trading interruptions are more probable in environments with considerable uncertainty regarding the

volatility of future price movements. Hopewell and Schwartz (1978 page 1355) examine price behavior prior to and following firm-specific trading halts on the New York Stock Exchange (NYSE). They state, "In essence, a temporary trading suspension is a signal by the Exchange that a temporary disequilibrium in the market for a security either currently exists or may exist in the near future." They demonstrate that price adjustments occur prior to news-related suspensions and attribute the market's reaction to information leakages and insider trading. They also determine that these price adjustments are firm specific.

The presence of asymmetric information prior to trading halts is substantiated by other researchers. For instance, Ferris, Kumar, and Wolfe (1992); and Kryzanowski and Nemiroff (1998) find that informational asymmetries in trading activity, price volatility, and abnormal returns occur prior to trading halts. Similarly, Wong, Chang, and Tu (2009) find that trading volume and volatility increases in the Taiwan Stock Exchange for short intervals immediately prior to trading halts that are triggered by price limit hits.

Kryzanowski and Nemiroff (2001 page 116) purport that trading halts are an attempt to discover and correct a state of asymmetric information between investors, and assert, "An imbalance of buy and sell orders unaccompanied by public information on that security suggests that uninformed traders and specialists have a larger informational disadvantage than under normal trading conditions." We suggest that this environment of elevated information asymmetry surrounding trading halts provides the conditions essential for short sellers to exploit their informational advantages.

INVESTOR BEHAVIOR PRIOR TO TRADING HALTS

Previous research explores the effect of trading halts on investor behavior, and finds that as the probability of an interruption in trading increases, market participants accelerate the timing of their trades, even if these transactions are not part of an optimal trading strategy. Subrahmanyam (1994) identifies this phenomenon, termed the magnet effect, and he develops a theoretical model that examines the ex ante effects of mandated trading halts. In this model, large traders prefer to utilize smaller trade sizes to minimize the price impact of their trades. However, if the costs associated with the inability to trade are greater than the costs of submitting large orders, these traders will advance their trades and subsequently increase price volatility.

Ackert, Church, and Jayaraman (2001) use experimental markets to analyze the impact of trading halts on price behavior, trading volume, and profitability. Providing support for Subrahmanyam's model, they find that trading activity is affected by trading halts: market participants advance trades when a halt is imminent. Du, Liu, and Ree (2005) investigate price limits in the Korean Stock Exchange and find evidence, prior to limit hits, of the magnet effect in returns, trading volume, and volatility. Similarly, Goldstein and Kavajecz (2004) provide empirical evidence in support of the magnet effect when they examine the trading strategy of NYSE market participants during the market turbulence of October 1997. They find that as the probability of a circuit breaker increases, market participants want to avoid being constrained not to trade, and subsequently accelerate the timing of their trades.

In summary, we purport that 1) short sellers possess superior information regarding specific firms and that they use this informational advantage to accurately forecast an impending trading halt, 2) trading halts occur in conditions of heightened information asymmetry and volatility; an environment that is conducive for short sellers, and 3) the 'magnet effect', which is

characterized by a firm-specific increase in trading volume and increased price volatility immediately prior to a trading suspension, provides a signal to short sellers and prompts them to alter their trading patterns to exploit their informational advantage.

HYPOTHESES (TRADING METRICS)

Our research questions if short sellers take advantage of their superior information by modifying their trading patterns surrounding interruptions in trading. To document short seller behavior, we examine several trading metrics that may alter prior to and/or following a trading halt, including the number of short sales executed, the short sale trade size, and the level of short interest on halted firms.

Number of Short Transactions

The relation between trading volume and stock prices is explored extensively in the literature, and a consensus has emerged that a positive correlation between price volatility and trading volume exists.[3] Trading volume is dependent on both the number and the size of trades. Some researchers suggest that the number of transactions is the more appropriate metric to gauge the impact of trading activity on market prices. For example, Jones, Kaul, and Lipson (1994) examine whether the number of transactions or the transaction size generates price volatility. Their findings suggest that the positive relation between volatility and volume simply reflects the positive relation between volatility and the number of transactions. McInish and Wood (1991), extricate the two components of volume, trade size and the number of trades, to determine the influence of each on returns. They find that the impact of the number of trades on returns supersedes the effect of trade size. Specifically concerning trading halts, Kryzanowski and

[3] Karpoff (1987) provides a review of the price volume relation and finds that volume is positively related to the degree of price changes.

Nemiroff (1998), in their examination of the price discovery process, find that the number of trades accurately gauges the level of informed trading prior to halts.

Short Trade Size

There is disagreement in the literature concerning the order-size preference of informed investors. Jones et al. (1994) describe two opposing theories: strategic and competitive models. With strategic models, monopolistic traders submit multiple smaller trades in an effort to camouflage their trading activity. Kyle (1985) develops a strategic model that examines the value of private information. He purports that informed traders have an incentive to conceal their privileged information by engaging in a number of comparatively small trades rather than a solitary large trade so that private information is gradually incorporated into security prices. Providing empirical support for this notion, Barclay and Warner (1993) examine the impact of trade size on cumulative price change. Based on their findings, they introduce the stealth-trading hypothesis, which states that price movements are caused primarily by the private information of informed traders and that informed traders utilize medium-sized orders.

In competitive models, the size of the trade is positively related to the precision of information held by informed traders. Easley and O'Hara (1987) study the effect of trade size on security prices. They demonstrate that trade size biases create an adverse selection problem: informed traders favor larger transactions while uniformed traders do not have a trade-size preference. Large trade sizes are therefore interpreted as a signal of informed trading and thus modify the market's perception of an asset's value. Similarly, Seppi (1990) develops a theoretical model of information-based block trades in which strategic traders, by utilizing large trades, reveal private information.

Further supporting the positive relation between transaction size and subsequent price impact, Hasbrouck (1991) finds that price impact is a positive function of trade size, and Spiegel and Subrahmanyam (2000) find that price volatility subsequent to a trade is related to the size of the transaction and that price variance increases in trade size. Koski and Michaely (2000) provide an examination of trade size in environments with various information asymmetries. Their results suggest a significant relation between price and liquidity effects and information content as measured by trade size.

The intent of short sellers when submitting their trades diverges from other types of strategic traders, those that would prefer stealth transactions to mask the informational content of their transactions. Short sellers, in line with the competitive model of order preferencing, can benefit from market recognition of their activity – they profit if the revelation of their private information through trading results in downward price movement. Empirically, the advantage gained by placing large short orders is demonstrated by Boehmer et al. (2008), who find that the largest short sale orders are the most informed – they have the most predictive power for future price movements. Similarly, the findings of Angel et al. (2003) suggest that the average short sale has a greater number of shares than nonshort sales.

Short Volume

Short selling is prevalent in financial markets. Boehmer et al. (2008) find that shorting represents almost 13 percent of 2000–2004 NYSE electronically submitted orders, while Deither et al. (2009B) report that during 2005, short selling comprises 24 percent of NYSE and 31 percent of National Association of Securities Dealers (NASDAQ) share volume.

Research further demonstrates that short selling increases prior to informational events.

For example, Safieddine and Wilhelm (1996) find that seasoned equity offerings often have high levels of short selling, and that this short selling activity is related to lower proceeds from share issuance. Aitken, Frino, McCorry, and Swan (1998) find that it is more likely that short transactions that execute the day prior to an informational event are informationally motivated. Christophe, Ferri, and Hsieh (2010) examine short selling prior to the public release of analyst downgrades for a sample of NASDAQ stocks. Their results demonstrate abnormal levels of short selling in the three trading days prior to an analyst announcement and a significant price reaction associated with the downgrade. Karpoff and Lou (2010) investigate short-sellers' role in identifying publicly traded firms that misrepresent their financial statements. They find evidence of increases in abnormal short interest in the 19 months preceding the public revelation of fiscal misconduct. They also demonstrate that levels of short selling increase according to the severity of the misrepresentation.

We contend that trading halts represent a type of informational event. As such, short sellers will increase activity prior to the trading halt in an attempt to exploit their informational advantage and increase the price impact of their trades. We purport that short sellers will execute a larger number of short transactions and they will utilize a larger transaction size, leading to an increase in short volume prior to interruptions in trading:

H_1: Prior to a trading halt, halted stocks will experience a substantial increase in the number of short transactions, short sellers will utilize larger trade sizes and halted stocks will experience a substantial increase in their short interest ratio, relative short selling, and abnormal short selling measures.

Post-Halt Short Transaction Metrics

Although a significant amount of research regarding short seller behavior exists, a much smaller body of research is available that focuses on the activities of short sellers surrounding informational events, particularly in describing their post-event behavior. For instance, Safieddine and Wilhelm (1996) examine short selling around seasoned equity offerings. However, their focus is on short selling pre and post adoption of Rule 10b-21 (which prohibits an investor from covering a short position with shares purchased at the offer price) and not on firm-specific informational events. Christophe et al. (2004) investigate short selling prior to earnings announcements, but their analysis does not address post-announcement short selling activity.

A description of short seller behavior both prior to and following an informational event is provided by Christophe et al. (2010) in their examination of analyst downgrades. They find that abnormal short selling increases prior to the downgrade announcement; peaks during the two-day period comprised of the event day and the day following the announcement, and then declines over the next nine trading days.

Because the intent of a trading halt is to reduce information asymmetry by facilitating the dispersion of new information to market participants and providing the time necessary to impound new information into stock prices, we expect that short selling will decline following the resumption of trading - short sellers will execute fewer and smaller short transactions:

H_2: Following the resumption of trading, halted stocks will experience a substantial decrease in the number of short transactions, short sellers will utilize smaller trade sizes and halted stocks will experience a substantial decrease in their short interest ratio, relative short selling, and abnormal short selling measures.

HYPOTHESES (MARKET QUALITY)

Beyond examining changes in short sellers' behavior surrounding trading halts, we also investigate the impact of short sales on market quality in the form of returns, price volatility and spreads for halted stocks. The intent of a trading halt is to improve market quality by providing the markets "… the opportunity to attract new trading interest, establish a reasonable market price, and resume trading in an affected stock in a fair and orderly fashion, …" (Rooney 2010). Short selling is also positively viewed by the SEC as, "… a healthy and necessary part of a free market," a mechanism "… which can help quickly transport price signals in response to negative information or prospects for a company" (Cox 2008). Acting in tandem, these two trading procedures have the potential to significantly affect market quality for halted stocks.

Returns

Previous research establishes that stocks with high levels of short selling generally experience price declines. For instance, Senchack and Starks (1993) and Desai, Ramesh, Thiagarajan, and Balachandran (2002) demonstrate that increases in short interest generate negative abnormal returns. Angel et al. (2003) find that abnormally low returns are preceded by days with high levels of short selling. Boehmer et al. (2008) find that heavily shorted stocks underperform by a risk-adjusted 15.6 percent annually as compared to lightly shorted stocks. The findings of Cohen et al. (2007) suggest that an increase in the demand for shorting is associated with negative abnormal returns the following month. Diether et al. (2009B) find that when investors sell short in the market during periods of high asymmetric information, their trades are

followed by days with negative returns.

In similar fashion, research demonstrates that stocks undergoing a trading halt customarily experience negative abnormal returns. For example, Kryzanowski (1979) tests the market efficiency implications of suspensions in trading and Madura, Richie, and Tucker (2006) analyze NASDAQ trading halts; both find significant abnormal negative returns surrounding halts in trading. Likewise, Howe and Schlarbaum (1986) examine the impact of trading suspensions on price behavior. They find that almost 80 percent of sample securities experienced negative abnormal returns during the suspension period.

Because each of these trading practices, short selling and trading halts, individually produce negative returns, it follows that the combination of the two will lead to a larger cumulative impact – stocks experiencing both a trading halts and high levels of short selling will experience larger negative abnormal returns:

H_3: Halted stocks with high levels of short selling will experience a larger decline in price surrounding a trading halt as compared to halted stocks with lower short selling activity.

Price Adjustment Speed

Researchers also provide insight into the impact of trading halts on the speed of price discovery. For instance, Hauser et al. (2006) examine trading halts in the Tel Aviv Stock Exchange and find a 40 percent increase in the rate of information dissemination subsequent to a trading halt. Additionally, they find that the speed of adjustments in price to new information is positively related to increases in trading activity. Madura et al. (2006) find the price discovery

process is more prominent for firms with specific news events. Engelen and Kabir (2006 page 1142) examine the impact of temporary interruptions in trading for firms listed on the Euronext Brussels Exchange. They find that, "stock prices adjust completely and instantaneously to the new information released during trading suspensions."

Diamond and Verrecchia (1987) investigate the effect of short-sale constraints on the speed at which security prices adjust to new information. They find that heightened levels of short selling (associated with reduced costs) increase the speed of adjustment for security prices, particularly to negative news.

Short selling and trading halts both serve to convey information to market participants. Working in tandem, the two trading mechanisms should increase the rate of information dissemination - stocks experiencing both trading halts and high levels of short selling will experience a faster price discovery process:

H_4: Halted stocks with high levels of short selling will experience more rapid adjustments in price surrounding trading halts as compared to halted stocks with lower short selling activity.

Price Volatility

SEC Chairman Mary Schapiro states, "I believe that circuit breakers for individual securities across the exchanges would help to limit significant volatility" (Wall Street Journal 2010). Although research examines the impact of trading halts on market quality, a consensus has not been reached as to whether trading halts successfully meet their objective of reducing price volatility.

Proponents of trading interruptions subscribe to the price efficiency hypothesis of trading halts, which purports that trading suspensions provide market participants the time necessary to adjust to new information, consequently leading to smaller price dispersions and increasing the efficiency of reopening prices (Bacha, Mohamed, and Ramlee 2008). Hauser et al. (2006), and Corwin and Lipson (2000) provide empirical support for the Price Efficiency Hypothesis of Trading Halts - their findings suggest a substantial increase in the rate of information dispersion following trading halts and indicate that clearing prices upon resumption of trade serve as good predictors of future stock prices. Likewise, Westerhoff (2003) examines the effectiveness of price limits in speculative markets and finds that security prices become less volatile and more accurately reflect intrinsic values following an interruption in trading.

In contrast, the volatility spillover hypothesis purports that volatility increases in the periods following halts due to order imbalances caused by the interruption in trading. Supporters of this viewpoint believe that the absence of recent transactions make market participants reluctant to trade. This unwillingness to trade leads to a noisier reopening price and higher price volatility. Support for this view is provided by Kim and Rhee (1997) whose findings suggest that stock volatility is not moderated by circuit breakers. Kryzanowski and Nemiroff (1998) and Ferris et al. (1992) find that volatility increases as new information is incorporated into asset prices. Similarly, Lee, Ready and Seguin (1994), who investigates firm-specific NYSE trading halts, find that post-halt volatility levels are elevated 50 to 115 percent.

When examining the relation between short selling and volatility, both Wu and Guo (2004) and Angel et al. (2003) find that short selling levels are directly related to price volatility. Likewise, Chang et al. (2007) find that when short selling is allowed, the volatility of both raw and abnormal returns increases significantly. This increase in price movement is not unexpected

if short sellers are informed; security prices should fluctuate if the actions of short sellers assist prices in adjusting to their fundamental values.

It follows then, that once the superior information held by short sellers is fully incorporated into security prices, short selling levels should fall and price volatility should diminish. Diether et al. (2009B) provide support for this view; they find that when investors sell short during periods of high asymmetric information, their trades are followed by days with lower volatility. Similarly, Bris (2008) examine the performance of 19 financial stocks following the SEC's 2008 emergency order to limit naked short selling and find that following a reduction in short selling due to the imposition of short sale restrictions, affected stocks experience a reduction in intraday return volatility.

The price efficiency hypothesis predicts that security prices will be more efficient after the resumption of trading. Short sellers, by using their superior information to move security prices towards their fundamental value, also serve to increase market efficiency. Relying on both of these notions, we purport that reopening prices for halted securities that experience a high level of short selling surrounding trading interruptions will demonstrate reduced volatility upon the resumption of trading and their reopening prices will serve as accurate predictors of future prices:

H_5: Halted stocks with high levels of short selling will have lower price volatility upon resumption of trade and their reopening prices will be better predictors of future prices as compared to halted stocks with lower short selling activity.

Spreads

Copeland and Galai (1983) describe the bid-ask spread as a mechanism used by dealers to balance the gains they receive from investors who are willing to pay a fee for liquidity and losses to informed traders who have superior information that allow them to more accurately predict future prices. If the market perceives that large trades have higher information content, then, as Hasbrouck (1991) finds, large trades should cause the spread to widen, thus providing compensation to dealers for their informational disadvantage.

If we assume that short-sellers, as informed traders, utilize large trade sizes to increase the price impact of their trades, we expect to see a positive relation between short selling levels and spreads. This notion is supported by Diether, Lee, and Werner (2009A) who examine pilot stocks for which short-selling tests were suspended. They find that an increase in short selling activity leads to an increase in quoted and effective spreads. We also expect that, based on a positive relation between short selling and spreads, as the information held by short sellers is fully reflected in asset prices, short selling activity will decrease and spreads narrow.

Trading halt literature provides insight into the impact of trading halts on the bid-ask spread. For instance, Ackert et al. (2001) examine the impact of trading halts on market behavior and find that spreads narrow after an interruption in trading. Likewise, the findings of Kim, Yague, and Yang (2008) suggest that the bid-ask spreads narrow after trading halts on the Spanish Stock Exchange.

Taking into account the post-halt decrease in spread predicted by the trading halt literature and the expected decrease in spreads from a post-halt decrease in short selling, we purport that securities experiencing a high level of short selling prior to trading interruption will demonstrate narrower spreads upon the resumption of trading:

H_6: Halted stocks with high levels of short selling will have lower spreads upon resumption of trading as compared to halted stocks with lower short selling activity.

DATA

We first identify NYSE and American Stock Exchange (AMEX) trading halts that occur during 2005–2006 by querying the Trades and Quotes (TAQ) database via Wharton Research Data Services (WRDS) for stocks with a trading mode of 4, 7 or 11, indicating halts in trading for news dissemination, order imbalance, or news pending, respectively. From this set, we remove observations where multiple halts occur for the same stock on the same trading day and halts that occur outside normal market hours.

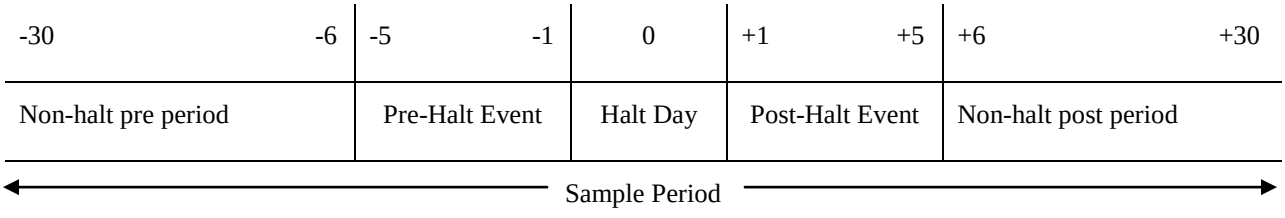
D'Avolio (2002) finds that 16 percent of stocks in the Center for Research in Security Prices (CRSP) data are potentially difficult to sell short. Of these stocks, the majority are in the bottom size decile and the prices of over half are under five dollars. They also find approximately 10 percent of stocks are never shorted – these are primarily illiquid stocks, for which shorting may represent a limited opportunity for profit. These researchers note that institutional investors, who lend stocks for shorting, are biased towards large, liquid stocks, and that the probability of incurring loan fees in excess of the risk free rate is inversely related to firm size and the level of institutional ownership. Accordingly, we, in a manner similar to Christophe et al. (2004), eliminate trading halts for any stock whose average daily price and trading volume during 2005 – 2006 was less than five dollars and 100 shares.

Because our intent is to examine trading activity and market quality prior to and following trading halts, we follow the methodology of Corwin and Lipson (2000) and eliminate halts that occur before 10:00 a.m. We also eliminate halts with incomplete data or halts that do

not resolve on the same trading day.

Rule 202T implemented the suspension of the short sale price test for a pilot list of stocks. The resolution was adopted in 2004 – the suspension was in effect from May 2, 2005 through August 6, 2007. Diether et al. (2009A) find that although daily returns and volatility levels are unaffected for pilot stocks during the test suspension, short selling activity, spreads and intraday volatility increases for these stocks. Because the test suspension period covers part, but not all of our sample period, to mitigate confounding effects, we remove from our sample any firms included in the pilot list of stocks for price test exclusion.

Finally, we remove observations where more than one trading halt occurs for the same firm within our event period. The event period is an 11-trading-day interval beginning five days prior to and ending 5 days after the halt day. Christophe et al. (2004) use a multiday pre-event period because short sellers may distribute their trading over several days prior to an event to disguise private information and because the average loan duration for equity is three days (Reed 2007). We establish a post-halt event period to examine trading activity and market quality for halted stocks following the resumption of trading. The non-halt period, spanning six to 30 days preceding and following a trading halt, provides an estimation period. For our intraday examination, we identify the halt period, which begins with the interruption in trading and ends when trading resumes. Intraday pre-halt periods are measured backwards from the beginning of the halt, and post-halt periods are measured forward from the reopening of trading.



Daily price, trading volume, return, and market capitalization data are obtained from the CRSP database. The Regulation SHO database, which was created in response to Rule 202T, provides trade size and time stamps for short-selling transactions. TAQ trade and quote data is used to examine intraday activity. Trade data is filtered to remove observations that occur outside of normal market hours, and transactions with a non-positive price, or a condition code other than zero. Quote data is filtered to retain observations that occur within normal market hours and have a positive bid or ask size, price and spread.

SUMMARY STATISTICS

After applying the previously described filters to refine our set of events, our remaining sample consists of 78 trading halts, 55 of which occur on the NYSE. Summary statistics describing these halts are presented in Table 1, Panels A through I. Firm names, trading halt mode and SIC code are listed in the Appendix E.

Table 1
Descriptive Statistics
This table contains summary statistics for trading halts that occur during 2005 – 2006 for NYSE-listed firms. Halts have been filtered to remove observations that occur outside of market hours or before 10:00 a.m., where more than one halt occurs for a sample firms on the same day, halts that do not resolve on the same trading day and multiple halts for the same firm within the 11-day event period, halts for Rule 202T pilot stocks, and observations for stocks whose average daily price and trading volume during 2005 – 2006 was less than five dollars and 100 shares.

Panel A: Halts by Year

Year	Number of Halts	Unique Firms
2005	48	44
2006	30	28
Full Sample	78	68

Panel B: Number of Halts per Year

Number of Halts in Sample	1	2	3	4	5
Number of Firms					
2005	42	1	0	1	0
2006	27	0	1	0	0
Full Sample	64	1	1	1	1

Panel C: Halts by Day of Week and Year

	Day of Week					
Year	Monday	Tuesday	Wednesday	Thursday	Friday	Total
2005	2	10	13	18	5	48
2006	4	9	7	5	5	30
Full Sample	6	19	20	23	10	78

Panel D: Halts by Month and Year

	Month											
Year	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec
2005	4	2	5	7	8	5	4	5	1	3	2	2
2006	1	2	4	4	1	3	0	3	1	5	3	3
Full Sample	5	4	9	11	9	8	4	8	2	8	5	5

Panel E: Halts and Duration by Halt Type

Trading Halt Type	Number of Halts	Mean Duration
News Dissemination (4)	6	0:29:27
Order Imbalance (7)	7	0:17:29
News Pending (11)	65	0:44:46
Full Sample	78	0:41:08

Panel F: Halt Firm Characteristics - Average Daily Values

	Price	Volume	Return	Market Cap
Year: 2005 (N =44)				
Mean	31.89	735,803	0.0590%	3,880,142
Max	110.65	5,902,434	0.3331%	65,755,430
Min	4.47	1099	-0.1728%	33,149
Std	23.90	1,295,571	0.1144%	10,371,325
Year: 2006 (N=28)				
Mean	33.23	1,408,912	0.0438%	4,946,224
Max	141.33	7,642,372	0.3072%	40,548,995
Min	6.45	1,187	-0.4135%	111,400
Std	27.81	1,856,984	0.1346%	9,403,555
Full Sample (N=72)				
Mean	32.41	997,568	0.0531%	4,294,729
Max	141.33	7,642,372	0.3331%	65,755,430
Min	4.47	1099	-0.4135%	33,149
Std	25.31	1,561,124	0.1219%	9,952,168

Panel G: CRSP Capitalization-Based Decile

Decile	2005	2006	Full Sample
1	0	0	0
2	2	0	2
3	4	2	6
4	4	1	5
5	5	2	7
6	6	8	14

7	2	3	5
8	9	4	13
9	4	3	7
10	8	5	13
Total	44	28	72

Panel H: Short-sale Trading Activity Across Exchanges (2005 – 2006)

	ADF	AMEX	ARCA	BSE	CHX	NASDAQ	NSX	NYSE	PHLX
Mean Shares Sold Short (%)	0.00	2.94	0.00	0.53	0.00	14.19	5.67	76.38	0.29
Mean Short-sale Trades (%)	0.00	3.73	0.00	0.64	0.00	12.77	6.77	76.07	0.03

Panel I: Short-selling Summary Statistics per Stock

	Mean	Median	Std Dev	Minimum	Maximum
Short Sale Daily Volume	201,427	192,125	72,895	67,124	1,285,773
Number of Daily Short Trades	379	349	149	128	2,727

Of these halts, sixty percent more occur in 2005 than in 2006 (48 as compared to 30). Similar to Christophe et al. (2004), we find that trading halts in our sample occur more frequently during the middle of the week – Tuesday through Thursday. These interruptions in trading occur in 23 out of the 24 sample period months, without evidence of an obvious seasonal pattern. We examine 68 unique firms, 64 of which experience a single halt during the sample period, and 4 different firms that experience 2, 3, 4, or 5 halts each.

The halts in our study are primarily (83 percent) implemented due to pending news. The mean duration of all sample halts is just over 41 minutes. Although the duration of trading halts reported by Lee et al. (1994), Corwin and Lipson (2000), and Christie, Corwin, and Harris (2002) is greater on average and for each halt type, our findings coincide with previous research in the ranking of halt types by length: news pending halts have the longest duration and order imbalance halts, the shortest.

Summary statistics suggest a substantial variation in the size of sample firms, stock price and trading volume with higher average values in 2006 as compared to 2005. The firms in our

study generally demonstrate positive returns over the two-year period examined. When the sample firms are categorized according to year-end capitalization portfolio assignments established by CRSP, we find, similar to Christophe et al. (2004) that large firms are more heavily represented in our sample - we have fewer firms in the lower market capitalization deciles. The dearth of smaller firms may be due, in part, to our data filter that eliminates trading halts for any stock whose average daily price during the sample period is less than five dollars.

We examine short-selling levels for our sample firms during the 2005 – 2006 sample period. For each exchange, we report both short volume as a percentage of the total shares shorted and the number of short sale transactions as a percentage of the total number of short selling trades. No short transactions for our sample firms/period are reported on the National Association of Securities Dealers Alternative Display Facility (ADF), Archipelago (ARCA) and the Chicago Stock Exchange (CHX).

In line with the findings presented by Diether et al. (2009B), approximately three-fourths of short volume and short trades for our sample firms are executed on the NYSE. Approximately 14 percent of short volume and 13 percent of short trades are placed on the NASDAQ market. The average firm in our sample has 379 short transactions per trading day with an average daily short volume of just over 200,000 shares.

RESULTS

Daily Short Metrics

To describe the daily behavior of short sellers surrounding trading halts, we track the mean number of trades, trade size and volume for short transactions for our sample firms in the pre-event period (days -5 through -1), the halt day (day 0), the post-event period (days +1 through +5), and the estimation period (days -30 through -6 and +6 through +30). We also calculate the short interest ratio, relative short selling, and abnormal short selling metrics for each of these periods. The short interest ratio is the number of shares sold short to shares outstanding (Angel et al., 2003). Relative short selling is computed by dividing the number of shares shorted by the number of shares traded (Christophe et al., 2004; and Diether et al., 2009B). Abnormal short selling is the percentage difference between the average daily shares sold short during the pre, post or event period and the average daily number of shares sold short during the estimation period (Lee et al., 1994; Corwin and Lipson, 2000; Christie et al., 2002, Christophe et al., 2004; and Christophe et al., 2010).

Our hypotheses concerning the behavior of short sellers surrounding trading halts are:

H_1: Prior to a trading halt, halted stocks will experience a substantial increase in the number of short transactions, short sellers will utilize larger trade sizes and halted stocks will experience a substantial increase in their short interest ratio, relative short selling, and abnormal short selling measures.

H_2: Following the resumption of trading, halted stocks will experience a substantial decrease in the number of short transactions, short sellers will utilize smaller trade sizes and halted stocks will experience a substantial decrease in their short interest ratio, relative short selling, and abnormal short selling measures.

The mean daily short number of trades, trade size and trading volume, presented in Table 2, are lower in the pre-event period than in the estimation period, indicating that short sellers do not increase their activity in the days prior to a trading halt. For example, the firms in our sample had an average of 431 trades of 430 shares each, producing a mean short volume of 255,325 shares in the pre-event period. These values are all less than the corresponding mean expected values computed for the estimation period. This finding, although in contrast to our priori, is similar to the results of Christophe et al. (2004) who demonstrate a decrease in short selling activity for firms during the five trading days preceding earnings announcements - another type of informational event.

On the event day, all three of these metrics, number, size and total volume of short transactions, increase dramatically. The average number of trades more than doubles, from 489 trades in the estimation period to over 1000 on the halt day. Trade size increases from 457 shares to 646 and subsequently volume triples to an average of nearly one million shares sold short on the halt day.

During the post-halt period, these values demonstrate a distinct reduction, but they remain above estimation period levels. The mean number of daily short transactions falls from 1,004 to 662, which is substantially larger than estimated 489 trades; the average trade size of 477 shares remains elevated above the estimation size of 457 shares. The short interest ratio

follows a similar pattern, with a low pre-halt value of 2.09, a remarkable increase on the halt day to 5.29, and a marked decline to 2.80 with higher than estimation period levels (2.27) in the five days following an interruption in trading.

Table 2
Average Daily Short Metrics
This table contains indicators of daily short selling behavior during the estimation (days -30 thru -6 and +6 thru +30), pre-event (days -5 thru -1), event (day 0) and post-event (days +1 thru +5) period surrounding interruptions in trading. The short interest ratio is the number of shares sold short to shares outstanding, and relative short selling is computed by dividing the number of shares shorted by the number of shares traded.
N = 78 Trading Halts

Period	Number of Trades	Trade Size	Volume	Short Interest Ratio	Relative Short Selling
Estimation	489	457	303,873	2.27	0.24
Pre-Event	431	430	255,325	2.09	0.23
Halt	1,004	646	982,050	5.29	0.23
Post-Event	662	477	489,637	2.80	0.23

The mean and median abnormal short selling values, shown in Figure 1, corroborate these findings. This figure demonstrates primarily negative abnormal short volume in trading days -5 through -1, indicating lower short selling activity in the pre-event period as compared to the estimation period. Abnormal short volume soars to levels over 200 percent of the estimation period values on the halt day. Short selling levels remain elevated on the day following the halt, and then decline from this exaggerated level during the post-halt period, with abnormal values remaining positive for the five days examined (indicating higher short selling levels in the post-halt period than in the estimation period).

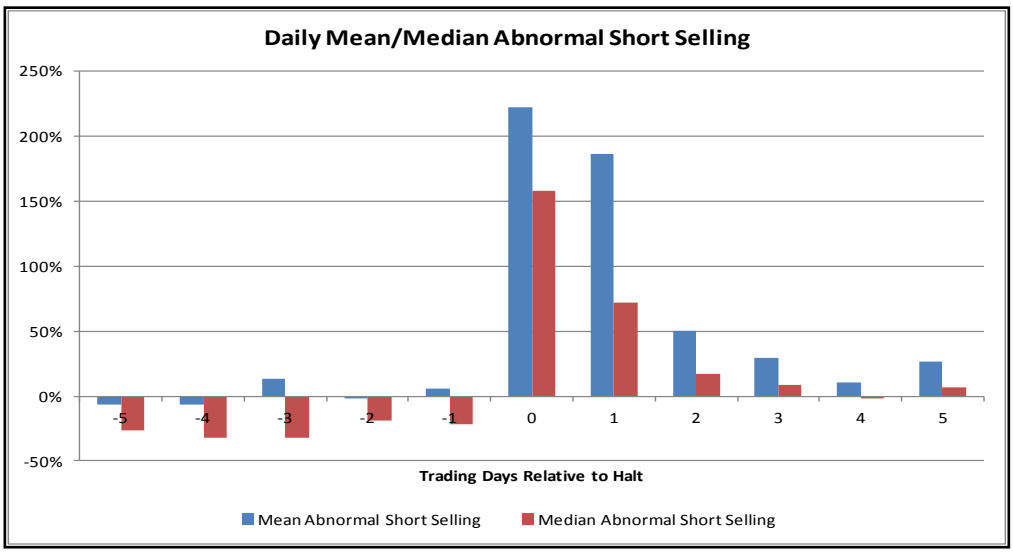


Figure 1
Daily Abnormal Short Selling
Abnormal short selling is the percentage difference between the average daily shares sold short during the pre, post or event period and the average daily number of shares sold short during the estimation period

The halt-day and post-halt results are similar to the findings of Christophe et al. (2010) who examine short selling activity surrounding analyst downgrades. They find that abnormal short selling increases substantially on the event day and then declines, but remains above the normal level for the following nine days.

Relative short selling however deviates from the pattern established by the other short selling measures: relative short selling values remain consistent, ranging from 0.24 in the estimation period to 0.23 for all other periods examined. These values are similar in magnitude to the values reported by Diether et al. (2009B) for NYSE stocks. This finding suggests that the increase in short volume during the halt and post-event periods are accompanied by a surge in trading volume.

A contemporary increase in trading and short volume is consistent with the findings of Karpoff (1986), who examines the impact of informational events on trading volume. This research purports that information leads to an increase in trading volume if it becomes necessary

for investors to update their demand prices or if the information is not anticipated. Investor disagreement or a divergence in investor expectations can lead to increased trading volume that can persist after an informational event. Accordingly, Lee et al. (1994) report that trading volume is 230 percent higher following NYSE trading halts as compared to levels following a 'pseudo halt' and that the elevated volume persists for three days.

If informed short sellers are able to anticipate both that a firm will experience an informational event and that this event will lead to a change in firm value, then we should expect abnormal short selling to increase prior to interruptions in trading. Using the following equation, we examine short selling levels while controlling for other variables that influence short selling levels (following Christophe et al., 2010):

$$ABSS_{(-5,-1)i} = \alpha_i + \beta_1 P_{(0i)} + \beta_2 CAR_{(-5,-1)i} + \beta_3 MOM_i + \beta_4 CAR_{(0,1)i} + \varepsilon_i \quad (1)$$

The dependent variable, $ABSS_{(-5,-1)}$ represents abnormal short-selling during the five days preceding the halt. $P(_0)$ is the share price of the halted firm on the halt day; this variable controls for the positive link between a stock's price and the willingness of market participants to short the stock.[4] $CAR_{(-5,-1)}$ is the cumulative abnormal return during the five day pre-event period – the halted firm's total return over the five days preceding the halt minus the median five-day cumulative total return during the non-event period. MOM represents momentum, which controls for long-term share price movement. Momentum is calculated as the halted firm's six-month cumulative return ending 30 days before the halt minus the return on the NYSE equally weighted portfolio during the same period. $CAR_{(0,1)}$ is the halted firm's holding period return

[4] Refer to D'Avolio, (2002) who shows that the majority of stocks that are impossible to short are priced less than five dollars and that the holdings of institutional investors, who lend stocks for shorting, are biased towards large, liquid stocks.

from day 0 to day 1 minus the median holding period return during the non-event period; this variable represents the market's assessment of the economic value of the news released surrounding a trading halt.

Table 3, Panel A presents the correlation matrix for the regression variables. Results indicate that the pre-halt abnormal short selling level, $ABSS_{(-5, -1)}$, is significantly negatively correlated with short-term pre-halt returns ($CAR_{(-5, -1)}$) and significantly positively correlated with long-term returns (MOM) prior to the trading halt. The correlation values indicates that pre-event short selling decreases with high contemporaneous returns, but increases for stocks with higher returns in the months prior to a trading halt.

Modeling a regression using ordinary least squares assumes that the error terms have uniform variances across all observations. To ensure that this assumption holds, we test each input data set using the Shapiro-Wilk test. The null hypothesis for this statistical test is that a population is distributed normally. If the test produces a p-value less than the designated alpha level, then the null hypothesis of normality can be rejected.

For this regression, the Shapiro-Wilk statistic is 0.73, with a p-value $< .001$, allowing us to reject the assumption of a normal distribution. Accordingly, we execute our regression and report results using errors adjusted to control for heteroscedasticity and serial correlation of the residuals.

Table 3, Panel B presents the regression results. We find that the level of abnormal short selling preceding a trading halt is positively associated with post-halt returns, $CAR_{(0,1)}$, suggesting that for a stock with a 1 percent increase in post-halt returns we expect a 2 to 3 percent increase in pre-halt abnormal short selling.

Although an increase in short selling is often associated with subsequent low returns, previous research also supports a relation between short selling and positive price movements. Angel et al. (2003) discuss how, depending upon the investment period length, short sellers may use either a momentum based strategy, which generates profits if prices continue to move in the same direction, or a contrarian strategy, where success is dependent on price reversals. When these researchers examine short selling activity on NASDAQ, they find that the highest number of short transactions occur for stocks with the highest returns – suggesting that short sellers follow a contrarian strategy. This is consistent with the research of Brent, Morse, and Stice (1990) who reported 3 to 4 percent higher monthly returns for stocks with an increase in short interest.

Table 3

Abnormal Short Selling Regression 1

This table contains the correlation matrix for regression variables (Panel A) with corresponding p-values in parentheses. Regression coefficients and associated t-values are listed in Panel B. In the model: $ABSS_{(-5,\ -1)} = \alpha + \beta_1 * Price_0 + \beta_2 * CAR_{(-5,\ -1)} + \beta_3 * MOM + \beta_4 * CAR_{(0,\ 1)} + \epsilon$, $ABSS_{(-5,-1)}$ represents abnormal short-selling during the five days preceding the halt, $P_{(0)}$ is the share price of the halted firm on the halt day, $CAR_{(-5,-1)}$ is the cumulative abnormal return during the five day pre-event period, MOM represents momentum, and $CAR_{(0,1)}$ is the halted firm's excess holding period return from day 0 to day . Regression results are reported using errors adjusted to control for heteroscedasticity and serial correlation of the residuals.

N = 75 Halts

Panel A: Correlation Matrix of Regression Variables

	$ABSS_{(-5,\ -1)}$	$Price_{(0)}$	$CAR_{(-5,-1)}$	MOM	$CAR_{(0,1)}$
$ABSS_{(-5,\ -1)}$	1	0.0588	-0.3058	0.2347	0.1897
		(0.6161)	(0.0076) ***	(0.0427) **	(0.1031)
$Price_{(0)}$		1	0.1911	-0.0238	0.0216
			(0.1005)	(0.8394)	(0.8544)
$CAR_{(-5,-1)}$			1	-0.2015	-0.10281
				(0.0831) *	(0.3801)
MOM				1	0.04217
					(0.7194)
$CAR_{(0,1)}$					1

Panel B: OLS Regression Results

	[1]	[2]	[3]	[4]
Intercept	0.0054 (0.07)	0.0218 (0.25)	-0.0019 (-0.02)	-0.1203 (-0.91)
$CAR_{(-5,-1)}$	-3.7378 (-1.22)	-3.5368 (-1.26)	-3.1058 (-1.27)	-3.3786 (-1.39)
$CAR_{(0,1)}$		3.0178 (1.78) *	2.9454 (1.88) *	2.8576 (1.89) *
MOM			68.6249 (1.66)	67.9963 (1.67) *
$Price_{(0)}$				0.0037 (1.12)
R^2	0.0935	0.1188	0.1488	0.1610
Adjusted R^2	0.0811	0.0943	0.1129	0.1131
F-Value	7.53 ***	4.85 **	4.14 ***	3.36 **

***, **, and * indicate statistical significance at the 0.01, 0.05 and 0.10 level respectively.

Using an alternate regression model, following Christophe et al. (2004), we control for pre-event trading volume and returns, and focus on post-halt returns to determine if abnormal levels of short selling are informationally motivated. In this equation, $ABSS_{(-5,-1)}$ again represents the abnormal short-selling during the five days before the halt, and $RET_{(0, +1)}$ is the stock return from closing day -1 to +1. $RET_{(-5, -1)}$ represents the movement of the stock price during the five days prior to the halt, and $ABVOL_{(-5, -1)}$ is the percentage difference between the average daily volume in the 5-day pre-event interval and the average daily volume in the estimation period.

$$ABSS_{(-5, -1)} = \beta_0 + \beta_1 RET_{(0, +1)} + \beta_2 RET_{(-5, -1)} + \beta_3 ABVOL_{(-5, -1)} + \varepsilon \qquad (2)$$

$RET_{(0, +1)}$ represents the market's immediate reaction to the trading halt. A significant negative (positive) coefficient indicates that short selling increases (decreases) prior to trading halts imposed under negative (positive) circumstances. $RET_{(-5, -1)}$ controls for the possibility that changes in the stock price might affect the level of short selling in the days preceding the trading

halt. $ABVOL_{(-5, -1)}$ accounts for the comovement in increased short selling activity and increased trading volume (increased volume might make a stock easier to short).

The correlation matrix of regression variables (Table 4 Panel A) demonstrates a significant positive correlation between pre-halt abnormal short selling levels and abnormal volume in the pre-halt period, suggesting that abnormal trading volume is linked to higher short selling activity. [5] Pre-event abnormal short selling is negatively correlated with pre-halt returns – stocks with higher return in the five days preceding a trading halt have lower levels of pre-halt shorting.

For this regression, the Shapiro-Wilk statistic is 0.79, with a corresponding p-value < .001. Accordingly, we execute our regression and report results using errors adjusted to control for heteroscedasticity and serial correlation of the residuals.

The regression results, listed in Table 4 Panel B, produce relatively high Adjusted R^2 values, ranging from 31.54 to 89.03 percent depending on the model specification. A significant relation is indicated between abnormal short selling and trading volume and return in the pre-halt period: pre-halt short selling levels are affected positively by stock price declines and by increased trading volume in the days preceding a trading halt. These results indicate that a stock with a one percent decrease (increase) in pre-halt returns (trading volume) we expect approximately a (0.70) two percent increase in pre-halt abnormal short selling. However, the coefficient for return over the halt day, $RET_{(0, +1),}$ is insignificant; this result fails to provide support for our hypothesis of informed trading by short sellers prior to a trading halt.

[5] Bris (2008) finds that short-sales ratios are affected by substantial increases in trading volume

Table 4

Abnormal Short Selling Regression 2

This table contains the correlation matrix for regression variables (Panel A) with corresponding p-values in parentheses. Regression coefficients and associated t-values are listed in Panel B. In the model: $ABSS_{(-5, -1)} = \alpha + \beta_1 RET_{(0, +1)} + \beta_2 RET_{(-5, -1)} + \beta_3 ABVOL_{(-5, -1)} + \varepsilon$, $ABSS_{(-5,-1)}$ represents the abnormal short-selling during the five days before the halt, and $RET_{(0, +1)}$ is the stock return from closing day -1 to +1. $RET_{(-5, -1)}$ represents the movement of the stock price during the five days prior to the halt, and $ABVOL_{(-5, -1)}$ is the percentage difference between the average daily volume in the 5-day pre-event interval and the average daily volume in the estimation period. Regression results are reported using errors adjusted to control for heteroscedasticity and serial correlation of the residuals.

N = 77 Halts

Panel A: Correlation Matrix of Regression Variables

	$ABSS_{(-5, -1)}$	$ABVOL_{(-5, -1)}$	$RET_{(0, +1)}$	$RET_{(-5, -1)}$
$ABSS_{(-5, -1)}$	1	0.73674	-0.06004	-0.28236
		(< .0001) ***	(0.6039)	(0.0128) **
$ABVOL_{(-5, -1)}$		1	-0.03914	-0.18791
			(0.7354)	(0.1017)
$RET_{(0, +1)}$			1	0.31322
				(0.0055) ***
$RET_{(-5, -1)}$				1

Panel B: OLS Regression Results

	[1]	[2]	[3]
Intercept	-0.17194 (-3.45) ***	-0.17303 (-3.47) ***	-0.17288 (-3.44) ***
$ABVOL_{(-5, -1)}$	0.74815 (7.76) ***	0.71968 (10.97) ***	0.71935 (11.08) ***
$RET_{(-5, -1)}$		-2.27965 (-2.26) **	-2.35715 (-2.00) **
$RET_{(0, +1)}$			0.10841 (0.24)
R^2	0.5428	0.5643	0.5645
Adjusted R^2	0.5367	0.5525	0.5466
F-Value	89.03 ***	47.91 ***	31.54 ***

*** and ** indicate statistical significance at the 0.01 and 0.05 level respectively.

Intraday Short Metrics

The significant increase in short selling metrics on the halt day evidenced in our daily tests prompts us to examine further short-selling behavior on the day the trading halt is called. We begin by first computing the 1) average number of short transactions, 2) average size of the short transactions, 3) short interest ratio, 4) relative short selling and 5) abnormal short selling

measures for the halted stocks in the eight 30-minute periods prior to a halt and following the resumption of trading.

Our investigation reveals that the number of trades, the transaction size, the overall short volume and the short interest ratio remain relatively stable throughout the periods leading up to the halt (Table 5). The pre-halt short interest ratio varies from 0.162 to 0.313. The number of short transactions ranges from 59 to 94 per period and mean period trade size is between 544 and 841 shares, producing short volume for the pre-halt periods ranging from 36,795 to 65,965 shares. A slight increase in pre-halt short activity, with volume breaching 60,000, is noted two periods preceding the halt.

