Large Stock Price Declines and Market Overreaction Using Intraday Data on the TSE

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ABSTRACT

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This paper examines the market overreaction hypothesis around large declines in the daily prices of individual stocks using 30-minute intraday data on the Toronto Stock Exchange (TSE). Five common stocks that experienced the largest percentage price drops for the 31 days centered on each of 100 randomly chosen trading days are studied The results show significant average abnormal returns and cumulative average abnormal returns for the prior and subsequent day to the event day and the event day itself. No significant changes occur in trading volumes, trading values and trading frequencies Relative bid-ask spreads increase significantly for the event day, and for the post-event period relative to the pre-event period. Trades tend to be seller-initiated during the sample period, and trade direction become more seller-initiated for the post-event period. Buy/sell imbalance occurs significantly on the event day.

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LARGE STOCK PRICE DECLINES AND MARKET OVERREACTION USING INTRADAY DATA ON THE TSE

1. INTRODUCTION

Various empirical studies on market overreaction test the Efficient Market Hypothesis (EMH). The EMH implies that price changes and returns follow a random walk in response to information. According to the overreaction hypothesis, large positive (negative) returns generated by (un)favourable news are followed by partially or fully offsetting returns.

One strand of the market overreaction literature focuses on the relationship between large stock price changes and market overreaction. Atkins and Dyl [1990] examine the daily returns of the three stocks listed on the NYSE that exhibited the largest daily percentage loss (increase) in value for each of 300 randomly chosen trading days. They find that the stock market overreacts to bad news, and weakly overreacts to good news. They show indirectly that the bid-ask spread accounts for the abnormal returns observed. Other research on large daily stock price movements and the overreaction hypothesis includes Arbel and Jaggi [1982], Bremer and Sweeney [1991], and Kryzanowski and Zhang [1992].

The availability of trade-by-trade and quote data has encouraged the study of intraday market reactions to information events. Lee [1992] examines the intraday

volume reaction around various types of earnings announcement dates. He divides each trading day into 13 half-hour intervals and classifies each trade as either buyer- or seller-initiated, and as either small or large. While little evidence exists of information 'leakage' prior to announcement, significant positive abnormal volumes exist subsequent to announcement. Both large and small trades experience some imbalance in buying/selling activities after news announcements

The primary objective of this thesis is to test for market overreaction around large declines in the daily prices of individual stocks on the Toronto Stock Exchange (TSE). Specifically, the five common stocks that experienced the largest percentage price drops for each of 100 randomly chosen trading days are studied herein. Using 30 minute trading intervals, the returns, return variances, volumes, trading values, trading frequencies, bid-ask spreads, trade directions and trade depths are examined for the 31 days centered on the event date. Both parametric and non-parametric tests are used to test changes in each of these measures of trade and quote activities.

The remainder of this thesis is organized as follows. In section 2, the relevant literature is reviewed. Section 3 describes the data sample. Testable hypotheses and the empirical procedure are given in sections 4 and 5, respectively. Section 6 discusses the empirical results. Summary and conclusions are given in section 7.

2. SELECTIVE REVIEW OF THE LITERATURE

Research conducted primarily on shares listed on the New York Stock Exchange in the 1960s finds that stock prices follow a "random walk", where successive price changes are independent of each other (i.e., serially uncorrelated). A market is efficient when market participants act in their own self-interest and use available information to obtain more desirable portfolios. By acting in this manner, investors collectively ensure that the responses of prices to new information are instantaneous and unbiased, and "fully reflect" all available and relevant information. Competition drives security prices from one equilibrium level to another so that the current price responses to new information are independent of prior prices changes. In such a market, no trading strategy can consistently make abnormal profits.

A basic issue associated with the EMH is whether the market reflects all information. Direct tests examine whether the price changes or returns generated in response to the release of specific pieces of information conform to EMH expectations, and indirect tests examine any statistical dependencies that exist in security price series. Indirect tests of the EMH examine short- and long-run serial correlations of price changes and "seasonality" of returns. The former measures whether price changes from transaction to transaction in one direction tend to be followed by price changes in the same or opposite directions. Direct tests measure

the performance of particular trading strategies, and the market's response to information signals that are expected to cause a change in the supply and demand for a security.

Neiderhoffer and Osborne [1966] find that the probability of a severe price change in a given direction depends on the prior price change for five actively traded stocks. Stock prices tend to reverse themselves more than can be explained by chance over very short intervals, such as from trade to trade. Neiderhoffer and Osborne also find some more complex dependencies, such as the probability of a price fall depending on whether the prior two changes are *rise-rise* or *fall-rise*.

Fama, Fisher, Jensen and Roll [1969], Dann [1981], Stickel [1985], Rendleman, Jones and Latane [1982], among others, find that the market reacts quickly to new information. Kryzanowski [1979] tests the efficiency implications of trading suspensions, where the direction of price movement is determined by the market's judgement on the favourableness of the information disseminated. Kryzanowski finds that the market appears to be efficient in the semi-strong form for public disclosures of favourable information, and inefficient for unfavourable information after trading suspensions are lifted.

2.1 Market Overreaction

Interest in market overreaction dates back to 1929, when Pigou [1929] notes that businessmen "act as conducting rods along which an error of optimism or pessimism, once generated, propagates itself about the business world."[1] Similarly, Ackley [1983] noted that price movements may develop a cumulative momentum in one direction, which can easily overshoot the ... long run equilibrium price."[2] More current academic research on market overreaction is rooted in the EMH.

Arbel and Jaggi [1982] examine whether a stock that displays an extreme price movement on a particular day also has an irregular price pattern around that day. Using the daily price leaders from the Wall Street Journal for 36 arbitrarily chosen days in 1977, they examine price relativeand residual return behaviour for the eleven days before and ten days after each event date. They find that new information is completely impounded on the event days, and that the average price movements is 15 percent. A standard ANOVA (Analysis of Variance) test is used to examine if the distribution of each stock's returns on the event date is different from its distribution for the pre-event dates. They find that the return distribution is significantly different only on the event day, which suggests that the market is fairly efficient.

1 A C Pigou, *Industrial Fluctuations*, Second edition (London McMillan,1929)

2 G Ackley, "Commodities and Capital Prices and Quantities," American Economic Review, March 1993

Howe [1986] examines the evidence for short- and long-term company-specific overreaction to favourable and unfavourable events using weekly data, where each event is a large price change. Howe notes that, if the overreaction hypothesis holds, then large positive returns generated by favourable news should be followed by below-normal returns. He finds evidence that is strongly consistent with the overreaction hypothesis.

DeBondt and Thaler [1985, 1987] test for stock market overreaction by forming portfolios of "losers" and "winners", where "losers" are stocks that have previously exhibited large abnormal negative returns and "winners" are stocks that have previously exhibited large abnormal positive returns. They find that losers subsequently outperform winners, which is consistent with weak form market inefficiency. The results of DeBondt and Thaler are criticized by Zarowin [1990] and others because they do not appropriately adjust for risk, seasonality or the size effect.

Atkins and Dyl [1990] examine the behaviour of common stock prices after a large daily price change. They randomly select three hundred trading days from the period, January 1975 to December 1984, for all stocks listed on the New York Stock Exchange (NYSE). For each of the three hundred trading days, three stocks exhibiting the largest percentage loss in value and three stocks exhibiting the largest percentage increase in value are selected. Using CRSP returns for 181

days centered on the event date, they calculate the cumulative abnormal returns based on three different measures of daily abnormal returns (mean-adjusted returns, market-adjusted and risk-adjusted) using both the value- and equal-weighted indexes

Their portfolios of losers exhibit significant and positive abnormal returns subsequent to the event date, which suggests that the initial price reaction was excessive. Positive abnormal returns are also identified prior to the day of the large price drop. In contrast, portfolios of winners exhibit small negative abnormal returns for about seven trading days following the day of the price increase. Since the bid-ask spread represents the minimum cost of transaction and the price reversal might simply be a shift from transactions at bid prices to those at ask prices, Atkins and Dyl examine the relationship between short-run stock price reversals and bid-ask spreads. Using ordinary least squares (OLS) regressions, they regress the abnormal returns for each loser and each winner for the day subsequent to the event date against their respective (out-of-sample) bid-ask spreads. While the coefficients for bid-ask spreads are significant, the R squares values are extremely small. This implies that the abnormal returns are not caused solely by the bid-ask spreads.

Zarowin [1990] reexamines the DeBondt and Thaler evidence on stock market overreaction by controlling for size differences between winners and losers. Size

is defined as the market value of the firm's equity at the end of the three-year ranking period. He finds that the mean size of losers is smaller than that for winners. Based on the Jensen performance results for five groups of losers and winners that are matched by size, Zarowin finds little evidence of a return difference between losers and winners, where size is controlled for. This evidence is contrary to the previous findings that losers outperform winners in the subsequent period. The previous findings appear to be attributable to the well-known size effect that favors losers due to their smaller size.

Kryzanowski and Zhang [1992] test the overreaction hypothesis for both nonpenny stocks and penny stocks for large percentage price changes and large net price changes. The sample consists of 500 event days randomly selected from the stocks listed on the Toronto Stock Exchange (TSE) over the period from January 1980 through December 1989 The five biggest losers and five biggest gainers are selected for each day for each of the two price change measures Abnormal returns are measured using the mean-adjusted return model and the traditional market model. They find strong evidence of market overreaction for the samples of % price losers for both nonpenny and penny stocks. While similar results are obtained for the net price change losers for penny stock weak evidence is found for the net price change losers for nonpenny stocks Kryzanowski and Zhang find that these positive abnormal returns become negative for (non)penny stocks if realistic market order strategies are assumed.

2.2 Intraday Data Analysis

A growing number of studies examine intraday market behaviour, such as trade direction, volatility and bid-ask spreads. Miller [1989] examines the overnight and intra-day price behaviour on the NYSE using transaction-by-transaction data. He tests for differences in trading patterns between the remainder of the day and the first 30 to 60 minutes, and the remainder of the day and the period just before the close.

Sweeney [1991] examines minute-by-minute returns from the Chicago Mercantile Exchange over a five month (101 day) period from August 10, 1987 to December 31, 1987 to show that the S&P 500 index cash and futures markets are strongly related causally. The Sims and ARIMA filters are employed to reduce the raw returns to white noise, and to eliminate any autocorrelation in the regression residuals.

Lee and Ready [1991] discuss alternative methods to classify a trade as a buy or sell order. An imbalance in buy-sell orders is used to measure the market's response to an information event. The two approaches used to infer the direction of a trade are to compare the trade price to the preceding trade price, and to compare the trade price to the bid/ask midpoint of the prevailing quote. They use a technique commonly known as the "tick test", which compares the trade price

to adjacent trades while considering the bid/ask quotes. A trade is classified as a buy if it is an uptick or a zero-uptick. Otherwise it is deemed a sell. They find 92 1 percent of the trades at the ask are classified as buys and 90 2 percent of trades at the bid are classified as sells. For trades inside the bid/ask spread, they separate trades based on the midpoint, and find that the tick test is correct at least 85 percent of the time.

Since prior studies of earnings news and trading volumes deal with a nondirectional volume metric (i.e., independent of trade direction), Lee [1992] investigates the intraday behaviour of directional volume surrounding dates on which earning news are released. The intraday behaviour of directional volume is measured by classifying each trade as either buyer- or seller-initiated For example, a buy/sell imbalance before the release of "good" or "bad" earnings news can imply information leakage before the announcement date. Lee also examines the differential effects of earnings news on small trades (low dollar value) and large trades (high dollar value). The transaction and quote data were obtained from the Institute for the Study of Security Markets (ISSM) for the NYSE. The data are for 253 trading days selected from the 12-month period from January 4, 1988 to December 30, 1988, during which the exchanges were open daily for 6 5 hours (9:30 a.m. to 4:00 p.m.). After screening the total sample of 1463 NYSE-listed firms for various deletion criteria such as trading halts, year-end price, outstanding shares and number of trades, the sample is reduced to 230 firms. The date and

time of earnings announcements are obtained from the Dow Jones News Service (DJNS) for each firm. Trades transacted for $10,000 or less are deemed small trades.

