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Liquidity Providers on the Nordic Exchange

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Abstract

The purpose of this paper is threefold. Firstly, the paper examines the relationship between stock returns and market makers on the Nordic Exchange. As the first study of its kind this paper focuses on the introduction of a market making service, but also the termination of such a service and its effects on asset pricing. The findings are in line with previous studies that the introduction of a liquidity provider is associated with abnormal returns. The results also show that there is no statistically significant evidence that the removal of a liquidity provider affects stock returns. Secondly, we analyze the effects on market quality and trading activity following the removal of a liquidity provider. We find no significant results that would indicate that the firms terminating their liquidity provider agreement suffer from a worsened market quality such as increased spreads, decreased market depth or trading activity. Finally, as the first paper to study which firms choose to terminate their contract with a liquidity provider, we perform a probit regression on common firm characteristics. We find evidence that the attributes turnover and spread are the foremost determinants in the firms' decision to terminate its liquidity providing contract.

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Table of contents

1 Introduction

In 2003 the Nordic Exchange (at the time the Stockholm Stock Exchange) introduced a system with liquidity providers. The purpose of a liquidity provider is to increase the liquidity in a firm's listed shares which is achieved by continuously quoting prices within a contractually determined spread. The interest from listed companies has been significant and currently circa 150 companies on the Nordic Exchange have contracted a liquidity provider. According to the Nordic Exchange liquidity providers lead to "increased interest and trading in a company's share [which] results in a more accurate price formation and valuation of the company, which is important to the company's stockholders. This creates a more liquid market and reduces costs for investors". The introduction and termination of this liquidity service is the focus of our study.

Previous research has found that stock returns are related to the costs of trading in the company's stock (see Amihud and Mendelson (1986) among others). The impact on market quality, such as spread, depth and trading activity, following the introduction of a liquidity provider on the Nordic Exchange, has already been thoroughly studied (see Anand, Tanggaard and Weaver (2005)). These findings suggest that liquidity providers improve market quality, as measured by spreads, turnover and market depth and that liquidity provider contracts are often set to enforce tighter spreads than before the liquidity provider was contracted. Therefore, we do not find it necessary to conduct a similar analysis. The purpose of this thesis is threefold. Firstly, we intend to contribute to the field of market microstructure and complement previous findings in the area by performing an extensive analysis of the effect of liquidity providers and improved market quality on short term stock returns. Secondly, we analyze the impact on liquidity and trading activity in firms that previously have contracted a liquidity provider but decided to terminate the service. Finally, we examine the common characteristics among firms that have terminated the liquidity provider contracts.

1.1 Contribution

Potential findings are relevant and have important implications for both investors and corporate management. Investors might find the results useful in their investment decisions, particularly when analyzing investment opportunities in firms with small market capitalizations. If liquidity can be assumed to at least to some extent be endogenously dependent on the firm, corporate managers will find our results

helpful in finding a balance between the investments needed to increase liquidity and the lower cost of equity capital which generally is associated with improved liquidity. The research available today on the effects of the contracting of a liquidity provider is mainly focused on the US and the pan-European region. Hence we believe that our findings will contribute to the understanding of the effects of liquidity providers for the Nordic setting. There are papers that study liquidity providers on the Stockholm Stock Exchange. However, our sample is nearly twice as extensive as previous papers. In addition, our data set for market quality consists of continuously calculated measures rather than data compiled by averaging 15 minute snapshots as is the case with the other papers (the data is further described in section 4). We will also contribute to new research by analyzing the effect the termination of the liquidity provider service has on asset pricing, market quality and trading activity. Moreover, we study firm characteristics typical for the firms that have terminated their liquidity provider contract. Our study is highly interesting for market participants in the sense that such a study has never been conducted before.

1.2 Outline

The remainder of the paper will be organized according to the following structure. The next section presents the institutional background which includes the structure of the relevant exchanges as well as the main characteristics of the liquidity provider system. In section 3 we present our theoretical framework and relevant research on liquidity and the effects of liquidity providers. In section 4 we describe our data. Section 5 and 6 comprises our study of the short term effects on asset pricing and the effects on market quality respectively. In section 7 we study the determinants of the firms that have terminated their liquidity provider contract. Finally, section 8 consists of our analysis and discussion and in section 9 we summarize our conclusions and provide some concluding remarks.

2 Institutional Background

In this section we present the main characteristics of the liquidity provider system and the institutional setting of the Nordic Exchange that is relevant for our study.

2.1 Liquidity Providers

The Nordic Exchange allows the listed firms to appoint a liquidity provider in order to increase the volume and improve the quality of the listed firms' stock. When a member of the Nordic Exchange such as a bank or brokerage firm takes on the role as a liquidity provider and the minimum requirements set by the Nordic Exchange are met, the listed firm's shares are marked with the letters "LP" in all stock listings. The requirements set by the Nordic Exchange, also presented in table I, are that the liquidity provider must quote prices in at least four trading lots on both bid and ask sides throughout the trading day and the quoted bid-ask spread must not exceed four percent based on the ask price during at least 85% of the trading day. A trading lot is the standardized quantity of a security that usually is the smallest amount traded. In addition, the members that enter contracts as liquidity providers must devote at least two members of their staff to operations associated with the liquidity provider agreement.

Table I. Minimum requirements set by the Nordic Exchange in order to obtain the "LP" listing.

Spread	Market depth	Time
Maximum of 4% calculated on the ask side	Minimum four trading lots on both the bid and ask side	Prices must be quoted at least 85% of the trading day and be present in both continuous trading and in the closing auction

These are however minimum requirements and the liquidity provider and the firm may agree to contract stricter terms, such as a spread tighter than 4%. Hence, conditions such as the minimum spread, market depth and the fee charged for the service are decided between the listed firm and the liquidity provider and are not set by the exchange. The Nordic Exchange monitors the liquidity providers and the quality of the service they provide. Failure to meet the minimum conditions will result in withdrawal of the "LP" listing. All trading members of the Nordic exchange can apply to become approved as a liquidity provider and currently 19 securities firms are approved liquidity providers.

The liquidity provider system is a voluntary contractual agreement and the listed firms must not enter into such a contract. The agreement may be entered into with any liquidity provider of choice and this contract can also be terminated by the listed firm.

Prior to the introduction of liquidity providers on the Nordic Exchange in 2003 there was no official market making system. The lack of a market making system resulted in a large number of shares with very low trading activity, especially for smaller firms. These shares showed usual signs of market inefficiencies such as very wide bid-ask spreads, only one-side quotes or even a complete lack of quotes.

