

**The Impact of Short Selling Restrictions and
Extreme Uncertainty on Liquidity and Order Flow:
Evidence from the London Stock Exchange**

Matthew Clifton
School of Finance and Economics
University of Technology, Sydney
PO Box 123
Broadway, NSW 2007
Australia
+61-2-9514-7777
Clifton.Matthew@gmail.com

David Michayluk
School of Finance and Economics
University of Technology, Sydney
PO Box 123
Broadway, NSW 2007
Australia
+61-2-9514-7761
David.Michayluk@uts.edu.au

May 2010

We are grateful to the London Stock Exchange for providing data and for the financial support of Capital Markets CRC. The comments and opinions expressed in this paper are the authors' and do not reflect those of the directors, members, or officers of the London Stock Exchange. The authors are responsible for any errors.

**The Impact of Short Selling Restrictions and
Extreme Uncertainty on Liquidity and Order Flow:
Evidence from the London Stock Exchange**

During the 2008-9 UK emergency temporary short selling ban, restricted stocks experienced lower trading activity, wider spreads, reduced order book depth, more trading using market orders and fewer limit orders at the best quotes. The restrictions occurred at a time of extreme uncertainty when price volatility increased and there was more trading activity in the upstairs market. Our findings suggest that limit order trading may be less viable during turbulent times and regulation aimed at maintaining orderly markets can influence trading behavior during crisis periods.

I. Introduction

The Financial Crisis of 2008-9 was the culmination of many economic events which caused extreme market conditions and led to coordinated world-wide regulatory intervention. Severe uncertainty affected the banking and finance sector with many stocks suffering precipitous price falls. The bankruptcy of Lehman Brothers in September 2008 in the US (arguably provoked by a "short squeeze") prompted financial regulators in many countries to introduce short selling restrictions to reduce the downward pressure on prices.

Order driven markets, such as the London Stock Exchange (LSE), rely upon limit orders for the provision of liquidity. Liquidity, however, may be impaired during extreme volatility due to order imbalances and this may, in turn, affect price discovery and further discourage participants from trading. One way to try to manage liquidity may be through the implementation of regulation designed to influence trading, however the exact rule for this purpose is elusive. In the US, the Securities and Exchange Commission acted to restrict short

selling¹. Despite divided opinions on the costs and benefits of short selling restrictions, the UK Financial Services Authority (FSA) followed suit in taking this approach to combat concerns specifically about the potential for market abuse, disorderly markets and transparency deficiencies². The ban in the UK was imposed on the 19th of September 2008 and lasted for 82 trading days before being rescinded on the 16th of January 2009.

This study examines the impact of severe uncertainty and short selling restrictions on liquidity and order flow in the UK. The ability to trade (both long and short) quickly and at low cost during extreme trading conditions is of interest to all investors. The response of market participants to new regulation is important to exchanges and regulators charged with maintaining fair and orderly markets. Trading activity and order flow during crisis periods and around circuit breakers are also important from a market design point of view as limit order trading is essential to the viability of an order driven market. Moreover, an understanding of how liquidity is affected by uncertainty and new trading constraints enhances our knowledge of how this aspect of market microstructure influences the return generation process.

This study also provides comprehensive evidence on the value of short sellers as liquidity providers, and the costs associated with their exclusion. On the one hand, in the context of a crisis, restricting short selling may stabilize prices by reducing speculation and excessive selling pressure. The counter argument is that restricting short sales may impair liquidity by reducing the supply of stocks and trading opportunities, leading to wider spreads and prices that are more volatile and prone to significant falls upon the dissemination of negative

¹ Emergency short selling restrictions were applied to some 56 countries during the Financial Crisis (see, for example, Gruenewald (2009) for a summary of the measures implemented by each country).

² The FSA provides a series of consultation papers available through their website, www.fsa.gov.uk.

information. This paper provides evidence on the changes in market quality and order flow to assess how regulatory intervention in short selling affected the market.

We find that stocks under short selling restrictions experience significant reductions in trading activity during the ban period. Quoted spreads of banned stocks are significantly wider during the restriction period compared to control stocks. Under short selling constraints, depth on the limit order book is significantly reduced and participants submit fewer orders in banned stocks relative to trades. Periods of increased price volatility are associated with increased trading activity in the upstairs market. These results are robust to changes in the overall market and provide empirical evidence that short selling restrictions may alter order submission strategies, impair market liquidity, and increase the cost of trading.

The remainder of the paper is organized as follows. Section II provides an overview of key macro-economic events and the actions taken by regulators during the 2008-9 Financial Crisis. The possible impact of such events on liquidity and order flow is discussed in Section III along with related research. Section IV describes institutional details and the data. Section V presents results and Section VI concludes.

II. The 2008-9 Financial Crisis

Financial markets stumbled in August 2007 as concerns grew over the increasing rate of US mortgage defaults. In September 2008, it became apparent that the crisis would not confine itself to the sub-prime mortgage market, but make a dramatic impact on the financial industry worldwide. The world witnessed the astonishing collapse (or forced nationalization) of some of the global economy's biggest financial conglomerates, and the most sweeping government interventions in financial markets in decades.

On the 7th of September 2008 the US government announced the largest financial bailout in the country's history as it took troubled mortgage giants Fannie Mae and Freddie Mac into temporary public ownership to save them from collapse. On the 15th of September, the investment banking giant Lehman Brothers filed the largest bankruptcy in US history with holdings of over US\$600 billion in assets. Figure 1 presents a timeline of major news announcements and stock prices around this turbulent period. The chart shows tumultuous prices in late September around the collapse of Fannie Mae and Freddie Mac and Lehman Brothers in the US. The crisis unfolding in the US economy and collapse of Lehman Brothers had serious ramifications for other banks, the likes of which extended around the globe.

[Insert Figure 1 about here]

Concerns regarding speculative short selling extended to the UK prompting the FSA to take emergency action. On the 18th of September 2008, the FSA announced that both naked and covered short selling of listed UK financial sector companies would be prohibited from the 19th of September 2008 until the 16th of January 2009. The new regulations did not apply to market makers, defined as those firms dealing as a principal in equities, options or derivatives to fulfill client orders, respond to client requests to trade or to hedge positions arising from those trades. Thus, short selling was permitted when used for the purpose of providing liquidity on a regular basis on both bid and offer sides of the market in comparable size. Trading in circumstances other than genuinely for the provision of liquidity was not exempt from the ban.

New disclosure rules were also implemented to increase market transparency; requiring participants to report net short positions representing an economic interest of 0.25% or more of the issued capital of a company. Ongoing disclosure was required for changes of 0.10% of

net short positions. The increased disclosure rules were to remain in place until the 30th of June 2009. The new rules on short selling were to be reviewed after 30 days, though they remained in force until the originally declared expiry dates. Figure 1 shows that the announcement of temporary emergency short selling restrictions on the 19th of September is associated with a temporary rise in prices, especially large banking stocks.

Soon after the commencement of short selling restrictions, the British government announced a major bank rescue package totaling some £500 billion (US\$850 billion) on the 8th of October 2008. The first week of October had seen major falls in the stock market and there were strong concerns about the stability of British banks. The plan aimed to restore market confidence and help stabilize the British banking system through the provision of a range of short-term loans and guarantees of interbank lending. The government action included £37 billion (US\$64) to buy preference shares in Royal Bank of Scotland and the recently merged Lloyds TSB and HBOS³. Following the announced bailout, stock prices continued to fall steeply throughout October.

Greater price stability occurred during November and December with the average stock price posting a slight recovery. However, during the last week of the short selling ban, British banks fell on renewed fears that banks worldwide would be hit with larger write-downs, and face the possibility of nationalization⁴. On the 19th of January 2009, just two trading days after the lifting of short selling restrictions, many banking shares collapsed again. Despite the earlier government bailout, the Royal Bank of Scotland (RBS) announced losses of £28 billion (US\$ 41 billion) for 2008; the largest corporate loss in UK history. RBS shares fell

³ "UK banks receive £37bn bail-out" (13 October 2008), BBC News Online, <http://news.bbc.co.uk/1/hi/business/7666570.stm> (retrieved 12 March 2009).

⁴ Landon, T. "British Banks, After Bailout, in Line for More" (18 January 2009), The New York Times, <http://www.nytimes.com/2009/01/19/business/worldbusiness/19ukbank.html> (retrieved 12 March 2009).

over 67 percent in one day and continuous trading in some stocks was interrupted by more than 30 intraday trading halts. Share prices in many other British banks also suffered heavy losses. The same day, the British government announced a second major bailout of British banks. The next day, Lloyds Banking Group and Barclays fell sharply again and RBS and HSBC continued to fall, suggesting ongoing concerns for the future of the British banking system.

III. Liquidity and Order Flow

The extraordinary events of the 2008-9 Financial Crisis placed severe strain on financial markets. Government bailouts, bankruptcies and precipitous price falls are a major concern for many investors, as evidenced by the extensive media attention received by financial markets during the crisis. However, crisis periods also provide a significant opportunity for market practitioners and academics to gain an improved understanding of how extreme uncertainty caused by macro-economic and stock-specific information events, and new trading constraints such as short selling restrictions, affect the ability of traditional market transaction mechanisms to set efficient prices.

This article analyzes key aspects of market quality during turbulent trading conditions including liquidity and the behavior of traders as revealed by their order flow. Liquidity enhances market efficiency by stimulating arbitrage activity and promoting the incorporation of private information into stock prices (Chordia, Roll, and Subrahmanyam, 2007). Imperfections in regulation and transaction mechanism design may cause markets to become highly illiquid and less capable of supplying immediacy at the low cost that participants are accustomed to. Increased volatility may discourage some participants from trading due to greater uncertainty over execution prices. Uncertainty may also increase the cost of trading as

limit order traders widen the bid-ask spread to adjust to adverse selection risk levels (see, for example, Bagehot, 1971, Copeland and Galai, 1983, and Glosten and Milgrom, 1985). Wider spreads may also be accompanied by low order book depths (Lee, Mucklow and Ready, 1993). Chordia, Roll and Subrahmanyam (2001) find that liquidity plummets during down markets, and that recent market volatility induces a decrease in trading activity and spreads. Therefore, measures that encourage steady liquidity provision may be necessary during crisis periods.

The LSE trading system implements a number of default circuit breaking mechanisms, which prevent rapid price movements caused by temporary order imbalance. For example, automated execution suspensions (during continuous trading) and price monitoring extensions (during call auctions) are triggered when order imbalance will result in significant short-term stock price movements. Greenwald and Stein (1991) argue that such trading halts can facilitate price discovery by reducing the risk of trading at unexpected prices, thereby encouraging traders to participate in the market. Kodres and O'Brien (1994) add that trading halts assist traders who may not be able to instantaneously adjust their trading interests to new information due to technological limitations or the costs of continuous monitoring. However, the extraordinary events of 2008-9 may have overwhelmed existing circuit breaker mechanisms. Increased volatility and frequency of trading halts during the financial crisis may have discouraged some traders from participating in the market. Moreover, incumbent circuit breakers may not have been designed to prevent prolonged periods of market disorder caused by extended buying or selling pressure.

During the crisis, market participants may have been short selling stocks without concern for the underlying value of the business, speculating that prices would fall without forecasting the future of the company purely beyond its near-term price action. Sustained price pressure

from short sellers may result in a deterioration of financial institutions' market capital and credit ratings, creating a downward spiral. In the context of the banking crisis, restricting short selling may have had a stabilizing effect on prices by reducing speculation and excessive selling pressure.

However, short selling is a legitimate investment technique and much of the academic literature suggests that short selling under normal conditions is beneficial to markets. Short selling permits investors with negative information to contribute to price discovery without the need to own the stock. The ability to sell stock that one does not own facilitates informational efficiency by reducing asymmetry in supply and demand. Miller (1977) argues that short selling restrictions may reduce liquidity and impede price formation by excluding market participants who do not own stock from trading. Furthermore, Diamond and Verrechia (1987) hypothesize that restrictions on short sales discourage liquidity-motivated trades thereby increasing the likelihood of informationally motivated behavior.