For each half-hour interval, Lee examines basic statistics for the frequency distributions of volume, mean abnormal volume, and cumulative mean abnormal volume for different trade sizes within the [-1,+2] event window. He finds little evidence of information 'leakage' in the pre-announcement period. During the half hour of the announcement, both small and large trades experience significant increases in volume which continue for a few days. However, the reaction of small trades is weaker and slower than that for large trades given that the abnormal volume of small trades represents a smaller proportion of total trading for that size class. To test the effect on order imbalance, Lee avoids the serial correlation problem associated with the occurrence of buys and sells by using a single direction measure, where bid size is compared to ask size on a frequency basis He finds that large trades experience an intense buying (selling) imbalance after announcements of good (bad) news and small trades experience a persistent period of remarkable buying activity for releases of both good and bad news.

3. SAMPLE AND DATA

Major business newspapers publish lists of winners and losers on various

stock exchanges in North America. The Wall Street Journal publishes 20 "Price percentage gainers and losers" for the NYSE and NASDAQ. The Globe and Mail publishes 10 "Top net gainers and losers" and "Biggest % gainers and losers" for common "stocks trading at least 1000 shares at $1 or more". The Financial Post publishes lists of 10 stocks under the headings of "Top % gainers", "Top net gainers", "Biggest % losers" and "Biggest net losers" after "warrants, rights, units and shares trading at less than 500 shares and below $1" are excluded.

To select the samples, 100 trading days (event dates) are chosen randomly from October 1, 1985 to October 31, 1990. Only common stocks with a per share price of $5 or above are studied, and all rights, warrants, units and preferred shares are excluded. For each event date, the five stocks (biggest losers) that experienced the worst returns are chosen using the TSE/Western tape. Some statistics on the event-day returns for the initial sample of 500 stocks are presented in Table 1. For each stock, all the trade-by-trade and quote data for the 31 days centered on its event date are used herein.

Due to absence of data for the 31-day period for some stocks, firms are retained if they have at least one trade on each of days 14, 15 and 16 (the event day), and at least one quote on each of days 1, 2, ..., 13. Stocks are only retained if they have a complete trading record prior to and on the event date. Some statistics for the deleted stocks based on this double-screen are presented in

Table 2. After screening, 297 firms remain in the sample.

Tables 3 and 4 provide the missing daily trades and quotes distributions, respectively, of the 297 events. In Table 3, the number of days with no trades post-event are given on the horizontal axis, and the number of days with no trades pre-event are given on the vertical axis. The number of firms with m days of no trades post-event and n days of no trades pre-event are given in this table. Table 4 is similar except that quotes instead of trades are used. In both tables, most firms are in the upper left-hand corners of the tables, which implies that the missing data problem is not widespread.

During the period from October 1985 to October 1990, the Toronto Stock Exchange opened at 9:30 a.m. and closed at 4:00 p.m.. Thus, observed returns for each company are calculated for each of the 13 half-hour intervals for each trading day. The information available for the stocks consists of company name, the date and time of trade or quote, the transaction price, number of shares traded, bid/ask price, and bid/ask size. If a stock does not trade in a 30-minute interval, then the last transacted price is used as this period's price. To test the robustness of the results, two subsamples of stocks with no more than 50% and 30% non-trading periods are also studied. These subsamples contain 138 and 70 companies, respectively.

4. HYPOTHESES

Intraday market reactions are investigated by examining the behaviour of abnormal returns, volatility, liquidity and trade direction around the event days for the sample, the two subsamples, and board lot traders.[3] The null hypotheses tested herein are as follows:

$H_0(1)$: No abnormal returns occur during the period surrounding the event date;

$H_0(2)$: No change in variance occurs from pre- to post-event period;

$H_0(3)$: No change in the relative bid-ask spread occurs from pre- to post-event period;

$H_0(4)$: No change in trading volume occurs from pre- to post-event period;

$H_0(5)$: No change in trading values occurs from pre- to post-event period;

$H_0(6)$: No change in trading frequencies occurs from pre- to post- event period;

$H_0(7)$: No change in trade direction (i.e., from buyer to seller initiated, or vice versa) based on the bid-ask spread occurs from pre- to post-event period; end

$H_0(8)$: No change in trade depth (measured by bid and ask sizes) occurs from pre- to post-event period.

3 On the TSE, a board lot is 100 shares for a stock whose price is $1 or more
Odd lots are trades of less than 100 shares for stocks whose price is $1 or more

5. METHODOLOGY

5.1 Abnormal returns

Mean-adjusted abnormal returns (ARs) are obtained using the following return-generating model:

$$R_{it} = \alpha_i + \sum_{i=1}^{n} \tau_{it} D_{it} + \varepsilon_{it}$$

where R_{it} is the return on firm i at time t;

α_i is the mean returns of firm i over the entire time period (i.e., for the 31 days centerred on the event date, i.e., for 30 minute intervals [201, 201]);

D_{it} is a dummy variable that is equal to one at time t in the event window and equal to zero otherwise;

τ_{it} is the parameter which measures the abnormal returns at time t in the event window for firm i; and

ε_{it} is the disturbance term for firm i at time t, and is normal distributed $(0, h_t)$.

The event window consists of the five days or 65 half-hour intervals [-32, 32] centered on the event day [0].

To test the significance of the ARs for various half-hour intervals within the

event window, the following parametric t-statistic is used:

$$t = SAR_{it} / s(SAR_{it})$$

where SAR_{it} is the standardized AR_{it}, and $s(SAR_{it})$ is the standard deviation of SAR_{it}. Each of these is given by:

$$SAR_{it} = AR_{it} / s(AR_{it}), \text{ and}$$

$$s(SAR_{it}) = [1/N(N-1) \sum_{i=1}^{n} (SAR_{it} - \Sigma\, SAR_{it}/N)^2]^{1/2}$$

where N is the number of stocks in the sample. Residual variance for the pre-window (pre-σ^2), post-window (post-σ^2) and pre- and post-window (pre-&post-σ^2) periods are used herein.

To evaluate the ARs over a multi-interval period T, cumulative average abnormal returns (CAARs) are computed for the following five multi-half-hour periods: [-32, -7], [7, 32], [-19, 19], [-6, 6], and [-32, 32]. The t-statistic for each CAAR is calculated as:

$$t = CAAR_T / (T^{1/2} * \sigma)$$

where σ is the variance from either the pre-, post- or pre-&post-window periods.

Since nonnormality may affect the parametric test inferences, non-parametric sign tests are also conducted to determine if the parametric results are robust.

5.2 Other Measures of Market Activity

Seven other measures of intraday market activity are examined herein. The conditional variance of returns is calculated as the square of the 30-minute returns. The relative bid-ask spread is computed as (Ask price - Bid price)/[(Ask price + Bid price)/2]. Trading volume is equal to the number of shares traded for each half-hour interval. Trading value is the total dollar value of shares traded for each half-hour interval (i.e., the sum of the number of shares traded for each transaction multiplied by the associated per-share price for each transaction).

Trade direction is based on six categories: number of trades below the bid price;[4] number of trades at the bid price; number of trades above the ask price; number of trades at the ask price; number of trades within the bid-ask spread but below the mid-spread; and number of trades within the bid-ask spread but above the mid-spread.

4 Since quotes are recorded ahead of trades that triggered them, trades may be outside of the bid-ask spreads

Trade depth is given by: (bid size - ask size), where the ask (bid) size is the number of buy (sell) orders for a particular firm for each half-hour interval. Higher positive (lower negative) values of trade depth indicate a higher proportion of sells to buys (buys to sells).

6. Empirical Results

All tests of significance are at the 0.05 level unless stated otherwise.

6.1 Abnormal Returns

The mean ARs for the mean-adjusted return model and their corresponding t-values for the event window [-32, 32] for the total sample are presented in Table 5. The corresponding median ARs and results of the sign tests are presented in Table 6. Based on Table 5, the mean ARs for only three of the 52 non-event day intervals are significant (and positive) based on the t-tests (i.e., for intervals -7, 11, and 31, respectively). Based on Table 6, the ARs for only two of the 52 non-event day intervals are significant (and positive) based on the sign tests (i.e., for intervals -20 and 31, respectively).

In contrast, based on Table 5, the mean ARs for 11 of the 13 event day intervals are significant (and negative) based on the t-tests. Similarly, based on

Table 6, the ARs for nine of the 13 event day intervals are significant (and negative) based on the sign tests.

To test robustness, the abnormal returns for the 138 companies with 50 percent or less non-trading intervals are examined next. The mean and median ARs, and their associated t- and sign test values are summarized in Tables 7 and 8, respectively. Based on Table 7, the mean ARs for only two of the 52 non-event day half-hour intervals are significant based on the t-tests (namely, intervals -7 and 11, respectively). Based on Table 8, none of the ARs are significant for the two surrounding non-event days based on the sign tests.

In contrast, based on Table 7, the mean ARs for 11 of the 13 event day intervals are significant based on the t-tests (i.e., only intervals 0 and 4 are insignificant). Based on Table 8, the ARs for nine of the 13 event day intervals are significant based on the sign tests.

The mean and median ARs, and tests of their significance for the 70 companies which had transactions in at least 70 percent of their intervals are summarized in Tables 9 and 10, respectively. Based on Table 9, the mean ARs for only three of the 52 non-event day intervals are significant based on the t-tests. These significant mean ARs for intervals -6, 11 and 31 are negative, positive and positive, respectively. Based on Table 10, ARs for five (three pre-event day) of the

52 non-event day intervals are significant (and negative) based on the sign test

Based on Table 9, the mean ARs for nine of the 13 event day intervals are significant (and negative) based on the t-tests. Based on Table 10, the ARs for eight of the 13 event day intervals are significant (and negative) based on the sign tests.

In summary, strong evidence for negative abnormal returns exists for the event day, and very weak evidence of abnormal returns exists for the two days surrounding the event day. Both the 138 and 70 subsamples tend to support the empirical results for the total sample.

6.2 Cumulative Abnormal Returns

The cumulative average abnormal returns (CAARs) for five multi-interval periods in the event window (namely, [-32, -7], [7, 32], [-19, 19], [-6, 6] and [-32, 32]) and three t-value estimates based on sigmas for pre-, post- and pre- and post-window periods are summarized in Table 11. While the CAARs are not significant for either of the two day periods before or after the event day, they are highly significant (and negative) for the event day for the total sample and the two subsamples. Thus, no evidence exists for market overreaction based on the CAARs around the event dates.

6.3 Volatility

Conditional variances are computed based on the square of the 30-minute returns for the event, pre- and post-event periods. The sample period covers the 30-minute intervals from periods -201 to +201, or from days -15 to +15. Means, medians, t- and sign test results for the total sample and the two subsamples are presented in Table 12. The event period is defined as period [-6,+6] or day 0 in Panel A, and as [-19,+19] or days [-1,+1] in Panel B. Panel C compares differences in variance on the event day relative to the prior day and to the subsequent day.

Based on the t-test, the event period variance is significantly higher than the post-event period variance, but not higher than the pre-event period variance. The change in variance pre-to-post event period is not significant. The change in variance pre-to-post event period is significant and positive based on the sign test if the event is narrowed from the three days centered on the event day to the event day itself. The event period variance is significantly higher than the variances of the pre- and of the post-event periods in all panels based on the sign test. Similar results are obtained for the two subsamples.

Thus, the conditional variance appears to increase on the event date, but decreases afterwards. No strong evidence of a variance change from the pre- to the post-event period is found.

6.4 Relative Bid-Ask Spreads

Descriptive statistics for the relative bid-ask spreads based on closing quotes for the six defined windows for the total sample are presented in Table 13. For both the t- and sign tests, the bid-ask spread is significantly higher for the event period compared to the pre- and post-event periods. Furthermore, the bid-ask spread for the post-event period is significantly higher than that for the pre-event period. Thus, the relative bid-ask spread increases on the event date, and falls back to a level which is still higher than that for the pre-event period (see Figure 1) The large price drop appears to have a permanent effect, not only on prices but also on the bid-ask spread.

6.4. Trading Volume

Table 14 presents the results for the trading volumes for the 30-minute intervals. Based on the t-values reported in Panels A and B, the trading volume for the event period is significantly higher than that for the pre- and for the post-event periods. However, the differences are not significant based on the sign tests Based on the t-values reported in Panel C, the trading volume on the event day is significantly higher than that for the subsequent day. However, the difference is again insignificant based on the sign test. No significant change is found from the pre- to the post-event periods for both the t- and sign tests. Thus, some evidence of abnormal trading volume exists on the event day relative to the two immediately

surrounding days. Similar results are obtained for the board lot subsample.

