

Tick Size Reduction and Market Quality

The Stockholm Stock Exchange

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Abstract

The implementation of the FESE tick size table 2 on June 7 2010 meant a reduction in the minimum tick size for all Large Cap stocks on the Stockholm Stock Exchange. By using order data from Nasdaq OMX, this study investigates the impact of the tick size reduction on market quality by examining quoted bid-ask spread, quoted depth, trading volume and volatility. The performed Wilcoxon rank-sum tests and difference-in-difference regressions provide significant empirical results of a reduction in bid-ask spread and depth along with an increase in trading volume. The reduction of the bid-ask spread is greatest for low-priced and high-volume stocks, for which the tick size is more likely to be a binding constraint. These findings are similar to much of the findings presented by previous research. This study concludes that this particular tick size reduction meant an enhanced market quality for small investors while the effect for large investors remained ambiguous. No significant findings were made regarding how the return volatility was effected by the tick size reduction.

Keywords: Market quality, liquidity, bid-ask spread, depth, trading volume

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1. Introduction

Throughout the last couple of decades, stock exchanges all over the world have followed a trend of reducing the tick sizes for traded equities. By reducing the tick size they hope to attract more listed companies, investors and capital, and thereby increasing the trading activity. On June 7, 2010, as part of the harmonization of tick size tables within the European equity market, the FESE tick size table 2 extended to apply from only OMXS30 to all stocks on the Large Cap list at the Stockholm Stock Exchange. For the affected stocks, this new tick size table meant a reduction in the minimum tick size. This thesis aims to investigate how the market quality for these stocks has been affected by the decrease in tick size, and whether this change has resulted in any significant difference in traded volume.

The tick size of a stock refers to the minimum possible price movement that a stock can experience. For example, a Large Cap stock trading at SEK 160 with the old tick size table had a minimum tick size of 0.5. It could therefore assume prices such as 160.0, 160.5, 161.0 and so forth. As a result of the new table, the stock's tick size would have been reduced to 0.1, enabling it to take the prices 160.0, 160.1, 160.2 and so on. A reduced tick size like the one presented here ought to affect the market quality in several ways. We believe that the quoted bid-ask spread will decline as a direct result of the reduced tick size, as traders seek to exploit the fact that the cost for immediacy has decreased. A reduction in the bid-ask spread is also likely to reduce the liquidity in terms of reduced quoted market depth. Since it is now less expensive to step in front of an already submitted order, traders will be more hesitant to post large orders as the risk of other traders stealing their possible transactions has increased. Considering the fact that the jumps between stock prices now are smaller, we also hypothesize that a tick size reduction should result in lower volatility. Taken together it is our last hypothesis that the tick size reduction will have a positive effect on traded volume. This we base on the fact that the lower cost of trading should result in higher volumes.

To conclude whether the stated hypotheses are correct we will perform an empirical examination of the different parameters as to see whether there has been any significant change in the variable related to the event. First of all we will conduct a Wilcoxon rank-sum test to see if there has been any change in the means around the event. Secondly, we will run two different regression set-ups in order to control for other factors and verify that the potential change is attributable to the tick size reduction and not something else. In order to more clearly distinguish the tick size effect we choose to exclude certain stocks that could impede our results. After having applied the restrictions that each stock has got to have at least one transaction per day and not change price bands for any time during the study, as well as be listed for the entire period, we end up with a treatment sample of 25 affected companies and a control sample of 145 companies. Out of these, 25 stocks are chosen to act as the control sample, where each treatment stock is assigned a matched control stock that is similar with respect to market capitalization and trading turnover. This matching procedure is necessary in order to run one of the regressions which make use of the difference between the treatment and its control in the regression. It also allows for better comparability between the treatment and control group.

Looking at the results of the regressions and the Wilcoxon rank-sum tests we can see that our results are much in line with the findings of previous research. When it comes to the bid-ask spread we notice a substantial decrease of around 25 percent. The decline is apparent also when it comes to the market depth, which has experienced a decrease of about 75 percent, whereof around 70 percent of those 75 percent can be attributable to the tick size reduction. The volatility has decreased with 27 percent for the treatment group. Hence it seems as though the volatility should have decreased due to the tick size introduction. However, we find no clear evidence supporting this claim as the regressions leave us with mostly insignificant results. In addition to this, the volatility for the control group has decreased with 27 percent as well. As a final result we notice that the volume for all firms has decreased during the examined period. Nevertheless we find proof, although a bit weak, for that the relative decrease is less for the treatment companies than for the control companies. In sum we conclude that the market quality has increased for small investors who are not limited by the shares available at the highest order book level. For larger investors who now have to divide their orders between several order levels, the effect on market quality is ambiguous.

Our contribution to this field of study is primarily that we study a tick size change that has never been examined as of today. Hence, we are able to come up with results showing how this particular change in tick size impacted the market quality. Since research has failed to establish one universally optimal tick size, it becomes necessary to study the effects of each individual tick size change separately to see if the market quality has been further improved. We furthermore apply a methodology that is more robust than many previous studies, that more often than not settles for just one regression with one definition of the parameters in question.

2 Background

The FESE¹ tick table 2 was first introduced for the OMXS30, an index containing the 30 most liquid stocks on the Stockholm Stock Exchange (henceforth SSE), on October 26, 2009. This tick size table was then implemented for its counterparties in Helsinki (OMXH25) and Copenhagen (OMXC20). On June 7, 2010, the tick table was extended to apply for all stocks trading on the Large Cap lists on these three exchanges. The implementation of the FESE tick size table 2 was a result of an agreement met between the FESE, the London Investment Banking Association and several Multilateral Trading Facilities including NASDAQ Europe. The new table is a step toward harmonizing and reducing the tick size regimes in Europe in order to create benefits for the markets and the market participants. The harmonization of tick size tables was initiated to prevent trading venues to undercut each other with regard to tick size. When tick sizes get too small it will harm liquidity by decreasing the market depth, and in turn lead to increased costs for market participants.

¹ Federation of European Securities Exchanges

Despite the supposed positive effects of FESE tick size table 2, the harmonization was not conducted for all stocks at the same time on SSE. Stocks trading on the Mid Cap and Small Cap lists were left unaffected and continued to trade according to the old tick size table. Compared to the old one, the new tick size table meant both increases and decreases in tick size depending on the price of the stock. Stocks that were priced up to SEK 499.50 experienced a decrease in tick size, companies trading between SEK 1,000-9,995 were left unaffected, while companies trading above SEK 10,000 experienced an increase tick size. However, as all affected Large Cap stocks on SSE fell into the first price category, they were all subject to a decrease in tick size.

3. Previous Research

A lot of research has been put into the field of tick sizes without reaching a conclusion of what constitutes an optimal tick size. Instead the previous research often focuses on the effects of one particular tick size change and its effect on market quality. Some papers even try to forecast the effects of a possible tick size change. Many of the studies examining tick size changes look at the impact on the bid-ask spread, market depth and trading volume. Although the results from these studies vary somewhat, they generally show a positive correlation between a reduction in tick size and bid-ask spread along with market depth. The trading volume however is more often than not found to have a negative correlation with tick size reductions.

Following an hypothesized reduction of the tick size from 1/8 to 1/16 dollar for U.S. exchange-listed stocks, Harris (1994) presents empirical results predicting a decrease in both bid-ask spreads and depths, making it difficult to determine the total effect on liquidity. In addition he also notices an increase in daily traded volume. The results of Harris (1994) represent in general what many subsequent studies conclude as well, even though there are some differences. Bacidore (1997) in contrast concludes that the trading volume remained unchanged following a change from 12.5 cents to 5 cents for stocks trading above 5 dollars on the Toronto Stock Exchange. He does however also find evidence in line with Harris' results, such as narrower bid-ask spreads and decreased depths. Bacidore especially points out that the decrease in depths does not bring negative implications for liquidity considering the simultaneous decrease in spreads. Goldstein and Kavajecz (2000) also find proof of decreased quoted bid-ask spreads and cumulative depths, when examining an actual tick size reduction from 1/8 to 1/16 dollar on the New York Stock Exchange.

Several empirical studies show that a smaller tick size is more favourable for low priced and/or frequently traded stocks. The converse is true for high priced and/or infrequently traded stocks, for which a large tick size may be preferable. Harris (1994) provides an explanation when he states that the minimum tick size seems to be a binding constraint for low-priced and frequently traded stocks, while it is rarely binding for high-priced and infrequently traded stocks. Bessembinder (2003) documents such findings, showing

that the quoted bid-ask spread and quoted depth decline in particular for high volume stocks with large market capitalization.

Some of the conducted research within the area of tick size changes distinguishes between the effects for two different groups, namely liquidity demanders trading small orders and liquidity demanders trading large orders. Harris (1994) argues that small traders would benefit from a reduction in tick size that reduces bid-ask spreads and depth, since they most likely will be able to find sufficient liquidity at the highest order book level. Goldstein and Kavajecz (2000) present evidence that suggest a decline in execution costs for smaller orders while the execution costs for larger orders of infrequently traded stocks rose. They did not notice any substantial difference for large orders of frequently traded stocks.

Several studies also account for return volatility when examining the effect of a tick size change upon market quality. The effect on volatility does not seem to be as clear cut as the effect on bid-ask spread since different articles reach different conclusions. Ronen and Weaver (1998) and Bessembinder (2003) for example find that return volatility decreases as an effect of a tick size reduction. Van Ness et al. (2000) on the other hand present results showing an increase in volatility on NYSE following an implementation of a 1/16 dollar tick size.

When it comes to SSE, findings from existing studies on tick size are much in line with the findings from other exchanges around the world. Niemeyer and Sandås (1994) provide evidence showing a positive relation between tick size and bid-ask spread, market depth and a negative relationship to trading volumes. They discuss the ambiguous effect on market quality given these results and conclude that the tick size reduction primarily benefits small traders. In their thesis, Bennemark and Chen (2007) investigate the effects on market quality of a tick size change on SSE in 2006. They show that bid-ask spread, breadth, depth and return volatility decreases. Bennemark and Chen believe the reduction in bid-ask spread outweighs the negative effects associated with the decrease in depth, therefore resulting in an enhanced market quality.

4. Theory & Hypotheses

When taking a broader perspective, the research conducted within the field of tick size changes originates from the theories of market microstructure. Market microstructure is defined as “the study of the process of exchanging assets under explicit trading rules” (O’Hara 1995, p.1). Instead of focusing on the mechanisms of trading, the area of market microstructure specifically analyzes how the price formation process is influenced by different trading mechanisms (O’Hara 1995). Liquid markets are said to offer trading without causing any impact on the price. It is widely established in literature and previous research that the bid-ask spread and depth are important constituents of liquidity, which together with volatility are three central components that give indications regarding market quality. An effect of market liquidity is how much is traded on the exchange. If the market quality is high, there will be more trades taking place,

generating volume. It is therefore these four measures we aim to look at when trying to decipher the effect of the tick size reduction on SSE.

4.1 Bid-Ask Spread

The bid-ask spread is the difference between the highest price a buyer wants to pay for a security, and the lowest price a seller is willing to sell the same security for. The bid-ask spread has an important role in financial markets and is commonly viewed as a central determinant of liquidity. For traders who demand immediacy, the bid-ask spread is the cost they have to pay in order to trade directly. If they want to buy the share immediately they have to pay the lowest ask price, and conversely if they want to sell it straight away they will have to pay the highest bid price. In contrast, dealers look upon the bid-ask spread as the benefit they receive for providing immediacy in a market (Harris 2003). A dealer is an actor who mediates trades in at stock market Harris (2003). Consequently, traders who value immediacy prefer smaller bid-ask spreads since it minimizes their cost of trading, while dealers prefer larger bid-ask spreads since it will maximize their profits.

Harris (2003) divides the bid-ask spread into a transaction component, including the operating and inventory risk part, and an adverse selection component. The bid-ask spread would equal the transaction cost component if all traders knew the true value of the share, that is, if there was perfect information in the market. Since this is not the case, informed traders can buy (sell) the share when the price is lower (higher) than the true value (O'Hara 1995). To compensate for the loss dealers suffer when trading with informed traders, they set broader bid-ask spreads to gain from the uninformed traders.

As seen in studies such as Harris (1994), Goldstein and Kavajecz (2000) and Jones and Lipson (2001) there is strong empirical evidence for that a reduction in tick size leads to narrower bid-ask spreads. We thereby expect the quoted bid-ask spread to decrease following a decrease in the tick size.

Hypothesis 1(a): A decrease of the tick size will lead to a decrease of the quoted bid-ask spread

It is commonly found in earlier studies that the bid-ask spread is beneficial for stocks that are low-priced and frequently traded (see Porter and Weaver (1997) and Goldstein and Kavajecz (2000)). Harris (1994) states that the tick size tends to be a binding constraint for low-priced, frequently traded stocks and that the bid-ask spread should decrease more for stocks where the tick size is a binding constraint. Accordingly, we have reason to expect a more observable decrease in the quoted bid-ask spread for high-volume stocks and low-priced stocks.

Hypothesis 1(b): A decrease of the tick size will lead to a relatively larger decrease in the quoted bid-ask spread for high-volume stocks

Hypothesis 1(c): A decrease of the tick size will lead to a relatively larger decrease in the quoted bid-ask spread for low-priced stocks

4.2 Depth

Market depth is a significant component of liquidity, where larger depths are considered to be liquidity enhancing. The depth is defined as the quantity of shares that can be traded at a given cost of liquidity (Harris 2003). Market depth is widely described as the ability of the securities in a market to absorb relatively large orders without dramatically impacting the price.