Table 5

Average Intraday Short Metrics

Mean values, which are computed for eight 30-minute periods prior to trading halts and following the resumption of trading, are on a per halt basis; they are adjusted for the number of halts with short transactions each period. The short interest ratio is the number of shares sold short to shares outstanding, and relative short selling is computed by dividing the number of shares shorted by the number of shares traded.

Period	Number of Halts	Number of Trades	Trade Size	Volume	Short Interest Ratio	Relative Short Selling
-8	21	94	692	65,338	0.313	0.259
-7	25	83	544	45,241	0.163	0.203
-6	32	59	628	36,795	0.185	0.240
-5	43	81	704	56,985	0.311	0.242
-4	49	63	613	38,790	0.162	0.220
-3	50	66	792	52,046	0.294	0.242
-2	55	73	841	61,604	0.207	0.247
-1	61	87	757	65,965	0.220	0.245
Halt						
1	68	162	1,293	209,182	1.601	0.238
2	56	120	1,126	135,328	0.777	0.223
3	53	99	855	84,429	0.611	0.253
4	43	63	998	63,200	0.472	0.286
5	38	76	1,011	77,129	0.560	0.288
6	32	81	1,145	92,495	0.479	0.266
7	25	93	1,191	111,295	0.363	0.266
8	14	31	339	10,470	0.236	0.245

Upon the resumption of trading, these metrics are all sharply elevated, and they remain inflated for at least three periods (seven periods for trade size) into the post-halt examination. During period +1, an average of 162 trades occur, with an mean trade size of 1,293 shares, resulting in a short volume of over 200,000 shares - an increase by a factor of four over the average pre-halt volume. The short interest ratio peaks at 1.60 in the first post-halt period, and its value remains elevated above pre-halt levels for six periods following the resumption of trading.

Abnormal short selling, shown in Figure 2, provides equivalent findings, with low or negative mean and median values preceding the halt, a slight increase in mean values three periods before the halt is implemented, and a spike to nearly 1200 percent upon the resumption of trading. Abnormal short selling levels then decline gradually, but remain positive through the eight post-halt periods examined.

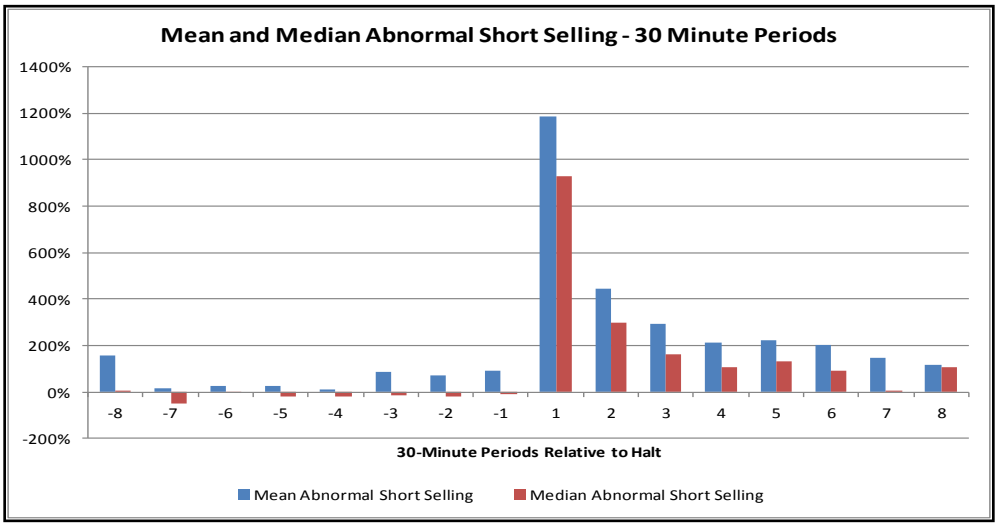


Figure 2
Intraday Abnormal Short Selling
Abnormal short selling is the percentage difference between the average daily shares sold short during 30-minute pre, post and event periods and the average daily number of shares sold short during the estimation period

The relative short selling levels, as with the daily examination, remain relatively constant throughout the halt day, ranging from 0.203 in period -7 to 0.288 in period +5. The constancy of

the relative short selling ratio suggests that elevated short selling levels are accompanied by corresponding increases in trading volume. To explore further, we plot both short selling and trading volume for our sample firms across the halt day. The graphic produced, Figure 3, depicts a contemporaneous increase in both trading and short selling volume immediately preceding the halt, peaking upon the continuation of trading and remaining elevated for several periods post-halt. This pattern coincides with significant increases in trading volume reported by Christie et al. (2002) one period preceding and several periods following the resumption of trade for a sample of NASDAQ firms experiencing a trading halt.

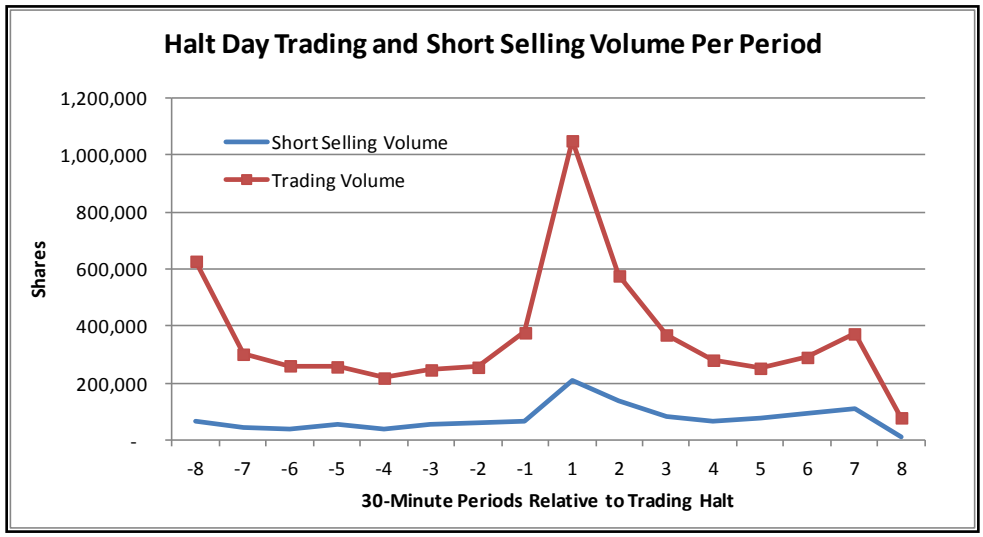


Figure 3
Halt Day Trading and Short Selling Volume

The results of our empirical investigation do not provide solid support for Hypothesis 1. Although an increase in each of the metrics we used to describe short seller behavior was anticipated during the pre-halt period, we found instead, at the daily level, that short selling activity did not increase substantially prior to the implementation of a trading halt. Our intraday examination provides evidence of only a modest increase in short selling immediately preceding an interruption in trading.

However, it does appear that short sellers significantly modify their behavior surrounding trading halts, as each of our short metrics, with the exception of relative short selling, demonstrates substantial increases on the event day, upon the resumption of trading. Support is provided for Hypothesis 2; average trade size, number of trades and volume for short transactions, short interest ratio and abnormal short selling all decrease markedly in the post-event period.

Daily Return Behavior

We next turn our investigation to the price behavior of stocks experiencing a trading halt by examining daily post-halt prices and subsequent returns. To help quantify the impact of short selling, we sort sample halts into quintiles according to mean pre-halt abnormal short selling (ABSS) and abnormal relative short selling (ABRELSS) levels. Abnormal relative short selling is calculated by subtracting the estimation period relative short selling from the relative short selling in the pre-halt period. We examine and report, in Table 6, daily mean and median post-announcement returns (each stock's two-day percentage return following the trading halt, measured from the close of the day preceding the halt day to the close of the following day) for the highest and lowest quintiles (following Christophe et al. 2004).

Our hypothesis concerning the return earned by sample firms surrounding interruptions in trading states that:

H_3: Halted stocks with high levels of short selling will experience a larger decline in price surrounding a trading halt as compared to halted stocks with lower short selling activity.

We find that the median and mean returns for the high and low quintiles determined by abnormal relative short selling levels are similar in sign (both positive) and magnitude. This result is consistent with Lee et al. (1994), who report a positive mean and median return for the halted firm as compared to a pseudo halt period (a corresponding trading period on a nonhalt day). The mean return differs by only 1.1 percent and median returns are nearly identical at 5.07 and 5.10 percent for the lowest and highest short selling quintiles respectively. This result is not surprising, as our examination of relative short selling through the sample period and on the event day finds this metric to be relatively stable.

However, we find that the post-halt returns for firms in the highest abnormal short selling quintile is a positive value of approximately two percent, as compared to a negative return of 2.56 percent for those firms with the lowest abnormal short selling levels. For the median return, both groups demonstrate positive values, but the return for firms with the highest short selling levels is more than double that of the lowest short selling category.

Table 6
Post-halt Daily Returns
Sample halts are sorted into quintiles according to mean pre-halt abnormal short selling and abnormal relative short selling levels. Mean and median post-announcement returns, each stock's two-day percentage return following the trading halt, measured from the close of the day preceding the halt day to the close of the following day, are reported for the highest and lowest short-selling quintiles

Short Selling Metric / Group	Mean Return	Median Return
Abnormal Short Selling		
Low Short Selling	-0.0256	0.0044
High Short Selling	0.0199	0.0108
Abnormal Relative Short Selling		
Low Short Selling	0.0448	0.0507
High Short Selling	0.0335	0.0510

To further test the association between high levels of short selling in the pre-event period and post-halt stock returns, we perform a non-parametric Chi-square test. For each of our

abnormal short selling metrics, ABSS and ABRELSS, we split the sample into two groups, the highest quintile of each measure for days -5 thru -1, and all other sample halts. We then examine how these groups are distributed across three categories of return from closing day -1 to +1. If short selling is randomly dispersed the halts should have the following distribution: 20 percent in the low return quintile, 20 percent in the high return quintile and 60 percent in the moderate return quintile (following Dechow et al., 2001; and Christophe et al., 2004). Accordingly, with 77 trading halt observations, 15 observations each (approximately 19 percent) should fall into the low and high return categories, and the remaining 47 observations (≈ 61 percent) should be designated as moderate.

Table 7 presents these findings, with quintiles established according to ABSS and RELABSS levels presented in Panel A and Panel B respectively. We find that the highest short-selling quintile for ABSS has the anticipated 20 percent of its observations in the low return category. However, nearly 27 percent of the halts in the highest short-selling quintile are associated with high returns – this result coincides with our findings from Table 6 (positive returns for high short selling stocks) and suggests that stocks with the highest levels of pre-halt abnormal short selling have higher post-halt returns. The other short-selling quintile category demonstrates a distribution that is in line with expected values.

When categorizing the stock according to levels of ABRELSS, we see a more pronounced shift of the high short-selling stocks (40 percent) into the high return category with the remaining short selling quintiles demonstrating a pattern similar to the expected values. The ABRELSS Chi-Square test produces a X^2 statistic that is significant at the 10 percent level, which allows us to reject the null hypothesis of independence between short selling and post-

announcement returns. However, because of the small sample size (over one third of the cells have expected counts with less than 5 observations), the Chi-Square test may not be valid.

Table 7
Daily Chi-Square Test
Samples halts are divided, using Abnormal Short selling and Relative Abnormal Short Selling, into two groups, the highest quintile of each measure for the five days preceding the halt and all other sample halts. This test examines how these groups are distributed across three categories of return on stock from closing day -1 to +1.

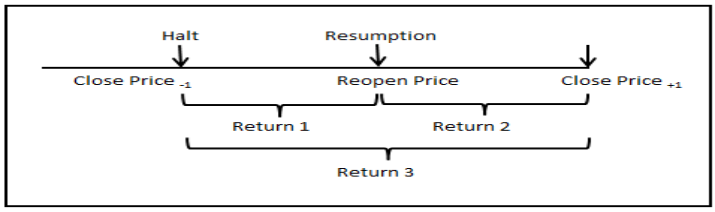
		Return Quintiles			
		Low Return	Moderate Return	High Return	Total
Sample Observations		15	47	15	77
Expected Percent		19.48%	61.04%	19.48%	100%
Panel A: Abnormal Short Selling, $ABBS_{(-5,-1)}$					
Highest Short Selling Quintile					
	Observations	3	8	4	15
	Percentage	20.00%	53.33%	26.67%	100%
Other Short Selling Quintiles					
	Observations	12	39	11	62
	Percentage	19.35%	62.90%	17.74%	100%
				X^2 statistic	0.6776
				Probability	0.7126
Panel B: Abnormal Relative Short Selling, $ABRELSS_{(-5,-1)}$					
Highest Short Selling Quintile					
	Observations	2	7	6	15
	Percentage	13.33%	46.67%	40.00%	100%
Other Short Selling Quintiles					
	Observations	13	40	9	62
	Percentage	20.97%	64.52%	14.52%	100%
				X^2 statistic	5.0182
				Probability	0.0813 *

33% of cells have expected counts < 5. Chi-Square test may not be valid
* indicates statistical significance at the 0.10 level.

Intraday Return Behavior

We repeat our price behavior tests on an intraday basis. For each of four 30-minute pre-event periods, we sort the firms into quintiles according to preannouncement abnormal short selling (ABSS) and abnormal relative short selling (ABRELSS) and examine mean post-announcement returns for the highest and lowest quintile. We examine three different intraday

returns: 1) the close of the period preceding the halt to the reopen, 2) the reopen to the close of the period following resumption of trading, and 3) the period spanning the halt from the close of the period prior to the halt to the close of the period following the halt. Return values are reported only for stocks in the lowest and highest short selling quintiles.



The return data, shown in Table 8, categorized by abnormal short selling indicates that for the halt period (Return 1), both the highest and lowest short selling quintiles experience positive returns, with the high short-selling stocks earning the highest gains (1.12 percent). This result is consistent with Corwin and Lipson (2000), who find that a majority of firms experiencing a trading halt have a positive price change from the last trade prior to the halt to the reopening price.

Immediately following the resumption of trading (Return 2), firms in both short-selling quintiles demonstrate negative returns, with a larger negative impact noted for the highest short selling quintile (-1.37 percent). The overall halt return (Return 3) for both groups is modest; the lowest short-selling firms earn a positive .23 percent while the highest short-selling firms earn a negative .27 percent return.

These results suggest that that the price reaction to the trading halts is greater in magnitude for the firms with high levels of short activity and that the negative reaction on the part of market participants appears to be incorporated into prices only after trading resumes.

When we examine the returns for firms classified according to levels of relative abnormal short selling, a different picture emerges. For the low short-selling quintile, the return in each of

the periods is negative (ranging from -0.36 percent to -1.7 percent), while the high short-selling quintile demonstrates consistently positive returns.

Table 8
Intraday Post-halt Returns
Firms are divided into quintiles according to preannouncement abnormal short selling and abnormal relative short selling for four 30-minute pre-event periods. $Return_1$ is from the close of the period preceding the halt to the reopen, $Return_2$ is from the reopen to the close of the period following the resumption of trading, and $Return_3$ is from the close of the period prior to the halt to the close of the period following the halt. Return values are reported only for stocks in the lowest and highest short selling quintiles.
N = 10 or 11 halts per quintile

	Mean $Return_1$	Mean $Return_2$	Mean $Return_3$
Abnormal Short Selling			
Low Short-Selling Quintile	0.0069	-0.0046	0.0023
High Short-Selling Quintile	0.0112	-0.0137	-0.0027
Abnormal Relative Short Selling			
Low Short-Selling Quintile	-0.0036	-0.0150	-0.0170
High Short-Selling Quintile	0.0068	0.0028	0.0094

We repeat the Chi-square test at the intraday level to determine the relation between high levels of abnormal short selling ($ABSS_{-5,-1}$) in the pre-event period and post-halt stock returns (Table 9). For Return 1, which targets the change in price over the halt period, 40 percent of the high short-selling firms report elevated returns. This shift of firms into the high return category coincides with the positive return of 1.12 percent reported in Table 8. Return 2, which is earned between the resumption of trading and the close of day +1, demonstrates, for the high short-selling quintile, a substantial increase, to 30 percent, in the number of firms categorized with low returns. Again, this finding adds support to the values reported in Table 8, in which the prices of high short selling firms decline 1.37 percent. The overall return, Return 3, has a perfectly expected distribution, indicating that the overall price impact from the trading halt is not significantly impacted by abnormal short selling levels. For each of our return categories, the distribution of the other quintile firms approximates the expected values.

Table 9

Intraday Chi-Square Test

Samples halts are divided, using Abnormal Short selling into two groups, the highest quintile of short selling for the five days preceding the halt and all other sample halts. This test examines how these groups are distributed across three categories of returns: $Return_1$ is from the close of the period preceding the halt to the reopen, $Return_2$ is from the reopen to the close of the period following the resumption of trading, and $Return_3$ is from the close of the period prior to the halt to the close of the period following the halt.

		Return Quintiles			
		Low Return	Moderate Return	High Return	Total
Sample Observations		10	32	10	52
Expected Percent		19.23%	61.54%	19.23%	100%
Panel A: $Return_1$					
Highest Short Selling Quintile					
	Observations	1	5	4	10
	Percentage	10%	50%	40%	100%
Other Short Selling Quintiles					
	Observations	9	27	6	42
	Percentage	21.43%	64.29%	14.29%	100%
				X^2 statistic	3.59
				Probability	0.1658
Panel B: $Return_2$					
Highest Short Selling Quintile					
	Observations	3	6	1	10
	Percentage	30.00%	60.00%	10.00%	100%
Other Short Selling Quintiles					
	Observations	7	26	9	42
	Percentage	16.67%	61.90%	21.43%	100%
				X^2 statistic	1.30
				Probability	0.5220
Panel C: $Return_3$					
Highest Short Selling Quintile					
	Observations	2	6	2	10
	Percentage	20.00%	60.00%	20.00%	100%
Other Short Selling Quintiles					
	Observations	8	26	8	42
	Percentage	23.81%	59.52%	16.67%	100%
				X^2 statistic	3.2717
				Probability	0.1948

33% of cells have expected counts < 5. Chi-Square test may not be valid

Diether et al. (2009B) provide insight into this return pattern: a sizeable negative return in the immediate 30-minute post-halt period and a positive average daily post-halt return. These researchers suggest that if short sellers increase their activity to provide liquidity at times when buyers are willing to pay a premium for immediacy, then after an initial negative reaction, stock prices will revert to normal levels when the buying pressure diminishes. Alternatively, if an increased level of shorting activity is in response to liquidity demands in periods of heightened uncertainty, due to either divergent opinions or informed trading, prices will return to normal levels when the cause of the uncertainty is resolved.

Hypothesis 3 states that halted stocks with higher levels of short selling will experience a larger decline in price surrounding a trading halt as compared to halted stocks without a significant level of short selling. At the daily level, however, we find evidence of the opposite effect – firms with higher shorting activity earn higher gains than do halted firms with lower short selling levels. On an intraday basis, our findings suggest that firms with elevated levels of shorting experience larger positive gains during the halt period and a substantial price decrease immediately after trading resumes.

Speed of Price Adjustment

Short selling and trading halts both have the potential to convey information to market participants, and thus affect the price discovery process. Accordingly, we investigate the rate at which the price of our sample firms' stock adjusts under the combined impact of these trading activities.

Our hypothesis concerning the impact of short selling on stock prices surrounding trading halts states:

H_4: Halted stocks with high levels of short selling will experience more rapid adjustments in price surrounding trading halts as compared to halted stocks with lower short selling activity.

To measure the impact of trading halts on the speed of price adjustment (SO_{Adj}) we follow the methodology of Hauser et al. (2006) and calculate:

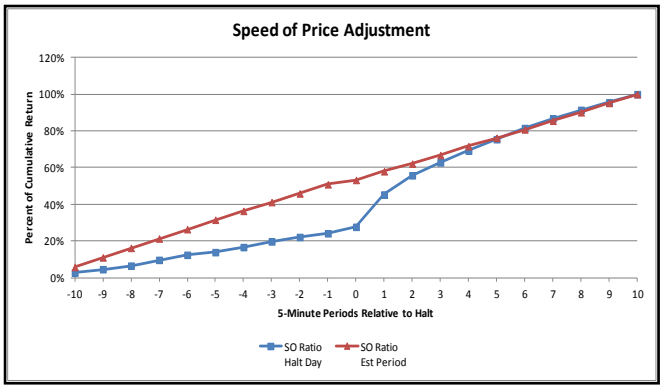
$$SO_{Adj} = \frac{CR(-10,T)}{CR(-10,10)} \quad (3)$$

Where: $CR_{(-10,T)}$ is the cumulative return starting ten intervals before trading halts are implemented to interval T, where T = -10, -9, … 10. Each interval is five minutes long. $CR_{(-10,10)}$ is the cumulative return over an approximate two-hour window.

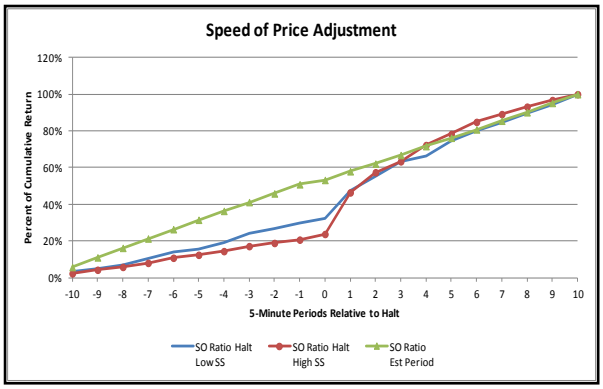
We first present the speed of price adjustment for all firms on the halt day as compared to the same relative 5-minute periods during the estimation period (Figure 4 Panel A). There is a discernible difference – during the estimation period, the speed of price adjustment is uniform throughout the twenty-one periods. On the halt day, in contrast, there is a sharp increase in the speed of price adjustment immediately following the resumption of trading, particularly in period +1. This finding coincides with results reported by Hauser et al. (2006) that the majority of price change occurs in the first ten minutes following the resumption of trading.

The speed of adjustment test is repeated, for both the halt day (Panel B) and over the estimation period (Panel C), with the additional step of separating firms into terciles according to halt-day abnormal short selling levels. For the estimation period, there is no difference in the speed of price adjustment for high and low short-selling firms. On the halt day, we note that the

stocks with the lowest short selling levels evidence a gradual increase in the speed of price adjustment starting several periods before the halt with a noticeable increase immediately following trade resumption. However, the high short-selling stocks demonstrate a larger proportion of their price response in period +1, immediately following the resumption of trading.

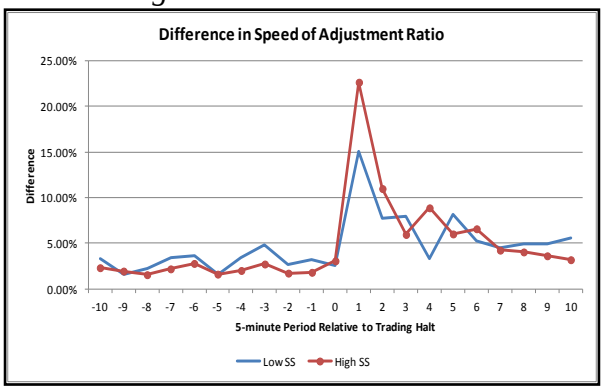


Panel A: Halt Day and Estimation Period Price Adjustment



Panel B: Halt Day Speed Adjustement by Short Selling Levels

Panel C: Estimation Period Adjustement by Short Selling Levels



Panel D: Difference in Adjustement by Short Selling Levels

Figure 4

Speed of Price Adjustment

Speed of price adjustment is calculated on the halt and estimation period for ten five-minute intervals before trading halts are implemented and following the resumption of trading. Price adjustment speeds and differences between halt and estimation period values are also reported for the highest and lowest short selling quintiles, as determined by halt-day abnormal short selling levels.

To examine further the difference in behavior between categories of firms by short selling, we calculate the difference in the speed of price adjustment for each group against a

benchmark that assumes 4.76 percent of the price change occurs in each 5-minute period (100 percent / 21 periods). These results, shown in Figure 4 Panel D, suggest that stocks with high levels of short selling demonstrate a larger increase in price adjustment than do stocks in the lowest short selling group (23 percent as compared to 15 percent) in the periods immediately following the resumption of trading.

Weighted Price Contribution

To investigate further the price discovery process for halted stocks, we identify the cumulative price change at the daily and intraday level in each sample interval (pre-halt, halt, post-halt) by calculating the weighted price contribution estimate, following Madura et al. 2006:

$$WPC = \sum_{i=1}^{N} \left(\frac{|\Delta P_j|}{\sum_{j=1}^{N} |\Delta P_j|} \right) \times \left(\frac{\Delta P_{i,j}}{\Delta P_j} \right) \quad (4)$$

Where: i ϵ each interval (pre-halt, halt, post-halt) and $\Delta P_{i,j}$ is the price change over interval i for halt j.

As presented in Table 10, nearly 60 percent of the price contribution at the daily level occurs on the halt day, with 28 percent occurring in the 5 days preceding the halt and only 11 percent in the post-halt period. This finding indicates that, although a significant price reaction occurs prior to the trading halt event, the majority of the market's reaction is confined to the halt day. Our results are similar to those of Madura et al. (2006), who report the majority of price change in the halt period (≈ 79 percent) and the least amount of price change in the post halt period in their examination of NASDAQ trading halts.

Table 10

Weighted Price Contribution

Cumulative price change is calculated at the daily and intraday level in each sample interval (pre-halt, halt, post-halt) by calculating the weighted price contribution estimate: $WPC = \sum_{i=1}^{N}\left(\frac{|\Delta P_j|}{\sum_{j=1}^{N}|\Delta P_j|}\right) \times \left(\frac{\Delta P_{i,j}}{\Delta P_j}\right)$ where: i ϵ each interval (pre-halt, halt, post-halt) and $\Delta P_{i,j}$ is the price change over interval i for halt j. Intraday periods are five minutes in length and are measured prior to the halt and following the resumption of trading. Halts are divided into quintiles (daily) and terciles (intraday) according to pre-halt abnormal short selling levels; cumulative price change is reported for stocks in the highest and lowest tercile.

	Pre-Halt$_{(-5,-1)}$		Halt$_{(0)}$		Post-Halt$_{(1,5)}$	
Panel A: Daily						
All Halts (N = 78)	0.2807	3.59***	0.5968	5.42***	0.1143	1.35
High Short Selling Quintile (N = 15)	0.1159	1.03	0.7579	3.13***	0.1261	0.97
Low Short Selling Quintile (N = 15)	0.5202	3.57***	0.7114	1.5	-0.2768	-0.84
Panel B: Intraday						
All Halts (N = 29)	0.0514	2.02*	0.4591	2.27**	0.4896	3.36***
High Short Selling Tercile (N = 11)	0.0307	0.73	0.0853	0.71	0.8841	3.17**
Low Short Selling Tercile (N = 9)	0.0586	1.16	0.6557	1.41	0.2857	2.70**

***, **, and * indicate statistical significance at the 0.01, 0.05 and 0.10 level respectively.

When we categorize daily weighted price contribution according to pre-halt abnormal short selling levels, we find that the majority of price change occurs on the halt day for both the highest and lowest short selling quintiles. However, the lowest short selling quintile demonstrates a significant positive price contribution in the pre-halt period and a negative contribution following the resumption of trading. This finding corroborates earlier findings of a negative mean post-announcement return (from day 0 to +1) for firms with low short selling levels (Table 6).

When we concentrate our examination of price contribution to the event day, we find that only five percent of price adjustment occurs in the five, five-minute periods immediately before the trading halt is implemented. The remaining price contribution is split between the halt

period and the five periods following the resumption of trading. Segmenting our results according to short selling levels confirms that only a small percentage of price contribution, three to six percent, occurs directly preceding the trading halts. However, it appears that price behavior is much different between firms with high and low levels of short selling. The majority, 88 percent, of price change for firms in the highest short selling tercile occurs in the post-halt period. For firms in the lowest short selling tercile, the largest price contribution, 66 percent, transpires while trading is halted.

Hypothesis 4 states that halted firms with high short selling will experience a more rapid adjustment in price prior to a trading halt as compared to halted stocks without a significant level of short selling. Our results, from both the speed of price adjustment and weighted price contribution tests suggest that effect of the trading halt on equity prices is more pronounced following the resumption of trading, not before the halt is implemented. However, both tests indicate a discernible difference between firms according to short selling activity; a larger price impact is reported in the post-halt period for stocks with the highest shorting levels.

Volatility

To explore the relation between trading halts and short selling activity, we examine, on both the daily and intraday level, price volatility surrounding interruptions in trading.

Our hypothesis concerning the effect of short selling on price volatility for firms experiencing a trading halt is:

H_5: Halted stocks with high levels of short selling will have lower price volatility upon resumption of trade and their reopening prices will be better predictors of future prices as compared to halted stocks with lower short selling activity.

Following the methodology of Diether et al. (2009A), we calculate daily volatility measures for the pre-halt period (days -5 through -1), the halt day (day 0), and a post-halt period (days +1 through +5). CRSP data is used to determine a daily mean transaction price range [(high price – low price)/ high price] and close-to-close volatility (by squaring the absolute daily return). TAQ data is used to calculate a daily quote range [(high quote – low quote) / high quote] as well as close-to-close and open-to-close volatility using absolute squared return. The difference between the pre and post measures for each of these metrics is the coefficient obtained by regressing each volatility measure on a post-halt period dummy variable (which equals one for observations during the five-day post-halt period); the difference is tested to determine if it is significantly different from zero. We repeat each test, after dividing our sample halts into quintiles according to levels of abnormal short selling. Results are reported in Table 11 – Panel A and Panel B for CRSP and TAQ data respectively.

Table 11

Daily Mean Volatility Measures

Daily volatility measures are calculated for the pre-halt period (days -5 through -1), the halt day (day 0), and a post-halt period (days +1 through +5). CRSP data is used to determine a daily mean transaction price range [(high price – low price)/ high price] and close-to-close volatility (by squaring the absolute daily return). TAQ data is used to calculate a daily quote range [(high quote – low quote) / high quote] and close-to-close and open-to-close volatility using absolute squared return. The difference between the pre and post measures for each of these metrics is the coefficient obtained by regressing each volatility measure on a post-halt period dummy variable, which equals one for observations during the five-day post-halt period. The difference is tested to determine if it is significantly different from zero, t-statistics are reported in parentheses. After dividing our sample halts into quintiles according to levels of abnormal short selling, we repeat each test and report values for the highest and lowest short-selling quintiles.

Panel A: CRSP Data

Periods/Volatility Metric	$Pre_{(-5,-1)}$	$Event_{(0)}$	$Post_{(1,5)}$	Difference		Difference N =
All Halts (N = 78)						
Transaction Price Range	2.5988	7.8411	3.0990	0.4952	(3.14) ***	947
Volatility (Close to Close)	0.0009	0.0110	0.0016	0.0007	(1.71) *	948
By Short Selling (N = 15 Halts per Quintile)						
Low Short-Selling Quintile						
Transaction Price Range	2.0370	5.3540	2.4200	0.3826	(1.39)	180
Volatility (Close to Close)	0.0004	0.0060	0.0010	0.0001	(0.95)	180

High Short-Selling Quintile						
Transaction Price Range	2.4690	11.092	3.1770	0.7088	(2.96) ***	180
Volatility (Close to Close)	0.0003	0.0115	0.0010	0.0006	(1.72) *	180
Panel B: TAQ Data						
All Halts (N = 78)						
Quote Range	10.99	15.39	11.29	0.3050	(0.7)	936
Volatility (Open to Close)	0.0005	0.0091	0.0008	0.0003	(1.73)*	923
Volatility (Close to Close)	0.0006	0.0100	0.0012	0.0006	(2.41)**	923
By Short Selling (N = 15 Halts per Quintile)						
Low Short-Selling Quintile						
Quote Range	8.19	11.04	8.15	-0.0430	(-0.05)	180
Volatility (Open to Close)	0.0003	0.0036	0.0005	0.0001	(0.86)	167
Volatility (Close to Close)	0.0010	0.0059	0.0007	0.0001	(0.41)	167
High Short-Selling Quintile						
Quote Range	13.44	20.16	13.08	-0.3617	(-0.41)	180
Volatility (Open to Close)	0.0003	0.0124	0.0007	0.0004	(1.71)*	180
Volatility (Close to Close)	0.0003	0.0112	0.0008	0.0005	(1.43)	180

***, **, and * indicate statistical significance at the 0.01, 0.05 and 0.10 level respectively.

At the daily level, the transaction price range of 7.84 is substantially higher on the event day, as compared to either the pre or the post-event period values of 2.59 and 3.09. The difference value of 0.4952 indicates that price variance in the post-halt period is significantly higher, at the one percent level, than during the five days preceding the halt.

When segmented according to short selling levels, the transaction price range is less in all three periods for the lowest short selling quintile as compared to values for all halts. The difference variable is not significant, suggesting there is not a measureable difference in transaction price range between the pre and post period for stocks in the lowest short-selling quintile. In contrast, the transaction price range is relatively larger in each period for the highest short selling stocks – increasing to 11.092 on the event day, with a large difference variable (0.7088). These results suggest a positive relation between pre-halt short selling and price movement throughout the event period. In contrast to our hypothesized relation, it appears that a high level of pre-halt short selling appears to increased post-halt price volatility.

A similar pattern, for all halts and for both short selling categories, is identified with close-to-close volatility: a sharp increase on the halt day and a reduction in the days following, with post-halt values exceeding pre-halt values. The difference variable is statistically significant for all firms and for high short-selling firms at the ten percent level; volatility appears mitigated for stocks with low levels of short activity.

These results indicate that price variance for all sample firms increases substantially on the halt day, then decrease considerably but remain elevated from pre-halt levels during the post-halt period. This effect appears to be stronger for firms with higher levels of short selling, suggesting that short selling activity translates into heightened price variability.

TAQ data is used to calculate daily quote ranges and open-to-close and close-to-close volatility measurements (reported in Panel B). A substantial increase in the quote range (15.39) is reported for all firms on the halt day; however, the pre and post halt quote range values are similar in magnitude and the difference between them is not statistically different from zero. A similar pattern is noted after segmenting halts according to short selling levels – high halt day values, with quote ranges lower following the resumption of trading and insignificant differences between the pre and post periods. However, the quote range during the event day for the highest short selling stocks is nearly twice the quote range for the lowest quintile, and corresponding quote range values are substantially higher during the pre and post halt periods.

Both volatility metrics demonstrate heightened levels on the event day, with open to close volatility increasing by a factor of ten over both the pre and post halt periods. The difference between the pre and post halt period is significant and positive. This result coincides with Christie et al. (2002), who find that volatility increases to more than nine times normal levels for NASDAQ halts that reopen after a five-minute quotation period.

When differentiating according to levels of short selling, volatility remains highest on the halt day, but a significant difference remains only for open-to-close volatility for firms with the highest levels of short selling. These findings coincide with our earlier results and suggest that short selling activity surrounding trading halts positively impacts price variability.

At the intraday level, we use TAQ data to calculate median and abnormal measures (as compared to the estimation period) for volume, number of quote revisions, absolute return and transaction price range during the four 30-minute periods preceding the halt and following the resumption of trading (following Corwin and Lipson, 2000). Significance is determined using the Wilcoxon signed-rank test, which allows us to compare measurements on our sample without relying on an assumption of normality.

The results of these tests, presented in Table 12, indicate significant increases in abnormal volume, the number of quote revisions and transactional price range in the four 30-minute periods preceding trading interruptions. More pronounced increases are noted in the post-halt periods, where most median values double and each of the abnormal metrics increases 100 – 300 times their corresponding estimation period values.

Table 12
Mean Interval Intraday Volatility Measures
TAQ data is used to calculate median and abnormal measures (as compared to the estimation period) for volume, number of quote revisions, absolute return and transaction price range during the four 30-minute periods preceding the halt and following the resumption of trading. Mean values are reported for the four 30-minute period preceding a trading halt (pre) and the four 30-minute periods following resumption of trading (post). Significance is determined using the Wilcoxon signed-rank test.

Panel A: All Halts (78)

Period	Volume	Quote Revisions	Absolute Return	Transaction Price Range
		Median		
$Pre_{(-4,-1)}$	35,000	416.5	0.2598	0.140
$Post_{(1,4)}$	71,550	539.0	0.5655	0.335
		Abnormal Percentage		
$Pre_{(-4,-1)}$	3.58 ***	5.97 ***	-16.50	4.35 **
$Post_{(1,4)}$	326.71 ***	104.50 ***	102.28 ***	186.27 ***

Panel B: By short-selling levels (15 halts per quintile)				
Lowest Short-selling Quintile				
			Median	
$Pre_{(-4,-1)}$	1,350	64	0.4491	0.100
$Post_{(1,4)}$	2,650	41	0.5102	0.210
			Abnormal Percentage	
$Pre_{(-4,-1)}$	-24.10	-9.55	9.26	19.51
$Post_{(1,4)}$	162.75 ***	15.77 **	63.58 ***	149.11 ***
Highest Short-selling Quintile				
			Median	
$Pre_{(-4,-1)}$	469,650	2232	0.4115	0.245
$Post_{(1,4)}$	1,285,800	3621	1.1645	0.600
			Abnormal Percentage	
$Pre_{(-4,-1)}$	82.37 ***	53.98 ***	28.18 ***	40.70 ***
$Post_{(1,4)}$	782.60 ***	233.32 ***	353.52 ***	393.29 ***

*** and ** indicate statistical significance at the 0.01 and 0.05 level respectively.

Each of these measures, when computed by short selling levels, demonstrates (in Panel B) values that are more prominent for firms with high levels of short selling. Median and abnormal values are large and consistently significant across all metrics in the pre and post periods for firms with the highest levels of short selling. Volume is particularly impacted: median short volume in the post-halt period is over a million shares with trading levels representing 782 percent of normal levels.

In contrast, firms with low levels of short selling show no significant abnormal values in the pre-halt period, and the median and abnormal values in the post-halt periods are smaller than corresponding values for firms with high short selling activity. These findings suggest that short selling has a distinct and measureable impact on volatility surrounding trading halts.

We further decompose our examination of each of our volatility measures by 30-minute periods and report the results in Table 13 Panel A. It appears that the largest increase for each of these metrics occurs in the period immediately following the resumption of trading. Abnormal values range from 222 percent for quote revisions to over 950 percent for trading volume. Each

of these metrics remains elevated through the four post-halt periods examined. There is little evidence of a significant impact on these measures during the pre-halt periods.

When categorized according to short selling levels (Table 13 Panel B), the difference between firms with high and low short-selling activity becomes quite evident. Firms in the high short-selling quintile have median and abnormal values that are larger in magnitude and are generally significant at a high level. Volatility levels upon resumption of trading for these firms demonstrate a monumental increase over pre-halt values and each of the measurements remain elevated through the four periods examined.

Table 13
Mean Period Intraday Volatility Measures
TAQ data is used to calculate median and abnormal measures (as compared to the estimation period) for volume, number of quote revisions, absolute return and transaction price range during the four 30-minute periods preceding the halt and following the resumption of trading. Panel A presents findings for all halts; results for the highest and lowest quintiles according to levels of abnormal short selling are presented in Panel B. Significance is determined using the Wilcoxon signed-rank test.

Panel A: All Halts (78)

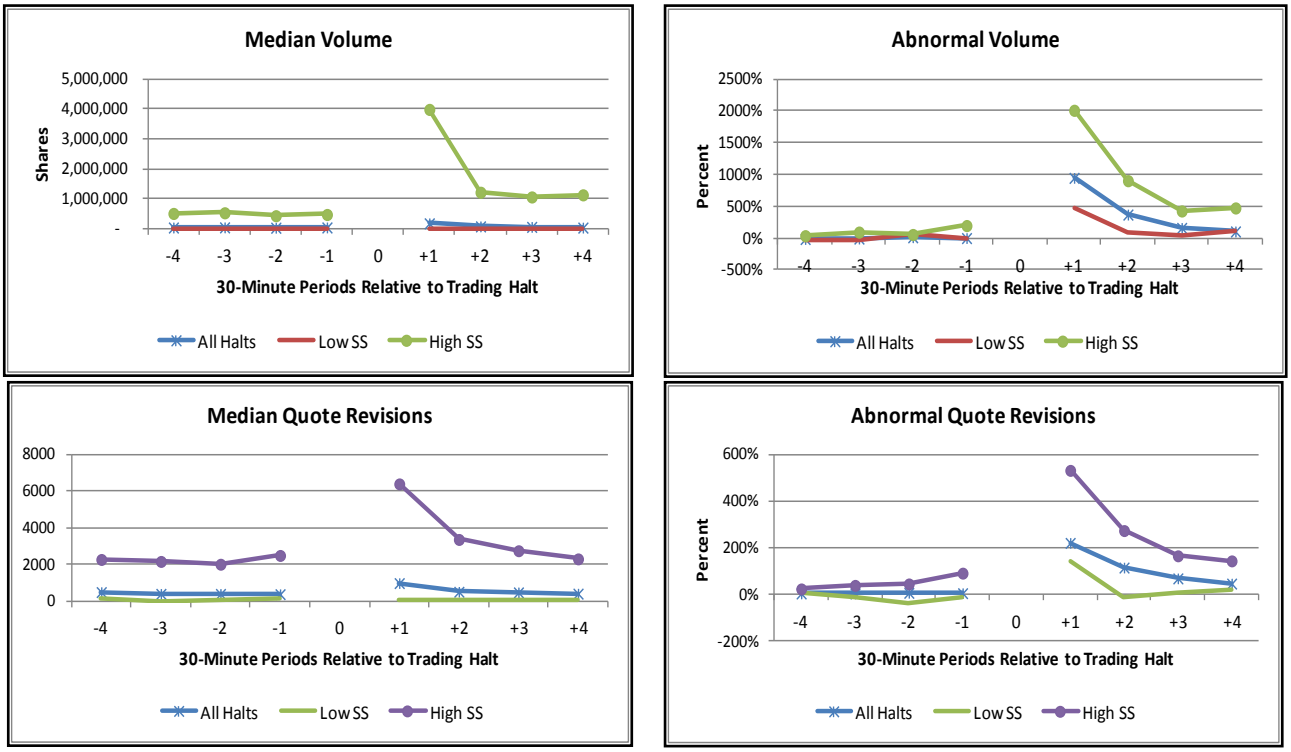
Period	Volume	Quote Revisions	Absolute Return	Transaction Price Range
		Median		
-4	34,800	497	0.3279	0.190
-3	40,000	404	0.2192	0.125
-2	27,600	400	0.2200	0.145
-1	37,300	383	0.2575	0.140
+1	174,400	987	2.1635	0.850
+2	73,100	516	0.4438	0.310
+3	56,100	481	0.4594	0.260
+4	31,800	411	0.3867	0.200
		Abnormal Percentage		
-4	-12.01	5.76	8.05	0.51
-3	-4.68 *	5.44	-25.43	5.63
-2	16.29 *	8.53	-19.79	-12.38
-1	2.41 **	6.95 **	-6.81	11.36 **
+1	950.06 ***	222.13 ***	483.04 ***	756.52 ***
+2	372.08 ***	116.53 ***	53.78 ***	196.74 ***
+3	162.37 ***	70.29 ***	64.68 ***	129.85 ***
+4	106.66 ***	47.93 ***	20.41 **	83.08 ***

Panel B: By short-selling levels (15 halts per quintile)				
Lowest Short-selling Quintile				
			Median	
-4	1,300	116	0.9814	0.090
-3	1,150	17	0.3617	0.100
-2	1,350	56	0.2683	0.130
-1	1,450	101	0.6045	0.090
+1	6,250	62	0.8189	0.540
+2	3,550	26	0.4119	0.110
+3	1,050	42	0.3617	0.130
+4	1,550	41	0.5024	0.185
			Abnormal Percentage	
-4	-21.17	5.76	199.32	69.18
-3	-38.15	-11.11	9.26	-6.07
-2	56.89	-34.92	-32.81	-12.93
-1	-1.22	-11.11	53.49	59.43
+1	471.92 ***	143.16 **	152.43 **	1,126.99 ***
+2	96.60 **	-8.38	15.45	27.16
+3	41.82	6.93	67.18	86.99 *
+4	120.79	22.53	69.10	172.32 ***
Highest Short-selling Quintile				
			Median	
-4	505,500	2276	0.3098	0.260
-3	527,550	2169	0.5376	0.275
-2	429,000	2016	0.2462	0.195
-1	470,400	2495	0.6388	0.310
+1	3,986,750	6397	3.4341	1.246
+2	1,214,200	3367	0.4555	0.420
+3	1,057,300	2752	0.5747	0.370
+4	1,128,200	2307	0.7648	0.300
			Abnormal Percentage	
-4	39.46 **	25.11 *	25.98	14.03
-3	96.43 ***	40.38 ***	59.91 **	47.32 ***
-2	58.40 ***	46.47 ***	-9.63	28.25 *
-1	199.10 ***	92.70 ***	156.15 ***	216.74 ***
+1	2,012.91 ***	532.47 ***	1,347.97 ***	1,068.83 ***
+2	905.34 ***	274.85 ***	65.62 **	258.00 ***
+3	429.02 ***	166.84 ***	170.83 ***	178.69 ***
+4	476.33 ***	145.14 ***	154.04 *	181.38 **

*** and ** indicate statistical significance at the 0.01 and 0.05 level respectively.

A significant increase is noted for the low short-selling firms for each metric during the period when trading resumes. However, few significant values are noted outside period +1, and the magnitude of the median and abnormal values are generally less than for firms in the high short selling quintile. In addition, high short-selling firms demonstrate a considerable impact in the pre-halt periods; firms in the lowest short-selling category fail to evidence a pre-halt effect.