6.5 Trading value

Table 15 presents the results for dollar trading values for the 30-minute intervals. The results are very similar to those reported in Table 14. Based on the t-values reported in Panels A and B, the trading value for the event period is significantly higher than that for the pre- and for the post-event periods. Based on the t-values reported in Panel C, the trading value on the event day is significantly lower than that for the subsequent day. No significant change is found in values from the pre- to post-event periods based on the t- and sign tests. Therefore, some evidence of abnormal trading dollar value exists on the event day relative to the surrounding days. Similar results are obtained for the board lot subsample.

6.6 Trading frequency

Table 16 presents the results for trading frequency for the 30-minute intervals. Based on the t- and sign tests (see Panels A and B), the average trading frequency on the event day is significantly higher than that for the pre- and for the post-event periods. The average trading frequency for the pre- and for the post-event periods are not significantly different from each other (see Panel C). Thus, significantly more trades occur, on average, on the event day relative to the surrounding periods. Similar results are obtained for the board lot subsample.

6.7 Trade Direction

Two types of criterion are used to classify the trades reported in Table 17 as being seller- or buyer-initiated. The first criterion classifies trades below (above) or at the bid (ask) price as being seller- (buyer-)initiated. The second criterion classifies trades within the bid-ask spread but below (above) the mid-spread as being seller- (buyer-)initiated. Thus, less trader remain unclassified with the second criterion, where only those trades at the mid-spread remain unclassified.

The seller- and buyer-initiated trades for various periods based on the first classification criterion are summarized in Parts 1 and 2 of Table 17, respectively. For all periods, the proportion of seller-initiated trades exceeds that of buyer-initiated trades. For example, based on Panel A of Parts 1 and 2 of Table 17, 46.1% and 33.8% of the trades are seller- and buyer-initiated trades pre-event. Thus, 19 1% of the trader are unclassified in terms of trade direction using the first criterion. These respective averages are significantly lower for the post-event period compared to either the pre-event period or the event day based on the t-test only. When the event "day" includes the three days centered on the event day,[5] the proportion of seller-initiated trades is significantly higher for the pre-event period compared to either the event "day" or the post-event period based on both tests. The proportion of seller-initiated trades on the event day is significantly higher than those for either

5 These days are not included as part of the pre- and post-event periods as a result

the immediately preceding day or the immediately following day for the t-test (and sign test for the later comparison).

The proportion of buyer-initiated trades is significantly lower for the event day compared to either the pre-event period or the post-event period for both tests. When the event "day" includes the three days centered on the event day, the proportion of buyer-initiated trades for the post-event period is significantly higher than that for the pre-event period based on the t-test only. The proportion of buyer-initiated

trades is significantly lower on the event day compared to that for the immediately preceding day based on both tests, and the proportion of buyer-initiated trades for the immediately following day is significantly lower than that for the immediately preceding day based on the t-test only.

The seller- and buyer-initiated trades for various periods based on the second classification criterion are summarized in Parts 3 and 4 of Table 17, respectively. For all periods except the day immediately prior to the event day, the proportion of seller-initiated trades exceeds that of buyer-initiated trades. For example, based on Panel A of Parts 3 and 4 of Table 17, 51.9% and 38.7% of the trades are seller- and buyer-initiated in the pre-event period [-201, -7]. The proportion of seller-initiated trades is significantly higher for the event day compared to either the pre-event period or the post-event period, and for the pre-event period compared to the post-event period based on the t-test (the sign test at the 0.10 level). When the event

"day" includes the three days centered on the event day, the proportion of seller-initiated trades is significantly higher for the pre-event period compared to the post-event period based on the t-test (the sign test at the 0.10 level). The proportion of seller-initiated trades on the event day is significantly higher than that for either the immediately preceding day or the immediately following day based on both tests

The proportion of buyer-initiated trades is significantly lower for the event day compared to either the pre-event period or the post-event period based on both tests. It is also lower for the pre-event period compared to the post-event period based on the sign test (t-test at the 0.07 level). When the event "day" includes the three days centered on the event day, the proportion of buyer-initiated trades is significantly lower for only the pre-event period compared to the post-event period based on both tests. The proportion of buyer-initiated trades is significantly higher on the immediately preceding day compared to the event day or the immediately following day based on both tests.

To summarize, significant changes in trade direction occur during the periods around the events studied herein. While both criterion for the classification of trade direction produce similar results and are robust for the board lot subsamples, the inferences are sensitive to inclusion or exclusion of the day immediately preceding and the day immediately following the studied event day in the pre- and post-event periods, respectively.

The proportion of seller-initiated trades is significantly lower on the day immediately preceding and immediately following the event day compared to that on the event day. The proportion of seller-initiated trades is significantly higher for the pre-event period compared to the post-event period regardless of how the two immediately surrounding days are dealt with. In contrast, the proportion of seller-initiated trades is significantly lower in the post-event period compared to the event day only if these two immediately surrounding days are included in the pre- and post-event periods, respectively. Furthermore, the proportion of seller-initiated trades based on the first criterion is significantly higher for the pre-event period compared to the event day only if the two surrounding days are excluded from the pre- and post-event periods and included in the event "day". Similarly, the proportion of seller-initiated trades based on the second criterion is significantly higher (lower) for the pre-event period compared to the event day only if the immediately preceding day is excluded (included) from the pre-event period and included (excluded) in the event "day"

The proportion of buyer-initiated trades is significantly lower on the event day and the day immediately preceding the event day. The proportion of buyer-initiated trades is significantly lower for the event day compared to either the pre-event period or the post-event period only if the day immediately preceding and immediately following the event day are included in the pre- and post-event periods, respectively. Similarly, the proportion of buyer-initiated trades is significantly higher in the post-event period compared to the pre-event period only if the these two

immediately surrounding days are excluded from the pre- and post-event periods, respectively.

6.8 Trade Depth

Trade depth is measured by the magnitude of bid size over ask size. A higher positive value for trade depth indicates higher selling pressure. Based on Panels A and B of Table 18, the trade depth for the event period is significantly higher than that for either the pre-event period or the post-event period based on both tests. Based on Panel C of Table 18, the trade depth for the event day is significantly higher than that for the immediate following day (both tests), and the trade depth for the immediately following day is significantly lower than that for the immediately preceding day based on the t-test only. Thus, the immediately preceding day and the event day appear to have more selling pressure (orders) relative to the surrounding periods.

7. CONCLUDING REMARKS

This paper examines the market overreaction hypothesis around large daily stock price drops using intraday data on the TSE. The five biggest losers are selected for each of 100 randomly chosen days. After double screening, 297 companies are retained in the sample. Two subsamples of stocks with no more than 50% and 30% non-trading periods are identified to test for robustness. Average

abnormal returns (AARs), cumulative average abnormal returns (CAARs), volatility, liquidity and trade direction and depth are investigated for the 31 days centered on the event date using 30-minute intervals. Liquidity measures studied include trading frequencies, trading volume, trading values and relative bid/ask spreads. The results are also tested for robustness by examining the trading activities of board lot traders.

The AARs and the CAARs are significant at the 0.05 level for the period of [-19, 19], and for the event day itself. The variance moves to its highest level on the event day, and changes significantly from the pre- to post-event period. No significant changes occur in trading volumes, trading values and trading frequencies from the pre-to-post event periods. Relative bid-ask spreads increase significantly for the event day [-6, 6], and for the post-event period relative to the pre-event period. Trades tend to be seller-initiated during the sample period, and trade direction become less seller-initiated from the pre- to post-event periods. Seller-initiated trades and buy/sell imbalance are especially pronounced on the event day.

The results are robust for the subsamples based on the proportion of non-trading activity, and the subsample of board lot trades. The results are somewhat sensitive to whether the day immediately preceding the event day and the day immediately following the event day are included in the pre-event and post-event periods, respectively, or whether they are considered to be part of the event "day".

The results indicate few opportunities for the profitable trading strategies. They 35indicate fairly efficient downward re-evaluations of firms prospects precipitated by unidentified events.

The results suggest several directions for future research. First, the market behaviour around large price drops due to the release of specific information needs to be examined. Second, the market behaviour around large successive daily price drops should be studied.

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Table 1

Descriptive statistics on the event-day returns for the five biggest losers for the 100 randomly chosen event days are presented below.

Statistics	Event-day Returns
Minimum	-0.432
25 percentile	-0.083
Mean	-0.07397
Median	-0.066
75 percentile	-0.053
Maximum	-0.033
Standard deviation	0.035992

Table 2

Descriptive statistics for the deleted stocks are presented below. Group 1 includes firms that do not have at least one trade on day 14. Group 2 includes firms that do not have at least one trade on day 15. Group 3 includes firms that do not have at least one trade on day 16. Group 4 includes firms that do not have at least one quote on each of the days from day 1 to day 13.

	Group 1	Group 2	Group 3	Group 4
Number of firms	109	108	12	10

Table 3. The numbers of firms with no trades for various number of days for the 31 days centered on the event day are presented below.

Number of days with no trades post-event

		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	0	136	17	8	2	2	3			1						1	1
	1	20	11	7	4	4		1									
*	2	8	6	5	1	2	1	1					1				
	3			1	1	1	1	1	2		1	2					
	4	2	2	2		2	1	1		1			1				
	5		1		1		2	1	1	1	2						
	6		1		1			1	1	2		2	1				
	7							3	2	1		1					
	8								1								
	9								1	1							
	10				1							1					
	11																
	12																
	13																1
	14																
	15																

* Number of days with no trades pre-event

Table 4. The numbers of firms with no quotes for various number of days for the 31 days centered on the event day are presented below.

Number of days with no quotes post-event

		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	0	289	6													1	1
	1																
*	2																
	3																
	4																
	5																
	6																
	7																
	8																
	9																
	10																
	11																
	12																
	13																
	14																
	15																

* Number of days with no quotes pre-event

Table 5. Mean abnormal returns, their standard errors, t-statistics and p-values for the event window [-32, 32] for the total sample of 297 losers are presented below. -6, 0 and 6 correspond to the 9:30-10:00a.m.(opening), the 12:30 to 1:00 p.m, and 3:30-4:00p.m. (closing) intervals on the event date, respectively. The mean abnormal returns are based on the mean-adjusted return model.

Interval	Mean (%)	Standard Errors (%)	t-stat	p-value
-32	0.221	3.457	1.102	0.271
-31	0.069	1.782	0.672	0.502
-30	0.018	1.603	0.19	0.849
-29	0.016	1.305	0.213	0.832
-28	-0.01	1.16	-0.153	0.879
-27	0.041	1.548	0.451	0.652
-26	0.065	1.467	0.759	0.448
-25	-0.046	1.374	-0.583	0.56
-24	-0.034	0.993	-0.59	0.556
-23	-0.035	0.984	-0.615	0.539
-22	-0.008	1.101	-0.119	0.906
-21	-0.015	1.316	-0.198	0.843
-20	0.123	1.299	1.637	0.103
-19	-0.04	2.488	-0.279	0.78
-18	-0.017	1.767	0.451	0.652
-17	-0.013	1.66	-0.137	0.891
-16	-0.109	1.752	-1.076	0.283
-15	-0.075	1.897	-0.68	0.497
-14	-0.074	1.423	-0.896	0.371
-13	0.06	1.864	0.556	0.578
-12	-0.015	1.218	-0.21	0.834
-11	0.061	1.649	0.637	0.525
-10	-0.116	1.682	-1.185	0.237
-9	-0.058	1.26	-0.795	0.427
-8	0.182	1.834	1.706	0.089
-7	0.195	1.67	2.011	0.045
-6	-1.851	4.072	-7.832	0
-5	-0.482	2.46	-3.379	0.001
-4	-0.424	1.485	-4.919	0
-3	-0.253	1.797	-2.428	0.016
-2	-0.388	1.735	-3.853	0
-1	-0.505	1.854	-4.699	0

Table 5 (continued)

Interval	Mean (%)	Standard Errors (%)	t-stat	p-value
0	-0.059	1.827	-0.558	0.578
1	-0.378	1.608	-4.047	0
2	-0.347	3.222	-1.855	0.065
3	-0.283	3.198	-1.523	0.129
4	-0.261	1.712	-2.629	0.009
5	-0.174	1.53	-1.956	0.051
6	-0.489	1.756	-4.802	0
7	0.139	3.435	0.698	0.486
8	-0.059	1.984	-0.51	0.611
9	0.039	1.407	0.478	0.633
10	-0.136	1.371	-1.713	0.088
11	0.231	1.335	2.977	0.003
12	0.016	1.309	0.211	0.833
13	-0.052	1.318	-0.683	0.495
14	-0.041	1.451	-0.484	0.628
15	0.109	1.249	1.503	0.134
16	-0.067	1.273	-0.911	0.363
17	0.091	1.072	1.461	0.145
18	0.069	1.067	1.119	0.264
19	-0.057	1.311	-0.749	0.455
20	-0.234	2.195	-1.84	0.0621
21	0.164	1.821	1.551	0.122
22	0.078	2.043	0.662	0.509
23	-0.125	1.421	-1.518	0.13
24	0.071	1.273	0.965	0.336
25	-0.125	1.249	-1.727	0.085
26	0.097	1.116	1.494	0.136
27	0.002	1.185	0.023	0.981
28	0.084	1.11	1.308	0.192
29	0.086	1.237	1.202	0.23
30	-0.094	1.192	-1.365	0.173
31	0.255	1.254	3.502	0.001
32	-0.099	1.523	-1.121	0.263

Table 6. Median abnormal returns, numbers of losers with positive, negative and zero ARs, Z-statistics and p-values for the event window [-32, 32] for the total sample of 297 losers are presented below. The median abnormal returns are based on the mean-adjusted return model. The Z-statistics and associated p-values are for a sign test of differences in medians.