In implementing the ban, the essential role that short selling plays in the provision of liquidity was not unrecognized by the FSA, as evidenced by the sanctioning of short sales for the purpose of market making. Nevertheless, short selling restrictions may have impaired liquidity by reducing the supply of stocks and trading opportunities, leading to wider spreads and prices that were more volatile and prone to significant falls upon the dissemination of negative information.

The theoretical view that short selling is beneficial to market efficiency is supported by some empirical studies. Bris, Goetzmann and Zhu (2007) study the effects of short selling regulations in many different countries and find that prices are less volatile and incorporate negative information faster in countries where short selling is feasible and practiced. They find strong evidence that the lifting of short sales restrictions is associated with increased

negative skewness in market returns but no significant impact on the frequency of crashes. These results imply not that extreme returns become more frequent, but rather with the ability to sell short they become more negative. Aitken, Frino, McCorry and Swan (1998) find evidence of negative returns following public disclosure of high or increasing levels of short selling, implying that short sellers play an important role in price discovery.

The findings of Bris et al. (2007) offer some support to the actions taken by many regulators to introduce short selling restrictions during the financial crisis to reduce the severity of a market panic. Short selling restrictions and increased transparency during turbulent times may reduce the potential for market abuse through excessive speculation. Efforts to temper the decline in financial sector stock prices during the 2008-9 Financial Crisis may have assisted in preventing further sudden price falls and promoting market confidence.

However, Chang, Cheng and Yu (2007) find higher volatility and less positive skewness of individual stock returns when short sales are allowed in the Hong Kong market. Their results strongly support Miller's (1977) hypothesis that short-sale constraints may lead to overvaluation. This difference in results may be due to differences in security characteristics across markets, and highlights the difficulty involved in predicting the impact of temporary short selling restrictions.

Existing research provides some insights into the relationship between the ability to sell short and market quality under normal trading conditions. However, little is known about the wider ramifications of temporary emergency short selling restrictions. Furthermore, there is little consensus about the extent or nature of investor reactions to the sudden prohibition of short sales. Some aspects of market quality during short selling restrictions have been examined during the 2008-9 Financial Crisis. Michayluk and Fernandez (2009) study the

impact of emergency restrictions in US cross-listed Canadian stocks and find wider spreads and reduced liquidity, implying that short sellers are net liquidity providers. Hansson and Rudowfors (2009) study the short selling ban on the LSE and report wider spreads and reduced trading activity in banned stocks during the ban. Gruenewald, Wagner, and Weber (2009) evaluate the approaches taken by the US and UK regulators and find that, on balance, short selling restrictions hamper the price discovery process. However, they do predict some benefits from the US regulator's proposal for a circuit breaker rule and the FSA's proposed disclosure regime.

Many of the extraordinary events of 2008-9 transpired within days of the imposing and lifting of short selling restrictions, respectively. Consequently, it is difficult to isolate the effects of these significant macro-economic events from those directly caused by the short selling ban. It remains unclear whether the introduction of temporary short selling restrictions is necessary, and whether reactions to the ban support or confound attempts to maintain equilibrium pricing. This paper acknowledges the difficulty associated with attempts to identify the separate impacts that may be the result of short sale constraints, strong signaling effects due to regulatory intervention, and major global and company-specific events. However, the primary focus of this study is indeed to determine as best as possible the contribution of short selling restrictions to observed changes in market quality.

This article includes several important extensions and improvements to existing research on temporary short selling restrictions and adds new insight into the behaviors of market participants during extreme market conditions. We study abnormal returns, volatility, and spreads, and we further characterize the limit order book with detailed analysis of available depth. In addition, an important distinction between trading in the downstairs market and trading in the upstairs market is made, providing a more accurate picture of trading activity

and the location of liquidity, as well as increased insight into traders' choice of venue under uncertainty and new trading constraints. The frequency of trading halts is also analyzed to provide direct evidence of the performance of existing circuit breaker devices during extreme trading conditions. We employ closely matched comparison stocks, study large and small stocks separately, and carry out both parametric and non-parametric tests of difference between periods and between ban and control groups. This analysis describes the effect of intense uncertainty on market quality and provides further evidence towards determining whether trading conditions are enhanced or hindered by the introduction of short selling restrictions.

A. Trading activity and choice of venue

We analyze trading activity in both the electronic and upstairs markets of the LSE. In addition to its centralized electronic limit order book, the LSE is accompanied by a parallel upstairs market, where larger traders employ the services of brokerage firms to locate counterparties and negotiate trade terms "off-book". The number of trades and the turnover (calculated as the volume traded in each security divided by the number of shares outstanding in that security) is examined separately in both markets to determine; firstly, to what extent net trading activity is affected by the ban, and secondly, whether altered trading conditions are associated with liquidity transfers between the two markets.

Short selling restrictions limit the ability of some participants to express their opinions through trading. A reduction in "on-book" limit order trading may have a compounding effect as a paucity of limit orders causes more traders to leave the order book (Handa and Schwartz, 1996). Therefore, we expect to see an overall reduction in trading activity during the ban, a testable implication which is expressed as the following hypothesis.

Hypothesis 1: Banned stocks experience less (more) net trading activity while the short selling ban is imposed (lifted).

In the upstairs market, liquidity may be in the form of orders held by brokers instead of orders placed on the limit order book. Corwin and Lipson (2000) suggest that limit order book and off-book liquidity sources compete with order flow and provide a pool of trading interest that can dampen temporary price fluctuations. Moreover, Grossman (1992) adds that upstairs markets aggregate information about investors' latent demands. The upstairs market can also offer increased flexibility and discretion to participants who wish to trade large amounts or trade under special conditions.

Grossman (1992) predicts that upstairs brokers lower execution costs by tapping into unexpressed liquidity and Bessembinder and Venkataraman (2004) provide empirical evidence to support this view. Goldstein and Kavajecz (2004) find that increases in implicit costs of supplying liquidity through the electronic limit order book may induce market participants to withdraw depth from the book, opting instead for the flexibility and discretion of off-book trading. Increased uncertainty and reductions in on-book liquidity may also influence the choice of trading venue between the downstairs and upstairs market⁵. Trades agreed to in the downstairs and upstairs markets are analyzed separately during the short selling restrictions to reveal the costs and benefits of discretionary off-book trading compared to electronic order execution.

⁵ In addition to liquidity flowing between the LSE electronic order book and the upstairs market, it is possible that liquidity changes may be explained by participants changing their choice of trading venue to other competing markets. Since the introduction of the Markets in Financial Instruments Directive (MiFID) in September 2007, multilateral trading facilities such as Chi-X Europe, BATS Europe, and Plus Markets have provided alternative liquidity sources. However, since short selling restrictions applied universally to banned stocks, irrespective of where they traded, it is unlikely that changes to trading activity in these stocks were caused by participants taking their business to competitors of the LSE.

Hypothesis 2: Banned stocks experience more (less) trading activity in the upstairs market relative to the downstairs market while the short selling ban is imposed (lifted).

B. Prices and volatility

Preventing informed short sellers from trading may restrict the demand for a particular security to the minority who hold the most optimistic expectations about the stock. Miller (1977) suggests that it is pessimists who would want to sell short and that constraining pessimists without constraining optimists may impart an upward bias to stock prices. However, Diamond and Verrecchia (1987) point out that the expectations of rational investors will adjust to constraints to remove any upward bias in prices. In any case, the large number of severe negative news announcements occurring throughout the period may dwarf any price biases caused by short selling restrictions.

Abnormal returns are examined in order to provide an indication of the unusual price movements experienced by stocks during the 2008-9 Financial Crisis. Abnormal returns are calculated as the difference between individual stock returns relative to the estimated expected return. Expected returns are estimated using the FTSE 100 index as a proxy for the market.

Hypothesis 3: Banned stocks experience greater abnormal stock returns following significant news events.

The impact of uncertainty and short selling restrictions on volatility is another important concern. Despite increased transparency, the new disclosure rules requiring participants to disclose changes in their short positions may have led to increased volatility. Diamond and Verrecchia (1987) predict that an unexpected increase in the announced short-interest in a stock is bad news. They also find that prohibiting traders from shorting reduces the

adjustment speed of prices to private information, especially when news is negative. Aitken et al. (1998) investigate the market reaction to short selling where short sales are transparent shortly after execution and confirm Diamond and Verrechia's predictions; finding significant negative abnormal returns following short sales. Market volatility is measured using two different approaches; the standard deviation of squared five-minute⁶ returns based on quote mid-points, and the natural logarithm of daily high and low prices.

Increased volatility and reduced order book depth may also trigger more automated execution suspensions. Christie, Corwin, and Harris (2002) and Lee, Ready and Seguin (1994) find that trading halts on the Nasdaq and NYSE increase, rather than reduce, volatility, which may exacerbate extreme trading conditions. The number of automatically triggered trading suspensions is studied to provide further evidence on the impact of uncertainty and short selling restrictions on the functioning of an order driven market.

Hypothesis 4: Banned stocks are more (less) volatile while the short selling ban is imposed (lifted).

C. Spreads and depths

Bid-ask spreads are of concern to investors because they are a variable cost of trading by market order. The information conveyed by trades is reflected in the adjustment of quotes by market makers and limit order placers. Liquidity providers tighten or widen their limit order placements based on their expectations about the risk of trading with an informed participant. Copeland and Galai (1983) show that the bid-ask spread is also related (inversely) to the level of trading activity. Therefore, bid-ask spreads may widen during short selling restrictions due to reduced trading activity.

⁶ Chordia, Roll, and Subrahmanyam (2007) also use a five-minute interval when computing daily variances from high frequency data.

We analyze quoted and effective spreads to determine how increased uncertainty and short selling restrictions impacted upon the execution costs faced by market participants. Time-weighted bid-ask spreads may underestimate the true cost of trading since quoted spreads do not measure execution cost beyond the quantity of stock available at the quoted depth. Additionally, quoted spreads may fluctuate during the trading day and traders may be more inclined to trade when the spread is tighter. Furthermore, it may be possible for participants to obtain more favorable conditions in the upstairs market. Under such circumstances quoted spreads may overestimate the cost of trading. To account for these factors, the volume-weighted effective spread of each stock is also calculated based on transaction prices actually paid by investors.

Hypothesis 5: Banned stocks experience wider (tighter) spreads while the short selling ban is imposed (lifted).

Declines in liquidity are likely to be linked with increased volatility as reduced order book depth causes remaining trades to experience larger price impact. Short selling restrictions may directly prevent participants from placing some orders on the limit order book. An increase in the information content of trades due to less speculation may also render participants less willing to supply liquidity on the limit order book because of perceived increases in the chances of transacting with an informed trader. However, Ahn, Bae and Chan (2001) find that market depth rises subsequent to increased volatility.

Both statistical and graphical⁷ analysis of depth of the order book is examined in order to determine the net effect of uncertainty and short selling constraints on traders' willingness to contribute liquidity during the sample period. For statistical comparisons, two depth measures

⁷ Goldstein and Kavajecz (2004) chart average cumulative limit order book depth to provide evidence of a relation between the shape of the order book and volatility during extreme market movements.

are calculated; the number of shares on offer within 0.1% of best quotes, and the number of shares available within 1% of best quotes, respectively⁸. Visual representation of the limit order book is achieved by aggregating available shares into discrete price ranges around the best quotes.

Hypothesis 6: Banned stocks exhibit less (greater) depth on the limit order book while the short selling ban is imposed (lifted).

D. Order flow

Limit order markets, such as the LSE, rely upon limit orders for the provision of liquidity. Handa and Schwartz (1996) find that an increase (decrease) in short-run volatility encourages (discourages) the placement of limit orders and, in turn, an increase (decrease) in limit order trading decreases (increases) short-run volatility. We examine the interaction between traders and the state of the market through analysis of order flow during short selling restrictions.

Buyers and sellers perform trades by submitting either limit orders or market orders. Glosten (1994) describes two types of investors: patient traders, who supply liquidity to the market, and other traders, who wish to trade immediately. The former place limit orders, and the latter place market orders. Limit orders are stored in a limit order book to await future execution. Execution is triggered by incoming market orders, which are matched with existing best offers in the book. Thus, transaction prices are determined by the interplay between those supplying liquidity and those demanding immediacy.