The depths are often affected when tick sizes are reduced. One of the reasons is that traders who reveal their orders are exposed to the risk that other investors can take advantage of their position and place an order at a slightly higher level in the order book. Consider an example where a large institutional investor puts a large buy order at the second order book level. Other traders might believe that the institutional investor possess some private information, since the institution is demanding large quantities. The other traders can utilize this situation by placing an order at the order level just above the institutional investor. In this case they could quite cheaply gain precedence over the large order from the institutional investor. (Harris 2003) Thus, when the tick size gets smaller, the cost of getting order priority through price decreases. As a result, the quoted depths are likely to fall, as investors want to safeguard themselves against this behavior. Another reason why depth could decrease due to a tick size reduction, is that such a reduction is mostly followed by a decrease in the bid-ask spread. As the bid-ask spread is the benefit dealers obtain from providing liquidity, the dealers are now forced to move down their orders in the order book to compensate for the narrower spread. (Goldstein and Kavajecz 2000) Prior studies generally show a decrease in the quoted depth after a tick size reduction, which for example are the findings of Harris (1994) and Bacidore (1997).

Because of the above theory combined with the empirical findings of previous research on the area, we expect the quoted depth to decrease.

Hypothesis 2(a): A decrease of the tick size will lead to a decrease in quoted depth

Hypothesis 2(b): A decrease of the tick size will lead to a relatively larger decrease in quoted depth for high-volume stocks

Hypothesis 2(c): A decrease of the tick size will lead to a relatively larger decrease in quoted depth for low-priced stocks

4.3 Volatility

Volatility is the variation of the price of a particular stock or financial instrument over a given period of time, and is commonly measured in standard deviation. Volatility can be divided into two components: fundamental volatility, reflecting the unexpected changes in the value of a share, and the transitory volatility which is caused by uninformed traders (Harris 2003). The fundamental volatility as such cannot be affected by a tick size change, since it depends on external shocks. The transitory volatility on the other hand can be affected by the bid-ask bounce, which is when the price jumps slightly up and down as im-

tient traders looks for immediacy (Harris 2003). As the bid-ask spread gets smaller, this variation should decrease as well, thereby reducing the overall volatility.

An opposing theory suggests that the volatility should increase as a result of decreased quoted depth. With fewer shares available at each order book level, the price is more likely to jump between different order book levels, therefore increasing the volatility (Porter and Weaver 1997).

Considering the contrasting theories and empirical findings, it is difficult to hypothesize about exactly how the volatility will be affected by this tick size change. As a result of a tick size reduction, Ronen and Weaver (1998) and Bessembinder (2003) shows that the return volatility decreases, while Van Ness et al. (2000) finds both an increases and decreases in volatility at different stock exchanges. Since Bennemark and Chen (2007) find evidence of a decrease in volatility following a previous tick size reduction on SSE, we have reason to expect a decrease in volatility for the examined tick size reduction.

Hypothesis 3(a): A decrease of the tick size will lead to a decrease in volatility

Hypothesis 3(b): A decrease of the tick size will lead to a relatively larger decrease in volatility for high-volume stocks

Hypothesis 3(c): A decrease of the tick size will lead to a relatively larger decrease in volatility for low-priced stocks

4.4 Trading volume

The trading volume is defined as the number of trades that are executed for a security during a defined time period. The bid-ask spread is an element of the cost of trading and will therefore affect the trading volume. Hence a reduced bid-ask spread following the tick size reduction would cause the trading volume to increase. Here it is possible to apply demand theory, since there ought to be a negative relationship between bid-ask spread (cost) and trading volume (quantity). Thus, if the bid-ask spread decreases, volume should increase. One should however be aware of the contrary relationship as well. If the volume increases exogenously then the bid-ask spread could decrease as a result since more traders and higher demand will tighten the spread. After a tick size reduction, Harris (1994) finds an increase in trading volume in contrast to Bacidore (1997) who shows that the trading volume is left unchanged. With regard to the theory that the cost of trading declines, we believe that the trading volume should increase.

Hypothesis 4(a): A decrease of the tick size till lead to an increase in trading volume.

Hypothesis 4(b): A decrease of the tick size will lead to a relatively larger increase in trading volume for high-volume stocks

Hypothesis 4(c): A decrease of the tick size will lead to a relatively larger increase in trading volume for low-priced stocks

5. Data

The primary data used in this thesis has been provided by NASDAQ OMX from their quotation database, which comprises all individual orders on financial instruments traded on SSE. The data contains the bid and ask prices, corresponding volumes and the number of orders at each level, for the 20 highest order book levels. Each financial instrument is uniquely identified through an "IdCode" while each order is given a unique "identifier" and is time stamped down to the closest millisecond. To complement this data, we have collected historical data from the NASDAQ OMX Nordic's website (NASDAQ OMX Nordic 2011) on the highest, lowest, closing and average prices, as well as volume and trading turnover. Thomson Datastream has been used to find the number of shares outstanding for all firms, and the variables necessary for calculating the distance metric mentioned below.

This study will use a time period that spans from April 19 to July 23, 2010, surrounding the tick size change on June 7. The sample period between April 19 and May 31 will act as a 6 week long pre-event estimation window, while the period between June 14 to July 23 will represent as a 6 week long post-event estimation window. We consider this estimation period sufficient to capture the effects of the event, being at least equal or even longer than the periods used by for example Porter & Weaver (1997), Ronen & Weaver (1998) and Bennemark & Chen (2007). Similar to many other studies, we choose to exclude a period just before and after the event to avoid any unusual trading behavior related to the event (see for example Bacidore (1997) and Ronen & Weaver (1998)). We set this period of exclusion to a period of one week before and after the introduction of the event. To cope with the high-frequency nature of the data, we have averaged it for each quarter of an hour throughout each trading day, which gives a total of 34 observations for each stock per day. The multiple observations per firm over time define this data as a panel dataset. In order to avoid some of the problems caused by extreme observations in the dataset, we have winsorized the dependent variables at the 98 percent level. This means that the values below the 1st percentile are assigned the value of the 1st percentile, and that values above the 99th percentile are assigned the values of the 99th percentile. By doing this the extreme values are "smoothed" instead of trimmed away. Thus, the impact of the extreme values is reduced at the same time as the number of observations is kept constant, which we consider to be preferable over losing some observations. See Tables 1 and 2 for descriptive statistics on original and winsorized data.

The initial total sample (whereof treatment firms) consists of the 293(37) stocks listed at SSE at the time of the event. In order to avoid biased results, the test will exclude companies that trade within two different price bands (see Table 3 for price band tables) during the period of interest. Hence, if a stock for example trades between SEK 145-155 during the pre-event period, it will be excluded from the sample since it during the time of interest trades within two different price bands (SEK 50-150 and SEK 150-500). It may appear quite harsh to exclude a stock that trades within a range of SEK 10, but the shifts between price bands will cause the stock to be trading with different tick sizes, independent of the event we are examining. We furthermore exclude companies that have less than one transaction per day, since

the illiquidity of these stocks could cause them to behave in an irrational way. Lastly we exclude stocks that have become publicly traded or delisted during the study since they inevitably lack data for some part of the examined period. All these exclusions render us with a final of 170 (25) firms. See Table 4 for excluded companies and the reason for their exclusion.

To be able to infer conclusion regarding the (b) and (c)-parts of our hypotheses, we have chosen to partition both the treatment and control samples into high/low volume stocks and high/low priced stocks. Each firm will therefore exist in one of the volume groups and in one of the price groups simultaneously. The division is conducted so that the high and low groups are about equal in size. The calculation of which group a company should belong to is based on the average of that parameter through the pre-event period.

Inspired by Boehmer et al.(2009), the control group for the regressions are chosen so that a similar unaffected company matches each company in the treatment group, thus creating a control group of equal size as the treatment group. In our case this means that the 25 treatment companies are matched with 25 control companies. See Table 5 for disclosure of which control company is matched to which treatment company. The matching company is found by creating a distance metric based on market capitalization and trading turnover collected for the time period starting October 16, 2009, and ending April 16, 2010. The distance metric is calculated as the sum of the proportional absolute difference in market capitalization and trading turnover between the affected and unaffected companies. The control company is chosen as to minimise the total distance measure. By following this approach, the control group will possess as similar characteristics as the treatment group as possible, which hopefully will improve our results and allow us to run the second type of regression.

6. Methodology

Conducting an investigation of the effects on market quality by a tick size event is not as straightforward as many other tests. Since there are several aspects that need to be accounted for, we have chosen to weigh in the effects of a few different variables, all directly or indirectly related to market quality. In our attempt to distinguish how the market has been affected we will examine how spreads, depths, volatility and volume have changed due to the event. Volume in itself is not a constituent of liquidity, but should be affected through changes in the three other parameters. Hence, looking for any potential difference in volume can be seen as a way of “double-checking” how the market has changed, since a higher market quality ought to result in increased trading and therefore higher volume. To obtain as robust results as possible, we will first implement a Wilcoxon rank-sum test comparing the means of each parameter before and after the tick size reduction, and thereafter run two different types of regressions. We attempt to further increase robustness through the use of two different definitions of the dependent variable for each measure.

6.1 The Parameters

The parameters, and their respective definitions, that will be used in the empirical tests are presented below.

6.1.1 Bid-Ask Spread

There are two commonly used measures of bid-ask spread, effective and quoted spread. The data available to us only allow us to look at the quoted bid-ask spread. The bid-ask spread is defined as the difference between the highest bid-price and the lowest ask-price. Because to its nature, the bid-ask spread will per definition always be positive. Consider a situation where the best ask-price would have been 105 and the best bid-price 110 (creating a bid-ask spread of -5), then a transaction would have taken place somewhere between 105 and 110, thus eliminating those orders and re-establishing a positive equilibrium, where the ask-price is higher than the bid-price. To ascertain robust results we will use two different definitions of bid-ask spread – absolute and relative. The absolute quoted spread is defined as the lowest ask-price minus the highest bid-price, measured in SEK:

$$\text{Absolute Spread} = \text{Lowest Ask} - \text{Highest Bid}$$

The relative spread is defined as the absolute spread divided by the midpoint of the best ask- and bid-prices, measured in basis points:

$$\text{Relative Spread} = \frac{\text{Lowest Ask} - \text{Highest Bid}}{\frac{(\text{Lowest Ask} + \text{Highest Bid})}{2}} * 10000$$

6.1.2 Depth

The second liquidity measure of interest is the quoted depth, which again is measured in both absolute and relative terms. The absolute depth is obtained by summing up the volumes at the best bid and ask level:

$$\text{Absolute Depth} = \text{Bid Volume} + \text{Ask Volume}$$

The relative measure has been calculated as the absolute depth divided by outstanding shares to give a reasonable idea of the proportion of the security's shares that are available at the best order book level and is measured in basis points:

$$\text{Relative Depth} = \frac{\text{Bid Volume} + \text{Ask Volume}}{\text{Number of Outstanding Shares}} * 10000$$

6.1.3 Volatility

The volatility is measured as the standard deviation of the logarithmic 15-minutes return. The logarithmic return is created through the use of a price variable that is equal to the midpoint of the highest bid- and lowest ask-price. The standard deviation is annualized to allow for easier interpretation. When we annual-

ize the return, we assume 252 trading days in a year and 34 quarters of an hour per day. The method therefore follows this order:

$$Price = \frac{Ask + Bid}{2}$$

$$Return = \ln(price_t) - \ln(price_{t-1})$$

$$SD = SD(Return)$$

$$Annualized\ SD = \frac{SD(15minutes\ return)}{\sqrt{\frac{1}{252 * 34}}}$$

The volatility is quoted in decimal form and calculated per day, which gives this measure a lower frequency than the two previous ones.

The second definition of volatility that we make use of is the proportional daily range of transaction prices, which is given by the difference between the highest and lowest price paid during the day divided by the midpoint of the two:

$$PropDaily = \frac{Highest\ transaction\ price - Lowest\ transaction\ price}{\frac{(Highest\ transaction\ price + Lowest\ transaction\ price)}{2}}$$

6.1.4 Volume

This measure is very straight-forward as we use the traded volume and trading turnover before and after the event. The traded volume is simply the number of shares that have been bought and sold during a time period. The trading turnover is the sum of the number of shares traded multiplied by the average price per share for a given time period. In this case the time-period for both measures will be one day since we do not have any intraday data for them.

6.2 Wilcoxon Rank-Sum Test

The first empirical test conducted is the Wilcoxon rank-sum test, which we hope will give an indication of how the parameter in question has been affected by the tick size change. The test is constructed to test whether there is any significant difference in means between the pre- and post-event period. If there is an effect on the studied parameter caused by the event, then the means of the post-period should be different from the mean from the pre-period. One should however be aware of that this test only tests the difference in means. It cannot distinguish whether it is the event that has caused the change or if it is just a trend. We have chosen to use the Wilcoxon rank-sum test over the t-test since we want to avoid the assumption of normality that the t-test prescribes (Newbold et al 2007). Furthermore, as Sawilowsky (2005) points out, the t-test only possesses a slight power advantage over the Wilcoxon rank-sum test even in those cases where normality occurs. The use of the Wilcoxon rank-sum test is also common in articles within this field of research, which can be seen in for example Ronen and Weaver (1998), Ahn et

al. (2007) and Van Ness et al. (2000). The Wilcoxon rank-sum test assumes that the two populations are identical in all aspects, apart from differences in locations (Newbold et al. 2007). This assumption should hold as the populations should be identical apart from the difference in mean caused by the event. However, since we do not proof that this is true we will be careful when drawing conclusions from this test. Furthermore, these tests should only be seen as a preliminary test as to whether the parameter in question has been affected. To allow for better inferences, the results from these tests will be interpreted in conjunction with the regression results.