Interval	Median (%)	Positive	Zero	Negative	Z-stat	p-value
-32	-0.005	143	0	154	0.58	0.562
-31	0.006	152	0	145	0.348	0.728
-30	0.005	158	0	139	1.045	0.296
-29	0	149	0	148	0	1
-28	-0.003	145	0	152	0.348	0.728
-27	0.003	155	0	142	0.696	0.486
-26	-0.003	145	0	152	0.348	0.728
-25	0	150	0	147	0.116	0.908
-24	-0.004	142	0	155	0.696	0.486
-23	0.001	151	0	146	0.232	0.817
-22	-0.006	140	0	157	0.928	0.353
-21	0.001	151	0	146	0.232	0.817
-20	0.015	168	0	129	2.205	0.028
-19	-0.022	134	0	163	1.625	0.104
-18	-0.007	143	0	154	0.58	0.562
-17	-0.007	138	0	159	1.161	0.246
-16	-0.003	147	0	150	0.116	0.908
-15	-0.007	138	0	159	1.161	0.246
-14	-0.005	138	0	159	1.161	0.246
-13	-0.003	144	0	153	0.464	0.643
-12	-0.004	139	0	158	1.045	0.296
-11	0.003	151	0	146	0.232	0.817
-10	0.001	151	0	146	0.232	0.817
-9	0.001	149	0	148	0	1
-8	0.003	152	0	145	0.348	0.728
-7	0.01	162	0	135	1.509	0.131
-6	-1.297	70	0	227	9.052	0
-5	-0.024	117	0	180	3.598	0
-4	-0.035	110	0	187	4.41	0
-3	-0.007	138	0	159	1.161	0.246
-2	-0.024	118	0	179	3.482	0.001
-1	-0.029	110	0	187	4.41	0
0	-0.004	139	0	158	1.045	0.296

Table 6 (continued)

Interval	Median (%)	Positive	Zero	Negative	Z-stat	p-value
1	-0.019	121	0	176	3.133	0.002
2	-0.017	127	0	170	2.437	0.015
3	-0.018	127	0	170	2.437	0.015
4	-0.014	132	0	165	1.857	0.063
5	-0.008	139	0	158	1.045	0.296
6	-0.034	117	0	180	3.598	0
7	0	149	0	148	0	1
8	-0.004	144	0	153	0.464	0.643
9	0.001	151	0	146	0.232	0.817
10	-0.01	135	0	162	1.509	0.131
11	0.006	162	0	135	1.509	0.131
12	0.002	153	0	144	0.464	0.643
13	-0.013	132	0	165	1.857	0.063
14	-0.002	144	0	153	0.464	0.643
15	0	148	0	149	0	1
16	-0.003	143	0	154	0.58	0.562
17	0.001	150	0	147	0.116	0.908
18	0.005	152	0	145	0.348	0.728
19	0.001	151	0	146	0.232	0.817
20	-0.02	137	0	160	1.277	0.202
21	0.01	160	0	137	1.277	0.202
22	-0.004	144	0	153	0.464	0.643
23	-0.003	145	0	152	0.348	0.728
24	-0.001	146	0	151	0.232	0.817
25	-0.004	141	0	156	0.812	0.417
26	0.008	155	0	142	0.696	0.486
27	-0.005	139	0	158	1.045	0.296
28	-0.001	146	0	151	0.232	0.817
29	0.001	152	0	145	0.348	0.728
30	0.001	151	0	146	0.232	0.817
31	0.014	169	0	128	2.321	0.02
32	0	149	0	148	0	1

Table 7. Mean abnormal returns, their standard errors, t-statistics and p-values for the event window [-32, 32] for the subsample of 138 losers are presented below. -6, 0 and 6 correspond to the 9:30-10:00 a.m.(opening), the 12:30 to 1:00 p.m, and 3:30-4:00 p.m. (closing) intervals on the event date, respectively. The mean abnormal returns are based on the mean-adjusted return model.

Interval	Mean (%)	Standard Errors (%)	t-stat	p-value
-32	0.495	4.498	1.294	0.198
-31	0.02	1.672	0.137	0.891
-30	0.222	1.518	1.72	0.088
-29	0.018	1.358	0.158	0.874
-28	-0.054	1.276	-0.5	0.618
-27	0	1.169	0.005	0.996
-26	-0.03	1.166	-0.3	0.764
-25	0.036	0.984	0.426	0.671
-24	-0.123	1.029	-1.409	0.161
-23	-0.071	1.072	-0.775	0.44
-22	-0.037	1.138	-0.386	0.7
-21	0.005	1.174	0.051	0.96
-20	0.072	1.145	0.736	0.463
-19	0.138	2.697	0.602	0.548
-18	-0.018	1.607	0.005	0.996
-17	-0.051	1.406	-0.428	0.67
-16	-0.037	1.517	-0.288	0.774
-15	-0.061	2.435	-0.294	0.769
-14	-0.092	1.367	-0.794	0.428
-13	0.224	2.348	1.122	0.264
-12	0.045	1.159	0.454	0.651
-11	0.099	1.168	0.998	0.32
-10	-0.283	2.208	-1.508	0.134
-9	0.034	1.013	0.398	0.691
-8	0.278	2.274	1.435	0.154
-7	0.29	1.415	2.411	0.017
-6	-1.751	5.033	-4.088	0
-5	-0.592	2.076	-3.347	0.001
-4	-0.429	1.283	-3.931	0
-3	-0.494	1.773	-3.276	0.001
-2	-0.481	1.893	-2.986	0.003
-1	-0.663	1.861	-4.187	0

Table 7 (continued)

Interval	Mean (%)	Standard Errors (%)	t-stat	p-value
0	-0.054	1.898	-0.336	0.737
1	-0.495	1.641	-3.544	0.001
2	-0.309	1.549	-2.346	0.02
3	-0.361	1.731	-2.453	0.015
4	-0.058	1.379	-0.493	0.623
5	-0.528	1.402	-4.428	0
6	-0.666	1.825	-4.289	0
7	-0.026	4.079	-0.076	0.94
8	-0.099	2.007	-0.578	0.564
9	0.066	1.355	0.572	0.569
10	0.032	1.283	0.292	0.771
11	0.376	1.282	3.447	0.001
12	0	1.266	0.004	0.996
13	-0.016	1.253	-0.147	0.883
14	-0.277	1.67	-1.949	0.053
15	0.175	1.504	1.369	0.173
16	0.098	1.374	0.837	0.404
17	0.107	1.231	1.023	0.308
18	0.117	1.144	1.206	0.23
19	-0.056	1.392	-0.47	0.6320
20	-0.289	2.206	-1.541	0.126
21	0.058	1.787	0.379	0.706
22	0.039	1.815	0.255	0.799
23	-0.194	1.244	-1.829	0.07
24	0.112	1.228	1.076	0.284
25	-0.171	1.332	-1.508	0.134
26	0.151	1.299	1.367	0.174
27	0.129	1.39	1.089	0.278
28	0.11	1.032	1.256	0.211
29	-0.055	1.4	-0.46	0.646
30	-0.046	1.292	-0.417	0.678
31	0.206	1.428	1.697	0.092
32	0.005	1.589	0.034	0.973

Table 8. Median abnormal returns, numbers of losers with positive, negative and zero ARs, Z-statistics and p-values for the event window [-32, 32] for the subsample of 138 losers are presented below. The median abnormal returns are based on the mean-adjusted return model. The Z-statistics and associated p-values are for a sign test of differences in medians.

Interval	Median (%)	Positive	Zero	Negative	Z-stat	p-value
-32	0	69	0	69	0	1
-31	0.006	70	0	68	0.085	0.932
-30	0.017	77	0	61	1.277	0.202
-29	-0.007	64	0	74	0.766	0.444
-28	-0.008	65	0	73	0.596	0.551
-27	0.004	71	0	67	0.255	0.798
-26	-0.009	63	0	75	0.936	0.349
-25	0.001	70	0	68	0.085	0.932
-24	-0.018	63	0	75	0.936	0.349
-23	-0.004	68	0	70	0.085	0.932
-22	-0.01	63	0	75	0.936	0.349
-21	0	68	0	70	0.085	0.932
-20	0.006	73	0	65	0.596	0.551
-19	-0.017	64	0	74	0.766	0.444
-18	-0.008	64	0	74	0.766	0.444
-17	-0.009	64	0	74	0.766	0.444
-16	0.009	71	0	67	0.255	0.798
-15	-0.01	64	0	74	0.766	0.444
-14	-0.014	61	0	77	1.277	0.202
-13	-0.009	64	0	74	0.766	0.444
-12	-0.006	64	0	74	0.766	0.444
-11	0.011	74	0	64	0.766	0.444
-10	-0.014	65	0	73	0.596	0.551
-9	0.008	73	0	65	0.596	0.551
-8	0.006	72	0	66	0.426	0.67
-7	0.014	77	0	61	1.277	0.202
-6	-1.228	30	0	108	6.555	0
-5	-0.037	55	0	83	2.298	0.022
-4	-0.078	50	0	88	3.15	0.002
-3	-0.021	59	0	79	1.617	0.106
-2	-0.035	56	0	82	2.128	0.033
-1	-0.082	46	0	92	3.831	0
0	-0.018	60	0	78	1.447	0.148

Table 8 (continued)

Interval	Median (%)	Positive	Zero	Negative	Z-stat	p-value
1	-0.051	48	0	90	3.49	0.001
2	-0.038	49	0	89	3.32	0.001
3	-0.027	58	0	80	1.788	0.074
4	-0.008	64	0	74	0.766	0.444
5	-0.027	55	0	83	2.298	0.022
6	-0.171	47	0	91	3.66	0
7	-0.016	63	0	75	0.936	0.349
8	-0.008	67	0	71	0.255	0.798
9	0.003	71	0	67	0.255	0.798
10	-0.009	65	0	73	0.596	0.551
11	0.007	76	0	62	1.107	0.269
12	0.002	71	0	67	0.255	0.798
13	-0.019	61	0	77	1.277	0.202
14	-0.015	60	0	78	1.447	0.148
15	-0.004	66	0	72	0.426	0.67
16	0.002	71	0	67	0.255	0.798
17	-0.002	68	0	70	0.085	0.932
18	0.006	71	0	67	0.255	0.798
19	-0.019	67	0	71	0.255	0.798
20	-0.029	63	0	75	0.936	0.349
21	0.006	73	0	65	0.596	0.551
22	-0.01	66	0	72	0.426	0.67
23	-0.001	68	0	70	0.085	0.932
24	-0.002	68	0	70	0.085	0.932
25	-0.009	64	0	74	0.766	0.444
26	0.014	76	0	62	1.107	0.269
27	-0.008	65	0	73	0.596	0.551
28	0.003	71	0	67	0.255	0.798
29	-0.006	65	0	73	0.596	0.551
30	0.001	71	0	67	0.255	0.798
31	0.012	74	0	64	0.766	0.444
32	-0.006	65	0	73	0.596	0.551

Table 9. Mean abnormal returns, their standard errors, t-statistics and p-values for the event window [-32, 32] for the subsample of 70 losers are presented below. -6, 0 and 6 correspond to the 9:30-10:00 a.m.(opening), the 12:30 to 1:00 p.m, and 3:30-4:00 p.m. (closing) intervals on the event date, respectively. The mean abnormal returns are based on the mean-adjusted return model.