Figure 5 graphs values for each volatility dimension, for all halts and for the high and low short selling quintiles. This representation confirms the disparity both between the pre and post halt periods, and between the behaviors of firms based on their short-selling activity. It also demonstrates that volatility levels at the resumption of trading are substantially larger for high short selling stocks, suggesting less efficient reopening prices for these firms.



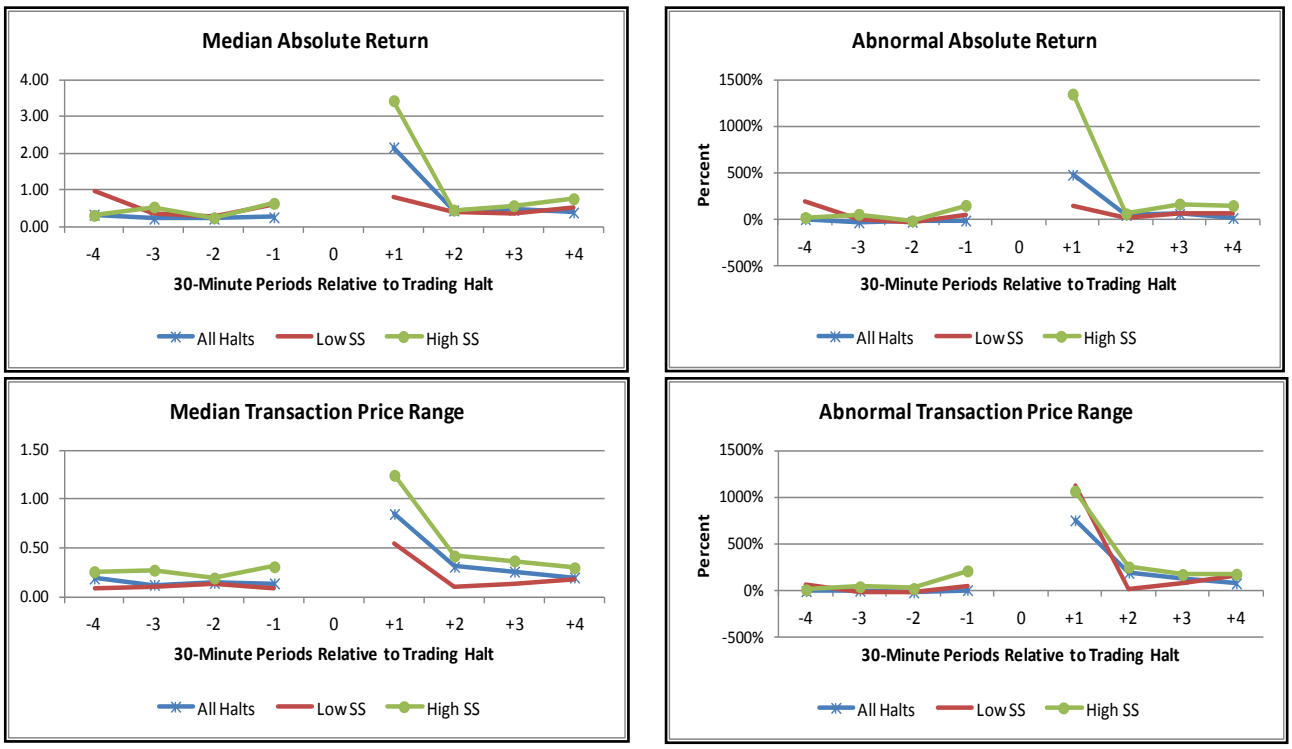


Figure 5

Intraday Volatility Measures

TAQ data is used to calculate median and abnormal measures (as compared to the estimation period) for volume, number of quote revisions, absolute return and transaction price range during the four 30-minute periods preceding the halt and following the resumption of trading. Results are reported for all halts, and for the highest and lowest quintiles of halts as determined by halt-day levels of abnormal short selling.

Hypothesis 5, which suggests that halted stocks with high short-selling levels will have lower price volatility and more efficient reopening prices, is not supported by our findings. Instead, we find that sample firms have increased volatility in the post-halt period and that reopening prices are less efficient. Short selling activity appears to increase instead of decrease volatility levels surrounding a halt in trading.

Spreads

To clarify the combined effect of short selling and trading halts on the bid-ask spread, we examine mean and median dollar spreads at several intervals preceding the halt and following the resumption of trading.

Our hypothesis concerning the impact of short selling on spreads surrounding trading halts purports that:

H_6: Halted stocks with high levels of short selling will have lower spreads upon resumption of trading as compared to halted stocks with lower short selling activity.

To compare halt-day values to the values expected during non-halt trading periods, we compute spreads using three different intervals: 30 minutes, 1 minute, and 15 seconds (following Corwin and Lipson, 2000). When we examine the 30-minute pre and post periods, we find, shown in Figure 6, that for both the mean and median spread, values in the pre-halt period are nearly identical to estimation period values. However, during the halt period, the spread more than triples; spreads remain elevated one period after the resumption of trading before reverting to normal levels.

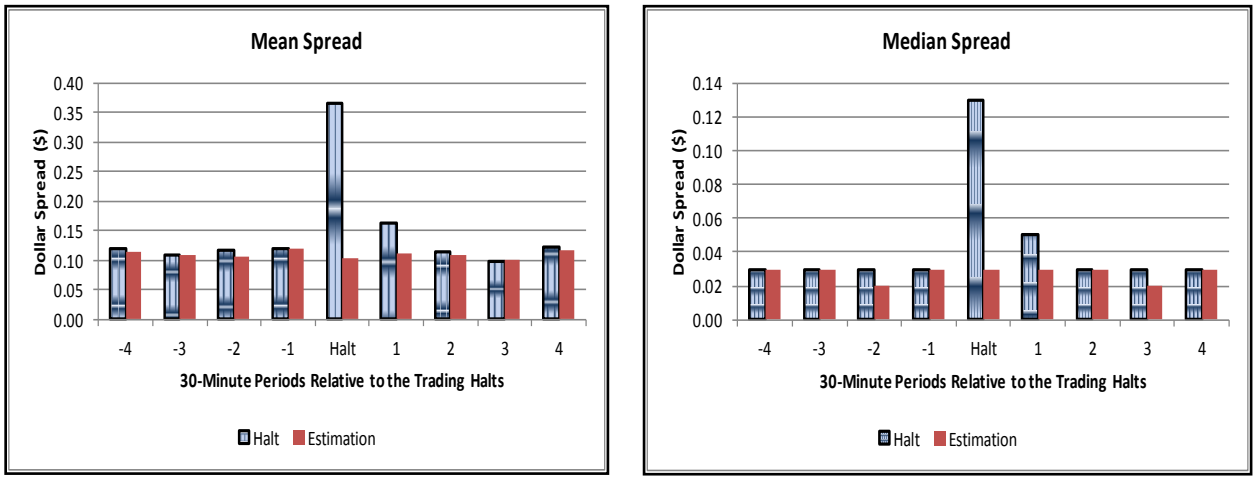


Figure 6

Halt and Estimation Period Mean and Median Spreads
Mean and median spreads are computed for 30-minute periods preceding the interruption of trading and following the resumption of trading on the halt day and during corresponding periods in the estimation period.

We categorize firms into quintiles according to abnormal short selling levels and repeat our examination for 30-minute periods. Our findings, presented in Figure 7, suggest that for firms with low levels of sort selling, spreads are measurably elevated in pre-halt periods -4 through -2. The spreads for these firms decrease immediately prior to the halt and remain at a relatively stable level during the remainder of the examination period. Firms in the high short selling quintile, however, demonstrate small spreads prior to the halt in trading, a dramatic increase during the halt period and a reduction immediately after trading resumes.

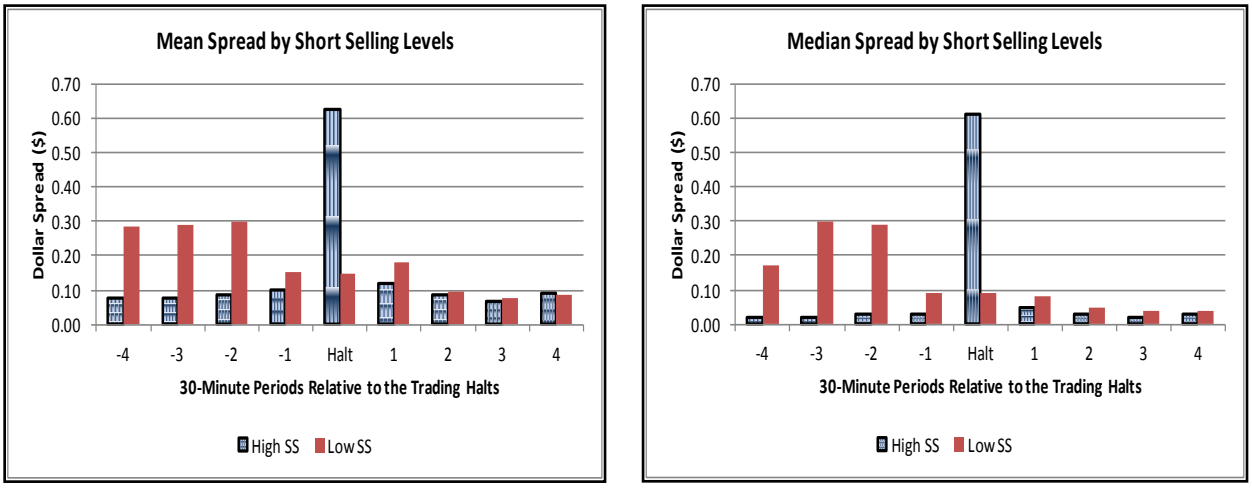
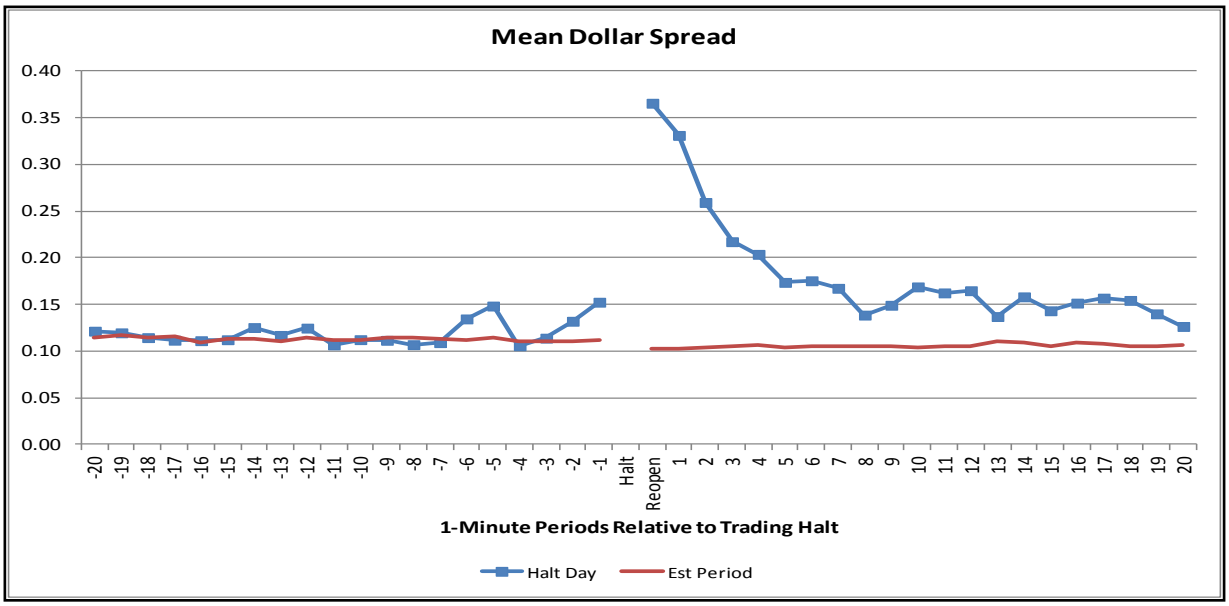


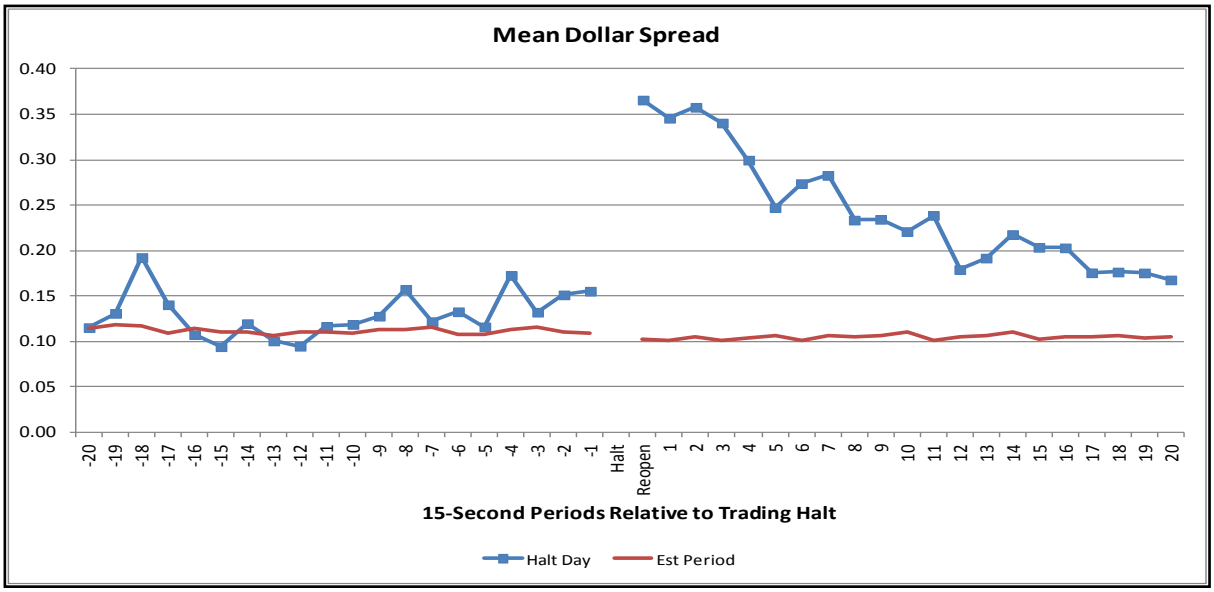
Figure 7
Mean Intraday Spreads: 30-Minute Periods
Mean and median spreads are computed for 30-minute periods preceding the interruption of trading and following the resumption of trading. Results are reported for firms in the highest and lowest quintiles of short selling according to halt-day abnormal short selling levels

Spreads are then examined for all halted stocks at one-minute (Figure 8 Panel A) and 15-second intervals (Figure 8 Panel B). We find that spreads are relatively stable leading up to the halt - they show a modest increase during the periods immediately preceding the break in

trading, a sharp increase during the halt period, and a gradual reduction during the post-halt periods. Spreads are near estimation period levels twenty minutes after the resumption of trade.



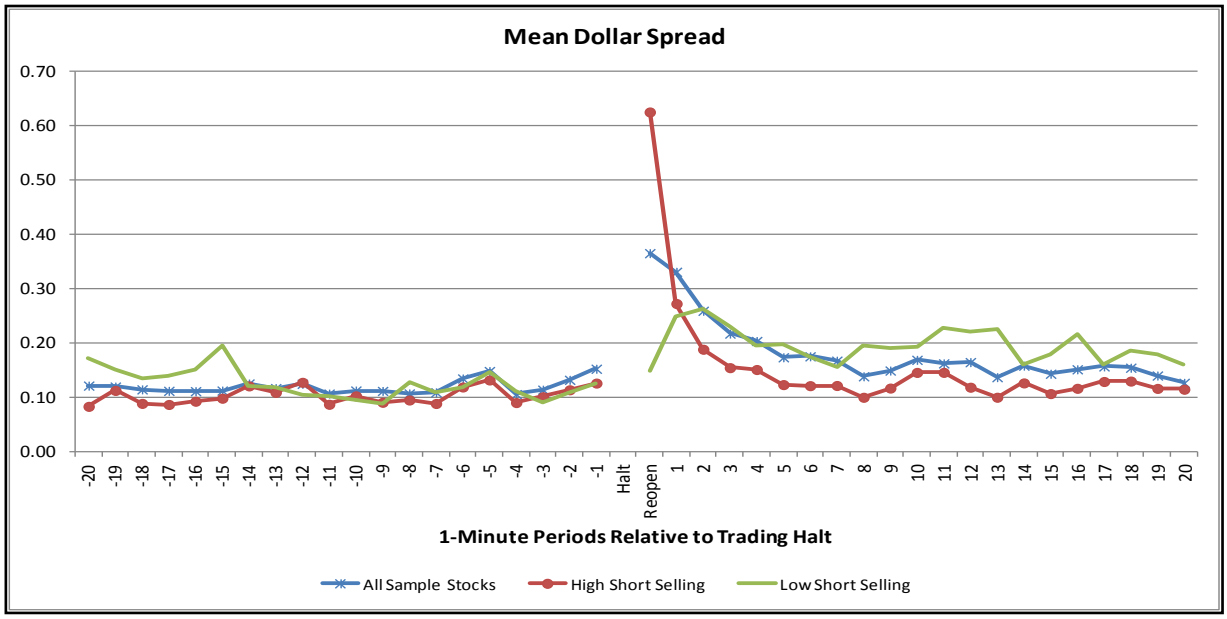
Panel A: 1-minute Spreads



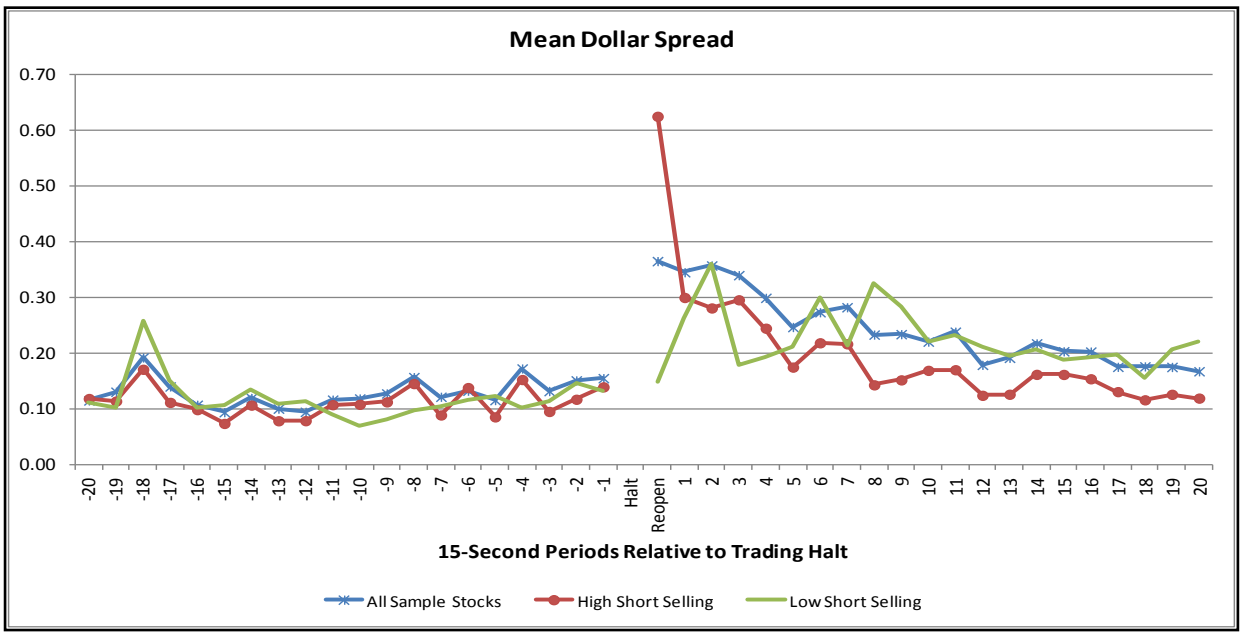
Panel B: 15-Second Spreads

Figure 8
Mean Intraday Spreads: 1-Minute and 15-Second Periods
Mean and median spreads are computed for 1-minute (Panel A) and 15-second (Panel B) periods preceding the interruption of trading and following the resumption of trading on the halt day and during corresponding periods in the estimation period.

Evaluating 1-minute and 15-second spreads according to short selling levels again demonstrates an observable difference in the spreads of high versus low short selling firms (Figure 9). The spreads for all firms and firms categorized by short selling levels vacillate around the 8 – 14 cent range in the pre-halt examination period. However, upon the reopening of trade, the spread for stocks in the high short-selling quintile increases to over 60 cents, then quickly declines, converging to a normal level in two to three minutes. For stocks classified with low short selling levels, the reopening spread is approximately 15 cents. The reaction on the part of these stocks appears delayed, occurring several periods after the resumption of trade, and spreads remain higher than for other stocks during the post-halt periods examined.



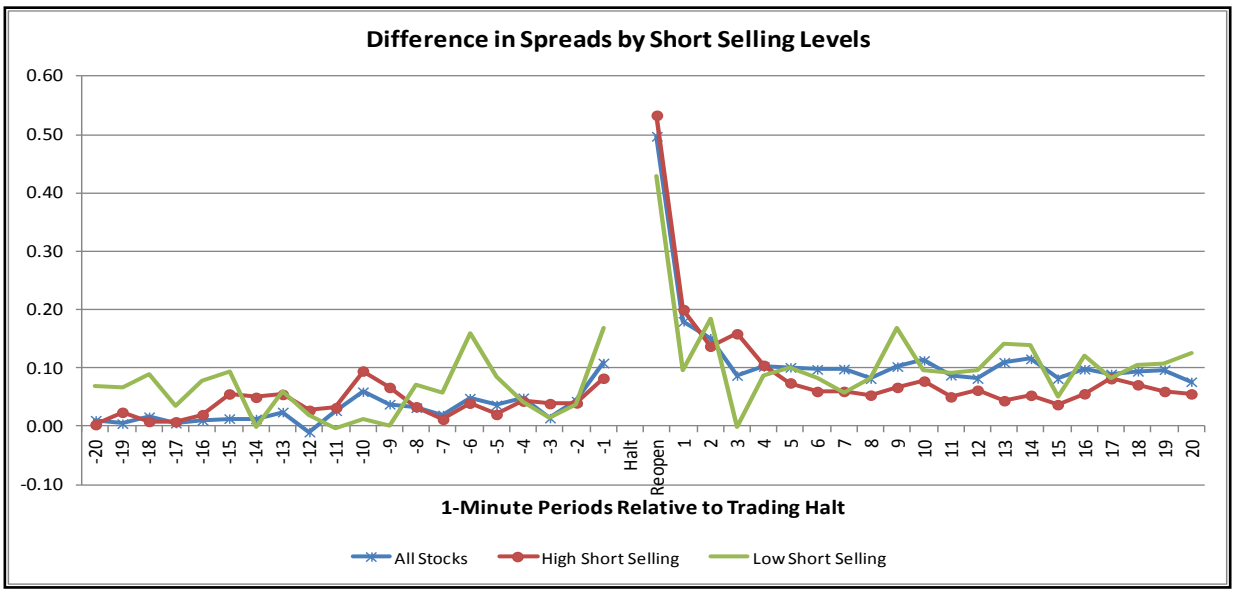
Panel A: 1-minute Spreads



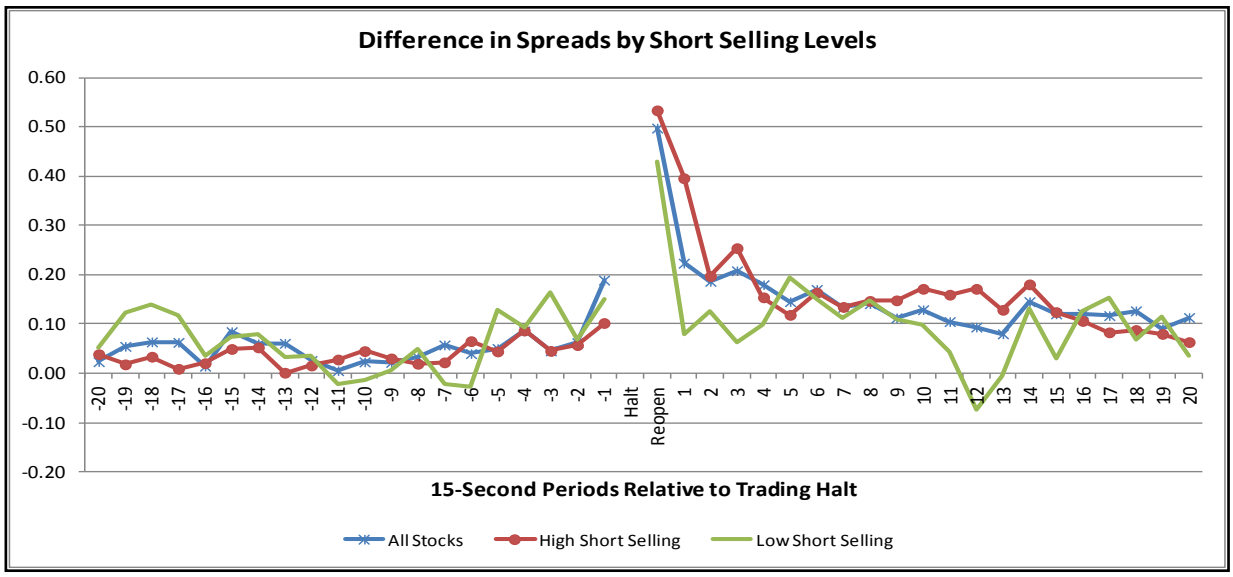
Panel B: 15-Second Spreads

Figure 9
Mean Intraday Spreads by Short Selling Levels
Mean and median spreads are computed for 1-minute (Panel A) and 15-second (Panel B) periods preceding the interruption of trading and following the resumption of trading on the halt day. Halts are then categorized according to halt-day abnormal short selling levels, and results are reported for all halts, and the highest and lowest short-selling quintiles.

We calculate the difference between the mean spread on the halt day and the estimation period for each pre and post halt period for all stocks and by short-selling levels. These results are reported in Table 14 (30-minute periods), Figure 10 (1-minute and 15-second periods) and Table 15 (15-second periods).



Panel A: 1-minute Spreads



Panel B: 15-Second Spreads

Figure 10
Differences in Spreads by Short Selling Levels
Differences in mean spreads are computed for one minute (Panel A) and 15-second (Panel B) periods between halt day means period spreads and and corresponding mean values for each period during the estimation interval.

We find that the difference in spreads is positive and significant in the period immediately preceding the halt for all stocks during the 30-minute periods (Table 14). However,

the most dramatic change occurs during the halt period, with the spread difference increasing from 0.04 to 0.50. The spread difference drops to 0.08 in the second post-halt period; the spread difference remains positive throughout the remainder of the post-halt periods examined.

Table 14
Spread Differences: 30-Minute Periods
For all stocks and by short-selling levels, the difference between the mean spread on the halt day and the estimation period is calculated for each 30-minute period. Results are reported for only the highest and lowest short selling quintiles, as established by halt-day abnormal short selling levels. Differences are tested to determine if they are statistically difference than zero. T-statistics are reported in parentheses.

Period	All Halts		High Short Selling		Low Short Selling	
-4	0.02	(1.27)	0.00	(-0.37)	0.10	(0.94)
-3	0.01	(0.38)	0.00	(0.19)	0.02	(0.18)
-2	0.03	(1.59)	0.01	(0.94)	0.09	(0.98)
-1	0.04	(3.75) ***	0.03	(2.64) **	0.07	(2.46) **
Halt	0.50	(6.99) ***	0.53	(4.15) ***	0.43	(1.61)
+1	0.08	(7.01) ***	0.06	(3.31) ***	0.09	(2.74) **
+2	0.03	(2.94) ***	0.03	(2.00) *	0.01	(0.18)
+3	0.02	(2.73) ***	0.01	(1.34)	0.01	(0.21)
+4	0.03	(2.62) **	0.03	(1.59)	0.01	(0.42)

***, **, and * indicate statistical significance at the 0.01, 0.05 and 0.10 level respectively.

When we examine the difference in means for the 30-minute periods according to short selling levels, the differences, for the high short selling quintile, are positive and significant for periods -1 through +2, with a spread difference of 0.53 during the halt period. In contrast, stocks in the lowest sort selling quintile are significant only in periods -1 and +1.

The difference values, shown in Table 15, for all halts by 15-second periods suggest that an increase in spreads begins five periods before trading is halted (75 seconds) with a measurable increase in period -1. Spread differences remain elevated for the twenty post-halt periods examined.

The high and low short selling groups both demonstrate an increase in spread difference in period -1 (immediately preceding the cessation of trading), elevated values during the halt

period, and reduction of spread differences in the post-halt periods. However, the difference value for high short selling stocks is quite large in period +1, and each of the difference values are larger than corresponding values for low short selling stocks for periods 0 through +4. Figure 10 displays this pattern for both the one-minute (Panel A) and 15-second (Panel B) examination periods.

We hypothesize that stocks with high levels of short selling will have lower spreads upon resumption of trade as compared to halted stocks without a significant level of short selling. Our findings suggest however that for all halted firms in our sample, spreads increase dramatically during the interruption in trading and they remain elevated following the resumption in trading. When we differentiate our halts according to abnormal short selling, we find that short selling activity appears to increase the spread during the halt period, but that spreads seem to recover to anticipated levels more quickly.

Table 15

Spread Differences: 15-Second Periods

For all stocks and by short-selling levels, the difference between the mean spread on the halt day and the estimation period is calculated for each 15-second period. Results are reported for only the highest and lowest short selling quintiles, as established by halt-day abnormal short selling levels. Differences are tested to determine if they are statistically difference than zero. T-statistics are reported in parentheses.

Period	All Halts		High Short Selling		Low Short Selling	
-20	0.02	(1.16)	0.04	(1.96) *	0.05	(1.38)
-19	0.05	(2.38) **	0.02	(1.06)	0.12	(1.79)
-18	0.06	(2.39) **	0.03	(1.85) *	0.14	(2.10) *
-17	0.06	(2.32) **	0.01	(0.68)	0.12	(2.82) **
-16	0.01	(1.04)	0.02	(1.57)	0.04	(0.81)
-15	0.08	(2.70) ***	0.05	(1.59)	0.07	(1.78)
-14	0.06	(2.35) **	0.05	(1.56)	0.08	(2.27) *
-13	0.06	(2.28) **	0.00	(0.08)	0.03	(0.54)
-12	0.03	(1.25)	0.02	(0.69)	0.04	(0.92)
-11	0.01	(0.36)	0.03	(1.17)	-0.02	(-0.67)
-10	0.02	(1.25)	0.05	(1.24)	-0.01	(-0.34)
-9	0.02	(0.96)	0.03	(0.71)	0.01	(0.16)
-8	0.03	(1.41)	0.02	(0.81)	0.05	(1.04)
-7	0.06	(1.98) *	0.02	(0.77)	-0.02	(-2.61) *

-6	0.04	(1.49)	0.07	(1.84) *	-0.03	(-0.54)
-5	0.05	(2.39) **	0.04	(1.29)	0.13	(1.08)
-4	0.09	(2.49) **	0.09	(1.7)	0.09	(1.60)
-3	0.05	(1.88) *	0.05	(1.41)	0.16	(2.40) *
-2	0.06	(1.76) *	0.06	(1.11)	0.07	(0.99)
-1	0.19	(3.54) ***	0.10	(2.10) *	0.15	(0.82)
Halt	0.50	(6.99) ***	0.53	(4.15) ***	0.43	(1.61)
1	0.22	(5.65) ***	0.40	(2.95) **	0.08	(1.27)
2	0.19	(6.98) ***	0.20	(5.73) ***	0.13	(2.41) **
3	0.21	(8.09) ***	0.25	(6.25) ***	0.06	(2.84) **
4	0.18	(7.38) ***	0.15	(3.05) **	0.10	(2.30) *
5	0.15	(5.25) ***	0.12	(3.81) ***	0.19	(1.86)
6	0.17	(7.37) ***	0.16	(5.50) ***	0.15	(3.39) **
7	0.13	(6.29) ***	0.13	(4.72) ***	0.11	(1.60)
8	0.14	(5.71) ***	0.15	(2.88) **	0.15	(2.29) *
9	0.11	(5.15) ***	0.15	(2.46) **	0.11	(2.53) **
10	0.13	(4.74) ***	0.17	(2.00) *	0.10	(1.58)
11	0.11	(4.48) ***	0.16	(2.58) **	0.04	(1.05)
12	0.09	(3.56) ***	0.17	(2.25) **	-0.07	(-0.78)
13	0.08	(3.77) ***	0.13	(1.90) *	-0.01	(-0.20)
14	0.15	(5.41) ***	0.18	(2.63) **	0.13	(2.69) **
15	0.12	(5.57) ***	0.12	(2.72) **	0.03	(0.46)
16	0.12	(5.87) ***	0.11	(3.45) ***	0.13	(1.60)
17	0.12	(4.20) ***	0.08	(3.19) ***	0.15	(1.86)
18	0.13	(5.81) ***	0.09	(3.37) ***	0.07	(1.00)
19	0.09	(4.28) ***	0.08	(2.50) **	0.11	(1.98) *
20	0.11	(4.07) ***	0.06	(2.80) **	0.03	(0.69)

***, **, and * indicate statistical significance at the 0.01, 0.05 and 0.10 level respectively.

CONCLUSION

Our research intent is to establish if short selling activity is altered surrounding trading halts and determine if short sellers noticeably influence market quality and impact security prices for halted firms. We hypothesize that short selling activity increases prior to a trading halt and decreases following the resumption of trading. We further purport that halted firms with high short selling activity, as compared to firms with lower levels of short selling, will experience a larger price decline and a more rapid adjustment in price surrounding halts, and lower price volatility and spreads after trading resumes.

We find little evidence at the daily level to support our proposition that short sellers increase their activity prior to the implementation of a trading halt. We are unable to identify increases in daily short trade size, number of trades or short volume prior to the event day. However, our findings suggest that short sellers substantially modify their trading behavior surrounding halts, as shorting metrics increase markedly on the halt day. An intraday examination of shorting levels suggests a modest increase in activity in the two 30-minute periods prior to the interruption in trading and a substantial increase in short selling in the periods immediately following the reopening of trading. As anticipated, short selling values decline in the post-halt period, but they remain elevated above estimation period levels during the post-halt daily examination and for several periods following the resumption of trading on the halt day itself.

Based on previous findings, our priori is that firms simultaneously undergoing a halt and high levels of short selling will experience negative returns. However, at the daily level, when

categorized according to abnormal short selling levels, firms in the highest shorting category demonstrate positive post-announcement returns. Chi-square test supports this conclusion by demonstrating a shift of high short selling firms in the high return category; regression results also indicate that pre-halt short selling increases for stocks with positive returns in the immediate post-halt period.

At the intraday level, the highest and lowest short selling (ABSS) quintiles of firms demonstrate positive returns during the trading interruption and negative returns immediately following the reopening of trading. Short selling appears to amplify these returns, as values for the high short-selling quintile are greater in magnitude. These findings suggest that relevant information is primarily incorporated into prices after trading resumes and that short selling assists the market in the price discovery process.

Results suggest that both trading halts and short selling activity affect the speed of price adjustment. A comparison between halt day and estimation period speeds identify heightened price movement in the period directly following the post-halt continuation of trading. Providing support for Hypothesis 4, differentiating between the lowest and highest short selling stocks indicates that the increase in the post-halt speed of price adjustment is more pronounced for firms with higher shorting activity.

The majority of price contribution at the daily level occurs on the halt day, for all stocks and for both the high and low short selling categories. At the intraday level, the weighted price contribution for all halts occurs primarily during the halt and post-halt periods – very little contribution is from the periods preceding the interruption in trading. However, for high short selling firms, almost ninety percent of price impact occurs after the resumption of trading. In

contrast, the firms in the lowest short selling category demonstrate the highest price impact while trading is halted.

When examining all firms, we find that intraday volatility measures fail to demonstrate a substantial impact preceding the halt. However, volatility increases markedly following the resumption of trading and it remains elevated through the post-halt periods examined. Short selling activity, in contrast to our expected findings, appears to increase volatility surrounding trading halts, as firms with high levels of short selling evidence both an impact prior to the implementation of a halt and substantially larger values (as compared to firms with low levels of short selling) in all periods.

Intraday spreads for all halts are relatively stable in the pre-halt periods, but they exhibit a modest increase two periods before trading is interrupted. Spreads are highest during the halt period and then gradually return to normal values. Upon the reopening of trading, the spreads for stocks in the high short-selling category are substantially elevated, but return to expected values within 20 minutes. For firms with the lowest short selling levels, reopening spreads do not show as large of an increase, but they remain above normal values for the remainder of the periods examined. Diether et al. (2009B) provides a rationale for the observed spread and volatility behavior, stating that if short sellers act as opportunistic risk bearers during periods of heightened uncertainty triggered by short-lived asymmetric information, then elevated levels of short selling might occur in conjunction with high intraday volatility and wide spreads.

Although our empirical investigation yields findings that do not fully support our proposed hypotheses, our results strongly indicate that short sellers modify their behavior surrounding exchange-mandated halts in trading. The market quality of halted firms, in terms of

price, volatility and spreads, is impacted not only by the interruption in trading, but also by levels of shorting activity.

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ESSAY 2:

CONTAGIOUS SHORT SELLING SURROUNDING TRADING HALTS

INTRODUCTION

The purpose of this paper is to determine if a short-selling contagion effect exists for contemporaries of firms experiencing a trading halt. Although trading suspensions represent a firm-specific event, they may be viewed as 'contagious' in the sense that they contain information relevant to other firms in the same industry. Recent studies demonstrate the presence of a contagion effect surrounding trading halts and they describe the associated impact on the market quality of related firms.[6] However, research does not establish whether interruptions in trading affect short selling activity for industry contemporaries. Our examination addresses this research issue; the potential for an intra-industry effect prompts us to examine if shorting levels vary significantly for organizations that are informationally related to a firm experiencing a trading halt. We also measure the impact of short sales on the market quality of these contemporary firms by examining their returns, price volatility, and spreads surrounding interruptions in trading for an industry member.

TRADING HALTS

Financial markets have regulations that suspend trading under specified conditions. These interruptions in trading can take the form of price limits, which are implemented when security prices cross boundaries established by market regulators, firm-specific trading halts that suspend trading on an individual security for a predetermined period, or market-wide circuit breakers that halt trading on the entire market when a designated index exceeds a pre-specified level. Firm-

[6] Refer to Spiegel and Subrahmanyam (2000); and Jiang, McInish, and Upson (2009)

specific trading halts can be further categorized according to their underlying cause; halts can be either news-related or they can be prompted by an order imbalance. A news-related trading halt is triggered by exchange officials when an information release is expected to have or demonstrates a significant impact on security prices. In contrast, an order imbalance trading halt is instigated when an exchange specialist observes a large imbalance between buy and sell orders (Kim and Yang 2004).

LITERATURE REVIEW

Research describes the impact of informational events on the affected firm. Previous researchers establish the presence of financial contagion and commonality in order flow for firms in the same industry and they demonstrate the impact, in terms of market quality and short selling activity, of an informational event on related firms. Our literature review describes this body of research and discusses how it pertains to our examination of short selling activity for informationally related firms surrounding interruptions in trading.

The Impact of Informational Events on the Affected Firm

Market Quality

A significant price, volatility, and liquidity impact on the securities of firms experiencing an informational event, such as earnings announcements, dividend declarations, bankruptcy announcements, stock splits, and trading halts, is demonstrated by prior research. These findings provide an important contribution to our current study; namely, that corporate events contain

information and subsequently they have a measurable impact on the market quality of the affected firm.[7]

In addition, this body of research provides evidence that informed market participants play a crucial role in the dynamic trading environment surrounding informational events. For instance, Bajaj and Vijh (1995) purport that excess returns surrounding dividend announcements represents compensation for the risk accepted by informationally motivated traders. Desai, Nimalendran, and Venkataraman (1998) report increases in volatility and spreads surrounding National Association of Securities Dealers Automated Quotations (NASDAQ) stock splits; their findings suggest that changes in trading activity are due, in part, to the actions of informed traders.

Short Selling

Microstructure literature shows that short sellers are informed traders that have the ability to earn abnormal returns in environments with elevated levels of information asymmetry.[8] This research stream also demonstrates that short selling increases prior to informational events – suggesting that short sellers possess important private information prior to its public revelation.[9]

Two examinations of short selling behavior preceding informational events hold particular importance for our investigation of firm-specific trading halts. In the first, Aitken, Frino, McCorry, and Swan (1998), suggest a higher probability of informed trading for short

[7] Beaver (1968); Lee, Mucklow, and Ready (1993); Aharony and Swary (1980); Datta and Iskandar-Datta (1995); Dawkins, Bhattacharya, and Bamber (2007); Lamoureux and Poon (1987); Conroy, Harris, and Benet (1990); Madura, Richie, and Tucker (2006); Kryzanowski (1979); Howe and Schlarbaum (1986); Ferris, Kumar, and Wolfe (1992); Christie, Corwin and Harris (2002); Corwin and Lipson (2000); Lee, Ready, and Senguin (1994); Bacha, Mohamed, and Ramlee (2008); Engelen and Kabir (2006); Hauser, Kedar-Levy, Pilo, and Shurki. (2006); Kim and Rhee (1997); and Kryzanowski and Nemiroff (1998), provide specific examples.

[8] Specific examples are provided by Senchack and Starks (1993); Arnold, Butler, Crack , and Zhang (2005); Chang, Cheng, and Yu (2007); Boehmer, Jones, and Zhang (2008); and Diether, Lee, and Werner (2009B).

[9] Refer to Safieddine and Wilhelm (1996); Karpoff and Lou (2010); Blau, Fuller, and Van Ness. (2011); and Christophe, Ferri, and Hsieh (2010).

transactions that execute the day prior to a trading halt. In the second, Christophe, Ferri, and Angel (2004) demonstrate that short selling activity preceding earnings announcements reflects firm-specific information.

The above-mentioned literature purports that certain firm-specific events provide a source of information for the market. It establishes that these events are associated with a measureable impact on the market quality of the corporation experiencing the event and it demonstrates that short sellers, who are deemed informed market participants, appear to recognize the potential information content of the announcements and to their advantage, successfully anticipate the market's reaction.

Financial Contagion and Commonality

Financial contagion, in a broad interpretation, refers to increases in volatility and the comovement of financial asset markets between countries (Kodres and Pritsker 2002), particularly following an economic shock to one country. Our research relies on a more narrow definition of contagion, one that refers to this same comovement and increase in volatility, but restricts itself to firms in the same or related industries surrounding an informational event for one company. Supporting this view, Kaufman (1994, page 123) describes contagion as "… the spillover of the effects of shocks from one or more firms to others," Alli, Thapa, and Yung (1994, page 1059) as "the transmission mechanism of stock price formation of industrial firms within a particular national market," and Ghosh, Guttery, and Sirmans (1998, page 592) as the market's use, "… of information about one firm's poor performance to infer that similar problems exist with other firms …"

Research into industry contagion establishes the commonality of returns, order flow, and transaction costs between related firms. For instance, Chordia, Roll, and Subrahmanyam (2000) find that the components of liquidity for a firm are closely associated with market and industry liquidity. Similarly, Huberman and Halka (2001) demonstrate the existence of a systematic component of liquidity. In their examination of Dow Jones Stocks, Hasbrouck and Seppi (2001) find the presence of common factors in both order flow and returns. Subrahmanyam (1991, page 44) examines market liquidity and price informativeness for baskets of securities. His research implies the, "strong tendency for both movements in the price of the basket and movements in the price of the portfolio to provide predictive information about subsequent price movements in the other."

Contagion is examined extensively in the banking and finance industry. For example, Lang and Stulz (1992) examine the impact of bankruptcy announcements on the value of firms operating within an industry and find support for the presence of industry contagion. However, their research also identifies the presence of a competitive effect – a gain in wealth by the rivals of the firm announcing bankruptcy. This gain is attributed to the information conveyed through the announcement regarding the potential redistribution of wealth from the bankrupt firm to its competitors and the anticipated improved competitive posture of other industry firms.

Ferris, Jayaraman, and Makhja (1997) extend Lang and Stulz's research and attempt to identify which related firms will experience a contagion or competitive effect. In line with Lang and Stulz, they find that bankruptcy announcements generate contagion. They further purport that the inability of their research to detect a competitive effect might be attributed to the fact that prior to Chapter 11 filing, the impact of the bankruptcy announcement is already incorporated into the stock prices of related firms. This notion suggests the presence of informed

trading – select investors are able to predict accurately both the impending bankruptcy and its impact, either positive or negative, on informationally related firms.

Bessler and Nohel (2000) examine bank stock returns surrounding dividend announcements to test for the presence of a contagion effect in environments with high levels of information asymmetry (bank insiders hold extensive amounts of confidential information). They find that dividend reductions induce negative abnormal returns for non-announcing banks. Additionally, they find that these contagion effects seem to be consistent with informed trading – the presence of contagion is related to firm characteristics that are common amongst affected institutions.

The results of Ferris et al. and Bessler and Nohel emphasize the import role that informed market participants play surrounding firm-specific informational events. Their findings regarding contagious informed trading, particularly in environments with high information asymmetry, provide support for our inquiry into potential changes in the levels of short selling for the industry competitors of halted firms.

The Impact of Informational Events on the Related Firm

Market Quality

Solidifying the relation between industry contemporaries, Tookes (2008) examines earnings announcements, and develops a model of informed trading that demonstrates how informational events can affect multiple firms in the same industry. This model predicts that it is advantageous for informed traders to execute information-based trades in securities for competitors and it demonstrates that competitors' trading levels and returns contain information beyond that of the order flow and returns of the firm experiencing an informational event.

Spiegel and Subrahmanyam (2000) demonstrate that a contagion or commonality effect occurs surrounding interruptions in trading. They construct a multi-security model that describes how a trading halt for a security can decrease liquidity and increase price volatility for stocks in the same industry. They purport that trading halts signal a state of information asymmetry for informationally related firms.