2.2 Market Structure

Market making is not an uncommon phenomenon in international markets, but rather a familiar concept that has been used for long. In previous market making systems it has been common for the market maker to decide whether they will make a market in a stock. Examples of such markets are NASDAQ, SEAQ, Nouveau Marché and Neuer Markt (Anand, Tanggaard, and Weaver (2005)).

In the autumn of 2006 a structural change was implemented in the Nordic financial markets. The stock exchange operator OMX gathered among others, the Swedish, Finnish and Danish companies and created a Nordic Exchange. The Nordic Exchange comprises the exchanges in Stockholm, Helsinki, Copenhagen, Island, Tallinn, Riga and Vilnius. In addition to these main markets the Nordic Exchange also comprises the alternative marketplace First North which targets growth companies. The exchange was created to establish an integrated trading system and today investors can approach the capital markets in the Nordic region as a single market for equities and derivatives products. In 2006 the Nordic Exchange was the fifth largest exchange in Europe in terms of number of equity transactions.

The Nordic Exchange is fully automated and trading is done through a trading system called SAXESS which is developed by OMX. Trading in shares, bonds, premium bonds, warrants, depository receipts and convertibles on the Nordic Exchange is done through the SAXESS system. Banks and securities companies that are members of OMX are able to trade in all companies on the Nordic list. Trading takes place in the local currency for the list of the company. The members of the exchange are connected to the marketplace and orders are automatically matched electronically when price, volume and other conditions are met. Equity trading on the Nordic Exchange commences with the opening call at 9.00 CET with continuous trading until the closing call at 17.20 CET.

The companies listed on the Nordic Exchange are divided into three segments; Large Cap, Mid Cap and Small Cap. Companies with a market capitalization over one billion euro are listed within the Nordic Large Cap segment. Companies with a market capitalization between €150m and €1bn are listed within the Mid Cap segment, while companies with a market capitalization below €150m are listed in the Small Cap segment. The rankings are revised every six months and are based on the weighted average price for May and November. Liquidity providers are most common among the companies within the Small Cap segment but also among Large Cap and Mid Cap companies.

2.3 Liquidity

Liquidity is a concept with many definitions and interpretations. Market liquidity is a term that refers to an asset's ability to be converted through an act of buying or selling without causing a significant movement in price and without loss of value (Pástor and Stambaugh (2003)). A more practical definition is offered in appendix 1 where we present an example of illiquidity consequences. In a paper by Kyle (1985) liquidity is split into three parts; tightness, depth and resiliency. A fourth dimension, immediacy, has since been introduced by Harris (1990). Tightness is the "the cost of turning around a position over a short period of time" or the spread between the theoretical price and the actual transaction price which is determined by the quotes. The tighter the spreads between the theoretical price and quotes the higher is the level of liquidity in the stock. In the continuous auction equilibrium the market is infinitely tight, as an instantaneous transaction is free of costs. Depth is the measure of the volume that can be traded at a specific quote price. If the market is liquid it can absorb large volumes without affecting the price level significantly, hence the depth is great. However, if the depth is low, large volumes will move the price level significantly. Resiliency is the "speed with which prices tend to converge towards the underlying liquidation value of the commodity" (Kyle (1985)). Immediacy measures the time it takes to sell a security. In accordance with this dimension a continuous market is more liquid than a call-market due to the difference in speed at which transactions are made between the two platforms.

As there are many aspects of the concept of liquidity it is not realistic to be able to capture them all in one measure. As previous studies have showed the importance of liquidity for effects on asset pricing much research has been done on the subject. For example, Pratt (1989) found that market discounts on illiquid stocks can exceed 30%, hence the area is highly relevant. These academic papers

have previously used a number of proxies to capture the level of liquidity. We have chosen the most distinguished measures and present them briefly below.

The main and most straightforward proxy for liquidity is the bid-ask spread. For small and normal-sized transactions the cost of illiquidity is the bid-ask spread, or the tightness of the market. As this is the most significant dimension of liquidity it has been widely used as a proxy for liquidity in previous research. Among others this approach to measure liquidity has been implemented by Eleswarapu (1997) and Amihud and Mendelson (1986). Amihud and Mendelson (1986) were the first to conduct an extensive study on the value of liquidity, using the bid-ask spread as a proxy for liquidity, in their paper "Asset Pricing and the Bid-Ask Spread".

If there are no additional fixed costs and the intrinsic value of a stock is positioned exactly between the bid and ask quote, half of the spread is paid each time an order is executed. Hence the investor is able to execute his order instantly given that he is willing to pay the spread for the immediate execution. From a market maker's perspective the spread is the compensation received for offering immediate execution. Part of this is compensation to the market maker for the risks of trading with more informed counterparties. In a paper by Bagehot (1971) the existence of illiquidity in the financial markets is explained by the existence of asymmetric information. Bagehot claimed that the asymmetric information distribution caused adverse selection as informed investors took advantage of less informed investors. This caused a decrease in trading activity as the less informed investors executed fewer transactions, which created illiquidity in the markets.

There are two main disadvantages with using bid-ask spreads as a proxy for the level of liquidity. Glosten and Harris (1988) study the differences between the actual and the effective spread on the NYSE during the period 1981-1983. They find that the quoted spread can be different from the effective spread, and that the effective spread is usually narrower. Secondly, the spread only measures the cost for the middle-sized and smaller trades.

Another measure of liquidity is the trading activity which commonly is measured as turnover (in absolute value, number of shares and number of trades). Furthermore, another commonly used proxy is the order book depth. As explained previously depth is the measure of the volume that can be traded at a specific quote price. If the market is liquid it can absorb large volumes without affecting the price level significantly. However, if the depth is low, large volumes will move the price level significantly.

Another important measure is the price impact which is closely related to the market depth of a security. It is very difficult for liquidity providers to tell apart an informed and an uninformed investor. As informed investors are more likely to place large orders to benefit as much as possible from their information advantage liquidity providers tend to quote wide spreads for these large orders. Hence the price impact of a large order is consequently more significant. This theory has been tested by Amihud (2000), Brennan and Subrahmanyam (1995) and Easley and O'Hara (1987) among others.

3 Theoretical Framework

In this section we present relevant academic literature, especially papers within the market microstructure field. Market microstructure is a branch of economics and finance concerned with the details of how exchange occurs in markets. Much academic literature is devoted to market quality improvements due to changes in market microstructure. As liquidity is considered a transaction cost we need to fully understand the concept behind market microstructure.