Interval	Mean (%)	Standard Errors (%)	t-stat	p-value
-32	0.017	2.377	0.06	0.952
-31	0.194	1.371	1.183	0.241
-30	0.183	1.401	1.094	0.278
-29	0.045	1.503	0.248	0.804
-28	-0.124	1.009	-1.027	0.308
-27	0.035	1.085	0.269	0.788
-26	-0.38	1.099	-2.89	0.005
-25	0.155	0.911	1.421	0.16
-24	-0.19	0.844	-1.883	0.064
-23	-0.218	0.936	-1.948	0.055
-22	0	1.097	-0.003	0.997
-21	-0.043	1.153	-0.311	0.757
-20	0.103	1.137	0.754	0.453
-19	-0.035	1.918	-0.154	0.878
-18	-0.014	1.281	0.269	0.788
-17	-0.093	1.356	-0.572	0.569
-16	-0.062	1.39	-0.37	0.712
-15	-0.348	3.004	-0.97	0.335
-14	0.044	1.104	0.332	0.741
-13	0.221	3.062	0.605	0.547
-12	0.095	1.267	0.629	0.531
-11	0.052	1.232	0.353	0.725
-10	-0.462	2.854	-1.355	0.18
-9	-0.018	1.112	-0.134	0.894
-8	0.43	2.848	1.264	0.211
-7	0.275	1.472	1.564	0.122
-6	-2.421	6.603	-3.068	0.003
-5	-0.886	2.014	-3.679	0
-4	-0.388	1.18	-2.753	0.008
-3	-0.464	1.811	-2.145	0.035
-2	-0.339	1.72	-1.647	0.104
-1	-0.609	1.774	-2.87	0.005

Table 9 (continued)

Interval	Mean (%)	Standard Errors (%)	t-stat	p-value
0	-0.044	2.021	-0.182	0.856
1	-0.598	1.946	-2.572	0.012
2	-0.225	1.715	-1.097	0.277
3	-0.445	1.746	-2.131	0.037
4	0.142	1.431	0.829	0.41
5	-0.58	1.5	-3.235	0.002
6	-0.67	1.713	-3.271	0.002
7	-0.374	4.768	-0.657	0.513
8	-0.032	1.801	-0.149	0.882
9	0.087	1.285	0.566	0.573
10	0.165	1.279	1.082	0.283
11	0.263	1.074	2.045	0.045
12	-0.016	1.101	-0.119	0.906
13	0.002	1.387	0.011	0.991
14	-0.297	1.817	-1.367	0.176
15	0.182	1.552	0.982	0.33
16	0.054	1.548	0.291	0.772
17	-0.012	1.263	-0.082	0.935
18	0.136	1.04	1.096	0.277
19	-0.228	1.288	-1.481	0.143
20	-0.354	2.265	-1.309	0.195
21	0.147	1.663	0.739	0.463
22	0.149	1.874	0.666	0.507
23	-0.117	1.278	-0.767	0.446
24	0.015	1.078	0.117	0.907
25	-0.161	0.881	-1.526	0.132
26	-0.01	1.057	-0.077	0.939
27	0	1.315	0	1
28	0.128	1.045	1.022	0.31
29	-0.003	0.975	-0.028	0.978
30	0.124	1.09	0.954	0.343
31	0.333	1.17	2.379	0.02
32	-0.135	1.159	-0.976	0.333

Table 10. Median abnormal returns, numbers of losers with positive, negative and zero ARs, Z-statistics and p-values for the event window [-32, 32] for the subsample of 70 losers are presented below. The median abnormal returns are based on the mean-adjusted return model. The Z-statistics and associated p-values are for a sign test of differences in medians.

Interval	Median (%)	Positive	Zero	Negative	Z-stat	p-value
-32	-0.013	33	0	37	0.359	0.72
-31	0.006	36	0	34	0.12	0.905
-30	0.005	38	0	32	0.598	0.55
-29	-0.01	30	0	40	1.076	0.282
-28	-0.015	30	0	40	1.076	0.282
-27	0.016	37	0	33	0.359	0.72
-26	-0.029	25	0	45	2.271	0.023
-25	-0.005	33	0	37	0.359	0.72
-24	-0.023	28	0	42	1.554	0.12
-23	-0.035	23	0	47	2.749	0.006
-22	-0.015	32	0	38	0.598	0.55
-21	-0.018	33	0	37	0.359	0.72
-20	-0.002	35	0	35	0	1
-19	-0.054	30	0	40	1.076	0.282
-18	-0.007	34	0	36	0.12	0.905
-17	-0.018	30	0	40	1.076	0.282
-16	-0.004	34	0	36	0.12	0.905
-15	-0.024	26	0	44	2.032	0.042
-14	-0.01	30	0	40	1.076	0.282
-13	-0.025	30	0	40	1.076	0.282
-12	-0.009	32	0	38	0.598	0.55
-11	0.027	38	0	32	0.598	0.55
-10	-0.023	29	0	41	1.315	0.189
-9	-0.007	32	0	38	0.598	0.55
-8	-0.001	35	0	35	0	1
-7	0.035	41	0	29	1.315	0.189
-6	-1.434	8	0	62	6.335	0
-5	-0.616	17	0	53	4.183	0
-4	-0.044	25	0	45	2.271	0.023
-3	-0.074	27	0	43	1.793	0.073
-2	-0.115	27	0	43	1.793	0.073
-1	-0.059	25	0	45	2.271	0.023
0	-0.022	29	0	41	1.315	0.189

Table 10 (continued)

Interval	Median (%)	Positive	Zero	Negative	Z-stat	p-value
1	-0.139	20	0	50	3.466	0.001
2	-0.079	22	0	48	2.988	0.003
3	-0.037	27	0	43	1.793	0.073
4	-0.007	33	0	37	0.359	0.72
5	-0.107	23	0	47	2.749	0.006
6	-0.568	23	0	47	2.749	0.006
7	-0.064	28	0	42	1.554	0.12
8	-0.021	32	0	38	0.598	0.55
9	-0.01	31	0	39	0.837	0.403
10	-0.01	33	0	37	0.359	0.72
11	-0.001	35	0	35	0	1
12	0.002	36	0	34	0.12	0.905
13	-0.03	25	0	45	2.271	0.023
14	-0.019	28	0	42	1.554	0.12
15	-0.013	31	0	39	0.837	0.403
16	-0.01	33	0	37	0.359	0.72
17	-0.054	29	0	41	1.315	0.189
18	-0.013	32	0	38	0.598	0.55
19	-0.027	30	0	40	1.076	0.282
20	-0.037	28	0	42	1.554	0.12
21	-0.007	34	0	36	0.12	0.905
22	-0.017	32	0	38	0.598	0.55
23	-0.001	35	0	35	0	1
24	-0.013	32	0	38	0.598	0.55
25	-0.035	27	0	43	1.793	0.073
26	-0.018	32	0	38	0.598	0.55
27	-0.027	26	0	44	2.032	0.042
28	-0.019	30	0	40	1.076	0.282
29	-0.01	31	0	39	0.837	0.403
30	0.003	37	0	33	0.359	0.72
31	0.028	38	0	32	0.598	0.55
32	-0.02	28	0	42	1.554	0.12

Table 11. The Cumulative Average Abnormal Returns (CAARs) and t-values based on three estimates of the standard deviations of the average abnormal returns (pre-sigma, post-sigma and pre- and post-sigma) for five multi-interval periods in the event window for the total sample and the two subsamples are presented below. * indicates significance at the 5% level.

Panel A: The total sample of 297 losers

Periods in half-hours	CAAR	Pre-t	Post-t	Pre-&Post-t
[-32, -7]	0.0038	0.5255	0.4275	0.46297
[7, 32]	0.0044	0.4243	1.0152	0.5337
[-19, 19]	-0.0550	-7.7094*	-12.0778*	-9.2105*
[-6, 6]	-0.0575	-11.5865*	-17.6691*	-13.7240*
[-32, 32]	-0.0497	-1.7461	-1.8821	-1.8129

Panel B: The sample of 138 losers

Periods in half-hours	CAAR	Pre-t	Post-t	Pre-&Post-t
[-32, -7]	0.0112	0.7280	1.0730	0.8681
[7, 32]	0.0055	0.3351	0.8770	0.4269
[-19, 19]	-0.0568	-3.7889*	-8.9003*	-4.9393*
[-6, 6]	-0.0668	-6.4468*	-14.5572*	-8.3494*
[-32, 32]	-0.0511	-2.6261*	-2.9811*	-2.7907*

Panel C: The subsample of 70 losers

Periods in half-hours	CAAR	Pre-t	Post-t	Pre-&Post-t
[-32, -7]	-0.0014	-0.1739	-0.1065	-0.1252
[7, 32]	0.0004	0.0490	0.0640	0.0550
[-19, 19]	-0.0728	-8.9979*	-8.6178*	-8.8255*
[-6, 6]	-0.0729	-7.7693*	-7.4982*	-7.6371*
[-32, 32]	-0.0738	-5.7011*	-5.4501*	-5.5795*

Table 12. The mean and median conditional variances of the half-hour returns for the total sample of 297 losers and the two subsamples of 138 and 70 losers are presented below. Standard t- and sign tests are used to test if the conditional variances are different in the pre-, post- and event periods. The pre- and post-event periods are [-201, -7] and [7, 201] respectively, if the event period is [-6, 6]; that is, the day of the large loss. They are [-201, -20] and [20, 201], respectively, if the event period is [-19, 19]; that is, the day of the large loss and the day immediately before and after this day. [b-a] is the difference between the event and pre-event measures; [c-b] is the difference between the post-event and event measures; and [c-a] is the difference between the post-event and pre-event measures. All variance measures are for a 30-minute interval. * indicates significance at the 5% level.

				t-test		Sign test				
Period	Mean	Median	Difference	t-stat	p-value	Incr	Equal	Decr	Z-stat	p-value
Panel A: Total sample of 297 losers with event defined as the half-hour intervals [-6, 6], i.e. day [0], where pre- and post-event periods are as defined above										
Pre-event (a)	0.064	0.012	b-a	-0.15	0.877	229	0	68	9.284	0
Event (b)	0.057*	0.022	c-b	-2.51	0.013	84	0	213	-7.427	0
Post-event (c)	0.022*	0.014	c-a	-1	0.319	160	0	137	1.277	0.202
Panel B: Total sample of 297 losers with event defined as half-hour intervals [-19, 19]; i.e. days [-1, 1], where pre- and post-event periods are as defined above										
Pre-event (a)	0.066	0.012	b-a	-0.63	0.531	223	0	74	8.588	0
Event (b)	0.038*	0.02	c-b	-3.05	0.002	80	0	217	-7.892	0
Post-event (c)	0.021*	0.014	c-a	-0.99	0.322	168	0	129	2.205	0.028
Panel C: Total sample of 297 losers with event defined as half-hour intervals [-6, 6]; i.e. day [0], where pre- and post-event periods are defined as the day immediately before and after the event, respectively										
Prior day (a)	0.029*	0.011	b-a	1.78	0.076	217	0	80	7.892	0
Event (b)	0.057*	0.022	c-b	-2.16	0.032	81	0	216	-7.776	0
Subsequent day (c)	0.026*	0.013	c-a	-0.59	0.558	169	0	128	2.321	0.020

