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Trading halts and the speed of adjustment of the market

Fong, Wai-Ming, Ph.D.
The Ohio State University, 1993
TRADING HALTS AND
THE SPEED OF ADJUSTMENT OF THE MARKET

DISSERTATION

Presented in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy
in the Graduate School of The Ohio State University

By

Wai-Ming Fong, B.S.Sc., M.A.

The Ohio State University
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To God Almighty
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CHAPTER I
INTRODUCTION

When a significant event for a stock occurs, the New York Stock Exchange (NYSE) may call a trading halt for the stock. The NYSE may delay the opening of the stock, or it may halt the continuous trading of the stock after the market has opened. During the trading halt, the NYSE announces the reason and some price indications. The reason is usually either an order imbalance or a news announcement. A price indication consists of a high price and a low price, enclosing the potential market re-opening price. Traders can submit orders during the halt, but the orders are not executed until the market re-opens with a call auction. After the market re-opens, the usual market of continuous trading resumes.

Trading halts serve three main purposes. The first purpose is to reduce volatility [e.g., the Market Volatility and Investor Confidence Panel (1990)]. The second purpose is to incorporate information into the market re-opening price [e.g., Hopewell and Schwartz (1978)]. The third purpose is to resolve information asymmetry [e.g., King, Pownall, and Waymire (1992)]. There is a debate about the effectiveness of trading halts.\(^1\) Lee, Ready, and Seguin (1992) find that volatility in the first post-halt trading day is significantly larger than volatility in the first post-pseudo-halt trading day (pseudo-halts are periods of

\(^1\) For example, Greenwald and Stein (1991) suggest that trading halts can reduce volatility, while Grossman in the Market Volatility and Investor Confidence Panel (1990) argues that trading halts can exacerbate volatility. Read Chapter III for details.
continuous trading that match trading halts in stock, time of the day, duration, and absolute excess return). They conclude that trading halts do not reduce volatility. However, since there is a potential bias caused by the difference in information events between trading halts and pseudo-halts, their conclusion is controversial. Hopewell and Schwartz (1978) find that information is incorporated into the market re-opening price for imbalance halts, but not for news halts. However, since they use daily data, how long it takes for the information left after news halts to be incorporated into post-halt prices is not yet known. There is no empirical evidence on the effectiveness of trading halts in resolving information asymmetry.

This study examines the intraday speed of market adjustment to triggers (events that trigger trading halts) in the NYSE. I address all three purposes of trading halts by focusing my analysis on the volatility adjustment process, the price adjustment process, and the resolution of information asymmetry. Although the results are not sufficient to let us conclude whether trading halts are effective or not, they provide indirect evidence on the effectiveness of trading halts by helping us understand more about how long it takes after the market re-opens for the market adjustment to complete. The more effective trading halts are, the more complete the market adjustment during the halts should be, and the shorter it should take after the market re-opens for the market adjustment to complete.

I find that the volatility adjustment process after trading halts is slow. The post-halt abnormal volatility needs a long time (5 trading days or longer) to decay because new information arrives after the market re-opens. Since the arrival rate of new information is determined by the information-generating process of stocks, it is doubtful whether the NYSE should expect that the post-halt market is calm even if trading halts really reduce volatility. The volatility adjustment process after trading halts is slow even in contrast
with the volatility adjustment process after pseudo-halts. It takes two and a half hours after the market re-opens for the post-halt volatility to decay to the level of post-pseudo-halt volatility. This suggests that the adjustment of the market to triggers is not completed during trading halts.

Triggers of news halts and imbalance halts are very significant information events which cause large price movements. For news halts, not all information is incorporated into the market re-opening price. The incomplete incorporation of information during the halts causes a pattern of price continuations in the post-halt period. The pattern indicates that information is not fully incorporated into prices until the market has re-opened for 30 minutes. For imbalance halts, information is incorporated into the market re-opening price.

I find that bid-ask spreads in the first one and a half hours of the post-halt period are larger than normal, and these abnormal bid-ask spreads are caused by information asymmetry, rather than by an adverse inventory position of market makers. Therefore, information asymmetry is not resolved until the market has re-opened for one and a half hours.

The above results do not necessarily suggest that trading halts are ineffective, since it is possible that had trading halts not been called, the speed of adjustment of the market would be lower. On the other hand, the results indicate that the adjustment of the market to events that trigger trading halts is not completed until the continuous market has resumed for a period of time.

We can categorize trading halts by their triggers or by whether they are delayed openings or intraday halts. Hopewell and Schwartz (1978) study the price adjustment process for different types of halts. On the other hand, no study, theoretical or empirical,
tries to investigate whether the decay in volatility and information asymmetry differs for different types of halts. The second objective of this study is to have an exploratory analysis on this issue. Since differences in the adjustment of the market between different types of halts should be caused by differences in the nature of the triggers and the effectiveness of the halts, the results help us understand more about the factors of adjustment of the market when trading halts are called.

An imbalance trigger may arise from the response of market participants to a news announcement\(^2\), or from the actions of informed traders who submit orders to exploit the market with their private information. Therefore, the likelihood for imbalance halts involving news announcements should be smaller than that for news halts. News announcements may help market participants know more about the information to the detriment of the monopolistic advantage of informed traders, so that more information may be revealed and more information asymmetry may be resolved during news halts than during imbalance halts. On the other hand, the call auction of trading halts, by imposing delay, may force informed traders to reveal information through their order placements\(^3\), so that the information revealed and information asymmetry resolved during trading halts may not differ for these two types of halts. Hopewell and Schwartz (1978) find that the price adjustment process is slower for news halts than for imbalance halts. Therefore, it seems that the presence of news announcements does not help the effectiveness of trading

\(^2\) The news announcement may be prior to the imbalance halt (if the NYSE under-estimates its significance and fails to initiate a news halt), or after the start of the imbalance halt (if the corporation fails to inform the NYSE of the forthcoming news). The news announcement may also arise from a source other than the corporation, such as a competitor. Read page 1361, Hopewell and Schwartz (1978).

\(^3\) Read page 72, Stoll (1985).
This study provides further evidence that the presence of news announcements does not help the effectiveness of trading halts. I find no difference in the abnormal volatility and abnormal bid-ask spreads in the post-halt period between imbalance halts and news halts, suggesting that the decay in volatility and information asymmetry is not faster for news halts.

A delayed opening prolongs the overnight trading halt, whereas an intraday halt replaces a period of continuous trading with a trading halt and a call auction. Therefore, an intraday halt seems to cause a more abrupt change in trading mechanism than a delayed opening. In view of the common corporate practice of releasing important news to the media after the close of NYSE trading, it is possible that the nature of the triggers of intraday halts (which occur during the trading time) is unusual in contrast with the nature of the triggers of delayed openings (which occur after the close of trading). I investigate whether the two differences between these two types of halts lead to a faster decay in volatility and information asymmetry for delayed openings. The results should let us understand more about how the process of market adjustment may be affected by how much the trading mechanism is changed and by the nature of triggers. I find that the abnormal bid-ask spreads in the post-halt period do not differ for these two types of halts, suggesting that there is no difference between the incompleteness of market adjustment to triggers during intraday halts and that during delayed openings. On the other hand, the new information that "clusters" with the triggers of intraday halts seems to be more significant than the new information that "clusters" with the triggers of delayed openings, so that post-halt abnormal volatility is larger for intraday halts than for delayed openings.

The rest of this study is organized as follows. In Chapter II, I describe the mechanism of trading halts. Chapter III reviews the relevant literature. In Chapter IV, I
discuss the objectives of this study, and explain how this study contributes to the literature. Chapter V describes the sample. Chapter VI discusses the study of the speed of adjustment of the market. Chapter VII studies the differences in decay of volatility and information asymmetry between different types of trading halts. The conclusion is in Chapter VIII.
CHAPTER II
MECHANISM OF TRADING HALTS

When a significant event for a stock occurs, the NYSE may call a trading halt for the stock. Trading halts can be classified by the time of the day they are called. When the NYSE delays the opening of a stock, the trading halt is a delayed opening; when the NYSE halts the continuous trading of a stock after the market has opened, the trading halt is an intraday halt. Trading halts can also be classified by the events that trigger them. In this study, I observe the following types of halts:

(1) Imbalance halt: When there is a large buy (or sell) order imbalance for a stock, the specialist, with the permission of a Floor Official, may halt the trading of the stock.

(2) Influx halt: When there is a sudden inflow of orders for a stock, the specialist, with the permission of a Floor Official, may halt the trading of the stock.

(3) News halt: When a major corporate announcement is imminent, the corporation executives are required to inform the exchange. A Floor Official, in consultation with the specialist, may halt the trading of the stock. If a news announcement has been disseminated, a Floor Official and the specialist may also halt the trading of the stock. "A news [trading] suspension request can also be initiated from the trading floor by either the Division of Stock Watch or the

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4 For details, read Hopewell and Schwartz (1978) and the documentation for NYSE and AMEX Trades and Quotes Transactions File of Institute for the Study of Security Markets.
specialist if unusual market activity or rumors that merit investigation occur."5

Not every order imbalance will trigger a trading halt. For example, even if there is an order imbalance accumulated overnight, the market opening will not be delayed if the specialist is willing to absorb the order imbalance by his own account to keep the opening price close to the preceding closing price. Of course, not every order influx will trigger a trading halt; and in fact, in our sample, there is only one influx halt. Similarly, not every news announcement will trigger a trading halt. As an illustration, out of the 796 earnings announcements and dividend declarations in the sample of Patell and Wolfson (1984), only 16 have triggered trading halts.

When a trading halt is triggered by an event of any of the above three types, the trading mechanism will be as follows.6 The specialist, supervised by various officials of the NYSE, announces the reason (i.e., the type of the event) of the trading halt and a price indication over the Consolidated Quotations System (CQS). A price indication consists of a high price and a low price, and indicates a range for the potential market re-opening price. More than one price indication may be announced before the market re-opens. Price indications are binding on the specialist to the extent that the market re-opening price cannot fall outside the range of the last price indication. Traders may infer from the price indication some information about the market condition, and can submit their orders. However, the orders will not be executed until the market re-opens. Only the specialist


(and other approved people) knows the accumulated orders. The supervised specialist re-opens the market with a call auction (which is similar to the call auction that opens the market daily). He aggregates all accumulated orders to form demand and supply schedules. The price and volume that clear the market are found from the schedules. Then, the usual market of continuous trading resumes.
CHAPTER III
REVIEW OF LITERATURE

Trading halts serve three main purposes. In Sections 3.1 through 3.3, I review the literature that studies these purposes. Section 3.4 discusses the literature that studies other issues on trading halts.

3.1 Trading Halts as Market Circuit Breakers

The NYSE uses trading halts as market circuit breakers\(^7\) to reduce volatility, but there is a debate about whether trading halts can decrease volatility.

The main arguments of proponents of using trading halts as market circuit breakers are that the information provided to traders during trading halts is useful for the resolution of the uncertainty caused by significant events, and call auctions allow volume shocks to be absorbed by large groups of market participants. The Market Volatility and Investor Confidence Panel (1990, pages 3 and 4) argue that a trading halt can "give buyers and sellers a chance to catch up their breath and calmly assess their positions, ... and help restore investor confidence in the market during periods of large price swings by allowing time for a broader range of investors to participate in the market". Schwartz (1988, pages 30, 53, and 54) argues that "[during] trading halts on the NYSE, the specialist assesses the

\(^7\) Different forms of market circuit breakers include price limits and restrictions on certain types of orders, besides trading halts. For details, read Appendix E, the Market Volatility and Investor Confidence Panel (1990).
market conditions and tests the water by sending out price indications; and that] specialist intervention, either to make stabilizing trades or to halt trading, prevents wide swings in price that might otherwise occur, either because the number of counterpart orders is temporarily sparse or because the market has over-reacted to news. "[When there are large order imbalances, the NYSE] maintains that [trading] suspensions may prevent or lessen inequities among market participants due to 'unnecessary' price fluctuations."8 Greenwald and Stein (1988 and 1991) support the practice of calling trading halts during times of large supply/demand shocks. They suggest that with the release of information during a trading halt to help resolve traders' uncertainty, a call auction can lead to a broader distribution of a volume shock and a more informative price. Miller (1990) argues that when the equilibrium price has changed significantly in a short period of time, finding the new equilibrium price should be accomplished by a call auction, which is more objective than relying on the personal judgment of the specialist.