3.1 Liquidity and Stock Returns

The first connection between market microstructure and long term asset pricing was initially established by Amihud and Mendelson (1986). The paper is based on NYSE and AMEX stocks during the period 1961-1980. The main conclusions are that (i) "in equilibrium, market-observed average returns are an increasing function of the spread", (ii) "asset returns to their holders, net of trading costs, increase with the spread" (iii) "there is a clientele effect, whereby stocks with higher spreads are held by investors with longer holding periods" and (iv) "due to the clientele effect, returns on higher-spread stocks are less spread-sensitive, giving rise to a concave return-spread relation." Their conclusion that the return of an asset is an increasing function of the level of liquidity is referred to as the liquidity premium theorem. As investors seek to maximize returns net of transaction costs it is obvious that wider spreads should imply higher required return. Therefore it is in the firms' interest to maintain a tight spread as tighter spreads lower their cost of capital. This conclusion has also been supported by Economides and Schwartz (1995) who claim that price stability and liquidity imply higher share prices.

More recently, research has reached conclusions that are not in line with the findings of Amihud and Mendelson (1986). The liquidity premium theorem presented by Amihud and Mendelson has been questioned by Eleswarapu and Reinganum (1993), Chalmers and Kadlec (1998) and Chen and Kan (1995). Eleswarapu and Reinganum (1993) conduct a study on the liquidity premium in asset pricing. They analyze data from the NYSE during the period 1961-1990 and their results show that the liquidity premium is only significantly positive during the month of January. The authors do not find any positive liquidity premium during the other months. The authors argued that Amihud and Mendelson had used a data sample that was somewhat restrictive, and that the analysis excluded smaller firms which led to

biased results. Chen and Kan apply a similar methodology as Amihud and Mendelson, nevertheless they could not find evidence of a relation between returns and bid-ask spreads.

3.2 Market Microstructure and the Minimum Price Variation

Market microstructure is a branch of economics and finance that focuses on how exchange occurs in markets. More specifically, market microstructure focuses on the working process of the market and how it affects trading costs, trading behavior, prices and volume. In this section we present some of the research previously conducted within the field and research on minimum price variation. We present this research as papers on changes in the market environment and its effects are related to our study.

In a paper by Amihud, Mendelson and Lauterbach (1997) the price effect of improvements in the trading mechanism on the Tel Aviv Stock Exchange was examined. The trading mechanism was changed from a manual call auction to iterated continuous trading sessions. Their results show that the improvements in market microstructure led to significant and permanent price increases, and the average cumulative abnormal return over the test period was approximately 5.5%. Hence these price increases were evidently strongly positively correlated with the improvement of liquidity.

In a paper by Baker and Khan (1993) the effects of dual trading on returns and liquidity was studied. According to the authors the variation in market structure would affect the returns due to the differences in liquidity and other services that differed between the markets. In the study the authors compare a set of NYSE and AMEX companies that had unlisted trading. The authors provide evidence that there are statistically significant positive returns following the announcement of unlisted trading privileges. They conclude that competition among markets is positively related to liquidity which in turn is positively related to stock returns. This implies that an increased competition among market makers is desirable for enhancing the efficiency of transactions in the financial markets. The conclusion is that measures that improve the market environment will lead to improvements in the liquidity level, which will initiate a positive price movement.

Much research has been made on the consequences of taking measures to decrease bid-ask spreads. In a paper by Harris (1994) the changes in spreads after a reduction in tick size is estimated and examined. The author analyzes the estimated change in trading volume and market depth of NYSE and AMEX stocks when the tick size is changed from $1/8 to $1/16. The results show that a reduction in the minimum price variation from $1/8 to $1/16 results in a narrowing of spreads of 38%, quotation sizes

would decrease by 16%, and the daily volume would increase 34% for stock with a price lower than $10. Ahn, Cao and Choe (1996) also studied the change in spreads when the NYSE and the AMEX lowered the minimum price variation from $1/8 to $1/16. This paper acted as an evaluation of the theoretical hypothesis put forward by Harris (1994). Their results show that there was a reduction in spreads, however, the reduction was much smaller than the one Harris estimated. The decline in spreads of the most actively traded companies was 19% but only 4% for the least traded companies. The results did not show any signs of an increased turnover or deepened market depth, which contradicts Harris' (1994) results.

3.3 Previous Research on Liquidity Providers

Anand, Tanggaard, and Weaver (2005) study the impact on market quality and the short term effects on assets pricing of the contracting of liquidity providers on the Stockholm Stock Exchange. The paper examines a sample of 50 firms that have contracted a liquidity provider. The authors find that the bid-ask spread narrows and that market depth increases following the contracting of a liquidity provider. The paper also shows that trading activity significantly increases following the contracting of a liquidity provider. In addition, they show that the average trade size increases, which is explained by the proposition that it is no longer necessary for traders to split their orders not to affect prices due to low market depth. The authors also show that there is a statistically significant decrease in return volatility. The evidence is valid for both intraday and daily return volatility. The reason is that liquidity providers help prevent large orders from significantly affecting prices, a behavior that is very similar to the NYSE specialists. Furthermore, they test and provide evidence that the average cumulative abnormal return (CAR) for the ten days following the contracting is statistically significant and approximately 6.2%. The authors found that CARs were inversely related to the spread movement, which implies that the abnormal returns were not caused by a market wide trend. Finally, the authors analyzed the liquidity providers and found that they did not profit from the trading activities, but rather only from the fees collected. The authors conclude that firms with low liquidity may benefit from taking measures to improve the liquidity of their securities such as appointing a liquidity provider.

The findings by Anand, Tanggaard, and Weaver are supported by other studies. In a master's thesis by Ingemarsson and Kozlowski (2005) the introduction of liquidity providers on the Stockholm Stock Exchange is once again studied. The authors conclude that the liquidity proxies spread and market

depth improves significantly following the introduction of a liquidity provider. However, the authors could not conclude that it was an increase in trading activity following the introduction. In addition, the authors perform an event study to analyze liquidity providers' effects on the short term impact on asset pricing. They find that stock prices increase following the contracting of a liquidity provider, but it is only statistically significant for the first two days following the introduction.

Kehr, Krahnen and Theissen (2001) study the specialists function and their effect on the market. The paper provides a detailed analysis of the call auction procedure on the Frankfurt Stock Exchange. Through the identification of the trades made by specialists the authors could ascertain the unaffected price level which would have existed without the existence of the specialists. These prices were then compared to the true prices the authors could conclude that the existence of specialists actually decrease return volatility. These results are in accordance with the findings of Anand, Tanggaard and Weaver (2005). In addition, the authors attempt to asses the cost of the service provided by the liquidity providers and find that the liquidity providers profit is equal to zero. Hence they receive no compensation other than the fees charged for the service. These results are in accordance with both Anand, Tanggaard and Weaver (2005) and Madhavan and Panchapagesan (2000). Another study on market quality after the introduction of market makers has been done by Nimalendran and Petrella (2002). They analyze the change in market quality on the Italian Stock Exchange following the introduction of liquidity providers in 1997. The authors find evidence that there is a significant increase in market quality following the introduction of market making measures. More specifically, the authors find that market making enabled lower execution costs, greater depth and a decrease in adverse selection costs. They also found that these benefits were larger for the most illiquid stocks. These results also support the findings by Grossman and Miller (1988) that liquidity providers can improve liquidity of stocks with low trading activity.