Handa and Schwartz (1996) and Foucault (1999) explain the following dilemma faced by each trader type. With a market order, a trader's demands are executed with certainty, at

⁸ Measures of depth include the non-visible component of "iceberg" orders (orders which have a large portion of the total available volume hidden from the market until the moment of execution).

prices no worse than those posted in the market⁹. With a limit order, a trader has the possibility to improve his or her execution price, but runs the risk of not being executed. Moreover, because the prices of limit orders are fixed over time, such orders can become mispriced when new public information arrives. This possibility creates a winner's curse problem for limit order traders since they are more likely to be executed against at a loss when their orders become mispriced. On the other hand, a shortage of limit orders can result in accentuated short-term price fluctuations that compensate a limit order trader (Handa and Schwartz, 1996). The liquidity of an order driven market is the amalgamation over time of participants' choices between market and limit orders, the prices for limit orders, and the relative frequency at which such decisions are made.

We study the changes participants make to order placement strategies in stocks affected by short selling restrictions. Order flow is examined in a similar fashion to Biais, Hillion and Spatt (1995) who use seven categories of order events, corresponding to degrees of aggressiveness. The most aggressive types of orders result in immediate execution (i.e. trades). The aggressiveness of a trade is classified into three categories depending on whether the size of the order is greater than, equal to or less than the depth available at the best quote, respectively. For the sake of brevity we report the combined values of the three categories of on-book trades as no qualitative changes in trade aggressiveness are observed in our results. However, we do maintain a separate category for trades executed in the upstairs market.

The remaining orders do not result in immediate execution. They are limit orders to buy or sell within the best bid and ask quotes, limit orders to buy (sell) that match the best bid (ask), limit orders to buy (sell) below the best bid (ask), and cancellation of previously posted limit orders. In contrast to Bias et al. (1995), we do find qualitative differences between

⁹ The presence of "iceberg" orders means large orders may transact at prices better than envisaged.

canceled orders placed at the quotes versus canceled orders placed outside of the quotes, so each of these categories is reported separately¹⁰. Therefore, in total we differentiate between seven different types of order events. In this paper, order flow activity is measured as the product of average frequency and average size of orders in each category, normalized by the number of shares outstanding. Thus, we are effectively measuring turnover activity at various levels of order aggressivity¹¹. The turnover in each category is then calculated as a percentage of the turnover in all categories in order to determine the relative trading activity at different locations on the limit order book.

Several researchers have analyzed order flow in different markets and trading conditions. Corwin and Lipson (2000) focus on the net effect of order flow on the limit order book during and around NYSE trading halts. Biais, Hillion, and Spatt (1995) analyze the dynamic interactions between order flow and the limit order book during normal market conditions on the Paris Bourse. Goldstein and Kavajecz (2004) provide a detailed analysis of liquidity provision during the NYSE market wide circuit breaker. Previous literature suggests that the order submission strategies of traders are influenced by the state of the market. For example, increased volatility will cause limit order traders to demand higher compensation for the increased perceived risk of transacting with an informed trader. Under such conditions, the spread will widen and the cost of market order trading will rise. On the other hand, increased execution risk may persuade traders to trade immediately upon arrival using market orders. When the depth at the quotes or the spread is large, Biais et al. (1995) find that investors quickly place orders within the quotes to gain price and time priority.

¹⁰ Biais et al. (1995) analyze only the best five quotes on each side of the limit order book, which may explain the similarity they find in the frequencies of orders canceled at and orders canceled outside the quotes.

¹¹ Employing turnover to analyze order flow, rather than simply event frequency, enables us to control for trade size.

According to Demsetz (1968), Cohen et al. (1981), and others, limit orders tighten the spread under normal conditions. Biais et al. (1995) find that order flow is concentrated near the quotes, while the depth of the book tends to be larger at nearby valuations. They also find that thin books elicit orders and thick books result in trades. Goldstein and Kavajecz (2004) find that limit orders widen the spread during unusual times, and that the migration of liquidity from the book to the upstairs market is most keenly seen in high trading volume stocks.

Hypothesis 7: The relative position of liquidity in the limit order book will change when the short selling ban is imposed and lifted, and will be greatest for large stocks.

Finally, we analyze the composition of the order flow during the Financial Crisis. Foucault (1999) provides a game theoretic model of price formation and order placement decisions in a dynamic limit order market. Volatility is found to be a main determinant of the mix between market and limit orders. When asset volatility increases, the probability of being picked off and the ensuing losses are larger. Consequently, limit order traders ask for a larger compensation for the risk of being picked off in markets with high volatility. Therefore market order trading is more costly under such market conditions and more traders may find it optimal to trade using limit orders. As a result, limit order execution probabilities are lower since market order trading is less frequent. When execution risk is high, traders are under pressure to trade immediately upon arrival because the probability of being executed with a limit order is small. For this reason, traders may be willing to place market orders at more unfavorable prices. Additionally, small firms are predicted to have a larger proportion of limit orders.

Ranaldo (2004) confirms Foucault's predictions, empirically documenting that patient traders become more aggressive when their own (opposite) side book is thicker (thinner), the spread wider, and temporary volatility increases. In this article, we examine the mix of limit and market orders before, during, and after short selling restrictions. Since we expect volatility and execution risk to be higher during short selling restrictions, the composition of the order flow is expected to include a greater proportion of market orders compared to limit orders.

Hypothesis 8: The proportion of market orders in the order flow of banned stocks will be greater (less) while the short selling ban is imposed (lifted).

IV. Description of the Market and Test Methodology

A. Structure of the London Stock Exchange

The LSE is one of the world's largest and most international organized markets with more than 3,000 companies listed from over 60 countries. The market is structured essentially as an electronic communication network (ECN), with multiple dealers and an electronic order display book. On the LSE's limit order book alone, over 600,000 trades worth more than £4 billion (US\$ 6.5 billion) are traded each day¹².

There are a number of market models offered by the LSE. SETS (the Stock Exchange Electronic Trading System) is an electronic order-driven system used to trade the UK blue chip stocks included in the FTSE 100 and the most liquid FTSE 250 Index securities. The SETS order book matches buy and sell orders on a price/time priority. SETSmm is an electronic hybrid trading service, with both market maker and anonymous orders. SETSmm

¹² "Secondary Market Statistics Factsheet" (December 2009), from London Stock Exchange website, <http://www.londonstockexchange.com/statistics/trading/trading.htm> (retrieved 23 January 2010).

includes such stocks as FTSE Mid Cap index securities not traded on SETS, and FTSE Small Cap index securities.

The LSE provides an array of additional markets, most notably SETSqx (Stock Exchange Electronic Trading Service – quotes and crosses) for less liquid stocks, which is a non-electronically executable market maker quote model where participants enter orders for trading at four scheduled auctions each day. In all markets, minimum tick sizes are determined according to stock price and trading activity. All stocks belonging to this study trade in either the SETS or SETSmm market model.

The LSE has registered market makers, whose purpose is to enhance liquidity and facilitate orderly trading. Although all stocks are eligible to participate, the focus is on medium and low liquidity stocks. In these agreements, a member firm agrees to maintain two-sided quotes on the market's central order book of at least a minimum size. Furthermore, they are required to maintain a market presence throughout continuous trading and must be present at the time auctions end. As a hybrid market, the limit order book may contain both public orders and those of registered market makers. The LSE offers a high degree of transparency with public display of all levels of visible limit orders.

The LSE provides a trade reporting service that enables clients to meet post-trade reporting obligations as defined by MiFID. Transactions negotiated and agreed to between brokers in the upstairs market may be reported to the LSE to meet regulatory requirements for immediate real-time trade reporting (with a maximum delay of three minutes). Reported off-book trades are then published in real-time to the market. Trades in the upstairs market can occur either during or outside normal trading hours.

Stocks trading on SETS commence the trading day with an opening call auction from 7:50am to 8:00am with an additional random time component of up to 30 seconds. Call

auctions permit limit and market order entry and deletion without automatic execution for a period of five minutes plus an additional random time component of up to 30 seconds. Continuous trading follows the opening auction until 4:30pm. Stock close prices are determined by a five minute closing auction plus a random time component of up to 30 seconds.

During continuous trading, participants enter the size of the order and specify the maximum (minimum) bid (ask) price at which they are willing to have their order executed. When the limit price of an order is not specified, the order is effectively treated as a market order, executing immediately against the best available orders on the book. Participants may also enter “Fill-or-kill” type orders where execution is conditional on the availability of sufficient volume up (down) to the specified ask (bid) price to completely fill the order at the time the order was received. Participants may also enter “Fill-and-kill” order types where an order is automatically deleted once it has been filled to a specified volume. The LSE limit order book also includes “iceberg” orders where only a specified portion of the outstanding limit order is made visible to the market. This functionality aims to prevent traders being discouraged from placing large orders on the limit order book for fear of fully revealing their intentions.

Limit order books can be subject to rapid price movements. Large orders may execute at many price steps, especially when the execution price is not specified and the available depth is low. In line with UK regulatory requirements, the LSE implements automatically triggered Price Monitoring Extensions (PMEs) when indicative uncrossing prices during call auctions exceed pre-determined thresholds. PMEs allow an additional five minutes for market participants to agree on the uncrossing price and a maximum of two PMEs are possible.

In order to minimize extreme price fluctuations during continuous trading hours, the LSE trading engine assesses the price of each automatic execution as it is about to occur against a dynamic and static reference price. Dynamic reference prices are defined as the last order book trade price observed before the aggressive order was entered. Static reference prices are defined as the last uncrossing price, the first automated trade of the day, or the previous day’s closing price if no automatic execution price has taken place on that trading day. If the price of a potential execution is more than a pre-defined percentage above or below the security-specific reference price (e.g. 5 or 10%) then no executions at that price will occur and an Automatic Execution Suspension Period (AESP) will be triggered and further automatic execution will be temporarily suspended. Such trading halts permit order entry and deletion without automatic execution for a period of five minutes plus an additional random time component of up to 30 seconds. It is not current practice to initiate trading halts pending company news announcements. Thus, trading halts act to limit the severity and continuation of rapid price changes, rather than anticipate large market movements.

The LSE provides a consolidated regulatory news service where company-specific and market-wide information concerning listed stocks is released to the market. The FSA’s introduction of new disclosure rules required participants to report changes to net short positions greater than 0.25% of a stock’s market capitalization by 3pm the following day. These types of announcements were available through the LSE news dissemination service.

B. Data and Sample Periods

Transaction details of all orders and trades are from the LSE’s proprietary research database. The system provides full reconstruction of the limit order book as well as information such as whether trades are buyer or seller initiated, and executed on or off book. All variables used in the analysis are 99.5% winsorized (that is, values smaller than the 0.5%

quantile are set equal to that quantile, and values larger than the 99.5% quantile are set equal to that quantile). This procedure is implemented in order to minimize the chances of spurious observations or corrupted data affecting the results.

The sample period in this study runs from the 23rd of July 2008 to the 12th of March 2009 and consists of 160 whole trading days¹³. In order to contrast the sudden implementation of short selling restrictions with their anticipated lifting, the ban period is divided into two periods so that four sub-periods are created in total; 40 trading days prior to the short selling ban (23 July – 18 September 2008), the first 40 trading days during the ban (19 September – 13 November 2008), the next 40 trading days that end on the last day of the ban (14 November 2008 – 15 January 2009), and 40 trading days subsequent to the ban (16 January – 12 March 2009).

C. Sample stocks

Only UK financial sector stocks were affected by the FSA's short selling restrictions¹⁴. On the 18th of September 2008, the FSA named 28 listed companies that would be subject to the ban. On the 22nd of September an additional seven companies were added to the list and subject to restrictions effective the following day. Five companies on the restricted list delisted during the ban period and these stocks are excluded from the analysis¹⁵. Table 1

¹³ Trading data from the 8th of September 2008 are excluded from the analysis due to a temporary market closure arising from technical issues, which lasted the majority of the trading day. The 24th and 31st of December 2008 were half-trading days with the market closing at 12:30pm. Spreads were significantly wider on these two days compared to the rest of the sample period. These days are excluded in order to minimize confounding effects that are more likely due to seasonality than the short selling ban.