6.3 Regressions

6.3.1 Difference-in-Difference Regressions

To ascertain that the changes in means stem from the tick size reduction and not any ongoing short- or long-term trend we will run regressions controlling for other variables. Since not all stocks on SSE are subject to the tick table change, it becomes natural to run a difference-in-difference regression where the affected firms will act as the treatment group and the unaffected firms as the control group. A difference-in-difference regression estimates the effect on the treatment companies by controlling for changes in the control group:

$$DiffinDiff = (Treatment_{After} - Treatment_{Before}) - (Control_{After} - Control_{Before})$$

A difference-in-difference regression requires two dummy variables. The dummy “Treatment” is assigned a value of 1 if the stock is affected by the tick size reduction, and 0 otherwise. In the same manner a dummy, “Event”, is created taking on the value of 1 if the time period is after the tick table change, and 0 if it is before the introduction of the new table. The difference-in-difference variable is then created through multiplying the two dummy variables. Hence, the most basic difference-in-difference regression is:

$$Y_{i,t} = \beta_0 + \beta_1 Event_{i,t} + \beta_2 Treatment_{i,t} + \beta_3 DiD_{i,t} + \varepsilon_{i,t} \quad (1.1)$$

where $Y_{i,t}$ is the liquidity measure of interest; $Event_{i,t}$ is a dummy which is assigned the value of 1 if the time period is post the tick table change and 0 if it is before; $Treatment_{i,t}$ is a dummy variable that takes on the value of 1 if it is an affected firm and 0 otherwise, and DiD is the difference-in-difference estimator that is 1 if the firm is treatment firm and the time period is post the event.

Consider the example where $Y_{i,t}$ equals the bid-ask spread for stock A. If the tick size is reduced for only that stock, everything else equal, and the actual spread does indeed decrease we would expect β_3 to be negative. It is therefore this difference-in-difference effect we are interested in when running regressions of this type.

To add robustness to the results, this regression will be run in three different set-ups, where we increase the number of controls in each step. The first equation will be equation (1.1) stated above. In a next step we will add both time and company fixed effects which gives us the second equation:

$$Y_{i,t} = \beta_0 + \beta_1 DiD_{i,t} + \alpha_i + \gamma_t + \varepsilon_{i,t} \quad (1.2)$$

where γ_t is calendar day dummies for each trading day controlling for time fixed effects, and α_i are dummies for each individual company controlling for company fixed effects. The “Event” and “Treatment” variables fall away since they are now controlled for under the fixed effects.

In the last step we will also add different control variables:

$$Y_{i,t} = \beta_0 + \beta_1 DiD_{i,t} + \theta X_{i,t} + \alpha_i + \gamma_t + \varepsilon_{i,t} \quad (1.3)$$

where θ is a vector consisting of betas for control variables in vector $X_{i,t}$. Hence, the control variables will be slightly different depending on which the dependent variable is. For all regressions we have averaged the quarterly data so that each company has one observation per day, thus giving us a panel dataset. This is done in order to avoid data with different frequencies, which would have biased our results.

6.3.2 Matched Companies Difference Regressions

Another type of regression that we will run is one inspired by Bohemer, Jones & Zhang (2009). It makes use of the difference between a treatment and its matched control company and will also be run in two different steps for increased robustness. The first being:

$$Y_{i,t} = \beta_0 + \beta_1 Event_{i,t} + \theta X_{i,t} + \varepsilon_{i,t} \quad (2.1)$$

where $Y_{i,t}$ is the liquidity measure of interest; $Event_{i,t}$ is a dummy variable that is assigned 1 for the post event period and 0 for the pre-event period; θ is a vector of betas for $X_{i,t}$, and $X_{i,t}$ is a vector of the pairwise differences between the treatment and control companies for the control variables. The second regression also controls for time and company fixed effects. This regression is given as:

$$Y_{i,t} = \beta_0 + \alpha_i + \gamma_t + \beta_1 Event_{i,t} + \theta X_{i,t} + \varepsilon_{i,t} \quad (2.2)$$

where α_i are the matched pair fixed effect, and γ_t are calendar day dummies for each trading day.

Using this type of regression makes the “Event” the variable of interest. Since all variables already are made up of differences, there is no need for a difference-in-difference variable to account for the difference in effect between the treatment and control group.

6.3.3 Control Variables

For the bid-ask spread and depth regressions the same control variables will be used. For regressions (1.1-1.3) the applicable control variables are logarithmic market cap, logarithmic volume and the annualized

standard deviation of return. The second type of regression (2.1-2.2) will make use of the difference of the following variables: volume, proportional daily range of transaction prices, market capitalization, and volume-weighted average price.

The control variables for regressions (1.1-1.3) for the volatility regressions are the number of transactions, logarithmic market capitalization and one lagged volatility parameter. The regressions (2.1-2.2) will make use of the difference between market capitalization, number of transactions and the volume-weighted average price.

Lastly, the control variables for the volume regressions (1.1-1.3) are the volatility (annualized standard deviation of return), logarithmic market capitalization and the quoted absolute bid-ask spread. For the regressions (2.1-2.2) the corresponding control variables are the differences of: proportional daily range of transaction prices, market capitalization and quoted absolute bid-ask spread.

6.4 Endogeneity Problem

We can identify endogeneity problems in our regressions in form of simultaneous equations and omitted variables. The simultaneous equations problems arise when we regress bid-ask spread on volume and vice versa, and also when we regress volume on bid-ask spread and depth. One way to handle the simultaneous equations problem is to specify instrumental variables for the endogenous variables in a two stage least squares (Wooldridge 2009). However, Harris (1994) shows that the endogeneity problem due to the simultaneous equations bias does not have any impact on the results, whereupon we do not feel the necessity of controlling for this. The regressions might also be endogenous due to the omitted variable bias, where an explanatory variable is left out of the regression (Wooldridge 2009). Harris (1994) suggests that one omitted variable is skilled traders who through their knowledge manage to obtain narrower bid-ask spreads. If the variable of skilled traders explains the bid-ask spread and it is left out, the results would be biased. As this cannot be ruled out, some caution has to be taken when interpreting the results.

7. Results

This section will present the outcome of the empirical tests that have been undertaken in our aim to examine our previously stated hypotheses. The section will look at each liquidity measure in turn, intertwining the results from the Wilcoxon rank-sum test and regression results, and finally comparing the outcome to our hypotheses. Graphs visualizing the effects on the parameters are found in the appendix.

7.1 Bid-Ask Spread

The effect of the tick size reduction on spreads can be seen in Table 6 and Table 7. Looking at the absolute spread, found in Table 6, it is apparent that the absolute spread has decreased for each treatment subgroup and for the treatment group as a whole, and that all figures are significant at the one percent level. Overall, the absolute spread has decreased with about SEK 0.13, or roughly 24 percent. Since the

average tick size reduction according to the tick size table for the studied treatment companies being approximately 74 percent, it seems as though the potential of the tick size reduction is not fully realized. Using the control group as a comparison, it is noticeable that the control group's companies' absolute spreads were left more or less unaffected by the tick change. This is of course in line with our expectations, since they were not subject to the reduction. Therefore, with the treatment group being affected and the control ditto being unaffected it is plausible to assert that the reduction in absolute spread is due to the examined tick size reduction.

The reduction in quoted absolute spread is supplemented by a reduction in relative spread as well, thereby corroborating our initial findings. For the treatment group we observe very similar results compared to the absolute spread with a reduction of 10.6 basis points, which corresponds to a decrease of 26 percent. For the control companies it appears as though the relative bid-ask spread has increased by 5 percent, which is slightly higher than the decrease of 0.6 percent that the same group experienced in absolute spread. However, these changes are both quite small in magnitude and it is debatable whether these changes stem from the examined event.

Turning the attention to the results of the regression gives an indication that the control group actually has not experienced a significant change in spread due to the tick size reduction. Looking at regression (1.1) in Table 14, it is observable that the "event"-variable is not significant neither for the absolute spread nor the relative spread. In addition, the magnitude of the coefficients is relatively small. Had the control group been subject to an effect during this time, then the "event"-variable would have been significant and different from zero.

A regressor that does show significance is the variable of interest of this test, namely the difference-in-difference-variable in regressions (1.1-1.3) and the "event"-variable in regressions (2.1-2.2). Beginning with the simple difference-in-difference regression (1.1) we can see that the difference-in-difference -variable is highly significant and has a negative beta coefficient just as expected. Reassuringly, the difference-in-difference -variable continues to be significant at the one percent level throughout regressions (1.2-1.3). Moreover, the coefficient remains similar in magnitude of around SEK 0.12 for the absolute spread and 7-9 basis points for the relative spread. Comparing the outcome of regression (1.3) with the result from the difference in means shows that the reduction in spreads for affected companies are roughly equal in size. For the absolute (relative) spread the difference in means witnesses about a reduction of SEK 0.13 (10.6 bp), while regression (1.3) shows a reduction of SEK 0.117 (9.16 bp). Performing the second type of regression gives quite similar results, with the absolute (relative) spread decreasing with SEK 0.119 (11.84 bp) in regression (2.2).

Because of the apparent reduction in the means combined with the highly significant negative betas for the difference-in-difference variable for both measures of spread, we consider the results to be robust.

Therefore can conclude that hypothesis 1(a) was correct, a decrease in tick size does lead to a decreased bid-ask spread.

Having confirmed that the bid-ask spread decreases, we continue our examination of spreads, and whether high volume stocks experience a bigger shock than low volume stocks. In Table 6, there seems to be evidence pointing in this direction. The absolute spread for the high volume stocks has decreased with SEK 0.17, which is equivalent to 47 percent. This should be compared to the low volume stocks which see a drop of SEK 0.09, equivalent to a decrease of 12 percent.

Looking at the equivalent numbers for the relative spread, the findings are the same. The high volume stocks decrease with 16.75 bp (52%), while the low volume group decreases with only 3.92 bp (7.6%), thereby supporting our findings in absolute spread. Hence, we can conclude that hypothesis 1(b) was correct, a decrease in tick size reduces the bid-ask spread more for high volume stocks.

In a similar manner we expect lower priced stocks to be affected to a larger degree than low priced stocks. Results in Table 6 show that for the absolute spread, the lower priced companies experience bigger drops in spread than do their higher priced counterparties. The lower priced companies experience a drop of 32.6 percent in absolute spread while the corresponding figure for the higher priced companies is a drop of 21 percent. The same trend can be found when looking at the relative spreads in Table 7, where low priced firms show a decrease of 36 percent, while high priced firms witness about a decrease of 15 percent. As a result, we accept hypothesis 1(c), meaning that low priced stocks are effected to a greater extent than high priced stocks.

7.2 Depth

The rather strong significance levels evident for the spreads are a theme that continues throughout this subsection regarding depths too. As can be seen from Table 8, the absolute depth has decreased for each subgroup and for the treatment group as a whole. The decrease in depths for all treatment groups taken together is 11367 shares, which is equivalent to a decrease of 78 percent. This of course constitutes quite a dramatic change in quoted depth. Comparing these figures to the control group, we can see that the control group suffers a decrease of 3813 shares, which in relative terms equals a decline of 36 percent. The significant decrease in depth for the control group is a bit puzzling, since these firms were not subject to the tick size reduction. A conceivable theory is that there is some sort of trend going on with decreased depths. On top of that, the new tick size table is introduced, which further reduces the depths of the treatment group.

The treatment group is more affected than the control group when looking at the alternative measure of depth, relative depth, as well. As can be seen from Table 9, the relative depth of the treatment group decreases with 0.71 bp (69%) while the control group decreases with 0.05 bp (11%). Hence, the means seem to suggest that the depth has decreased for the treatment companies.

Taking a look at regression (1.1) showing the simple difference-in-difference regression gives us an early indication that the tick size reduction has caused a decrease in depth, as both the beta-coefficients for absolute and relative depth are negative and significant at the one percent level. Observable in the same table is that the “event”-variable is negative and significant which signals an overall trend of decreased depth.

As more control variables are added to throughout regressions (1.1-1.3), the difference-in-difference -variable starts to stabilize around a coefficient of -10,000 shares for the absolute depth and -0.67 for the relative depth. Furthermore, the difference-in-difference -variables for the depth measures are significant at the one percent level through regressions all the regressions. The magnitude of the coefficient for absolute depth in regression (1.3), -10089, is relatively similar to the one found in the Wilcoxon rank-sum test, -11367. The difference between these two numbers can probably be explained by the trend of decreased depths as we noticed previously. For the relative spread, the figures between the two are quite similar as well, which indicates that the relative spread has decreased with about 0.70 basis points.