However, there are critics who suggest that trading halts may actually exacerbate volatility. Sanford Grossman in the Market Volatility and Investor Confidence Panel (1990) argues that actual price movements provide better information about the market condition to traders than price indications do, and that temporarily closing the market creates uncertainty about the size of order imbalance and makes it impossible for forces of the market to work efficiently. G. William Schwert in the Market Volatility and Investor Confidence Panel (1990) suggests from the results of Amihud and Mendelson (1987) that trading halts and call auctions may lead to large volatility [Amihud and Mendelson (1987) find that the volatility at the market opening is larger than the volatility at the market

There are several empirical works comparing trading halts and market circuit breakers with periods of continuous trading. Roll (1988), Bertero and Mayer (1990), and Lauterbach and Ben-Zion (1991) study the market crash of October 1987. They find that the stocks that experienced price contingent trading halts had smaller absolute returns for the several days after the market crash than the stocks that did not, but all the stocks had similar absolute returns for the several months after the market crash. They conclude that price contingent trading halts mitigate short-run volatility, but not long-run volatility.

Lee, Ready, and Seguin (1992) also investigate whether trading halts reduce volatility. They have two major findings. First, volume and volatility in the first post-halt trading day are significantly larger than normal. Second, volume and volatility are significantly larger in the first post-halt trading day than in the first post-pseudo-halt trading day. They conclude that trading halts do not reduce volatility. The reasons they suggest are that the information provided to traders during trading halts is insufficient, and the coverage of trading halts by news media increases the heterogeneity of traders' beliefs.

3.2 Incorporation of Information into Prices

The second purpose that trading halts are supposed to serve is to incorporate information into the market re-opening price. Using weekly Canadian data, Kryzanowski (1979) concludes that: (1) there are significant abnormal returns before and during trading halts, and (2) the market is efficient in the semi-strong form for favorable, but not unfavorable, new public information.

Hopewell and Schwartz (1976 and 1978) study the daily abnormal return patterns around the times of trading halts. They find that there are significant abnormal returns in
days before trading halts and in days of trading halts. They also find a statistically
significant pattern of price continuations after news halts (the mean abnormal return in the
first post-halt day is significantly positive when during-halt return is positive, and is
significantly negative when during-halt return is negative) and no pattern after imbalance
halts. Their results suggest that information is incorporated into the market re-opening
price for imbalance halts, but not for news halts.

3.3 Resolution of Information Asymmetry

Trading halts may be called to resolve information asymmetry. Glosten (1989,
page 229) suggests that "[one] can ... interpret trading suspensions as a reaction to the
existence of private information". "The NYSE maintains that information lags in the
marketplace can create inequities arising from monopolistic access to information by a
select group of investors. It argues that [trading] suspensions for news announcements
provide wider and thus more equitable information dissemination." King, Pownall, and
Waymire (1992) assert that one of the purposes that trading halts serve is to allow time for
information to be widely disseminated so that informed traders cannot exploit uninformed
traders, and that trading halts "are likely to be called for material disclosures that are
characterized by more uncertain, difficult, and protracted price discovery processes". Stoll
(1985, pages 72 and 73) argues that "a call auction market, by imposing delay, may
be a mechanism that forces information traders to reveal, through their order placements,
the existence of information. Indeed, in continuous markets such as the NYSE, periods of

---


10 Page 513.
apparent informational asymmetry, manifested by an imbalance in orders, cause a trading halt and put into process a call auction procedure". Bhattacharya and Spiegel (1993) study cross-sectional patterns in trading halts, and conclude that larger levels of information asymmetry are required to induce a halt for a stock with a greater level of total risk in returns of the stock (holding the fraction of the hedgeable risk of the stock constant).

3.4 Other Issues on Trading Halts

Besides the above three purposes, there are other (minor) reasons why the NYSE calls trading halts.11 The NYSE argues that a sudden order influx can temporarily overwhelm the specialist, and may lead to inaccurate order executions. Consequently, a trading halt may be called. The price continuity test of the NYSE may also encourage specialists to initiate trading halts, which provide official sanction for a large price change.

There are empirical studies relating price indications and duration of trading halts to information uncertainty. Schwartz (1982) finds that successive price indications released during trading halts have narrower spreads and are more accurate in enclosing the market re-opening price, and he suggests that these are consistent with a "progressive resolution of specialist uncertainty as successive indications appear"12. King, Pownall, and Waymire (1992) find that if a trading halt has a larger absolute during-halt return, it tends to have a longer trading halt and more price indications, and its price indications tend to have lower accuracy and wider spreads.


12 Page 234.
4.1 The Speed of Adjustment of the Market

To address the issue on whether trading halts reduce volatility, the ideal experiment is to compare volatility around trading halts with volatility in a continuous trading setting, holding the information events constant. However, the experiment is not feasible: once a trading halt is called, we cannot observe what would happen had the halt not been called.

A possible approach that provides indirect evidence on the effectiveness of trading halts in reducing volatility is to study the volatility adjustment process after the market re-opens, and compare it with the volatility adjustment process after pseudo-halts. Two issues can be addressed by this approach. The first issue is whether post-halt volatility needs a long time to decay to normal. This shows the speed of volatility adjustment process after trading halts, and also suggests whether post-halt volatility is affected by new information that arrives after the market re-opens.\footnote{In view of the well-documented phenomenon of autocorrelation of volatility, it is likely that post-halt volatility is affected by new information that arrives after the market re-opens. Read, for example, Lamoureux and Lastrapes (1990) for the hypothesis of time dependence in the rate of information arrival to the market for individual stocks.} If part of post-halt abnormal volatility is caused by the arrival of new information, the NYSE should not expect that the post-halt market is calm even if trading halts are effective in reducing volatility. The
second issue is how intraday volatility adjustment process in the post-halt period differs from that in the post-pseudo-halt period. This can tell us the speed of volatility adjustment process after trading halts (in contrast with the speed of volatility adjustment process after pseudo-halts) so that we should know more about how incomplete the market adjustment to triggers during trading halts is. The less effective trading halts are, the less complete the market adjustment during halts should be, and the longer it should take after the market re-opens for the market adjustment to complete.

In fact, Lee, Ready, and Seguin (1992) use the above approach. However, there are two drawbacks in their study. The first drawback is that they regard their results as direct evidence on the effectiveness of trading halts, and conclude that trading halts do not reduce volatility. Their conclusion is controversial, because there is a potential bias caused by the difference in information events between trading halts and pseudo-halts. Although information events of pseudo-halts are similar in price movement to information events of trading halts, they are not significant enough (at least in the opinion of the NYSE) to trigger trading halts. Holding other things constant, the difference in information events between the two cases is likely to inflate the post-halt volatility relative to the post-pseudo-halt volatility. The second drawback of their study is that they use daily observations, and study only the first post-halt trading day. Although they have a figure showing an intraday pattern of the post-halt abnormal volatility, together with an intraday pattern of the post-pseudo-halt abnormal volatility, they have not tested for the significance of the difference between the two patterns. But even if they had analyzed how much and how long volatility differs in the two cases, their analysis would not be fair. The reason is that their pseudo-halts might under-match their trading halts in absolute
Because of the two drawbacks in their study, the two issues that can be addressed by the above approach are not yet addressed. This study investigates these two issues using the above approach.

Since the second purpose that trading halts are supposed to serve is to incorporate information into prices, it should be natural to investigate whether trading halts incorporate all information into the market re-opening price, and to examine the time needed for the information left after halts to be incorporated into post-halt prices. The results provide indirect evidence on the effectiveness of trading halts in incorporating information into prices. There are empirical works (reviewed in Section 3.2) that study whether all information is incorporated into the market re-opening price. However, since none of them uses intraday data, the time needed for the information left after halts to be incorporated into post-halt prices is not yet known. This study addresses this issue.

The studies reviewed in Section 3.3 explain why trading halts are called to resolve information asymmetry. However, none of them provides any kind of evidence on the effectiveness of trading halts in resolving information asymmetry. It is not necessarily true that information asymmetry is completely resolved during trading halts, since informed traders may be able to avoid revealing some of their private information in their orders. This study provides indirect evidence on the effectiveness of trading halts in resolving information asymmetry by examining how long it takes after the market re-opens for information asymmetry to be resolved.

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14 If I had used their method to select pseudo-halts, my sample of pseudo-halts would under-match the sample of trading halts in absolute excess return. Read Section 6.1.2 for details.
To sum up, the first objective of this study is to address all three purposes of trading halts and focus on the intraday speed of market adjustment to events that trigger trading halts in the NYSE. By helping us understand more about how long it takes after the market re-opens for the market adjustment to complete, the results provide indirect evidence on the effectiveness of trading halts. The more effective trading halts are, the more complete the market adjustment during the halts should be, and the shorter it should take after the market re-opens for the market adjustment to complete.

4.2 Differences between Different Types of Trading Halts

Hopewell and Schwartz (1978) study the price adjustment process for different types of halts. No study, theoretical or empirical, tries to investigate the decay in volatility and information asymmetry for different types of halts. Differences in the adjustment of the market between different types of halts should be caused by differences in the nature of the triggers and the effectiveness of the halts. The second objective of this study is to have an exploratory analysis on how the decay in volatility and information asymmetry differs for different types of halts. The results should help us understand more about the factors of adjustment of the market when trading halts are called.

Hopewell and Schwartz (1978) suggest that an imbalance trigger may arise from the response of market participants to a news announcement. However, since it is also possible that an imbalance trigger arises from informed traders' orders, the likelihood for imbalance halts involving news announcements should be smaller than that for news halts. If news announcements let market participants know more about the information to the detriment of the monopolistic advantage of informed traders, more information can be revealed and more information asymmetry can be resolved during news halts than during
imbalance halts, so that the decay in volatility and information asymmetry can be faster for news halts. On the other hand, the arguments (reviewed in Section 3.3) for the resolution of information asymmetry during halts do not rely on the presence of news announcements. Therefore, it is also possible that the decay in volatility and information asymmetry does not differ for these two types of halts. The results of Hopewell and Schwartz (1978) indicate that the price adjustment process is slower for news halts than for imbalance halts. Therefore, it seems that the presence of news announcements does not help the effectiveness of trading halts. This study investigates whether the decay in volatility and information asymmetry is faster for news halts. The results should give further evidence on whether the presence of news announcements helps the effectiveness of trading halts or not.

Delayed openings and intraday halts have more similarities than differences, but the differences may be sufficient to impact the process of market adjustment. First, in view of the common corporate practice of releasing important news to the media after the close of NYSE trading, it is possible that the nature of the triggers of intraday halts is unusual in contrast with the nature of the triggers of delayed openings. The difference in the nature of triggers between the two halt types may cause a difference in the speed of adjustment of the market to triggers or in the arrival rate of new information. Second, a delayed opening prolongs the overnight trading halt, whereas an intraday halt replaces a period of continuous trading with a trading halt and a call auction. Therefore, an intraday halt seems to cause a more abrupt change in trading mechanism than a delayed opening. The difference in the resulting change in trading mechanism between the two halt types may
cause a difference in the speed of adjustment of the market to triggers. This study investigates whether the two differences between these two types of halts lead to a faster decay in volatility and information asymmetry for delayed openings. The results should let us understand more about how the process of market adjustment may be affected by how much the trading mechanism is changed and by the nature of triggers.