Building upon Spiegel and Subrahmanyam's research and Tookes' model of informed trading, Jiang, McInish, and Upson (2009, page 704) examine the relation between financial contagion and interruptions in trading. They state, "Under the Tookes model, an informational event in one stock in an industry can instigate informed and insider trading in related stocks in that industry …" Jiang et al. offer evidence of contagion by demonstrating the impact of New York Stock Exchange (NYSE) trading halts, including increases in spreads, price impact, and trading volume, on firms that are informationally related.

Short Selling

Previous research purports that short sellers are informed market participants. Building upon this notion, a theoretical justification for an increase in short selling for related firms surrounding an informational event is provided by Tookes (2008). She suggests that when the informed insiders of a halted firm are restricted from shorting their own stocks, they or their proxies take advantage of their superior industry knowledge and submit informed trades on informationally related securities (Jiang et al. 2009).

Providing empirical support for Tookes' proposition, Efendi, Kinney, and Swanson (2005) examine changes in short selling levels for corporations that announce they will restate financial statements due to accounting irregularities. These researchers find evidence of a

contagion effect – increases in levels of short interest for corresponding industry firms. Further, they purport that short sellers have superior knowledge; the majority of short-selling increases were for firms related to companies restating major irregularities. This research supports the notion that short sellers are informed and provides an essential link between informational events and short selling for related firms.

Our investigation differs from the work of Efendi et al. (2005) in two significant ways. First, their examination demonstrates increases in short interest for industry and size matched counterpart firms *after* the announcement of a restatement. We purport that short seller expertise will allow short sellers to increase their activity *prior* to the implementation of a trading halt; we anticipate heightened short selling preceding an informational trading halt event. Second, Effendi et al. focus on how short sellers utilize accounting information to identify over-valued firms, whereas our investigation relies on short sellers responding to short-term changes in market activity.

We rely on the Tookes' model and the findings of Efendi et al. (2005) to hypothesize that short sellers will increase their trading activity for industry contemporaries surrounding interruptions in trading. Further, we extend the demonstrated relation between firm specific trading halts and a market response for informationally related firms provided by Jiang et al. (2009), and Spiegel and Subrahmanyam (2000), to examine whether changes in short selling activity for related firms substantially alter their market quality.

HYPOTHESES

Existing literature demonstrates that informational events have a significant impact on the market quality of affected firms and that short selling for these firms increases prior to firm-specific informational events. It also establishes that a contagious reaction, consisting of changes in market quality and increases in short selling, occurs for industry contemporaries surrounding an informational event. These findings provide a cornerstone for our assertion that an informational event for one firm can significantly influence related firms. We extend this research to determine if this contagion effect includes short selling activity surrounding interruptions in trading.

Short Selling

Market microstructure literature establishes that short sellers possess superior private information. It also demonstrates the presence of intra-industry contagion surrounding informational events, including trading halts, and it demonstrates that short selling increases prior to informational events for both affected and informationally related firms. We build upon these findings and suggest that industry contemporaries of a firm subject to a trading halt will experience increases in short-selling activity. To document short seller behavior, we examine several trading metrics that quantify the level of short sales for these related firms:

H_1: Surrounding a trading halt, securities that are informationally related to a halted stock will experience a significant increase in the number of short transactions, short interest ratio, relative short selling, and abnormal short selling measures.

Market Quality - Returns, Price Volatility and Spreads

Interruptions in trading have a significant effect on the market quality of halted firms. Madura et al. (2006), provide an overview of the literature's findings regarding the impact of trading halts on returns, price volatility, and spreads. They summarize, stating that in general, stocks undergoing a trading halt: (1) experience abnormal negative returns, and (2) following a trading halt, volatility is elevated and spreads remain wide. Jiang et al. (2009, page 705) state, "a firm-specific trading halt is an informational event that impacts the market beyond that of the halted company." In the presence of contagion and commonality of returns, order flow, and transaction costs, it follows that informationally related firms will experience similar changes in their market quality.

Returns

Securities with high short-selling levels typically experience price declines. Providing empirical support for this assertion, Senchack and Starks (1993), Desai, Ramesh, and Thiagarajan (2002), and Cohen, Diether, and Malloy (2007) demonstrate that increases in short interest generate negative abnormal returns. Boehmer et al. (2008) find that heavily shorted stocks underperform annually by a risk-adjusted 15.6 percent as compared to lightly shorted stocks, and Diether et al. (2009B) find that during periods of high asymmetric information, short sale transactions are followed by negative returns.

Providing support for the asserted negative relation between trading halts and returns, Kryzanowski (1979) finds significant abnormal negative returns surrounding halts in trading, and Howe and Schlarbaum (1986) report that almost 80 percent of halted securities experience negative abnormal returns during the suspension period.

Demonstrating the impact of informational events on related firms, Lang and Stulz (1992) examine the impact of bankruptcy announcements and find that the market value of a portfolio containing the common stock of a bankrupt firm's competitors experiences a considerable decrease following a firm's bankruptcy announcement. Bessler and Nohel (2000) examine bank stock returns surrounding dividend announcements and find that dividend reductions induce negative abnormal returns for non-announcing banks. In addition, Jiang et al. (2009) find, consistent with the informed trading model of Tookes, an increase in the price impact of trades for informationally related firms during halts in trading.

Based on the findings of negative abnormal returns surrounding both trading halts and high short selling levels, and the increased impact of trades for related firms surrounding informational events, specifically trading halts, we purport that firms with higher levels of short selling will experience a larger price decline:

H_2: Securities that are informationally related to a halted stock and have high short selling levels will experience a larger decline in price surrounding a trading halt as compared to informationally related stocks with lower short selling activity.

Price Volatility

Chang et al. (2007) examine the relation between short selling and volatility and find that when short selling is permitted, the volatility of both raw and abnormal returns increases substantially. Likewise, Wu and Guo (2004) and Angel, Christophe, and Ferri (2003) find that short selling levels are directly related to price volatility.

The findings of Kim and Rhee (1997), Kryzanowski and Nemiroff (1998), and Ferris et al. (1992) provide support for the notion that stock volatility is not mitigated by interruptions in trading. Similarly, Christie et al. (2002) find elevated volatility following NASDAQ trading halts, and Lee et al. (1994), who investigate firm-specific NYSE trading halts, find that post-halt volatility levels are elevated 50 to 115 percent. We purport that surrounding interruptions in trading, informationally related stocks experience a similar increase in volatility as halted stocks. Spiegel and Subrahmanyam (2000, page 388) state, "… high volatility of price changes in one stock should be followed by a high volatility in another stock with a positively correlated private information variance (e.g. another stock in the same industry)."

Considering the increase in volatility described by both the trading halt and the short selling literature and the anticipated contagion of volatility from halted stocks to industry contemporaries, we predict that informationally related stocks with increased short selling activity will experience higher volatility levels:

H_3: Securities that are informationally related to a halted stock and have high short selling levels will have higher price volatility surrounding trading halts as compared to informationally related securities with lower levels of short selling activity.

Spreads

The bid-ask spread is used by dealers to balance the gains they receive from liquidity traders with losses suffered to informed traders who are better able to forecast future prices (Copeland and Galai 1983). If large transactions are viewed as having higher information content, as purported by Easley and O'Hara (1987), they should cause the spread to widen to provide compensation to dealers for their informational disadvantage (Hasbrouck 1991). If informed short-sellers submit large transaction in an attempt to increase the price impact of their trades, we would expect to see a positive relation between short selling levels and spreads. Diether, Lee, and Werner (2009A) find support for this notion; they examine pilot stocks, for which short-selling tests are suspended, and find that increases in short selling activity lead to increases in quoted and effective spreads.

Spiegel and Subrahmanyam (2000) suggest that during the trading suspension, the ask (bid) price of an informationally related security will be greater (less) than during a non-halt period. They explain that liquidity traders withdraw from the market after observing high levels of information asymmetry. Subsequently, the market maker observes both the increased asymmetry and the decrease in liquidity and widens spreads to compensate for losses to informed traders. Providing empirical support for this belief, Jiang et al. (2009) find that firm-specific trading halts increase spreads significantly for informationally related firms.

Spreads widen surrounding trading halts and with increases with short selling activity. It follows then, that a firm that is both informationally related to a halted firm and experiences high levels of shorting will evidence wider spreads:

H_4: Securities that are informationally related to a halted stock and have high short selling levels will have wider spreads surrounding trading halts as compared to informationally related securities with lower levels of short selling activity.

DATA

We first identify NYSE and American Stock Exchange (AMEX) trading halts that occur during 2005–2006 by querying the Trades and Quotes (TAQ) database via Wharton Research Data Services (WRDS) for stocks with a trading mode of 4, 7 or 11, indicating halts in trading for news dissemination, order imbalance, or news pending, respectively. From this set, we remove observations where multiple halts occur for the same stock on the same trading day and halts that occur outside normal market hours.

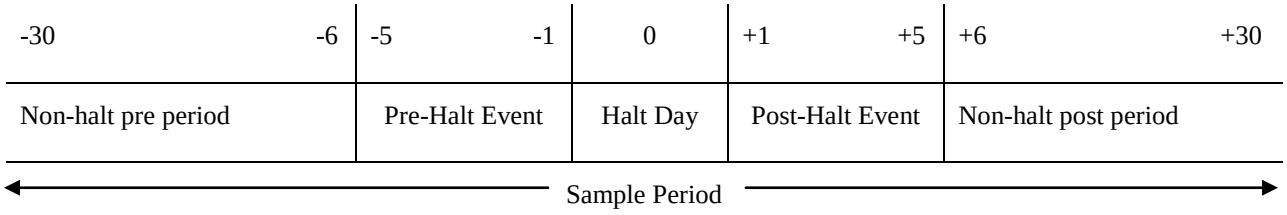
D'Avolio (2002) finds that 16 percent of stocks in the Center for Research in Security Prices (CRSP) data are potentially difficult to sell short. Of these stocks, the majority are in the bottom size decile and the prices of over half are under five dollars. They also find approximately 10 percent of stocks are never shorted – these are primarily illiquid stocks, for which shorting may represent a limited opportunity for profit. These researchers note that institutional investors, who lend stocks for shorting, are biased towards large, liquid stocks, and that the probability of incurring loan fees in excess of the risk free rate is inversely related to firm size and the level of institutional ownership. Accordingly, we, in a manner similar to Christophe et al. (2004), eliminate trading halts for any stock whose average daily price and trading volume during 2005 – 2006 was less than five dollars and 100 shares.

Because our intent is to examine trading activity and market quality prior to and following trading halts, we follow the methodology of Corwin and Lipson (2000) and eliminate

halts that occur before 10:00 a.m. We also eliminate halts with incomplete data or halts that do not resolve on the same trading day.

Rule 202T implemented the suspension of the short sale price test for a pilot list of stocks. The resolution was adopted in 2004 – the suspension was in effect from May 2, 2005 through August 6, 2007. Diether et al. (2009A) find that although daily returns and volatility levels are unaffected for pilot stocks during the test suspension, short selling activity, spreads and intraday volatility increases for these stocks. Because the test suspension period covers part, but not all of our sample period, to mitigate confounding effects, we remove from our sample any firms included in the pilot list of stocks for price test exclusion.

Finally, we remove observations where more than one trading halt occurs for the same firm within our event period. The event period is an 11-trading-day interval beginning five days prior to and ending 5 days after the halt day. Christophe et al. (2004) use a multiday pre-event period because short sellers may distribute their trading over several days prior to an event to disguise private information and because the average loan duration for equity is three days (Reed 2007). We establish a post-halt event period to examine trading activity and market quality following the resumption of trading. The non-halt period, spanning six to 30 days preceding and following a trading halt, provides an estimation period. For our intraday examination, we identify the halt period, which begins with the interruption in trading and ends when trading resumes. Intraday pre-halt periods are measured backwards from the beginning of the halt, and post-halt periods are measured forward from the reopening of trading.



Daily price, trading volume, return, and market capitalization data are obtained from the CRSP database. The Regulation SHO database, which was created in response to Rule 202T, provides trade size and time stamps for short-selling transactions. TAQ trade and quote data is used to examine intraday activity. Trade data is filtered to remove observations that occur outside of normal market hours, and transactions with a non-positive price, or a condition code other than zero. Quote data is filtered to retain observations that occur within normal market hours and have a positive bid or ask size, price and spread.

REFERENCE GROUPS

We model our selection criteria for stocks related to halted firms on the methodology implemented by Jiang et al. (2009). These researchers select a reference group for each of the firms experiencing a trading halt by first identifying securities with the same 4-digit Standard Industrial Classification (SIC) code. To define further the informational relationship, they develop a scheme based on four dimensions: daily returns, trading volume, price volatility and spreads.

Daily Returns

For each candidate stock, one with a SIC code that matches a halted stock, we obtain daily returns from CRSP, regress them on the CRSP value-weighted return (the market model) and capture the residual. A Pearson correlation is estimated between the residuals for the halted stock and its industry contemporary stocks. Informational relatedness is established if the correlation of the residuals is significant at the ten percent level.

Price Volatility

Highly correlated volatility measurements suggest a substantial degree of comovement in informed trading between two stocks (Jiang et al. 2009). Daily volatility is estimated as the squared residual from the market model (previously described for returns). Stocks are considered a related firm if their squared residual has a Pearson correlation with that of a halted stock at or above the ten percent significance level.

Trading Volume

We next apply a model developed by Ferris, Haugen, and Makhija (1988) and utilized by Jiang et al. (2009) to separate the effects of firm or industry events from the effects produced by market-wide, macro-economic conditions:

$$v_{i,t} = \alpha_I + \beta_i v_{m,t} + \gamma_{i,t} \quad (1)$$

Where $v_{i,t}$ is the daily trading volume divided by the outstanding shares for stock *i* on day *t*, $v_{m,t}$ is the total market volume divided by the total number of shares outstanding for all securities on day *t*, and $\gamma_{i,t}$ is the residual of the regression. For each stock, the regression is estimated once for each sample year. Informationally related stocks are those whose Pearson correlation is statistically significant at the ten percent level with the regression residual of the halted stock.

Spreads

Using daily closing bid and ask prices, we estimate the average percentage spread {(ask – bid) / share price} over 5-day increments for each year of the sample – producing approximately 50 spread measurements per year for each stock. Stocks are designated as informationally related

if their spread measurement is statistically correlated with that of the halted stock at the ten percent level.

Industry counterpart firms are removed from the sample if they do not pass all four information relatedness tests. Related firms are also eliminated if their average daily price and trading volume during 2005 – 2006 is less than five dollars and 100 shares. Halts without a related firm demonstrating statistically significant correlation for all four measures are dropped from the sample. For halted firms with more than twenty related firms remaining after the relatedness tests are applied, we select the fifteen most similar firms, based on market capitalization, to retain in our sample of contemporary firms.

SUMMARY STATISTICS

The previously described filters produce a sample of 78 trading halts. Forty-seven of these halts have reference firms that show significant correlation for daily returns, price volatility, trading volume, and spreads. Table 1, Panels A through E, contains descriptive statics for the trading halts; Table 2 and Table 3, Panels A through D, describe firm characteristics and short selling activity for the halted and related firms, respectively. The sample of related firms contains 172 unique firms, representing 188 related firm observations.

Table 1
Descriptive Statistics - Halts
This table describes our sample of 2005-2006 trading halts for NYSE-listed firms. Halts have been filtered to remove observations that occur outside of market hours or before 10:00 a.m., where more than one halt occurs for a sample firms on the same day, halts that do not resolve on the same trading day and multiple halts for the same firm within the 11-day event period, halts for Rule 202T pilot stocks, observations for stocks whose average daily price and trading volume during 2005 – 2006 was less than five dollars and 100 shares, and halts without a significantly correlated reference firm.

Panel A: Halts by Year

Year	Number of Halts	Unique Firms
2005	31	30
2006	16	14
Full Sample	47	42

Panel B: Number of Halts per Year

Number of Halts in Sample	1	2	3	4
Number of Firms				
2005	29	1	0	0
2006	13	0	1	0
Full Sample	40	0	1	1

Panel C: Halts by Day of Week and Year

	Day of Week					
Year	Monday	Tuesday	Wednesday	Thursday	Friday	Total
2005	1	8	10	9	3	31
2006	3	4	4	3	2	16
Full Sample	4	12	14	12	5	47

Panel D: Halts by Month and Year

	Month											
Year	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec
2005	4	1	3	5	5	4	2	3	0	2	1	1
2006	0	1	0	1	1	1	0	3	1	4	2	2
Full Sample	4	2	3	6	6	5	2	6	1	6	3	3

Panel E: Halts and Duration by Halt Type

Trading Halt Type	Number of Halts	Mean Duration
News Dissemination (4)	5	34:56
Order Imbalance (7)	4	20:17
News Pending (11)	38	46:45
Full Sample	47	43:14

Of the 47 halts, almost twice as many occur in 2005 than in 2006 (31 as compared to 16). Similar to the research of Christophe et al. (2004), we find that trading halts in our sample occur more frequently during the middle of the week – Tuesday through Thursday. These interruptions in trading occur in 20 out of the 24 sample period months, with the highest single monthly value of five halts occurring in the months of April and May 2005. We examine 42 unique halt firms,

40 of which experience a single halt during the sample period and 2 different firms that experience 3 or 4 halts each.

The halts in our study are primarily (81 percent) implemented due to pending news. The mean duration of all sample halts is just over 43 minutes. Although the duration of trading halts reported by previous research, including Lee et al. (1994), Corwin and Lipson (2000), and Christie et al. (2002), is greater on average and for each halt type, our findings coincide with the ranking of halt types by length: news pending halts have the longest duration and order imbalance halts, the shortest.

Summary statistics for both halted and related firms suggest a substantial variation in the size of sample firms, stock prices, and trading volume, with generally higher average values in 2006 as compared to 2005. However, the range in average security prices, trading volume, and returns is substantially larger for the sample of related firms as compared to halted firms, and the variability in volume and market capitalization is much higher for both samples in 2006. The firms, on average, demonstrate positive returns over the two-year period examined. When both sets of firms are categorized according to the year-end capitalization portfolio assignments established by CRSP, we find, similar to Christophe et al. (2004) that large firms are more heavily represented in our sample of halt firms. There are fewer halt firms in the lower market capitalization deciles, perhaps due, in part, to our data filter that eliminates trading halts for any stock whose average daily price during the sample period is less than five dollars. In contrast, the related firms are distributed throughout all ten of the market capitalization deciles. Both samples demonstrate the largest number of firms, over 20 percent of observations, in decile six.

We examine short-selling levels for our halt and related stocks during the 2005 – 2006 sample period. For each exchange, we report both short volume as a percentage of the total

shares shorted and the number of short sale transactions as a percentage of the total number of short selling trades. No short transactions for our sample firms/period are reported on the National Association of Securities Dealers Alternative Display Facility (ADF), Archipelago (ARCA) and the Chicago Stock Exchange (CHX).

In line with the findings presented by Diether et al. (2009B), approximately three-fourths of short volume (72 – 79 percent) and short transactions (76 percent) for our sample halt and related firms are executed on the NYSE. Approximately 15 - 18 percent of short volume and 13 - 17 percent of short transactions are placed on the NASDAQ market. On average, a much smaller percentage of short selling occurs on AMEX for the related firms as compared to the halted firms. The average halt firm in our sample has 306 short transactions per trading day with an average daily short volume of nearly 140,000 shares, as compared to only 214 short transactions and approximately 100,000 shares for our related firms.

Table 2
Descriptive Statistics – Halted Firms
This table contains summary statistics for our sample of NYSE-listed firms experiencing a trading halt during 2005 – 2006. Halts have been filtered to remove observations that occur outside of market hours or before 10:00 a.m., where more than one halt occurs for a sample firms on the same day, halts that do not resolve on the same trading day and multiple halts for the same firm within the 11-day event period, halts for Rule 202T pilot stocks, observations for stocks whose average daily price and trading volume during 2005 – 2006 was less than five dollars and 100 shares, and halts without a significantly correlated reference firm.

Panel A: Halt Firm Characteristics - Average Daily Values

	Price	Volume	Return %	Market Cap
Year: 2005 (N =30)				
Mean	32.41	388,030	0.0698	1,948,666
Max	110.65	2,752,299	0.3119	18,124,822
Min	4.47	2,199	-0.1728	33,181
Std	24.23	591,165	0.1030	3,410,900
Year: 2006 (N=14)				
Mean	36.47	1,126,753	0.0253	6,043,945
Max	96.10	3,866,092	0.3072	40,548,995
Min	11.12	1,007	-0.4135	179,914
Std	22.29	1,373,142	0.1734	11,819,955

Full Sample (N=44)				
Mean	33.70	623,078	0.0556	3,251,709
Max	110.65	3,866,092	0.3119	40,548,995
Min	4.47	1,007	-0.4135	33,181
Std	23.45	962,743	0.1292	7,335,372

Panel B: CRSP Capitalization-Based Decile

Decile	2005	2006	Full Sample
1	0	0	0
2	2	0	2
3	4	2	6
4	3	0	3
5	3	1	4
6	5	4	9
7	2	0	2
8	5	2	7
9	2	2	4
10	4	3	7
Total	30	14	44

Panel C: Short-sale Trading Activity Across Exchanges (2005 – 2006)

	ADF	AMEX	ARCA	BSE	CHX	NASDAQ	NSX	NYSE	PHLX
Mean Shares Sold Short (%)	0.00	4.11	0.00	0.21	0.00	17.44	6.18	71.81	0.26
Mean Short-sale Trades (%)	0.00	4.65	0.00	0.12	0.00	13.09	6.10	76.02	0.01

Panel D: Short-selling Summary Statistics per Stock

	Mean	Median	Std Dev	Minimum	Maximum
Short Sale Daily Volume	139,362	129,313	58,674	52,639	1,034,216
Number of Daily Short Trades	306	276	131	105	2,472

Table 3

Descriptive Statistics – Related Firms

This table contains summary statistics for our sample of 172 unique firms (188 related firm observations) that demonstrate informational relatedness to a filtered sample of NYSE-listed firms experiencing a trading halt during 2005 – 2006. Information relatedness is demonstrated by the same SIC code and significant correlations in daily returns, price volatility, trading volume and spreads. Stocks with no significant informational relatedness or whose average daily price and trading volume during 2005 – 2006 was less than five dollars and 100 shares were dropped from the sample.

Panel A: Related Firm Characteristics - Average Daily Values

	Price	Volume	Return %	Market Cap
Year: 2005 (N =142)				
Mean	24.19	339,829	0.0175	1,879.353

Max	211.88	4,846,502	0.5471	35,625,501
Min	5.03	852	-0.3233	1,979
Std	22.56	722,150	0.1168	4,893,932
Year: 2006 (N=46)				
Mean	31.44	489,523	0.0514	3,286,848
Max	205.98	4,619,097	0.2142	35,217,897
Min	5.95	1,953	-0.1681	13,630
Std	33.24	1,064,233	0.0759	7,461,652
Full Sample (N=188)				
Mean	25.97	376,456	0.0258	2,223,740
Max	211.88	4,846,502	0.5471	35,625,501
Min	5.03	852	-0.3233	1,979
Std	25.68	818,492	0.1090	5,641,374

Panel B: CRSP Capitalization-Based Decile

Decile	2005	2006	Full Sample
1	14	3	17
2	12	4	16
3	11	0	11
4	13	4	17
5	15	3	18
6	30	15	45
7	8	6	14
8	9	1	10
9	17	2	19
10	13	8	21
Total	142	46	188

Panel C: Short-sale Trading Activity Across Exchanges (2005 – 2006)

	ADF	AMEX	ARCA	BSE	CHX	NASDAQ	NSX	NYSE	PHLX
Mean Shares Sold Short (%)	0.00	0.76	0.00	0.39	0.00	15.37	4.83	78.28	0.38
Mean Short-sale Trades (%)	0.00	0.67	0.00	0.43	0.00	16.62	5.70	76.55	0.03

Panel D: Short-selling Summary Statistics per Stock

	Mean	Median	Std Dev	Minimum	Maximum
Short Sale Daily Volume	101,967	96,957	41,641	37,008	856,838
Number of Daily Short Trades	214	195	92	74	1,818

RESULTS

Daily Short Metrics

To detect changes in the daily activity of short sellers surrounding trading halts, we track the average number of trades, trade size, and volume for short transactions for our sample of informationally related firms in the pre-halt period (days -5 through -1), the halt day (day 0), the post-halt period (days +1 through +5), and the estimation period (days -30 through -6 and +6 through +30). We also calculate the short interest ratio, relative short selling, and abnormal short selling metrics for each of these periods. The short interest ratio is described by Angel et al. (2003), as the number of shares sold short to shares outstanding. Relative short selling is calculated by dividing the number of shares shorted by the number of shares traded (Christophe et al., 2004; and Diether et al., 2009B). Abnormal short selling is the percentage difference between the average daily shares sold short during the pre, halt, or post period and the average daily number of shares sold short during the estimation period (Lee et al., 1994; Corwin and Lipson, 2000; Christie et al., 2002, Christophe et al., 2004; and Christophe et al., 2010). For each short selling metric, a difference value is computed to determine if corresponding pre-halt, halt, and post-halt values differ from estimation period levels. Significance is determined using the Wilcoxon signed-rank test, which allows us to compare measurements on our sample without relying on an assumption of normality.

Our hypothesis concerning the behavior of short sellers surrounding trading halts states:

H_1: Surrounding a trading halt, securities that are informationally related to a halted stock will experience a significant increase in the number of short transactions, short interest ratio, relative short selling, and abnormal short selling measures.

For our sample of related firms, the daily short volume, number of trades, and the short interest ratio, listed in Table 4 Panel A, are elevated on the halt day, as compared to all other periods examined. Short volume increases for related firms approximately 19 percent on the event day over the average short volume computed during the five days prior to the halt. The average trade size during the event period ranges from 446 shares on the halt day to 484 shares in the pre-halt period; these values are similar to the estimation-period average trade size of 478 shares. Average relative short selling values are comparatively stable throughout the event period; their magnitude of 0.2504 to 0.2697 is similar to the results of Diether et al., 2009B, who report an average relative short selling value for NYSE large firms of 0.2339.

Table 4
Average Daily Short Metrics and Differences
Panel A contains measurements of average daily short selling levels for related stocks during the estimation (days -30 thru -6 and +6 thru +30), pre-event (days -5 thru -1), event (day 0), and post-event (days +1 thru +5) periods surrounding interruptions in trading for informationally related stocks. The short interest ratio is the number of shares sold short to shares outstanding, and relative short selling is computed by dividing the number of shares shorted by the number of shares traded. Abnormal short selling is the percentage difference between the average daily shares sold short during the pre, post, or event period and the average daily number of shares sold short during the estimation period.
Panel B contains the mean difference for each of our short selling metrics between estimation period levels and levels in the pre, halt, and post periods. The Signed Rank Test is used to determine significance. *P-values* are reported in parentheses.
N = 188 Related Firm Observations

Panel A: Short Selling Measurements

Period	Number of Trades	Trade Size	Volume	Short Interest Ratio	Relative Short Selling	Abnormal Short Selling
Estimation	192	478	95,848	1.18	0.2966	--

Pre-Event	187	484	89,233	1.13	0.2697	0.0274
Halt	204	446	106,171	1.22	0.2613	0.0896
Post-Event	183	472	86,401	1.02	0.2504	0.0629

Panel B: Differences Between Event and Estimation Periods

Metric	Pre-Halt	Halt	Post-Halt
Number of Trades	-3.31 (0.0676) *	15.40 (0.7437)	-7.21 (0.0002) ***
Trade Size	3.75 (0.2061)	-30.21 (0.0003)***	-11.25 (0.0069) ***
Volume	-7,089 (0.0084) ***	9,733 (0.5024)	-9,851 (<.0001) ***
Short Interest Ratio	-0.0530 (0.0057) ***	0.0440 (0.1554)	-0.1546 (<.0001)***
Relative Short Selling	-0.0184 (0.3216)	-0.0307 (0.9287)	-0.0367 (0.1200)
Abnormal Short Selling	0.0234 (0.0059) ***	0.0896 (0.2790)	0.0580 (<.0001) ***

*** and * indicate statistical significance at the 0.01 and 0.10 level respectively.

On average, abnormal short selling is elevated in all event periods, with increases of 2.74, 8.96, and 6.29 percent in the pre, halt, and post periods, respectively. Abnormal short selling values, viewed at the daily level, are displayed in Figure 1. Abnormal sort selling appears to vary substantially throughout the event period, ranging from a minimum of -15.29 percent two trading days following the halt (day +2) to a maximum in excess of 18 percent the following day (day +3). Consecutive increases in abnormal short selling are demonstrated on the halt day and again on day +1; this increase is followed by a marked decrease in short selling on day +2.

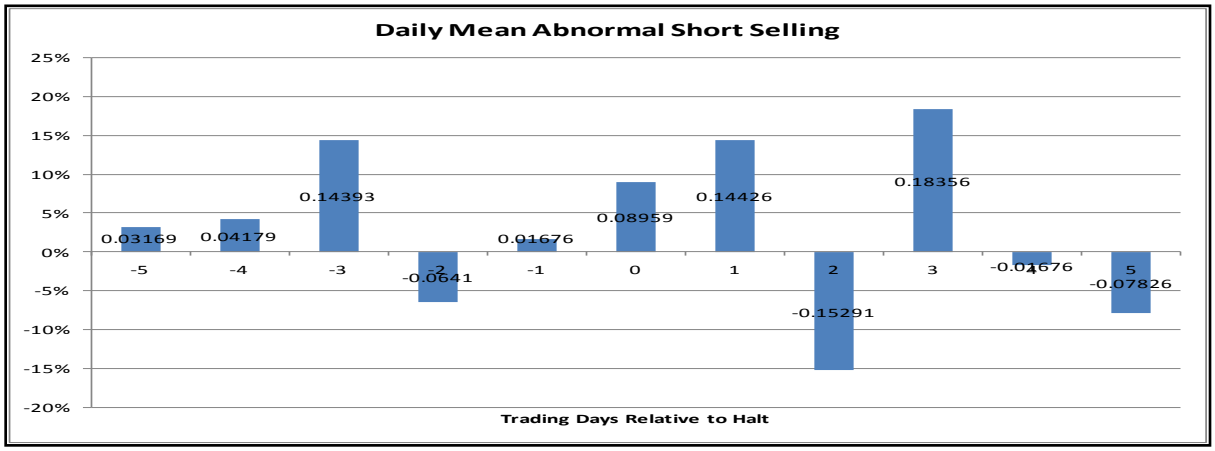


Figure 1

Daily Abnormal Short Selling
Abnormal short selling is listed for each day of the event period. Abnormal short selling is the percentage difference between the average short volume during the pre, halt or post period and the average daily number of shares sold short during the estimation period

We calculate the percentage of stocks on each day of the event period that have a positive abnormal short selling value; a positive value indicates that the daily short selling volume is greater on this day than during an average day in the estimation period. Resulting values, shown in Figure 2, demonstrate that on each day of the event period, approximately one third of our sample firms have positive abnormal short selling. On the halt day, however, in excess of forty percent of the sample firms have higher short volume than on an average, estimation period, trading day.

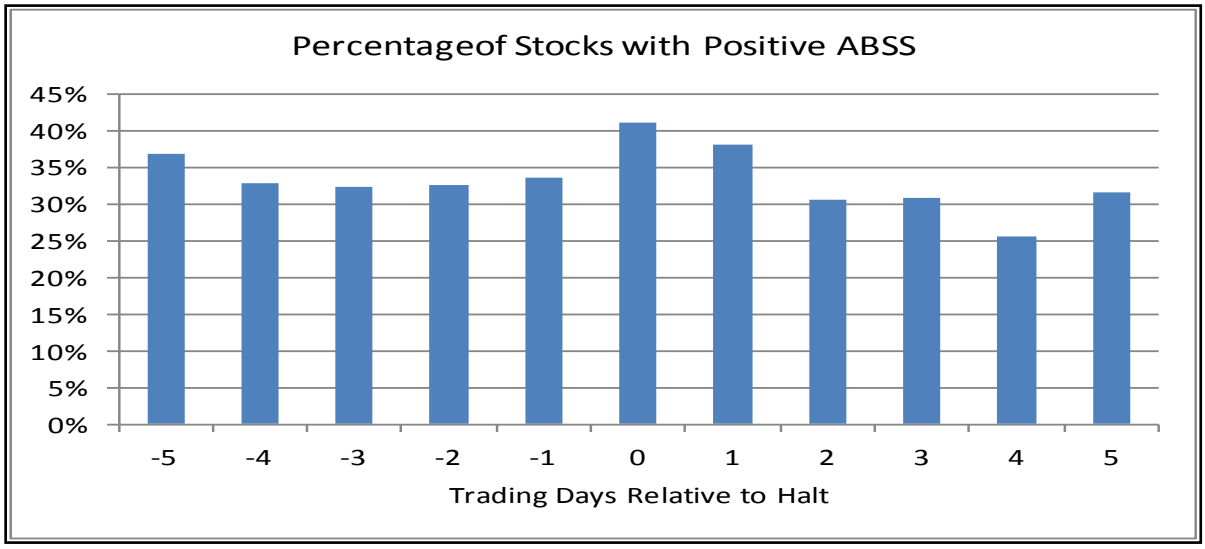


Figure 2
Percent of Stocks with Daily Positive Abnormal Short Selling
The number of stocks with positive abnormal short selling values as a percent of all sample stocks is computed for the event period. Abnormal short selling is the percentage difference between the average daily shares sold short during the pre, halt, or post period and the average daily number of shares sold short during the estimation period

Panel B of Table 4 contains mean values that describe by how much pre, halt, and post periods levels for each short selling metric differ from corresponding values during the

estimation period. A significant decrease in the number of trades, short volume, and the short interest ratio occurs in both the pre- and post-halt periods (the five days preceding and following the event day). This result indicates that short sellers modify their behavior in regards to our sample of firms in the days leading up to and following a halt in trading for a related industry member by submitting fewer and smaller short transactions. The only short-selling measurement that demonstrates a significant difference on the halt day is trade size, which on average is thirty shares smaller than the mean trade size during the estimation period. Difference values for relative short selling are insignificant for all three of the event periods; a lack of significance suggests that for our sample of related firms, the trading halt event does not substantially alter the relation between their short and overall trading volume. An increase in short selling for related firms is substantiated by the difference statistic for abnormal short selling – this measurement is two to six percent higher during the pre- and post-halt intervals. However, no significant increase in abnormal short selling over estimation period levels is identified on the halt day.

Market microstructure research demonstrates that short sellers use their superior knowledge to extract gains in the market surrounding informational events. We build upon this finding to determine, by examining the relation between pre- and post-event returns and pre-event short selling levels, if informed market participants increase their short selling activity for related firms prior to interruptions in trading. Using the following equation, we examine short selling levels while controlling for other variables that might influence short selling activity (following Christophe et al., 2010):

$$ABSS_{(-5,-1)i} = \alpha_i + \beta_1 Log(P_0)_i + \beta_2 CAR_{(-5,-1)i} + \beta_3 MOM_i + \beta_4 CAR_{(0,1)i} + \varepsilon_i \qquad (2)$$

The dependent variable, $ABSS_{(-5,-1)}$ represents abnormal short-selling during the five days preceding the halt. $LogP(_0)$ is the natural logarithm of a related firm's share price on the event day; this variable controls for the positive link between a stock's price and the willingness of market participants to short the stock.[10] $CAR_{(-5,-1)}$ is the cumulative abnormal return earned during the five day pre-halt period – the halted firm's total return over the five days preceding the halt minus the median five-day cumulative return during the estimation period. MOM represents momentum, which controls for long-term share price movement. Momentum is calculated as the related firm's six-month cumulative return ending 30 days before the halt, minus the return on the NYSE equally weighted portfolio during the same period. $CAR_{(0,1)}$ is the related firm's holding period return from day 0 to day 1, minus the median holding period return during the estimation period; this variable represents the market's assessment of the economic value of the information associated with an interruption in trading.

Using ordinary least squares to model a regression equation relies on the assumption that the error terms have uniform variances across all observations. We use the Shapiro-Wilk test on each regression input data set to ensure that the assumption of normality holds. The null hypothesis for this statistical test is that a population is distributed normally. If the test produces a *p-value* less than the designated alpha level of 0.10, then the null hypothesis of normality can be rejected. When this occurs, we report results using errors adjusted to control for heteroscedasticity and serial correlation of the residuals.

Table 5, Panel A displays the correlation matrix for the regression variables. The correlation values demonstrate two significant relations between returns and short selling. Returns in the five-day pre-halt period are inversely related to pre-halt abnormal short selling

[10] Refer to D'Avolio, (2002) who shows that the majority of stocks that are difficult to short are priced less than five dollars and that the holdings of institutional investors, who lend stocks for shorting, are biased towards large, liquid stocks.

activity. However, a positive correlation between $CAR_{(0,1)}$ and $ABSS_{(-5, -1)}$ indicates that prior to a halt, short selling increases with positive post-halt returns. Although the regression results, reported in Table 5, Panel B, produce coefficients for $CAR_{(-5,-1)}$ and $CAR_{(0,1)}$ with signs that agree with the direction demonstrated by the correlation matrix, the regression fails to demonstrate a significant relation between any of the independent variables and pre-event abnormal short selling levels.

Table 5

Abnormal Short Selling Regression 1

This table contains the correlation matrix for regression variables (Panel A) with corresponding *p-values* in parentheses. Regression coefficients and associated *t-statistics* are listed in Panel B. In the model: $ABSS_{(-5, -1)} = \alpha + \beta_1 * Price_0 + \beta_2 * CAR_{(-5, -1)} + \beta_3 * MOM + \beta_4 * CAR_{(0, 1)} + \epsilon$, $ABSS_{(-5,-1)}$ represents abnormal short-selling during the five days preceding the halt, $LogP_{(0)}$ is the share price of the related firm on the halt day, $CAR_{(-5,-1)}$ is the cumulative abnormal return during the five day pre-event period, MOM represents momentum, and $CAR_{(0,1)}$ is the related firm's holding period return from day 0 to day 1 . Regression results are reported using errors adjusted to control for heteroscedasticity and serial correlation of the residuals.

N = 173 Related firm observations

Panel A: Correlation Matrix of Regression Variables

	Log Price$_{(0)}$	ABSS$_{(-5, -1)}$	CAR$_{(0,1)}$	CAR$_{(-5,-1)}$	MOM
Log Price$_{(0)}$	1	-0.1198	-0.0642	0.0131	0.2704
		(0.1164)	(0.4012)	(0.8646)	(0.0003) ***
ABSS$_{(-5, -1)}$		1	0.1306	-0.1500	0.0028
			(0.0868) *	(0.0489) **	(0.9708)
CAR$_{(0,1)}$			1	-0.1928	0.0395
				(0.0110) **	(0.6061)
CAR$_{(-5,-1)}$				1	
MOM					1

Panel B: OLS Regression Results

	[1]	[2]	[3]	[4]
Intercept	0.0419	0.0480	0.4819	0.5108
	(0.65)	(0.67)	(1.25)	(1.35)
CAR$_{(0,1)}$	6.8141	5.5103	5.1365	5.0681
	(1.01)	(1.34)	(1.30)	(1.25)
CAR$_{(-5,-1)}$		-2.6916	-2.6900	-2.6716
		(-0.47)	(-0.48)	(-0.48)
Log Price$_{(0)}$			-0.1451	-0.1543
			(-1.29)	(-1.40)

MOM				0.1393
				(0.38)
R^2	0.0171	0.0332	0.0457	0.0463
Adjusted R^2	0.0113	0.0219	0.0287	0.0236
F-Value	2.07 *	2.92 *	2.70 **	2.04 *

***, **, and * indicate statistical significance at the 0.01, 0.05 and 0.10 level respectively.

Following Christophe et al. (2004), we next implement a regression model that controls for pre-event trading volume and returns, and focuses on post-halt returns to determine if abnormal levels of short selling are informationally motivated. In this equation, $ABSS_{(-5,-1)}$ again represents abnormal short-selling during the five days preceding the halt, and $RET_{(0, +1)}$ is the stock return from closing day -1 to +1. $RET_{(-5, -1)}$ represents the movement of the stock price during the five days prior to the halt, and $ABVOL_{(-5, -1)}$ is the percentage difference between the average daily volume in the 5-day pre-halt interval and the average daily volume in the estimation period.

$$ABSS_{(-5, -1)} = \beta_0 + \beta_1 RET_{(0, +1)} + \beta_2 RET_{(-5, -1)} + \beta_3 ABVOL_{(-5, -1)} + \varepsilon \quad (3)$$

The variable of interest is $RET_{(0, +1)}$, which represents the market's immediate reaction to the trading halt. A significant negative (positive) coefficient indicates that short selling increases (decreases) prior to trading halts imposed under negative (positive) circumstances. $RET_{(-5, -1)}$ controls for the possibility that changes in the stock price might affect the level of short selling in the days preceding the trading halt. $ABVOL_{(-5, -1)}$ accounts for the comovement in increased short selling activity and trading volume in the pre-event period, as increased volume might make a stock less difficult to short.

Table 6 contains, in Panel A, the correlation matrix between the regression variables and, in Panel B, the regression results. Similar to the correlation matrix from the previous regression, a significant negative correlation is demonstrated between abnormal short selling and returns in the pre-event period. A positive relation is noted between pre-event abnormal short selling and trading volume prior to the halt. The association between trading volume and short volume in the pre-halt period is substantiated by the regression results: the coefficient for $ABVOL_{(-5,-1)}$ is positive, and the explanatory power of the equation (R^2) increases considerably from .0566 to .4517 when the $ABVOL_{(-5,-1)}$ variable is added to the model. However, no significance is found for the $Ret_{(0,+1)}$ variable: this test fails to provide support at the daily level for our assertion that short selling activity for related firms prior to a trading halt for an industry counterpart is informationally motivated.

Table 6

Abnormal Short Selling Regression 2

This table contains the correlation matrix for regression variables (Panel A) with corresponding *p-values* in parentheses. Regression coefficients and associated *t-statistics* are listed in Panel B. In the model: $ABSS_{(-5,\ -1)} = \alpha + \beta_1 RET_{(0,\ +1)} + \beta_2\ RET_{(-5,\ -1)} + \beta_3 ABVOL_{(-5,\ -1)} + \varepsilon$, $ABSS_{(-5,-1)}$ represents the abnormal short-selling during the five days before the halt, and $RET_{(0,\ +1)}$ is the stock return from closing day -1 to +1. $RET_{(-5,\ -1)}$ represents the movement of the stock price during the five days prior to the halt, and $ABVOL_{(-5,\ -1)}$ is the percentage difference between the average daily volume in the 5-day pre-halt interval and the average daily volume in the estimation period. Regression results are reported using errors adjusted to control for heteroscedasticity and serial correlation of the residuals.

N = 188 Related firm observations

Panel A: Correlation Matrix of Regression Variables

	$ABSS_{(-5,\ -1)}$	$RET_{(0,\ +1)}$	$RET_{(-5,\ -1)}$	$ABVOL_{(-5,\ -1)}$
$ABSS_{(-5,\ -1)}$	1	0.0394	-0.1845	0.6376
		(0.5819)	(0.0093)***	(<.0001)***
$RET_{(0,\ +1)}$		1	0.4938	0.0192
			(4.39)***	(0.7889)
$RET_{(-5,\ -1)}$			1	-0.0231
				(0.7468)
$ABVOL_{(-5,\ -1)}$				1

Panel B: OLS Regression Results

	[1]	[2]	[3]
Intercept	0.0257	0.0428	0.0636
	(0.42)	(0.59)	(1.09)
$RET_{(0, +1)}$	0.8589	3.7654	3.2108
	(0.81)	(1.00)	(1.28)
$RET_{(-5, -1)}$		-4.720	-4.246
		(-0.91)	(-1.25)
$ABVOL_{(-5, -1)}$			0.9244
			(4.39) ***
R^2	0.0015	0.0566	0.4517
Adjusted R^2	-0.0035	0.0469	0.4432
F-Value	0.30	5.85 **	53.27 ***

*** and ** indicate statistical significance at the 0.01 and 0.05 level respectively.

Intraday Short Metrics

Our examination of short selling activity for informationally related firms surrounding a halt in trading for an industry member is repeated at the intraday level. We compute, on the event day, the 1) average number and size of short transactions, 2) short interest ratio, 3) relative short selling, and 4) abnormal short selling measures for the related stocks in eight 30-minute periods prior to and following the trading halt interval.

The results from our intraday examination of short selling activity, contained in Table 7, provide considerable support for the notion that short sellers increase their activity for informationally related stocks surrounding halts in trading for an industry member.[11] An increase in the number of short transactions is noted for sample firms beginning two periods prior to the halt, when the number of short trades increases from 1,536 to 2,031. The number of short transactions continues to increase, with 2,491 short trades in the 30 minutes prior to the halt; the

[11] The number of short transactions, trading volume, and short volume has been adjusted in period zero to compensate for the variable period length (halt in trading). Each of these metrics has been converted by finding the average value per minute and multiplying by 30 minutes.

number of short transactions then declines to 2,303 during the halt period and 2,189 following the resumption of trading for the halted firm.

In our intraday examination, the relative short selling measures range from 0.260 to 0.492, with the highest level occurring during the break in trading for the halted firm. These values, particularly during the halt period, are generally larger than the average daily halt-day value of 0.263 listed in Table 4. This finding suggests that on average, short selling comprises a higher percentage of trading volume during the eight intraday periods surrounding the halt than on the event day as a whole.

Of the metrics calculated, short volume provides the most remarkable increase: short volume more than doubles from period -2 to period -1 (667,701 to 1,367,705). A modest decline occurs during the halt period (1,007,887), but short volume remains elevated, with over one million shares shorted in the interval immediately following the halt period. Abnormal short selling levels vary considerably throughout the periods examined, but evidence negative values in the three periods preceding the halt, near estimation levels during the halt period, and a substantial increase following the resumption of trading for the halted firm.