Looking at the second type of regression confirms the effect of reduced absolute depth both in regression (2.1) and (2.2). Regression (2.2) gets a slightly larger effect on absolute depth compared to regressions (1.1-1.3), with a value of -13356. However, this is still an effect with the expected sign and high significance, whereby we find it logical to claim that the absolute depth decreases when tick size is reduced. Especially when considering that the relative depth regressions corroborate these findings, as can be seen in Tables 16 and 17.

Considering that eight all ten regressions, plus the results from the Wilcoxon rank-sum tests, suggest that depth decreases following a tick size reduction, we would be inclined to accept hypothesis 2(a), thereby acknowledging a reduction in depth.

The reduction in depth is, as hypothesized, greater for high volume stocks than for low volume stocks which is evident in Tables 8 and 9. For the absolute (relative) depth, the decrease is 81 percent (73%) compared to the low volume stocks that only experience a drop of 54 percent (54%). Hence, with significant t-statistics we claim that high volume stocks experience a bigger decrease in depth than low volume stocks when faced with a tick size reduction.

In a similar manner, and as can be seen in Tables 8 and 9, the depth for low priced stocks experience a decrease in absolute (relative) depth of 81 percent (72%) compared to the high priced stocks’ decrease of 65 percent (63%). Therefore we find that we were right in hypothesis 2(c), low priced stocks are exposed to higher drops in depth than high priced stocks are.

7.3 Volatility

Discerning the effects on volatility by the tick size reduction is of particular interest, since neither previous research nor theory point in one single direction as to what might happen with this market quality

measure. Approaching this problem with the Wilcoxon rank-sum test available in Table 12, shows that for the treatment companies the annualized volatility decreases with 10.2 percentage points, which equals 27 percent. Yet again however, there is a possibility of a downward sloping trend in volatility. This also seems to be the case, since the control group's overall volatility decreases with 11.3 percentage points, or 27 percent after the event. The trend of lower volatility could for example be attributable to either a pre-event period with high volatility or a post-event period of low volatility. The regressions (1.1-1.3 and 2.1-2.2) fail to provide any significant coefficient for the difference-in-difference estimator, which implies that the effect is not significantly different from zero.

Looking at the alternative definition of volatility, the proportional daily range of transaction prices, it is noticeable that only one out of five regressions for this measure, and only one of ten for all volatility related regressions, shows any significance. The significant regression, (1.3) for the proportional daily range of transaction prices, has a negative coefficient of small magnitude for the difference-in-difference regressor. Considering the insignificant findings and the very small effect in the significant regression, we cannot conclude that there has been any change in volatility, whereupon we fail to reject hypothesis 3(a).

Having established that the volatility does neither increase nor decrease for treatment firms, it is really superfluous to further investigate hypothesis 3(b) and 3(c). For the sake of argument however we still make a swift overlook of the results.

From Table 12 we can see that high volume stocks experience a drop in volatility of 29 percent, while the low volume stocks experience a decrease of 24 percent. Thus there does not seem to be any big difference between high and low volume stocks, even though there is a slight sign that high volume stocks are more affected.

Turning our attention to price level of the stock instead we notice that this classification fails to deliver any major difference either. The low priced stocks witness about a decline in volatility of 29 percent. The high priced stocks on the other hand show a decline of 24 percent. Yet again there is such a small difference that we refrain from making any grandiose statement about the potential difference between the two groups.

7.4 Volume

Table 10, presenting the results of the difference of means for volume, shows slightly surprising results. The volume for the treatment group as a whole has decreased by 29 percent, which is the exact opposite of our hypothesised outcome. This would mean that the reduction in tick size has decreased trading activity which seems a bit counterintuitive since a lower spread reduces the costs of trading. Making it less expensive to trade should according to basic economic theory increase the quantity, that is increase the volume, which appears not to have been the case. Turning the attention to the control group shows a similar effect. For the control groups there is an even more substantial decrease in volume of 51 percent.

The story is the same for trading turnover with decreases of 31 percent and 38 percent for the treatment and control group respectively.

The reduction in both treatment and control groups raises the question whether it is the event in itself that has caused the changes with different magnitude, or if all companies have been affected equally much by another factor. Trading volume is a measure that varies a lot over time and it would be interesting considering a situation where trading volume in general decreased with about 50 percent for all stocks on SSE during the examined period. If that is the case then a reduction of 30 percent for the treatment companies should rather be looked upon as a 20 percent increase in volume compared to the new base.

From the regressions in Table 18 it is possible to deduce that the treatment companies did get increased trading volume as a result of the reduced tick size. All regressions for the trading volume are significant at the one percent level, and it appears as though the event caused an increase of around 190,000 shares being traded each day on average. For the trading turnover, the case is not as convincing, with results being significant only at the ten percent level for regressions (1.1-1.3). Regressions (2.1-2.2) fail to show significance for both the trading volume and turnover which puts the results in some doubts. However, given the strong significance for trading volume in regressions 1.1-1.3, we are inclined to conclude that the tick size reduction has increased the volume despite the weakness.

For the high (low) volume companies, we can notice a decrease in volume of 294189 (45409) shares, which is equivalent to 28 percent (41%). Thus, in this case, low volume stocks seem to experience a larger decrease in volume than high volume stocks. Hence, hypothesis 4(b) is rejected.

Having the same look at the price level hypothesis, no substantial difference between low priced and high priced stocks can be deduced. The low (high) priced stocks decrease in volume with 28 percent (29%). Due to the limited differences between the two groups we fail to draw any conclusion regarding hypothesis 4(c), indicating that the price level does not change how much the stock in question is affected by the tick size reduction when it comes to volume.

8. Implications and Conclusion

This section aims to discuss and analyze the results obtained in the previous section.

The results of this thesis are mostly in line with previous research, with an observable decrease in the quoted bid-ask spread for the affected companies following the tick size reduction implemented through the FESE tick size table 2. The same results has been found by the majority of other research undertaken in this field of study (see e.g. Harris (1994), Goldstein and Kavajecz (2000) and Jones and Lipson (2001)). A decrease in spreads follows quite intuitively from a reduced tick size. One reason for a stock not to decrease in spread when the tick size has been reduced is that it is not constrained by the tick size and trades independently of it. This however does not seem to be the case for the examined sample in general

as the spreads decreased substantially. The narrower spread seen in isolation means that this particular tick size reduction has lowered the costs of trading through decreasing the cost of execution. As a result, liquidity, and in the wider context market quality has been enhanced. We also present evidence for that low-priced and high-volume stocks experience the greatest reductions in bid-ask spread after the tick size change. This finding agrees with the previous research of, among others, Porter and Weaver (1997) and Goldstein and Kavajecz (2000).

Our findings regarding the decreased quoted depth are also in line with much of the previously conducted research, such as by Harris (1994) and Bacidore (1997). The decline in depth harms liquidity and might force some investors to split their orders over several order book levels to get the number of shares they demand. The lower depths can also be a result of dealers moving away from the best quotes in order to ensure their benefits for providing liquidity. The reduced depths constitute a decrease in liquidity and therefore also a deterioration of market quality. This reduction of market quality could possibly strike hardest against large institutional investors who usually demand large volumes and now are forced to trade over several order levels. For small traders however, the reduction in depths might not even be noticeable, for in which case the reduction has had very limited effect on their view of market quality.

The weak findings regarding volatility make us hesitant on drawing any conclusions regarding the volatility. It seems as though there is a slight decrease even though we cannot establish it at a reasonable significance level. Therefore it is possible that the reduction in bid-ask spread did not affect the transitory volatility to a large extent, or that the transitory volume only makes up a small part of the volatility. Considering the different effects on volatility found in different papers, and the non-existing effect in our and other's cases, we believe that the effect on volatility by a tick size change is at best very limited. We are doubtful if there exists an effect besides in theory, where predictions are made for both a positive and negative correlation. Thus, the volatility seems to have a very limited effect on market quality in this case.

This study can also conclude that the trading volume increased as a result of the tick size reduction, which is in line with findings of for example Bacidore (1997) and Niemeyer and Sandås (1994). The finding is also supported by theory which suggests that a lower bid-ask spread means a decrease in the cost of trading which subsequently should attract investors and increase the number of trades.

The empirical results from this study imply that the overall effect on market quality is ambiguous. In terms of market quality it is difficult to judge if the improvements in bid-ask spread are large enough to compensate for the decline in depth. However, given that the volume increases after the new tick table has been introduced, supports the suggestion that the market quality overall has benefited from the implementation. Increased trading should indicate that market participants are more willing to act on the market, which in turn must be a sign of improved market quality. This must not however be the case for all the actors in the market. Large institutional investors might very well be adversely affected if the reduction in the bid-ask spread is not enough to outweigh the cost of having to divide their orders over several

order depths. Using a similar reasoning, a small investor has most likely gained from the tick size reduction as he or she probably is less dependent on large order depths.

The policy makers should be cautious if considering a further reduction in tick size, since an even larger drop in depths could scare away large investors, which would be harmful for the overall liquidity. On the other hand it would be interesting to see whether a further decrease could decrease trading costs even more, which is ought to be positive for all involved parties.

9. Further Research

This study leaves space for additional studies on tick size in general and the tick size reduction on June 7, 2010, on SSE in particular. One aspect that would be interesting to divulge is how a tick size change affect different type of investors, through investigating how the behavior of large versus small traders change. Such an investigation would be able to reduce the speculation around this importance of the trader's size and instead give hard facts about the effects. Furthermore, it could be interesting to look at some parameters that we have been impossible for us to look at given the data set we had. Effective spread could be an example of such a variable that many studies look at, but we have been unable to do. Therefore, there is lapse of knowledge surrounding that matter in the context of this particular tick size reduction.

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11. Appendix

Tables 1 & 2 Descriptive statistics

Tables 1 and 2 below present descriptive statistics for all the independent variables used in the tests. The winsorized data is cut at the 1 percent level at each tail. Table 1 presents the statistics for the 25 treatment companies before and after the introduction of the new tick size table. Table 2 presents the same statistics for the 25 control companies. The spread and depth parameters are measured in 15-minutes intervals, creating a maximum of 34 observations per day. The volume- and volatility-related parameters are measured on a daily basis.

Table 1. Descriptive Statistics for Treatment Firms

Variable	Descriptives	Before		After	
		Unwinsorized	Winsorized	Unwinsorized	Winsorized
Absolute Bid-Ask Spread	Mean	0.5499	0.5459	0.4335	0.4131
	Median	0.4392	0.4392	0.2500	0.2500
	Max	9.1996	2.2414	10.5661	2.2414
	Min	0.0000	0.0220	0.0112	0.0220
	StdDev	0.4302	0.4048	0.5807	0.4509
	N	21990	21990	23740	23740
Relative Bid-Ask Spread	Mean	41.8125	41.7140	31.9906	31.0797
	Median	33.9559	33.9559	18.0291	18.0291
	Max	524.8169	237.1541	823.6575	237.1541
	Min	0.0000	6.5737	1.9287	6.5737
	StdDev	29.2522	28.3194	44.0620	36.3854
	N	21990	21990	23740	23740
Absolute Depth	Mean	14772	14585	3216	3218
	Median	5603	5603	1880	1880
	Max	336496	134108	61393	61393
	Min	20	283	11	283
	StdDev	23744	22408	4120	4118
	N	21990	21990	23740	23740
Relative Depth	Mean	1.2423	1.0288	0.3234	0.3237
	Median	0.6042	0.6042	0.1897	0.1897
	Max	34.9211	5.0671	5.7892	5.0671
	Min	0.0017	0.0377	0.0011	0.0377
	StdDev	2.1763	1.1725	0.4891	0.4879
	N	21990	21990	23740	23740
Volume	Mean	609178	609182	434400	434407
	Median	256675	256675	191102	191102
	Max	8121154	8121154	7022074	7022074
	Min	750	1340	365	1340
	StdDev	1071076	1071073	773285	773281
	N	725	725	725	725
Trading Turnover	Mean	66800000	64000000	44600000	44100000
	Median	33100000	33100000	26800000	26800000
	Max	991000000	413000000	741000000	413000000
	Min	82167	148725	48765	148725
	StdDev	99700000	82900000	58900000	54100000
	N	725	725	725	725
Volatility	Mean	0.3884	0.3831	0.2814	0.2816
	Median	0.3130	0.3130	0.2432	0.2432
	Max	2.6531	1.5230	1.5294	1.5230
	Min	0.0563	0.1080	0.0796	0.1080
	StdDev	0.2844	0.2540	0.1515	0.1512
	N	725	725	725	725
Proportional Daily Range of Transaction Prices	Mean	0.0342	0.0340	0.0258	0.0257
	Median	0.0306	0.0306	0.0226	0.0226
	Max	0.1397	0.0897	0.1438	0.0897
	Min	0.0044	0.0074	0.0023	0.0074
	StdDev	0.0181	0.0172	0.0147	0.0139
	N	725	725	725	725