¹⁴ Firms listed on the London Stock Exchange, but registered outside of the UK, were not covered by the FSA's ban on short selling. However, many internationally incorporated banking and finance stocks were also banned from short selling by financial regulators in their home countries. Therefore, these stocks experienced similar short selling restrictions, which prevented them from being short sold on the London Stock Exchange.

¹⁵ Alliance & Leicester, Bradford & Bingley, HBOS, Highway Insurance Group, and London Scottish Bank delisted during the sample period.

reports summary statistics of the restricted securities that make up the sample of banned stocks.

[Insert Table 1 about here]

A control sample of stocks is constructed to account for market-wide changes that may have occurred during the period due to factors other than the short selling restrictions. Suitable non-banned control stocks are identified by matching on the stock price, volatility (natural log of daily high-low price change), number of trades, average trade size, and market capitalization value. Following Chakravarty et al. (2004), control stock characteristics are minimized according to the expression,

$$\sum_k [(c_j^k - c_i^k) / \{(c_j^k + c_i^k) / 2\}]^2 \quad (1),$$

where c_i^k (c_j^k) is the restricted (matched) stock measure for characteristic k . As well as minimizing the sum, no single factor in the above summation is allowed to exceed unity. For every banned stock¹⁶, one control stock is selected (with no replacement) from the universe of listed companies on the LSE that constitute the closest matches. Control stocks are selected based on the closest match before and after the ban¹⁷ using data from June 2008 and April 2009. The 26 banned stocks and their accompanying comparison stocks are each further divided into two groups ("large" and "small") based on high and low market capitalization.

Table 2 reports characteristics of the banned and matched control stock groups across the five characteristics used to match the stocks. As expected, the average values of each measure are approximately equal between banned and control stocks. The average market

¹⁶ Three banned stocks (Arbuthnot Banking Group, European Islamic Investment Bank, and Islamic Bank of Britain) were excluded from the analysis due to very low liquidity.

¹⁷ Control groups were also formed by matching before and after the ban, respectively, with little qualitative difference in results.

capitalization of the large group is more than 20 times that of the group consisting of smaller stocks. The average number of daily transactions and average trade size is also higher in the large group suggesting that separate analysis of large and small stocks is warranted.

[Insert Table 2 about here]

V. Results

A. *Trading activity and choice of venue*

We examine investor activity before, during and after the short selling ban. Table 3 reports the average number of daily trades and turnover during four sample periods. Under short selling constraints, trading on the limit order book in banned stocks is lower than in control stocks. During the first half of the ban period (Ban 1), the number of trades in financial stocks fell by 11.6 percent, while trading in other stocks actually increased by 40.8 percent. Trading activity in both groups fell again during the Ban Period 2 with banned stocks decreasing more than control groups. Trading interest in banking and finance stocks jumped 62.1 percent in the Post Ban period while comparison stocks fell slightly. Similar patterns of trading activity are observed in measurements of turnover.

The on-book turnover in larger stocks is higher in banking and finance stocks is higher than control stocks before and after the ban. In smaller stocks, turnover is less in non-banking stocks relative to control stocks during all periods, however trading activity is further reduced during the ban. Both large and small stocks experience more frequent trading on the limit order book in banking and finance stocks outside of the ban.

It could be argued that the observed reduction in trading activity during the short selling ban may be largely explained by the UK government's announcement of an emergency bailout plan for the British banking system, rather than the short selling restrictions

themselves. If this hypothesis were correct, one may reasonably expect to also witness less trading activity following the banking turmoil in January 2009 and the second bailout announcement. Instead, there is an increase in trading activity so that both before and after short selling restrictions, banking and finance stocks are more actively traded than other stocks. This finding suggests that the presence of short selling restrictions prevented some market participants from transacting. Alternatively, the government's second intervention inspired greater confidence than the first. Based on these findings, it seems reasonable to accept Hypothesis 1; that banned stocks experienced less (more) net trading activity while the short selling ban is imposed (lifted).

[Insert Table 3 about here]

Next, off-book trading activity is examined to determine the importance of the upstairs market as a source of liquidity. Table 3 shows that prior to the ban, trading activity in the upstairs market (as measured by turnover) was approximately 20 percent higher compared to control stocks. By this measure, similar to the decline in on-book trading activity, participation in the upstairs market in banned stocks is reduced during the ban relative to control stocks. However, the reduction in off-book trading activity was less severe than on-book trading. Therefore, some liquidity shifted from the limit order book to the upstairs market.

Comparisons between sample periods reveal that trading in the upstairs market increased in all stocks at the commencement of the ban. Trading activity in both markets fell during the Ban 2 period for both banned and non-banned stocks. Following the ban, off-book turnover in large banking and finance stocks rose 68.6 percent relative to the Ban 2 period and 87.8 percent relative to control stocks.. Figure 2 shows the average number of daily off-book

trades during the four sample periods. It is clear that there are two periods where off-book trading activity is more prevalent. The spikes in upstairs market activity align with acute periods of market distress; the first which involved the collapse of Fannie Mae and Freddie Mac, Lehman Brothers, HBOS, the introduction of short selling restrictions and subsequent British government emergency bailout; and the second which followed the crash of the UK banking sector and second British government emergency bailout. Thus, influxes of trading activity in the upstairs market appear to be associated with significant macro-economic events which may provoke differences in opinion and uncertainty.

[Insert Figure 2 about here]

The effects concerning off-book trading activity in large stocks are also witnessed in small stocks. However, unlike larger stocks, trading activity in smaller securities during the Post Ban period does not return to Pre Ban levels and may provide evidence of a “Flight to Quality” with investors moving capital from smaller stocks to larger stocks. The British government’s bailout may also have had greater implications for larger stocks. These results are also in line with Goldstein and Kavajecz (2004) who find that during periods of heightened uncertainty, the migration of liquidity from the limit order book to the upstairs market is most keenly seen in high trading volume stocks.

The results concerning off-book trading activity suggest that the execution costs offered by brokers for large trades were lower compared to the cost of trading on the limit order book during periods of acute uncertainty. These findings are consistent with those predicted by Grossman (1992), and verified by others such as Bessembinder and Venkataraman (2004) and Goldstein and Kavajecz (2004). The observed increases in frequency of off-book trades suggest that investors prefer discretionary trading during times of increased financial

uncertainty. This article provides further evidence that severe market uncertainty may augment the attractiveness of off-book trading. Furthermore, the upstairs market may be an important source of liquidity during periods of market turmoil, a finding that is of interest in debates regarding consolidation and fragmentation.

The strong impact of macro-economic events on activity in the upstairs market makes it difficult to determine the influence of short selling restrictions on off-book trading. Therefore, we are unable to accept Hypothesis 2, sighting severe uncertainty and execution risk during the sample period as dominant factors driving trading activity in the upstairs market, rather than direct effects of the short selling ban.

B. Prices and volatility

Table 4 reports abnormal returns and several measures of volatility. Prices in large banned stocks show significant declines relative to the overall market during the Ban 1 and Post Ban periods. These are likely due to the barrage of negative news announcements specific to the banking and finance sector at these times. We accept Hypothesis 3 for large stocks; that the presence of extraordinary economic conditions resulted in highly abnormal conditions. That abnormal returns during the Ban 1 and Post Ban periods are so much greater than those observed during the Pre Ban and Ban 2 periods is suggestive of a relatively insignificant affect on prices due to short selling restrictions (and suspected speculative short selling behavior).

For smaller stocks the effects of the ban on prices are less clear. Period changes are not statistically significant different from each other. Another observation is that larger stocks suffered much greater price falls than smaller banking and finance securities, perhaps due to their greater exposure to the global financial crisis. Furthermore, prices in matched control stocks fell more than the banned stocks during the sample period.

Both intraday and daily measures of volatility in large banned stocks are elevated during the Ban 1 and Post Ban periods, as shown in Figure 3. However, the acute volatility during these periods may be more likely associated with the uncertainty caused by the extreme economic events which occurred at key dates within each of the periods. For example, sharp increases in volatility commence one week before the implementation of the short selling ban, corresponding with the collapse of US mortgage giants and Lehman Brothers. Both large and small stocks exhibit dramatic changes in the days surrounding the start of the short selling ban, which occurred shortly after the events in the US. Therefore, it is difficult to discern the immediate impact of the FSA's intervention.

Volatility peaks on the day of the British government's announcement of a banking bailout plan, three weeks after the introduction of the short selling ban. Volatility again increases following the announcement of a second bailout of banking and finance companies and around the same time as the lifting of the short selling ban. The increased volatility around such dates, which occur both during and outside of short selling restrictions, makes it very difficult to draw conclusions regarding the impact of the ban itself.

[Insert Figure 3 about here]

Volatility in small banned stocks is higher during short selling restrictions *and* less following the lifting of the ban. However, this may be further evidence of the predominance of the bailout plan having less impact on investors and volatility in control stocks falls similarly. Therefore, we do not accept Hypothesis 4 that banned stocks are more (less) volatile while the short selling ban is imposed (lifted).

Increased volatility may help to explain the observed acute increases in off-book trading activity. Likewise, more off-book trades may have led to greater volatility on the limit order

book. Greenwald and Stein (1991) argue that traders are reluctant to enter a market when they are unsure of the price at which their market orders will be executed. When prices become volatile, shocks to liquidity and fundamentals may occur between the time investors decide to trade and the time their orders are executed. The transaction risk associated with increased volatility may be partially insured via the increased discretion and flexibility of trading offered in the upstairs market. Therefore, the temporary periods of increased volatility may explain the observed increases in off-book trading as amplified execution risk on the limit order book drove many participants to the relative safety of the upstairs market.

Table 4 also reports a surge in the number of rapid price movements as evidenced by the significant increase in the number of automatic trading halts, most notably during the Ban 1 and Post Ban periods. The sharp increase in the frequency of emergency circuit breakers suggests that the limit order book was less capable of meeting the liquidity demands of traders. Moreover, the increase in trading halts provides evidence of the strain placed upon the market mechanism to process and update the views of all participants effectively. The deterioration in quality of the limit order book may also explain the increased trading activity in the upstairs market. Consistent with results reported above, market changes are more pronounced in larger stocks, which may be due to the high exposure to the global economic crisis of the UK's largest banks compared to smaller banks.

C. Spreads and depth

Table 5 reports quoted and effective spread measures for both banned stocks and control stocks. Both spread measures are substantially higher in all stocks during the short selling ban as well as during the Post Ban period. Cross-sectional comparisons show that spreads in banned stocks increased more than in control stocks. Quoted spreads in large banned stocks increased by 145 percent from the Pre Ban period to the Ban 1 period compared to a 50

percent increase in control stocks. Quoted spreads increased slightly from the Ban 1 period to the Ban 2 period. Quoted spreads are tighter during the period following short selling restrictions, despite the high uncertainty surrounding the banking crash which occurred shortly after. The difference in quoted spreads between the Ban and Control group in large stocks increased from -3.3 percent before the ban to 57.7 percent in Ban period 1. Relative changes between banned stocks and non-banned stocks are less in small stocks with the difference in quoted spreads between the Ban and Control group increasing from 27.6 percent before the ban to 68.8 percent in the Ban 1 period.

[Insert Table 5 about here]

The dramatic evolution of spreads throughout the period of market turbulence is presented in Figure 4. Spreads appear to follow a different pattern to that traced by off-book trading activity and volatility. Unlike volatility, spreads only increase following the start of the ban. Quoted spreads in banned stocks are consistently higher during the enforcement of short selling restrictions. The most significant differences appear to take place during the first stage of the ban. After the ban is lifted, the quoted spreads of the ban and control groups decrease and converge. These findings suggest that the banning of short sales may have resulted in increased information asymmetry, leading liquidity suppliers to demand greater compensation for their services in the form of wider quotes. Therefore, we accept Hypothesis 5; that quoted spreads in banned stocks are wider (tighter) while the short selling ban is imposed (lifted).