Table 7
Intraday Short Metrics
Short selling values for related stocks are computed for eight 30-minute periods prior to trading halts and following the resumption of trading for halted firms. The short interest ratio is the number of shares sold short during the 30-minute period to shares outstanding, and relative short selling is computed by dividing, for each period, the number of shares shorted by the number of shares traded. Abnormal short selling is the percentage difference between the number of shares sold short during the intraday halt-day period and the average number of shares sold short during corresponding intervals in the estimation period.

Period	Number of Trades	Average Trade Size	Volume	Short Interest Ratio	Relative Short Selling	Abnormal Short Selling
-8	987	533	525,725	0.216	0.298	0.207
-7	1,019	401	408,616	0.116	0.277	-0.186
-6	1,243	389	483,667	0.120	0.307	-0.062
-5	1,311	397	520,361	0.134	0.348	0.248
-4	1,373	390	535,461	0.135	0.396	0.207

-3	1,536	327	502,240	0.079	0.299	-0.256
-2	2,031	329	667,701	0.119	0.260	-0.011
-1	2,491	549	1,367,705	0.113	0.302	-0.163
Halt	2,303	377	1,007,887	0.113	0.492	0.001
1	2,189	476	1,042,413	0.139	0.355	0.176
2	1,536	518	795,893	0.105	0.315	-0.008
3	1,662	437	726,633	0.109	0.338	0.034
4	1,126	393	442,139	0.093	0.282	-0.159
5	1,260	523	658,813	0.122	0.337	0.070
6	1,344	511	687,336	0.146	0.341	0.181
7	928	633	587,865	0.126	0.342	0.162
8	410	476	195,334	0.116	0.360	0.003

For each short selling metric, we compute and test for significance the mean difference between the period value on the halt day and the corresponding period value during the estimation interval. Resulting values, listed in Table 8, suggest a measurable change in short selling activity for our sample of related firms immediately surrounding the break in trading for the halted firm. Although the number of trades submitted by short sellers shows no significant change, the difference value for average trade size, volume, short interest ratio, and abnormal short selling measures are generally negative during the three periods preceding the halt and during the halt period, suggesting that short selling is lower than estimation period levels during these intervals. In contrast, the difference in trade size, short volume, and abnormal short selling are positive following the halt interval, as short selling increases to above estimation period levels.

Table 8

Intraday Short Metric Differences

This table contains, for each short selling metric, the mean difference between estimation period (days -30 to -6, and 6 to 30) and halt day short selling levels. The difference value is computed for the eight 30-minute periods prior to the halt in trading and following the resumption of trading for halted firms. The short interest ratio is the number of shares sold short to shares outstanding, and relative short selling is computed by dividing the number of shares shorted by the number of shares traded. Abnormal short selling is the percentage difference between the average daily shares sold short during the event period and the average daily number of shares sold short during the estimation period. The Signed Rank Test is used to determine significance. *p-values* are in parentheses.

Period	Number of Trades	Average Trade Size	Volume	Short Interest Ratio	Relative Short Selling	Abnormal Short Selling
-8	1.89 (0.9896)	16.13 (0.5557)	2492.29 (0.2611)	-0.0589 (0.0986) *	0.0072 (0.7818)	0.2075 (0.1538)
-7	5.29 (0.7647)	-70.31 (0.0481) **	231.731 (0.1070)	-0.0259 (0.0639) *	-0.0239 (0.3232)	-0.1862 (0.0511) *
-6	2.27 (0.6295)	-4.27 (0.0940) *	-248.87 (0.4523)	-0.0258 (0.0695) *	-0.0233 (0.1826)	-0.06238 (0.0272) **
-5	3.49 (0.4313)	24.61 (0.5389)	1053.83 (0.9659)	0.0115 (0.7213)	0.0189 (0.7428)	0.24814 (0.4365)
-4	1.93 (0.4539)	-28.07 (0.1369)	-373.27 (0.8199)	0.0250 (0.8153)	0.0681 (0.1875)	0.2069 (0.2453)
-3	-1.08 (0.4169)	-62.42 (<.0001) ***	-2902.16 (<.0001) ***	-0.0360 (0.0001) ***	-0.0213 (0.2636)	-0.2559 (<.0001) ***
-2	3.18 (0.5135)	-125.60 (<.0001) ***	-1558.11 (0.0934) *	-0.0180 (0.0091) ***	-0.0497 (0.0098) ***	-0.0112 (0.0062) ***
-1	1.88 (0.4805)	-38.18 (0.0001) ***	2372.11 (0.0057) ***	-0.0276 (0.0005) ***	-0.0119 (0.5434)	-0.1630 (<.0001) ***
Halt	0.75 (0.5408)	-122.81 (<.0001) ***	-3694.45 (0.0028) ***	-0.1333 (0.0037) ***	-0.0010 (0.6213)	0.00107 (0.0002) ***
1	0.81 (0.1280)	60.76 (0.027) **	132.62 (0.0544) *	0.0010 (0.2288)	0.0272 (0.5038)	0.17614 (0.0148) **
2	0.56 (0.4450)	-7.02 (0.0452) **	888.98 (0.0241) **	-0.0042 (0.0859) *	0.0036 (0.5190)	-0.0081 (0.0005) ***
3	1.48 (0.8083)	34.40 (0.0343) **	319.70 (0.1632)	-0.0291 (0.1045	0.0277 (0.9888)	0.0345 (0.0057) ***
4	0.82 (0.8220)	-51.01 (0.0023) ***	-595.63 (0.0287) **	-0.0057 (0.0283) **	-0.0051 (0.5293)	-0.1594 (0.0005) ***
5	3.76 (0.1914)	12.36 (0.0105) **	2800.29 (0.2482	0.0054 (0.08137) *	0.00294 (0.8948)	0.07031 (0.1147)
6	4.90 (0.1889)	-152.15 (0.1249)	3142.46 (0.5457)	0.0224 (0.8901)	-0.4888 (0.4835)	0.1808 (0.2361)
7	0.11 (0.0419) **	334.68 (0.3913)	1943.80 (0.0124) **	-0.0167 (0.0133) **	0.0169 (0.3970)	0.1623 (0.0029) ***
8	-2.96 (0.1080)	-71.54 (0.1202)	-1360.59 (0.0532) *	-0.0103 (0.0769) *	0.0660 (0.4545)	0.0031 (0.0816) *

***, **, and * indicate statistical significance at the 0.01, 0.05 and 0.10 level, respectively.

Hypothesis 1 purports that short sellers increase their activity for informationally related firms surrounding a halt in trading for an industry member. Our investigation of daily and intraday short metrics evidences a measurable change in short seller behavior for our sample of related firms. However, instead of the anticipated increase, it appears that short sellers reduce their activity surrounding the halt event. During the 5-day pre- and post-halt periods, short sellers submit fewer trades at a smaller average trade size, resulting in a decrease in short volume during these intervals. A decline is short activity is also detected at the intraday level, as short selling metrics, including average trade size, volume, the short interest ratio and abnormal short selling, decrease prior to the halt period. An increase in shorting is identified in the intraday period immediately following the resumption of trading for the halted firm, as the average short trade size, volume, and abnormal short selling levels are significantly above estimation period values.

Daily Return Behavior

Price behavior for our sample of related stocks is examined at the daily level; post-halt prices and subsequent returns are measured to help quantify the impact of short selling. Our hypothesis concerning the returns earned by related firms surrounding interruptions in trading for an industry member states:

H_2: Securities that are informationally related to a halted stock and have high short selling levels will experience a larger decline in price surrounding a trading halt as compared to informationally related stocks with lower short selling activity.

Related firms are sorted into quintiles according to mean pre-halt abnormal short selling (ABSS) and abnormal relative short selling (ABRELSS) levels. Abnormal relative short selling is calculated by subtracting the estimation period relative short selling measurement from the relative short selling value in the pre-halt period. We examine and report, in Table 9, daily mean and median post-halt returns (each stock's two-day percentage return following the trading halt, measured from the close of the day preceding the halt day to the close of the following day) for the highest and lowest short selling quintiles (following Christophe et al. 2004).

Table 9
Post-halt Daily Returns
Related stocks are sorted into quintiles according to mean abnormal short selling and abnormal relative short selling levels during the five days preceding a trading halt. Mean and median post-announcement returns, each stock's two-day percentage return following the trading halt, measured from the close of the day preceding the halt day to the close of the following day, are reported for the highest and lowest short-selling quintiles. Differences (low short selling – high short selling) between the returns for each short selling category are computed and tested for significance using the Signed Rank Test. *p-values* are listed in parentheses.

Short Selling Metric / Group	Mean Return	Median Return	Difference
Abnormal Short Selling			
Low Short Selling	0.0032	0.0012	-0.0061
High Short Selling	0.0095	0.0041	(0.2821)
Abnormal Relative Short Selling			
Low Short Selling	-0.0009	0.0015	-0.0096
High Short Selling	0.0088	0.0024	(0.3490)

The mean and median post-halt returns for the highest short selling quintile, formed according to both ABSS and ABRELSS levels, are positive and larger in magnitude than corresponding returns for stocks in the lowest short selling group. For instance, the mean return of 0.95 percent for the ABSS high short selling category is almost three times as large as the 0.32 percent earned by the stocks in the lowest short selling quintile. This finding suggests that heightened levels of short selling preceding a trading halt lead to higher post-halt returns.

However, when the difference between returns for high and low quintile firms for both short selling category are tested for significance, no evidence is found to support the assertion that short selling activity for related firms surrounding halts for an industry member impacts post-halt returns.

We perform a non-parametric Chi-square test to examine more closely the relation between high levels of short selling in the pre-event period and post-halt stock returns. For each of our abnormal short selling metrics, ABSS and ABRELSS, we split the sample into two groups, the highest quintile of each measure for the 5-day pre-event period and all other sample halts. We then examine how these groups are distributed across three categories of return from closing day -1 to +1. If short selling is randomly distributed, the halts should evidence the following pattern: 20 percent in the low return quintile, 20 percent in the high return quintile and 60 percent in the moderate return quintile (following Dechow et al., 2001; and Christophe et al., 2004). Accordingly, 39 observations each (approximately 20 percent) should fall into the low and high return categories, and the remaining 119 observations (approximately 60 percent) should be designated as moderate. Table 10 lists the results of the Chi-square examination.

For the highest short selling quintile, we note a measurable increase in the number of stocks assigned to the high return category, 23.08 percent for the ABSS group and 25.64 percent for the ABRELSS group. The number of high short selling stocks assigned to the low return category, for each short selling metric, is below the expected value of 19.80 percent. The return distribution for the stocks in the other short selling quintiles is similar to the expected pattern, with only a slight shift of stocks from the high to the low return category noted. The Chi-square statistics produced for each of the short selling groups, however, are not statistically significant

and therefore fail to provide support for the anticipated relation between short selling activity and returns for related firms.

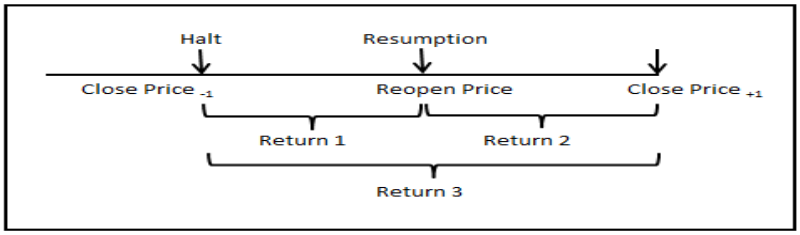
Table 10
Daily Chi-Square Test
Samples halts are divided, using pre-halt abnormal short selling and relative abnormal short selling levels, into two groups, the highest quintile of each measure for the five days preceding the halt and all other sample halts. This test examines how these groups are distributed across three categories of return on stock from closing day -1 to +1.

		Return Quintiles			
		Low Return	Moderate Return	High Return	Total
Sample Observations		39	119	39	197
Expected Percent		19.80%	60.41%	19.80%	100%
Panel A: Abnormal Short Selling, $ABBS_{(-5,-1)}$					
Highest Short Selling Quintile					
	Observations	6	24	9	39
	Percentage	15.38%	61.54%	23.08%	100%
Other Short Selling Quintiles					
	Observations	33	95	30	158
	Percentage	20.89%	60.13%	18.99%	100%
				X^2 statistic	0.7528
				Probability	0.6863
Panel B: Abnormal Relative Short Selling, $ABRELSS_{(-5,-1)}$					
Highest Short Selling Quintile					
	Observations	7	22	10	39
	Percentage	17.95%	56.41%	25.64%	100%
Other Short Selling Quintiles					
	Observations	32	97	29	158
	Percentage	20.25%	61.39%	18.35%	100%
				X^2 statistic	1.0513
				Probability	0.5912

Intraday Return Behavior

Using average abnormal short selling (ABSS) and abnormal relative short selling (ABRELSS) levels in the eight 30-minute pre- and post halt event-day periods, related stocks are sorted into quintiles and the mean and median post-halt returns for the highest and lowest

quintiles are examined (Christophe et al. 2004). We calculate three different intraday returns: 1) from the close of the period preceding the halt to the reopen, 2) from the reopen to the close of the period following resumption of trading, and 3) the interval spanning the halt, from the close of the period prior to the halt to the close of the period following the halt. Return values are reported only for stocks in the lowest and highest short selling quintiles.



Results, listed in Table 11, show that returns for the highest short selling quintile in each period, with the exception of ABRELSS return$_1$, are positive. For the stocks with the highest levels of short selling, each return is larger than the corresponding return for stocks in the lowest short selling quintile. For each short selling metric, differences between returns for the low and high short quintiles is calculated and tested for significance. None of the difference values are statistically different from zero - these results fail to provide support for our hypothesis that for informationally related stocks, increased short selling activity surrounding interruptions in trading is associated with negative price movements.

Table 11

Intraday Post-halt Returns

Related firms are divided into quintiles according to average halt day abnormal short selling and abnormal relative short selling levels in the eight 30-minute pre- and post-event periods. $Return_1$ is from the close of the period preceding the halt to the reopen, $Return_2$ is from the reopen to the close of the period following the resumption of trading, and $Return_3$ is from the close of the period prior to the halt to the close of the period following the halt. Return values are reported only for stocks in the lowest and highest short selling quintiles. Differences between each of the returns for each short selling category are computed and tested for significance using the Signed Rank Test. *P-values* are listed in parentheses.

N = 26 or 27 stocks per quintile

	Mean $Return_1$	Mean $Return_2$	Mean $Return_3$
Abnormal Short Selling			
Low Short-Selling Quintile	-0.0004	0.0014	0.0010
High Short-Selling Quintile	0.0011	0.0027	0.0038
Mean Difference (Low – High)	-0.0018	-0.0012	-0.0030
	(0.1707)	(0.5542)	(0.1430)
Abnormal Relative Short Selling			
Low Short-Selling Quintile	-0.0015	0.0005	-0.0009
High Short-Selling Quintile	-0.0004	0.0020	0.0016
Mean Difference (Low – High)	-0.00110	-0.0015	-0.0026
	(0.4755)	(0.4524)	(0.2536)

To examine further the relation between event day short selling and returns, we repeat our Chi-square distribution test at the intra-day level, for all three return periods, using the average abnormal short selling levels over the eight 30-minute pre- and post-halt periods to sort our stocks into quintiles. Results are listed in Table 12.

If sample stocks are evenly distributed amongst the return categories, i.e. intraday short selling levels have no impact on returns, 26 stocks will be assigned to the low and the high return categories (approximately 20 percent) each, and 79 stocks will be categorized as moderate. In contrast, we find that for all three returns, there is a substantial shift into the high return category for stocks in the highest abnormal short selling quintile. For $return_3$, which represents the overall return associated with the event, an excess of 42 percent of stocks with the highest abnormal short selling levels are assigned to the high return group. In contrast, for each return, the stocks

in the other short selling quintiles have fewer (more) stocks in the high (low) return category than the expected distribution. The Chi-square statistic for each of the returns is significant at the ten percent level or higher, allowing us to reject the null hypothesis that short selling levels and post-announcement returns are independent.

Table 12
Intraday Chi-Square Test
Samples stocks are divided, using Abnormal Short selling, into two groups, the highest quintile of short selling for the eight 30-minute pre- and post-halt day periods and all other sample stocks. This test examines how these groups are distributed across three categories of returns: $Return_1$ is from the close of the period preceding the halt to the reopen, $Return_2$ is from the reopen to the close of the period following the resumption of trading, and $Return_3$ is from the close of the period prior to the halt to the close of the period following the halt.

		Return Quintiles			
		Low Return	Moderate Return	High Return	Total
Sample Observations		26	79	26	131
Expected Percent		19.85%	60.31%	19.85%	100%
Panel A: $Return_1$					
Highest Short Selling Quintile					
	Observations	1	18	7	26
	Percentage	3.85%	69.23%	26.92%	100%
Other Short Selling Quintiles					
	Observations	25	61	19	105
	Percentage	23.81%	58.10%	18.10%	100%
				X^2 statistic	5.4314
				Probability	0.0662 *
Panel B: $Return_2$					
Highest Short Selling Quintile					
	Observations	3	14	9	26
	Percentage	11.54%	53.85%	34.62%	100%
Other Short Selling Quintiles					
	Observations	23	65	17	105
	Percentage	21.90%	61.90%	16.19%	100%
				X^2 statistic	4.9173
				Probability	0.0856 *

Panel C: Return$_3$					
Highest Short Selling Quintile					
	Observations	2	13	11	26
	Percentage	7.69%	50.00%	42.31%	100%
Other Short Selling Quintiles					
	Observations	24	66	15	105
	Percentage	22.86%	62.86%	14.29%	100%
				X^2 statistic	11.2309
				Probability	0.0036***

*** and * indicate statistical significance at the 0.01 and 0.10 level respectively.

Our second hypothesis predicts that related stocks with high short selling levels surrounding a trading halt for an industry counterpart will experience lower returns than related stocks with less short selling activity. Our findings from testing this hypothesis are mixed. At both the daily and intraday level, the difference variable between returns for high and low short selling stocks is insignificant. The daily Chi-square examination also fails to produce evidence of a relation between returns and short selling activity for our sample stocks. However, the Chi-square distribution test at the intraday level provides support for the notion that high short selling levels are associated with higher post-halt returns. One possible explanation for the positive returns earned by related firms surrounding a halt in trading for an industry contemporary is identified by Lang and Stultz (1992). This research predicts a competitive effect surrounding informational events for related firms, a gain in value for related firms due to the potential redistribution of wealth and improved competitive position.

Volatility

Our investigation into the impact of short selling on stocks that are informationally related to firms experiencing a trading halt now addresses price volatility, which we examine on

both the daily and intraday level. Our hypothesis concerning the effect of short selling on price volatility for our sample of related stocks states:

H_3: Securities that are informationally related to a halted stock and have high short selling levels will have higher price volatility surrounding trading halts as compared to informationally related securities with lower short selling activity.

We calculate daily volatility measures for our related stocks for the pre-halt period, the halt day, and the post-halt period following the methodology of Diether et al. (2009A). CRSP data is used to compute a daily mean transaction price range [(high price – low price)/ high price] and close-to-close volatility (by squaring the absolute daily return). The daily quote range [(high quote – low quote) / high quote] and close-to-close and open-to-close volatility, using absolute squared return, is calculated using TAQ data. We regress each volatility metric on a post-halt dummy variable (which equals one for observations during the five-day post-halt period); the coefficient obtained represents the difference between the pre- and post-halt volatility measurements. The difference is tested, using the Wilcoxon signed-rank test, to determine if it is significantly different from zero. We repeat each test, after dividing our sample of related firms into quintiles according to levels of abnormal short selling in the eight 30-minute pre- and post-halt intraday periods. Results are reported in Table 13 – Panel A and Panel B for CRSP and TAQ data, respectively.

Table 13

Daily Mean Volatility Measures

Daily volatility measures are calculated for the pre-halt period (days -5 through -1), the halt day (day 0), and a post-halt period (days +1 through +5). CRSP data is used to determine a daily mean transaction price range [(high price – low price)/ high price] and close-to-close volatility (by squaring the absolute daily return). TAQ data is used to calculate a daily quote range [(high quote – low quote) / high quote] and close-to-close and open-to-close volatility using absolute squared return. The difference between the pre and post measures for each of these metrics is the coefficient obtained by regressing each volatility measure on a post-halt period dummy variable, which equals one for observations during the five-day post-halt period. The difference is tested, using the signed rank test to determine if it is significantly different from zero, *t-statistics* are reported in parentheses. After dividing our sample halts into quintiles according to average intraday levels of abnormal short selling, we repeat each test and report values for the highest and lowest short-selling quintiles.

Panel A: CRSP Data					
Periods/ Volatility Metric	$Pre_{(-5,-1)}$	$Event_{(0)}$	$Post_{(1,5)}$	Difference	
All Related Stocks (N = 171)					
Transaction Price Range	2.24	2.42	2.12	-0.12039	(-1.31)
Volatility (Close to Close)	0.0004	0.0005	0.0004	-0.00001	(-0.15)
By Short Selling Levels					
Low Short-Selling Quintile					
Transaction Price Range	2.50	2.62	2.44	-0.05943	(-0.25)
Volatility (Close to Close)	0.0004	0.0004	0.0005	0.00014	(1.06)
High Short-Selling Quintile					
Transaction Price Range	2.45	2.75	1.99	-0.45406	(-2.45) **
Volatility (Close to Close)	0.0005	0.0010	0.0002	-0.00028	(-1.97) **
Panel B: TAQ Data					
All Related Stocks (N = 171)					
Quote Range	0.6548	0.6860	0.6766	0.0218	(0.24)
Volatility (Open to Close)	0.0006	0.0006	0.0011	0.0000	(-0.52)
Volatility (Close to Close)	0.0013	0.0005	0.0011	-0.0001	(-1.51)
By Short Selling					
Low Short-Selling Quintile					
Quote Range	0.5998	0.6597	0.6613	0.0615	(0.54)
Volatility (Open to Close)	0.0003	0.0010	0.0003	-0.0000	(-0.26)
Volatility (Close to Close)	0.0005	0.0003	0.0004	-0.0001	(-0.66)
High Short-Selling Quintile					
Quote Range	0.7626	0.8041	0.6515	-0.1110	(-1.58)
Volatility (Open to Close)	0.0004	0.0005	0.0002	-0.0003	(-1.89) *
Volatility (Close to Close)	0.0005	0.0011	0.0002	-0.0003	(-1.85) *

** and * indicate statistical significance at the 0.05 and 0.10 level, respectively.

Volatility metrics based on CRSP data demonstrate that the transaction price range for sample stocks is larger on the event day as compared to the average price range in the pre- and post-halt intervals. With the exception of the high short selling quintile, the event-day price range is 18 to 30 percent larger than price ranges during the 5-day periods preceding and following the halt day. The close-to-close volatility measurement for the all stocks and the low short selling categories are nearly identical for the three examination periods, varying by only 0.0001. Volatility measurements for the high short selling group demonstrate the largest amount of variation. For this category, the halt day transaction price range is 30 percent greater than the pre-halt value and 76 percent larger than the average price range in the post-halt period. Close-to-close volatility increases by a factor of two (five) over pre-halt (post-halt) levels. For the high short selling quintile, the difference value, comparing pre- and post-halt volatility measurements, are negative for both the transaction price range and close-to-close volatility, indicating a significant decrease in volatility for these related firms on the five trading days following a trading halt event. Differences for the all stocks and low short selling quintile are not significant. These results suggest that increased short selling activity for firms related to an industry member experiencing a trading halt results in lower post-halt volatility.

The daily quote range and volatility metrics calculated with TAQ data provide similar findings. Modest changes in the quote range are noted for the all stocks and the low short selling quintile. However, close-to-close and open-to-close volatility appears elevated for all stocks in the post-halt period and the event-day open-to-close volatility for stocks in the low short selling category. None of the difference variables for the all sample stocks category and the quintile of low short selling stocks are significant. In contrast, the high short selling quintile of stocks has

elevated volatility measurements on the halt day, and significantly lower volatility differences for both open-to-close and close-to-close metrics.

At the intraday level, we use TAQ data to calculate median and abnormal measures (as compared to the estimation period) for volume, number of quote revisions, absolute return and transaction price range during the four 30-minute periods preceding the halt and following the resumption of trading for the halted firm (following Corwin and Lipson, 2000). Significance is determined using the Wilcoxon signed-rank test. The results are first presented, in Table 14, as averages for the pre-halt (periods -4 through -1), halt (period 0), and post-halt periods (periods +1 though +4). Table 15 list volatility metrics for each 30-minute period separately. For each presentation, we present values for all related stocks (Panel A) and then differentiate the volatility measurements for stocks according to levels of short selling (Panel B). Short selling quintiles are established using average halt-day abnormal short selling levels in the eight 30-minute pre- and post-event periods. Results are shown for the highest and lowest quintiles.

Table 14

Mean Interval Intraday Volatility Measures

TAQ data is used to calculate median and abnormal measures (as compared to the estimation period) for volume, number of quote revisions, absolute return and transaction price range during the four 30-minute periods preceding the halt and following the resumption of trading. Mean values are reported for the four 30-minute period preceding a trading halt (pre) and the four 30-minute periods following resumption of trading (post). To differentiate between firms according to short selling levels (Panel B), we divide firms into quintiles according to average halt day abnormal short selling levels in the eight 30-minute pre- and post-event periods. Results are shown for the highest and lowest quintile. Significance is determined using the Wilcoxon signed-rank test.

Panel A: All Related Stocks (188)

Period	Volume	Quote Revisions	Absolute Return	Transaction Price Range
		Median		
$Pre_{(-4,-1)}$	5,000	62	0.2040	0.080
$Event_{(0)}$	4,839	74	0.2048	0.070
$Post_{(1,4)}$	6,008	60	0.1639	0.070
		Abnormal Percentage		
$Pre_{(-4,-1)}$	-1.97 ***	6.17	4.62 **	0.41 ***
$Event_{(0)}$	1.55 **	14.39	20.70	13.09 *
$Post_{(1,4)}$	8.56 **	14.02	5.06 ***	9.36 **

Panel B By short-selling levels (38 Halts per Quintile)				
Lowest Short-selling Quintile				
			Median	
$Pre_{(-4,-1)}$	3,050	55	0.1640	0.055
$Event_{(0)}$	3,429	78	0.1920	0.060
$Post_{(1,4)}$	2,872	71	0.1524	0.040
			Abnormal Percentage	
$Pre_{(-4,-1)}$	-21.16 ***	5.70 *	-15.23 ***	-6.70 **
$Event_{(0)}$	-12.55 **	-3.57	32.50	-17.16
$Post_{(1,4)}$	-33.41 ***	15.73	-9.95 **	-21.94 ***
Highest Short-selling Quintile				
			Median	
$Pre_{(-4,-1)}$	12,300	73	0.2536	0.110
$Event_{(0)}$	8,219	94	0.1221	0.070
$Post_{(1,4)}$	10,116	82	0.2189	0.095
			Abnormal Percentage	
$Pre_{(-4,-1)}$	53.30 ***	22.66 **	16.06	6.98
$Event_{(0)}$	47.80 *	34.52	-19.70 **	-5.79
$Post_{(1,4)}$	75.31 ***	36.19 ***	28.26	35.87 **

*** and ** indicate statistical significance at the 0.01 and 0.05 level respectively.

Abnormal trading volume, for all stocks, is significantly different from trading volume in the estimation period - levels are lower than normal (negative) preceding the halt and above estimation period levels (positive) during and following the halt period. Our examination of abnormal volume for each of our short selling quintiles demonstrates that abnormal trading volume is negative (12 to 33 percent lower) for stocks in the low short selling quintile. For stocks in the high short selling category, median period values are substantially larger and abnormal volume is positive (47 to 75 percent) in each of the periods examined. This finding suggests that short selling has a positive relation with trading volume and subsequent volatility.

For the all stocks category, the number of quote revisions is not statistically different from the level generated during the estimation period. However, when segmented according to short selling levels, stocks in the low short selling group demonstrate a higher than normal number of quote revisions in the pre-halt period. Stocks with the highest level of short selling

appear to have an increased number and significantly elevated abnormal quote revisions in both the pre- and post-halt periods.

Increased volatility, in the form of absolute returns, is noted for all stocks in the pre- and post-halt periods. However, when examining this metric for stocks segmented by shorting activity, both quintiles experience negative abnormal absolute returns, stocks with low levels of shorting during the pre- and post-halt periods, and stocks in the high short selling quintile during the halt interval.

The transaction price range is larger than estimation period levels for all stocks in the pre, halt, and post–halt periods. This positive relation is also evident during the post-halt period for stocks with the highest level of short selling. In contrast, stocks with low shorting levels demonstrate a substantially lower price range immediately preceding and following the halt in trading for an industry member.

Table 15 presents the volatility metrics for each period separately (Panel A) and then separates firms according to short selling levels (Panel B). For all related firms, abnormal volume is negative in periods -4 and -3; this metric is positive in the two periods immediately preceding the halt and the during the halt period. Although median values appear larger in the four post-halt periods, there is no statistical difference between halt and estimation period levels for these intervals. When segmented according to levels of short selling, a general pattern emerges; stocks with the lowest (highest) levels of short selling demonstrate negative (positive) abnormal volume.

Table 15

Mean Period Intraday Volatility Measures

TAQ data is used to calculate median and abnormal measures (as compared to the estimation period) for volume, number of quote revisions, absolute return and transaction price range during the four 30-minute periods preceding the halt and following the resumption of trading. Panel A presents findings for all related stocks; results for the highest and lowest quintiles according to levels of intraday abnormal short selling are presented in Panel B. Significance is determined using the Wilcoxon signed-rank test.

Panel A: All Related Firms (188)

Period	Volume	Quote Revisions	Absolute Return	Transaction Price Range
		Median		
-4	2,700	46	0.1900	0.055
-3	5,650	62	0.2112	0.070
-2	5,000	80	0.2531	0.090
-1	6,000	59	0.1929	0.080
0	4,839	74	0.2048	0.070
+1	6,500	70	0.1507	0.070
+2	6,000	56	0.1876	0.070
+3	5,362	59	0.1777	0.070
+4	6,400	59	0.1345	0.060
		Abnormal Percentage		
-4	-8.72 ***	2.50	-2.26	-14.66 ***
-3	-12.66 ***	-5.17 *	11.07	-7.13 **
-2	9.31 *	10.30	11.56	24.13
-1	0.59 **	13.22	-1.05	-3.14 **
+1	1.55 **	14.39	20.70	13.09 *
0	9.28	11.42	3.14	3.98
+2	11.08	15.08	13.79	13.05
+3	4.25	20.50	2.01	14.82
+4	9.87	78.08	-0.36 **	4.65

Panel B: By Short-Selling Quintile (38 Halts per Quintile)

Lowest Short-selling Quintile				
		Median		
-4	1,940	45	0.1013	0.040
-3	3,000	47	0.2036	0.050
-2	3,500	67	0.0822	0.060
-1	4,617	68	0.2114	0.060
0	3,429	78	0.1920	0.060
+1	1,600	76	0.1422	0.030
+2	3,670	63	0.1580	0.035
+3	2,872	74	0.1728	0.060
+4	5,700	55	0.1384	0.040

		Abnormal Percentage		
-4	-35.98 ***	3.28	-23.11	-28.72
-3	-37.80 **	-12.54	-2.15	-25.44 **
-2	-8.07	14.84	-46.48 ***	4.30
-1	-13.61 **	12.54	-2.46	7.84
0	-12.55 ***	-3.57	32.50	-17.16
+1	-33.40 ***	10.00	-13.60	-26.24 ***
+2	-35.02 ***	4.95	-20.15	-19.86 **
+3	-29.28 **	52.54	-7.29	-27.11 **
+4	-37.29 **	-14.78	11.51	-7.75
Highest Short-selling Quintile				
		Median		
-4	8,841	70	0.2884	0.080
-3	14,790	62	0.2010	0.105
-2	12,300	81	0.2934	0.150
-1	13,200	96	0.2128	0.110
0	8,200	94	0.1221	0.070
+1	10,500	97	0.2430	0.080
+2	10,300	77	0.2628	0.080
+3	9,666	82	0.2188	0.120
+4	10,100	92	0.1451	0.070
		Abnormal Percentage		
-4	10.19	14.68	29.36	-19.76
-3	35.80	1.18	-16.92	-4.04
-2	96.49 **	26.61	45.10	43.56
-1	58.16 **	38.79	2.77	2.33
0	47.80 *	34.52	-19.70 **	-5.79
+1	77.06 ***	33.67	21.80	31.24
+2	92.68 **	45.71	30.11	48.37
+3	47.85	38.83 **	27.17	40.34 **
+4	86.49 **	24.13	35.41	21.20

***, ** and * indicate statistical significance at the 0.01 and 0.05 and 0.10 level respectively.

Although our examination of volatility metrics at the period level reports a positive 0.41 percent abnormal transaction price range for all stocks in the pre-halt period (Table 14), we find that this metric, when examined on a period-by-period basis, is generally negative in the periods leading up to the halt, ranging from a -3.14 percent to -14.66 percent. The all stocks group

reports a positive 9.36 percent abnormal price range in the post-halt period, yet a significant increase in abnormal price range is not supported when reporting by periods - the lowest short selling quintile demonstrates negative abnormal transaction price ranges following the resumption in trading for the halted firm (periods +1 through +3).

Based on the findings of previous literature, we hypothesize that short selling activity has a positive impact on volatility for stocks related to an industry member experiencing a trading halt. Our examination of volatility, however, provides mixed results. At the daily level, we find evidence, in the form of a lower transaction price range and close-to-close and open-to-open volatility measurements, those stocks with the highest short selling levels demonstrate lower post-halt volatility – short selling appears to reduce these metrics in our sample of related stocks. However, at the intraday level, our findings suggest that stocks with the lowest level of short selling activity have reduced volatility (negative abnormal volume and abnormal transaction price range) as compared to stocks with higher short selling (positive abnormal volume).

Spreads

Previous research has established that short selling and trading halts both impact the bid-ask spread. To investigate the combined effect of these two market activities, we examine mean and median dollar spreads for related firms at several intervals preceding the halt period and following the resumption of trading for the halted firm.

Our hypothesis concerning the effect of short selling activity on spreads surrounding interruptions in trading purports:

H_4: Securities that are informationally related to a halted stock and have high short selling levels will have wider spreads surrounding trading halts as compared to informationally related securities with lower short selling activity.

Following Corwin and Lipson (2000), we compute spreads using three different intervals: 30 minutes, 1 minute, and 15 seconds. We categorize firms into quintiles according to average abnormal short selling levels in the eight 30-minute pre- and post-halt periods and repeat our examination for each time interval. The difference between each spread measurement and its corresponding estimation period value is calculated and tested, using the Wilcoxon signed-rank test, to determine if it is statically different from zero.

Thirty-minute median spreads for the event day and estimation period, and for the highest and lowest short selling quintiles for this time interval, are displayed in Figure 3 and Figure 4, respectively. Median spreads during the estimation period are generally three cents; event day median spreads are similar in size, with the exception of periods +2 and +4, when they increase to four cents.

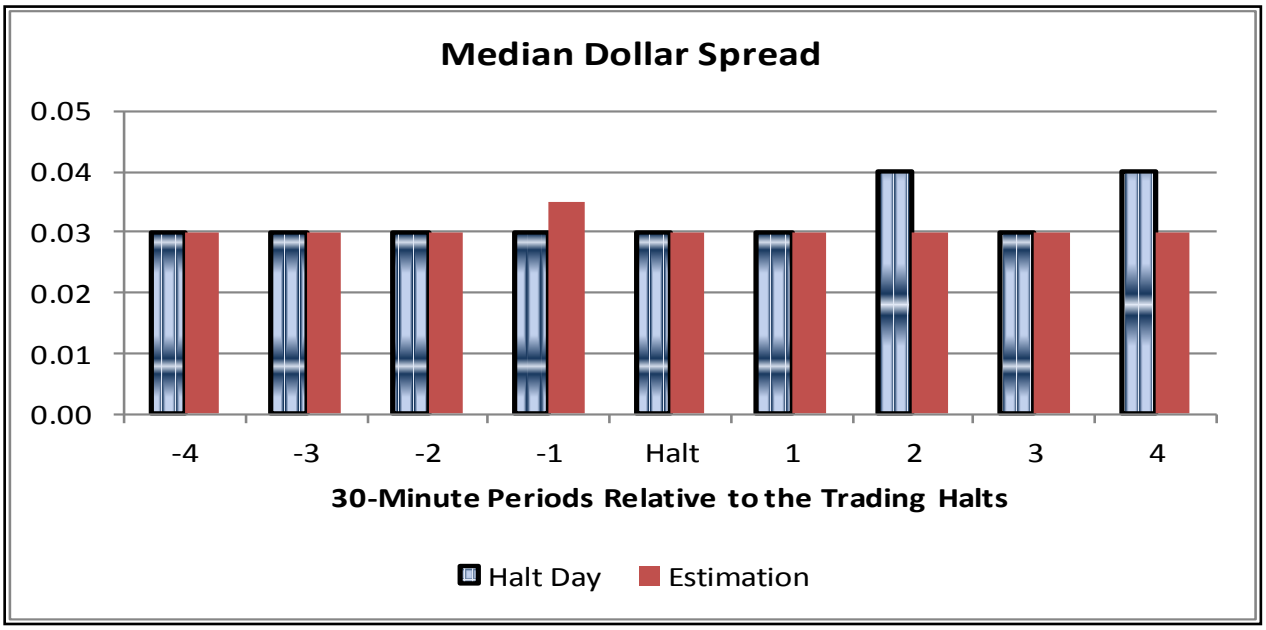


Figure 3
Halt and Estimation Period Median Spreads
Median spreads are computed for 30-minute periods preceding the interruption of trading and following the resumption of trading on the halt day and during corresponding periods in the estimation period.

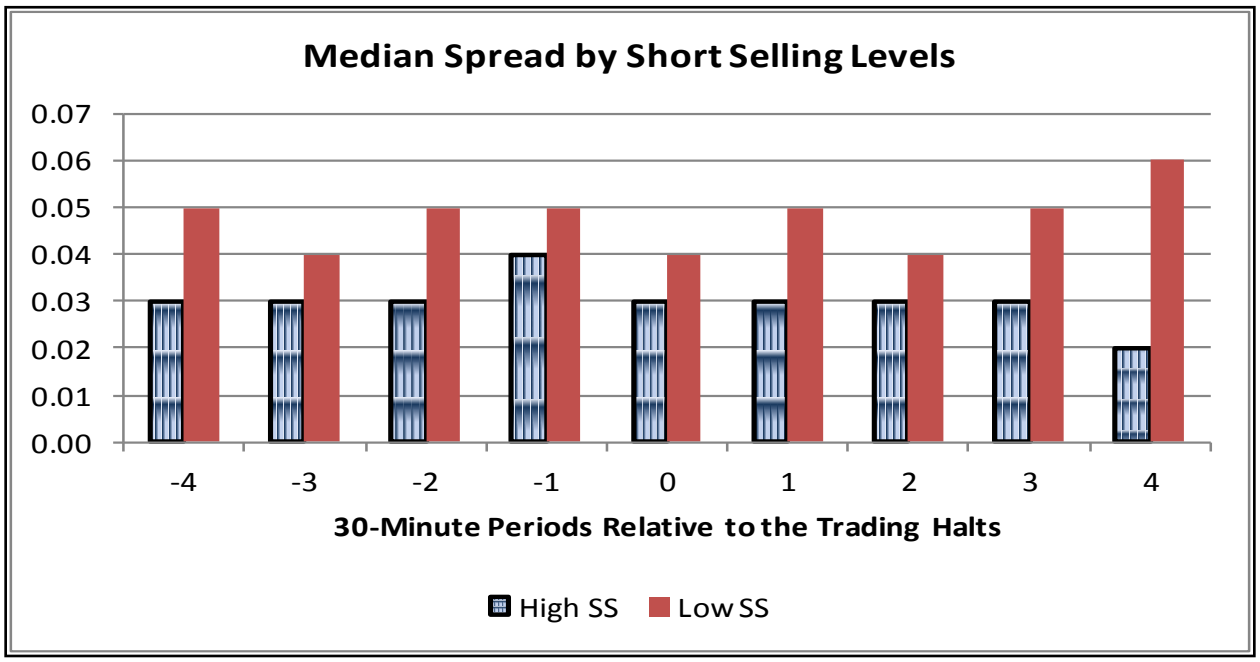


Figure 4
Intraday Spreads: 30-Minute Periods
Median spreads are computed for 30-minute periods preceding the interruption of trading and following the resumption of trading. Results are reported for firms in the highest and lowest quintiles of short selling according to halt-day abnormal short selling levels.

The difference in each 30-minute mean spread measurement from estimation period values, listed in Table 16, confirms that spreads on the event day do not differ significantly from estimation period spreads – the difference statistic is only significant in period +3. When examined according to short selling levels, median spreads for stocks with the highest levels of abnormal short selling appear substantially smaller than corresponding spreads for stocks in the lowest short selling quintile. However, the difference statistic for 30-minute spreads for both short selling quintiles does not provide evidence that either spread measurement varies significantly from estimation period levels. At 30-minute intervals, it appears that spreads for

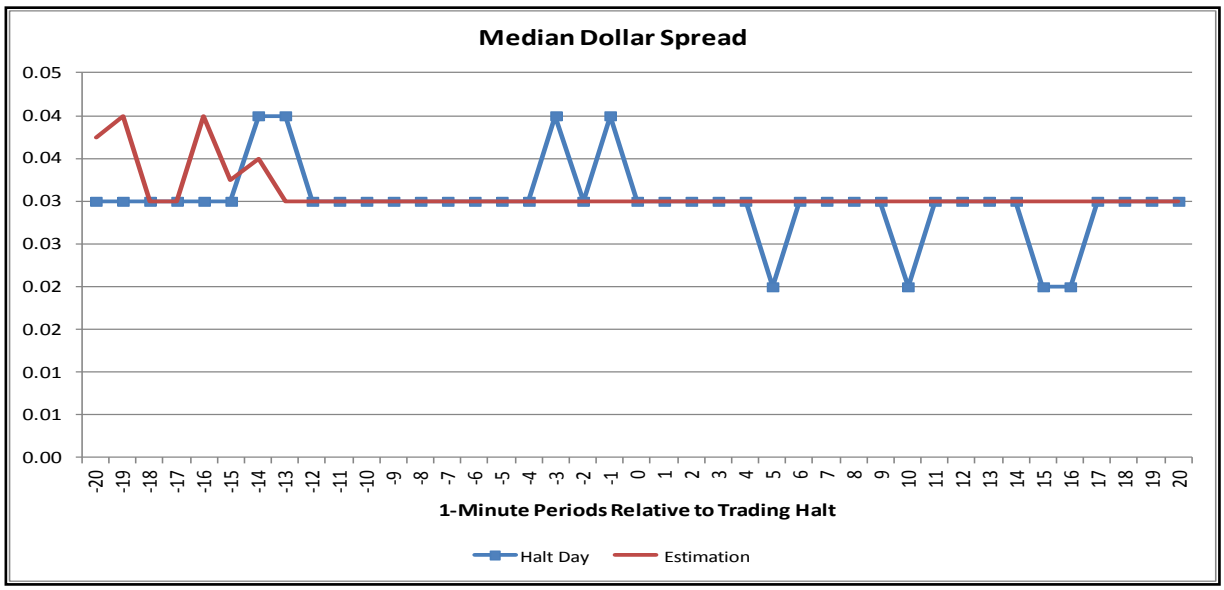
related stocks surrounding a trading halt for an industry counterpart are not substantially impacted by the either the interruption is trading or short selling activity.

Table 16
Spread Differences: 30-Minute Periods
For all related stocks and by short-selling levels, the difference between the mean spread on the halt day and the estimation period is calculated for each 30-minute period. Results are reported for only the highest and lowest short selling quintiles, as established by halt-day abnormal short selling levels. Differences are tested, using the signed rank test, to determine if they are statistically difference than zero. *T-statistics* are reported in parentheses.