Table 2. Descriptive Statistics for Control Firms

Variable	Descriptives	Before		After	
		Unwinsorized	Winsorized	Unwinsorized	Winsorized
Absolute Bid-Ask Spread	Mean	0.3678	0.3583	0.3615	0.3561
	Median	0.2500	0.2500	0.2500	0.2500
	Max	8.7500	2.2414	6.0833	2.2414
	Min	0.0000	0.0220	0.0060	0.0220
	StdDev	0.4496	0.3748	0.3997	0.3618
	N	25098	25098	26864	26864
Relative Bid-Ask Spread	Mean	47.7136	45.8102	44.6237	43.5924
	Median	31.4187	31.4187	32.6334	32.6334
	Max	1021.8980	237.1541	779.4985	237.1541
	Min	0.0000	6.5737	0.5346	6.5737
	StdDev	56.7597	45.0139	46.9672	40.0027
	N	25098	25098	26864	26864
Absolute Depth	Mean	73776	10564	6752	6752
	Median	4687	4687	4652	4652
	Max	6514417	134108	125400	125400
	Min	12	283	22	283
	StdDev	404584	24441	7923	7923
	N	25098	25098	26864	26864
Relative Depth	Mean	0.4779	0.4775	0.4262	0.4261
	Median	0.3228	0.3228	0.3173	0.3173
	Max	6.6002	5.0671	6.5644	5.0671
	Min	0.0003	0.0377	0.0042	0.0377
	StdDev	0.5045	0.4998	0.3647	0.3627
	N	25098	25098	26864	26864
Volume	Mean	2541243	1061337	477334	477344
	Median	350422	350422	189415	189415
	Max	127000000	8121154	6950054	6950054
	Min	51	1340	51	1340
	StdDev	10400000	1856984	692644	692636
	N	724	724	724	724
Trading Turnover	Mean	74200000	65600000	41400000	40700000
	Median	20700000	20700000	11500000	11500000
	Max	2040000000	413000000	756000000	413000000
	Min	4149	148725	4133	148725
	StdDev	149000000	94500000	68300000	63200000
	N	724	724	724	724
Volatility	Mean	0.4399	0.4275	0.3909	0.3144
	Median	0.3385	0.3385	0.2752	0.2752
	Max	3.1749	1.5230	56.0904	1.5230
	Min	0.0845	0.1080	0.0624	0.1080
	StdDev	0.3581	0.2953	2.0795	0.1768
	N	725	725	725	725
Proportional Daily Range of Transaction Prices	Mean	0.0376	0.0371	0.0298	0.0297
	Median	0.0338	0.0338	0.0271	0.0271
	Max	0.1630	0.0897	0.1212	0.0897
	Min	0.0031	0.0074	0.0000	0.0074
	StdDev	0.0200	0.0179	0.0145	0.0140
	N	724	724	724	724

Table 3. FESE Tick Size Table 2 and the Previous Tick Size Table

FESE Tick Size Table 2		Previous tick size table	
Price Intervall (SEK)	Tick Size	Price Intervall (SEK)	Tick Size
0-0.4999	0.0001	0.00 - 4.99	0.01
0.5-0.9995	0.0005	5.00 - 14.95	0.05
1-4.999	0.001	15.00 - 49.90	0.1
5-9.995	0.005	50.00 – 149.75	0.25
10-49.99	0.01	150.00 - 499.50	0.5
50-99.95	0.05	500.00 - 4999.00	1
100-499.9	0.1	5000.00 -	5
500-999.5	0.5		
1000-4999	1		
5000-9995	5		
10000-	10		

The FESE Tick Size Table 2 was implemented on the OMXS30 on October 26 2009. It was extended to apply for all Large Cap stocks on June 7 2010

The previous tick size table continued to be in use for all Small Cap and Mid Cap stocks after June 7 2010. Stocks in the price interval 0.00-499.50 experienced a reduction in tick size, stocks in the price interval 1000-9995 were unaffected while stocks above 10000 experienced an increase in tick size

Table 4. Excluded Companies

Excluded Company (A-G)	1	2	3	Excluded Company (H-O)	1	2	3
Aarhus Karlshamn	x			Havsfrun Investments B		x	
Acap Invest A		x		Heba B		x	
Acap Invest B		x		Hemtex	x		
Alfa Laval	x			Hexagon	x		
Anoto Group	x			HL Display		x	
Arise Windpower			x	Holmen A		x	
Atlas Copco A	x			HQ	x		
Atlas Copco B	x			Hufvudstaden C	x	x	
Atrium Ljungberg		x		Husqvarna A	x		
Balder B	x			Husqvarna C	x		
BE Group	x			Indl & Finl Systems		x	
Beijer Electronics	x	x		Intellecta B		x	
Billerud	x			ITAB Shop Concept		x	
Boliden	x			Jeeves Infosystems		x	
Bong Ljungdahl		x		Kabe Husvagnar B		x	
Borås Väveri		x		KappAhl	x		
BTS Group		x		Karo Bio	x		
Bygghmax			x	Kungsleden	x		
Catena		x		Lammhults Design Group	x	x	
Cellavision	x			LBI International	x		
Consilium B		x		Ledstiernan B			x
Corem Pref			x	Luxonen		x	
CTT Systems		x		Malmbergs Elektriska		x	
Dagon		x		Mekonomen	x		
Duni	x			Micronic Mydata	x		
Duroc B		x		Midsona A		x	
Electra	x			Midway Holdings A		x	
Electrolux A		x		Modul 1		x	
Elektronikgruppen B		x		MSC Konsult B		x	
Elos B		x		MTG A		x	
Eniro	x			Munters	x		
Enquest			x	Nederman Holding		x	
Ework Scandinavia		x		Netonnet		x	
Fabege	x			Nokia	x		
Fagerhult		x		Novestra		x	
Fast Partner		x		Novotek	x	x	
Fenix Outdoor	x	x		OEM International		x	
Formpipe	x			Orc Software	x		
G& L Beijer		x		Ortivus A	x	x	
Geveko B		x		Ortivus B	x	x	
Global Health Partner		x		Oxygene	x		

1. Excluded due to movement between price bands
2. Excluded due to less than one transaction per day
3. Excluded due to recently being listed/delisted

Excluded Company (P-X)	1	2	3
PA Resources	x		
Pfizer	x		
Poolia B		x	
Prevas B		x	
Probi	x		
Profilgruppen	x	x	
Ratos A		x	
Ratos B	x		
Reijlkoncernen	x	x	
Rottneros	x		
Saab B	x		
Sagax		x	
Säki		x	
Sandvik	x		
SCA A	x		
SCA B	x		
SEB A	x		
SEB C	x		
Sectra B		x	
Sigma B	x	x	
Sintercast	x		
Softronic		x	
SSAB B	x		
Stora Enso A	x		
Sweco A		x	
Sweco B	x		
Svedbergs	x		
Swedol B		x	
Svolder A		x	
Tele2 A		x	
TeliaSonera	x		
Tieto	x		
Tilgin		x	
Traction B		x	
Trelleborg	x		
Unibet	x		
VBG Group		x	
Wihlborgs	x		
XANO Industri B		x	

1. Excluded due to movement between price bands

2. Excluded due to less than one transaction per day

3. Excluded due to recently being listed/delisted

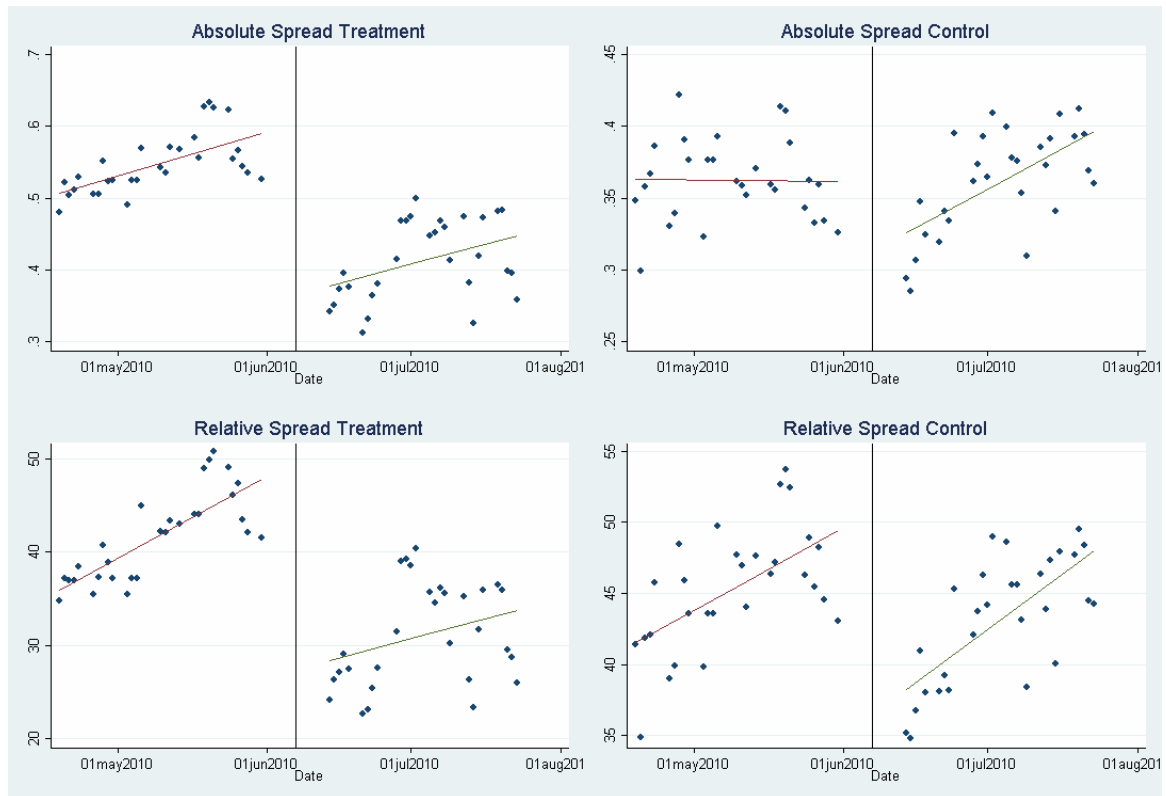
Table 5. Matched Control Companies

Treatment Company	Control Company
Autoliv	SSAB A
Industrivärden A	Active Biotech
Industrivärden C	SAS
Holmen B	JM
Elekta B	Volvo A
Hufvudstaden A	PEAB B
NCC A	Niscayah
NCC B	Intrum Justitia
Seco Tools B	Wallenstam
Latour B	Systemair
Meda A	Ericsson A
Castellum	Loomis
Kinnevik A	Brinova
Kinnevik B	Securitas
Lundbergsföretagen B	Black Earth Farming
Stora Enso R	Getinge
Axfood	Nobia
Oriflame	Swedish Orphan Biovitrum
Millicom	Scania B
Lundin Mining	MTG B
Hakon Invest	Öresund
Lindab International	Höganäs
Melker Schörling	SKF A
Alliance Oil	Lundin Petroleum
Swedbank Pref	Axis

The above table shows pairwise matched treatment and control companies. The companies are matched so that they are as similar as possible with regards to market capitalization and trading turnover.

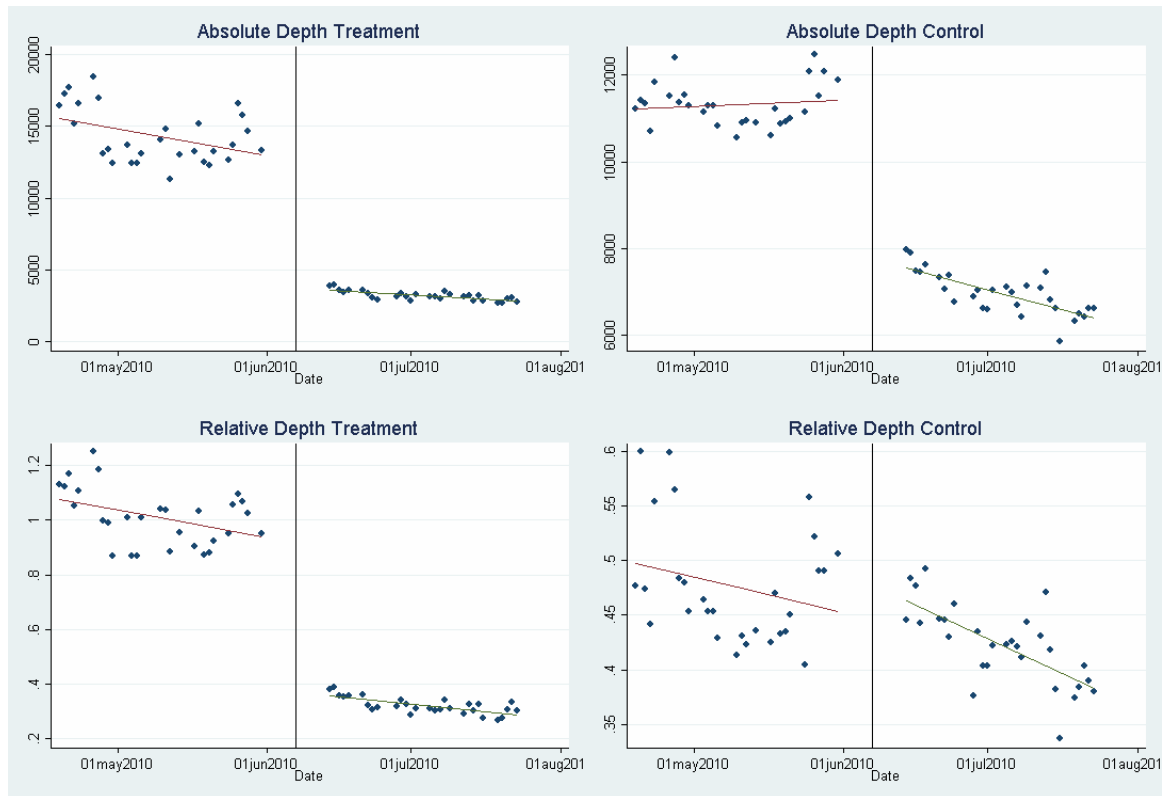
Graphs 1-4 Bid-Ask Spread

Graphical illustration of bid-ask spread means around the event day of June 7 2010. The absolute spread is defined as the difference between the lowest ask price and the highest bid price and is measured in SEK. The relative bid-ask spread is defined as the absolute spread divided by the midpoint of the lowest ask price and the highest bid price, and is measured in basis points.