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15 The arrival rate of new information should be determined by the information-generating process of stocks, so it should not be affected by trading mechanism.
CHAPTER V
THE SAMPLE

The sample is constructed from the NYSE and AMEX Trades and Quotes Transactions File of Institute for the Study of Security Markets (the ISSM tape) for 1988 and 1989. I search through the ISSM tape (for each of the two years) for trading halts of NYSE common stocks. The common stocks must have an average of at least 15 trades per day, and no price of less than or equal to $5 during the year. Since this study focuses on intraday analyses, small stocks and thinly-traded stocks are excluded from the sample to avoid potential biases to the results. The following are also dropped from the sample:

1. 35 trading halts preceding delistings of the stocks from the NYSE: there is no data for the post-halt period in the ISSM tape.
2. 2 trading halts with missing during-halt return: the during-halt return is missing, because the trading halts started at the opening of the first trading day of the 1988 ISSM tape.
3. 15 trading halts with no price indications: a regular trading halt should have at least one price indication.
4. 11 trading halts with the ISSM tape recording wrong data for their characteristics: By examining the data around the trading halts, I discover that 8 have wrong time of either the start or the end of the halt, and 3 have wrong during-halt return. They may lead to some potential biases to the results, so they are dropped from the sample.
Finally, in the sample, there are 1513 trading halts. Table 1 summarizes their characteristics, which suggest that the sample is similar to the samples of other empirical studies on trading halts. The sample has more trading halts with "good news" than trading halts with "bad news". The average spread between the high price and the low price of the first price indication is more than 7% of the midpoint of the price indication. The mean and standard deviation of the spread of the last price indication are smaller than those of the first price indication. The average volume at the market re-opening is 134.57% of the total volume in the control day [the 10th (or later) post-halt trading day, see Section 6.1.1]. The average duration of trading halt is 0.87 trading hour.\footnote{I calculate the duration of a trading halt using the time recorded in the ISSM tape for the first quote condition indicating the start of the trading halt and the time recorded in the ISSM tape for the market re-opening trade.} The average absolute during-halt excess return is 6.05%.

During-halt excess return is during-halt return minus contemporary market return. Excess returns are used throughout the study to purge price movements related to the market. I use a data set of the S&P 500 index level at the end of every 5-trading-minute interval during 1988 and 1989 to compute the market returns.\footnote{I would like to thank Prof. K.C. Chan for providing me with the data set of the S&P 500 index level. The data set is constructed from the "Quote Capture" information of the Chicago Mercantile Exchange. Read Chan, Chan, and Karolyi (1991) for details.} During-halt return is defined to be $\log_e(\text{price}_2/\text{price}_1)$. $\text{price}_1$ is the price of the trade preceding trading halt, and is adjusted for dividend using the information provided by the ISSM tape. $\text{price}_2$ is the market re-opening price. Some trading halts (which represent a very small portion of the sample) have a re-opening quotation, instead of a re-opening trade, $\text{price}_2$ is then the midpoint of the re-opening quotation. Lee and Ready (1991) show that quotations are...
sometimes recorded faster than trades. Following Lee, Ready, and Seguin (1992), even if the first "normal" quotation\(^{18}\) after a trading halt is recorded in the ISSM tape earlier than the first "normal" trade\(^{19}\), I deem that the market has re-opened with a trade whenever the time difference between the first quotation and the first trade is no more than 10 seconds.

Out of the 1513 trading halts, 725 are triggered by order imbalances, 787 are triggered by news announcements that have been or are pending to be disseminated, and only 1 is triggered by an order influx. Table 1 shows some similarities and differences between imbalance triggers and news triggers. They cause similar numbers of trading halts, volume at the market re-openings, and spreads of the price indications.\(^{20}\) In contrast with news triggers, imbalance triggers cause larger absolute during-halt excess returns, shorter trading halts, and involve more "bad news" than "good news".\(^{21}\)

\[\text{"[When there are large order imbalances, the NYSE] maintains that [trading] suspensions may prevent or lessen inequities among market participants due to 'unnecessary' price fluctuations. ... The NYSE maintains that information lags in the marketplace can create inequities arising from monopolistic access to information by a select group of investors. It argues that [trading] suspensions for news announcements provide wider and thus more}\]

\(^{18}\) A quotation that is eligible for inclusion in the National and NASD Best Bid and Offer calculation: read the documentation for the ISSM tape for details.

\(^{19}\) A trade coded as "regular", "sold last", or "opening": read the documentation for the ISSM tape for details.

\(^{20}\) The t-statistics of 2-sample (assuming unequal variance) t-tests for the difference in volume at the market re-opening, spread of the first price indication, and spread of the last price indication between imbalance halts and news halts are respectively -0.697, 0.816, and 1.320.

\(^{21}\) The t-statistics of 2-sample (assuming unequal variance) t-tests for the difference in absolute during-halt excess return, duration of trading halt, and during-halt excess return between imbalance halts and news halts are respectively 2.920, -20.532, and -2.974.
equitable information dissemination." In view of the above explanation of the NYSE and the definition of the two halt types (as discussed in Chapter II), it seems that imbalance halts are called because there exists a large demand for liquidity services, whereas news halts are called to resolve information asymmetry. However, Table 1 suggests that triggers of both halt types are very significant information events. They cause very significant absolute during-halt excess returns, volume at the market re-openings, and spreads of the price indications. This suggests that one of the reasons for calling imbalance halts is the existence of information asymmetry. The only one influx halt in the sample seems to be triggered by a significant information event (which may be an "abnormal" order influx).

Hopewell and Schwartz (1978, page 1361) suggest that there is a "common corporate practice of releasing important news to the media after the close of NYSE trading". This may be the reason why 72% of the sample are delayed openings and 28% are intraday halts. Table 1 suggests that a delayed opening tends to have a larger during-halt excess return, a larger absolute during-halt excess return, a shorter trading halt, and a larger volume at the market re-opening than an intraday halt.\(^\text{23}\) Spreads of price indications do not differ for delayed openings and intraday halts.\(^\text{24}\)

\(^{22}\) Pages 1357 - 1358, Hopewell and Schwartz (1978).

\(^{23}\) The t-statistics of 2-sample (assuming unequal variance) t-tests for the difference in during-halt excess return, absolute during-halt excess return, duration of trading halt, and volume at the market re-opening between delayed openings and intraday halts are respectively 2.004, 6.532, -8.455, and 2.465.

\(^{24}\) The t-statistics of 2-sample (assuming unequal variance) t-tests for the difference in spread of the first price indication and spread of the last price indication between delayed openings and intraday halts are respectively 1.161 and 0.634.
CHAPTER VI
THE SPEED OF ADJUSTMENT OF THE MARKET

This chapter provides indirect evidence on the effectiveness of trading halts by analyzing the intraday speed of market adjustment to events that trigger trading halts in the NYSE. In Section 6.1, I study the volatility adjustment process. In Section 6.2, I analyze the price adjustment process. Section 6.3 studies the resolution of information asymmetry. Section 6.4 concludes this chapter.

6.1 The Volatility Adjustment Process

6.1.1 The Persistence of Volatility

6.1.1.1 Methods

This section studies the volatility adjustment process after the market re-opens. In Section 6.1.2, I compare it with the volatility adjustment process after pseudo-halts.

I study the intraday volatility adjustment process in the first 5 post-halt trading days. The results show the speed of volatility adjustment process after trading halts, and also suggest whether post-halt volatility is affected by new information that arrives after the market re-opens. The post-halt volatility may be affected by the information left after halts or the arrival of new information (or both). If the post-halt volatility is affected solely by the information left after halts, we should not observe abnormal volatility long after the market re-opens. If the post-halt volatility is affected also by the arrival of new information, we may still observe abnormal volatility in the 4th or 5th post-halt trading
Before I can study the post-halt abnormal volatility, I need to find a proxy for the normal level that the post-halt volatility returns to. It is undesirable to choose some days in the pre-halt period as the proxy, since triggers may change the normal level of volatility due to reasons such as a leverage effect. Days too close to trading halts are not suitable either, since triggers and new information may still have some effects on those days. Days too far away from trading halts are also unsuitable, since the normal level of volatility may have changed. The 10th post-halt trading day is a reasonable compromise between the too close and the too far away, so it is chosen as the proxy for the normal level that the post-halt volatility returns to. As later results suggest, choosing a day that is later than the 10th post-halt trading day as the control day is unlikely to affect the conclusion.

For some trading halts, the 10th post-halt trading day is not a good control day, because it is within 5 trading days before or 10 trading days after a trading halt of the same stock. In this case, I try later trading days (i.e., the 11th, the 12th, ... post-halt trading days) until I get one that is at least 5 trading days before and 10 trading days after a trading halt of the same stock. It is possible that, according to the above criteria, a particular trading day can be the control day for two trading halts of the same stock. In this case, I choose the next trading day as the control day for the second trading halt. I successfully find the control day [the 10th (or later) post-halt trading day] for 1435 trading halts. The remaining 78 trading halts in the sample are too close either to the end of the 1989 ISSM tape or the delistings of the stocks. They are dropped from the analysis of this

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25 Leverage effect is introduced by Black (1976) and Christie (1982), who suggest that changes in the value of a firm's equity affect the risk of the firm's equity.
I study the intraday volatility adjustment process in the first 5 post-halt trading days by comparing the absolute excess return of every 30-trading-minute interval in the post-halt period with the absolute excess return of the time-of-the-day-matched interval\textsuperscript{26} in the 10th (or later) post-halt trading day.

6.1.1.2 Results

The results are shown in Table 2 and Figure 1. To avoid a clumsy presentation of a lot of results, Table 2 shows the results for selected intervals only, while Figure 1 shows the t-statistics for intervals 1 through 65 (i.e., the first 5 post-halt trading days).

Table 2 and Figure 1 show that the absolute excess returns in the post-halt period are initially larger (by an average of 1\% in interval 1) than the absolute excess returns in the control day. The difference between the two cases decays gradually to zero so that the t-statistics also decay. The t-statistics are significant for intervals 1 through 27, and are still significant for some intervals afterwards. Obviously, the volatility adjustment process after trading halts is slow. The absolute excess returns in the 4th and 5th post-halt trading days are still slightly larger than normal, suggesting that at least part of the post-halt abnormal volatility is caused by the arrival of new information. Since the arrival rate of new information is determined by the information-generating process of stocks, it is doubtful whether the NYSE should expect that the post-halt market is calm even if trading halts are effective in reducing volatility.

\textsuperscript{26} Read Wood, McInish, and Ord (1985) for the intraday pattern of volatility.
6.1.2 Trading Halts versus Pseudo-Halts

6.1.2.1 Methods

This section analyzes the intraday pattern of the difference between volatility in the post-halt period and volatility in the post-pseudo-halt period. How much and how long volatility differs in these two cases can tell us more about the speed of volatility adjustment process after trading halts (in contrast with the speed of volatility adjustment process after pseudo-halts).

For every trading halt in the sample, I search through the ISSM tapes for 1988 and 1989 for periods of continuous trading that match the trading halt in stock, time of the day, and duration. These periods of continuous trading are candidates for the pseudo-halt. If the trading halt is a delayed opening, the duration of the candidates for the pseudo-halt includes the overnight trading halt. To avoid an overlapping of the post-halt period and the post-pseudo-halt period, candidates for the pseudo-halt that are within 10 trading days before or after a trading halt of the same stock are dropped. To avoid a possible bias caused by a leverage effect, candidates for the pseudo-halt that differ from the trading halt in the sign of excess return are dropped.

I then proceed as follows to find the pseudo-halt for a trading halt.  