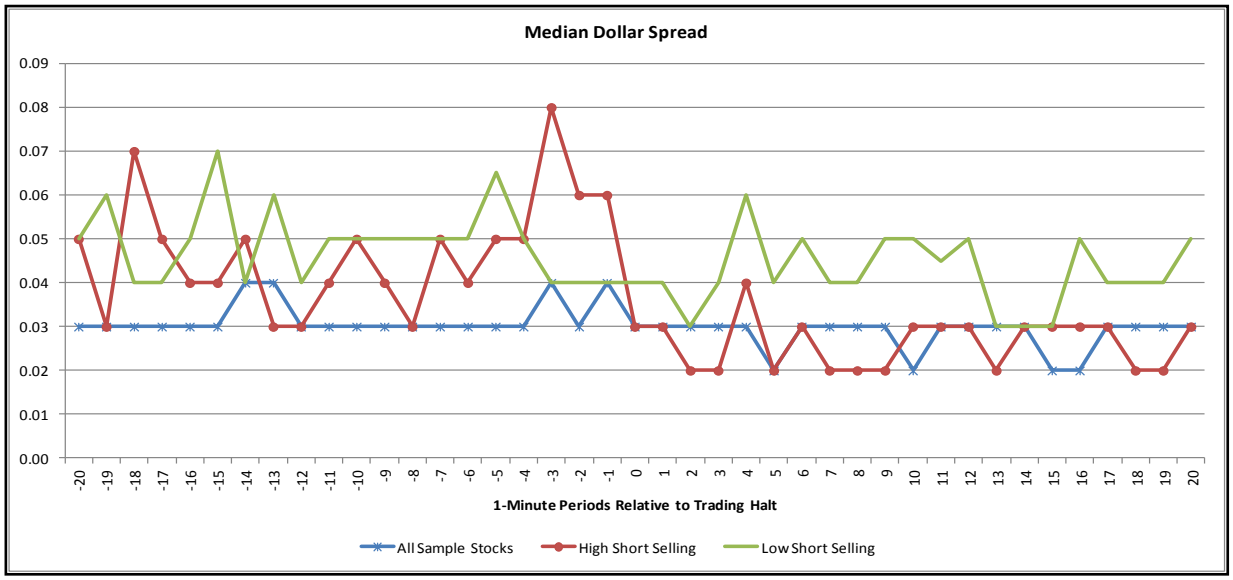
Period	All Related Stocks		High Short Selling		Low Short Selling	
-4	0.00	(-1.13)	0.00	(-0.11)	-0.01	(-1.53)
-3	-1.13	(-1.82) *	-0.01	(-2.54) **	0.00	(-0.38)
-2	0.00	(0.63)	-0.01	(-1.55)	0.01	(0.70)
-1	0.00	(-0.25)	0.00	(0.67)	0.00	(0.72)
Halt	0.00	(0.62)	-0.01	(-1.30)	0.01	(0.77)
+1	0.00	(-0.53)	0.00	(0.27)	0.00	(0.56)
+2	0.00	(0.12)	0.00	(0.38)	0.01	(1.33)
+3	0.00	(1.37)	0.01	(1.65)	0.01	(2.01) *
+4	0.00	(0.87)	0.01	(1.47)	0.01	(1.26)

** and * indicate statistical significance at the 0.05 and 0.10 level, respectively.

Median spreads are shown for 1-minute intervals in Figure 5, and 15-second intervals in Figure 6, with Panel A containing spreads for the halt and estimation period, and Panel B containing spreads for firms categorized by short selling levels. Two deviations from estimation period levels are substantiated by both examinations. An increase in spreads is noted in the 1-minute period immediately preceding the event period – a corresponding increase is seen in the two 15-second periods prior to the halt. A decrease in spreads occurs approximately 5 minutes after the resumption of trading (periods 17 – 20 using 15-second intervals). Differences in the spread measurement from estimation period levels are computed for both the 15-second and 1-minute intervals.



Panel A: 1-Minute Spreads

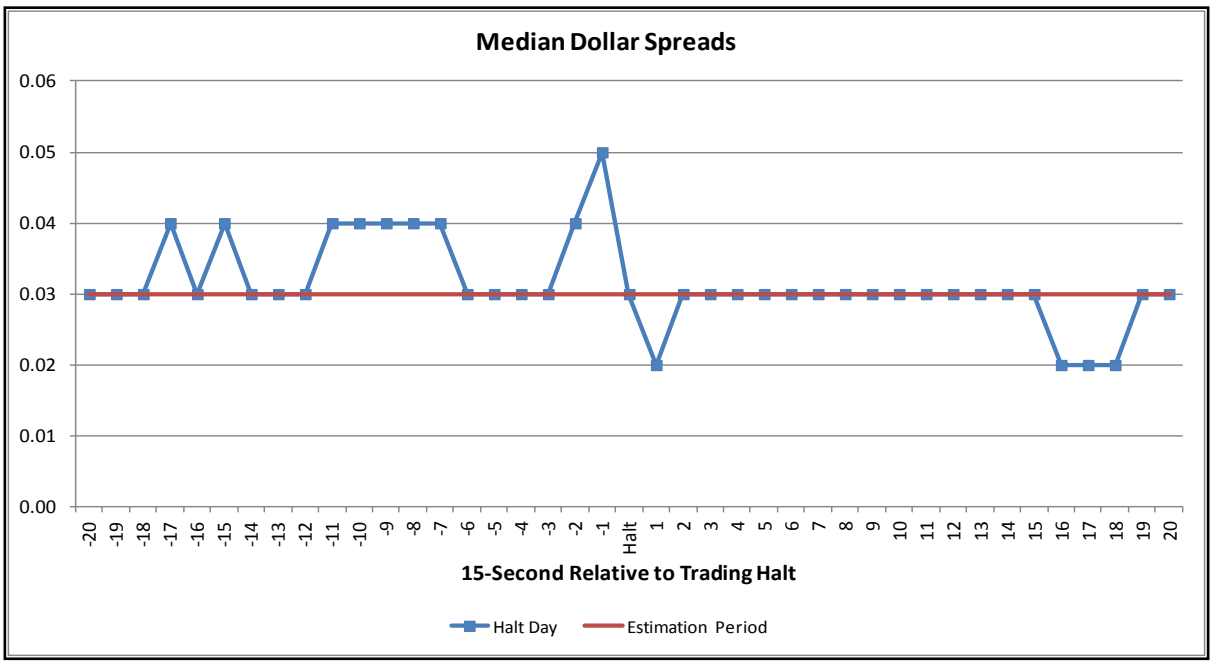


Panel B: 1-Minutes Spreadsby Short Selling Levels

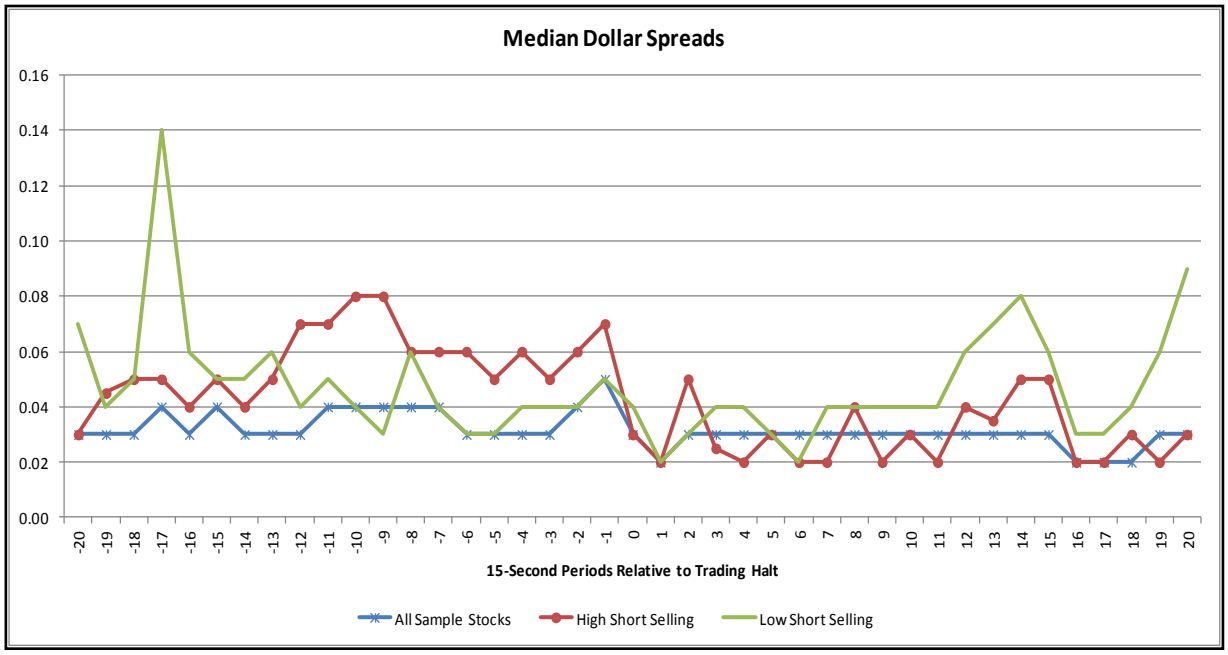
Figure 5

Intraday Spreads: 1-Minute Periods

Median spreads are computed during 1-minute intervals preceding and following the resumption of trading on the halt day and during corresponding estimation periods. Results are reported for all related stocks (Panel A) and by short selling levels (Panel B) for firms in the highest and lowest quintiles of short selling according to halt-day abnormal short selling levels.



Panel A: 15-Second Spreads



Panel B: 15-Second Spreads by Short Selling Levels

Figure 6

Intraday Spreads – 15 Second Periods

Median spreads are computed during 15-second intervals preceding and following the resumption of trading on the halt day and during corresponding estimation periods. Results are reported for all related stocks (Panel A) and by short selling levels (Panel B) for firms in the highest and lowest quintiles of short selling according to halt-day abnormal short selling levels.

The resulting difference values indicate that median spreads for related firms do not vary significantly between event day and estimation periods; nor do they differ between high and low levels of short selling activity. Values for 15-second interval are listed in Table 17; the results for 1-minute intervals, not reported, provide similar findings.

Table 17

Spread Differences: 15-Second Periods

For all stocks and by short-selling levels, the difference between the mean spread on the halt day and the estimation period is calculated for each 15-second period. Results are reported for only the highest and lowest short selling quintiles, as established by halt-day abnormal short selling levels. Differences are tested, using the signed rank test to determine if they are statistically difference than zero. *T-statistics* are reported in parentheses.

Period	All Related Stocks		High Short Selling		Low Short Selling	
-20	0.0037	(0.77)	0.0367	(2.76) **	0.0144	(2.68) **
-19	-0.0032	(-0.48)	0.0011	(0.08)	-0.0069	(-1.06)
-18	-0.0007	(-0.11)	0.0061	(0.48)	-0.0014	(-0.20)
-17	0.0099	(1.51)	0.0119	(1.12)	0.0071	(0.79)
-16	-0.0021	(-0.57)	0.0063	(0.51)	0.0135	(1.89)
-15	-0.0082	(-2.09) **	0.0038	(0.33)	-0.0084	(-1.08)
-14	-0.0038	(-0.64)	0.0016	(0.11)	0.0067	(0.76)
-13	-0.0047	(-1.17)	0.0098	(1.3)	0.0036	(0.35)
-12	-0.0040	(-0.88)	0.0116	(1.25)	0.0141	(1.44)
-11	-0.0061	(-1.16)	-0.0098	(-0.7)	-0.0050	(-0.38)
-10	0.0020	(0.48)	0.0161	(1.94)*	-0.0030	(-0.25)
-9	0.0038	(0.61)	0.0008	(0.05)	-0.0106	(-1.43)
-8	-0.0012	(-0.24)	0.0148	(0.71)	-0.0041	(-0.82)
-7	0.0083	(1.40)	0.0286	(2.02) *	0.0040	(0.53)
-6	-0.0020	(-0.41)	0.0006	(0.05)	0.0003	(0.03)
-5	0.0025	(0.31)	0.0035	(0.47)	-0.0089	(-1.69)
-4	-0.0014	(-0.28)	0.0156	(1.47)	-0.0128	(-2.21)*
-3	0.0080	(0.99)	-0.0036	(-0.40)	0.0153	(1.35)
-2	0.0009	(0.17)	0.0021	(0.17)	0.0028	(0.29)
-1	0.0012	(0.22)	-0.0011	(-0.09)	0.0074	(1.06)
Halt	0.0018	(0.62)	-0.0065	(-1.26)	0.0051	(0.77)
1	-0.0049	(-0.81)	-0.0116	(-0.93)	-0.0006	(-0.05)
2	0.0053	(1.22)	0.0068	(0.95)	0.0071	(0.68)
3	-0.0015	(-0.28)	-0.0117	(-0.87)	0.0173	(1.07)
4	0.0091	(1.22)	0.0025	(0.22)	0.0162	(1.23)
5	0.0123	(1.40)	0.0047	(0.41)	0.0187	(1.31)
6	-0.0042	(-0.73)	0.0059	(1.20)	-0.0106	(-2.13) *
7	0.0013	(0.28)	-0.0098	(-1.41)	0.0068	(0.70)
8	-0.0034	(-0.61)	-0.0069	(-0.98)	0.0198	(1.23)
9	-0.0051	(-1.12)	-0.0084	(-0.96)	-0.0002	(-0.03)

10	0.0034	(0.69)	0.0037	(0.32)	0.0082	(0.70)
11	-0.0028	(-0.51)	-0.0172	(-1.71)	0.0057	(0.47)
12	0.0049	(0.70)	-0.0160	(-1.19)	0.0065	(0.81)
13	0.0053	(0.71)	0.0035	(0.23)	-0.0004	(-0.03)
14	0.0010	(0.18)	0.0077	(0.50)	0.0069	(0.63)
15	0.0054	(1.20)	0.0073	(0.72)	0.0175	(1.33)
16	-0.0075	(-1.22)	-0.0119	(-0.88)	0.0007	(0.06)
17	0.0082	(0.75)	-0.0027	(-0.40)	0.0124	(0.92)
18	0.0048	(0.79)	-0.0080	(-0.92)	0.0268	(1.56)
19	-0.0021	(-0.38)	-0.0122	(-1.36)	0.0188	(1.35)
20	0.0032	(0.42)	-0.0043	(-0.30)	0.0116	(0.67)

** and * indicate statistical significance at the 0.05 and 0.10 level, respectively.

Based on the established positive relation between spreads and both short selling and trading halts and the presence of contagion and commonality in order flow for related firms, we hypothesize that spreads for informationally related firms will increase surrounding an interruption in trading for an industry member. However, our examination of spreads at three different time intervals fails to provide support for this assertion; it appears that spreads for our sample of related firms are not significantly affected by a trading halt for a contemporary firm or by short seller behavior surrounding the interruption in trading.

CONCLUSION

The objective of this research is to determine if informed market participants modify their behavior, in regards to short selling activity, for stocks that are informationally related to industry contemporaries that experience a halt in trading. Further, our aim is to discover if the anticipated increase in short selling substantially affects market quality for these related firms. Our investigation is based on the previously established impact of both short selling and trading halts on security prices, return variability, and spreads, and the contagion and commonality in order flow between industry counterparts identified in previous research.

Our results provide some evidence that short sellers modify their behavior in regards to related firms surrounding halts in trading for an industry member. At the daily level, short sellers appear to reduce their activity regarding related firms prior to and following a trading halt – they submit fewer trades, resulting in a decrease in short volume during the 5-day pre- and post-halt periods. A decrease is short selling activity is also detected at the intraday level, as the average trade size, volume, short interest ratio, and abnormal short selling measures decrease prior to the halt period. However, an increase in shorting is identified in the 30-minute period immediately following the resumption of trading, as the average short trade size, volume, and abnormal short selling levels are significantly above estimation period values. Although changes in short selling activity were identified prior to the implementation of a halt, the lack of significance in our regression equations do not provide the support necessary for us to purport that this activity is informationally motivated.

Hypothesis 2 is based on the established relation between short selling and returns; it suggests that an increase in short selling leads to negative returns for our sample of related stocks. Although no significant findings were obtained from the daily examination, results from the intraday Chi-square test suggests that related firms with the highest short selling levels earn larger gains that sample firms with lower levels of short activity. One possible explanation for this result is that related firms derive a benefit (i.e. the competitive effect suggested by Lang and Stultz, 1992) when a fellow industry member is subjected to a halt in trading.

Our examination of volatility for related firms provides evidence that price volatility is affected by the halt in trading for an industry member. Intraday results for volume, absolute return, and transaction price ranges are generally higher surrounding halts in trading than during the estimation period. Short selling levels appear to impact volatility; at the daily level short selling activity appears to mitigate volatility, reducing the transaction price and quote range and close-to-close and open-to-close volatility metrics. In the intraday periods immediately surrounding the halt interval, however, firms with low short selling levels evidence lower volume, absolute return, and transaction price range than corresponding estimation period levels. In support of Hypothesis 3, stocks with the highest shorting activity demonstrate an increase in volume and the number of quote revisions.

Our final hypothesis predicts that spreads will increase for related firms surrounding halts in trading for an industry counterpart. This notion is based on the high levels of information asymmetry associated with halts in trading and the corresponding need for wider spreads to compensate for losses to informed traders. Our examination of spreads was unable to detect any significant deviation from estimation periods or between stocks with different levels of short selling activity.

This investigation into short selling activity for related firms surrounding halts in trading for an industry member provides mixed results. Although a shift in short selling activity and a modest impact in market quality is detected in our sample of related firms, our examination fails to establish that these changes are informationally motivated.

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ESSAY 3:

DOES PREDATORY TRADING OCCUR AROUND TRADING HALTS?

INTRODUCTION

Our research examines market activity surrounding trading halts to determine if predatory trading occurs. Firms undergoing a trading halt often experience unfavorable market responses, including significant price declines and increases in volatility, which may necessitate that a trader holding the halted stock liquidates his position. When a constrained trader attempts to liquidate, his situation may be recognized by other strategic traders who then engage in predatory trading by withdrawing liquidity.

We make two primary contributions to microstructure literature. First, we establish whether predatory behavior is present surrounding interruptions in trading or, as suggested by Brunnermeier and Pedersen (2005), that trading halts eliminate the opportunity for predation. Second, we determine if documented changes in market quality for halted firms are linked to predatory trading. Brunnermeier and Pedersen state (page 1852), "Predatory trading is important in connection with large security trades in illiquid markets." Trading halts, which significantly impact liquidity, are common in current financial markets; it is therefore important to understand more clearly the associated market dynamics.

TRADING HALTS

Financial markets have regulations that suspend trading under specified conditions. The primary purpose of trading halts is to, "provide an opportunity for normal information transmission in times of market duress" (Lee, Ready, and Seguin 1994, page 183). These interruptions in trading can take the form of price limits, which are implemented when security

prices cross boundaries established by market regulators, firm-specific trading halts (either news or order-imbalance related) that suspend trading on an individual security for a predetermined period, or market-wide circuit breakers that halt trading on the entire market when a designated index exceeds a pre-specified level (Kim and Yang, 2004).

Trading halts produce a significant impact on the market quality of affected firms. Madura, Richie, and Tucker (2006) provide an overview of the microstructure literature's findings on the impact of trading halts. They summarize these findings, stating that in general, stocks undergoing a trading halt experience abnormal negative returns and elevated levels of volume and volatility.

Several findings from the trading halt literature directly contribute to our current study of predation. In the first, Subrahmanyam (1994) analyzes the behavior of market participants prior to an impending market-wide trading halt. He hypothesizes that a 'magnet effect' is created—market participants, concerned over the impending inability to trade, modify their strategies and advance the timing of their trades to enable submission before trading is suspended. Goldstein and Kavajecz (2004) provide empirical support for the magnet effect when they examine the trading behavior of New York Stock Exchange (NYSE) market participants during the October 1997 market turbulence.

The second research contribution is from Lee et al. (1994) who examine NYSE trading halts and find that interruptions in trading lead to increases in both volume and volatility. In the trading day following a halt, they report that volume is 230 percent greater and volatility is 50 to 115 percent larger as compared to a control period of continuous trading. Elevated volume continues for at least three days and price volatility remains inflated for one full day following the resumption of trading.

We suggest that the increase in trading volume and price volatility surrounding an interruption in trading may be partially attributed to strategic traders submitting predatory orders. As Wong, Chang, and Tu (2009, page 39) state, "The only situation when institutions' trades resulted in the magnet effect is when they are trading aggressively against the individuals towards the limit bounds." Lee et al. (1994, page 210) assert, "The effects of halts on volume and volatility are clear. However, determining the source of these effects is complicated, since a halt is associated with a number of simultaneous factors."

Our third finding is provided by Corwin and Lipson (2000) from their investigation of order flow and liquidity surrounding trading halts on the NYSE. This research examines spreads and limit order book composition to determine the effect of trading halts on liquidity. They find that depth near the quotes on the limit order book and for the specialist is abnormally low surrounding halts. We consider if this decrease in liquidity is related to the actions of predatory trades that withdraw liquidity from the market.

Offering an alternate view, Brunnermeier and Pedersen (2005) theorize that trading halts may instead mitigate the problem of predatory trading. During a halt, traders have the opportunity to update their beliefs of an asset's value; upon the resumption of trading, they are able to participate in a batch auction. Brunnermeier and Pedersen's trading model assumes that long-term traders utilize limit orders, distressed traders submit market orders, and predators submit market orders to maximize their profit. After all orders are collected, they execute at a single price in the auction, after which sequential trading resumes. In this scenario, price overshooting is smaller compared to the model without a trading interruption. Providing support for Brunnermeier and Pedersen's assertion, Kim and Yang (2004, page 126) state, "Trading halts can help protect traders from incurring heavy losses during periods of extreme illiquidity."

TRADING HALTS AND THE NEED TO LIQUIDATE

It is necessary to justify why a trading halt, particularly the associated price decrease, could create the need for a trader to liquidate his position. Brunnermeier and Pedersen (2005) maintain that a trader who uses portfolio insurance, stop loss orders, or other risk management strategies may need to liquidate in response to price drops. Similarly, Schoeneborn and Schied (2009) suggest that a variety of circumstances, including margin calls or stop-loss strategies, in conjunction with large price drops can force market participants to liquidate a large asset position quickly.

Brunnermeier and Pedersen (2009) examine the relation between funding and market liquidity. They find that market liquidity is related to volatility – trading more volatile securities require higher margin payments. They show that if capital for speculators is abundant enough to eliminate the risk of reaching a funding constraint, market liquidity remains high and insensitive to changes in capital and margins. However, when speculators reach their capital constraints they reduce their positions and market liquidity subsequently declines.

Attari, Mello, and Ruckes (2005) examine trading strategies implemented against financially constrained arbitrageurs. They report that in many financial markets a substantial percentage of trading volume is placed by a few large traders and that these traders are recognized by fellow market participants. These traders are often arbitrageurs, in the sense that their principal activity entails taking large positions to exploit small discrepancies in asset pricing. This research purports that a binding capital constraint can cause an arbitrageur to liquidate partially or fully their position, however, his trades and the subsequent impact on market prices become predictable. By exploiting the arbitrageur's capital constraint, competitors can engage in predatory trading, but only for arbitrageurs with large asset positions.

PREDATION

The effectiveness of predatory trading relies on the relation between liquidity and asset pricing. Liquidity describes the ability to trade large quantities of an asset, at a low cost, and without significantly influencing prices. Research develops models that demonstrate this relation. For example, Pastor and Stambaugh (2001 page 643) purport that order flow produces larger return reversals in the presence of decreased levels of liquidity. They state, "Liquidation is costlier when liquidity is lower, and those costs are especially unwelcome to an investor whose wealth has already dropped …" Easley, Engle, O'Hara, and Wu (2008 page 172) develop a dynamic model of trading that describes how trade composition interacts with market liquidity, depth, and order flow. They state, "… order flow is informative regarding subsequent price movements," and "… market observers can infer new information regarding the value of the asset from the composition and existence of trades." They purport that when a portfolio manager submits consecutive sell orders, the price change resulting from these orders could be significant.

Similarly, Acharya and Pedersen (2005) develop a liquidity-adjusted capital asset pricing model and find that an asset's required rate of return is dependent in part on its liquidity and that illiquid securities have high liquidity risk in illiquid markets. They suggest that investors should be concerned about a security's performance and tradability when liquidity "dries up."

Additional research explicitly models the relation between liquidity and predatory behavior. For instance, Carlin, Lobo, and Viswanthan (2007) develop an equilibrium-trading model based on liquidity needs. The model demonstrates how episodes of illiquidity and subsequent predatory trading occur during interruptions in the cooperation normally present between market participants, which may occur in the case of a large sale. Within their model,

predatory traders race distressed traders to the market and quickly sell, eventually reversing their trades.

Brunnermeier and Pedersen (2005) examine predatory trading, which they describe as trades that exploit the needs of other investors who are attempting to reduce their positions quickly. Within their model, the predatory trader attempts to front-run the distressed trader by selling before him and buying back shares after the distressed trader has pushed down the price. The combined selling by the predatory and the liquidating trader leads to price overshooting. The predator profits by selling his assets at a price higher than the price at which he can repurchase them after the distressed trader has left the market. This research demonstrates that predation is profitable if the market is illiquid and if the distressed trader's position is large relative to the buying capacity of other traders.

Schoeneborn and Schied (2009) also suggest that informed market participants are aware of market liquidity needs and can extract a profit by engaging in predatory trading. Additionally, they suggest that price overshooting is mitigated as the number of predators in the market increases. With a large number of predators, the seller's intentions are impounded into prices almost immediately and the price exhibits little additional drift.

We suggest that informed traders can exploit their informational advantage concerning the plight of liquidating traders by initiating either sell market or short sell transactions. Examining both short and non-short trading, Shkilko, Van Ness, and Van Ness (2012) examine large "no–news" negative price reversals. They find that aggressive short selling significantly increases the impact of price declines. They also find, consistent with predation theory, that price reversals are associated with aggressive non-short selling.

An empirical example of predation is provided by Cai (2003), who examines trading behavior surrounding the 1998 event in which Long-Term Capital Management (LTCM) faced binding margin constraints and a subsequent need for immediate liquidation. The author finds evidence that informed traders, with superior information about customer order flow, exploited their informational advantage by front running LTCM's trades.

Onayev and Zdorovtsov (2008) also investigate predatory trading in an attempt to determine if it occurs surrounding the annual reconstitution of the Russell 3000 Index. These researchers purport that predatory trading has the potential to affect which stocks are included in the index as well as each member's weight. If speculative traders are able to predict or affect which securities will be entering or exiting the index, they can establish a preemptive position in these securities, and later earn significant gains. These researchers find evidence of strategic predatory trading in that the resulting membership weights in the index were influenced by the manipulation of some securities' closing prices.

We purport that a halt in trading and the associated decline in a halted security's price can necessitate that constrained investors liquidate their positions. As the constrained trader begins liquidating, other strategic traders recognize the plight of the constrained trader. The strategic trader then initiates predatory trading by selling in parallel with the constrained trader. This activity leads to order imbalances, price declines, and price overshooting.

HYPOTHESES

Research models describe a sequence of events that comprise predatory behavior. Predation is centered on the need of a constrained trader to liquidate his position. These models predict that once this need is recognized by other market participants, predatory activity begins as strategic traders sell in parallel with the constrained trader, causing price declines and making liquidation more costly. After the constrained trader leaves the market, the strategic traders repurchase the asset, producing substantial price reversals. For example, Attari et al. (2005) purport strategic predatory trading can lead to significant distortions in price, and Brunnermeier and Pedersen's (2005) description of predatory trading entails large price reversals. We examine order flow and security prices for halted firms surrounding interruptions in trading to determine if predatory activity is evident through (1) significant initial price declines, (2) order imbalances with a higher percentage of sells for non-short trades, and increased levels of short sales, and (3) large price reversals with increased buying pressure.

$H_{1:}$ Securities undergoing trading halts will demonstrate predatory trading by experiencing an initial significant price decline.

H_2: Securities undergoing trading halts will demonstrate predatory trading by experiencing event-day order imbalances caused by both non-short and short selling.

H_3: Securities undergoing trading halts will demonstrate predatory trading by experiencing large price reversals.

DATA

We first identify NYSE and American Stock Exchange (AMEX) trading halts that occur during 2005–2006 by querying the Trades and Quotes (TAQ) database via Wharton Research Data Services (WRDS) for stocks with a trading mode of 4, 7 or 11, indicating halts in trading for news dissemination, order imbalance, or news pending, respectively. From this set, we remove observations where multiple halts occur for the same stock on the same trading day and halts that occur outside normal market hours.

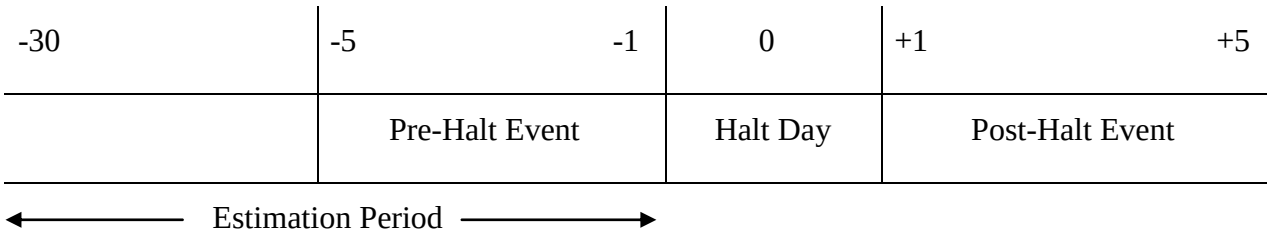
D'Avolio (2002) finds that 16 percent of stocks in the Center for Research in Security Prices (CRSP) data are potentially difficult to sell short. Of these stocks, the majority are in the bottom size decile and the prices of over half are under five dollars. They also find approximately 10 percent of stocks are never shorted – these are primarily illiquid stocks, for which shorting may represent a limited opportunity for profit. These researchers note that institutional investors, who lend stocks for shorting, are biased towards large, liquid stocks, and that the probability of incurring loan fees in excess of the risk free rate is inversely related to firm size and the level of institutional ownership. Accordingly, we, in a manner similar to Christophe, Ferri, and Angel (2004), eliminate trading halts for any stock whose average daily price and trading volume during 2005 – 2006 was less than five dollars and 100 shares.

Because our intent is to examine trading activity and market quality prior to and following trading halts, we follow the methodology of Corwin and Lipson (2000) and eliminate halts that occur before 10:00 a.m. We also eliminate halts with incomplete data or halts that do not resolve on the same trading day.

Rule 202T implemented the suspension of the short sale price test for a pilot list of stocks. The resolution was adopted in 2004 – the suspension was in effect from May 2, 2005

through August 6, 2007. Diether et al. (2009A) find that although daily returns and volatility levels are unaffected for pilot stocks during the test suspension, short selling activity, spreads and intraday volatility increases for these stocks. Because the test suspension period covers part, but not all of our sample period, to mitigate confounding effects, we remove from our sample any firms included in the pilot list of stocks for price test exclusion.

Finally, we remove observations where more than one trading halt occurs for the same firm within our event period. The event period is an 11-trading-day interval beginning five days prior to and ending 5 days after the halt day. Christophe et al. (2004) use a multiday pre-event period because short sellers may distribute their trading over several days prior to an event to disguise private information and because the average loan duration for equity is three days (Reed 2007). We create an estimation period 30 days prior to the halt to establish normal trading behavior, in terms of trading volume and price movement. For our intraday examination, we identify the halt period, which begins with the interruption in trading and ends when trading resumes. Intraday pre-halt periods are measured backwards from the beginning of the halt, and post-halt periods are measured forward from the reopening of trading.



Daily price, trading volume, return, and market capitalization data are obtained from the CRSP database. The Regulation SHO database, which was created in response to Rule 202T, provides trade size and time stamps for short-selling transactions. TAQ trade and quote data is

used to examine intraday activity. Trade data is filtered to remove observations that occur outside normal market hours, and transactions with a non-positive prices, or a condition code other than zero. Quote data is filtered to retain observations that occur within normal market hours and have a positive bid or ask size, price and spread.

SUMMARY STATISTICS

After applying data filters to refine our set of events, our remaining sample consists of 78 trading halts, 55 of which occur on the NYSE. Summary statistics describing these halts are presented in Table 1, Panels A through I. Firm names, trading halt mode and SIC code are listed in Appendix E.

Of these halts, sixty percent more occur in 2005 than in 2006 (48 as compared to 30). Similar to Christophe et al. (2004), we find that trading halts in our sample occur more frequently during the middle of the week – Tuesday through Thursday. These interruptions in trading occur in 23 out of the 24 sample period months, without evidence of an obvious seasonal pattern. We examine 68 unique firms, 64 of which experience a single halt during the sample period, and 4 different firms that experience 2, 3, 4, or 5 halts each.

The halts in our study are primarily (83 percent) implemented due to pending news. The mean duration of all sample halts is just over 41 minutes. Although the duration of trading halts reported by Lee et al. (1994); Corwin and Lipson (2000); and Christie, Corwin, and Harris (2002) is greater on average and for each halt type, our findings coincide with previous research in the ranking of halt types by length: news pending halts have the longest duration and order imbalance halts, the shortest.

Summary statistics suggest a substantial variation in the size of sample firms, stock price and trading volume with higher average values in 2006 as compared to 2005. The firms in our study generally demonstrate positive returns over the two-year period examined. When the sample firms are categorized according to year-end capitalization portfolio assignments established by CRSP, we find, similar to Christophe et al. (2004) that large firms are more heavily represented in our sample - we have fewer firms in the lower market capitalization deciles. The dearth of smaller firms may be due, in part, to our data filter that eliminates trading halts for any stock whose average daily price during the sample period is less than five dollars.

We examine short-selling levels for our sample firms during the 2005–2006 sample period. For each exchange, we report both short volume as a percentage of the total shares shorted and the number of short sale transactions as a percentage of the total number of short selling trades. No short transactions for our sample firms/period are reported on the National Association of Securities Dealers Alternative Display Facility (ADF), Archipelago (ARCA) and the Chicago Stock Exchange (CHX).

In line with the findings presented by Diether, Lee, and Werner (2009B), approximately three-fourths of short volume and short trades for our sample firms are executed on the NYSE. Approximately 14 percent of short volume and 13 percent of short trades are placed on the NASDAQ market. The average firm in our sample has 379 short transactions per trading day with an average daily short volume of just over 200,000 shares.

Table 1

Descriptive Statistics

This table contains summary statistics for trading halts that occur during 2005 – 2006 for NYSE-listed firms. Halts have been filtered to remove observations that occur outside of market hours or before 10:00 a.m., where more than one halt occurs for a sample firms on the same day, halts that do not resolve on the same trading day and multiple halts for the same firm within the 11-day surrounding halts, halts for Rule 202T pilot stocks, and observations for stocks whose average daily price and trading volume during 2005 – 2006 was less than five dollars and 100 shares.

Panel A: Halts by Year

Year	Number of Halts	Unique Firms
2005	48	44
2006	30	28
Full Sample	78	68

Panel B: Number of Halts per Year

Number of Halts in Sample	1	2	3	4	5
Number of Firms					
2005	42	1	0	1	0
2006	27	0	1	0	0
Full Sample	64	1	1	1	1

Panel C: Halts by Day of Week and Year

	Day of Week					
Year	Monday	Tuesday	Wednesday	Thursday	Friday	Total
2005	2	10	13	18	5	48
2006	4	9	7	5	5	30
Full Sample	6	19	20	23	10	78

Panel D: Halts by Month and Year

	Month											
Year	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec
2005	4	2	5	7	8	5	4	5	1	3	2	2
2006	1	2	4	4	1	3	0	3	1	5	3	3
Full Sample	5	4	9	11	9	8	4	8	2	8	5	5

Panel E: Halts and Duration by Halt Type

Trading Halt Type	Number of Halts	Mean Duration
News Dissemination (4)	6	0:29:27
Order Imbalance (7)	7	0:17:29
News Pending (11)	65	0:44:46
Full Sample	78	0:41:08

Panel F: Halt Firm Characteristics - Average Daily Values

	Price	Volume	Return	Market Cap
Year: 2005 (N =44)				
Mean	31.89	735,803	0.0590%	3,880,142
Max	110.65	5,902,434	0.3331%	65,755,430

Min	4.47	1099	-0.1728%	33,149
Std	23.90	1,295,571	0.1144%	10,371,325
Year: 2006 (N=28)				
Mean	33.23	1,408,912	0.0438%	4,946,224
Max	141.33	7,642,372	0.3072%	40,548,995
Min	6.45	1,187	-0.4135%	111,400
Std	27.81	1,856,984	0.1346%	9,403,555
Full Sample (N=72)				
Mean	32.41	997,568	0.0531%	4,294,729
Max	141.33	7,642,372	0.3331%	65,755,430
Min	4.47	1099	-0.4135%	33,149
Std	25.31	1,561,124	0.1219%	9,952,168

Panel G: CRSP Capitalization-Based Decile

Decile	2005	2006	Full Sample
1	0	0	0
2	2	0	2
3	4	2	6
4	4	1	5
5	5	2	7
6	6	8	14
7	2	3	5
8	9	4	13
9	4	3	7
10	8	5	13
Total	44	28	72

Panel H: Short-sale Trading Activity Across Exchanges (2005 – 2006)

	ADF	AMEX	ARCA	BSE	CHX	NASDAQ	NSX	NYSE	PHLX
Mean Shares Sold Short (%)	0.00	2.94	0.00	0.53	0.00	14.19	5.67	76.38	0.29
Mean Short-sale Trades (%)	0.00	3.73	0.00	0.64	0.00	12.77	6.77	76.07	0.03

Panel I: Short-selling Summary Statistics per Stock

	Mean	Median	Std Dev	Minimum	Maximum
Short Sale Daily Volume	201,427	192,125	72,895	67,124	1,285,773
Number of Daily Short Trades	379	349	149	128	2,727

RESULTS

The model of predation developed by Brunnermeier and Pedersen (2005) describes how contemporaneous selling by the distressed and predatory traders leads to price overshooting: a substantial initial price decline is followed by a rebound as predatory traders repurchase shares. Appendix D contains diagrams that depict the price reaction associated with predation and the subsequent change in the value of holdings of the predators and the distressed trader. To determine whether halted stocks in our sample show evidence of predation, we examine halt-day price movements and attempt to link subsequent returns with the predatory trading behavior of market participants.

Initial Price Decline

Our hypothesis regarding the price behavior of halted stocks purports that:

$H_{1:}$ Securities undergoing trading halts will demonstrate predatory trading by experiencing an initial significant price decline.

To identify and measure price declines, we compute, for the halted stocks for 5-minute intervals on the halt-day $abret$, a standardized abnormal return measure:

$$abret_{i,j} = \frac{ret_{i,j} - \overline{ret_{i,J\in[-30;-1]}}}{st.dev(ret)_{i,j\in[-30;-1]}} \quad (1)$$

Where $ret_{i,j}$ represents the return for stock *i* during interval *j* on the halt day, $\overline{ret_{i,J\in[-30;-1]}}$ is the average return for stock *i* during the pre-halt period (days -30 to -1), and $st.dev(ret)_{i,j\in[-30;-1]}$ is the stock's pre-halt return standard deviation. For example, an *abret* value of two indicates that the excess return earned is two return standard deviations greater than the return in the corresponding interval during the estimation period. Twelve periods are measured backwards from the beginning of the halt and forward from the resumption of trading.

The abnormal standardized return values are displayed in Figure 1. Preceding the halt, *abret* values appear relatively stable and cluster near zero until two periods immediately prior to the interruption in trading, when a measurable increase is noted from 0.04 to 0.45. An extreme price movement occurs in period -1, with the abnormal standardized return increasing to 1.30; this upward trend continues upon the resumption of trading. Prices experience a steep decline as *abret* values drop from a peak of 1.46 in period +1 to a low of -2.94 in the following period, before immediately rebounding to -0.76. The price behavior demonstrated upon the resumption of trading closely resembles the pattern predicted in the predatory model: an initial price decline, price overshooting and a subsequent recovery.

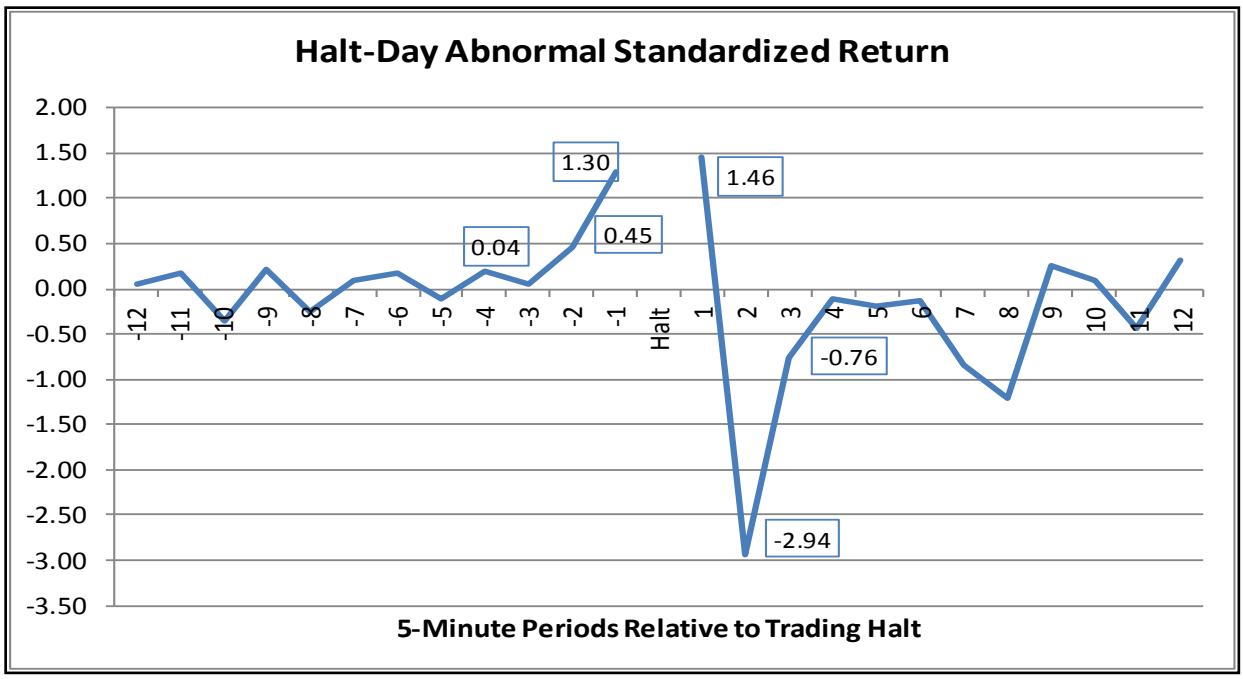


Figure 1
Abnormal Standardized Return
Abnormal standardized returns, the difference between the return on the halt day and estimation period standardized by the estimation period standard deviation, are computed for 5-minute intervals on the halt day. Periods are measured backwards from the beginning of the halt and forward from the resumption of trading.

Previous research uses stock price synchronicity, the R-squared (R^2) statistic obtained by regressing the return for an individual stock on market returns (the market model), to explain the extent to which private information is incorporated into stock prices (Stowe and Xing, 2011). Xing and Anderson (2011, page 260), state that this statistic should, "directly mirror the relative amount of firm-specific information impounded into stock prices." Following the methodology of Onayev and Zdorovtsoz (2008), we use this regression approach to determine the portion of price movement attributable to the periods surrounding a trading halt. At the daily level, we regress the return for the pre-halt estimation period on the return earned on the halt day. At the intraday level, the return for the halt day is regressed on the return for the 30-minute periods prior to the halt and following the resumption of trading. We also examine whether price

behavior on the halt day differs from the trading behavior exhibited during the 30-day pre-halt estimation period. Coefficient and Adjusted R^2 values are presented in Table 2.

Table 2
Daily and Intraday Regressions
The daily coefficient and R^2 are obtained by regressing the return earned in the 30 days prior to the halt on to the halt day return. The intraday values result from regressing the halt day return on the return earned 30 minutes prior to the interruption in trading and following the resumption of trading. Intraday regressions are repeated for the 30-day pre-halt estimation period. *T*-statistics are shown in parentheses.

Dependent Variable	Coefficient		Adjusted R^2	N
Halt Day				
Daily	0.1705	(1.09)	.0497	62
Intraday $_{Pre}$	0.1388	(1.41)	.2203	52
Intraday $_{Post}$	0.3034	(9.61) ***	.6060	62
Estimation Period				
Intraday $_{Pre}$	0.0013	(1.23)	.0084	62
Intraday $_{Post}$	0.0031	(2.26) **	.0633	62

*** and ** indicates statistical significance at the 0.01 and 0.05 level, respectively

The coefficient of determination, R^2, obtained from our regression model describes the proportion of return variability ascribed to the dependent variable: at the daily level, it explains the extent to which the halt-day return contributes to the monthly return. If the return for a stock is evenly distributed throughout the month, each trading day is responsible for approximately 4.76 percent of the price contribution (1 ÷ 21 days). The Adjusted R^2 value of 4.97 percent computed for the event day indicates that the halt-day return provides approximately the expected contribution towards the month's return. However, previous trading halt research and our examination of abnormal standardized return both suggest that halted stocks experience substantial price declines on the halt day.[12] Finding both extreme intra-day price movements and an overall expected daily return contribution suggests that price declines surrounding trading

[12] Refer to Kryzanowski (1979); and Madura, Richie, and Tucker (2006) for examples of the impact of trading halts on returns.

halts are accompanied by a rebound - stock prices recover to near their original levels by the end of the trading day. This result lends credence to the presence of the price decline and reversal associated with predation.

At the intraday level, the R^2 values describe how the 30-minute period pre- and post-halt returns contribute to the return earned on the halt day. Each 30-minute trading period, on average, should provide approximately 7.69 percent of price contribution (1 ÷ 13 periods). For the estimation period, the contribution in the 30 minutes prior to the trading halt is much smaller at only 0.84 percent, but the post-halt period Adjusted R^2 of 6.33 percent is at a more-anticipated level. In contrast, halt-day values are substantially elevated - over 22 and 60 percent of price contribution occurs in the pre- and post-halt periods, respectively. This finding corresponds with the considerable price movement immediately prior to the halt and following the resumption of trading noted in our examination of abnormal standardized return.

To determine if there exists a causal relation between the trading activity and price movement surrounding halts, we compute Granger Causality for 5-minute periods on the halt day between short volume, non-short volume, and returns. Periods are measured backward from the implementation of the halt and forward from the resumption of trading. Partial canonical and cross correlations, which demonstrate significance for up to nine intervals, are used to determine the appropriate number of lags to examine. These results are presented in Panel A of Table 3.

Chi-Square and associated *p*-values describing the causal relation between non-short volume, short volume, and returns are listed in Table 3, Panel B. The null hypothesis of the Granger Causality Wald test purports that the value of the dependent variable is influenced only by itself; an alpha value indicating statistical significance allows us to reject the null hypothesis and establishes that one variable exerts influence over another.

Table 3

Correlations and Granger Causality

Granger Causality is computed for each period between short volume, non-short volume, and returns. Periods are 5-minute intervals measured backwards from the halt and forward from the resumption of trading. Partial canonical and cross correlations are used to determine the appropriate number of lags – *p*-values are reported for nine lags. NS Vol represents non-short volume and S Vol represents short volume.