[Insert Figure 4 about here]

The most striking result of Table 5 is the substantial decline in depth. While short selling restrictions are in place, the amount of shares available on the limit order book during the Ban 1 and Ban 2 periods in both large and small stocks is decreased significantly. Between the Pre Ban and Ban 1 periods, large stocks experience a 92 percent decline in depth close to the best quotes compared to a 48 percent decline in control stocks. Between the Ban 2 and Post Ban periods, depth within 0.1 percent of best quotes increases by 313 percent while depth in comparison stocks actually declines by 17 percent. Panel A of Figure 5 depicts the change in depth on a daily basis. In large stocks, the number of shares available within three percent of the best quotes on the limit order book begins to decline about one week before the commencement of short selling restrictions. The fall in liquidity is mostly keenly felt in large banking and finance stocks. An abrupt increase in depth in large stocks is evident on the first day of the Post Ban period. These findings add weight to speculation that short selling restrictions had a negative impact on liquidity.

[Insert Figure 5 about here]

Table 5 also reveals that more depth disappears at prices within 0.1 percent of best prevailing bid and ask quotes compared to depth within one percent of best quotes. Thus, the slope of the order book changed during the sample period. Additional panels of Figure 5 provide 3-D visualization of these phenomena.

Panels B through E of Figure 5 show that limit order book depth decreases significantly and abruptly at around day 40 of the sample period in both banned and control stocks. This date coincides with the beginning of the ban period and the rapid reduction in depth is most severe and persistent in large banned stocks. At approximately half way through the sample period there is an increase in depth in large comparison stocks and a temporary spike in large

banned stocks. In large stocks banned from short selling, posted volume increases abruptly at around day 120, which corresponds with the lifting of short selling restrictions. The amount of available depth in smaller banned stocks follows a similar pattern to larger stocks, though the changes are less in magnitude. These findings are consistent with participants' being less willing to post liquidity due to the exclusion of short sellers from the market. The analysis of depth on the limit order book provides strong evidence to support Hypothesis 6; that depth in banned stocks is less (greater) while the short selling ban is imposed (lifted).

Figure 5 also reveals that the slope of the order book is initially much steeper in large stocks. Naes and Skjeltorp (2006) find a significant negative relationship between the order book slope and variation in analysts' earnings forecasts; implying that the greater the disagreement among analysts, the more gentle the average slope of the order book. Their result suggests that the order book slope acts as a proxy for dispersed beliefs about asset values. That the steepness of the slope of the order book in large stocks is so dramatically reduced during the short selling ban suggests greater disagreement between participants regarding the true price of banking and finance stocks.

The symmetry of the buy and sell sides of the limit order book graphs is also worth noting. Despite the existence of asymmetric trading constraints imposed by short selling restrictions, depth on both sides of the limit order book is remarkably similar in both quantity and position. This finding is consistent with the hypothesis that information conveyed by order imbalances is quickly transformed into spread and depth adjustments by competing limit order traders. The behavior of such traders is analyzed further through examination of their order flow during the short selling ban.

D. Order flow

The impact of uncertainty and short selling constraints on order flow is now examined. Interestingly, separate analysis of buy-side and sell-side transactions does not reveal any significant differences between measures such as the number of buyer and seller initiated trades, the average order size, or the placement of liquidity. This may be further evidence that limit order traders effectively adjust their quotes to reach new equilibrium prices and avoid accumulation of significant positions on one side of the market.

Table 6 reports the proportion of order flow activity in seven different categories. During short selling restrictions, the proportion of off-book trades relative to all other transactions increased significantly in banned stocks. This change is consistent with an increase in traders' preferences for settlement in the upstairs market during moments of particularly high market volatility. In smaller stocks, the percentage of trades executed in the upstairs market was also higher during the ban period. This finding is consistent with the hypothesis that the observed wider spreads and reduced depth led to higher transaction costs, which may have caused participants to direct transactions to the upstairs market.

[Insert Table 6 about here]

Although the average number of on-book trades decreased in banned stocks during the ban as reported earlier, such trades as a proportion of order flow actually increased. This is due to a decrease in the use of market orders and as revealed by the order to trade ratio measure. The order to trade ratio (calculated as the sum of all trading events divided by the sum of all order activity (entered and canceled) of banned stocks was significantly lower during the ban relative to control stocks, suggesting that participants placed fewer orders on the order book while short selling restrictions were imposed. During the ban period, approximately 10 percent of the order flow pertaining to large stocks resulted in trades, while

the figure is about 5.6 percent for control stocks. For all large stocks, just over 7 percent of the order flow involves trades when short selling restrictions are not in place. Consistent with the prediction of Foucault (1999), smaller stocks have a larger proportion of limit orders compared to market orders (i.e. their order to trade ratio is higher) than large stocks.

The cumulative effect of fewer limit orders in the order flow may also explain the observed declines in depth on the limit order book. Consistent with Lee et al. (1993), Kavajecz (1999) and Rinaldo (2004), during expected moments of trading uncertainty, limit order traders reduce the market depth and widen the bid-ask spread. This result is seemingly at odds with the finding of Biais et al. (1995) who find the conditional probability that investors place limit orders (rather than hitting the quotes) is larger when the bid-ask spread is large or the order book is thin. It may be that there are additional determinants which influence traders' decisions regarding the use of market or limit orders. Alternatively, the unusual market conditions created by the combination of high volatility and short selling restrictions may have resulted in atypical trader behavior.

Orders within the quotes also increased during the ban for both large and small stocks, consistent with a trend of increased trader aggressivity. It appears that during the restrictions, order flow that would have previously been placed at the best quote (or elsewhere in the limit order schedule) during the Pre and Post ban periods was instead kept out of the market until the decision was made to improve the best quote. The undercutting behavior observed in the order flow reflects the tradeoff between execution probability and price. When the depth at the quotes is already large, new orders at that price are less likely to be executed, so it is optimal to beat the best quote, to obtain a larger probability of execution, at the cost of a less favorable execution price. However, as reported earlier in this article, there was actually less depth available at the best quotes relative to the rest of the book. Therefore, despite relatively

smaller volumes at the best quotes, during short selling restrictions traders still found it optimal to beat the best quote to obtain a larger probability of execution, at the cost of a less favorable execution price.

Table 6 also shows that banned stocks experienced more activity at the best quotes relative to control stocks, especially smaller stocks. At the same time, the number of orders canceled at the best quote also increased during the ban. The increased attention at the best quotes comes at the expense of orders placed and canceled away from the best quotes.

To summarise, in large stocks during the ban, traders were more aggressive with a greater proportion of the order flow consisting of market orders and limit orders improving upon the best prevailing quote (or limit orders replacing orders that had just been consumed by market orders). This behavior implies more active order management and suggests that liquidity providers are sensitive to changes in information asymmetry risk as found by Lee, Mucklow, and Ready (1993). The findings are consistent with Rinaldo (2004) who finds an increase in aggressiveness when the spread is wider. Parlour (1998) also specifies that depth affects the probability of execution of a limit order. Parlour finds that market orders are used when the risk of not executing is high because of a thin book, and limit orders when this risk is low. The results of Table 6, combined with the observed reductions in depth, afford general acceptance of Hypothesis 7; that the placement of liquidity will change when the short selling ban is imposed and lifted, and will be greatest for large stocks. The nature of the change is an increase in liquidity where the probability of execution is highest.

The proportion of limit orders in the order flow of large banned stocks is lower when the short selling ban is in force compared to control stocks. In small stocks, the order flow comprises fewer limit orders in both banned and control stocks during the ban. Cohen et al. (1981) show that as more and more investors shift to limit orders, the probability of the

spread increasing falls, while the probability of it decreasing rises. The decreasing order to trade ratio indicates that participants were using more market orders and fewer limit orders during the ban. This finding is consistent with the predictions of Cohen et al (1981) of such behavior leading to wider spreads. It appears that the presence of short selling restrictions had a stronger influence than volatility on the composition of the order flow. We accept Hypothesis 8 as it is found that the proportion of limit orders in the order flow of banned stocks is less while the short selling ban is imposed.

VI. Conclusion

This article examines the impact of short selling constraints on liquidity and order submission strategies on the London Stock Exchange. The considerable market impact of significant economic and news events plays an important role in the set of observed market changes. However, during the 2008-09 UK emergency temporary short selling ban, bid-ask spreads widened significantly while the number of trades and turnover on the limit order book decreased. Thus, short selling restrictions appear to have discouraged some participants from trading. The exclusion of certain traders and information from the market may have increased the risk of trading with informed participants, causing limit order traders to demand higher compensation for liquidity provision in the form of wider spreads.

Significant reductions in limit order book depth were also observed in banned stocks while short selling restrictions were enforced. During the ban, less volume was placed at the best quotes compared to the rest of the book suggesting greater disagreement among participants. Overall, traders showed greater reluctance to provide liquidity during the ban. Analysis of the composition of the order flow reveals that traders of banned stocks became less patient with more of the order flow consisting of market orders and orders within the

quotes. When market participants did choose to provide liquidity, orders were more likely to be placed within the quotes to increase the probability of execution and reduce adverse selection risks.

Sharp increases in volatility and trading in the upstairs market were also observed during the sample period. These effects are closely aligned with the release of significant macro-economic events.. Periods of increased volatility may have caused liquidity to shift from the limit order book to the upstairs market as traders sought to lower their execution risk and price impact.

It should be emphasized that these results cannot completely resolve the question of whether emergency measures such as temporary short selling restrictions are desirable. The fact that the Financial Services Authority (in the case of short selling restrictions) and the British government (in the case of the bailouts) were seen to be taking action may have in itself restored some market confidence. The central problem is that it cannot be known what would have occurred in the absence of regulatory and government intervention.

However, the results do provide a more complete understanding of trading activity during extreme trading conditions and the associated effects on liquidity. By comparing market conditions and trader behavior to control stocks and across multiple periods we are able to provide more evidence on the effectiveness of the short selling ban. We also provide increased understanding of the complex interaction between the order book and order flow. The findings of this study have implications for the viability of limit order books during turbulent periods as well as regulation aimed at maintaining orderly markets during crisis periods. This research highlights the important role of upstairs trading in electronic markets, and that regulatory intervention may have unforeseen consequences on market quality.

References

- Ahn, H., Bae, K., Chan, K., 2001, Limit orders, depth, and volatility: evidence from the Stock Exchange of Hong Kong, *Journal of Finance*, Vol. 56, No. 2, 769-790.
- Aitken, M. J., Frino, A., McCorry, M. S., Swan, P. L., 1998, Short Sales Are Almost Instantaneously Bad News: Evidence from the Australian Stock Exchange, *Journal of Finance*, Vol. 53, No. 6, 2205-2223.
- Biais, B., Hillion, P., Spatt, C., 1995, An Empirical Analysis of the Limit Order Book and the Order Flow in the Paris Bourse, *Journal of Finance*, Vol. 50, No. 5, 1655-1689.
- Bessembinder, H., Venkataraman, K., 2004, Does an electronic stock exchange need an upstairs market?, *Journal of Financial Economics*, Vol. 73, 3-36.
- Bris, A., Goetzmann, W. N., Zhu, N., 2007, Efficiency and the Bear: Short Sales and Markets Around the World, *Journal of Finance*, Vol. 62, No. 3, 1029-1079.
- Chakravarty, S., Wood, R.A., Van Ness, R.A., 2004, Decimals and liquidity: A study of the NYSE, *The Journal of Financial Research*, Vol. 27, 75-94.
- Chordia, T., Roll, R., Subrahmanyam, A., Liquidity and Market Efficiency, (March 26, 2007), Available at SSRN: <http://ssrn.com/abstract=794264>.
- Chordia, T., Roll, R., Subrahmanyam, A., 2001, Market Liquidity and Trading Activity, *Journal of Finance*, Vol. 56, No. 2, 501-530.
- Chang, E. C., Cheng, J. W. Cheng, Y. Yu, 2007, Short-Sales Constraints and Price Discovery: Evidence from the Hong Kong Market, *Journal of Finance*, Vol. 62, No. 5, 2097-2121.