If I had used the method of Lee, Ready, and Seguin (1992), for every trading halt, I would have chosen the candidate for pseudo-halt that most closely matches the trading halt in absolute excess return. However, the resulting pseudo-halt would typically under-match the trading halt in absolute excess return. I could have followed their practice of dropping the resulting pseudo-halt if it miss-matches the trading halt by 1% or more (or even 0.25% or more). However, the resulting sample of pseudo-halts that survive the constraint would still have an average absolute during-pseudo-halt excess return that is significantly smaller than the average absolute during-halt excess return of the sample of trading halts (when the constraint is 1%, t-statistic = -9.190; when the constraint is 0.25%, t-statistic = -3.153).
halt in absolute excess return.  If I cannot find one, I try to find the candidate that over-matches the trading halt the least and also the candidate that under-matches the trading halt the least. The two candidates, if both found, are averaged to become the pseudo-halt: the average of their absolute excess returns becomes the absolute during-pseudo-halt excess return, and the average absolute excess return of interval t after these two candidates becomes the absolute excess return of interval t in the post-pseudo-halt period. I set a filter rule on the resulting pseudo-halt. If either one of the two candidates cannot be found, or miss-matches the trading halt by more than 1% in absolute excess return, then the resulting pseudo-halt is dropped, and there is no pseudo-halt for the trading halt concerned.

Therefore, if a trading halt has a matching pseudo-halt, it is either exactly matched or slightly miss-matched by the pseudo-halt. I successfully find matching pseudo-halts for 672 trading halts, 44.4% of the sample. The average absolute during-pseudo-halt excess return of the sample of pseudo-halts is insignificantly different from the average absolute during-halt excess return of the sample of trading halts (t-statistic = 0.693).

The usual reason why a trading halt does not have a matching pseudo-halt is that there is no candidate exactly matching or over-matching the trading halt. The characteristics of the 672 trading halts that have matching pseudo-halts are summarized in Table 3. We can see that the triggers for the 672 trading halts are the "smaller" events in the original sample. The "smaller" events cause smaller absolute during-halt excess

28 If the absolute excess return for a candidate does not deviate from the absolute during-halt excess return by more than 0.01%, then the candidate is regarded as exactly matching the trading halt. If there are more than one candidate exactly matching the trading halt, I choose the one that is closer to the trading halt in time.

29 This kind of failure to find matching pseudo-halts for the trading halts with the largest price
return than the "bigger" events (that are excluded from the analysis of this section), but they can still trigger trading halts. The reason may be that the ex ante during-halt volatility for these "smaller" events may be large. Hence, for the trading halts that have matching pseudo-halts, the ex ante during-halt volatility may be underestimated by the ex post absolute during-halt excess return. On the other hand, the ex ante during-pseudo-halt volatility may not be underestimated by the ex post absolute during-pseudo-halt excess return. This makes the results reported below more vulnerable to the potential bias caused by the difference in information events between trading halts and pseudo-halts.

6.1.2.2 Results

I analyze the intraday pattern of the difference between the post-halt volatility and the post-pseudo-halt volatility by comparing the absolute excess return of every 30-trading-minute interval in the post-halt period with the absolute excess return of the corresponding 30-trading-minute interval in the post-pseudo-halt period. The results are shown in Table 4 and Figure 2. The results after interval 26 do not provide additional information, so they are not reported.

Table 4 and Figure 2 show that the absolute excess returns in the post-halt period are initially larger (by an average of 0.6% in interval 1) than the absolute excess returns in the post-pseudo-halt period. The difference between the two cases decays gradually to zero so that the t-statistics also decay and become insignificant after the 5th interval. In other words, the post-halt volatility is larger than the post-pseudo-halt volatility until the market has re-opened for two and a half hours.

movements is also experienced by Lee, Ready, and Seguin (1992).
Therefore, even though the volatility during trading halts equals the volatility during pseudo-halts, the speed of decay in volatility is lower after trading halts than after pseudo-halts. This does not necessarily imply that trading halts increase volatility, since the above results may be affected by the potential bias caused by the difference in information events between the two cases. Nevertheless, the difference in volatility adjustment process between trading halts and pseudo-halts should at least suggest that the adjustment of the market to information events is not completed during trading halts.30

The results in Section 6.1.1 suggest one of the causes for the post-halt abnormal volatility --- the arrival of new information after trading halts. The results in this section suggest another cause --- the adjustment of the market to triggers is not completed during trading halts.

6.2 The Price Adjustment Process

6.2.1 Methods

This section studies whether trading halts incorporate all information into the market re-opening price, and examines the time needed for the information left after halts to be incorporated into post-halt prices.

If part of the information available during halts is not incorporated in the market re-opening price, systematic patterns could exist in the post-halt excess returns. These

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30 There is an alternative interpretation of the results: the arrival rate of new information after trading halts is larger than that after pseudo-halts. However, it is likely that at least part of the difference in volatility adjustment process between the two cases is caused by the incompleteness of market adjustment to information events during trading halts. First, the post-halt volatility is larger than the post-pseudo-halt volatility in the first two and a half hours (but not afterwards). Second, the results in Sections 6.2 and 6.3 also suggest that the market adjustment to information events is not completed during trading halts.
patterns give rise to potentially profitable trading strategies conditional on existing information. Although there are many different possible trading strategies, recent empirical works can suggest a fruitful direction to choose some trading strategies to test. The classic study that investigates the patterns in the post-halt excess returns is Hopewell and Schwartz (1978). Their sample is divided into many groups. The pre-halt, during-halt, and post-halt patterns for each group are analyzed. Out of the many post-halt patterns analyzed, only the one after news halts is statistically significant.

In fact, it is natural to group trading halts into categories by their triggers. Imbalance triggers may involve a large demand for liquidity services, whereas news triggers may not. If market makers earn their revenue from providing liquidity services, implied bid-ask spreads at the call auction can cause a pattern of price reversals after imbalance halts.

Because of the results of Hopewell and Schwartz (1978) and the above arguments, I divide the halts in the sample into groups by their triggers and the sign of during-halt excess returns. For every group, the mean excess return of every 5-trading-minute interval after the market re-opens is calculated. I use a t-statistic to test if the mean excess return is different from zero. A price reversal pattern after the market re-opens may be a manifestation of implied bid-ask spreads at the call auction, or it may be caused by an over-reaction to information during halts. A price continuation pattern suggests an incomplete incorporation of information during halts. The magnitude of the pattern suggests the size of the temporary price effect of implied bid-ask spreads, over-reaction to

31 Bases for grouping include the whole sample, trigger, duration of trading halt, and the sign of during-halt return.
information, or incomplete incorporation of information. The duration of the pattern indicates how long the temporary price effect remains in the post-halt market. An absence of pattern in the post-halt excess returns suggests complete incorporation of information and low implied bid-ask spreads during trading halts.

6.2.2 Results

Tables 5 and 6 show the mean and t-statistic of excess returns after imbalance halts with positive during-halt excess return and negative during-halt excess return respectively. Tables 7 and 8 show the same for news halts. In the sample, there is one influx halt and one trading halt with zero during-halt excess return. Since they do not form a group, they are dropped from this analysis. To avoid a clumsy presentation of a lot of results, Tables 5 through 8 show the results for selected intervals only, while Figures 3 through 10 show the t-statistics and mean cumulative excess returns for intervals 1 through 24 (i.e., the first 2 trading hours after the market re-opens). The results for interval 25 onwards do not show additional information, so they are not reported.

Table 5, Figure 3, and Figure 4 show no pattern of excess returns after imbalance halts with positive during-halt excess return.\(^{32}\) This suggests that information is completely incorporated in the market re-opening price, and implied bid-ask spreads at the call auction are low. Table 6, Figure 5, and Figure 6 show that there is a pattern of price reversals after imbalance halts with negative during-halt excess return. The magnitude of price reversals is not very large. The mean cumulative excess return is about 0.65% after

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\(^{32}\) The t-statistics for the cumulative excess returns are insignificant. For example, the t-statistic at the 24th interval is -0.840.
the 10th interval. Therefore, the price reversals may be caused by the temporary price effect of implied bid-ask spreads at the call auction, and there need not be an over-reaction to information during the halts. The process of price reversals lasts for a short while after the market re-opens. The t-statistic of excess returns is significant for the first and third intervals. The mean cumulative excess return increases almost monotonically for the first 50 minutes after the market re-opens. These results suggest that the temporary price effect of implied bid-ask spreads at the call auction remains in the post-halt market for 50 minutes.

Tables 7 through 8 and Figures 7 through 10 show that there is a process of price continuations after news halts. The magnitude of price continuations is not very large. When during-halt excess return is positive, the mean cumulative excess return is about 0.35%. When during-halt excess return is negative, the mean cumulative excess return is about -0.65%. The price continuation pattern suggests that the information of news announcements is not completely incorporated in the market re-opening price. However, considering the magnitude of price continuations, it is doubtful that an investor can profitably exploit the pattern after transaction costs. The process of price continuations lasts for a short while in the post-halt period. When during-halt excess return is positive, the t-statistic of excess returns is significant for the first interval, and the mean cumulative excess return increases almost monotonically for the first 50 minutes after the market re-opens.

33 The t-statistics for the cumulative excess returns are significant. For example, the t-statistic at the 24th interval is 3.908.

34 The t-statistics for the cumulative excess returns are significant. For example, the t-statistic at the 24th interval is 3.196.

35 The t-statistics for the cumulative excess returns are significant. For example, the t-statistic at the 24th interval is -3.496.
excess return increases almost monotonically for the first 25 minutes after the market re-opens. When during-halt excess return is negative, the t-statistic of excess returns is significant for the first 5 intervals, and the mean cumulative excess return decreases almost monotonically for the first 30 minutes after the market re-opens. These suggest that information is not fully incorporated into prices until the continuous market has resumed for 30 minutes.

6.2.3 Conclusion

The price adjustment process for news halts seems to be slower than that for imbalance halts (in the sense that information is incorporated into prices more slowly for news halts). First, information is fully reflected by the market re-opening price for imbalance halts with positive during-halt excess return. Second, for imbalance halts with negative during-halt excess return, the market re-opening price deviates from the new equilibrium price because of the temporary price effect of implied bid-ask spreads at the call auction; whereas for news halts, the market re-opening price deviates from the new equilibrium price because of the temporary price effect of incomplete incorporation of information. For imbalance halts with negative during-halt excess return, the temporary price effect of implied bid-ask spreads at the call auction remains in the post-halt market for 50 minutes. For news halts, information is not fully incorporated into prices until the market has re-opened for 30 minutes.
6.3 The Resolution of Information Asymmetry

6.3.1 Methods

This section investigates whether trading halts resolve all information asymmetry, and examines the time needed for the information asymmetry left after halts to be resolved through post-halt trading. Besides adding to the evidence on the speed of adjustment of the market to triggers, there are other reasons why the results should be interesting. First, if the information asymmetry at the market re-opening is severe, the revelation of private information in the post-halt period may cause significant price movements. Second, the information asymmetry can increase bid-ask spreads in the post-halt period\(^\text{36}\), affecting the liquidity of the market. Third, the results suggest how much information asymmetry uninformed market makers and traders need to face when they participate in the market around the times of trading halts.

If information asymmetry is incompletely resolved during halts, bid-ask spreads in the post-halt period should be larger than the bid-ask spread that is normally quoted. As information asymmetry is gradually resolved through post-halt trading, keeping other things constant, bid-ask spreads should gradually return to normal. Therefore, we can use the pattern of abnormal bid-ask spreads in the post-halt period to understand the pattern of information asymmetry left after halts. The absence of abnormal bid-ask spreads in the post-halt period should suggest that the information asymmetry caused by triggers is largely or completely resolved during halts. On the other hand, the presence of abnormal bid-ask spreads in the post-halt period may be caused by the information asymmetry left

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\(^{36}\) Read, for example, McInish and Wood (1992) for a survey of literature on determinants of bid-ask spreads.
after halts, by new information that arrives after the market re-opens, or by an undesirable inventory position of market makers in the post-halt period\textsuperscript{37} (or by all of them). In that case, before we can use the pattern of abnormal bid-ask spreads in the post-halt period to understand the pattern of information asymmetry left after halts, the real cause of abnormal bid-ask spreads need to be ascertained.