Panel A: Correlations

Partial Canonical Correlations			Schematic Representation of Partial Cross Correlations		
Lag	X^2	Pr > X^2	Short Volume	Non-Short Volume	Return
1	1313.28	<.0001 ***	+ + .	+ + .	. . +
2	148.93	<.0001 ***	+ - .	+ . .	- + .
3	80.09	<.0001 ***	+ . .	+ + .	. . .
4	34.12	<.0001 ***	- - .	. . .	. . +
5	27.13	0.0013 ***	. . .	- . .	. . .
6	20.80	0.0136 **	- . .	+ . .	. . .
7	27.26	0.0013 ***	. + .	- . .	. . .
8	6.54	0.6852	. . .	. . .	. . .
9	34.92	<.0001 ***	+ - .	- . .	. . .
10	8.83	0.4530	. . .	. . .	. . .
11	10.63	0.3022	. + .	. . .	. . .
12	11.63	0.2350	. . .	. . .	. . .

Panel B: Granger Causality Wald Test

	NS Vol → Return		S Vol → Return		Return → NS Vol		Return → S Vol		NS Vol → S Vol		S Vol → NS Vol	
Lag	X^2	Pr > X^2	X^2	Pr > X^2	X^2	Pr > X^2	X^2	Pr > X^2	X^2	Pr > X^2	X^2	Pr > X^2
1	0.05	0.8256	3.68	0.0550 *	0.07	0.7899	1.44	0.2305	254.72	<.0001 ***	10.77	0.0010 ***
2	0.11	0.9485	5.13	0.0770 *	2.01	0.3658	10.92	0.0042 ***	148.69	<.0001 ***	12.05	0.0024 ***
3	0.13	0.9886	6.50	0.0895 *	2.23	0.5256	10.07	0.0179 **	124.54	<.0001 ***	7.25	0.0642 *
4	0.23	0.9938	7.83	0.0982 *	3.26	0.5151	13.38	0.0096 ***	137.65	<.0001 ***	20.27	0.0004 ***
5	0.23	0.9988	7.91	0.1615	3.62	0.6047	15.38	0.0089 ***	155.74	<.0001 ***	22.49	0.0004 ***
6	0.88	0.9897	8.24	0.2209	3.69	0.7189	15.37	0.0176 **	155.89	<.0001 ***	20.16	0.0026 ***
7	1.47	0.9833	8.80	0.2670	4.14	0.7631	15.46	0.0306 **	170.12	<.0001 ***	23.20	0.0016 ***
8	1.53	0.9922	8.81	0.3589	5.33	0.7222	15.34	0.0528 *	169.53	<.0001 ***	23.20	0.0031 ***
9	1.62	0.9961	8.75	0.4606	8.65	0.4704	16.48	0.0576 *	188.28	<.0001 ***	28.87	0.0007 ***

+ is > 2 * std error, - is < -2 * std error, . is in between

***, ** and * indicates statistical significance at the 0.01, 0.05, and 0.10 level, respectively

We find no indication that a significant causal relation exists in either direction between non-short volume and returns. However, it appears that short volume granger-causes returns for up to four lagged periods and returns in the previous nine periods influence short volume. A significant bi-directional relation for all nine periods is also noted between levels of short and non-short trading volume. These relations are depicted in Figure 2.

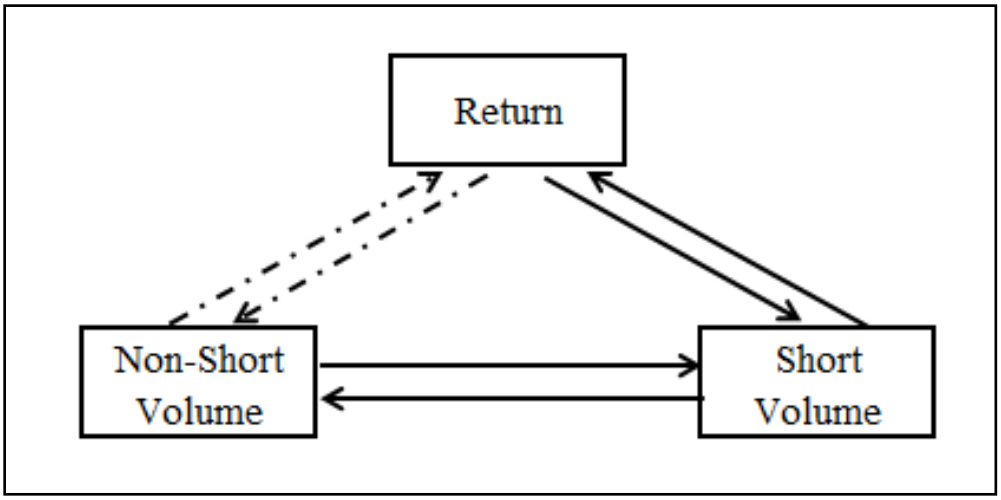


Figure 2
Granger Causality
Granger Causality is computed for 5-minute periods on the halt day between short volume, non-short volume, and returns. Periods are measured backward from the implementation of the halt and forward from the resumption of trading. Arrows indicate direction of causality; solid lines depict a significant relation while dashed lines demonstrate that no significant relation was identified.

Results from the Granger Causality test suggest that short selling activity leads to increased price movement and that returns impact the trading behavior of short sellers. When viewed in the context of predatory behavior surround trading halts, the initial price decline might be explained by the relation between short selling and returns: as returns decrease short selling increases, and the increase in short selling leads to further price declines until the distressed trader exits that market and predators begin repurchasing the asset.

In support of Hypothesis 1, the securities of sample firms evidence behavior that might be attributed to predatory trading activity, particularly on the part of short sellers. Prices demonstrate, following the resumption of trading, the sharp decline and rebound described in predatory models. Intraday price contribution values indicate increased price movement surrounding the halt, while the proportional daily price contribution of the halt day in monthly returns lends support to the presence of a price rebound.

Order Imbalances

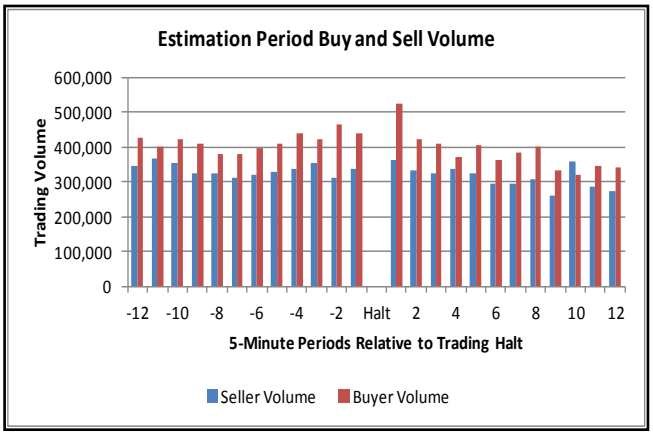
The trading model of predation presented in previous literature suggests that predatory traders initially engage in contemporaneous selling while the distressed trader is attempting to liquidate his position, then predators switch roles and begin repurchasing the asset. This trading behavior should lead to order imbalances, with higher levels of selling as prices decline and increased buying as prices rebound. Brown, Walsh, and Yuen (1997 page 539) state, "… a temporal imbalance between buy and sell orders arriving at a market increases the likelihood that informed traders are attempting to pre-empt good or bad news …." Chordia, Roll, and Subrahmanyam (2002 page 118) find that excess buy (sell) orders drive up (down) security prices; they state, "For an individual stock, a large order imbalance could be random or induced by either public or private information."

Our hypothesis regarding the relation between buy and sell orders for halted stocks suggest that:

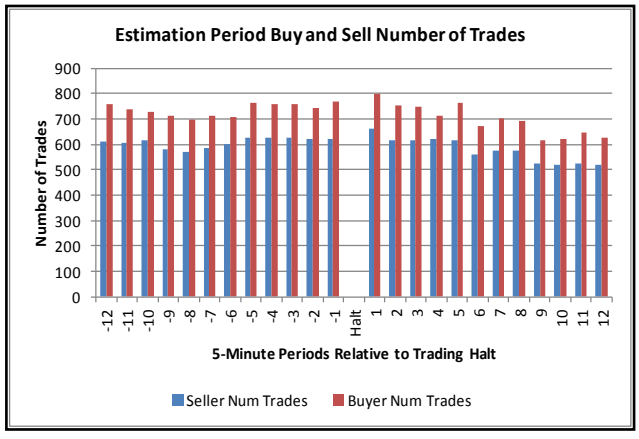
H_2: Securities undergoing trading halts will demonstrate predatory trading by experiencing event-day order imbalances caused by both non-short and short selling.

To determine if halted stocks experience a buy-sell order imbalance we first measure the buy/sell trading volume and number of trades for 5-minutes periods on the event day. Twelve periods (one hour) are measured backwards from the halt and forward from the resumption of trading. Trades are classified as buyer or seller initiated using the Lee and Ready (1991) algorithm with contemporaneous transactions. The tick test is used to designate trades that execute at the mid-point between the bid and ask price. Mean period buy and sell volume and number of trades is also computed for the 30-day pre-halt estimation period.

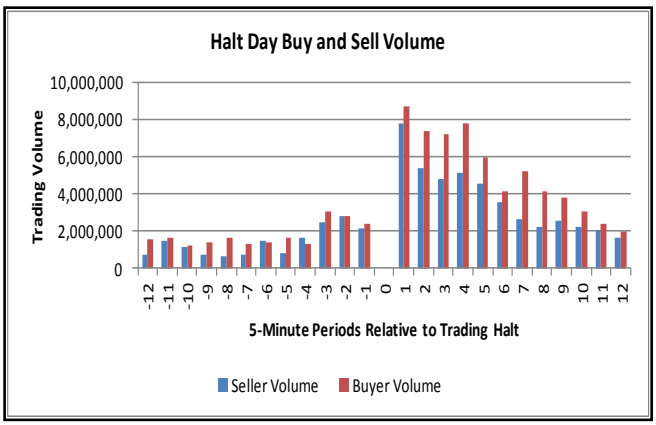
A discernible difference between halt day and estimation period buy/sell trading activity is demonstrated in Figure 3. During the estimation period, both the trading volume and the number of trades are relatively constant, with levels of buyer-initiated trades and volume surpassing seller-initiated amounts in each 5-minute period (Panels A and B). On the halt day, a measurable increase in both trading volume and the number of trades occurs in the three periods prior to the interruption in trading. The number of transactions and the resulting volume increase remarkably as trading resumes (Panels C and D).



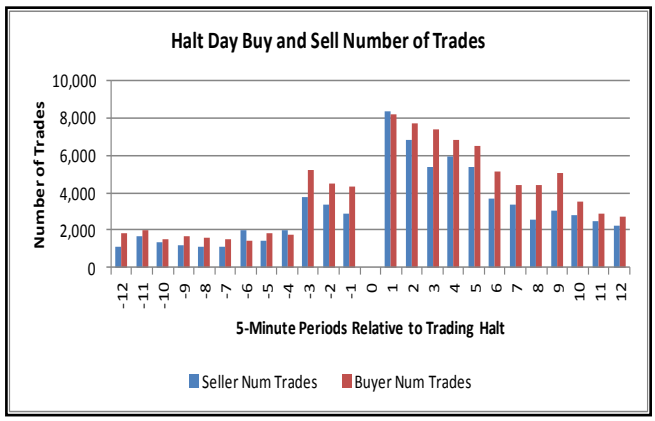
Panel A: Estimation Period Volume



Panel B: Estimation Period Number of Trades



Panel C: Halt-Day Volume



Panel D: Halt-Day Number of Trades

Figure 3
Volume and Number of Trades
Volume and the number of trades are computed for 5-minute periods relative to trading halts on the halt day and during the estimation period (30 days trading days prior to the halt). Trades are classified as buyer or seller initiated according to the Lee and Ready (1991) algorithm using contemporaneous transactions. Periods are measured backwards from the halt and forward from the resumption of trade.

Order flow imbalance is calculated for the pre-halt estimation period and the halt day as the difference between the volume (number of trades) of buys and sells, divided by the total volume (number of transactions) during 5-minute periods relative to the halt:

$$Order\ Flow\ Imbalance_i = (Buys_i - Sells_i) / (Buys_i + Sells_i) \quad (2)$$

We also calculate, for each 5-minute period, the difference between the halt day and the 30-day pre-halt estimation period for each order imbalance measurement. Values for the estimation period, the halt day and differences are listed in Table 4 (trading volume) and Table 5 (number of Transactions) and are shown in Figure 4 – estimation period, halt day and differences in Panels A, B, and C, respectively.

Table 4

Order Imbalance – Trading Volume

Order flow imbalance is computed for the 30-day pre-halt estimation period and the event day as the difference between the volume of buys and sells, divided by the total volume over the period. The differences in order imbalance ratios are computed between the halt and the estimation period. Trades are classified as buyer or seller initiated using the Lee and Ready algorithm and contemporaneous transactions. *t*-statistics are listed in parentheses

Period	Estimation Period		Halt Day		Differences	
-12	0.0632	(6.16) ***	0.0305	(0.48)	-0.0457	(-0.74)
-11	0.0592	(4.77) ***	0.1234	(1.81) *	0.0572	(0.79)
-10	0.0842	(6.64) ***	0.0927	(1.33)	0.0039	(0.05)
-9	0.0856	(7.18) ***	0.1308	(1.92) *	0.0473	(0.69)
-8	0.0718	(4.62) ***	0.1055	(1.52)	0.0283	(0.39)
-7	0.0870	(7.06) ***	0.1321	(2.22) **	0.0372	(0.66)
-6	0.0904	(6.61) ***	0.0539	(0.69)	-0.0273	(-0.33)
-5	0.0780	(5.52) ***	0.1426	(2.07) **	0.0623	(0.92)
-4	0.0653	(5.68) ***	0.0629	(0.92)	0.0027	(0.04)
-3	0.0848	(5.82) ***	0.0595	(0.86)	-0.0402	(-0.60)
-2	0.0844	(6.57) ***	0.0436	(0.66)	-0.0393	(-0.61)
-1	0.0989	(7.08) ***	0.0919	(1.42)	-0.0076	(-0.11)
Halt						
1	0.0928	(7.05) ***	0.1032	(1.87) *	0.0632	(1.04)
2	0.0831	(6.70) ***	0.1980	(4.27) ***	0.1112	(2.21) **
3	0.0764	(7.52) ***	0.2545	(4.83) ***	0.1574	(2.97) ***
4	0.0587	(4.01) ***	0.1593	(2.88) ***	0.1118	(2.08) **
5	0.0861	(7.06) ***	0.1222	(2.14) **	0.0497	(0.75)
6	0.0884	(7.09) ***	0.1004	(1.80) *	0.0172	(0.29)
7	0.0813	(7.08) ***	0.0720	(1.18)	0.0081	(0.13)
8	0.0836	(7.32) ***	0.1370	(1.96) *	0.0630	(0.88)
9	0.0566	(4.40) ***	0.0906	(1.37)	0.0403	(0.60)
10	0.0779	(8.19) ***	0.1156	(1.72) *	0.0396	(0.56)
11	0.0792	(5.58) ***	0.1707	(2.80) ***	0.1055	(1.57)
12	0.0889	(5.81) ***	0.1228	(1.71) *	0.0370	(0.49)

***, ** and * indicates statistical significance at the 0.01, 0.05 and 0.10 level respectively

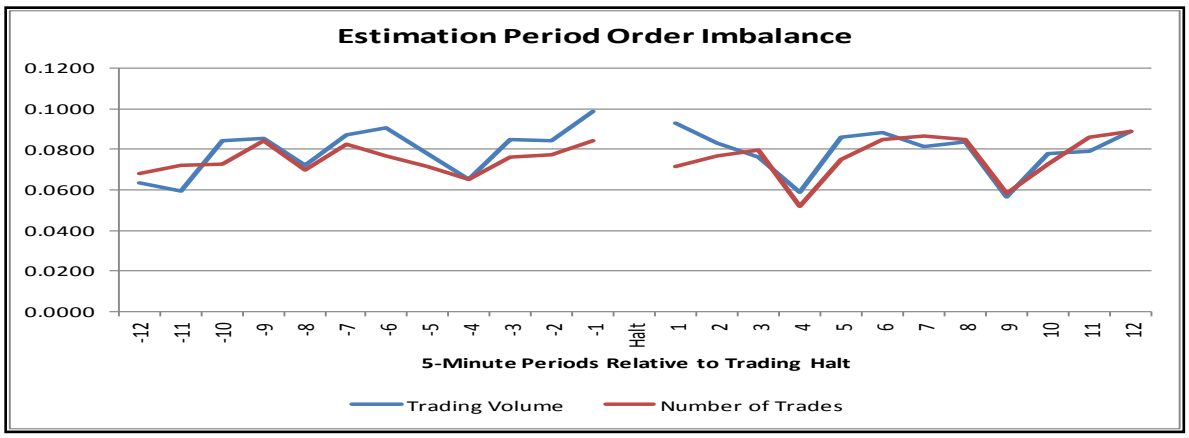
Table 5

Order Imbalance – Number of Transactions

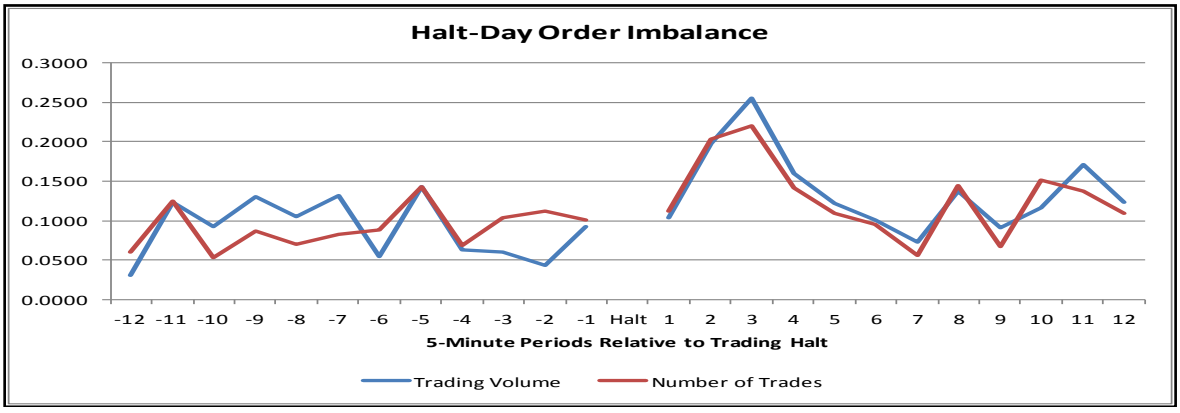
Order flow imbalance is computed for the 30-day pre-halt estimation period and the event day as the difference between the number of buy and sell trades, divided by the total number of transactions over the period. The differences in order imbalance ratios are computed between the halt and the estimation period. Trades are classified as buyer or seller initiated using the Lee and Ready algorithm and contemporaneous transactions. *t*-statistics are listed in parentheses

Period	Estimation Period		Halt Day		Differences	
-12	0.0679	(7.30) ***	0.0597	(1.15)	-0.0175	(-0.34)
-11	0.0720	(7.53) ***	0.1252	(2.34) **	0.0461	(0.80)
-10	0.0728	(8.08) ***	0.0531	(0.92)	-0.0220	(-0.35)
-9	0.0841	(9.62) ***	0.0864	(1.64)	-0.0006	(-0.01)
-8	0.0700	(6.51) ***	0.0692	(1.44)	-0.0059	(-0.12)
-7	0.0823	(8.39) ***	0.0832	(1.73) *	-0.0007	(-0.02)
-6	0.0767	(8.02) ***	0.0883	(1.41)	0.0156	(0.24)
-5	0.0714	(9.11) ***	0.1432	(2.72) ***	0.0733	(1.37)
-4	0.0653	(6.89) ***	0.0678	(1.41)	0.0016	(0.03)
-3	0.0759	(7.89) ***	0.1030	(1.92) *	0.0162	(0.29)
-2	0.0775	(7.50) ***	0.1115	(2.56) **	0.0369	(0.87)
-1	0.0845	(8.64) **	0.1001	(2.05) **	0.0226	(0.41)
Halt						
1	0.0714	(6.47) ***	0.1123	(2.66) **	0.0664	(1.42)
2	0.0766	(7.90) ***	0.2035	(5.29) ***	0.1336	(3.47) ***
3	0.0795	(8.01) ***	0.2202	(5.30) ***	0.1437	(3.44) ***
4	0.0521	(3.77) ***	0.1415	(3.42) ***	0.1001	(2.47) **
5	0.0748	(7.67) ***	0.1089	(2.58) **	0.0426	(0.88)
6	0.0849	(8.09) ***	0.0957	(2.37) **	0.0076	(0.18)
7	0.0865	(7.78) ***	0.0559	(1.36)	-0.0161	(-0.38)
8	0.0850	(10.28) ***	0.1448	(2.85) ***	0.0638	(1.19)
9	0.0580	(5.67) ***	0.0672	(1.22)	0.0124	(0.22)
10	0.0725	(7.56) ***	0.1519	(3.33) ***	0.0787	(1.59)
11	0.0859	(7.51) ***	0.1369	(2.79) ***	0.0602	(1.14)
12	0.0890	(8.72) ***	0.1094	(2.05) **	0.0293	(0.49)

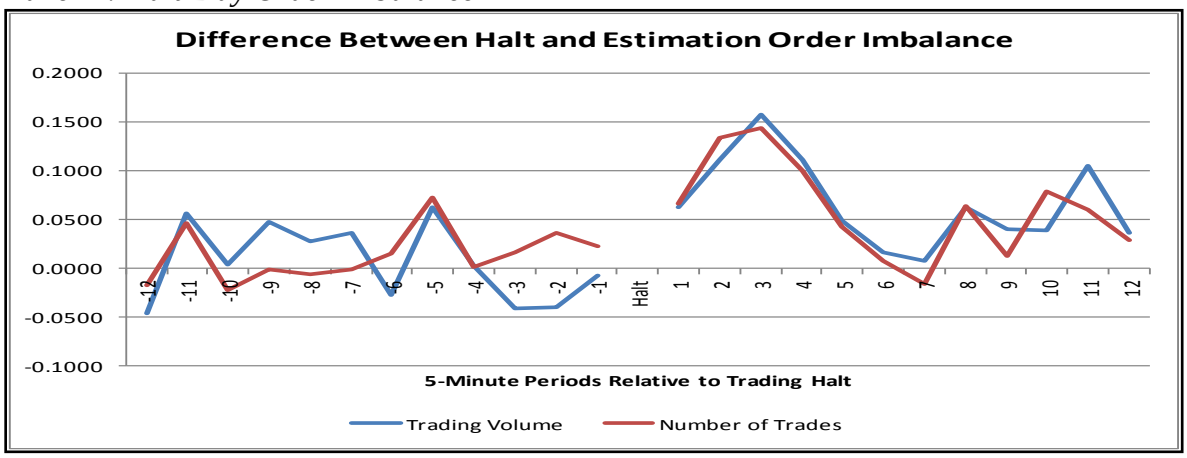
***, ** and * indicates statistical significance at the 0.01, 0.05 and 0.10 level respectively



Panel A: Estimation Period Order Imbalance



Panel B: Halt-Day Order Imbalance



Panel C: Difference in Halt and Estimation Order Imbalances

Figure 4

Order Imbalance

Order flow imbalance is computed for the 30-day pre-halt estimation period (Panel A) and the event day (Panel B) as the difference between the volume (number) of buys and sells, divided by the total volume (number of transactions) over the period. The differences in order imbalance ratios between the halt and the estimation period are presented in Panel C. Trades are classified as buyer or seller initiated using the Lee and Ready algorithm and contemporaneous transactions.

During the estimation period, order imbalance metrics for both trading volume and number of trades are positive and relatively stable for all periods, ranging from 5.21 to 9.89 percent. Previous studies support the presence of a higher number of buyer-initiated transactions: Chordia and Subrahmanyam (2002); and Chordia et al. (2002) find, in their examination of daily trading on the NYSE, positive order imbalances (buys exceeding sells) for the number of trades, shares, and dollar volume.

On the halt day, order imbalance metrics for volume and number of trades range from 3.05 to 14.26 percent in the periods preceding the halt. Upon the resumption of trading, both measurements increase significantly, with maximum values, occurring in period +3, of 25.45 percent for trading volume and 22.02 percent for the number of trades; these metrics remain elevated for six consecutive post-halt periods. The difference variable demonstrates a corresponding significant increase in periods +2 through +4, when the order imbalance is approximately 11 to 16 percent higher than on non-halt days.

Chordia et al. (2002) examine daily order imbalances on the NYSE. They find that order imbalance increases following a market decline and selling activity is heightened following market rises. We are able to identify this pattern in our results: order imbalance metrics peak in period +3 after the negative abnormal standardized return in period +2, and more seller-initiated activity (lower order imbalance values) occur in periods +4 though +6 as stock prices rebound and *abret* values increase.

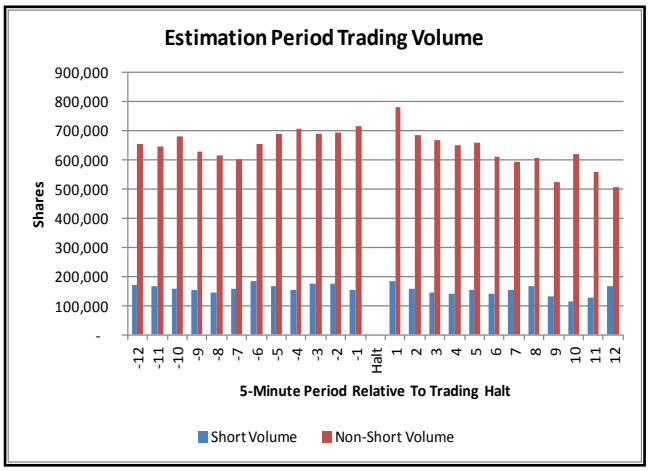
In all halt-day periods, buyer-initiated activity exceeds the activity initiated by sellers. The largest buy/sell discrepancy occurs upon the post-halt continuation of trading. This result is in direct opposition to our expectations: an increase in seller-initiated activity is anticipated

directly after the halt during the interval when prices decline and positive order imbalances are expected to correspond with buyer-initiated activity during the price rebound.

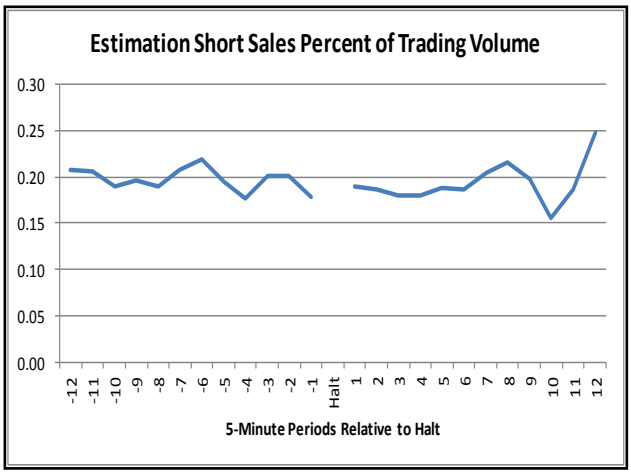
This unexpected result might be attributed to the manner in which the Lee-Ready algorithm categorizes short sales. Asquith, Oman, and Safaya (2010), describe how previous studies analyzing the Lee-Ready algorithm report 72 to 93 percent accuracy rates. However, these tests are performed prior to the 2001 conversion to reporting market prices in decimals – narrower spreads resulting from decimalization potentially make it more difficult to classify trades accurately. Additionally, these researchers explain how the uptick rule, which allows execution of a short sale only on an uptick or zero tick, may cause short sales to execute at a price above the bid-ask spread midpoint and subsequently result in the improper classification of short sale transactions as buyer-initiated. Results from this research suggest that the Lee-Ready algorithm overwhelmingly classifies short transactions, which represent nearly 30 percent of trading volume, as buyer-initiated. Specifically, they find that the Lee-Ready algorithm, using contemporaneous transactions, classifies 66.5 percent of short trades as buyer-initiated. When differentiating between stocks participating in the SEC Pilot study (Rule 202T), they find, during June and December of 2005, between 85.1 and 88.0 percent of short sales for a sample of NYSE non-pilot stocks are classified as buyer-initiated.

To determine if this explanation is applicable to our research, we compute, for both the halt day and the 30-day pre-halt estimation period, levels of non-short and short volume, and the percent short volume represents of total volume during each of the twelve pre- and post-halt periods (shown in Figure 5). The estimation period results demonstrate relatively constant values, with short selling activity representing approximately twenty percent of overall trading volume (Panels A and B). On the halt day, however, we identify several key differences. During

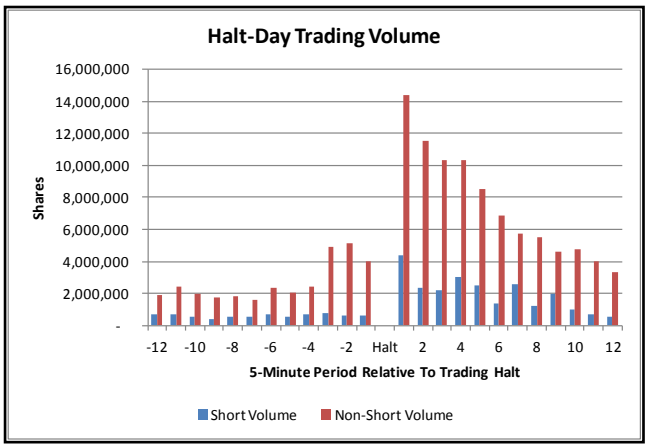
periods -3 through -1, overall trading volume increases while levels of short volume remains stable; short selling represents only 11 to 13 percent of trading volume during these intervals. Both trading volume and short selling activity increase dramatically as trading resumes – short selling represents over 23 percent of trading volume in the first post-halt period. Although trading and short volume remain well above pre-halt levels, they show marked decreases in the second post-halt period. Short selling appears to experience a more substantial decrease, as the percent short selling represents of total volume falls to less than 17 percent.



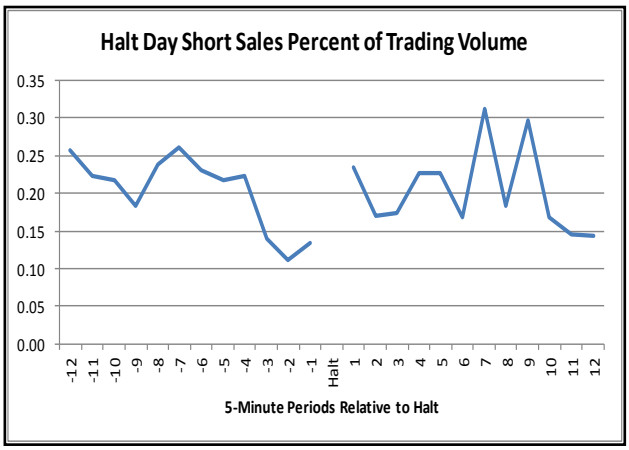
Panel A: Estimation Trading Volume



Panel B: Estimation Shorting Percentage



Panel C: Halt-Day Trading Volume



Panel D: Halt-Day Shorting Percentage

Figure 5

Short and Non-short Selling Volume and Percent of Trades

Short and non-short trading volume and the percent short sales represents of total trading volume is computed for 5-minute periods on the halt day and during the 30-day pre-halt estimation period. Periods are measured backwards from the halt and forward from the resumption of trading.

We are able to identify the anticipated inverse relation between short selling levels and returns by relying on Granger causality test results: lagged short selling impacts returns. Using one period lags, we categorize, for three post-halt periods, short selling levels as high or low, depending on their position relative to the approximate 20 percent estimation period average established from Figure 5 Panel B. We also note whether abnormal standardized returns increase or decrease from the previous period. The results, shown below, indicate that 1) lagged short selling levels are low in period +1 as abnormal standardized returns peak, 2) lagged short selling increases in period +2 as abnormal standardized returns fall (increased selling activity and associated price declines), and 3) lagged short selling is lower in period +3, as abnormal standardized returns begin to rebound. This model provides a possible scenario in which short sellers engage in predatory activity surrounding halts in trading.

Period	+1	+2	+3
Short Selling Lagged 1 Period	Low	High	Low
Abnormal Return	Increase	Decrease	Increase

To explore further the role of short sellers surrounding halts in trading, we calculate two short-selling metrics. First, *abshvol*, a standardized short selling measure, is computed for halted stocks for 5-minute intervals on the halt day (Shkilko et al. 2012):

$$abshvol_{i,j} = \frac{shvol_{i,j} - \overline{shvol_{i,J\in[-30;-1]}}}{st.dev(shvol)_{i,j\in[-30;-1]}} \quad (3)$$

Where $shvol_{i,j}$ represents the volume of shares shorted for stock *i* during interval *j* on the halt day, $\overline{shvol_{i,J\in[-30;-1]}}$ is the average short volume for the pre-halt period (days -30 to -1), and $st.dev(shvol)_{i,j\in[-30;-1]}$ is the standard deviation of the short volume during the pre-halt period. Periods are measured backwards from the halt and forward from the resumption of

trading. The *abshvol* value allows for the identification of substantial changes between the short selling behavior exhibited during the estimation period and halt-day short selling. Results are listed in Table 6 and shown in Figure 6.

Table 6

Abnormal Standardized Short Volume

Abnormal standardized short volume, the difference between the short volume on the halt and estimation day standardized by estimation period standard deviation, are computed for 5-minute intervals on the halt day. Periods are measured backwards from the beginning of the halt and forward from the resumption of trading. *t*-statistics are listed in parentheses

Period	Abnormal Standardized Short Volume
-12	1.39 (1.28)
-11	1.35 (1.15)
-10	0.59 (1.60)
-9	1.24 (1.87) *
-8	1.89 (1.41)
-7	1.39 (1.43)
-6	1.65 (1.83) *
-5	1.67 (1.58)
-4	2.03 (1.69) *
-3	1.53 (1.78) *
-2	1.32 (2.45) **
-1	2.18 (2.73) ***
Halt	
1	19.63 (6.66) ***
2	11.90 (5.26) ***
3	12.49 (4.38) ***
4	12.76 (3.81) ***
5	10.83 (3.75) ***
6	7.58 (5.07) ***
7	9.36 (2.84) ***
8	5.87 (3.14) ***
9	8.61 (2.53) **
10	5.33 (2.93) ***
11	3.16 (3.01) ***
12	3.62 (3.49) ***

***, ** and * indicates statistical significance at the 0.01, 0.05 and 0.10 level respectively

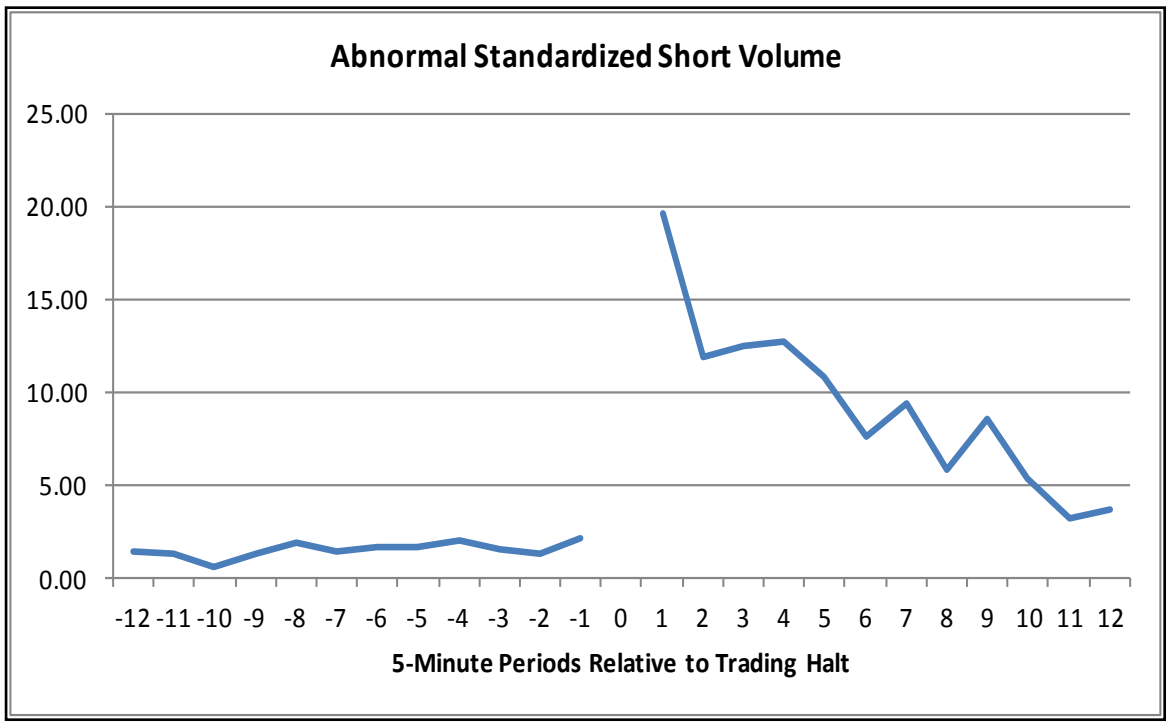


Figure 6
Abnormal Standardized Short Volume
Abnormal standardized short volume, the difference between the short volume on the halt and estimation day standardized by estimation period standard deviation, are computed for 5-minute intervals on the halt day. Periods are measured backwards from the beginning of the halt and forward from the resumption of trading.

Abnormal standardized short selling begins to increase four periods prior to the cessation of trading, with values approximately two pre-halt standard deviations larger than in the estimation period. A large increase occurs in the first post-halt period, as abnormal short selling levels climb to 19.63. *Abshvol* values then decline, but remain elevated above estimation levels over the remaining periods examined.

To quantify short-seller aggressiveness, we follow Shkilko et al., 2012, and calculate *shimb*, an order-imbalance metric the represents the difference between the short volume (number of trades) initiated by buyers and sellers scaled by total short sale volume (number of trades). The Lee-Ready algorithm, using contemporaneous transactions, is used to classify short

trades as buyer or seller initiated. The tick test is used to designate trades that execute at the mid-point between the bid and ask price. Results are reported in Table 7.

$$shimb_i = (Short\ Buys_i - Short\ Sells_i) / (Short\ Buys_i + Short\ Sells_i) \quad (4)$$

Table 7
Short Selling Order Imbalance
Short-selling order imbalance (*shimb)* is computed for each period as the difference between short volume (number of trades) initiated by buyers and sellers scaled by total short volume (number of trades). 5-minute periods are measured backwards from the beginning of the halt and forward from the resumption of trading. *t*-statistics are listed in parentheses

Period	Trading Volume		Number of Trades	
-12	0.3239	(3.29) ***	0.4060	(5.40) ***
-11	0.4877	(5.46) ***	0.3707	(4.58) ***
-10	0.2567	(2.52) **	0.3636	(4.56) ***
-9	0.3511	(4.35) ***	0.3090	(3.74) ***
-8	0.2262	(2.47) **	0.2939	(4.10) ***
-7	0.4015	(3.91) ***	0.2850	(3.13) ***
-6	0.1126	(1.04)	0.2177	(2.93) ***
-5	0.2561	(2.75) **	0.3358	(4.60) ***
-4	0.3928	(4.73) ***	0.3941	(6.57) ***
-3	0.3541	(5.72) ***	0.3777	(8.16) ***
-2	0.1246	(1.18)	0.2133	(3.02) ***
-1	0.1357	(1.58)	0.2389	(4.20) ***
Halt				
1	0.3404	(5.28) ***	0.3604	(7.61) ***
2	0.2331	(3.18) ***	0.3253	(6.96) ***
3	0.1834	(2.54) **	0.2836	(5.37) ***
4	0.3197	(4.72) ***	0.2970	(7.20) ***
5	0.2504	(3.43) ***	0.2897	(6.84) ***
6	0.3686	(5.63) ***	0.2777	(5.09) ***
7	0.3333	(4.15) ***	0.3229	(6.08) ***
8	0.3619	(4.52) ***	0.3479	(6.90) ***
9	0.3019	(3.99) ***	0.3123	(5.69) ***
10	0.2816	(3.63) ***	0.3467	(6.57) ***
11	0.4618	(6.60) ***	0.4085	(7.81) ***
12	0.4309	(6.37) ***	0.3531	(6.11) ***

*** and ** indicates statistical significance at the 0.01 and 0.05 level respectively

Shimb values are positive for both metrics and all periods reported, suggesting that more short sale volume and transactions are initiated by buyers than by sellers. The *shimb* value for the

number of trades is lower in the two periods preceding the halt and then increases substantially in the two periods following the resumption of trading.

The absence of negative *shimb* values suggest that the results may be impacted by the previously discussed concern that short selling transactions are misclassified as a buyer-initiated activity by the Lee-Ready algorithm. Although the accuracy of the classification algorithm is in question, we can still gain valuable insight into short seller aggressiveness surrounding trading halts by calculating the difference in *shimb* between the 30-day pre-halt estimation period and the halt day. These results are shown in Figure 7 for the five periods preceding the halt and following the resumption of trading.

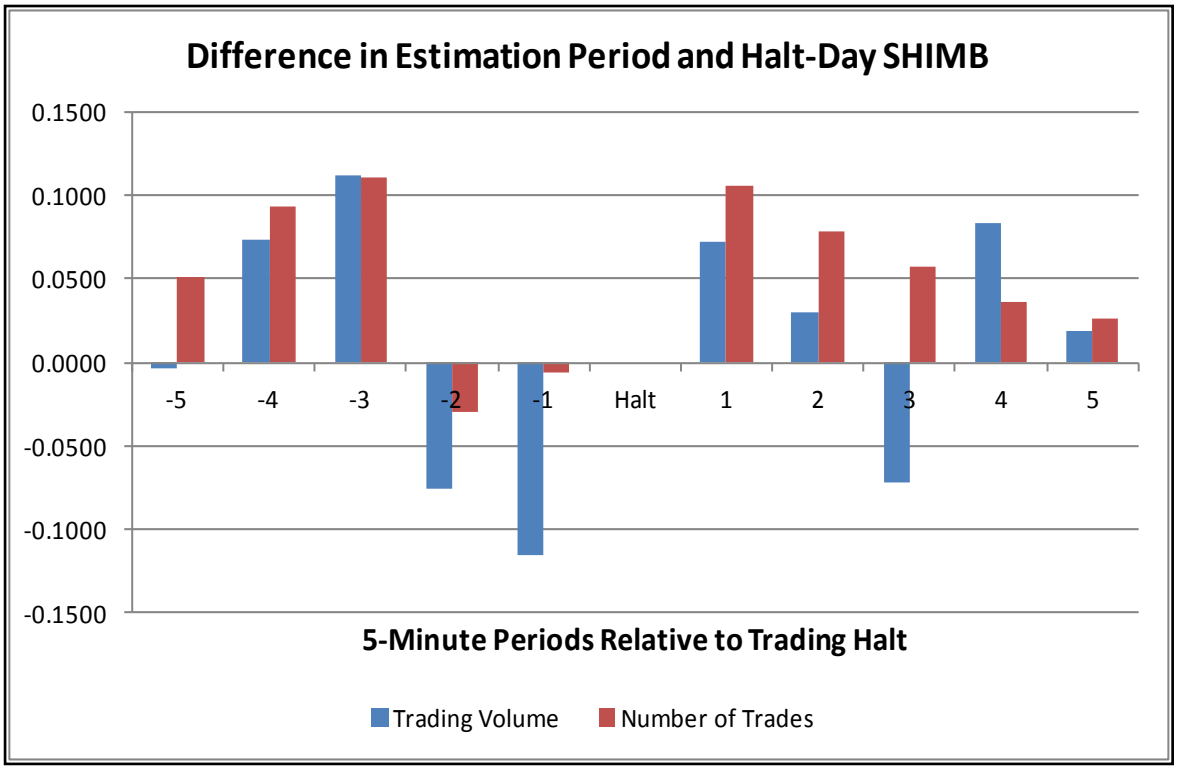


Figure 7

Short-selling Order Imbalance Differences

Short-selling order imbalance (*shimb)* is calculated as the difference between short volume (number of trades) initiated by buyers and sellers scaled by total short volume (number of trades). The difference between estimation period and halt-day *shimb* values is computed for 5-minute periods, measured backwards from the beginning of the halt and forward from the resumption of trading.

The *shimb* difference is positive in periods -4 and -3 for both short volume and number of trades; a positive *shimb* difference indicates a higher proportion of buyer-initiated short activity during these periods on the halt day as compared to estimation period levels. These metrics are negative in the two periods prior to the implementation of the halt. A negative shimb value suggests increased short seller aggressiveness: during these periods on the halt day a greater percentage of the short transactions are seller-initiated as compared to the corresponding interval in the estimation period. After the resumption of trading, the *shimb* difference reverts to positive values.

Our findings fail to support Hypothesis 2. Order imbalance levels do not demonstrate the expected relation to changes in return predicted by the predatory model. However, this result might be attributed to the manner in which transactions, particularly short sales, are categorized as buyer or seller initiated by the Lee-Ready algorithm. Using the relation suggested by the Granger Causality Wald test, we are able to identify possible predatory behavior with the expected pattern of high short selling levels and low returns by lagging short selling activity by one period.

Price Reversals

Predatory trading models predict that after an initial decline, halted stocks will experience a measurable price reversal. This rebound in price coincides with the constrained trader's completion of liquidation and subsequent exit from the market, and the repurchasing of assets by predatory traders.

Our hypothesis regarding the price behavior of halted stocks suggests that:

H_3: Securities undergoing trading halts will demonstrate predatory trading by experiencing large price reversals.

We first determine how many sample firms experience significant price declines on the event day. Following Shkilko et al. (2012) we compute for the non-halt trading period, the average standard deviation of 5-minute cumulative returns from the market open to close. We consider that a significant price decline occurs if a security's halt-day period return decreases by two or more estimation period standard deviations. To detect departures from normal trading behavior, this result is compared to the number of price declines identified in the 30-day pre-halt estimation period. Results are listed in Table 8.