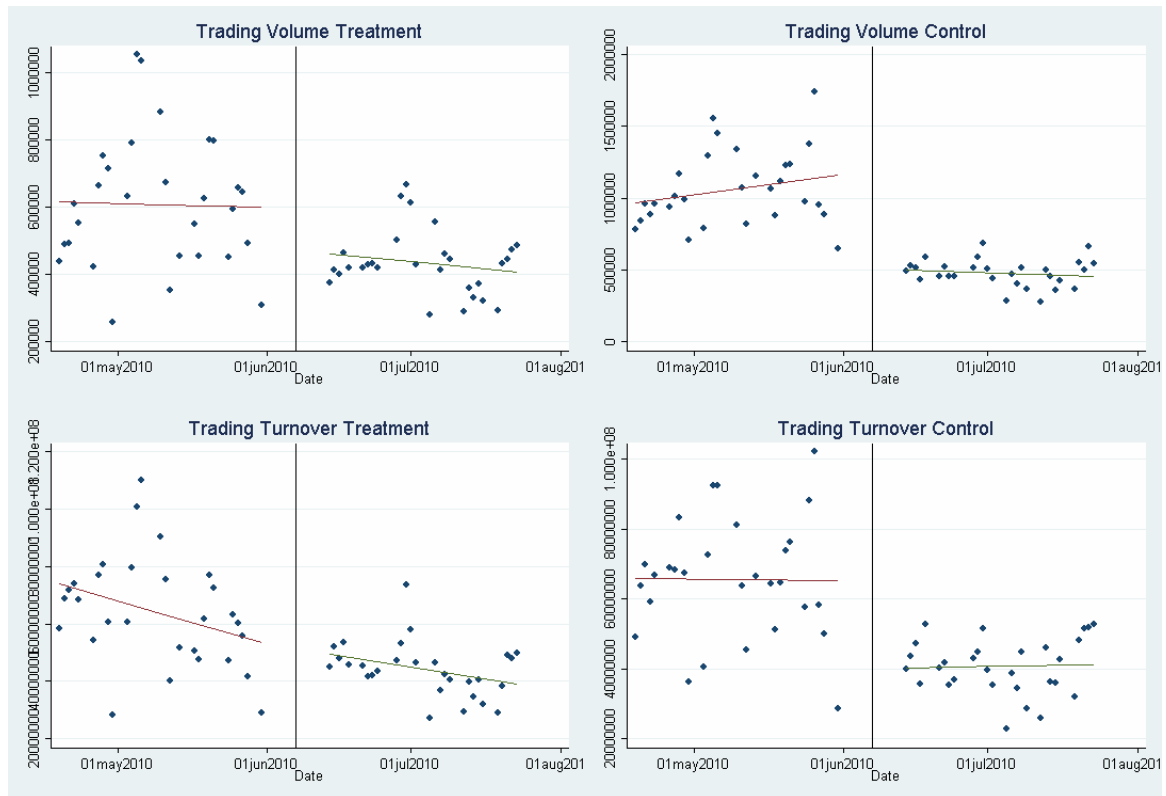
Graphs 5-8 Depth

Graphical illustration of depth means around the event day of June 7 2010. The absolute depth is defined as the sum of the shares available at the highest bid price and lowest ask price. The relative depth is defined as the absolute depth divided by the amount of outstanding shares, and is measured in basis points.



Graphs 9-12 Trading Volume and Trading Turnover

Graphical illustration of trading volume and trading turnover means around the event day of June 7 2010. The trading volume is defined as the amount of shares that are traded for each security over the course of a day. The trading turnover is defined as the volume multiplied by the daily volume-weighted average share price and is measured in SEK.



Graphs 12-16 Volatility and Proportional Daily Range of Transaction Prices

Graphical illustration of volatility and proportional daily range of transaction prices means around the event day of June 7 2010. The volatility is defined as the annualized standard deviation of logarithmic daily returns, and is measured in decimal form. The proportional daily range of transaction prices is defined as the difference between the highest and lowest price paid for a security over a day, divided by the midpoint of the two.

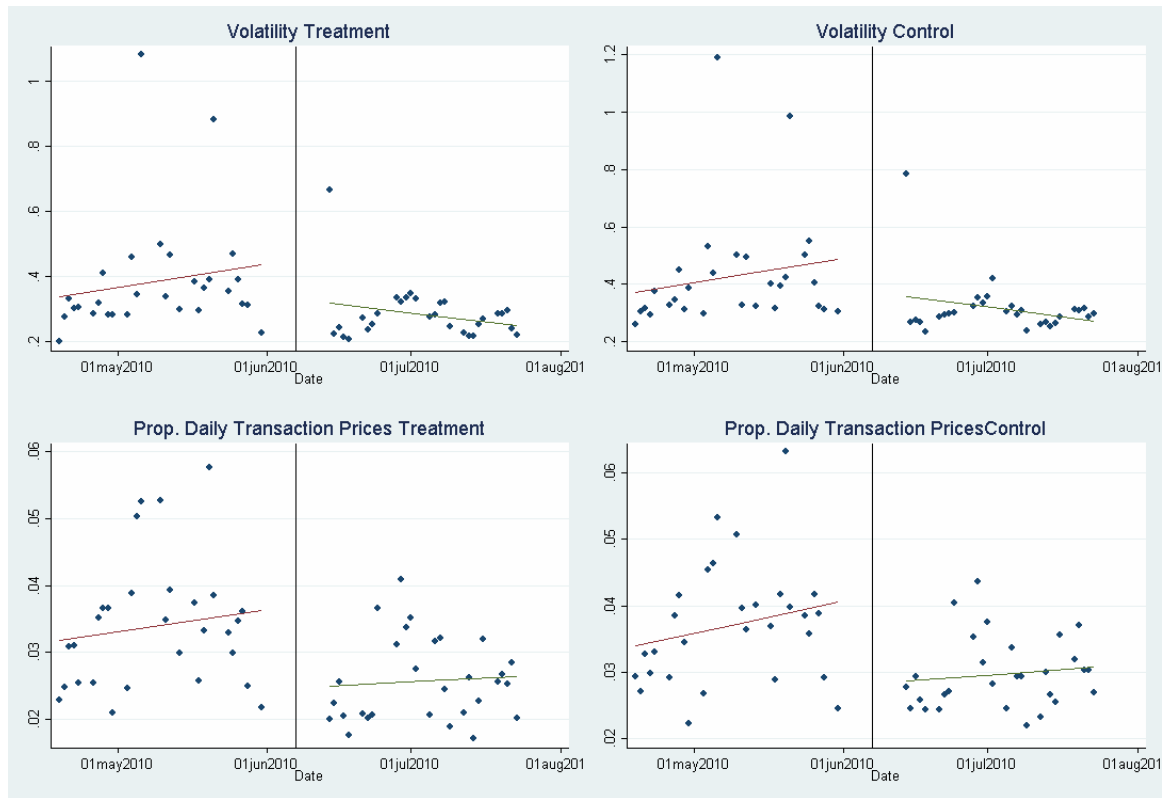


Table 6. Absolute Bid-Ask Spread

This table presents the means of the pre- and post-event periods, and the change between the two for the absolute bid-ask spread. The bid-ask spread is defined as the difference between the lowest ask price and the highest bid price, expressed in SEK. The Z-value is obtained through the Wilcoxon rank-sum test. The data for the 25 treatment companies and their matched control companies, is on a 15-minute basis for each trading day. The partition into high/low volume and high/low-priced stocks is made so that "high" groups contain 13 companies and the "low" groups contain 12 companies each. Thus each company exists simultaneously in both a volume and a price group.

Event Group	Stock Type	Pre	Post	Change	Change (%)	Z-value	N (Pre)	N (Post)
Treatment Group	High Volume	0.3555	0.1871	-0.1685***	-47.4%	-84.60	11485	12406
	Low Volume	0.7539	0.6606	-0.0933***	-12.4%	-24.11	10505	11334
	High Price	0.7381	0.5828	-0.1554***	-21.0%	-44.27	11419	12396
	Low Price	0.3382	0.2278	-0.1104***	-32.6%	-63.04	10571	11344
	Overall	0.5459	0.4131	-0.1327***	-24.3%	-63.90	21990	23740
Control Group	High Volume	0.1719	0.1765	0.0046***	2.7%	5.23	12366	13357
	Low Volume	0.5393	0.5337	-0.0056***	-1.0%	-2.69	12732	13507
	High Price	0.3974	0.4050	0.0076***	1.9%	3.49	12377	13313
	Low Price	0.3202	0.3080	-0.0122***	-3.8%	-3.25	12721	13551
	Overall	0.3583	0.3561	-0.0022	-0.6%	-0.64	25098	26864

*** p<0.01, **p<0.05, *p<0.10

Table 7. Relative Bid-Ask Spread

This table presents the means of the pre- and post-event periods, and the change between the two for the relative bid-ask spread. The relative bid-ask spread is defined as the difference between the lowest ask price and the highest bid price, divided by the mid-point of the two, expressed in basis points. The Z-value is obtained through the Wilcoxon rank-sum test. The data for the 25 treatment companies and their matched control companies, is on a 15-minute basis for each trading day. The partition into high/low volume and high/low-priced stocks is made so that "high" groups contain 13 companies and the "low" groups contain 12 companies each. Thus each company exists simultaneously in both a volume and a price group.

Event Group	Stock Type	Pre	Post	Change	Change (%)	Z-value	N (Pre)	N (Post)
Treatment Group	High Volume	32.35	15.60	-16.75***	-51.8%	-106.91	11485	12406
	Low Volume	51.95	48.03	-3.92***	-7.6%	-23.06	10505	11334
	High Price	39.62	33.66	-5.96***	-15.0%	-51.27	11419	12396
	Low Price	43.98	28.26	-15.72***	-35.7%	-75.18	10571	11344
	Overall	41.71	31.08	-10.63***	-25.5%	-85.13	21990	23740
Control Group	High Volume	31.29	28.07	-3.21***	-10.3%	-3.01	12366	13357
	Low Volume	59.92	58.94	-0.98***	-1.6%	-4.65	12732	13507
	High Price	30.05	31.50	1.45***	4.8%	2.94	12377	13313
	Low Price	61.14	55.47	-5.67***	-9.3%	-4.56	12721	13551
	Overall	45.81	43.59	-2.22	-4.8%	-0.03	25098	26864

*** p<0.01, **p<0.05, *p<0.10

Table 8. Absolute Depth

This table presents the means of the pre- and post-event periods, and the change between the two for the absolute depth. The absolute depth is the sum of the number of shares available at the lowest ask price and highest bid price. The Z-value is obtained through the Wilcoxon rank-sum test. The data for the 25 treatment companies and their matched control companies, is on a 15-minute basis for each trading day. The partition into high/low volume and high/low-priced stocks are made so that "high" groups contain 13 companies and the "low" groups contains 12 companies each. Thus each company exists simultaneously in both a volume and a price group.

Event Group	Stock Type	Pre	Post	Change	Change (%)	Z-value	N (Pre)	N (Post)
Treatment Group	High Volume	24894	4754	-20140***	-80.9%	-93.14	11485	12406
	Low Volume	3315	1536	-1778***	-53.6%	-52.03	10505	11334
	High Price	5091	1784	-3307***	-65.0%	-64.32	11419	12396
	Low Price	24841	4785	-20056***	-80.7%	-69.28	10571	11344
	Overall	14585	3218	-11367***	-77.9%	-86.06	21990	23740
Control Group	High Volume	17502	9923	-7579	-43.3%	-1.19	12366	13357
	Low Volume	3826	3616	-211**	-5.5%	-2.20	12732	13507
	High Price	4248	4313	64	1.5%	0.21	12377	13313
	Low Price	16710	9149	-7561***	-45.3%	-4.22	12721	13551
	Overall	10564	6752	-3813*	-36.1%	-1.95	25098	26864

*** p<0.01, **p<0.05, *p<0.10

Table 9. Relative Depth

This table presents the means of the pre- and post-event periods, and the change between the two for the relative depth. The relative depth is the sum of the number of shares available at the lowest ask price and highest bid price, divided by the number of outstanding shares, and is expressed in basis points. The Z-value is obtained through the Wilcoxon rank-sum test. The data for the 25 treatment companies and their matched control companies, is on a 15-minute basis for each trading day. The partition into high/low volume and high/low-priced stocks is made so that "high" groups contain 13 companies and the "low" groups contain 12 companies each. Thus each company exists simultaneously in both a volume and a price group.