- Christie, W. G., Corwin, S. A., Harris, J. H., 2002, Nasdaq Trading Halts: The Impact of Market Mechanisms on Prices, Trading Activity, and Execution Costs, *Journal of Finance*, Vol. 57, No. 3, 1443-1478.
- Cohen, K. J., Maier, S. F., Schwartz, R. A., Whitcomb, D. K., 1981, Transaction Costs, Order Placement Strategy, and Existence of the Bid-Ask Spread, *Journal of Political Economy*, Vol. 89, No. 2, 287-305.
- Copeland, T., Galai, D., 1983, Information Effects on the Bid-Ask Spread, *Journal of Finance*, Vol. 38, No. 5, 1453-1469.
- Corwin, S. A., Lipson, M. L., 2000, Order Flow and Liquidity around NYSE Trading Halts, *Journal of Finance*, Vol. 55, No. 4, 1771-1801.
- Diamond, D. W., Verrecchia, R. E., 1987, Constraints on Short-Selling and Asset Price Adjustment to Private Information, *Journal of Financial Economics*, Vol. 18, 277-311.
- Demsetz, H., 1968, The cost of transacting, *Quarterly Journal of Economics*, Vol. 82, No. 1, 33-53.
- Foucault, T., 1999, Order flow composition and trading costs in a dynamic limit order market, *Journal of Financial Markets*, Vol. 2, No. 2, 99-134.
- Glosten, L., 1994, Is the Electronic Open Limit Order Book Inevitable?, *Journal of Finance*, Vol. 49, No. 4, 1127-1161.
- Goldstein, M. A., Kavajecz, K. A., 2004, Trading strategies during circuit breakers and extreme market conditions, *Journal of Financial Markets*, Vol. 7, 301-333.
- Greenwald, B. C., Stein, J. C., 1991, Transactional risk, market crashes, and the role of circuit breakers, *Journal of Business*, Vol. 64, 443-462.
- Grossman, S. J., 1992, The Informational Role of Upstairs and Downstairs Trading, *The Journal of Business*, Vol. 65, No. 4, 509-528.

Gruenewald, S., N., Wagner, A. F., Weber, R., Short Selling Regulation after the Financial Crisis – First Principles Revisited (December 15, 2009). Swiss Finance Institute Research Paper No. 09-28. Available at SSRN: <http://ssrn.com/abstract=1439652>.

Handa, P., Schwartz, R. A., 1996, Limit Order Trading, *Journal of Finance*, Vol. 51, No. 5, 1835-1861.

Hansson, F., Rudowfors, E., 2009, Get Shorty? - Market Impact of the 2008-09 UK Short Selling Ban, Working Papers in Economics No 365, University of Gothenburg.

Lee, C. M. C., Mark J. Ready, and Paul J. Seguin, 1994, Volume, volatility, and New York Stock Exchange trading halts, *Journal of Finance*, Vol. 49, No. 1, 183-214.

Michayluk, D., Fernandez, L., 2009, Are short sellers really informed?, Working paper, University of Technology Sydney.

Miller, E. M., 1977, Risk, Uncertainty, and Divergence of Opinion, *Journal of Finance*, Vol. 32, No. 4, 1151-1168.

Kavajecz, K., 1999, A specialist's quoted depth and the limit order book, *Journal of Finance*, Vol 54, 741-771.

Naes R., Skjeltorp, J. A., 2006, Order book characteristics and the volume-volatility relation: Empirical evidence from a limit order market, *Journal of Financial Markets*, Vol. 9, No. 2, 408-432.

Parlour, C. 1998, Price dynamics in limit order markets, *Review of Financial Studies*, Vol. 11, No. 4, 789-816.

Ranaldo, A., 2004, Order aggressiveness in limit order book markets, *Journal of Financial Markets*, Vol. 7, 53-74.

Woolridge, J. R., Dickinson, A., 1994, Short Selling and Common Stock Prices, *Financial Analysts Journal*, Vol. 50, No. 1, 20-28.

Table 1 Banned Stocks

The table reports characteristics of banned stocks included in the analysis. Data are from June 2008, the month immediately preceding the Pre-ban period.

Symbol	Company	VWAP (£)	Volatility (%)	On market trades	Average trade size	Market Capitalization (£m)
ADN	Aberdeen Asset Management	1.37	2.67	1,222	3,802	1,004
ADM	Admiral Group	8.61	3.20	1,239	689	2,410
ATST	Alliance Trust	3.34	1.92	307	1,701	1,942
AV.	Aviva	6.18	2.87	3,831	2,197	8,383
BARC	Barclays	3.54	5.35	13,845	5,018	23,563
BRE	Brit Insurance Holdings	2.11	2.69	903	1,606	577
CSN	Chesnara	1.58	3.50	55	1,165	139
CBG	Close Brothers Group	5.67	2.55	1,095	699	905
FCAM	F&C Asset Management	0.06	1.95	7	107,828	96
FP.	Friends Provident Group	1.58	2.22	261	1,830	468
HSBA	HSBC Holdings	1.20	2.24	2,028	5,385	1,712
INVP	Investec	8.51	1.78	9,542	3,884	84,761
JR.	Just Retirement Holdings	0.11	1.10	6	14,966	45
LGEN	Legal & General Group	3.28	4.16	1,964	1,452	1,395
LLOY	Lloyds TSB Group	1.63	5.78	84	740	273
NVA	Novae Group	1.17	2.40	3,572	6,043	3,955
OML	Old Mutual	3.76	4.58	9,745	4,316	18,136
PFG	Provident Financial	3.48	1.34	23	704	250
PRU	Prudential	1.15	3.23	2,758	5,319	3,958
RAT	Rathbone Brothers	7.56	3.45	1,397	623	1,089
RBS	Royal Bank of Scotland Group	6.52	2.53	3,680	2,044	10,620
RSA	RSA Insurance Group	9.77	2.45	202	183	361
SDR	Schroders	2.42	7.11	18,429	12,331	28,155
STJ	St James's Place	2.53	4.18	3,094	2,507	4,277
STAN	Standard Chartered	10.23	2.50	2,037	579	1,934
SL.	Standard Life	1.37	2.94	2,909	4,988	4,267

Table 2 Ban and Control Groups

The table reports the average values of criteria used to match large and small, banned and control stocks before and after the sample period using data from the months of June 2008 and April 2009. Variables used are daily volume-weighted average price, volatility as measured by log of daily high/low prices, number of on market trades, average trade size and market capitalization. Daily firm averages are calculated first, followed then by month and then grouping. Standard deviations of observations are reported in parentheses.

Stock size	Group	VWAP (£)		Volatility (%)		On market trades		Average trade size		Market Capitalization (£m)	
Large	Banned	3.36	(3.36)	5.50	(1.74)	6,660	(4,930)	4,930	(3,970)	18,100	(24,400)
	Control	3.98	(4.28)	3.56	(0.81)	5,620	(3,740)	4,130	(3,170)	22,700	(33,200)
Small	Banned	4.26	(3.25)	4.28	(0.75)	868	(714)	1,120	(839)	894	(629)
	Control	4.34	(3.38)	4.17	(0.72)	817	(626)	1,100	(635)	822	(546)

Table 3 Trading Activity

The table reports the average number and turnover of on and off-book trades each day for banned and control samples during four sample periods. Firm daily averages are calculated first then averages are calculated across firms each day and then each period. There are 26 banned stocks in the sample; divided into two groups of high (Panel A) and low (Panel B) market capitalization stocks. Twenty-six comparable matching stocks are assigned to similar high and low market capitalization groups. “Pre ban” and “Post ban” represent the 40 trading days prior to and after the ban period, respectively. “Ban 1” and “Ban 2” denote the first and second halves (40 trading days each) of the ban period, respectively. Paired signed-rank statistics are used to measure significance of changes between periods and groups, respectively. Values in bold face type denote significance at the 5% level or higher.

		Mean values				Change between periods (%)		
		Pre ban	Ban 1	Ban 2	Post ban	Pre ban - Ban 1	Ban 1 - Ban 2	Ban 2 - Post ban
Panel A: Large Stocks								
Ban group	On book trades	7,646.4	6,761.5	4,283.0	6,944.0	-11.6	-36.7	62.1
	Off book trades	165.0	181.7	87.9	212.7	10.1	-51.6	142.0
	On book turnover	0.61	0.49	0.29	0.61	-19.2	-40.6	111.2
	Off book turnover	0.14	0.16	0.10	0.18	17.2	-34.2	68.6
Control group	On book trades	5,905.5	8,314.4	6,174.8	6,044.7	40.8	-25.7	-2.1
	Off book trades	103.2	111.7	73.1	83.6	8.2	-34.5	14.3
	On book turnover	0.52	0.66	0.42	0.39	28.0	-36.1	-7.9
	Off book turnover	0.11	0.15	0.10	0.09	35.4	-31.7	-9.7
Difference between groups (%)	On book trades	29.5	-18.7	-30.6	14.9			
	Off book trades	59.9	62.7	20.3	154.6			
	On book turnover	17.5	-25.8	-31.0	58.2			
	Off book turnover	20.5	4.3	0.5	87.8			
Panel B: Small Stocks								
Ban group	On book trades	938.8	595.2	453.3	714.1	-36.6	-23.9	57.6
	Off book trades	10.6	11.0	8.1	9.0	3.8	-26.8	11.2
	On book turnover	0.35	0.24	0.14	0.19	-32.7	-42.6	43.2
	Off book turnover	0.08	0.15	0.09	0.11	78.9	-40.1	25.3
Control group	On book trades	874.5	840.4	681.9	677.5	-3.9	-18.9	-0.6
	Off book trades	11.9	13.0	11.7	10.9	9.5	-10.0	-6.8
	On book turnover	0.42	0.44	0.31	0.29	6.1	-29.7	-5.4
	Off book turnover	0.12	0.13	0.13	0.12	10.4	0.5	-9.8
Difference between groups (%)	On book trades	7.3	-29.2	-33.5	5.4			
	Off book trades	-10.8	-15.4	-31.2	-17.9			
	On book turnover	-15.3	-46.3	-56.1	-33.5			
	Off book turnover	-30.1	13.3	-32.4	-6.1			

Table 4 Prices and Volatility

The table reports abnormal returns, intraday volatility (calculated as first standard deviation of squared five-minute returns), daily high/low volatility, and frequency of intraday trading halts for banned and control samples during four sample periods. Firm daily averages are calculated first then averages are calculated across firms each day and then each period. There are 26 banned stocks in the sample; divided into two groups of high (Panel A) and low (Panel B) market capitalization stocks. Twenty-six comparable matching stocks are assigned to similar high and low market capitalization groups. “Pre ban” and “Post ban” represent the 40 trading days prior to and after the ban period, respectively. “Ban 1” and “Ban 2” denote the first and second halves (40 trading days each) of the ban period, respectively. Paired signed-rank statistics are used to measure significance of changes between periods and groups, respectively. Values in bold face type denote significance at the 5% level or higher.