Table 8
Stocks with Large Price Declines
Stocks are categorized on both the halt day and during the 30-day pre-halt estimation period, by the number of periods in which they experience large price declines. A large price declines is defined as a decrease in a security's period return by two or more estimation period (30 days prior to the halt) standard deviations. 5-minute periods are measured from market open to close (78 periods).

	Number of Stocks	
Number of Periods with Price Declines	Halt Day	Estimation Period
0	9	70
1	14	5
2	8	1
3	7	1
4	7	1
5	7	0
6	5	0
7	3	0
8	2	0
9	3	0
10	3	0
11	2	0
12	1	0
13	3	0
16	2	0
19	1	0

23	1	0
Total Number of Stocks	78	78
Stocks with no large price decline	11.54%	89.74%
Stocks with large price declines	88.46%	10.26%

On the halt day, over 88 percent of sample stocks (69 of 78 stocks) experience at least one substantial price decline. In contrast, a significant price decline can be identified in only one tenth (8 of 78) of sample stocks during the estimation period. Only three stocks show more than one period with a price decline during the estimation period as compared to 55 stocks on the event day.

Figure 8 shows the proportion of stocks that experience a significant price decline in each five-minute period relative to the trading halt. Prior to the halt, between two and eight percent of stocks that trade during each period demonstrate large price declines compared to approximately 35 percent of stocks that trade in periods +1 and +2. The proportion of stocks with large price declines remains above pre-halt levels for eight periods (40 minutes) following the resumption of trading.

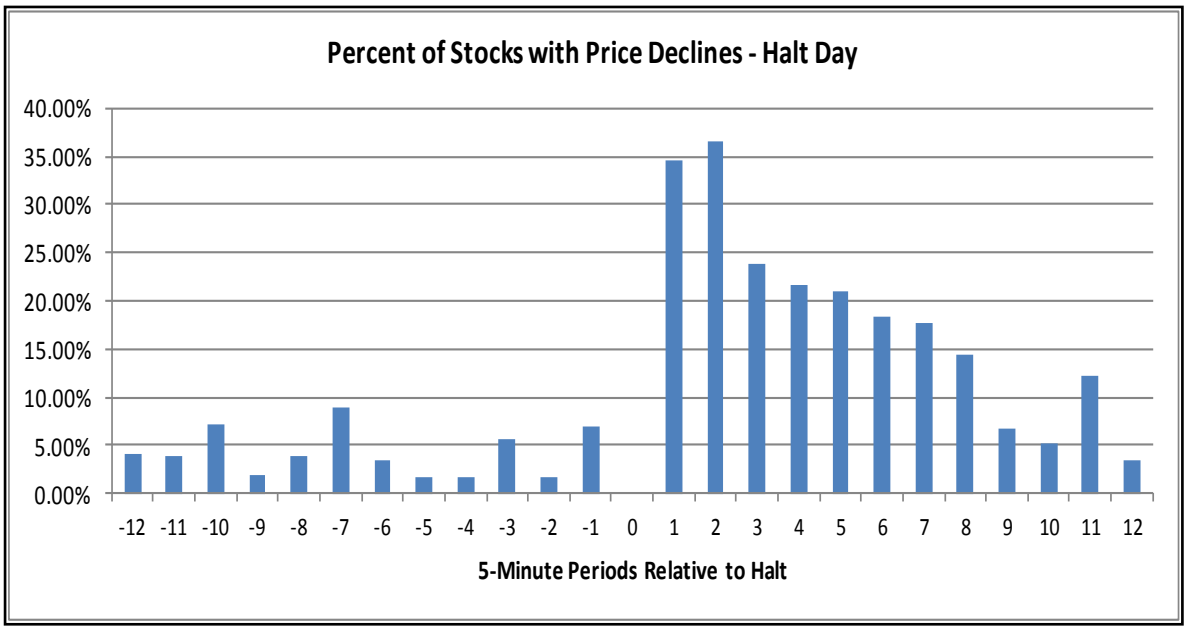


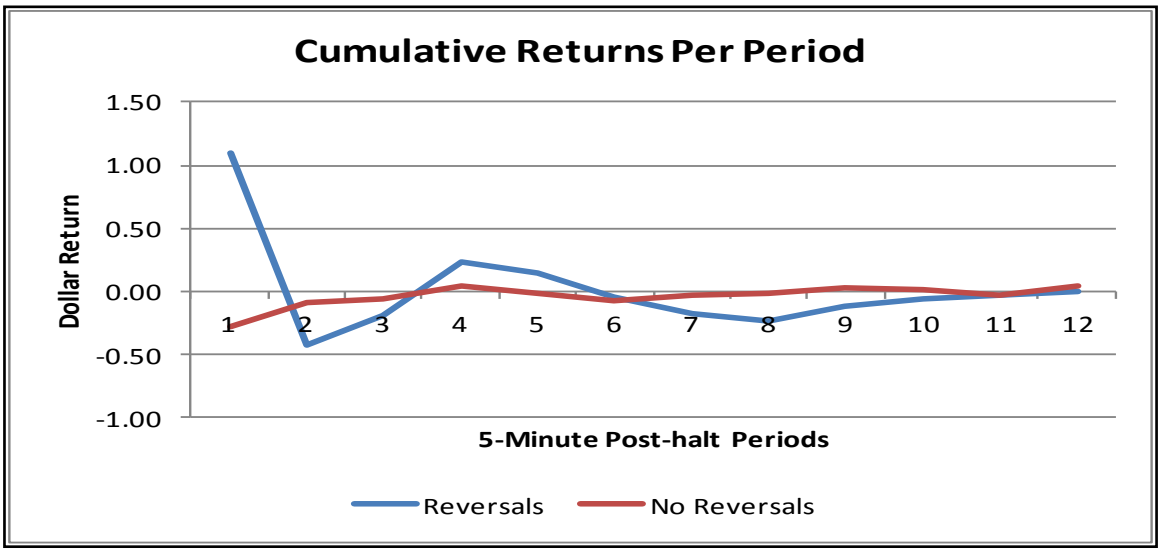
Figure 8

Firms with Large Declines – by Period
The ratio of sample stocks with a large price decline to sample stocks that trade during each period is computed. A large price declines is defined as a decrease in a security's period return by two or more estimation period (30 days prior to the halt) standard deviations. 5-minute periods are measured backwards from the halt and forward from the resumption of trade.

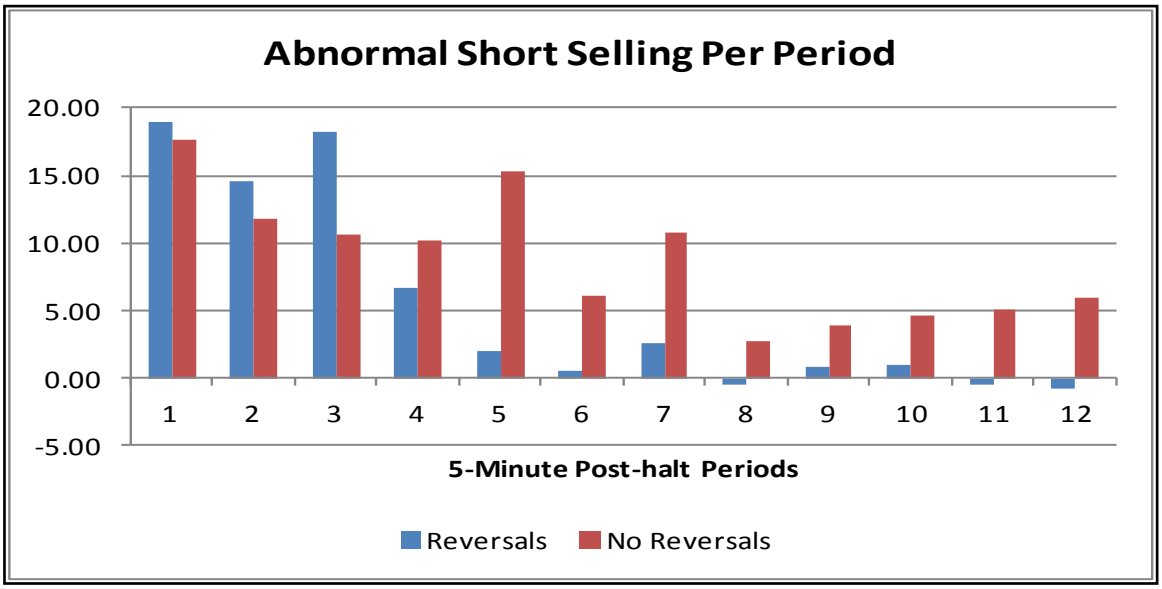
The high number of firms demonstrating large price declines immediately following the continuation of trading suggests that the initial price behavior associated with predatory trading is present for our sample stocks. However, these price declines could occur independently of predation; it is necessary to examine the firms that exhibit substantial price declines and determine if large price reversals occur. Borrowing from Shkilko et al. (2012), we identify a large price reversal if the security's return rebounds by 60 percent of the initial price decline by the close of the trading day.

Of the 69 stocks that experience substantial price declines on the event day, 20 stocks, representing 26 halts, evidence large price declines during periods +1 and +2. Only four of these 20 stocks demonstrate a large price reversal prior to the end of the trading day. In an attempt to uncover differences in the return and short selling behavior of these four stocks as compared to stocks that demonstrate substantial price declines in the first two post-halt periods but no significant reversal, we compute, for each group, mean cumulative returns and abnormal short selling levels for 12 post-halt periods. Abnormal short selling is the percentage difference between shares sold short during the event period and the average daily number of shares sold short during the estimation period. Results are shown in Figure 9, which makes a separate comparison for each metric between reversal and non-reversal stocks. Figure 10 attempts to link short selling behavior and returns; it displays these measurements together for each stock group.

Abnormal short selling is scaled by a factor ten, for Figure 10, to allow plotting on the same graph.



Panel A: Cumulative Returns

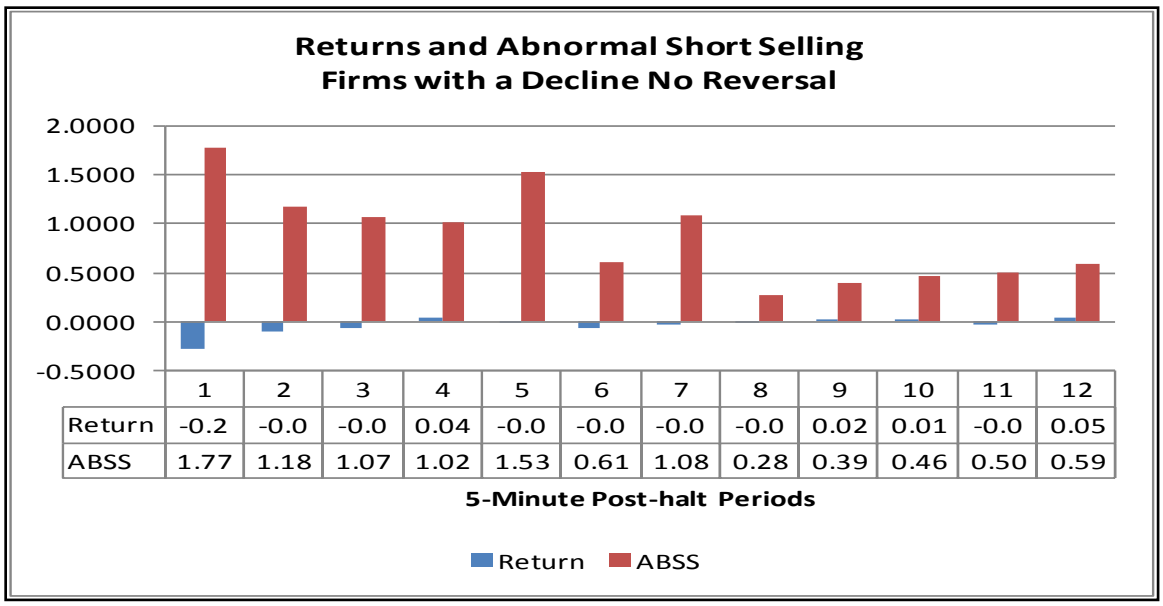


Panel B: Abnormal Short Selling

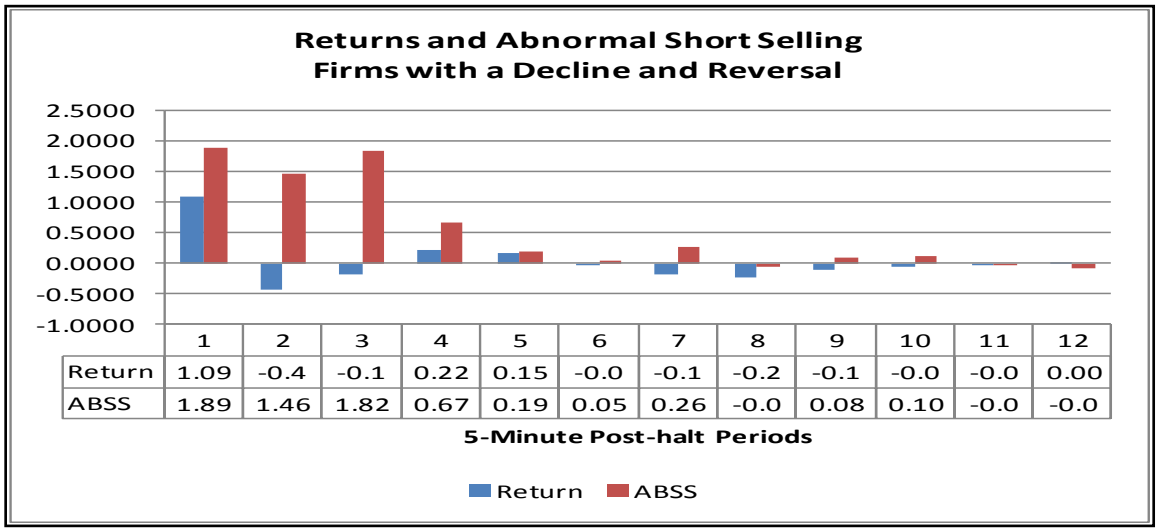
Figure 9

Cumulative Returns and Abnormal Short Selling

Cumulative dollar returns and abnormal short selling are computed on the halt day for firms with large price declines in the first two post-halt periods. Five-minute periods are measured from the resumption of trading. Large price declines are defined as a decrease in return in excess of two average return standard deviations obtained from the 30-day pre-halt estimation period. Abnormal short selling is the percentage difference between shares sold short during the event period and the average daily number of shares sold short during the estimation period. Results are shown for with and without a price reversal of at least 60 percent of the original price decline.



Panel A: Firms Without Reversals



Panel B: Firms With Reversals

Figure 10

Cumulative Returns and Abnormal Short Selling: Reversals / No Reversals

Cumulative dollar returns and abnormal short selling are computed on the halt day for firms with large price declines in the first two post-halt periods. Five-minute periods are measured from the resumption of trading. Large price declines are defined as a decrease in return in excess of two average return standard deviations obtained from the 30-day pre-halt estimation period. Abnormal short selling is the percentage difference between shares sold short during the event period and the average daily number of shares sold short during the estimation period. Abnormal short selling is scaled by a factor ten to allow plotting on the same graph. Results are shown for with and without a price reversal of at least 60 percent of the original price decline.

From Figure 9, we make two noteworthy observations. Return patterns, shown in Panel A, are quite different for each set of firms. The firms with price reversals demonstrate a pronounced decline from periods +1 to +2, and a sharp rebound in periods +3 and +4. In contrast, the non-reversing firms appear to have a gradual appreciation in price during the first four post-halt periods without evidence of extreme price movements. Abnormal short selling levels, shown in Panel B, suggest differences as well. Although levels are similar for both groups immediately upon the resumption of trading, short selling for the reversal stocks remains elevated for three periods and then declines substantially with near estimation periods levels by the eighth post-halt period. Short selling levels for the non-reversing stocks appear to be more arbitrary and they remain noticeably elevated throughout the periods examined.

Figure 10 fails to demonstrate for either firm group, a predatory relation between short selling levels and returns. For firms with no reversal identified (Panel A), the highest short selling levels and lowest returns occur simultaneously in the first post-halt period. For firms experiencing reversals, short selling levels are highest immediately preceding the substantial price decline in period two. However, short selling remains elevated in the two periods that follow, even as the price begins to rebound. This observation is consistent with Shkilko et al. (2012), who find that prior to large price reversals; short selling increases as short sellers demand liquidity instead of supply it.

Our examination of price reversals provides only limited support for Hypothesis 3. We document reliable evidence that substantial price declines surrounding interruptions in trading occur. However, beyond our observations that return and short selling patterns appear different for stocks depending on whether they experience a large price reversal, we are unable to

establish that the price reversals associated with predatory activity take place for a significant portion of our sample of stocks.

CONCLUSION

The model of predation developed by Brunnermeier and Pedersen (2005) describes a distinct pattern of price behavior: an initial price decline is followed by a substantial reversal. Our research intent is to discover if predatory activity occurs surrounding trading halts – if strategic market participants take advantage of a distressed trader's need to liquidate.

Our investigation identifies that overall, sample stocks experience a substantial decline in price immediately following the resumption of trading; this decline appears on aggregate to reverse itself by the end of the trading day. Results also demonstrate that short selling and returns exert influence on each other, however, the impact of non-short volume on returns is not established. Although an increase in trading, both short and non-short volume, is identified surrounding our trading halt events, the anticipated shift in buying and selling activity is not evidenced, perhaps due to the manner in which transactions, particularly short sales, are classified. Price reversals are identified for a fraction of sample stocks, but our research is unable to definitively demonstrate that predatory behavior occurs surrounding halts in trading.

Aitken and Dyl (1990), in their examination of stock behavior subsequent to large price changes, find statistically significant reversals in price. They look to previous research to provide possible explanations, which might apply to the price behavior of sample stocks in our study. For example, De Bondt and Thaler (1985) suggest that irrationality might lead investors to place too much emphasis on events and thereby make inaccurate forecasts. Brown, Harlow, and Tinic (1988) purport that in an uncertain environment, information is not incorporated immediately and investors overreact to what they perceive as bad news.

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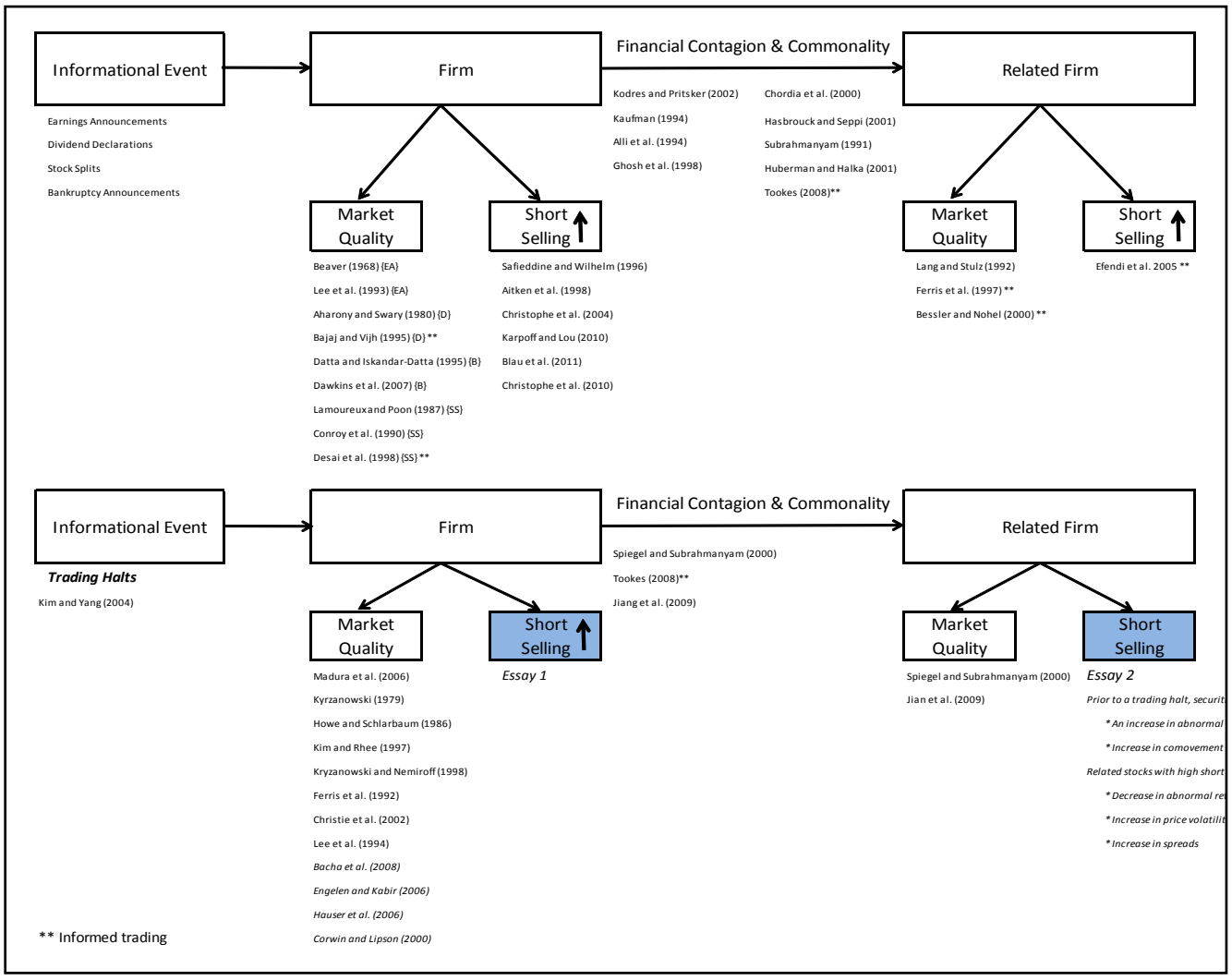
LIST OF APPENDICES

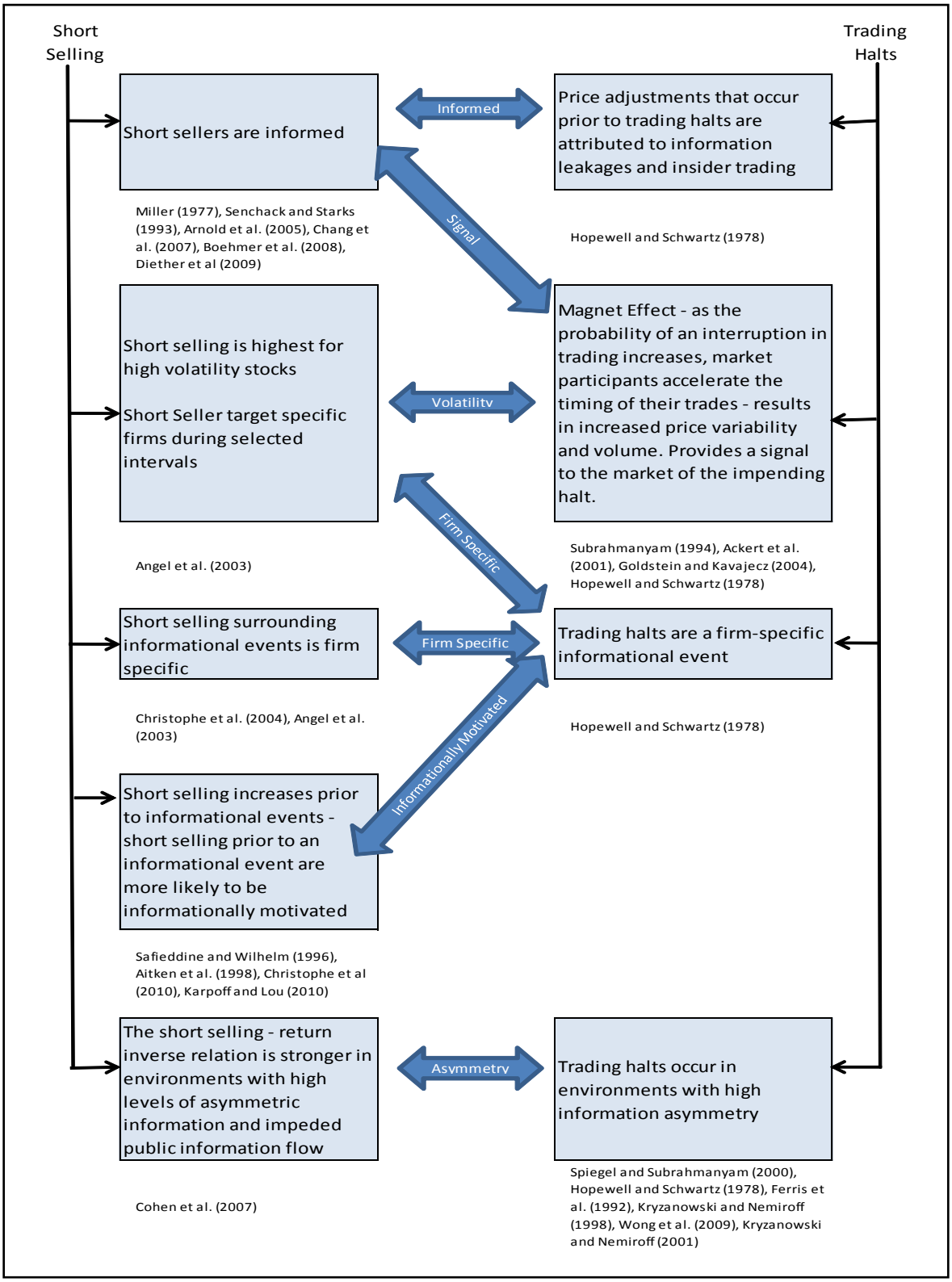
APPENDIX: A

Research justification for examining short selling activity surrounding trading halts.



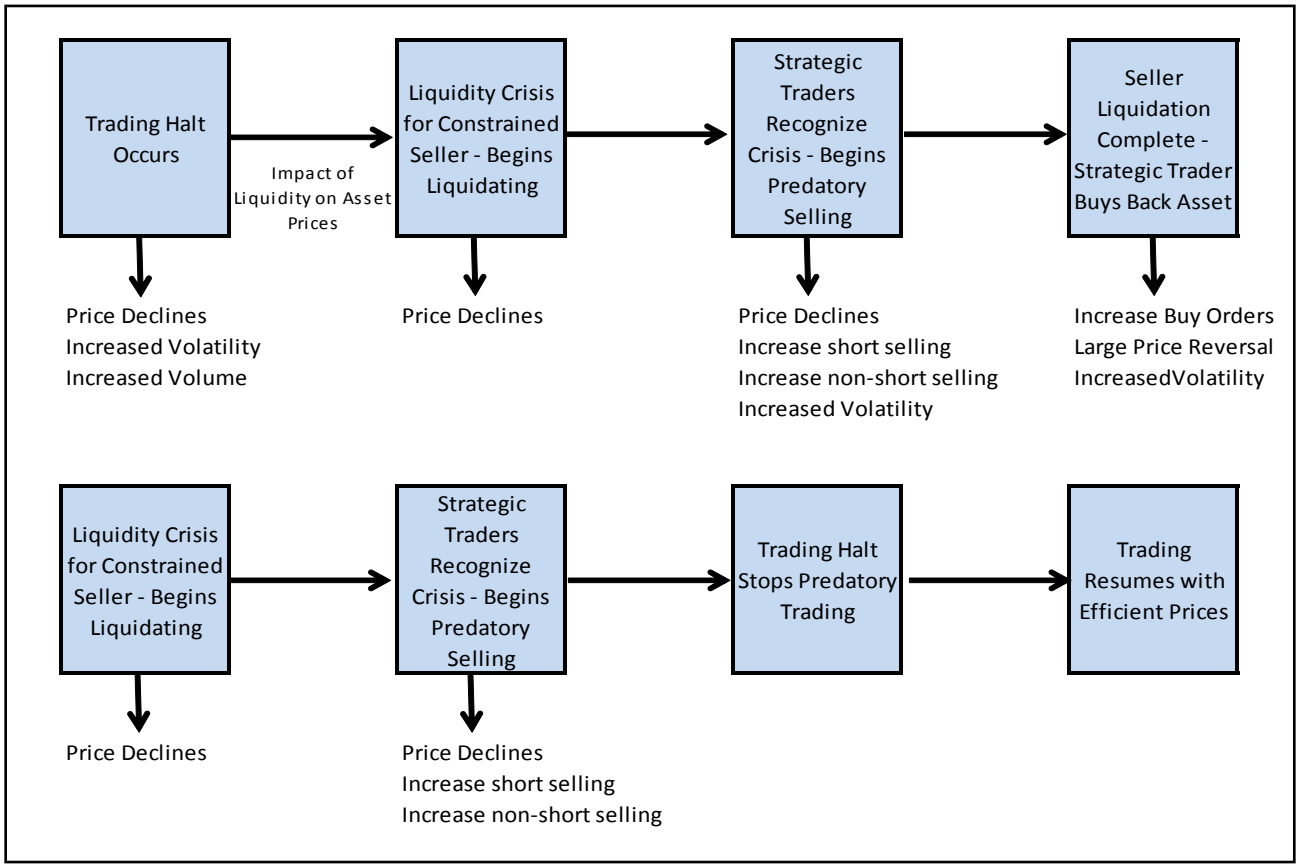
APPENDIX: B

Diagram depicting the relation between short selling and trading halts



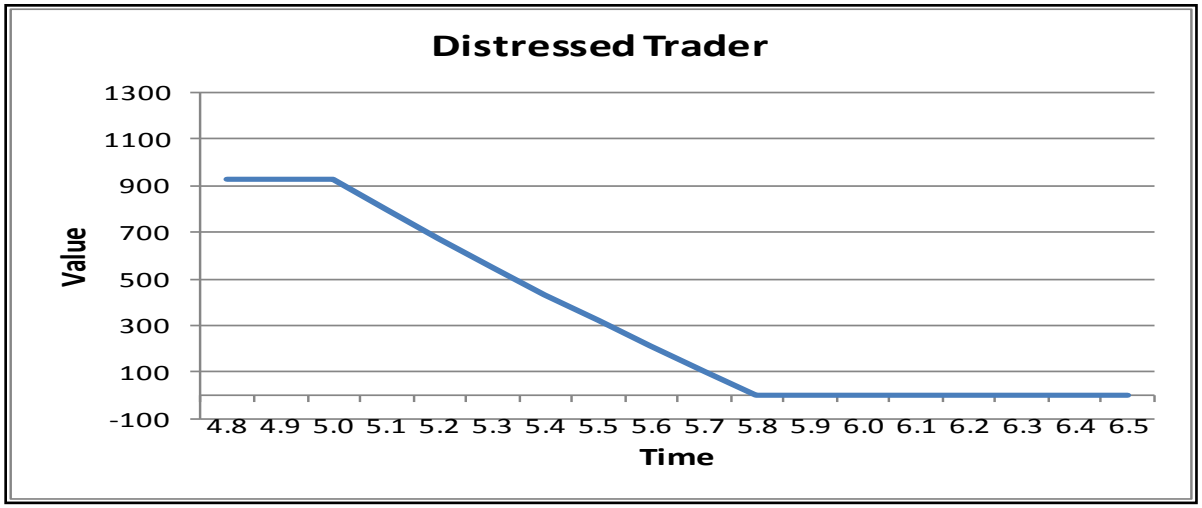
APPENDIX: C

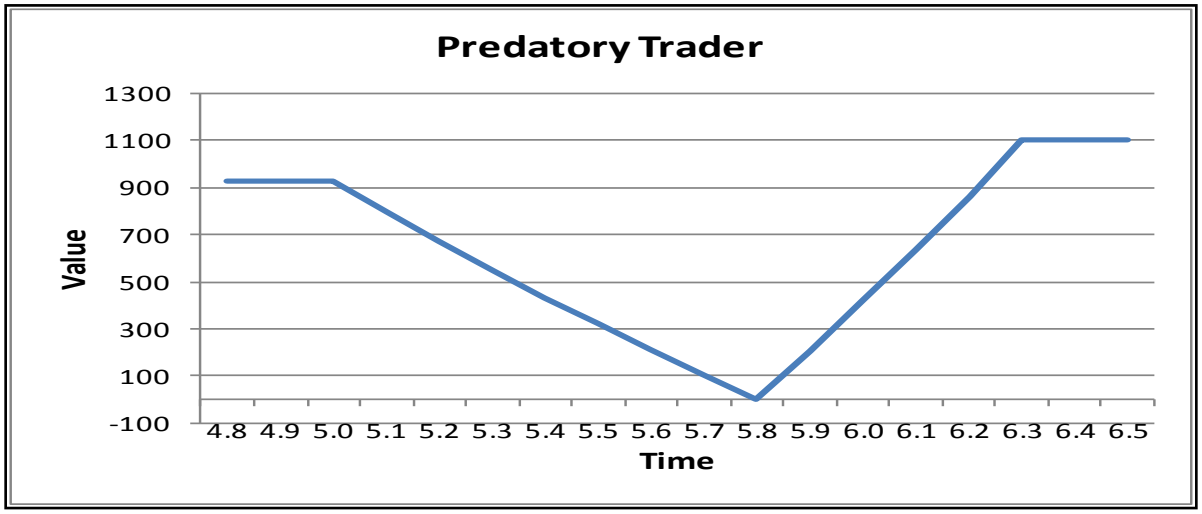
Possible roles of trading halts with predatory behavior (precipitate or mitigate)



APPENDIX D

Value of holdings for the distressed and predatory trader and price behavior during predation





APPENDIX E

List of Sample Firms

Firm	Symbol	Mode	SIC
AMERICREDIT CORP	ACF	4	Personal Credit Institutions
ADAMS RESOURCES & ENERGY INC	AE	7	Crude Petroleum & Natural Gas
UNITED CAPITAL CORP	AFP	11	Electronic Coils, Transformers & Other Inductors
AGRIUM INC	AGU	11	Agricultural Chemicals
AMERICAN ISRAELI PAPER MLS LTD	AIP	11	Paper Mills
ALPHARMA INC	ALO	11	Pharmaceutical Preparations
BLAIR CORP	BL	4	Retail-Catalog & Mail-Order Houses
BAUSCH & LOMB INC	BOL	11	Retail-Building Materials, Hardware, Garden Supply
CONAGRA INC	CAG	11	Meat Packing Plants
CAMBREX CORP	CBM	11	Services-Engineering, Accounting, Research, Management
CAMECO CORP	CCJ	11	Miscellaneous Metal Ores
CORUS ENTERTAINMENT INC	CJR	11	Radio Broadcasting Stations
CORUS ENTERTAINMENT INC	CJR	11	Radio Broadcasting Stations
CORUS ENTERTAINMENT INC	CJR	11	Radio Broadcasting Stations
CANTEL MEDICAL CORP	CMN	11	Services-Commercial Physical & Biological Research
CAREMARK RX INC	CMX	11	Services-Home Health Care Services
CANADIAN NATIONAL RAILWAY CO	CNI	11	Railroads, Line-Haul Operating
COMSTOCK RESOURCES INC	CRK	11	Crude Petroleum & Natural Gas
CONTINENTAL MATERIALS CORP	CUO	11	Concrete, Gypsum & Plaster Products
C V S CORP	CVS	11	Retail-Drug Stores and Proprietary Stores
DELUXE CORP	DLX	11	Blankbooks, Looseleaf Binders & Bookbindg & Related Work
DOMTAR INC	DTC	11	Paper Mills
DYNEGY INC NEW	DYN	11	Natural Gas Transmission
ENCANA CORP	ECA	11	Crude Petroleum & Natural Gas
ELKCORP	ELK	11	Asphalt Paving & Roofing Materials
ENERGY PARTNERS LTD	EPL	11	Crude Petroleum & Natural Gas
EMPIRE RESOURCES INC DEL	ERS	7	Wholesale-Metals Service Centers & of fices
FAIRCHILD SEMICONDUCTOR INTL INC	FCS	11	Semiconductors & Related Devices
FORDING CANADIAN COAL TRUST	FDG	11	Trust Services
FAMILY DOLLAR STORES INC	FDO	11	Retail-Variety Stores
HALLWOOD GROUP INC	HWG	11	Broadwoven Fabric Mills, Man Made Fiber & Silk
IAMGOLD CORP	IAG	11	Gold and Silver Ores
IRWIN FINANCIAL CORP	IFC	4	State Commercial Banks
IMERGENT INC	IIG	7	Services-Computer Integrated Systems Design
QUEBECOR WORLD INC	IQW	11	Commercial Printing
INTERTAPE POLYMER GROUP INC	ITP	11	Converted Paper & Paperboard Prods (No Containers/Boxes)
J E D OIL INC	JDO	11	Crude Petroleum & Natural Gas
JONES APPAREL GROUP INC	JNY	11	Apparel & Other Finished Prods of Fabrics & Similar Matl
KADANT INC	KAI	11	Special Industry Machinery (No Metalworking Machinery)
LEVITT CORP FLA	LEV	11	Land Subdividers & Developers (No Cemeteries)
LIONS GATE ENTERTAINMENT CORP	LGF	11	Services-Motion Picture & Video Tape Production
MINERALS TECHNOLOGIES INC	MTX	11	Industrial Inorganic Chemicals
NAVISTAR INTERNATIONAL CORP	NAV	11	Truck & Bus Bodies
NAVISTAR INTERNATIONAL CORP	NAV	11	Truck & Bus Bodies
NACCO INDUSTRIES INC	NC	11	Industrial Trucks, Tractors, Trailers & Stackers
NOVAGOLD RESOURCES INC	NG	11	Gold and Silver Ores
NUVEEN MASS DIV ADV MUNI FD	NMB	7	Trust Services
NATIONAL SEMICONDUCTOR CORP	NSM	11	Semiconductors & Related Devices
NATIONAL SEMICONDUCTOR CORP	NSM	11	Semiconductors & Related Devices
NATIONAL SEMICONDUCTOR CORP	NSM	11	Semiconductors & Related Devices
NATIONAL SEMICONDUCTOR CORP	NSM	11	Semiconductors & Related Devices
NATIONAL SEMICONDUCTOR CORP	NSM	11	Semiconductors & Related Devices
QUANEX CORP	NX	11	Steel Works, Blast Furnaces & Rolling Mills (Coke Ovens)
ONE LIBERTY PROPERTIES INC	OLP	11	Real Estate Investment Trusts
PIONEER DRILLING CO	PDC	7	Drilling Oil & Gas Wells
PARK NATIONAL CORP	PRK	7	National Commercial Banks

RIVIERA HOLDINGS CORP	RIV	11	Services-Miscellaneous Amusement & Recreation
RETAIL HOLDRS TRUST	RTH	4	Trust Services
BOSTON BEER INC	SAM	11	Malt Beverages
BOSTON BEER INC	SAM	11	Malt Beverages
BOSTON BEER INC	SAM	11	Malt Beverages
BOSTON BEER INC	SAM	11	Malt Beverages
SCHWAB CHARLES CORP NEW	SCH	11	Security Brokers, Dealers & Flotation Companies
SHAW GROUP INC	SGR	11	Miscellaneous Fabricated Metal Products
STONE ENERGY CORP	SGY	11	Crude Petroleum & Natural Gas
SIGNET GROUP PLC	SIG	11	Retail-Jewelry Stores
SUNLINK HEALTH SYSTEMS INC	SSY	11	Services-Commercial Physical & Biological Research
TELEPHONE & DATA SYSTEMS INC	TDS	4	Radiotelephone Communications
TEKTRONIX INC	TEK	11	Instruments For Meas & Testing of Electricity & Elec Signals
TENET HEALTHCARE CORP	THC	11	Services-General Medical & Surgical Hospitals, NEC
TODCO	THE	11	Drilling Oil & Gas Wells
TECHNICAL OLYMPIC U S A INC	TOA	11	General Bldg Contractors - Residential Bldgs
TELUS CORP	TU	11	Radiotelephone Communications
UNITEDHEALTH GROUP INC	UNH	11	Hospital & Medical Service Plans
UNISOURCE ENERGY CORP	UNS	11	Electric Services
UNITED STATES CELLULAR CORP	USM	4	Radiotelephone Communications
WESTMORELAND COAL CO	WLB	7	Bituminous Coal & Lignite Mining
WELLSFORD REAL PROPERTIES INC	WRP	11	Real Estate Investment Trusts

VITA

Mary C. Funck

Academic Background

M.B.A.	Western Illinois University	Macomb, IL	Finance	2006
M.S.	Western Illinois University	Macomb, IL	Computer Science	2002
B.S.	Western Illinois University	Macomb, IL	Computer Science	1997

Work Experience

Academic Experience

Graduate Teaching and Research Assistant, University of Mississippi (2007 – 2012). Department of Finance.

Senior Associate Faculty, Western Illinois University (1998 – 2007). Computer Science Department.

Faculty Presenter, Western Illinois University (Summer 2006). Center of Innovation, Research, and Teaching.

Administrative Intern, Western Illinois University (2004 – 2005). Western Illinois Entrepreneurship Center.

Graduate Teaching Assistant, Western Illinois University (Spring Semester 1998). Computer Science Department.

Teaching

Courses Taught

FIN 331	Business Finance I (taught for 11 semesters)
FIN 334	Investments (taught for 2 semesters)
CS 101	Introduction to Computers (Computer Applications and Literacy)
CS 301	Advanced Spreadsheet Concepts (Microsoft Excel)
CS 483(G)	Micro Database Applications (Microsoft Access)
CS 220	Introduction to COBOL (IBM Mainframe Platform)

CS 230 External Files (Intermediate COBOL & JCL)

CS 211 Principles of Computer Science I (Introductory Computer Science Principles)

CS 214 Principles of Computer Science II (Introductory Java Programming)

Research / Intellectual Contributions

Publications

Watson, E., and Funck, M. (2012). "A Cloudy Day in the Market: Short Selling Behavioral Bias or Trading Strategy," International Journal of Managerial Finance, 8 (3), 238 – 255.

Papers Under Review

Funck, M, Van Ness B.F., and Van Ness, R. A. (2012). "Fly the Friendly Skynet: Reaction to a False-News Event for United Airlines," forthcoming publication at the Journal of Applied Finance.

Presentation of Papers

Funck, M, Van Ness B.F., and Van Ness, R. A. (2011). "United Airlines and an Internet Bot: Market Quality, Trading Halts and Investor Reaction to a No-News Event," presented at the Eastern Finance Association Meeting, Savannah, Georgia, April 2011.

Myers, J., Horstman (Funck) M., Marchand, H., "Methamphetamine Precursor Control Act (MPCA) Study ." presented at i2 National User Conference, Arlington, VA, May 2007.

Horstman (Funck) M., Myers, J., Marchand, H., "Methamphetamine Precursor Control Act (MPCA) Study." Presented at the Illinois State Academy of Science 2007 Annual Meeting. Springfield, IL, April 2007.

Horstman (Funck) M., Brown J., Myers, J., "A New Tool, Using Alice to Overcome Obstacles Inherent in Teaching Introductory Programming Concepts." Presented at the Illinois State Academy of Science 2007 Annual Meeting. Springfield, IL, April 2007.

Hackmann, R., Horstman (Funck) M., Sawhney, S., Agan, Y., "Information Value of Secondary Statistics." Presented at the Midwest Business Administration Association Annual Meeting, Chicago, IL March 2007.

Marchand, H., Myers, J., Horstman (Funck) M., "Methamphetamine Precursor Control Act (MPCA) Study." Presented at the third Annual Rural Public Health Institute, Effingham, IL,

March 2007.

Hackmann, R., Horstman (Funck) M., "Disparate U.S. GDP Values and their Implication in a Global Economy." American Association of Business and Behavioral Sciences Annual Meeting, Las Vegas, NV, February 2007.

Sawhney, R., Horstman (Funck) M., "Examining Patient Record Flow at CS Medical Center." American Association of Business and Behavioral Sciences Annual Meeting, Las Vegas, NV, February 2007.

Horstman (Funck), M., "Entrepreneurship – An Innovative Approach to Product Availability in Rural Retail Markets." Midwest Business Administration Association Annual Meeting, Chicago, IL, March 2005.

Research Grants

Internally Funded

2009	Funck, M. Graduate Summer Research Grant, University of Mississippi
2006	Myers, J., Horstman (Funck), M., Marchand, H., Internal Grant - Methamphetamine Precursor Control Act (MPCA) Study, Western Illinois University

Service

Service to the University

Departmental Activity

Coordinator of Graduate Teaching Assistants, Western Illinois University, Computer Science Department 1999 – 2004

Chair, Service Course Committee, Western Illinois University, Computer Science Department

College Activity

Proctor – Bloomberg Assessment Test, School of Business Administration, University of Mississippi, November 2011

University –Wide Activity

Served in the Faculty Mentor Program – Western Illinois University

Served as faculty participant in student orientation programs – Western Illinois University

Service to the Profession

Editorial and Review Activities

2011	Invited Manuscript Contributor, Brigham Houston, "Fundamentals of Financial Management" seventh edition
2009	Invited reviewer for journal article submission to The Financial Review (National)
2007	Invited Manuscript Reviewer, Pearson Education "Exploring Series"
2005	Invited Manuscript Reviewer, "Java Programming – From Problem Analysis to Program Design", Chapters 15 - 20
2004 – 2005	Invited Manuscript Reviewer, "Java Programming - From Problem Analysis to Program Design."
2004	Invited Manuscript Reviewer, "Robots: Learning to program with Java."
2004	Invited Manuscript Reviewer, comparison of three Java texts for Course Technology Publishers
2003 – 2004	Invited Manuscript Reviewer, "Go! Series."
2002 – 2003	Invited Manuscript Reviewer, "Computing Today."
2002	Invited Manuscript Reviewer, "Essentials Series."
2002	Invited Manuscript Reviewer, "Grauer Exploring Series."

Other

Awards

2011	'Random Acts of Kindness' award from Student Alumni Council, University of Mississippi
1998	Outstanding Graduate Teaching Assistant, Computer Science Department, Western Illinois University