Table 12 (continued)

				t-test		Sign test				
Period	Mean	Median	Difference	t-stat	p-value	Incr	Equal	Decr	Z-stat	p-value
Panel D: Subsample of 138 losers with event defined as half-hour intervals [-6, 6]; i.e. day [0], where pre- and post-event periods are as defined above										
Pre-event (a)	0.111	0.013	b-a	-0.65	0.515	96	0	42	4.512	0
Event [b)	0.051*	0.02	c-b	-1.59	0.115	50	0	80	-3.15	0.002
Post-event (c)	0.023*	0.016	c-a	-0.97	0.334	76	0	62	1.107	0.269
Panel E: Subsample of 138 losers with event defined as half-hour intervals [-19, 19]; i.e. days [-1, 1], where pre- and post-event periods are as defined above										
Pre-event (a)	0.117	0.013	b-a	-0.8	0.425	95	0	43	4.341	0
Event (b)	0.038*	0.02	c-b	-2.15	0.033	47	0	91	-3.66	0
Post-event (c)	0.023*	0.015	c-a	-0.97	0.335	79	0	59	1.617	0.106
Panel F: Subsample of 138 losers with event defined as half-hour intervals [-6, 6]; i.e. day [0], where pre- and post-event periods are defined as the day immediately before and after the event, respectively										
Prior day (a)	0.033*	0.009	b-a	0.83	o.408	97	0	41	4.682	0
Event (b)	0.051*	0.020	c-b	-1.08	0.282	48	0	90	-3.490	0
Subsequent day (c)	0.031*	0.016	c-a	-0.15	0.878	92	0	46	3.831	0

Table 12 (continued)

				t-test		Sign test				
Period	Mean	Median	Difference	t-stat	p-value	Incr	Equal	Decr	Z-stat	p-value
Panel G: Subsample of 70 losers with event defined as half-hour intervals [-6, 6]; i.e. day [0], where pre- and post-event periods are as defined above										
Pre-event (a)	0.018*	0.012	b-a	1.47	0.147	51	0	19	3.705	0
Event (b)	0.067	0.017	c-b	-1.47	0.146	20	0	50	-3.466	0.001
Post-event (c)	0.018*	0.014	c-a	0.06	0.95	36	0	34	0.12	0.905
Panel H: Subsample of 70 losers with event defined as half-hour intervals [-19, 19]; i.e. days [-1, 1], where pre- and post-event periods are as defined above										
Pre-event (a)	0.016*	0.012	b-a	2.25	0.027	52	0	18	3.944	0
Event (b)	0.047*	0.019	c-b	-2.27	0.026	21	0	49	-3.227	0.001
Post-event (c)	0.017*	0.013	c-a	0.31	0.756	41	0	29	1.315	0.189
Panel I: Subsample of 70 losers with event defined as half-hour intervals [-6, 6]; i.e. day [0], where pre- and post-event periods are defined as the day immediately before and after the event, respectively										
Prior day (a)	0.039	0.009	b-a	0.68	0.501	49	0	21	3.227	0.001
Event (b)	0.067	0.017	c-b	-0.92	0.363	25	0	45	-2.271	0.023
Subsequent day (c)	0.035*	0.015	c-a	-0.18	0.858	50	0	20	3.466	0

Table 13. The mean and median measures of the relative bid-ask spread for the half-hour intervals for the total sample of 297 losers are presented below. Standard t- and sign tests are used to test if the relative bid-ask spreads are different in the pre-, post- and event periods. The pre- and post-event periods are [-201, -7] and [7, 201], respectively, if the event period is [-6, 6]; that is, the day of the large loss. They are [-201, -20] and [20, 201], respectively, if the event period is [-19, 19]; that is, the day of the large loss and the day immediately before and after this day. [b-a] is the difference between the event and pre-event measures; [c-b] is the difference between the post-event and event measures; and [c-a] is the difference between the post-event and pre-event measures. All measures of relative bid-ask spread are for a 30-minute interval. * indicates significance at the 5% level.

				t-test		Sign test				
Period	Mean	Median	Difference	t-stat	p-value	Incr	Equal	Decr	Z-stat	p-value
Panel A: Total sample of 297 losers with event defined as half-hour intervals [-6, 6]; i.e. day [0], where pre- and post-event periods are as defined above										
Pre-event (a)	0.031*	0.027	b-a	8.24	0	223	0	74	8.588	0
Event (b)	0.042*	0.032	c-b	-5.97	0	107	0	190	-4.758	0
Post-event (c)	0.035*	0.029	c-a	4.74	0	188	0	109	4.526	0
Panel B: Total sample of 297 losers with event defined as half-hour intervals [-19, 19]; i.e. days [-1, 1], where pre- and post-event periods are as defined above										
Pre-event (a)	0.031*	0.026	b-a	8.04	0	214	0	83	7.543	0
Event (b)	0.038*	0.031	c-b	-4.49	0	117	0	180	-3.597	0
Post-event (c)	0.035*	0.029	c-a	4.54	0	186	0	111	4.293	0
Panel C: Total sample of 297 losers with event defined as half-hour intervals [-6, 6]; i.e. day [0], where pre- and post-event periods are defined as the day immediately before and after the event, respectively										
Prior day (a)	0.034*	0.026	b-a	6.37	0	212	1	84	7.381	0
Event (b)	0.042*	0.032	c-b	-2.47	0.014	124	6	167	-2.462	0.013
Subsequent day (c)	0.039*	0.031	c-a	3.67	0	193	0	104	5.106	0

Table 14. The mean and median measures of trading volume for the half-hour intervals for the total sample of 297 losers and the board lot trades are presented below. Standard t- and sign tests are used to test if the trading volumes are different in the pre-, post- and event periods. The pre- and post-event periods are [-201, -7] and [7, 201], respectively, if the event period is [-6, 6]; that is, the day of the large loss. They are [-201, -20] and [20, 201], respectively, if the event period is [-19, 19]; that is, the day of the large loss and the day immediately before and after this day. [b-a] is the difference between the event and pre-event measures; [c-b] is the difference between the post-event and event measures; and [c-a] is the difference between the post-event and pre-event measures. All measures of trading volume are for a 30-minute interval. * indicates significance at the 5% level.

				t-test		Sign test				
Period	Mean	Median	Difference	t-stat	p-value	Incr	Equal	Decr	Z-stat	p-value
Panel A: Total sample of 297 losers with event defined as half-hour intervals [-6, 6]; i.e. day [0], where pre- and post-event periods are as defined above										
Pre-event (a)	2138	632	b-a	2.66	0.008	132	0	165	-1.856	0.063
Event (b)	3852	455	c-b	-2.76	0.006	147	0	150	-0.116	0.908
Post-event (c)	2264	576	c-a	0.52	0.603	134	0	163	-1.624	0.104
Panel B: Total sample of 297 losers with event defined as half-hour intervals [-19, 19]; i.e. days [-1, 1], where pre- and post-event periods are as defined above										
Pre-event (a)	2094	565	b-a	2.66	0.008	160	2	135	1.397	0.162
Event (b)	3289	594	c-b	-2.91	0.004	132	1	164	-1.801	0.072
Post-event (c)	2193	560	c-a	0.4	0.692	143	0	154	-0.58	0.562
Panel C: Total sample of 297 losers with event defined as half-hour intervals [-6, 6]; i.e. day [0], where pre- and post-event periods are defined as the day immediately before and after the event, respectively										
Prior day (a)	2761	362	b-a	1.86	0.064	161	2	134	1.513	0.130
Event (b)	3852	455	c-b	-1.05	0.293	106	1	190	-4.824	0
Subsequent day (c)	3255	319	c-a	0.99	0.323	138	2	157	-1.048	0.295

Table 14 (continued)

				t-test		Sign test				
Period	Mean	Median	Difference	t-stat	p-value	Incr	Equal	Decr	Z-stat	p-value
Panel D: Board lot trades of the total sample of 297 losers with event defined as half-hour intervals [-6, 6]; i.e. day [0], where pre- and post-event periods are as defined above										
Pre-event (a)	2135	630	b-a	2.65	0.008	131	1	165	-1.918	0.055
Event (b)	3848	455	c-b	-2.76	0.006	147	1	149	-0.058	0.954
Post-event (c)	2261	573	c-a	0.52	0.603	133	1	163	-1.685	0.092
Panel E: Board lot trades of the total sample of 297 losers with event defined as half-hour intervals [-19, 19]; i.e. days [-1, 1], where pre- and post-event periods are as defined above										
Pre-event (a)	2091	561	b-a	2.65	0.008	160	1	136	1.336	0.181
Event (b)	3285	587	c-b	-2.91	0.004	133	0	164	-1.74	0.082
Post-event (c)	2190	559	c-a	0.4	0.693	143	0	154	-0.58	0.562
Panel F: Board lot trades of the total sample of 297 losers with event defined as half-hour intervals [-6, 6]; i.e. day [0], where pre- and post-event periods are defined as the day immediately before and after the event, respectively										
Prior day (a)	2757	361	b-a	1.86	0.064	159	5	133	1.436	0.143
Event (b)	3847	455	c-b	-1.05	0.294	106	6	185	-4.572	0
Subsequent day (c)	3251	315	c-a	0.99	0.323	136	4	157	-1.168	0.243

Table 15. The mean and median measures of trading value for the half-hour intervals for the total sample of 297 losers and the board lot traders are presented below. Standard t- and sign tests are used to test if the trading values are different in the pre-, post- and event periods. The pre- and post-event periods are [-201, -7] and [7, 201], respectively, if the event period is [-6, 6]; that is, the day of the large loss. They are [-201, -20] and [20, 201], respectively, if the event period is [-19, 19]; that is, the day of the large loss and the day immediately before and after this day. [b-a] is the difference between the event and pre-event measures; [c-b] is the difference between the post-event and event measures; and [c-a] is the difference between the post-event and pre-event measures. All measures of trading value are for a 30-minute interval. * indicates significance at the 5% level.

				t-test		Sign test				
Period	Mean	Median	Difference	t-stat	p-value	Incr	Equal	Decr	Z-stat	p-value
Panel A: Total sample of 297 losers with event defined as half-hour intervals [-6, 6]; i.e. day [0], where pre- and post-event periods are as defined above										
Pre-event (a)	25438	5426	b-a	2.41	0.017	132	0	165	-1.856	0.063
Event (b)	55934	4050	c-b	-2.3	0.022	144	0	153	-0.464	0.643
Post-event (c)	28808	4417	c-a	0.94	0.346	136	0	161	-1.392	0.164
Panel B: Total sample of 297 losers with event defined as half-hour intervals [-19, 19]; i.e. days [-1, 1], where pre- and post-event periods are as defined above										
Pre-event (a)	24471	4615	b-a	2.51	0.013	158	0	139	1.044	0.296
Event (b)	47746	4794	c-b	-2.47	0.014	131	0	166	-1.972	0.049
Post-event (c)	27414	4405	c-a	0.83	0.405	143	0	154	-0.58	0.562
Panel C: Total sample of 297 losers with event defined as half-hour intervals [-6, 6]; i.e. day [0], where pre- and post-event periods are defined as the day immediately before and after the event, respectively										
Prior day (a)	38968	3493	b-a	1.47	0.141	160	0	137	1.276	0.201
Event (b)	55933	4050	c-b	-0.84	0.404	104	0	193	-5.106	0
Subsequent day (c)	48334	2723	c-a	1.00	0.321	134	0	163	-1.624	0.104

Table 15 (continued)

				t-test		Sign test				
Period	Mean	Median	Difference	t-stat	p-value	Incr	Equal	Decr	Z-stat	p-value
Panel D: Board lot trades of the total sample of 297 losers with event defined as half-hour intervals [-6, 6]; i.e. day [o], where pre- and post-event periods are as defined above										
Pre-event (a)	25383	5404	b-a	2.41	0.017	131	0	166	-1.972	0.049
Event (b)	55862	4050	c-b	-2.31	0.022	144	1	152	-0.406	0.684
Post-event (c)	28750	4406	c-a	0.94	0.346	136	0	161	-1.392	0.164
Panel E: Board lot trades of the total sample of 297 losers with event defined as half-hour intervals [-19, 19]; i.e. days [-1, 1], where pre- and post-event periods are as defined above										
Pre-event (a)	24417	4588	b-a	2.51	0.013	158	0	139	1.044	0.296
Event (b)	47682	4794	c-b	-2.47	0.014	131	0	166	-1.972	0.049
Post-event (c)	27355	4405	c-a	0.84	0.404	145	0	152	-0.348	0.728
Panel F: Board lot trades of the total sample of 297 losers with event defined as half-hour intervals [-6, 6]; i.e. day [0], where pre- and post-event periods are defined as the day immediately before and after the event, respectively										
Prior day (a)	38909	3460	b-a	1.47	0.141	158	1	138	1.104	0.269
Event (b)	55861	4050	c-b	-0.84	0.404	104	4	189	-4.907	0
Subsequent day (c)	43274	2707	c-a	1.00	0.32	132	2	163	-1.746	0.081