Event Group	Stock Type	Pre	Post	Change	Change (%)	Z-value	N (Pre)	N (Post)
Treatment Group	High Volume	1.5013	0.4026	-1.0987***	-73.2%	-104.02	11485	12406
	Low Volume	0.5122	0.2372	-0.2749***	-53.7%	-46.15	10505	11334
	High Price	0.7227	0.2700	-0.4527***	-62.6%	-69.84	11419	12396
	Low Price	1.3595	0.3823	-0.9772***	-71.9%	-73.32	10571	11344
	Overall	1.0288	0.3237	-0.7051***	-68.5%	-100.91	21990	23740
Control Group	High Volume	0.4684	0.3909	-0.0775*	-16.5%	-1.79	12366	13357
	Low Volume	0.4863	0.4609	-0.0253***	-5.2%	-3.07	12732	13507
	High Price	0.3924	0.3858	-0.0066	-1.7%	-1.34	12377	13313
	Low Price	0.5602	0.4657	-0.0945***	-16.9%	-5.34	12721	13551
	Overall	0.4775	0.4261	-0.0513***	-10.8%	-4.30	25098	26864

*** p<0.01, **p<0.05, *p<0.10

Table 10. Absolute Volume

This table presents the means of the pre- and post-event periods, and the change between the two for the absolute volume. The absolute volume is defined as the number of shares that are traded in a particular instrument on a day. The Z-value is obtained through the Wilcoxon rank-sum test. The data for the 25 treatment companies and their matched control companies, is on a daily basis. The partition into high/low volume and high/low-priced stocks is made so that "high" groups contain 13 companies and the "low" groups contain 12 companies each. Thus each company exists simultaneously in both a volume and a price group.

Event Group	Stock Type	Pre	Post	Change	Change (%)	Z-value	N (Pre)	N (Post)
Treatment Group	High Volume	1069574	775385	-294189***	-27.5%	-4.26	377	377
	Low Volume	110424	65015	-45409***	-41.1%	-4.63	348	348
	High Price	319335	225486	-93849***	-29.4%	-2.87	377	377
	Low Price	923183	660739	-262444***	-28.4%	-2.75	348	348
	Overall	609182	434407	-174775***	-28.7%	-3.81	725	725
Control Group	High Volume	1928507	845960	-1082547***	-56.1%	-8.34	377	377
	Low Volume	119197	76860	-42337***	-35.5%	-5.33	347	347
	High Price	766282	439695	-326587***	-42.6%	-4.73	377	377
	Low Price	1381902	518249	-863653***	-62.5%	-3.56	347	347
	Overall	1061337	477344	-583993***	-55.0%	-5.69	724	724

*** p<0.01, **p<0.05, *p<0.10

Table 11. Trading Turnover

This table presents the means of the pre- and post-event periods, and the change between the two for the trading turnover. The trading turnover is defined as the number of shares that are traded on a day multiplied by the volume-weighted average share price. The Z-value is obtained through the Wilcoxon rank-sum test. The data for the 25 treatment companies and their matched control companies, is on a daily basis. The partition into high/low volume and high/low-priced stocks is made so that "high" groups contain 13 companies and the "low" groups contain 12 companies each. Thus each company exists simultaneously in both a volume and a price group.

Event Group	Stock Type	Pre	Post	Change	Change (%)	Z-value	N (Pre)	N (Post)
Treatment Group	High Volume	101000000	70900000	-30100000***	-29.8%	-4.39	377	377
	Low Volume	23900000	15100000	-8800000***	-36.8%	-3.93	348	348
	High Price	74700000	54200000	-20500000**	-27.4%	-2.40	377	377
	Low Price	52400000	33100000	-19300000***	-36.8%	-3.51	348	348
	Overall	64000000	44100000	-19900000***	-31.1%	-4.05	725	725
Control Group	High Volume	115000000	71800000	-43200000***	-37.6%	-5.80	377	377
	Low Volume	12400000	6939304	-5460696***	-44.0%	-5.41	347	347
	High Price	91800000	58400000	-33400000***	-36.4%	-4.97	377	377
	Low Price	37200000	21500000	-15700000***	-42.2%	-3.42	347	347
	Overall	65600000	40700000	-24900000***	-38.0%	-5.81	725	725

*** p<0.01, **p<0.05, *p<0.10

Table 12. Volatility

This table presents the means of the pre- and post-event periods, and the change between the two for the volatility. The volatility is defined as annualized standard deviation of logarithmic daily returns, and is expressed in decimal form. The Z-value is obtained through the Wilcoxon rank-sum test. The data for the 25 treatment companies and their matched control companies, is on a daily basis. The partition into high/low volume and high/low-priced stocks is made so that "high" groups contain 13 companies and the "low" groups contain 12 companies each. Thus each company exists simultaneously in both a volume and a price group.

Event Group	Stock Type	Pre	Post	Change	Change (%)	Z-value	N (Pre)	N (Post)
Treatment Group	High Volume	0.3882	0.2764	-0.1118***	-28.8%	-8.51	377	377
	Low Volume	0.3776	0.2872	-0.0904***	-23.9%	-5.98	348	348
	High Price	0.3559	0.2691	-0.0868***	-24.4%	-7.47	377	377
	Low Price	0.4125	0.2950	-0.1175***	-28.5%	-7.00	348	348
	Overall	0.3831	0.2816	-0.1015***	-26.5%	-10.21	725	725
Control Group	High Volume	0.4160	0.3114	-0.1046***	-25.1%	-5.12	377	377
	Low Volume	0.4400	0.3175	-0.1225***	-27.8%	-7.11	348	348
	High Price	0.4106	0.3002	-0.1104***	-26.9%	-6.78	377	377
	Low Price	0.4459	0.3297	-0.1162***	-26.1%	-5.58	348	348
	Overall	0.4275	0.3144	-0.1131***	-26.5%	-8.67	725	725

*** p<0.01, **p<0.05, *p<0.10

Table 13. Proportional Daily Range of Transaction Prices

This table presents the means of the pre- and post-event periods, and the change between the two for the proportional daily range of transaction prices. It is defined as the difference between the highest price paid on a day minus the lowest price paid divided by the midpoint of the two. The Z-value is obtained through the Wilcoxon rank-sum test. The data for the 25 treatment companies and their matched control companies, is on a daily basis. The partition into high/low volume and high/low-priced stocks is made so that "high" groups contain 13 companies and the "low" groups contain 12 companies each. Thus each company exists simultaneously in both a volume and a price group.

Event Group	Stock Type	Pre	Post	Change	Change (%)	Z-value	N (Pre)	N (Post)
Treatment Group	High Volume	0.0337	0.0273	-0.0064***	-19.0%	-6.13	377	377
	Low Volume	0.0343	0.0241	-0.0102***	-29.7%	-8.47	348	348
	High Price	0.0321	0.0235	-0.0086***	-26.8%	-8.55	377	377
	Low Price	0.0361	0.0282	-0.0079***	-21.8%	-6.16	348	348
	Overall	0.0340	0.0257	-0.0083***	-24.3%	-10.30	725	725
Control Group	High Volume	0.0383	0.0319	-0.0064***	-16.7%	-5.14	377	377
	Low Volume	0.0357	0.0274	-0.0083***	-23.2%	-6.50	347	347
	High Price	0.0361	0.0286	-0.0075***	-20.8%	-6.56	377	377
	Low Price	0.0381	0.0310	-0.0071***	-18.6%	-5.06	347	347
	Overall	0.0371	0.0297	-0.0074***	-19.9%	-52.76	25093	26859

*** p<0.01, **p<0.05, *p<0.10

Table 14. Dependent Variables: Absolute and Relative Spread

This table presents the results of OLS regressions using robust standard errors. The dataset is a panel with daily observations for the 25 treatment and 25 control firms. The independent variable absolute spread is defined as the lowest ask price minus the highest bid price and measured in SEK, while the relative spread is defined as the absolute spread divided by the midpoint of the best bid and ask prices and measured in basis points. The "Event"-variable is a dummy variable that is assigned a 1 if the time period is after the tick size reduction and 0 if it is before the reduction. "Treatment" is also a dummy variable that is given a 1 if the firm is a treatment firm, and 0 if it is a control firm. The "Diff-in-diff" variable is obtained through multiplying the two dummy variables with each other. Hence, it is 1 if the firm is a treatment firm and the time period is post the event. In all other cases it will be 0. Log (Market Cap) is the logarithmic market capitalization on a daily basis calculated through multiplying the volume-weighted average share prices with the number of outstanding shares. Log (Volume) is the logarithmic value of all traded stocks on a given day for each company. The volatility is measured as the annualized standard deviation of logarithmic returns and is presented in decimal form. Where time dummy variables are used it refers to the use of daily calendar day dummies for each trading day, and company fixed effects control for company-specific effects.

Variable	Absolute Spread			Relative Spread		
	Reg (1.1)	Reg (1.2)	Reg (1.3)	Reg (1.1)	Reg (1.2)	Reg (1.3)
Diff-in-Diff	-0.124*** (-4.52)	-0.124*** (-11.82)	-0.117*** (-11.23)	-7.769*** (-2.91)	-7.769*** (-7.24)	-9.163*** (-8.90)
Event	0.0111 (0.57)			-0.802 (-0.37)		
Treatment	0.171*** (9.01)			-3.248* (-1.73)		
Log (Market Cap)			-0.0217*** (-2.86)			-21.43*** (-21.74)
Log (Volume)			-0.0425*** (-6.92)			-3.942*** (-6.44)
Volatility			0.00616 (1.45)			0.574 (1.29)
Constant	0.308*** (22.07)	0.354*** (16.32)	1.368*** (5.69)	38.93*** (23.81)	31.76*** (13.42)	577.3*** (20.48)
Time Dummy Variables	No	Yes	Yes	No	Yes	Yes
Company Fixed Effects	No	Yes	Yes	No	Yes	Yes
R2	0.033	0.864	0.869	0.017	0.847	0.862
N	2900	2900	2898	2900	2900	2898

t-statistics in parantheses

*** p<0.01, **p<0.05, *p<0.10

Table 15. Dependent Variables: Absolute Diff Spread and Relative Diff Spread

This table presents the results of OLS regressions using robust standard errors. The dataset is a panel with daily observations for the 25 treatment and 25 control firms. Each variable is a difference between the treatment company and its matched control company. The independent variable Diff Spread is therefore the difference in spread, which in turn is defined as the lowest ask price minus the highest bid price and measured in SEK, while the Relative Spread, which is used in the Relative Diff Spread is defined as the Absolute Spread divided by the midpoint of the best bid and ask prices and measured in basis points. The "Event"-variable is a dummy variable that is assigned a 1 if the time period is after the tick size reduction and 0 if it is before the reduction. Diffvol is the difference in volume, where volume is defined as the sum shares traded during one day. Diffpropdaily is the difference between the proportional daily range of transaction prices, where that in turn is defined as the highest price paid during a day minus the lowest price paid divided by the midpoint of the two. Diffmarketcap is the difference in market capitalization, which is measured as the number of outstanding shares multiplied by the daily volume-weighted average share price. Where time dummy variables are used it refers to the use of daily calendar day dummies for each trading day, and company fixed effects control for company-specific effects.

Variable	Absolute Diff Spread		Relative Diff Spread	
	Reg (2.1)	Reg (2.2)	Reg (2.1)	Reg (2.2)
Event	-0.125*** (-7.57)	-0.119** (-2.36)	-8.729*** (-4.97)	-11.84** (-2.31)
diffvol	-1.40e-09*** (-2.60)	-1.39e-09** (-2.56)	0.000000553*** (6.20)	0.000000355*** (4.07)
diffpropdaily	1.568*** (3.36)	1.250*** (4.03)	346.0*** (7.07)	171.7*** (5.44)
diffaverage	0.00158*** (38.91)	-0.00240*** (-4.83)	-0.0216*** (-5.82)	-0.117*** (-2.61)
diffmarketcap	1.83e-13 (0.57)	1.11e-11*** (4.66)	-1.72e-10*** (-5.48)	-3.04e-10 (-1.46)
Constant	0.0806*** (6.59)	0.267*** (5.38)	0.756 (0.55)	5.185 (1.01)
Time Dummy Variables	No	Yes	No	Yes
Company Fixed Effects	No	Yes	No	Yes
R2	0.453	0.782	0.131	0.689
N	1448	1448	1448	1448

t-statistics in parantheses

*** p<0.01, **p<0.05, *p<0.10

Table 16. Dependent Variables: Absolute and Relative Depth

This table presents the results of OLS regressions using robust standard errors. The dataset is a panel with daily observations for the 25 treatment and 25 control firms. The independent variable Absolute Depth is defined as the sum of the number of shares available at the highest bid price and lowest ask price, while the Relative Depth is defined as the Absolute Depth divided by the number of outstanding and measured in basis points. The "Event"-variable is a dummy variable that is assigned a 1 if the time period is after the tick size reduction and 0 if it is before the reduction. "Treatment" is also a dummy variable that is given a 1 if the firm is a treatment firm, and 0 if it is a control firm. The "Diff-in-diff" variable is obtained through multiplying the two dummy variables with each other. Hence, it is 1 if the firm is a treatment firm and the time period is post the event. In all other cases it will be 0. Log (Market Cap) is the logarithmic market capitalization on a daily basis calculated through multiplying the volume-weighted average share prices with the number of outstanding shares. Log (Volume) is the logarithmic value of all traded stocks on a given day for each company. The volatility is measured as the annualized standard deviation of logarithmic returns and presented in decimal form. Where time dummy variables are used it refers to the use of daily calendar day dummies for each trading day, and company fixed effects control for company-specific effects.