Glosten (1989) points out that liquidity providers can help prevent market failures, as they supply stocks with liquidity during periods with low market depth in the order book. Mann, Venkataraman and Waisburd (2002) present evidence in support of this theory. According to Mann, Venkataraman and Waisburd this prevention of market failure is linked to the positive return which is a consequence from the introduction of a liquidity provider. Hence this is further evidence of the connection between required returns and transaction costs. Mann, Venkataraman and Waisburd (2002) analyze companies on the Paris Bourse for which a liquidity provider was introduced. The study is performed on data between 1995 and 1998 when a new market making system was introduced. To study the change in returns following the introduction of a liquidity provider the authors performed an event study to estimate the CAR. The

authors divided the data sample into two sub-samples according to the level of liquidity. Similar to the study by Anand, Tanggaard, and Weaver the authors defined the event window as 5 days prior to the introduction of a liquidity provider to 10 days after the introduction. Their results showed no significant abnormal return for the liquid sample, however for the illiquid sample the authors found a significant abnormal return of approximately 4%.

3.4 Cumulative Abnormal Returns

In section 5 of this paper we analyze the impact that improved liquidity has on asset prices by conducting an event study. As the vastness of literature suggests, we expect that improved liquidity will increase security prices (see Amihud and Mendelson (1986) as a starting point). The method employed to study cumulative abnormal returns and to conclude whether the relationship between liquidity and asset pricing holds for our specific settings was introduced by Fama, Fisher, Jensen and Roll (1969). The authors use all available monthly return data to estimate the parameters of the market model $\left(R_{it} = \alpha_{it} + \beta_{it} R_{Mt} + u_{it}\right)$. The methodology eliminates the influence of market wide factors on a stock's return, hence treating any unexplained fraction of the actual return as attributable to firm specific information such as the event. This event study methodology has, with some minor modifications, become widely accepted as standard when performing event studies.

Evidence put forward by Blume (1971) and Levy (1971) shows that estimated market model parameters are not stationary across contiguous time periods. As a result, it is often the case that studies with monthly data use somewhere between five and seven years of data and studies using daily data, such as ours, regularly use up to one year of observations to estimate the parameters of the market model.

In addition, if the event studied is included in the estimation period, the parameter estimates will likely be biased. This is easily solved by estimating the parameters using data prior to the event period. We present more details of the approach and specific details of our study in section 5.

4 Data

In this section we will present the data set that we have used in our study. We begin by presenting how our data set has been constructed, thereafter we describe what actions have been taken to counteract erroneous data observations.

4.1 Data Collection

The data set consists of 95 firms with stocks listed on the Nordic Exchange and First North that have contracted a liquidity provider and 17 firms that have had a liquidity provider, but terminated the service. The time period studied ranges from 2002 to 2007. We first obtained a list of firms that had either entered or terminated a contract with a liquidity provider from the Nordic Exchange's archive of market notices and through contacts with the Nordic Exchange. The initial sample of firms were reduced for mainly three reasons; namely that firms either had the liquidity providing service since listing on the Nordic Exchange (or the number of trading days prior to the introduction of a liquidity provider was for some other reason not sufficient to estimate normal returns, see section 5), that the date the market making commenced was unavailable and that firms terminated the liquidity provider service due to delisting in relation to takeovers. We created a sub-sample of firms that had terminated their contract with a liquidity provider in order to analyze market quality and trading activity as the relevant data was unavailable for some stocks in the full sample. Liquidity providers commenced making markets for the stocks in our sample on 77 different dates over a 40 month long period and quit making markets on 16 different dates over a 33 month period. We believe that the dispersion of dates reduces the probability that any changes would be caused by market wide factors (e.g. such as seasonal variations in liquidity). For that reason, we decided that it was not necessary to create a control sample of firms that did not contract a liquidity provider.

As we primarily study the impact on market quality, trading activity and stock returns, our data has primarily been collected from two sources, the SIX Trust database and the OMX Group. SIX Trust were used to collect return data for the stocks in our sample and the relevant index. The data used starts 135 days before and ends 10 days after the initiation or termination of the liquidity provider agreement.

The OMX Group's Market Research department provided us with daily order book data and trade data used to analyze the market quality and trading activity of the stocks in our sample.

In addition, in order to study the determinants of the termination of liquidity provider services, data containing average spread, average daily turnover and market capitalization at month end for a sample of 71 firms that had contracted a liquidity provider was collected from monthly reports issued by the Nordic Exchange (OMX). The data was collected both for the month prior to contracting and for either the last month of contracting, for the firms that terminated their contract with a liquidity provider, or for October 2007, for the firms that did not terminate the liquidity provider service during the period studied. The time in months from the date of initiation to October 31, 2007 or the date of termination of the liquidity provider service was also calculated.

4.2 Daily Order Book Data

The daily order book data provided by the OMX Group were obtained from the TARGIN database which contains detailed information from intraday order book data such as a select number of liquidity indicators. The exchanges operating under the OMX Nordic Marketplaces uses mainly six concepts to determine liquidity. They are order coverage, implicit spread cost, depth in the order book, competition in the order book, price quotation indicators and roundtrip measuring of the liquidity. These six indicators are referred to as liquidity market indicators. During the continuous trading phase, the liquidity market indicators are continuously updated. Each time a quotation changes the structure of an order book, the changes are included in the various liquidity market indicators. As quotations are randomly inserted into order books the measures are time-weighted.

4.3 Limitations

The data set has been modified in some ways to make the analysis possible. Firstly, some companies that have contracted a liquidity provider have been removed from the analysis for the reasons mentioned previously. This could potentially bias the results. Another important issue to consider is that some companies already had informal contracts with financial institutions resembling the current liquidity providing agreements. This has implications when the formal introduction of liquidity providers on the Stockholm Stock Exchange took place. If such informal agreements exist in our data this would introduce a reduction in the reliability of our data. Another issue to be taken into account is the risk of analyzing

companies with common characteristics. As these companies are influenced by the same external factors such as market wide changes they might bias the results. However, we believe that the diversity among the companies in our data sample is large enough to eliminate such a bias.