Table 16. The mean and median measures of trading frequency for the half-hour intervals for the total sample of 297 losers and the board lot trades are presented below. Standard t- and sign tests are used to test if the trading frequencies are different in the pre-, post- and event periods. The pre- and post-event periods are [-201, -7] and [7, 201], respectively, if the event period is [-6, 6]; that is, the day of the large loss. They are [-201, -20] and [20, 201], respectively, if the event period is [-19, 19]; that is, the day of the large loss and the day immediately before and after this day. [b-a] is the difference between the event and pre-event measures; [c-b] is the difference between the post-event and event measures; and [c-a] is the difference between the post-event and pre-event measures. All measures of trading frequency are for a 30-minute interval. * indicates significance at the 5% level.

				t-test		Sign test				
Period	Mean	Median	Difference	t-stat	p-value	Incr	Equal	Decr	Z-stat	p-value
Panel A: Total sample of 297 losers with event defined as half-hour intervals [-6, 6]; i.e. day [0], where pre- and post-event periods are as defined above										
Pre-event (a)	1.152*	0	b-a	2.34	0.02	88	174	35	4.689	0
Event (b)	2.007*	0	c-b	-2.24	0.026	29	177	91	-5.569	0
Post-event (c)	1.286*	0	c-a	1.06	0.288	43	207	47	-0.316	0.751
Panel B: Total sample of 297 losers with event defined as half-hour intervals [-19, 19]; i.e. days [-1, 1], where pre- and post-event periods are as defined above										
Pre-event (a)	1.108*	0	b-a	2.69	0.008	72	190	35	3.48	0
Event (b)	1.791*	0	c-b	-2.75	0.006	26	197	74	-4.7	0
Post-event (c)	1.236*	0	c-a	1.02	0.308	41	212	44	-0.217	0.828
Panel C: Total sample of 297 losers with event defined as half-hour intervals [-6, 6]; i.e. day [0], where pre- and post-event periods are defined as the day immediately before and after the event, respectively										
Prior day (a)	1.522*	0	b-a	1.53	0.127	75	169	53	1.856	0.063
Event (b)	2.007*	0	c-b	-0.18	0.855	43	177	77	-3.012	0.002
Subsequent day (c)	1.956*	0	c-a	1.39	0.166	63	168	66	-0.176	0.860

Table 16 (continued)

				t-test		Sign test				
Period	Mean	Median	Difference	t-stat	p-value	Incr	Equal	Decr	Z-stat	p-value
Panel D: Board lot trades of the total sample of 297 losers with event defined as half-hour intervals [-6, 6]; i.e. day [0], where pre- and post-event periods are as defined above										
Pre-event (a)	1.074*	0	b-a	2.39	0.017	88	175	34	4.798	0
Event (b)	1.919*	0	c-b	-2.31	0.022	28	180	89	-5.547	0
Post-event (c)	1.205*	0	c-a	1.06	0.29	42	213	42	0	1
Panel E: Board lot trades of the total sample of 297 losers with event defined as half-hour intervals [-19, 19]; i.e. days [-1, 1], where pre- and post-event periods are as defined above										
Pre-window (a)	1.054*	0	b-a	2.68	0.008	69	194	34	3.35	0
Window (b)	1.721*	0	c-b	-2.85	0.005	26	201	70	-4.389	0
Post-window (c)	1.155*	0	c-a	0.85	0.394	43	210	44	0	1
Panel F: Board lot trades of the total sample of 297 losers with event defined as half-hour intervals [-6, 6]; i.e. day [0], where pre- and post-event periods are defined as the day immediately before and after the event, respectively										
Prior day (a)	1.412*	0	b-a	1.64	0.102	73	177	47	2.282	0.022
Event (b)	1.919*	0	c--b	-0.13	0.899	44	177	76	-2.829	0.004
Subsequent day (c)	1.886*	0	c-a	1.52	0.128	60	179	58	0.092	0.926

Table 17. The proportional mean and median measures of trade direction for the half-hour intervals for the total sample of 297 losers and the board lot trades are presented below. Standard t- and sign tests are used to test if the trade directions are different in the pre-, post- and event periods. The pre- and post-event periods are [-201, -7] and [7, 201], respectively, if the event period is [-6, 6]; that is, the day of the large loss. They are [-201, -20] and [20, 201], respectively, if the event period is [-19, 19]; that is, the day of the large loss and the day immediately before and after this day. [b-a] is the difference between the event and pre-event measures; [c-b] is the difference between the post-event and event measures; and [c-a] is the difference between the post-event and pre-event measures. All measures of trade diretion are for a 30-minute interval. * indicates significance at the 5% level.

Part 1. Less than and equal to bid

				t-test		Sign test				
Period	Mean	Median	Difference	t-stat	p-value	Incr	Equal	Decr	Z-stat	p-value
Panel A: Total sample of 297 losers with event defined as half-hour intervals [-6, 6]; i.e. day [0], where pre- and post-event periods are as defined above										
Pre-event (a)	0.461*	0.448	b-a	0.48	0.630	148	0	149	0.000	1.000
Event (b)	0.468*	0.467	c-b	-2.27	0.024	138	3	156	-0.991	0.321
Post-event (c)	0.432*	0.420	c-a	-3.01	0.003	133	1	163	-1.685	0.092
Panel B: Total sample of 297 losers with event defined as half-hour intervals [-19, 19]; i.e. days [-1, 1], where pre- and post-event periods are as defined above										
Pre-event (a)	0.468*	0.448	b-a	-3.38	0.001	130	3	164	-1.924	0.054
Event (b)	0.433*	0.413	c-b	-0.09	0.928	138	1	158	-1.104	0.269
Post-event (c)	0.432*	0.426	c-a	-3.56	0	129	1	167	-2.15	0.031
Panel C: Total sample of 297 losers with event defined as half-hour intervals [-6, 6]; i.e. day [0], where pre- and post-event periods are defined as the day immediately before and after the event, respectively										
Prior day (a)	0.398*	0.370	b-a	2.99	0.003	160	21	116	2.588	0.009
Event (b)	0.468*	0.467	c-b	-2.97	0.003	115	17	165	-2.928	0.003
Subsequent day (c)	0.398*	0.389	c-a	-0.02	0.984	128	29	140	-0.671	0.501

Table 17(continued)

				t-test		Sign test				
Period	Mean	Median	Difference	t-stat	p-value	Incr	Equal	Decr	Z-stat	p-value
Panel D: Board lot trades of the total sample of 297 losers with event defined as half-hour intervals [-6, 6], i.e. day [0], where pre- and post-event periods are as defined above										
Pre-event (a)	0.453*	0.437	b-a	-1.73	0.085	127	1	169	-2.383	0.017
Event (b)	0.420*	0.388	c-b	1.31	0.193	165	1	131	1.918	0.055
Post-event (c)	0.446*	0.441	c-a	-0.86	0.393	150	1	146	0.174	0.861
Panel E: Board lot trades of the total sample of 297 losers with event defined as half-hour intervals [-19, 19], i.e. days [-1, 1], where pre- and post-event periods are as defined above										
Pre-event (a)	0.456*	0.439	b-a	-1.77	0.077	134	2	161	-1.513	0.130
Event (b)	0.432*	0.428	c-b	1.03	0.305	151	2	144	0.349	0.726
Post-event (c)	0.446*	0.444	c-a	-1.12	0.262	147	1	149	-0.058	0.953
Panel F: Board lot trades of the total sample of 297 losers with event defined as half-hour intervals [-6, 6]; i.e. day [0], where pre- and post-event periods are defined as the day immediately before and after the event, respectively										
Prior day (a)	0.373*	0.338	b a	2.00	0.046	139	41	117	1.312	0.189
Event (b)	0.420*	0.388	c-b	-1.00	0.320	119	47	131	-0.695	0.486
Subsequent day (c)	0.394*	0.357	c-a	0.93	0.353	123	51	123	0.000	1.000

Table 17 (continued)

Part 2. Greater than and equal to ask

				t-test		Sign test				
Period	Mean	Median	Difference	t-stat	p-value	Incr	Equal	Decr	Z-stat	p-value
Panel A: Total sample of 297 losers with event defined as half-hour intervals [-6, 6]; i.e. day [0], where pre- and post-event periods are as defined above										
Pre-event (a)	0.338*	0.340	b-a	-4.74	0	104	2	191	-5.007	0
Event (b)	0.276*	0.284	c-b	5.83	0	201	2	94	6.171	0
Post-event (c)	0.353*	0.354	c-a	1.73	0.084	162	0	135	1.508	0.131
Panel B: Total sample of 297 losers with event defined as half-hour intervals [-19, 19]; i.e. days [-1, 1], where pre- and post-event periods are as defined above										
Pre-event (a)	0.332*	0.338	b-a	0.20	0.844	141	0	156	-0.812	0.416
Event (b)	0.334*	0.333	c-b	1.76	0.079	175	0	122	3.017	0.003
Post-event (c)	0.353*	0.358	c-a	2.27	0.024	162	2	133	1.630	0.103
Panel C: Total sample of 297 losers with event defined as half-hour intervals [-6, 6]; i.e. day [0], where pre- and post-event periods are defined as the day immediately before and after the event, respectively										
Prior day (a)	0.381*	0.333	b-a	-4.84	0	116	25	156	-2.364	0.018
Event (b)	0.276*	0.284	c-b	0.74	0.46	123	46	128	-0.252	0.800
Subsequent day (c)	0.289*	0.250	c-a	-3.87	0	119	35	143	-1.42	0.155

Table 17 (continued)

				t-test		Sign test				
Period	Mean	Median	Difference	t-stat	p-value	Incr	Equal	Decr	Z-stat	p-value
Panel D: Board lot trades of the total sample of 297 losers with event defined as half-hour intervals [-6, 6], i.e. day [0], where pre- and post-event periods are as defined above										
Pre-event (a)	0.331*	0.337	b-a	-3.35	0.001	116	3	178	-3.557	0
Event (b)	0.278*	0.222	c-b	4.32	0	183	1	113	4.010	0
Post-event (c)	0.349*	0.348	c-a	1.96	0.051	151	1	145	0.290	0.771
Panel E: Board lot trades of the total sample of 297 losers with event defined as half-hour intervals [-19, 19], i.e. days [-1, 1], where pre- and post-event periods are as defined above										
Pre-event (a)	0.328*	0.330	b-a	-0.52	0.606	132	5	160	-1.58	0.114
Event (b)	0.322*	0.311	c-b	2.02	0.044	168	1	128	2.266	0.023
Post-event (c)	0.348*	0.350	c-a	2.12	0.035	157	1	139	0.988	0.323
Panel F: Board lot trades of the total sample of 297 losers with event defined as half-hour intervals [-6, 6]; i.e. day [0], where pre- and post-event periods are defined as the day immediately before and after the event, respectively										
Prior day (a)	0.316*	0.286	b-a	-1.79	0.074	107	66	124	-1.052	0.292
Event (b)	0.278*	0.222	c-b	-1.07	0.285	97	88	112	-0.968	0.332
Subsequent day (c)	0.258*	0.167	c-a	-2.86	0.005	96	71	130	-2.195	0.028

Table 17 (continued)