I analyze the pattern of abnormal bid-ask spreads in the post-halt period by comparing the bid-ask spread at the end of every 5-trading-minute interval in the first 5 post-halt trading days with the bid-ask spread at the end of the time-of-the-day-matched interval\textsuperscript{38} in the 10th (or later) post-halt trading day. The bid-ask spreads in the 10th (or later) post-halt trading day are used as the proxy for the normal level that bid-ask spreads in the post-halt period return to. The reason for choosing the 10th (or later) post-halt trading day as the control day is explained in Section 6.1.1. I analyze the pattern of abnormal bid-ask spreads for 5 post-halt trading days. If abnormal bid-ask spreads in the post-halt period are caused solely by the information asymmetry left after halts, we should not observe abnormal bid-ask spreads long after the market re-opens. On the other hand, if abnormal bid-ask spreads in the post-halt period are caused also by some new information that arrives after the market re-opens, we may still observe abnormal bid-ask spreads in the 4th or 5th post-halt trading days. It is possible that abnormal bid-ask spreads in the post-halt period are caused by an adverse inventory position of market makers, but the results in Section 7.1 suggest that the abnormal bid-ask spreads are caused by information asymmetry, rather than an adverse inventory position of market makers.

\textsuperscript{37} Read Amihud and Mendelson (1980).

\textsuperscript{38} Read McInish and Wood (1992) for the intraday pattern of bid-ask spreads.
6.3.2 Results

I use a t-statistic to test the significance of the mean difference between the bid-ask spread at the end of every 5-trading-minute interval in the post-halt period and the bid-ask spread at the end of the time-of-the-day-matched interval in the control day. The trading halts without a control day are dropped from this analysis (see Section 6.1.1). The results are shown in Table 9 and Figure 11. The results for interval 49 onwards do not show additional information, so they are not reported.

Table 9 and Figure 11 show that the bid-ask spreads in the post-halt period are initially larger (by an average of 0.12% in interval 1) than the bid-ask spreads in the control day. The difference between the two cases decays gradually to zero so that the t-statistics also decay and become insignificant after the 18th interval. In other words, bid-ask spreads in the post-halt period do not return to normal until the market has re-opened for one and a half hours.

The results in Section 7.1 suggest that the abnormal bid-ask spreads are caused by information asymmetry, rather than an adverse inventory position of market makers. Since the bid-ask spreads are not abnormal for a long period of time, it seems that the pattern of abnormal bid-ask spreads reflects the pattern of information asymmetry left after trading halts, rather than the pattern of information asymmetry caused by new information. In view of the results in Section 6.1.1, it seems that the arrival of new information causes abnormal volatility, but not abnormal information asymmetry. In other words, the new information seems to cause significant price movements, but does not seem to bring abnormal uncertainty of the true value of the stocks.

Therefore, the results suggest that not all the information asymmetry caused by triggers is resolved during trading halts. The information asymmetry left after halts causes
an increase in bid-ask spreads in the post-halt period (by an average of 0.12% in the first 5 minutes). The post-halt market liquidity, therefore, may be lower than normal. Information asymmetry is not resolved until the market has re-opened for one and a half hours. This suggests that the adjustment of the market to triggers is not completed during trading halts, and part of the post-halt abnormal volatility may be caused by the incorporation of private information after the market re-opens.

6.4 Conclusion

The post-halt abnormal volatility needs a long time to decay, because new information arrives after the market re-opens. It is doubtful whether the NYSE should expect that the post-halt market is calm even if trading halts are effective in reducing volatility. The volatility adjustment process after trading halts is slow in contrast with the volatility adjustment process after pseudo-halts. The post-halt volatility is larger than the post-pseudo-halt volatility for two and a half hours after the market re-opens. This does not necessarily imply that trading halts increase volatility, since there is a potential bias caused by the difference in information events between the two cases. On the other hand, the results suggest that the adjustment of the market to triggers is not completed during trading halts.

Triggers of both imbalance halts and news halts are very significant information events. For imbalance halts, information is incorporated into the market re-opening price (which is affected by implied bid-ask spreads at the call auction, though). For news halts, not all information is incorporated into the market re-opening price. The incomplete incorporation of information into prices during the halts causes a pattern of price continuations in the post-halt period. The pattern of price continuations indicates that
information is not fully incorporated into prices until the market has re-opened for 30 minutes.

Not all the information asymmetry caused by triggers is resolved during trading halts. The information asymmetry left after halts causes an increase in bid-ask spreads in the post-halt period. The information asymmetry is not resolved until the market has re-opened for one and a half hours.

The above results indicate that the adjustment of the market to triggers is not completed until the continuous market has resumed for a period of time (of course, this does not necessarily suggest that trading halts are ineffective, since it is possible that had trading halts not been called, the speed of adjustment of the market would be lower).
CHAPTER VII
DIFFERENCES BETWEEN DIFFERENT TYPES OF TRADING HALTS

This chapter investigates how the decay in volatility and information asymmetry differs for different types of halts. In Section 7.1, I compare imbalance halts with news halts. In the sample, there is only one influx halt, so I do not try to compare it with the other two types of halts. In Section 7.2, I compare delayed openings with intraday halts.

7.1 Imbalance Halts versus News Halts
7.1.1 Methods

The results of Hopewell and Schwartz (1978) and Section 6.2 indicate that the price adjustment process is slower for news halts than for imbalance halts. This section investigates whether the decay in volatility and information asymmetry is faster for news halts. The results provide further evidence on whether the presence of news announcements helps the effectiveness of trading halts or not.

If the decay in volatility and information asymmetry is faster for news halts than for imbalance halts, holding other things constant, the abnormal volatility and abnormal bid-ask spreads after news halts should be smaller than those after imbalance halts. Therefore, I investigate how the abnormal volatility and abnormal bid-ask spreads in the post-halt period differ for the two halt types.

I investigate how the post-halt abnormal volatility differs for the two halt types using the following regression:
(1) \[ \text{PAR}_{it} - \text{CAR}_{it} = a_t + b_i \text{ORD}_i + c_i \text{DEL}_i + d_i \text{SR}_i + e_i \text{AR}_i + u_{it}; \]
\[ i = 1, 2, \ldots, N_t; u_{it} \sim N(0, \sigma^2_i); t = 1, 2, \ldots, 65; \]

where

- \text{PAR}_{it} = \text{the absolute excess return (in \%) of 30-trading-minute interval } t \text{ after trading halt } i; \]
- \text{CAR}_{it} = \text{the absolute excess return (in \%) of the 30-trading-minute interval in the control day matching the time of the day of the interval } t \text{ for PAR}_{it}; \]
- \text{ORD}_i = \text{trigger dummy (= 1 if trading halt } i \text{ is triggered by an order imbalance, = 0 if triggered by a news announcement);} \]
- \text{DEL}_i = \text{delayed-opening dummy (= 1 if trading halt } i \text{ is a delayed opening, = 0 otherwise);} \]
- \text{SR}_i = \text{dummy of the sign of the excess return during trading halt } i \text{ (= 1 if negative, = 0 if positive);} \]
- \text{AR}_i = \text{the absolute excess return (in \%) during trading halt } i; \]
- \text{N}_t = \text{number of non-missing observations for interval } t. \]

The coefficient \( b \) of \text{ORD} should be significantly positive if the abnormal volatility after imbalance halts is larger than the abnormal volatility after news halts, given the effects of \text{DEL}, \text{SR}, and \text{AR} on the abnormal volatility.

\text{DEL} is included in the regression to account for effects of differences between intraday halts and delayed openings (discussed in Section 7.2). \text{SR} is included in the regression to account for the leverage effect (if any) that remains after the use of the absolute excess returns in the 10th (or later) post-halt trading day as the proxy for the normal level.
The coefficient $e$ of AR should be significant. The post-halt abnormal volatility can be caused by the information left after halts or by the arrival of new information. If the during-halt volatility (as measured by AR) is larger, the information left after halts may be more significant. In view of the well-documented autocorrelation of volatility, it is likely that the larger the during-halt volatility, the more significant the new information is. I estimate the regression for the first 5 post-halt trading days (i.e., $t = 1, 2, \ldots, 65$). If the post-halt abnormal volatility is caused solely by the information left after halts, $e_t$ is unlikely to be significant for large $t$. If the post-halt abnormal volatility is caused also by the arrival of new information, $e_t$ may be significant for large $t$.

I investigate how the abnormal bid-ask spreads in the post-halt period differ for the two halt types using the following regression:

$$ (2) \quad P_{Bi} - C_{Bi} = a_t + b_t ORD_i + c_t DEL_i + d_t SR_i + e_t AR_i + u_{it}; $$

where

$$ P_{Bi} = \text{the bid-ask spread in } \% \text{ of the midpoint between the bid and the ask at the end of 5-trading-minute interval } t \text{ after trading halt } i; \text{ and} $$

$$ C_{Bi} = \text{the bid-ask spread in } \% \text{ of the midpoint between the bid and the ask at the end of the 5-trading-minute interval in the control day matching the time of the day of the interval } t \text{ for } P_{Bi}. $$

The coefficient $b$ of ORD should be significantly positive if the abnormal bid-ask spreads after imbalance halts are larger than the abnormal bid-ask spreads after news halts, given the effects of DEL, SR, and AR on the abnormal bid-ask spreads.

DEL is included in the regression to account for effects of differences between intraday halts and delayed openings (discussed in Section 7.2). SR is included in the
regression to account for, if any, the leverage effect remained after the use of bid-ask spreads in the 10th (or later) post-halt trading day as the proxy for the normal level.

If abnormal bid-ask spreads in the post-halt period are caused by the information asymmetry left after halts or new information (or both), the coefficient e of AR may be significant. The reason is that if the during-halt information asymmetry (AR is its proxy) is more severe, the information asymmetry left after halts may be more significant, and the information asymmetry caused by new information may be more significant too. I estimate the regression for the first 5 post-halt trading days (i.e., t = 1, 2, ..., 390). If abnormal bid-ask spreads in the post-halt period are caused solely by the information asymmetry left after halts, e_t is unlikely to be significant for large t. If abnormal bid-ask spreads in the post-halt period are caused also by the arrival of new information, e_t may be significant for large t.

To avoid multicollinearity problem, the one influx halt and the one trading halt with zero during-halt excess return are dropped from regressions (1) and (2).

7.1.2 Results

I first discuss the results of regression (1) with Table 10 and Figures 12 through 16. Table 10 and Figure 13 show that the coefficient b of ORD is, generally speaking, insignificant, implying that there is no difference in the post-halt abnormal volatility between the two halt types. In other words, given the effects of DEL, SR, and AR, there is no difference in the information left after halts and the arrival rate of new information between imbalance halts and news halts.

Table 10 and Figure 14 show that the coefficient c of DEL is significant. This is discussed in Section 7.2. Table 10 and Figure 15 show that the coefficient d of SR is
slightly significant. This suggests that much of the leverage effect has been controlled for by the use of absolute excess returns in the 10th (or later) post-halt trading day as the proxy for the normal level.

Table 10 and Figure 16 show that the coefficient $e$ of AR is significantly positive for most of the time during the first 4 post-halt trading days. The significance of $e_t$ decreases on $t$, but $e_t$ is still marginally significant on the 5th post-halt trading day. The results are consistent with the arguments in Section 6.1.1 that the post-halt abnormal volatility is caused by the information left after halts and also by the arrival of new information.

The results of regression (2) are shown in Table 11 and Figures 17 through 21. The results for interval 49 onwards do not show additional information, so they are not reported. The results show that only the coefficient $e$ of AR has a pattern of significance. There are a few significant t-statistics for the coefficients of the three dummy variables, but they can be caused by pure randomness. I discuss the insignificance of the coefficient $c$ of DEL in Section 7.2. The insignificance of the coefficient $d$ of SR suggests that the leverage effect has been controlled for by the use of bid-ask spreads in the 10th (or later) post-halt trading day as the proxy for the normal level.