4.4 Erroneous Data

Some issues have been observed with the data set that has forced us to make adjustment in order to enable an unbiased analysis. The data obtained from the SIX Trust database used to calculate returns had a limited number of missing values in the daily data as no trades had taken place on some days. This was solved by manual correction as we replaced these missing values with the last price paid (hence setting the return to zero). By doing so, the variance decreases and becomes more accurate as the return becomes zero rather than being treated as a missing value. We also studied the data in detail to ensure that the returns were reasonable, which we found it to be and hence no further adjustments were made.

5 Asset Pricing

Described in the theoretical framework, empirical findings suggest that there is a negative relationship between liquidity and stock returns. As previous findings have observed improvements in market quality, such as a decreased bid-ask spreads and increased depth following the introduction of a liquidity provider (see primarily Anand, Tanggaard, and Weaver (2005) and Ingemarsson and Kozlowski (2005), both papers study stocks on the Stockholm Stock Exchange corresponding to approximately half the stocks in our sample), a decrease in spreads suggests that stock prices should react positively. Conversely, if the termination of a liquidity provider contract deteriorates liquidity, stock prices should decrease. However, liquidity providers are compensated for making markets in a firm's stock, which at least partly offsets the potential benefit of improved liquidity. The decision of initiating or terminating a contract with a liquidity provider is hence a capital budgeting decision. As any other project or investment opportunity, it should be evaluated on a net present value basis.

In order to study the link between liquidity and asset pricing, we conduct two event studies with the initiation and the termination of a liquidity providing service as the events. As the contracting of a liquidity provider implies that the effects will take place once the service commences we choose the starting and ending dates of the service as the event dates. However, the announcement dates for the service may be different from the starting and ending date for some firms. We do not expect this to bias our results as any effects on liquidity will likely occur once the service has commenced and since the number of firms with significantly different announcement dates are highly limited. In addition, as our event window captures five days prior to the introduction of the liquidity provider almost all announcement days and subsequently announcement effects are taken into account when performing the study. By studying the cumulative abnormal return surrounding the introduction and removal of a liquidity provider we will be able to determine whether the contracting of a liquidity provider affects firm value.

In order to analyze the effects on asset pricing we have formulated the following hypotheses:

H_0: The introduction of a liquidity provider has no impact on stock returns

Which is tested against the alternative hypothesis:

H_1: The introduction of a liquidity provider causes abnormal stock returns

The hypothesis used to analyze the termination of a liquidity providing services is:

H_0: The removal of a liquidity provider has no impact on stock returns

This is tested against the alternative hypothesis:

H_1: The removal of a liquidity provider causes abnormal stock returns

The event window consists of 16 days and is defined as τ-5 to τ+10, where τ is the date of the introduction or removal of a liquidity provider. We believe that 16 days is an appropriate length of the event window as we expect it to take some time before the improved liquidity is fully reflected in a security's price. We estimate cumulative abnormal returns using the market model with the OMX Stockholm All-Share Index as a proxy for the market portfolio. We believe this to be the best market proxy available as the wider and more international OMX Nordic All-Share Index is not available for all relevant time periods and because our sample of firms solely consists of Swedish firms. The parameters of the market model are estimated using ordinary least squares with the estimation window set to τ-135 to τ-6. The length of the event window was chosen to approximately correspond to six months trading data. Normal returns are estimated for the firms in the sample and the predictions are then used to calculate the abnormal returns. The cumulative abnormal return for asset *i* is defined as:

$CAR_i(\tau_1, \tau_2) = \sum_{\tau_1}^{\tau_2} AR_{it}$, $AR_{it} = R_{it} - E(R_{it})$, where R_{it} and $E(R_{it})$ are the observed return for stock *i* during time *t* and the normal return for asset *i* during time *t* estimated with the market model and where τ_1 and τ_2 represent the event window's lower and upper limit, respectively. If the individual CARs are assumed to be independent, the distribution of the average CAR is approximately normally distributed under the null hypothesis, equal to $\overline{CAR}(\tau_1, \tau_2)$ ~N(0, $\sigma^2(\tau_1,\tau_2)$ (see MacKinlay (1997) and Binder (1998) for a detailed overview of the event study methodology).

The results from the event study for the full sample are summarized in table II below.

Table II. Results for the event study on the introduction of a liquidity provider.

		Prior to 2004-01-05 sample	**After 2004-01-05 sample**	***Total***
Illiquid sample	CAR	11.26	-4.11	*7.07*
	Test statistic	2.69**	-0.64	*2.01***
	N	24	9	*33*
Liquid sample	CAR	3.34	0.68	*2.03*
	Test statistic	1.13	0.36	*1.23*
	N	24	38	*62*
Total	*CAR*	*7.30*	-0.24	*2.08*
	Test statistic	*2.85**	-0.12	*1.26*
	N	*48*	47	*95*

**Significant at 1%, **significant at 5%, ***significant at 10%*

As shown in the table, the results are inconclusive and do not indicate whether the introduction of a liquidity provider is associated with a positive abnormal return. The average CAR is 2.08% for the event window, but as it is far from statistically significant and hence not economically interesting, the null hypothesis that the introduction of a liquidity provider has no impact on stock returns can not be rejected.

The market quality varied substantially among the stocks in the sample that contracted a liquidity provider and as the short term impact on asset pricing is dependent on the improvement in market quality, according to previous research, the impact on asset pricing following the introduction of a liquidity provider should be greater for firms that initially had poor market quality. Therefore, to further analyze the effects of the introduction of a liquidity provider, we create two sub-samples based on liquidity, with average bid-ask spreads as the proxy for liquidity and two sub-samples based on the date of contracting. Hence, two tests are conducted with respect to the spreads, and two tests with respect to time. The two sub-samples based on the stocks' liquidity include the stocks with the smallest and largest bid-ask spreads prior to the contracting of a liquidity provider. Hence, the sub-samples should reflect the most illiquid and the least illiquid stocks of the full sample. The actual split between the samples is made for stocks with an average bid-ask spread exceeding 4% and for firms with an average bid-ask spread equal to or below 4%. We have chosen the 4% level as a limit due to the fact that it is the minimum requirement for spreads set out by the Nordic Exchange in the liquidity provider contracts. The two samples consist of 33 and 62 firms for the most illiquid and the least illiquid sample, respectively. As the most illiquid stocks have the most to gain from the introduction of a liquidity provider, we expect the illiquid sample to experience a higher CAR.