		Mean values				Change between periods (%)		
		Pre ban	Ban 1	Ban 2	Post ban	Pre ban - Ban 1	Ban 1 - Ban 2	Ban 2 - Post ban
Panel A: Large Stocks								
Ban group	Abnormal returns	0.11	-1.50	-0.30	-1.03	-1,516.6	-80.0	241.5
	Intraday volatility	0.60	3.91	1.65	7.39	552.8	-58.0	349.0
	Daily volatility	4.95	11.26	8.03	10.43	127.6	-28.8	30.0
	Trading halts	0.09	0.66	0.24	0.57	631.9	-63.4	137.3
Control group	Abnormal returns	0.19	-0.14	0.25	0.08	-175.5	-275.3	-67.2
	Intraday volatility	0.34	1.23	0.88	0.39	258.7	-28.4	-56.1
	Daily volatility	3.73	7.14	5.34	4.24	91.5	-25.3	-20.5
	Trading halts	0.03	0.17	0.09	0.07	500.0	-50.0	-20.0
Difference between groups (%)	Abnormal returns	-43.4	962.5	-221.4	-1,364.0			
	Intraday volatility	75.5	219.4	87.4	1,814.8			
	Daily volatility	32.7	57.7	50.4	145.8			
	Trading halts	213.3	282.2	180.0	730.6			
Panel B: Small Stocks								
Ban group	Abnormal returns	0.27	0.17	0.44	0.19	-35.1	152.2	-57.0
	Intraday volatility	0.51	1.90	1.23	0.80	270.0	-35.3	-35.1
	Daily volatility	4.33	8.59	6.37	5.52	98.3	-25.9	-13.3
	Trading halts	0.04	0.39	0.18	0.06	773.9	-52.2	-66.7
Control group	Abnormal returns	-0.08	-0.51	0.23	0.19	527.6	-144.9	-17.4
	Intraday volatility	0.53	1.90	1.16	0.66	255.4	-38.7	-43.2
	Daily volatility	4.28	7.28	6.40	5.13	70.0	-12.1	-19.8
	Trading halts	0.03	0.18	0.12	0.04	607.7	-30.4	-68.8
Difference between groups (%)	Abnormal returns	-432.4	-134.4	93.1	0.5			
	Intraday volatility	-3.7	0.2	5.7	20.8			
	Daily volatility	1.2	18.1	-0.5	7.5			
	Trading halts	76.9	118.5	50.0	60.0			

Table 5 Spreads and Depth

The table reports average daily values of time-weighted relative quoted spreads, volume-weighted actual spreads, time-weighted volume available at the best quoted bid and ask prices, and time-weighted depth within 1% of best quoted prices for banned and control samples during four sample periods. Firm daily averages are calculated first then averages are calculated across firms each day and then each period. There are 26 banned stocks in the sample; divided into two groups of high (Panel A) and low (Panel B) market capitalization stocks. Twenty-six comparable matching stocks are assigned to similar high and low market capitalization groups. “Pre ban” and “Post ban” represent the 40 trading days prior to and after the ban period, respectively. “Ban 1” and “Ban 2” denote the first and second halves (40 trading days each) of the ban period, respectively. Paired signed-rank statistics are used to measure significance of changes between periods and groups, respectively. Values in bold face type denote significance at the 5% level or higher.

		Mean values				Change between periods (%)		
		Pre ban	Ban 1	Ban 2	Post ban	Pre ban - Ban 1	Ban 1 - Ban 2	Ban 2 - Post ban
Panel A: Large Stocks								
Ban group	Quoted spread	12.83	31.44	32.00	27.82	145.1	1.8	-13.1
	Effective spread	12.28	33.45	25.67	28.40	172.5	-23.3	10.6
	Depth 0.1%	666,161	52,081	37,618	155,523	-92.2	-27.8	313.4
	Depth 1.0%	1,959,750	298,330	236,103	610,098	-84.8	-20.9	158.4
Control group	Quoted spread	13.27	19.93	21.39	18.62	50.2	7.3	-13.0
	Effective spread	12.13	19.32	18.93	15.83	59.3	-2.1	-16.4
	Depth 0.1%	674,785	348,361	595,271	494,021	-48.4	70.9	-17.0
	Depth 1.0%	2,074,192	1,323,686	1,856,342	1,664,667	-36.2	40.2	-10.3
Difference between groups (%)	Quoted spread	-3.3	57.7	49.6	49.4			
	Effective spread	1.2	73.1	35.6	79.4			
	Depth 0.1%	-1.3	-85.1	-93.7	-68.5			
	Depth 1.0%	-5.5	-77.5	-87.3	-63.4			
Panel B: Small Stocks								
Ban group	Quoted spread	68.11	138.37	143.46	116.72	103.2	3.7	-18.6
	Effective spread	56.02	110.91	107.80	82.82	98.0	-2.8	-23.2
	Depth 0.1%	44,716	25,083	29,323	41,400	-43.9	16.9	41.2
	Depth 1.0%	179,549	80,400	71,167	96,891	-55.2	-11.5	36.2
Control group	Quoted spread	53.40	81.99	104.41	90.18	53.5	27.4	-13.6
	Effective spread	40.04	61.62	72.28	61.40	53.9	17.3	-15.1
	Depth 0.1%	34,557	18,799	22,079	23,527	-45.6	17.4	6.6
	Depth 1.0%	147,627	116,922	112,556	105,189	-20.8	-3.7	-6.6
Difference between groups (%)	Quoted spread	27.6	68.8	37.4	29.4			
	Effective spread	39.9	80.0	49.1	34.9			
	Depth 0.1%	29.4	33.4	32.8	76.0			
	Depth 1.0%	21.6	-31.2	-36.8	-7.9			

Table 6 Order Flow

The table reports the relative turnover of order placement in seven different categories and the ratio of the number of orders to trades in large and small groups of ban and control stocks during four sample periods. The frequency of each of these categories is calculated as follows: for each stock, the number of times each category of events occurs is computed. For each stock, the average order size in each category is also calculated and divided by the number of shares outstanding. Total turnover in each category is calculated as the product of the frequency of trades multiplied by the trade size. These totals are averaged for each sample group and percentages are obtained by dividing by the sum of all event averages. The order to trade ratio is calculated as the sum of all order activity not executing immediately and canceled order activity divided by the sum of all trading activity. Firm daily averages are calculated first then averages are calculated across firms each day and then each period. There are 26 banned stocks in the sample; divided into two groups of high (Panel A) and low (Panel B) market capitalization stocks. Twenty-six comparable matching stocks are assigned to similar high and low market capitalization groups. “Pre ban” and “Post ban” represent the 40 trading days prior to and after the ban period, respectively. “Ban 1” and “Ban 2” denote the first and second halves (40 trading days each) of the ban period, respectively. Paired signed-rank statistics are used to measure significance of changes between periods and groups, respectively. Values in bold face type denote significance at the 5% level or better.

		Mean values				Change between periods (%)		
		Pre ban	Ban 1	Ban 2	Post ban	Pre ban - Ban 1	Ban 1 - Ban 2	Ban 2 - Post ban
Panel A: Large Stocks								
Ban group	Trades on book	5.6	8.0	7.0	5.8	41.0	-12.4	-16.2
	Trades off book	1.4	2.7	2.6	1.8	97.4	-3.3	-30.4
	Orders within	2.4	6.1	4.9	4.0	150.7	-18.6	-20.0
	Orders at	13.8	12.8	10.8	11.2	-7.6	-15.5	3.6
	Orders out	32.7	28.5	31.9	33.3	-12.6	11.8	4.3
	Cancels at	9.2	9.6	7.6	7.6	3.8	-20.6	-0.5
	Cancels out	34.9	32.4	35.2	36.4	-7.1	8.6	3.4
	Order/Trade ratio	19.9	17.4	21.1	22.9	-12.6	21.5	8.7
Control group	Trades on book	6.8	5.4	3.8	4.6	-21.1	-29.9	23.3
	Trades off book	1.5	1.2	1.0	1.2	-21.7	-17.4	21.9
	Orders within	3.7	3.5	2.4	2.7	-4.1	-32.2	12.6
	Orders at	13.8	11.9	9.3	11.8	-13.9	-21.4	26.9
	Orders out	31.3	33.3	37.4	34.4	6.5	12.2	-8.0
	Cancels at	9.0	8.1	6.1	7.9	-9.9	-24.0	28.7
	Cancels out	34.0	36.7	40.0	37.4	7.9	9.3	-6.7
	Order/Trade ratio	15.7	24.1	37.4	26.9	53.2	55.5	-28.2
Change between groups (%)	Trades on book	-17.0	48.4	85.5	26.1			
	Trades off book	-11.6	123.0	161.0	49.1			
	Orders within	-34.4	71.5	105.9	46.3			
	Orders at	0.1	7.4	15.6	-5.7			
	Orders out	4.4	-14.3	-14.6	-3.2			
	Cancels at	3.1	18.9	24.3	-3.9			
	Cancels out	2.8	-11.5	-12.1	-2.6			
	Order/Trade ratio	26.3	-28.0	-43.7	-14.8			

Table 6 (continued) Order Flow

		Mean values				Change between periods (%)		
		Pre ban	Ban 1	Ban 2	Post ban	Pre ban - Ban 1	Ban 1 - Ban 2	Ban 2 - Post ban
Panel B: Small stocks								
Ban group	Trades on book	2.7	3.4	3.4	2.5	22.9	0.1	-26.0
	Trades off book	1.9	3.6	3.3	2.4	84.5	-7.8	-27.1
	Orders within	5.7	4.5	4.9	5.4	-21.7	8.9	9.8
	Orders at	6.2	5.4	4.8	4.9	-12.3	-11.0	1.6
	Orders out	37.4	38.5	39.0	38.6	3.0	1.4	-1.1
	Cancels at	6.7	4.6	4.2	4.7	-31.8	-9.5	12.7
	Cancels out	39.3	40.1	40.4	41.6	1.9	0.9	2.8
	Order/Trade ratio	60.3	75.8	81.1	69.0	25.8	7.0	-14.9
Control group	Trades on book	3.1	2.1	1.8	2.1	-32.4	-12.7	15.6
	Trades off book	2.9	2.2	3.0	2.5	-25.1	40.6	-17.4
	Orders within	5.4	4.3	3.5	5.3	-20.0	-18.0	48.9
	Orders at	6.7	4.0	3.2	4.4	-40.8	-20.3	37.7
	Orders out	36.5	40.7	41.8	39.3	11.4	2.9	-6.0
	Cancels at	6.1	3.6	2.8	4.5	-40.8	-21.1	58.1
	Cancels out	39.3	43.2	43.8	41.9	9.9	1.2	-4.1
	Order/Trade ratio	67.3	84.4	111.5	92.8	25.3	32.1	-16.8
Difference between groups (%)	Trades on book	-10.6	62.6	86.6	19.5			
	Trades off book	-32.8	65.6	8.6	-4.2			
	Orders within	6.0	3.8	38.0	1.7			
	Orders at	-7.9	36.4	52.3	12.4			
	Orders out	2.3	-5.4	-6.8	-1.9			
	Cancels at	10.9	27.7	46.5	4.4			
	Cancels out	-0.1	-7.3	-7.6	-0.9			
	Order/Trade ratio	-10.5	-10.1	-27.3	-25.6			

Figure 1 Timeline of Stock Prices Major News Announcements

This figure plots major news announcements and volume-weighted average prices of large and small groups of banned and control stocks during four sample periods. Firm daily averages are calculated first and then across firms each day. There are 26 banned stocks in the sample; divided into two groups of high (Panel A) and low (Panel B) market capitalization stocks. Twenty-six comparable matching stocks are assigned to similar high and low market capitalization groups. “Pre ban” and “Post ban” represent the 40 trading days prior to and after the ban period, respectively. “Ban 1” and “Ban 2” denote the first and second halves (40 trading days each) of the ban period, respectively.

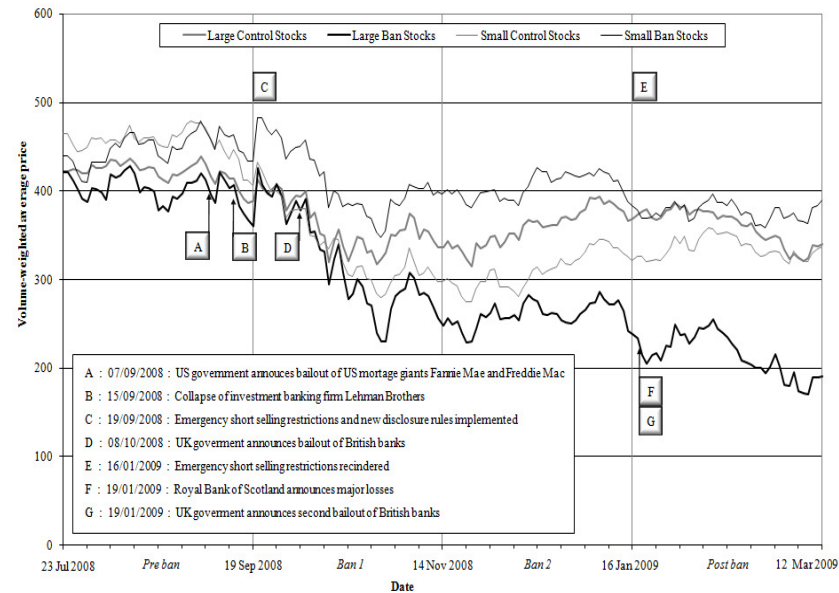


Figure 2 Trading Activity in the Upstairs Market

This figure plots the average number of trades in the upstairs market in large and small groups of ban and control stocks during four sample periods. Firm daily averages are calculated first and then across firms each day. There are 26 banned stocks in the sample; divided into two groups of high (Panel A) and low (Panel B) market capitalization stocks. Twenty-six comparable matching stocks are assigned to similar high and low market capitalization groups. “Pre ban” and “Post ban” represent the 40 trading days prior to and after the ban period, respectively. “Ban 1” and “Ban 2” denote the first and second halves (40 trading days each) of the ban period, respectively.