Part 3. Less than midpoint of bid-ask spread

				t-test		Sign test				
Period	Mean	Median	Difference	t-stat	p-value	Incr	Equal	Decr	Z-stat	p-value
Panel A: Total sample of 297 losers with event defined as half-hour intervals [-6, 6]; i.e. day [0], where pre- and post-event periods are as defined above										
Pre-event (a)	0.519*	0.505	b-a	2.57	0.011	165	0	132	1.856	0.063
Event (b)	0.559*	0.552	c-b	-3.94	0	114	0	183	-3.945	0
Post-event (c)	0.494*	0.474	c-a	-2.54	0.011	133	1	163	-1.685	0.092
Panel B: Total sample of 297 losers with event defined as half-hour intervals [-19, 19]; i.e. days [-1, 1], where pre- and post-event periods are as defined above										
Pre-event (a)	0.527*	0.510	b-a	-1.86	0.064	142	1	154	-0.639	0.522
Event (b)	0.507*	0.500	c-b	-1.15	0.249	128	3	166	-2.157	0.031
Post-event (c)	0.494*	0.474	c-a	-3.24	0.001	132	0	165	-1.856	0.063
Panel C: Total sample of 297 losers with event defined as half-hour intervals [-6, 6]; i.e. day [0], where pre- and post-event periods are defined as the day immediately before and after the event, respectively										
Prior day (a)	0.445*	0.450	b-a	4.81	0	168	21	108	3.551	0
Event (b)	0.559*	0.552	c-b	-3.71	0	117	14	166	-2.853	0.004
Subsequent day (c)	0.467*	0.449	c-a	0.84	0.399	137	24	136	0	1.000

Table 17 (continued)

				t-test		Sign test				
Period	Mean	Median	Difference	t-stat	p-value	Incr	Equal	Decr	Z-stat	p-value
Panel D: Board lot trades of the total sample of 297 losers with event defined as half-hour intervals [-6, 6], i.e. day [0], where pre- and post-event periods are as defined above										
Pre-event (a)	0.519*	0.498	b-a	-2.63	0.009	131	2	164	-1.863	0.062
Event (b)	0.467*	0.436	c-b	1.57	0.118	156	1	140	0.871	0.383
Post-event (c)	0.498*	0.492	c-a	-2.38	0.018	143	1	153	-0.523	0.601
Panel E: Board lot trades of the total sample of 297 losers with event defined as half-hour intervals [-19, 19], i.e. days [-1, 1], where pre- and post-event periods are as defined above										
Pre-event (a)	0.522*	0.502	b-a	-1.66	0.098	134	1	162	-1.513	0.130
Event (b)	0.499*	0.478	c-b	-0.08	0.933	145	1	151	-0.232	0.815
Post-event (c)	0.498*	0.488	c-a	-2.58	0.01	139	0	158	-0.988	0.323
Panel F: Board lot trades of the total sample of 297 losers with event defined as half-hour intervals [-6, 6], i.e. day [0], where pre- and post-event periods are defined as the day immediately before and after the event, respectively										
Prior day (a)	0.443*	0.462	b-a	1.02	0.310	137	43	117	1.192	0.233
Event (b)	0.467*	0.436	c-b	-0.52	0.605	119	46	132	-0.757	0.448
Subsequent day (c)	0.454*	0.435	c-a	0.43	0.670	127	42	128	0	1.000

Table 17 (continued)

Part 4. Geater than midpoint of bid-ask spread

				t-test		Sign test				
Period	Mean	Median	Difference	t-stat	p-value	Incr	Equal	Decr	Z-stat	p-value
Panel A: Total sample of 297 losers with event defined as half-hour intervals [-6, 6]; i.e. day [o], where pre- and post-event periods are as defined above										
Pre-event (a)	0.387*	0.391	b-a	-2.95	0.003	117	1	179	-3.54	0
Event (b)	0.343*	0.333	c-b	3.92	0	184	3	110	4.257	0
Post-event (c)	0.404*	0.416	c-a	1.77	0.07	166	1	130	2.034	0.041
Panel B: Total sample of 297 losers with event defined as half-hour intervals [-19, 19]; i.e. days [-1, 1], where pre- and post-event periods are as defined above										
Pre-event (a)	0.380*	0.389	b-a	1.71	0.088	145	0	152	-0.348	0.727
Event (b)	0.398*	0.391	c-b	0.53	0.593	167	4	126	2.336	0.019
Post-event (c)	0.404*	0.410	c-a	2.44	0.015	170	2	125	2.561	0.010
Panel C: Total sample of 297 losers with event defined as half-hour intervals [-6, 6]; i.e. day [0], where pre- and post-event periods are defined as the day immediately before and after the event, respectively										
Prior day (a)	0.450*	0.429	b-a	-4.46	0	115	18	164	-2.873	0.004
Event (b)	0.343*	0.333	c-b	-0.26	0.792	129	34	134	-0.246	0.805
Subsequent day (c)	0.338*	0.333	c-a	-4.44	0	116	25	156	-2.364	0.018

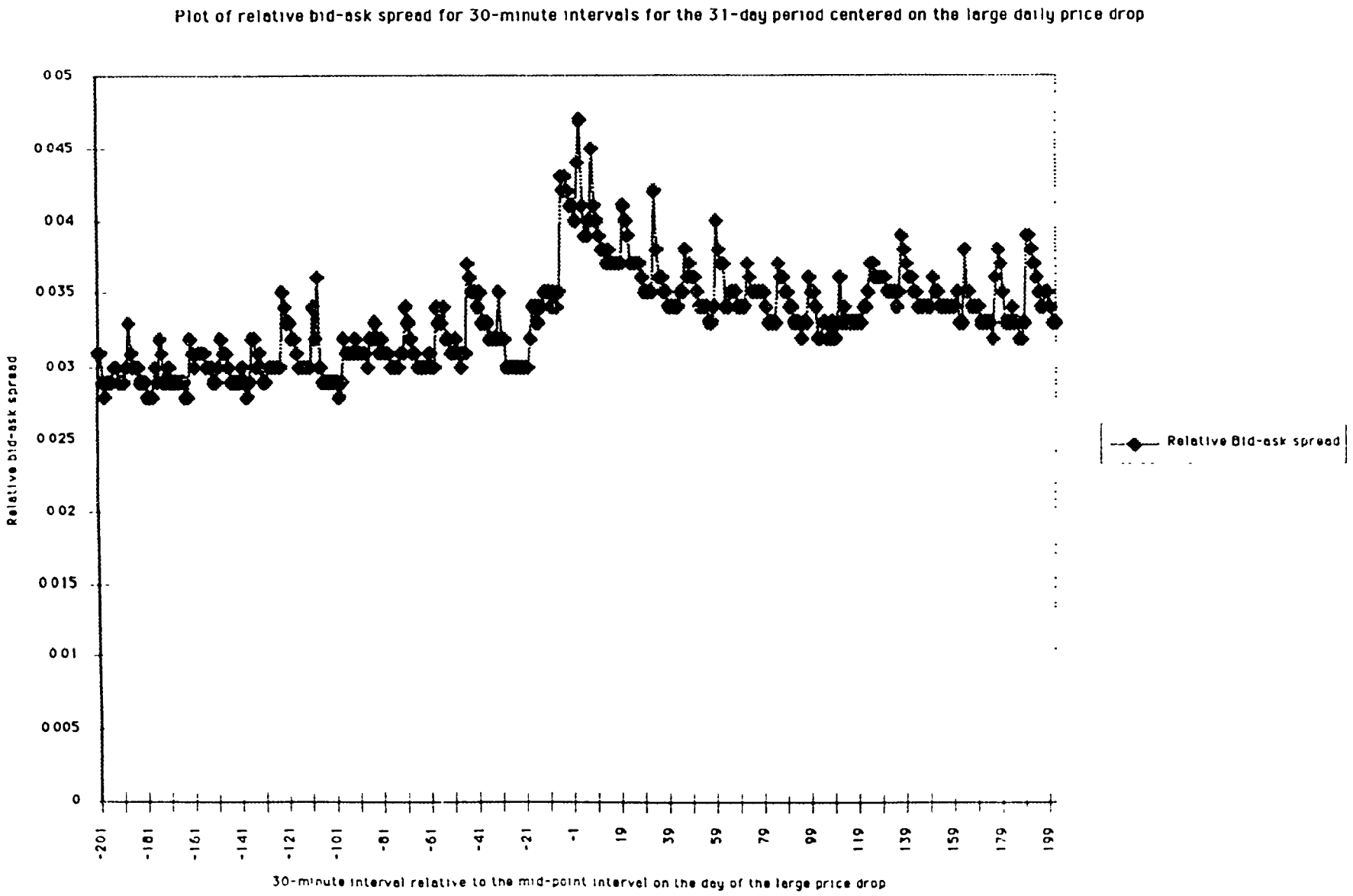
Table 17 (continued)

				t-test		Sign test				
Period	Mean	Median	Difference	t-stat	p-value	Incr	Equal	Decr	Z-stat	p-value
Panel D: Board lot trades of the total sample of 297 losers with event defined as half-hour intervals [-6, 6], i.e. day [0], where pre- and post-event periods are as defined above										
Pre-event (a)	0.382*	0.390	b-a	-4.36	0	118	2	177	-3.324	0
Event (b)	0.309*	0.291	c-b	4.87	0	181	0	116	3.778	0
Post-event (c)	0.392*	0.404	c-a	1.01	0.314	149	1	147	0.058	0.953
Panel E: Board lot trades of the total sample of 297 losers with event defined as half-hour intervals [-19, 19], i.e. days [-1, 1], where pre- and post-event periods are as defined above										
Pre-event (a)	0.381*	0.387	b-a	-1.59	0.112	136	1	160	-1.28	0.200
Event (b)	0.360*	0.358	c-b	2.45	0.015	162	0	135	1.569	0.116
Post-event (c)	0.392*	0.404	c-a	1.10	0.274	153	0	144	0.523	0.601
Panel F: Board lot trades of the total sample of 297 losers with event defined as half-hour intervals [-6, 6]; i.e. day [0], where pre- and post-event periods are defined as the day immediately before and after the event, respectively										
Prior day (a)	0.350*	0.333	b-a	-1.85	0.066	110	53	134	-1.472	0.141
Event (b)	0.309*	0.291	c-b	-0.03	0.974	111	71	115	-0.199	0.841
Subsequent day (c)	0.309*	0.250	c-a	-1.86	0.064	108	59	130	-1.361	0.173

Table 18. The mean and median measures of trade depth for the half-hour intervals for the total sample of 297 losers are presented below. Standard t- and sign tests are used to test if the trade depths are different in the pre-, post- and event periods. The pre- and post-event periods are [-201, -7] and [7, 201], respectively, if the event period is [-6, 6]; that is, the day of the large loss. They are [-201, -20] and [20, 201], respectively, if the event period is [-19, 19]; that is, the day of the large loss and the day immediately before and after this day. [b-a] is the difference between the event and pre-event measures; [c-b] is the difference between the post-event and event measures; and [c-a] is the difference between the post-event and pre-event measures. All measures of trade depth are for a 30-minute interval. * indicates significance at the 5% level.

				t-test		Sign test				
Period	Mean	Median	Difference	t-stat	p-value	Incr	Equal	Decr	Z-stat	p-value
Panel A: Total sample of 297 losers with event defined as half-hour intervals [-6, 6]; i.e. day [0], where pre- and post-event periods are as defined above										
Pre-event (a)	0.547	0.436	b-a	3.43	0.001	172	2	123	2.794	0.005
Event (b)	6.939*	1.846	c-b	-3.11	0.002	127	1	169	-2.383	0.017
Post-event (c)	0.601	0.723	c-a	0.04	0.97	156	0	141	0.812	0.417
Panel B: Total sample of 297 losers with event defined as half-hour intervals [-19, 19]; i.e. days [-1, 1], where pre- and post-event periods are as defined above										
Pre-event (a)	-0.006	0.357	b-a	3.73	0	186	2	109	4.424	0
Event (b)	5.911*	2.051	c-b	-2.87	0.004	130	1	166	-2.034	0.042
Post-event (c)	0.465	0.643	c-a	0.3	0.763	157	0	140	0.928	0.353
Panel C: Total sample of 297 losers with event defined as half-hour intervals [-6, 6]; i.e. day [0], where pre- and post-event periods are defined as the day immediately before and after the event, respectively										
Prior day (a)	8.283*	1.692	b-a	-0.56	0.577	135	20	142	-0.360	0.718
Event (b)	6.939*	1.846	c-b	-2.44	0.015	120	17	160	-2.33	0.019
Subsequent day (c)	2.510	0.154	c-a	-2.07	0.039	130	14	153	-1.307	0.191

Figure 1


Plot of relative bid-ask spread for 30-minute intervals for the 31-day period centered on the large daily price drop
Relative bid-ask spread
0.05
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
-201
-181
-161
-141
-121
-101
-81
-61
-41
-21
-1
19
39
59
79
99
119
139
159
179
199
30-minute interval relative to the mid-point interval on the day of the large price drop
Relative Bid-ask spread