The sub-samples with regard to date of contracting are used to test for potential changes over time. The two samples consist of the firms that contracted a liquidity provider before and after January 5, 2004 respectively. We have chosen this specific date as a limit as this creates two equally large samples (48 and 47 firms respectively). This time limit is essentially the first year after the introduction of the first liquidity providers on the Nordic Exchange. The rationale behind creating a sub-sample on time is that we expect the firms with the lowest liquidity to contract a liquidity provider immediately and to control for time. This sample would also be nearly identical to the samples used in previous studies on the Nordic Exchange. We perform event studies on the sub-samples in the same manner as before. The results for the sub-samples based on stock liquidity prior to the contracting are also presented in table II above.

Similar to the previous results, the average CAR following the introduction of a liquidity provider is positive, by 7.07% for the most illiquid sample. These findings are statistically significant and the null hypothesis that the introduction of a liquidity provider has no impact on stock returns can be rejected at the 5% level. The sub-sample with the least illiquid stocks has an average CAR of 2.03% that is not statistically significant at any reasonable level. As predicted the effect on asset returns are greatest for the illiquid firms. For the least illiquid stocks on the other hand, the positive abnormal return is not statistically significant which may imply that the costs of contracting a liquidity provider offsets the potential gains by improved market quality.

The results for the sub-samples based on the date of contracting of a liquidity provider are also presented in table II. The average CAR following the introduction of a liquidity provider is positive by 7.30% for the first half of firms that contracted a liquidity provider (the 48 firms that contracted a liquidity provider prior to January 5, 2004) and the result is significant at the 1% level. The sub-sample with 47 firms that contracted a liquidity provider after January 5, 2004 has an average CAR of -0.24%, which however is not statistically significant. The findings that the first firms that contracted a liquidity provider have a statistically significant positive abnormal return are interesting. The most plausible explanation is that the first firms contracting a liquidity provider also had poor market quality and liquidity as measured by the bid-ask spread prior to the contracting. By studying the two sub-samples we find that the two samples are indeed similar.

We further divide the data into four new sub-samples consisting of 24 illiquid firms that contracted a liquidity provider prior to January 5, 2004, 9 illiquid firms that contracted a liquidity provider after January 5, 2004 as well as 24 liquid firms that contracted a liquidity provider prior to January 5, 2004 and 38 liquid firms that contracted a liquidity provider after January 5, 2004. The

obtained results are presented along with the other findings in table II above. Of these four samples it is only the sample consisting of the illiquid firms that were among the first firms to contract a liquidity provider. These firms experienced an average CAR of 11.26% that is statistically significant at the 5% level. Hence, we can reject the null hypothesis for three of the sub-samples. Our results are in accordance with previous findings in the sense that the short run effect on asset pricing is greater for illiquid stocks than for less illiquid ones.

We also perform an event study for firms that have had a liquidity provider but decided to terminate the service. For this analysis the full sample consists of 18 firms and a smaller sample consisting of 9 firms. The smaller sample is studied, even though it contains a limited number of firms, as the same firms are further analyzed in the next section with regards to market quality and trading activity. It is interesting to study the effects on asset pricing following the termination of the service and whether the termination causes negative abnormal returns. The event study is performed in the same way as before. The results are presented in table III.

Table III. Test statistics for the event study of firms that terminated their contract with a liquidity provider.

Sample	Average CAR	Test statistic	N
Terminated contract full sample	-1.34%	-0.469	18
Terminated contract sub-sample	0.60%	0.179	9

The results from this event study are inconclusive and statistically insignificant, both for the full sample of firms that terminated the liquidity providing service and for the smaller sample that is further analyzed in the next section. Hence, the null hypothesis that the removal of a liquidity provider has no impact on stock returns can not be rejected.

6 Market Quality and Trading Activity

This section focuses solely on the firms that have terminated their contract with a liquidity provider. We analyze the effects on market quality and trading activity following the removal of a liquidity provider. Previous research has only focused on the introduction of liquidity providers. However, as the Nordic Exchange has been employing this system since 2003 sufficient data is now available to study the impact of termination of the liquidity providing service.

Our expectations are that the termination of the liquidity providing service will decrease the market quality of the stocks. Hence we expect the average spread to widen and the market depth to decrease. As market quality is related to trading activity we also expect to find that the daily trading volume decreases and that the daily number of trades decreases. Finally, we test whether the average trade size changes. Whether this measure increases or decreases is however somewhat inconclusive. Academic literature claims that smaller trades are less profitable in stocks with high transaction costs. Conversely, larger transactions affect prices to a greater extent as liquidity decreases, forcing investors to split larger transactions into multiple smaller transactions. Therefore we should expect the average trade size to decrease.

Previous studies on liquidity in general have used different proxies of liquidity in their analyses. For the analysis of market quality our base was to focus on the required measures for liquidity provider contracts as set out by the Nordic Exchange. The minimum requirements which was described in table I in section 2 are i) max 4% spread based on the ask, ii) at least four trading lots on both bid and ask side as well as iii) prices being quoted at least 85% of the trading time. As our data for this section of the study consists of daily liquidity measures used by the Nordic Exchange, we calculate averages for the relevant time periods before and after the market making in the firms' stocks had seized. The pre- and post-event periods are 20 days long each, i.e. data was averaged for τ-20 to τ-1 and τ to τ+19, where τ now is the first trading day without a liquidity provider (following a period in which a liquidity provider was contracted).

For our analysis of trading activity the measures turnover (value traded), number of trades and average trade value will be used. When studying market quality we focus on a set of liquidity measures calculated and provided by the Nordic Exchange (appendix 2 provides a complete description of how the measures are calculated). However, we test a limited number of measures in this part and include additional tests of similar measures as a robustness check in appendix 3. We test the differences between

the pre- and post-event periods with a paired t-test. In order to analyze the effects on market quality we formulate and test the following hypotheses:

H_1: Market spread stays the same following the removal of a liquidity provider

Our tests show that the relative spread does not decrease significantly after the termination of a liquidity provider contract.

H_2: Market depth measured as the total value of all orders stays the same following the removal of a liquidity provider

The market depth measured as the value of all orders in the order book does not decrease but rather increases and is not statistically significant.

As described in the theoretical framework, previous studies have concluded that bid-ask spreads are inversely related to trading activity. This implies that deterioration in market quality measured by an increased bid-ask spread should lead to a decrease in trading activity. However, as the previous two hypotheses could not be rejected since spreads and market depth did not change as anticipated, we do no longer expect trading activity to change significantly either.

H_3: Daily turnover stays the same following the removal of a liquidity provider

The results show that the daily trading value increases slightly after the termination of a liquidity providing contract, but the results are not significant on a reasonable level.