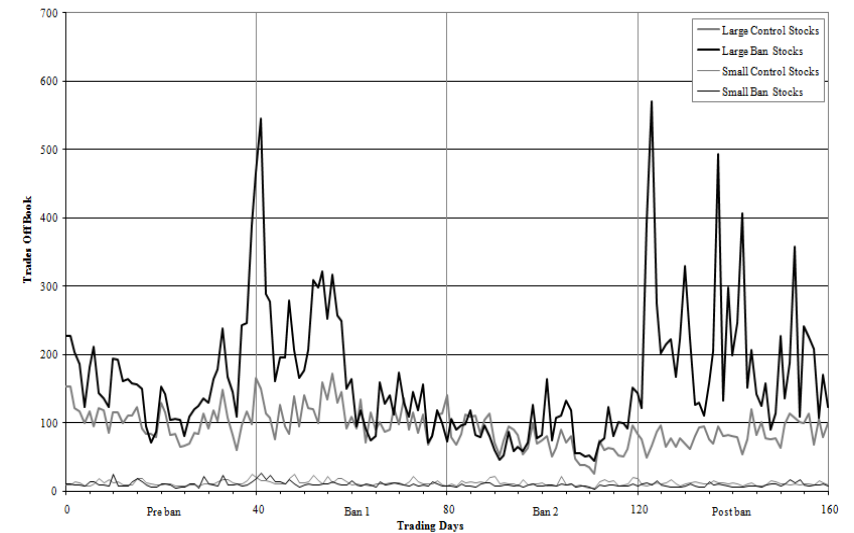


Figure 3 Daily Volatility

This figure plots the average daily stock price volatility in large and small groups of ban and control stocks during four sample periods. Firm daily averages are calculated first and then across firms each day. There are 26 banned stocks in the sample; divided into two groups of high (Panel A) and low (Panel B) market capitalization stocks. Twenty-six comparable matching stocks are assigned to similar high and low market capitalization groups. “Pre ban” and “Post ban” represent the 40 trading days prior to and after the ban period, respectively. “Ban 1” and “Ban 2” denote the first and second halves (40 trading days each) of the ban period, respectively.

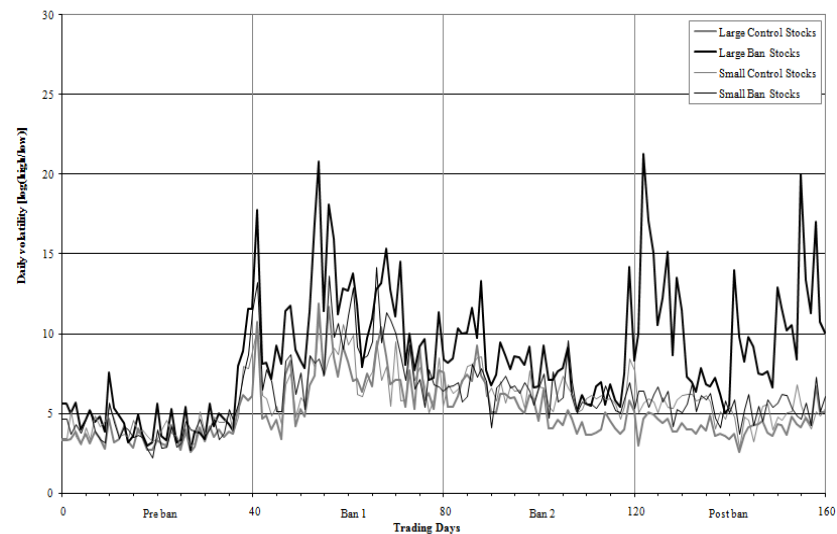


Figure 4 Quoted Spreads

This figure plots average time-weighted quoted spreads of large and small groups of ban and control stocks during four sample periods. Firm daily averages are calculated first and then across firms each day. There are 26 banned stocks in the sample; divided into two groups of high (Panel A) and low (Panel B) market capitalization stocks. Twenty-six comparable matching stocks are assigned to similar high and low market capitalization groups. “Pre ban” and “Post ban” represent the 40 trading days prior to and after the ban period, respectively. “Ban 1” and “Ban 2” denote the first and second halves (40 trading days each) of the ban period, respectively.

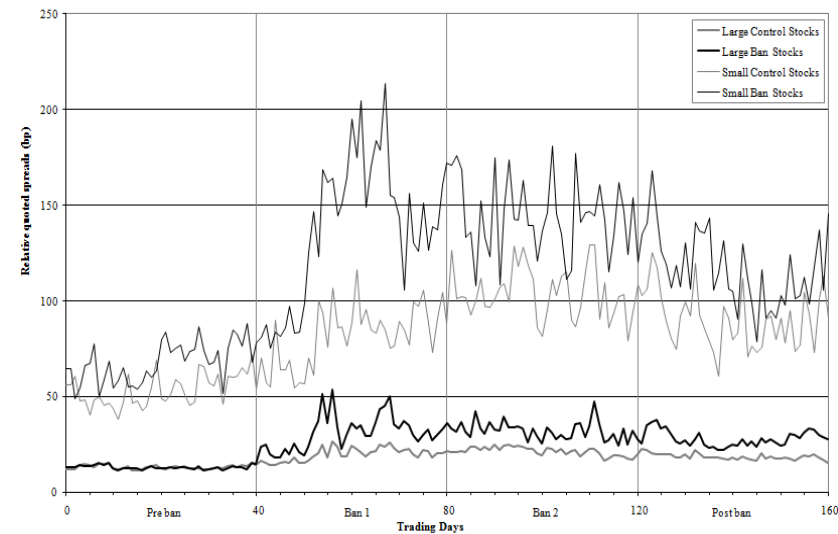


Figure 5 Depth of the limit order book

These figures plot aggregate cumulative limit order book depth. Visible and non-visible order volumes are aggregated into price steps above and below the midpoint for large and small groups of ban and control stocks throughout the four sample periods. Firm daily averages are calculated first and then across firms each day. Panel A depicts average depth up to three percent from the best quotes. Panels B through E depicts the average quantity of shares available at the indicated distances from the normalized midpoint price. Each series contains data for 13 stocks; representing banned and control, and high and low market capitalization stocks, respectively. Short selling restrictions are in place from day 41 to 120.

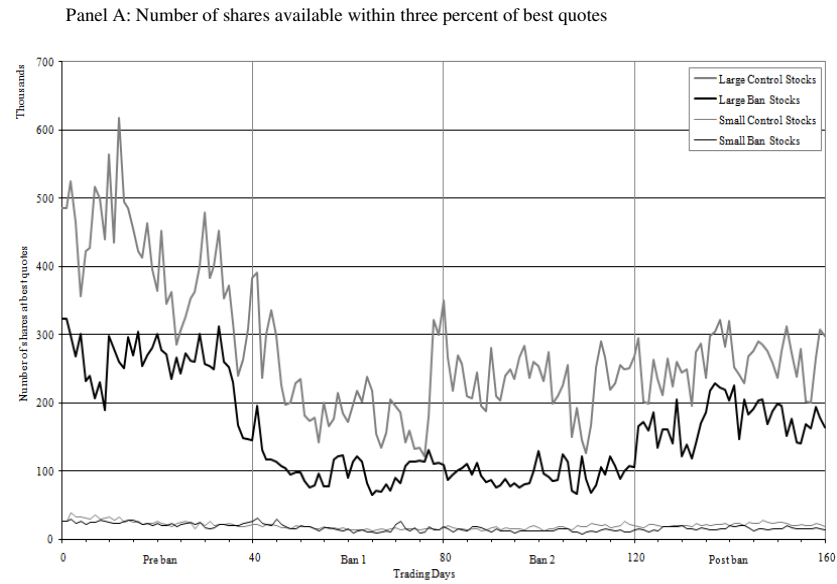
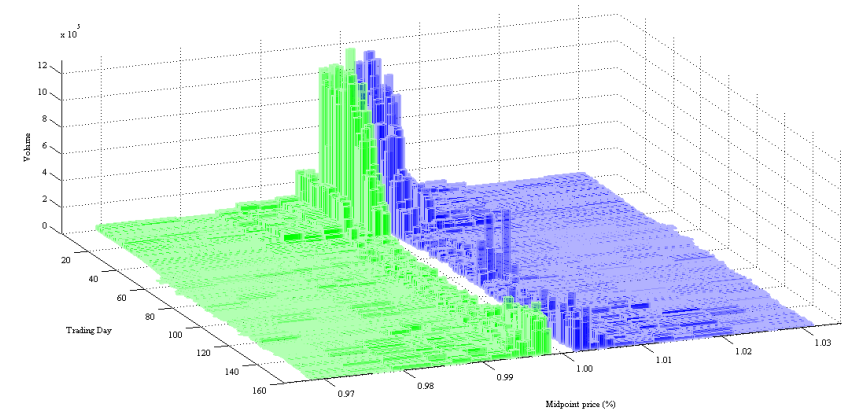


Figure 5 (continued) Depth of the limit order book

Panel B: Depth of large banned stocks



Panel C: Depth of large control stocks

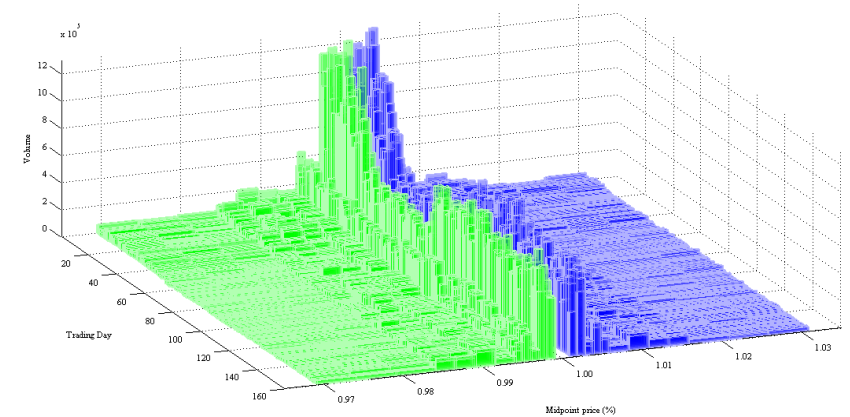
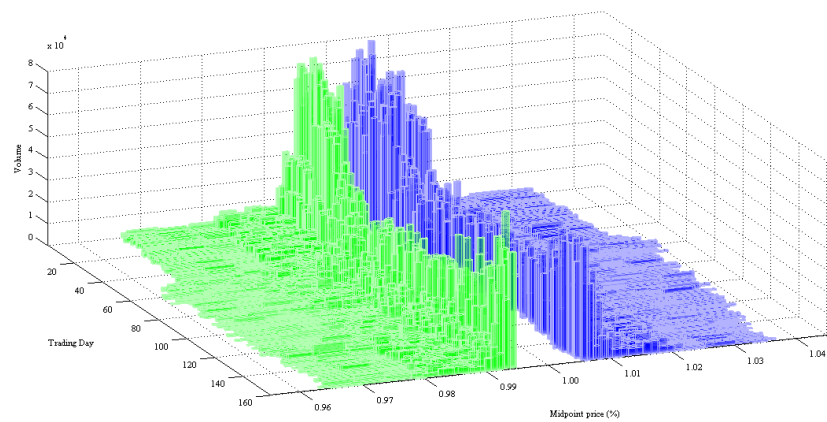


Figure 5 (continued) Depth of the limit order book

Panel D: Depth of small banned stocks



Panel E: Depth of small control stocks