The insignificance of the coefficient $b$ of ORD suggests that given the effects of DEL, SR, and AR, there is no difference in information asymmetry in the post-halt period between the two halt types. It also suggests that the abnormal bid-ask spreads in the first one and a half hours after the market re-opens as reported in Section 6.3 are caused by information asymmetry, not by an undesirable inventory position of market makers. If the abnormal bid-ask spreads were caused by an adverse inventory position of market makers in the post-halt period, the coefficient $b$ of ORD should have been significantly positive.
The reason is that if the market makers have an undesirable inventory position in the post-halt period, their inventory position is likely to be worse when triggers are order imbalances than when triggers are news announcements. Although the results suggest that the abnormal bid-ask spreads in the post-halt period are not caused by an adverse inventory position of market makers, they do not necessarily suggest that the inventory position of market makers in the post-halt period is desirable. An undesirable inventory position of market makers may affect the midpoint between bids and asks, rather than the bid-ask spreads.  

The coefficient $e$ of AR is significantly positive in the first two intervals, and is, generally speaking, insignificant afterwards. Hence, the results are consistent with the arguments in Section 6.3 that the pattern of abnormal bid-ask spreads in the post-halt period reflects the information asymmetry left after halts, rather than the information asymmetry caused by new information.

7.1.3 Conclusion

There is no difference in the abnormal volatility and abnormal bid-ask spreads in the post-halt period between news halts and imbalance halts. This suggests that the speed of adjustment of the market to triggers (in terms of decay in volatility and resolution of information asymmetry) and the arrival rate of new information do not differ for these two halt types.

The results of Hopewell and Schwartz (1978) and Section 6.2 indicate that the price adjustment process is slower for news halts than for imbalance halts. The results of

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this section show that the decay in volatility and information asymmetry is not faster for news halts. Therefore, there is no evidence that the presence of news announcements helps the effectiveness of trading halts.

7.2 Delayed Openings versus Intraday Halts

7.2.1 Methods

An intraday halt seems to cause a more abrupt change in trading mechanism than a delayed opening, and the nature of its trigger may be unusual in contrast with the nature of the trigger of a delayed opening. This section investigates whether these differences between delayed openings and intraday halts lead to a faster decay in volatility and information asymmetry for delayed openings. The results should let us understand more about how the process of market adjustment may be affected by how much the trading mechanism is changed and by the nature of triggers.

I investigate how the adjustment of the market differs for these two types of trading halts with regressions (1) and (2) in Section 7.1. The coefficient $c$ of $\text{DEL}$ should be significantly negative, if the decay in volatility and information asymmetry is faster for delayed openings (given the effects of $\text{ORD}$, $\text{SR}$, and $\text{AR}$).

7.2.2 Results

Table 10 and Figure 14 suggest that intraday halts have larger post-halt abnormal volatility than delayed openings. The $t$-statistic of the coefficient $c$ of $\text{DEL}$ in regression (1) is significantly negative most of the time for the first nine intervals. From intervals 10 through 65, it is usually negative, and is sometimes significantly so. The difference in the post-halt abnormal volatility between the two halt types can be caused by the difference in
the incompleteness of adjustment of the market to triggers during halts or by the difference in the arrival rate of new information.

On the other hand, Table 11 and Figure 19 show that the t-statistic of the coefficient \( c \) of DEL in regression (2) is insignificant, so intraday halts and delayed openings have similar abnormal bid-ask spreads in the post-halt period. This suggests that the information asymmetry left after intraday halts is similar to the information asymmetry left after delayed openings. Therefore, the incompleteness of adjustment of the market to triggers during intraday halts does not seem to differ from that during delayed openings. Although intraday halts and delayed openings have similar abnormal bid-ask spreads in the post-halt period, it is still possible that the arrival rate of new information after intraday halts is larger than that after delayed openings. As explained in Section 6.3, the new information seems to cause significant price movements, but not abnormal uncertainty of the true value of the stocks.

Therefore, the difference in the post-halt abnormal volatility between intraday halts and delayed openings is likely to be caused by the difference in the arrival rate of new information, rather than by the difference in the incompleteness of adjustment of the market to triggers during halts. The new information that "clusters" with the triggers of intraday halts seems to be more significant than the new information that "clusters" with the triggers of delayed openings. The new information causes abnormal volatility but not abnormal information asymmetry. From Table 1, we can see that the trigger of an intraday halt tends to cause a smaller absolute during-halt excess return and a smaller volume at the market re-opening than the trigger of a delayed opening. The trigger of an intraday halt seems to be a "smaller" information event than the trigger of a delayed opening, but it still causes a trading halt. The reason may be that the new information that "clusters" with it is
more significant than the new information that "clusters" with a delayed opening trigger.

7.2.3 Conclusion

Although an intraday halt seems to cause a more abrupt change in trading mechanism than a delayed opening, and its trigger may be unusual in contrast with the trigger of a delayed opening, there is no difference between the incompleteness of market adjustment to triggers during intraday halts and that during delayed openings. On the other hand, the new information that "clusters" with the triggers of intraday halts seems to be more significant than the new information that "clusters" with the triggers of delayed openings.
CHAPTER VIII
CONCLUSION

Trading halts serve three main purposes: to reduce volatility, incorporate information into the market re-opening price, and resolve information asymmetry. There is a debate about the effectiveness of trading halts. Some empirical studies try to provide direct evidence on the effectiveness of trading halts in reducing volatility, but their conclusions are controversial. There are some empirical works that investigate whether all information is incorporated into the market re-opening price, but how long it takes for the information left after halts to be incorporated into post-halt prices is not yet examined. There is no empirical evidence on the effectiveness of trading halts in resolving information asymmetry. This study contributes to the literature by addressing all three purposes of trading halts and focusing on the intraday speed of market adjustment to events that trigger trading halts in the NYSE. Although the results are not sufficient to let us conclude whether trading halts are effective or not, they help us understand more about whether the market adjustment to events that trigger trading halts is completed or not during the halts and how long it takes after the market re-opens for the market adjustment to complete. These results provide indirect evidence on the effectiveness of trading halts. The more effective trading halts are, the more complete the market adjustment during the halts should be, and the shorter it should take after the market re-opens for the market adjustment to complete.
I find that the volatility adjustment process after trading halts is slow. The post-halt abnormal volatility needs a long time (5 trading days or longer) to decay because new information arrives after the market re-opens. Since the arrival rate of new information is determined by the information-generating process of stocks, it is doubtful whether the NYSE should expect that the post-halt market is calm even if trading halts really reduce volatility. The volatility adjustment process after trading halts is slow in contrast with the volatility adjustment process after pseudo-halts, even though pseudo-halts are periods of continuous trading with information events causing the same price movement as the triggers of trading halts. It takes two and a half hours after the market re-opens for the post-halt volatility to decay to the level of post-pseudo-halt volatility. Since there is a potential bias caused by the difference in information events between trading halts and pseudo-halts, these results do not necessarily imply that trading halts increase volatility. On the other hand, they suggest that the adjustment of the market to triggers is not completed during trading halts.

Triggers of imbalance halts and news halts are very significant information events which cause large price movements. For imbalance halts, information is incorporated into the market re-opening price. There is no pattern of post-halt excess returns after imbalance halts with positive during-halt excess return. There is a pattern of small price reversals after imbalance halts with negative during-halt excess return, suggesting that the market re-opening price is affected by implied bid-ask spreads at the call auction. The temporary price effect of the implied bid-ask spreads remains in the post-halt market for 50 minutes. For news halts, not all information is incorporated into the market re-opening price. The incomplete incorporation of information into prices during news halts causes a pattern of price continuations after the halts (the pattern may not be exploitable after
transaction costs, though). The pattern indicates that, for these news halts, information is not fully incorporated into prices until the market has re-opened for 30 minutes.

I find that bid-ask spreads in the first one and a half hours of the post-halt period are larger than normal. There is evidence that these abnormal bid-ask spreads are caused by information asymmetry left after halts, rather than by new information or an adverse inventory position of market makers. Therefore, the results suggest that the information asymmetry caused by triggers is not resolved until the market has re-opened for one and a half hours.

The above results do not necessarily suggest that trading halts are ineffective, since it is possible that had trading halts not been called, the speed of adjustment of the market would be lower. On the other hand, the results indicate that the adjustment of the market to events that trigger trading halts is not completed until the continuous market has resumed for a period of time.

We can categorize trading halts by their triggers or by whether they are delayed openings or intraday halts. There are empirical works that study the price adjustment process for different types of halts. On the other hand, no study, theoretical or empirical, tries to investigate whether the decay in volatility and information asymmetry differs for different types of halts. The second objective of this study is to have an exploratory analysis on this issue. Since differences in the adjustment of the market between different types of halts should be caused by differences in the nature of the triggers and the effectiveness of the halts, the results help us understand more about the factors of adjustment of the market when trading halts are called.

The likelihood for imbalance halts involving news announcements should be smaller than that for news halts. Previous studies (and this study) find that the price
adjustment process is slower for news halts than for imbalance halts, suggesting that the presence of news announcements does not help the effectiveness of trading halts. I find that there is no difference in the abnormal volatility and abnormal bid-ask spreads in the post-halt period between imbalance halts and news halts. This suggests that the decay in volatility and information asymmetry is not faster for news halts. Hence, the results provide further evidence that the presence of news announcements does not help the effectiveness of trading halts.

An intraday halt seems to cause a more abrupt change in trading mechanism than a delayed opening, and its trigger may be unusual in contrast with the trigger of a delayed opening. I investigate whether these differences between the two types of halts lead to a faster decay in volatility and information asymmetry for delayed openings. The results should let us understand more about how the process of market adjustment may be affected by how much the trading mechanism is changed and by the nature of triggers. I find that the abnormal bid-ask spreads in the post-halt period do not differ for intraday halts and delayed openings, suggesting that there is no difference between the incompleteness of market adjustment to triggers during intraday halts and that during delayed openings. On the other hand, the new information that "clusters" with the triggers of intraday halts seems to be more significant than the new information that "clusters" with the triggers of delayed openings, so that post-halt abnormal volatility is larger for intraday halts than for delayed openings.
TABLE 1

Summary statistics of characteristics of the 1513 trading halts.a

<table>
<thead>
<tr>
<th>Types of trading halts</th>
<th>N</th>
<th>R</th>
<th>AR</th>
<th>D</th>
<th>V</th>
<th>SP1</th>
<th>SP2</th>
</tr>
</thead>
<tbody>
<tr>
<td>All types</td>
<td>1513</td>
<td>1.73</td>
<td>6.05</td>
<td>0.87</td>
<td>134.57</td>
<td>7.45</td>
<td>4.91</td>
</tr>
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<td></td>
<td></td>
<td>(9.34)</td>
<td>(7.32)</td>
<td>(0.79)</td>
<td>(361.91)</td>
<td>(4.98)</td>
<td>(3.84)</td>
</tr>
<tr>
<td>Imbalance halts</td>
<td>725</td>
<td>0.99</td>
<td>6.62</td>
<td>0.50</td>
<td>127.49</td>
<td>7.55</td>
<td>5.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(9.19)</td>
<td>(6.45)</td>
<td>(0.29)</td>
<td>(278.57)</td>
<td>(4.58)</td>
<td>(3.77)</td>
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<tr>
<td>News halts</td>
<td>787</td>
<td>2.42</td>
<td>5.53</td>
<td>1.21</td>
<td>140.69</td>
<td>7.34</td>
<td>4.79</td>
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<tr>
<td></td>
<td></td>
<td>(9.44)</td>
<td>(8.02)</td>
<td>(0.93)</td>
<td>(426.31)</td>
<td>(5.33)</td>
<td>(3.90)</td>
</tr>
<tr>
<td>Influx halt</td>
<td>1</td>
<td>3.19</td>
<td>3.19</td>
<td>0.38</td>
<td>584.38</td>
<td>11.97</td>
<td>6.9</td>
</tr>
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<td></td>
<td></td>
<td>(...)</td>
<td>(...)</td>
<td>(...)</td>
<td>(...)</td>
<td>(...)</td>
<td>(...)</td>
</tr>
<tr>
<td>Delayed openings</td>
<td>1093</td>
<td>2.01</td>
<td>6.78</td>
<td>0.77</td>
<td>146.86</td>
<td>7.54</td>
<td>4.95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(9.81)</td>
<td>(7.36)</td>
<td>(0.78)</td>
<td>(391.36)</td>
<td>(4.85)</td>
<td>(3.65)</td>
</tr>
<tr>
<td>Intraday halts</td>
<td>420</td>
<td>1.03</td>
<td>4.15</td>
<td>1.13</td>
<td>102.22</td>
<td>7.20</td>
<td>4.80</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(7.97)</td>
<td>(6.88)</td>
<td>(0.74)</td>
<td>(267.17)</td>
<td>(5.31)</td>
<td>(4.29)</td>
</tr>
<tr>
<td>R &gt; 0</td>
<td>851</td>
<td>6.92</td>
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<td>138.20</td>
<td>7.71</td>
<td>5.05</td>
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<tr>
<td></td>
<td></td>
<td>(8.07)</td>
<td>(8.07)</td>
<td>(0.75)</td>
<td>(356.92)</td>
<td>(4.87)</td>
<td>(3.87)</td>
</tr>
<tr>
<td>R &lt; 0</td>
<td>661</td>
<td>-4.94</td>
<td>4.94</td>
<td>0.93</td>
<td>130.00</td>
<td>7.12</td>
<td>4.74</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(6.07)</td>
<td>(6.07)</td>
<td>(0.83)</td>
<td>(368.80)</td>
<td>(5.11)</td>
<td>(3.78)</td>
</tr>
<tr>
<td>R = 0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0.74</td>
<td>43.45</td>
<td>3.97</td>
<td>1.99</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(...)</td>
<td>(...)</td>
<td>(...)</td>
<td>(...)</td>
<td>(...)</td>
<td>(...)</td>
</tr>
</tbody>
</table>