Variable	Absolute Depth			Relative Depth		
	Reg (1.1)	Reg (1.2)	Reg (1.3)	Reg (1.1)	Reg (1.2)	Reg (1.3)
Diff-in-Diff	-6607.0*** (-5.17)	-6607.0*** (-8.45)	-10088.7*** (-19.21)	-0.633*** (-13.30)	-0.633*** (-25.86)	-0.672*** (-29.06)
Event	-4463.7*** (-4.44)		-2531.0 (-1.60)	-0.0537*** (-2.86)		
Treatment	2863.1** (2.30)			0.533*** (12.26)		
Log (Market Cap)			-32438.2*** (-62.96)			-0.308*** (-8.56)
Log (Volume)			310.4* (1.75)			0.0317*** (3.50)
Volatility			75.86** (2.12)			0.000201 (0.10)
Constant	11420.0*** (11.77)	13810.0*** (8.14)	764155.2*** (59.02)	0.476*** (30.15)	0.799*** (15.89)	7.579*** (8.91)
Time Dummy Variables	No	Yes	Yes	No	Yes	Yes
Company Fixed Effects	No	Yes	Yes	No	Yes	Yes
R2	0.057	0.659	0.844	0.148	0.783	0.797
N	2900	2900	2898	2900	2900	2898

t-statistics in parantheses

*** p<0.01, **p<0.05, *p<0.10

Table 17. Dependent Variables: Absolute Diff Depth and Relative Diff Depth

This table presents the results of OLS regressions using robust standard errors. The dataset is a panel with daily observations for the 25 treatment and 25 control firms. Each variable is a difference between the treatment company and its matched control company. The independent variable Diff Depth is therefore the difference in depth, which in turn is defined as the sum of shares available at the lowest ask price and highest bid price, while the Relative Depth, which is used in the Relative Diff Depth is defined as the Absolute Depth divided by the number of outstanding shares, and measured in basis points. The "Event"-variable is a dummy variable that is assigned a 1 if the time period is after the tick size reduction and 0 if it is before the reduction. Diffvol is the difference in volume, where volume is defined as the sum shares traded during one day. Diffpropdaily is the difference between the proportional daily range of transaction prices, where that in turn is defined as the highest price paid during a day minus the lowest price paid divided by the midpoint of the two. Diffmarketcap is the difference in market capitalization, which is measured as the number of outstanding shares multiplied by the daily volume-weighted average share price. Where time dummy variables are used it refers to the use of daily calendar day dummies for each trading day, and company fixed effects control for company-specific effects.

Variable	Absolute Diff Depth		Relative Diff Depth	
	Reg (2.1)	Reg (2.2)	Reg (2.1)	Reg (2.2)
Event	-10389.9*** (-11.61)	-13356.3*** (-3.65)	-0.684*** (-15.10)	-0.813*** (-6.37)
diffvol	0.00205*** (7.31)	0.00137*** (5.99)	2.83e-08*** (7.48)	2.38e-08*** (6.95)
diffpropdaily	57471.9** (2.40)	-6578.1 (-0.37)	0.621 (0.64)	-1.158* (-1.81)
diffaverage	-31.87*** (-12.17)	42.38 (1.06)	-0.00129*** (-8.58)	0.00407** (2.07)
diffmarketcap	4.98e-08*** (3.79)	-0.000000460 (-1.59)	5.66e-13 (0.57)	1.32e-11 (1.54)
Constant	8847.3*** (9.72)	7649.4** (2.01)	0.667*** (14.20)	0.444*** (2.90)
Time Dummy Variables	No	Yes	No	Yes
Company Fixed Effects	No	Yes	No	Yes
R2	0.483	0.760	0.224	0.800
N	1448	1448	1448	1448

t-statistics in parantheses

*** p<0.01, **p<0.05, *p<0.10

Table 18. Dependent Variables: Trading Volume and Trading Turnover

This table presents the results of OLS regressions using robust standard errors. The dataset is a panel with daily observations for the 25 treatment and 25 control firms. The independent variable Volume is defined as the number of shares that are traded for the security during a day, while the Trading Turnover is defined as the Volume multiplied by the volume-weighted average share price and therefore measured in SEK. The "Event"-variable is a dummy variable that is assigned a 1 if the time period is after the tick size reduction and 0 if it is before the reduction. "Treatment" is also a dummy variable that is given a 1 if the firm is a treatment firm, and 0 if it is a control firm. The "Diff-in-diff" variable is obtained through multiplying the two dummy variables with each other. Hence, it is 1 if the firm is a treatment firm and the time period is post the event. In all other cases it will be 0. Log (Market Cap) is the logarithmic market capitalization on a daily basis calculated through multiplying the volume-weighted average share prices with the number of outstanding shares. The volatility is measured as the annualized standard deviation of logarithmic returns and presented in decimal form. The bid-ask Spread is defined as the difference between the lowest ask price and the highest bid price. Where time dummy variables are used it refers to the use of daily calendar day dummies for each trading day, and company fixed effects control for company-specific effects.

Variable	Trading Volume			Trading Turnover		
	Reg (1.1)	Reg (1.2)	Reg (1.3)	Reg (1.1)	Reg (1.2)	Reg (1.3)
Diff-in-Diff	409218.1*** (4.62)	409452.7*** (7.58)	189941.5*** (4.75)	10666803.1 (1.43)	5045388.8* (1.72)	4979456.0* (1.69)
Event	-583993.0*** (-7.93)			-32865464.2*** (-5.41)		
Treatment	-452155.3*** (-5.68)			-7417951.9 (-1.12)		
Volatility			28106.4* (1.92)			1337068.8 (1.37)
Log (Market Cap)			-2063074.1*** (-55.54)			1177666.0 (0.51)
Bid-ask Spread			-61188.9** (-2.34)			-4546769.8** (-2.12)
Constant	1061337.4*** (15.38)	610913.0*** (6.97)	48583612.2*** (56.12)	74231965.7*** (13.45)	53709513.8*** (10.52)	27379684.6 (0.51)
Time Dummy Variables	No	Yes	Yes	No	Yes	Yes
Company Fixed Effects	No	Yes	Yes	No	Yes	Yes
R2	0.042	0.657	0.811	0.019	0.741	0.742
N	2898	2898	2898	2898	2898	2898

t-statistics in parantheses

*** p<0.01, **p<0.05, *p<0.10

Table 19. Dependent Variables: Diff Volume and Diff Trading Turnover

This table presents the results of OLS regressions using robust standard errors. The dataset is a panel with daily observations for the 25 treatment and 25 control firms. Each variable is a difference between the treatment company and its matched control company. The independent variable Diff Volume is therefore the difference in volume which in turn is defined as the sum shares traded during one day, while the Trading Turnover which is used in the Diff Trading Turnover is defined as the daily volume multiplied by the daily volume-weighted average price. The "Event"-variable is a dummy variable that is assigned a 1 if the time period is after the tick size reduction and 0 if it is before the reduction. Diffspread is the difference in spread, where the spread is measured as the difference between the lowest ask price and the highest bid price. Diffpropdaily is the difference between the proportional daily range of transaction prices, where that in turn is defined as the highest price paid during a day minus the lowest price paid divided by the midpoint of the two. Diffmarketcap is the difference in market capitalization, which is measured as the number of outstanding shares multiplied by the daily volume-weighted average share price. Where time dummy variables are used it refers to the use of daily calendar day dummies for each trading day, and company fixed effects control for company-specific effects.

Variable	Diff Volume		Diff Trading Turnover	
	Reg (2.1)	Reg (2.2)	Reg (2.1)	Reg (2.2)
Event	378117.5*** (4.79)	207435.9 (0.88)	4512122.3 (1.37)	6032220.8 (0.48)
diffpropdaily	22305915.8*** (8.57)	11978137.8*** (7.27)	271205585.0*** (3.11)	647923635.6*** (7.15)
diffmarketcap	-0.00000474*** (-2.98)	-0.000118*** (-5.40)	0.000304*** (2.91)	0.00157* (1.91)
diffspread	-740378.3*** (-9.96)	-214264.4*** (-4.61)	-10952689.8*** (-4.01)	-8776892.7*** (-3.32)
Constant	-295160.3*** (-4.22)	-54083.4 (-0.32)	-56160.0 (-0.02)	12572886.1 (1.60)
Time Dummy Variables	No	Yes	No	Yes
Company Fixed Effects	No	Yes	No	Yes
R2	0.161	0.670	0.020	0.401
N	1448	1448	1448	1448

t-statistics in parantheses

*** p<0.01, **p<0.05, *p<0.10

Table 20. Dependent Variables: Volatility and Proportional Daily Range of Transaction Prices

This table presents the results of OLS regressions using robust standard errors. The dataset is a panel with daily observations for the 25 treatment and 25 control firms. The independent variable volatility is measured as the annualized standard deviation of logarithmic returns presented in decimal form, while the Proportional Daily Range of Transaction Prices is defined as the highest priced paid during the day minus the lowest, divided by the midpoint of the two. The "Event"-variable is a dummy variable that is assigned a 1 if the time period is after the tick size reduction and 0 if it is before the reduction. "Treatment" is also a dummy variable that is given a 1 if the firm is a treatment firm, and 0 if it is a control firm. The "Diff-in-diff" variable is obtained through multiplying the two dummy variables with each other. Hence, it is 1 if the firm is a treatment firm and the time period is post the event. In all other cases it will be 0. Transactions corresponds to the number of transactions that have taken place during a day. Log (Market Cap) is the logarithmic market capitalization on a daily basis calculated through multiplying the volume-weighted average share prices with the number of outstanding shares. L1 Volatility is the lagged volatility of one period, i.e. one day, and L1 Prop Daily Range is the counterpart for the proportional daily range of transaction prices. Where time dummy variables are used it refers to the use of daily calendar day dummies for each trading day, and company fixed effects control for company-specific effects.

Variable	Volatility			Prop. Daily Range		
	Reg (1.1)	Reg (1.2)	Reg (1.3)	Reg (1.1)	Reg (1.2)	Reg (1.3)
Diff-in-Diff	0.0116 (0.69)	0.0116 (1.01)	-0.0136 (-1.03)	-0.000926 (-0.79)	-0.000923 (-0.99)	-0.00286*** (-2.67)
Event	-0.113*** (-8.85)			-0.00733*** (-8.68)		
Treatment	-0.0444*** (-3.07)			-0.00309*** (-3.35)		
Transactions			0.0000571*** (5.24)			0.00000520*** (8.89)
Log (Market Cap)			-0.0315*** (-2.62)			-0.00416*** (-2.95)
L1 Volatility			0.119*** (3.73)			
L1 Prop Daily Range						0.109*** (4.39)
Constant	0.428*** (38.99)	0.230*** (10.47)	0.852*** (2.97)	0.0371*** (55.74)	0.0262*** (13.94)	0.133*** (4.04)
Time Dummy Variables	No	Yes	Yes	No	Yes	Yes
Company Fixed Effects	No	Yes	Yes	No	Yes	Yes
R2	0.060	0.577	0.640	0.068	0.435	0.488
N	2900	2900	2198	2898	2898	2196

t-statistics in parantheses

*** p<0.01, **p<0.05, *p<0.10

Table 21. Dependent Variables: Diff Volatility and Diff Prop. Daily Range

This table presents the results of OLS regressions using robust standard errors. The dataset is a panel with daily observations for the 25 treatment and 25 control firms. Each variable is a difference between the treatment company and its matched control company. The independent variable Diff Volatility is therefore the difference in volatility, which in turn is defined as the annualized standard deviation of logarithmic daily returns, while the Prop. Daily Range of Transaction Prices which is used in the Diff Prop. Daily Range is defined as the difference between the highest price paid during the day and the lowest price for the same security, divided by the midpoint of the two. The "Event"-variable is a dummy variable that is assigned a 1 if the time period is after the tick size reduction and 0 if it is before the reduction. Diffmarketcap is the difference in market capitalization, which is measured as the number of outstanding shares multiplied by the daily volume-weighted average share price. Difftransactions is the difference in amount of transactions that has taken place on each day. The diffaverage is the difference in volume-weighted average share price for the day in question. Where time dummy variables are used it refers to the use of daily calendar day dummies for each trading day, and company fixed effects control for company-specific effects.

Diff Volatility and Diff Proportional Daily Range of Transaction Prices

Variable	Diff Volatility		Diff Prop. Daily Range	
	Reg (2.1)	Reg (2.2)	Reg (2.1)	Reg (2.2)
Event	0.00425 (0.32)	0.0377 (0.88)	-0.00169 (-1.61)	0.00536 (1.02)
diffmarketcap	1.21e-12*** (3.23)	3.83e-12 (1.00)	-2.16e-14 (-0.71)	-3.65e-13 (-1.15)
difftransactions	0.0000192** (2.37)	0.0000590*** (5.74)	0.00000240*** (4.67)	0.00000694*** (9.75)
diffaverage	-0.000368*** (-9.27)	-0.000399 (-0.56)	-0.0000317*** (-10.58)	-0.0000475 (-0.80)
Constant	-0.0166 (-1.47)	-0.0363 (-0.71)	-0.000361 (-0.45)	-0.00194 (-0.38)
Time Dummy Variables	No	Yes	No	Yes
Company Fixed Effects	No	Yes	No	Yes
R2	0.068	0.291	0.098	0.335
N	1448	1448	1448	1448

t-statistics in parantheses

*** p<0.01, **p<0.05, *p<0.10