H_4: Daily number of trades stays the same following the removal of a liquidity provider

Our results indicate a statistically insignificant increase in the daily number of trades.

H_5: Average trade value stays the same following the removal of a liquidity provider

Our analysis indicates that the average trade size decreases, but the results are still insignificant. Our findings are summarized in table IV below and additional tests of similar measures are performed in appendix 3.

Table IV. Results for tests of market quality and trading activity.

Measure	Pre-Event	Post-Event	Diff. (%)	t-Statistic	p-Value	N
Market Quality						
Average Relative Spread (%)	0.841	0.833	-0.88	0.043	0.483	9
Value of All Levels	4,607,886	4,779,087	3.72	-0.450	0.332	9
Trading Activity						
Daily Trading Value	42,578,892	51,196,075	20.24	-0.916	0.193	9
Daily Number of Trades	295	390	32.23	-1.042	0.164	9
Average Trade Value	86.780	80.755	-6.94	0.702	0.251	9

7 Determinants of the Removal of a Liquidity Provider

In this section we study the determinants of termination of liquidity provider services. We analyze the characteristics of firms that decide to end the liquidity providing agreement in order to find common attributes. To our knowledge, such a study has never been done before as previous research mainly has focused on the introduction of liquidity providers.

We study whether characteristics such as firm size (market capitalization), turnover, spread, cumulative abnormal return in relation to the introduction of a liquidity provider (divided by the firm's standard deviation) and time are relevant factors when terminating the liquidity providing contract. Our expectations are that the relevant determinants for terminating a liquidity providing contract are size, turnover and spread. However, we are somewhat less certain that time since initiation and the cumulative abnormal return are important determinants. Our null hypothesis is:

> H_0: Firm size, turnover, spread, CAR or time since initiation are not significant determinants of the termination of a liquidity provider contract

Which is tested against the alternative hypothesis:

> H_1: Firm size, turnover, spread, CAR or time since initiation are significant determinants of the termination of a liquidity provider contract

We believe that firm size is a relevant variable as large firms and potentially firms that grow substantially since the liquidity provider service was initiated will reach a certain size where the level of liquidity is significantly better than what the liquidity provider contract stipulates. We expect that turnover is closely linked to liquidity and that the results are similar to the ones for firm size and therefore a significant determinant of termination of liquidity provider services. Firms that experience high trading activity will enjoy a high level of liquidity, hence the need for a liquidity provider becomes smaller as trading activity is high. Finally, the size of the bid-ask spread should be a relevant factor in the decision of terminating a liquidity provider contract as the spread is a highly relevant proxy for liquidity. Firms that enjoy spreads far narrower than the requirement stipulated by the contracts should find it rational to terminate such an agreement. In addition, we do not expect the time variable to be an important determinant, however, if it would be important we expect that the probability of terminating a liquidity provider contract increases with time since initiation.

In order to assess the relationship between the chosen firm characteristics and the termination of a liquidity provider contract we need a statistical model capable of estimating the probability of contract termination. For this analysis we apply the standard probit model, which is commonly used in academic research similar to our study.

The standard probit model uses the dummy variable $Terminated_i$ as the dependent variable. For each firm the variable takes the value one if the firm has terminated its liquidity provider contract and otherwise it is zero. As explanatory variables we use: $Market\ capitalization_{it}$, $Turnover_{it}$, $Spread_{it}$, CAR_i/σ_i and $Time_i$, where *i* represents the firm and *t* is the point in time. $Market\ capitalization_{it}$ is the logarithm of the market capitalization for firm *i* at time *t* in million SEK, $Turnover_{it}$ is the logarithm of the average daily turnover for firm *i* at time *t* in SEK, $Spread_{it}$ is defined as the bid-ask spread expressed in percent for firm *i* at time *t*, CAR_i/σ_i is the cumulative abnormal return for firm *i* following the introduction of a liquidity provider divided by the standard deviation for firm *i* and $Time_i$ is the time since initiation of the liquidity provider service expressed in months. For the variables $Market\ capitalization_{it}$, $Turnover_{it}$ and $Spread_{it}$ the data set contains observations at the time of initiation of the liquidity provider contract, and termination of it, or if no termination occurred, observations from October 2007.

The results, presented in table V below, indicate that the $Turnover_1$, M$arket\ capitalization_1$ and $Spread_1$ which all refer to the time of termination, are significant determinants of the termination of liquidity provider contracts.

Table V. Estimated coefficients in the standard probit model.

Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
Market Capitalization$_0$	-0.538	-0.385	-0.140	-0.573	-
Market Capitalization$_1$	-0.634	-0.887	-0.891	0.118	-0.866***
Time	-0.006	-0.005	-0.007	-0.009	-0.007
Turnover$_0$	0.386	0.201	0.183	-	-
Turnover$_1$	1.766**	1.816*	1.310*	-	1.187**
Spread$_0$	-2.968	-3.471	-	-2.113	-
Spread$_1$	104.051	64.783	-	-67.057***	-
CAR/σ	0.983	-	-	-	1.059
N	64	71	71	71	64
Pseudo R^2	0.257	0.274	0.250	0.104	0.206

**Significant at 1%, **significant at 5%, ***significant at 10%*

We can conclude that the most significant explanatory variable for the termination of a liquidity provider contract is the turnover at the time of termination. This variable is significant in all of the regressions, in specification (2) and (3) the variable is significant at the 1% level and in specification (1) and (5) the variable is significant at the 5% level. The marginal effect of $Turnover_1$ is positive and statistically significant in all specifications where included. Therefore, a higher level of trading in a firms' stock the more likely, on average, that the firm will terminate its liquidity provider contract than firms with lower turnover. In addition to the turnover, we find that the spread at the time of termination, which is closely linked to the turnover, is positive and significant at the 10% level in specification (4). This result implies that firms with a narrow spread are more likely, on average, to terminate their liquidity provider contract than firms with a wider spread. Finally, we also find statistically significant results for market capitalization at the time of termination. In specification (5) we find that the marginal effect of the market capitalization at the time of termination is negative and statistically significant at the 10% level. These results indicate that firms with a large market capitalization are, on average, less likely to terminate the liquidity provider contract. This is rather surprising as we expected size to be positively related with the termination of a liquidity provider contract.

We could not find any evidence that the variables at the time of the introduction of a liquidity provider are significant determinants in the termination of a liquidity provider contract. Neither did we find significant results that indicate that the time since initiation is a relevant determinant in the decision to terminate. Nor could we find any evidence that CAR divided by the firm's standard deviation is a determinant in the decision to terminate a liquidity provider contract. Our expectations were highest for turnover and market capitalization, and the results are therefore partly in accordance with our expectations.