a N = number of observations. R = during-halt excess return in %. AR = absolute R in %. D = duration of the trading halt in trading hours. V = volume at the market re-opening in % of the total volume of the control day. SP1 = the spread between the high price and the low price of the first price indication in % of the midpoint between the high price and the low price. SP2 = the spread of the last price indication; the last price indication is also the first price indication if there is only one price indication. Numbers without parentheses are means. Numbers with parentheses are standard deviations.
TABLE 2

The difference between the absolute excess returns of 30-trading-minute intervals after the market re-opens and the absolute excess returns of the time-of-the-day-matched intervals in the control day.\(^a\)

<table>
<thead>
<tr>
<th>30-trading-minute interval after the market re-opens</th>
<th>Number of non-missing observations</th>
<th>Mean difference in absolute excess return(%)</th>
<th>t-statistic(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1429</td>
<td>1.041</td>
<td>24.631</td>
</tr>
<tr>
<td>2</td>
<td>1428</td>
<td>0.4046</td>
<td>15.054</td>
</tr>
<tr>
<td>3</td>
<td>1427</td>
<td>0.2824</td>
<td>10.942</td>
</tr>
<tr>
<td>4</td>
<td>1427</td>
<td>0.209</td>
<td>9.776</td>
</tr>
<tr>
<td>5</td>
<td>1426</td>
<td>0.1995</td>
<td>10.955</td>
</tr>
<tr>
<td>10</td>
<td>1414</td>
<td>0.146</td>
<td>7.836</td>
</tr>
<tr>
<td>15</td>
<td>1387</td>
<td>0.0764</td>
<td>3.69</td>
</tr>
<tr>
<td>20</td>
<td>1381</td>
<td>0.0556</td>
<td>3.92</td>
</tr>
<tr>
<td>25</td>
<td>1361</td>
<td>0.0887</td>
<td>4.091</td>
</tr>
<tr>
<td>30</td>
<td>1351</td>
<td>0.0315</td>
<td>1.899</td>
</tr>
<tr>
<td>35</td>
<td>1349</td>
<td>0.0722</td>
<td>4.241</td>
</tr>
<tr>
<td>40</td>
<td>1331</td>
<td>0.0589</td>
<td>3.424</td>
</tr>
<tr>
<td>45</td>
<td>1327</td>
<td>0.031</td>
<td>1.741</td>
</tr>
<tr>
<td>50</td>
<td>1323</td>
<td>0.0209</td>
<td>1.09</td>
</tr>
<tr>
<td>55</td>
<td>1307</td>
<td>0.0169</td>
<td>1.072</td>
</tr>
<tr>
<td>60</td>
<td>1304</td>
<td>0.0414</td>
<td>3.128</td>
</tr>
<tr>
<td>65</td>
<td>1286</td>
<td>-0.013</td>
<td>-0.51</td>
</tr>
</tbody>
</table>

\(^a\) Selected intervals are shown here, t-statistics for intervals 1 through 65 are shown in Figure 1.

\(^b\) t-statistic for the difference between the absolute excess return of a 30-trading-minute interval after the market re-opens and the absolute excess return of the time-of-the-day-matched interval in the control day.
<table>
<thead>
<tr>
<th>Types of trading halts</th>
<th>N</th>
<th>R</th>
<th>AR</th>
<th>D</th>
<th>V</th>
<th>SP1</th>
<th>SP2</th>
</tr>
</thead>
<tbody>
<tr>
<td>All types</td>
<td>672</td>
<td>0.33</td>
<td>1.37</td>
<td>0.96</td>
<td>73.84</td>
<td>5.28</td>
<td>3.53</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.81)</td>
<td>(1.23)</td>
<td>(0.85)</td>
<td>(229.01)</td>
<td>(3.61)</td>
<td>(2.37)</td>
</tr>
<tr>
<td>Imbalance halts</td>
<td>230</td>
<td>0.47</td>
<td>1.68</td>
<td>0.47</td>
<td>79.70</td>
<td>4.90</td>
<td>3.29</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.10)</td>
<td>(1.34)</td>
<td>(0.26)</td>
<td>(185.83)</td>
<td>(2.87)</td>
<td>(2.23)</td>
</tr>
<tr>
<td>News halts</td>
<td>442</td>
<td>0.26</td>
<td>1.21</td>
<td>1.21</td>
<td>70.72</td>
<td>5.47</td>
<td>3.65</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.64)</td>
<td>(1.14)</td>
<td>(0.93)</td>
<td>(249.09)</td>
<td>(3.93)</td>
<td>(2.43)</td>
</tr>
<tr>
<td>Delayed openings</td>
<td>415</td>
<td>0.39</td>
<td>1.61</td>
<td>0.91</td>
<td>92.50</td>
<td>5.12</td>
<td>3.45</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.03)</td>
<td>(1.30)</td>
<td>(0.96)</td>
<td>(283.87)</td>
<td>(3.44)</td>
<td>(2.20)</td>
</tr>
<tr>
<td>Intraday halts</td>
<td>257</td>
<td>0.22</td>
<td>0.98</td>
<td>1.04</td>
<td>43.41</td>
<td>5.54</td>
<td>3.66</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.38)</td>
<td>(0.99)</td>
<td>(0.62)</td>
<td>(72.19)</td>
<td>(3.86)</td>
<td>(2.62)</td>
</tr>
<tr>
<td>R &gt; 0</td>
<td>355</td>
<td>1.61</td>
<td>1.61</td>
<td>0.90</td>
<td>73.19</td>
<td>5.37</td>
<td>3.62</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.34)</td>
<td>(1.34)</td>
<td>(0.83)</td>
<td>(150.37)</td>
<td>(3.30)</td>
<td>(2.46)</td>
</tr>
<tr>
<td>R &lt; 0</td>
<td>316</td>
<td>-1.11</td>
<td>1.11</td>
<td>1.02</td>
<td>74.68</td>
<td>5.18</td>
<td>3.43</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.03)</td>
<td>(1.03)</td>
<td>(0.87)</td>
<td>(294.95)</td>
<td>(3.94)</td>
<td>(2.27)</td>
</tr>
<tr>
<td>R = 0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0.74</td>
<td>43.45</td>
<td>3.97</td>
<td>1.99</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(. )</td>
<td>(. )</td>
<td>(. )</td>
<td>(. )</td>
<td>(. )</td>
<td>(. )</td>
</tr>
</tbody>
</table>

a N = number of observations. R = during-halt excess return in %. AR = absolute R in %. D = duration of the trading halt in trading hours. V = volume at the market re-opening in % of the total volume of the control day. SP1 = the spread between the high price and the low price of the first price indication in % of the midpoint between the high price and the low price. SP2 = the spread of the last price indication; the last price indication is also the first price indication if there is only one price indication. Numbers without parentheses are means. Numbers with parentheses are standard deviations.
TABLE 4

The difference between the absolute excess returns of 30-trading-minute intervals in the first 2 post-halt trading days and the absolute excess returns of the corresponding 30-trading-minute intervals in the first 2 post-pseudo-halt trading days.a

<table>
<thead>
<tr>
<th>30-trading-minute interval after the market re-opens</th>
<th>Number of non-missing observations</th>
<th>Mean difference in absolute excess return(%)</th>
<th>t-statisticb</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>667</td>
<td>0.6009</td>
<td>10.799</td>
</tr>
<tr>
<td>2</td>
<td>667</td>
<td>0.2341</td>
<td>6.437</td>
</tr>
<tr>
<td>3</td>
<td>667</td>
<td>0.1301</td>
<td>3.093</td>
</tr>
<tr>
<td>4</td>
<td>667</td>
<td>0.0893</td>
<td>2.871</td>
</tr>
<tr>
<td>5</td>
<td>666</td>
<td>0.0901</td>
<td>3.053</td>
</tr>
<tr>
<td>6</td>
<td>665</td>
<td>0.0219</td>
<td>0.83</td>
</tr>
<tr>
<td>12</td>
<td>647</td>
<td>0.051</td>
<td>1.726</td>
</tr>
<tr>
<td>18</td>
<td>637</td>
<td>0.027</td>
<td>1.333</td>
</tr>
<tr>
<td>24</td>
<td>631</td>
<td>0.0198</td>
<td>0.834</td>
</tr>
<tr>
<td>25</td>
<td>626</td>
<td>-0.0272</td>
<td>-1.006</td>
</tr>
<tr>
<td>26</td>
<td>623</td>
<td>-0.0454</td>
<td>-1.182</td>
</tr>
</tbody>
</table>

a Selected intervals are shown here, t-statistics for intervals 1 through 26 are shown in Figure 2.

b t-statistic for the difference between the absolute excess return of a 30-trading-minute interval in the first 2 post-halt trading days and the absolute excess return of the corresponding 30-trading-minute interval in the first 2 post-pseudo-halt trading days.
TABLE 5

The excess returns of 5-trading-minute intervals after imbalance halts with positive during-halt excess return.a

<table>
<thead>
<tr>
<th>5-trading-minute interval after the market re-opens</th>
<th>Number of non-missing observations</th>
<th>Mean excess return (%)</th>
<th>t-statisticb</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>394</td>
<td>0.06</td>
<td>1.656</td>
</tr>
<tr>
<td>2</td>
<td>394</td>
<td>0.04</td>
<td>0.999</td>
</tr>
<tr>
<td>3</td>
<td>394</td>
<td>-0.02</td>
<td>-0.619</td>
</tr>
<tr>
<td>4</td>
<td>394</td>
<td>-0.09</td>
<td>-3.034</td>
</tr>
<tr>
<td>5</td>
<td>393</td>
<td>0</td>
<td>0.053</td>
</tr>
<tr>
<td>6</td>
<td>393</td>
<td>-0.05</td>
<td>-1.721</td>
</tr>
<tr>
<td>12</td>
<td>392</td>
<td>0</td>
<td>-0.042</td>
</tr>
<tr>
<td>18</td>
<td>392</td>
<td>0.02</td>
<td>1.285</td>
</tr>
<tr>
<td>22</td>
<td>392</td>
<td>0.03</td>
<td>1.403</td>
</tr>
<tr>
<td>23</td>
<td>392</td>
<td>0.03</td>
<td>1.876</td>
</tr>
<tr>
<td>24</td>
<td>392</td>
<td>0.02</td>
<td>1.018</td>
</tr>
</tbody>
</table>

a Selected intervals are shown here, t-statistics for intervals 1 through 24 are shown in Figure 3.

b t-statistic for the excess return.
TABLE 6

The excess returns of 5-trading-minute intervals after imbalance halts with negative during-halt excess return.\(^a\)

<table>
<thead>
<tr>
<th>5-trading-minute interval after the market re-opens</th>
<th>Number of non-missing observations</th>
<th>Mean excess return (%)</th>
<th>t-statistic(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>331</td>
<td>0.17</td>
<td>3.532</td>
</tr>
<tr>
<td>2</td>
<td>331</td>
<td>0.06</td>
<td>1.134</td>
</tr>
<tr>
<td>3</td>
<td>331</td>
<td>0.17</td>
<td>3.751</td>
</tr>
<tr>
<td>4</td>
<td>330</td>
<td>0.07</td>
<td>1.85</td>
</tr>
<tr>
<td>5</td>
<td>330</td>
<td>0.01</td>
<td>0.146</td>
</tr>
<tr>
<td>6</td>
<td>329</td>
<td>0.07</td>
<td>1.929</td>
</tr>
<tr>
<td>12</td>
<td>329</td>
<td>0</td>
<td>0.131</td>
</tr>
<tr>
<td>18</td>
<td>328</td>
<td>0.01</td>
<td>0.508</td>
</tr>
<tr>
<td>22</td>
<td>328</td>
<td>0.03</td>
<td>1.025</td>
</tr>
<tr>
<td>23</td>
<td>328</td>
<td>-0.02</td>
<td>-0.887</td>
</tr>
<tr>
<td>24</td>
<td>328</td>
<td>-0.01</td>
<td>-0.58</td>
</tr>
</tbody>
</table>

\(^a\) Selected intervals are shown here, t-statistics for intervals 1 through 24 are shown in Figure 5.

\(^b\) t-statistic for the excess return.
TABLE 7

The excess returns of 5-trading-minute intervals after news halts with positive during-halt excess return.\(^a\)

<table>
<thead>
<tr>
<th>5-trading-minute interval after the market re-opens</th>
<th>Number of non-missing observations</th>
<th>Mean excess return (%)</th>
<th>t-statistic(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>456</td>
<td>0.24</td>
<td>5.959</td>
</tr>
<tr>
<td>2</td>
<td>456</td>
<td>0.06</td>
<td>1.62</td>
</tr>
<tr>
<td>3</td>
<td>456</td>
<td>0.05</td>
<td>1.567</td>
</tr>
<tr>
<td>4</td>
<td>454</td>
<td>0.01</td>
<td>0.361</td>
</tr>
<tr>
<td>5</td>
<td>454</td>
<td>0.02</td>
<td>0.659</td>
</tr>
<tr>
<td>6</td>
<td>452</td>
<td>-0.02</td>
<td>-0.898</td>
</tr>
<tr>
<td>12</td>
<td>452</td>
<td>-0.02</td>
<td>-0.843</td>
</tr>
<tr>
<td>18</td>
<td>452</td>
<td>-0.02</td>
<td>-1.17</td>
</tr>
<tr>
<td>22</td>
<td>452</td>
<td>0</td>
<td>-0.048</td>
</tr>
<tr>
<td>23</td>
<td>452</td>
<td>0.03</td>
<td>1.293</td>
</tr>
<tr>
<td>24</td>
<td>452</td>
<td>0</td>
<td>0.057</td>
</tr>
</tbody>
</table>

\(^a\) Selected intervals are shown here, t-statistics for intervals 1 through 24 are shown in Figure 7.

\(^b\) t-statistic for the excess return.
TABLE 8

The excess returns of 5-trading-minute intervals after news halts with negative during-halt excess return.\(^a\)

<table>
<thead>
<tr>
<th>5-trading-minute interval after the market re-opens</th>
<th>Number of non-missing observations</th>
<th>Mean excess return (%)</th>
<th>t-statistic(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>330</td>
<td>-0.14</td>
<td>-2.734</td>
</tr>
<tr>
<td>2</td>
<td>330</td>
<td>-0.16</td>
<td>-3.103</td>
</tr>
<tr>
<td>3</td>
<td>330</td>
<td>-0.14</td>
<td>-2.821</td>
</tr>
<tr>
<td>4</td>
<td>330</td>
<td>-0.09</td>
<td>-1.76</td>
</tr>
<tr>
<td>5</td>
<td>330</td>
<td>-0.1</td>
<td>-2.148</td>
</tr>
<tr>
<td>6</td>
<td>330</td>
<td>-0.02</td>
<td>-0.488</td>
</tr>
<tr>
<td>12</td>
<td>329</td>
<td>-0.02</td>
<td>-0.972</td>
</tr>
<tr>
<td>18</td>
<td>329</td>
<td>0.05</td>
<td>2.036</td>
</tr>
<tr>
<td>22</td>
<td>329</td>
<td>-0.02</td>
<td>-0.685</td>
</tr>
<tr>
<td>23</td>
<td>329</td>
<td>0.02</td>
<td>0.844</td>
</tr>
<tr>
<td>24</td>
<td>329</td>
<td>0</td>
<td>0.024</td>
</tr>
</tbody>
</table>

\(^a\) Selected intervals are shown here, t-statistics for intervals 1 through 24 are shown in Figure 9.

\(^b\) t-statistic for the excess return.
TABLE 9

The difference between the bid-ask spreads at the end of 5-trading-minute intervals in the first 4 post-halt trading hours and the bid-ask spreads at the end of the time-of-the-day-matched intervals in the control day.a

<table>
<thead>
<tr>
<th>5-trading-minute interval after the market re-opens</th>
<th>Number of non-missing observations</th>
<th>Mean difference in bid-ask spreadb</th>
<th>t-statisticc</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1423</td>
<td>0.1226</td>
<td>8.968</td>
</tr>
<tr>
<td>2</td>
<td>1421</td>
<td>0.0738</td>
<td>5.509</td>
</tr>
<tr>
<td>3</td>
<td>1419</td>
<td>0.0755</td>
<td>5.705</td>
</tr>
<tr>
<td>4</td>
<td>1423</td>
<td>0.0803</td>
<td>5.864</td>
</tr>
<tr>
<td>5</td>
<td>1420</td>
<td>0.0697</td>
<td>5.241</td>
</tr>
<tr>
<td>6</td>
<td>1419</td>
<td>0.0555</td>
<td>4.175</td>
</tr>
<tr>
<td>12</td>
<td>1420</td>
<td>0.0182</td>
<td>1.423</td>
</tr>
<tr>
<td>18</td>
<td>1423</td>
<td>0.026</td>
<td>2.131</td>
</tr>
<tr>
<td>24</td>
<td>1422</td>
<td>0.0057</td>
<td>0.456</td>
</tr>
<tr>
<td>30</td>
<td>1416</td>
<td>0.002</td>
<td>0.165</td>
</tr>
<tr>
<td>36</td>
<td>1419</td>
<td>0.0034</td>
<td>0.275</td>
</tr>
<tr>
<td>42</td>
<td>1411</td>
<td>-0.0078</td>
<td>-0.632</td>
</tr>
<tr>
<td>46</td>
<td>1415</td>
<td>-0.0151</td>
<td>-1.23</td>
</tr>
<tr>
<td>47</td>
<td>1412</td>
<td>-0.0033</td>
<td>-0.274</td>
</tr>
<tr>
<td>48</td>
<td>1409</td>
<td>0.0018</td>
<td>0.141</td>
</tr>
</tbody>
</table>

a Selected intervals are shown here, t-statistics for intervals 1 through 48 are shown in Figure 11.

b Bid-ask spread is in % of the midpoint between the bid and the ask.

c t-statistic for the difference between the bid-ask spread at the end of a 5-trading-minute interval after the market re-opens and the bid-ask spread at the end of the time-of-the-day-matched interval in the control day.
<table>
<thead>
<tr>
<th>t</th>
<th>N_t</th>
<th>Adj. R^2 (%)</th>
<th>F-statistic</th>
<th>a_t</th>
<th>b_t</th>
<th>c_t</th>
<th>d_t</th>
<th>e_t</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1427</td>
<td>4.55</td>
<td>17.995</td>
<td>0.907</td>
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<td>-0.371</td>
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\( a \) Estimates of coefficients for selected intervals are shown here, \( t \)-statistics for coefficients for intervals 1 through 65 are shown in Figures 12 through 16.
### TABLE 11

Results of regression (2).\textsuperscript{a}

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<th>a&lt;sub&gt;t&lt;/sub&gt;</th>
<th>b&lt;sub&gt;t&lt;/sub&gt;</th>
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\textsuperscript{a} Estimates of coefficients for selected intervals are shown here, t-statistics for coefficients for intervals 1 through 48 are shown in Figures 17 through 21.
APPENDIX B

FIGURES
FIGURE 1

30-trading-minute interval after the market re-opens

t-statistic for the difference between the absolute excess returns of 30-trading-minute intervals after the market re-opens and the absolute excess returns of the time-of-the-day-matched intervals in the control day.
FIGURE 2

t-statistic for the difference between the absolute excess returns of 30-trading-minute intervals in the first 2 post-halt trading days and the absolute excess returns of the corresponding 30-trading-minute intervals in the first 2 post-pseudo-halt trading days.

30-trading-minute interval after the market re-opens
FIGURE 3

$t$-statistic for the excess returns of 5-trading-minute intervals after imbalance halts with positive during-halt excess return.
FIGURE 4

Mean cumulative excess return after imbalance halts with positive during-halt excess return.
5-trading-minute interval after the market re-opens

FIGURE 5

t-statistic for the excess returns of 5-trading-minute intervals after imbalance halts with negative during-halt excess return.
Mean cumulative excess return after imbalance halts with negative during-halt excess return.

FIGURE 6
5-trading-minute interval after the market re-opens

FIGURE 7

t-statistic for the excess returns of 5-trading-minute intervals after news halts with positive during-halt excess return.
Mean cumulative excess return after news halts with positive during-halt excess return.
5-trading-minute interval after the market re-opens

FIGURE 9

t-statistic for the excess returns of 5-trading-minute intervals after news halts with negative during-halt excess return.
FIGURE 10

Mean cumulative excess return after news halts with negative during-halt excess return.
FIGURE 11

t-statistic for the difference between the bid-ask spreads at the end of 5-trading-minute intervals after the market re-opens and the bid-ask spreads at the end of the time-of-the-day-matched intervals in the control day.
30-trading-minute interval after the market re-opens

FIGURE 12

$t$-statistic for the intercept $a$ in regression (1).
30-trading-minute interval after the market re-opens

FIGURE 13

t-statistic for the coefficient $b$ of ORD in regression (1).
FIGURE 14

t-statistic for the coefficient $c$ of DEL in regression (1).

30-trading-minute interval after the market re-opens
t-statistic for the coefficient $d$ of SR in regression (1).

FIGURE 15

30-trading-minute interval after the market re-opens
30-trading-minute interval after the market re-opens

FIGURE 16

t-statistic for the coefficient $e$ of AR in regression (1).
5-trading-minute interval after the market re-opens

FIGURE 17

t-statistic for the intercept \( a \) in regression (2).
5-trading-minute interval after the market re-opens

FIGURE 18

t-statistic for the coefficient b of ORD in regression (2).
5-trading-minute interval after the market re-opens

FIGURE 19

t-statistic for the coefficient c of DEL in regression (2).
5-trading-minute interval after the market re-opens

FIGURE 20

t-statistic for the coefficient d of SR in regression (2).
5-trading-minute interval after the market re-opens

FIGURE 21

t-statistic for the coefficient $e$ of AR in regression (2).
LIST OF REFERENCES