To conclude, our results show that we can not reject the null hypothesis unanimously. Nevertheless, turnover at the time of termination is a strong determinant of the termination of liquidity provider contracts. In addition, a firm's spread and market capitalization at termination also provide some explanatory power.

8 Analysis and Discussion

In this section we discuss the results of our empirical investigations. We begin the discussion with the event study and thereafter proceed with our analysis of market quality and trading activity following the removal of a liquidity provider. Previous studies have focused on the improvements in market quality and partly on the value for firms to contract a liquidity provider. We focus on the potential value added by liquidity providers by analyzing the link between improved market quality and its short run effects on asset pricing. Additionally, previous research has to our knowledge never studied firms terminating a liquidity provider agreement and whether these firms suffer from a potentially deteriorating market quality.

An asset's liquidity is related to its return and hence the asset's cost of capital. In the first section of our analysis we studied the link between liquidity and asset pricing by performing event studies with the initiation and termination of a liquidity provider agreement as the events. For the full sample consisting of 95 firms we observed a statistically insignificant positive average CAR. We analyzed sub-samples with regards to liquidity prior to contracting (proxied by the bid-ask spread) and time of contracting. Our results show that the sub-sample with the most illiquid firms has an average CAR of 7.07% that is statistically significant at the 5% level. Similarly, the sub-sample with the 48 first firms to contract a liquidity provider experienced a positive abnormal return of 7.30%, significant at the 1% level. However, the results for the sub-sample with the least illiquid stocks and the sub-sample with firms that contracted a liquidity provider after January 5, 2004 did not indicate any statistically significant abnormal returns. The sub-samples were even further analyzed and a sample consisting of the most illiquid firms that also contracted a liquidity provider prior to January 5, 2004, experienced an average CAR of 11.26% which was significant at the 5% level. Furthermore, various combinations of samples were analyzed but showed no statistically significant results.

Our null hypothesis that the introduction of a liquidity provider does not cause abnormal returns could only be rejected for three of the sub-samples. As theory suggests, improved liquidity seems to, at least in the short run, impact asset pricing. Our results imply that the improved liquidity for the sub-samples with the illiquid firms is valued by investors. The findings support the liquidity premium theorem presented by Amihud and Mendelson (1986). On the contrary, the sub-samples with firms that had a relatively good liquidity prior to assigning a liquidity provider did not show a statistically significant

abnormal return. This could be due to the cost of contracting a liquidity provider, which may offset the gains from an improvement in market quality.

For the other focus of this study, our starting hypothesis was that if a firm decides to terminate a liquidity provider agreement the firm's stock should return to the state in market quality it experienced before the introduction of the liquidity provider. However, our results indicate that this is not necessarily the case as we find no significant results indicating that the firms terminating their liquidity provider agreement suffer from a worsened market quality such as increased spreads and decreased depth or lower trading activity. Additionally, we do not find any significant evidence of either positive or negative average abnormal returns in connection with the termination of liquidity provider contracts.

Finally, in our analysis of the determinants behind the decision to terminate a liquidity provider contract we have found that the marginal effect of the turnover is positive and statistically significant. Therefore, a higher level of trading in a firms' stock the more likely, on average, that the firm will terminate its liquidity provider contract than firms with lower turnover. In addition to the turnover, we find that the bid-ask spread at the time of termination is positive and statistically significant. This result implies that firms with small spreads are more likely, on average, to terminate their liquidity provider contract than firms with larger spreads. Finally, we also find statistically significant results for market capitalization at the time of termination.

There are many potential explanations for these results. Firstly, firms that have chosen to terminate their contract may have experienced a significant increase in trading activity following the contracting of a liquidity provider. When a firm passes a certain turnover threshold the liquidity available in the market is much greater than what is offered by the requirements stipulated in the liquidity provider contract. Hence the firm reaps no benefit from continuing to contract the liquidity provider. Examples of such highly liquid firms that have terminated their liquidity provider contract are Investment AB Öresund, Lundin Mining, Millicom International Cellular and Vostok Gas (previously Vostok Nafta Investment). When considering the turnover and bid-ask spreads in these stocks it is obvious that the firms do no longer need a liquidity provider in order to maintain a good market quality of their stock.

In addition to the trading activity, we found that the spread at the time of termination is positive and significant. This would imply that firms with a narrow spread are more likely, on average, to terminate their liquidity provider contract than firms with a wider spread. As we have concluded that turnover is related to the termination of a liquidity provider contract, it is not surprising that the bid-ask

spread has the same effect, as spreads and turnover are interlinked. As an example from the firms above, the average spread of Millicom International Cellular's depository receipts was 0.23% in October 2007, hence far narrower than what usually is stipulated by a liquidity provider.

9 Conclusions

The approach in this thesis is holistic. We have conducted the first ever study on the termination of liquidity providing contracts. In addition, we have partly confirmed the findings of previous research on the introduction of liquidity providers. Today approximately one fourth of the listed companies have contracted a liquidity provider, implying that there has been a drastic increase of such contracts since inception of the liquidity provider system in 2003. According to previous literature the introduction of liquidity providers have significantly improved the market quality of these firms. To investors the improvement in market quality is beneficial as transaction costs associated with trading activities have decreased. Previous research on liquidity and asset pricing suggest that an increase in market quality leads to an increase in stock prices. Our study confirms this relationship, at least partly, as we observe a statistically significant short run positive abnormal return for three sub-samples of firms that have contracted a liquidity provider. For the most illiquid firms we observe an average abnormal return of 7.07% and an average abnormal return of 7.30% for the 48 first firms that contracted a liquidity provider. These findings support the liquidity premium theorem initially presented by Amihud and Mendelson (1986).

We have also extended previous research on liquidity providers by analyzing the effects of the termination of liquidity providing contracts. We study the effect of termination on asset returns as well as market quality and trading activity. Previous research has concluded that market quality improves and trading activity increases following the contracting of a liquidity provider. However, we do not find evidence of the opposite as the market quality and trading activity seem to remain unchanged following the removal of a liquidity provider. Moreover, firms that terminate their liquidity provider contract do not experience any significant abnormal returns. These results can be explained by the fact that most of the firms that terminated their liquidity provider agreement enjoyed a high level of trading activity and low spreads.

Finally, in our analysis of the determinants of the decision to terminate a liquidity provider contract we find statistically significant evidence that turnover and spread are the foremost determinants of termination, which supports the suggested explanation above.

9.1 Suggestions for Further Research

As liquidity providing is a relatively new service and especially in the Nordic setting, much research remains to be done. During our study we have come across numerous topics that provide interesting areas for potential future research. Below we present these areas that we believe would be interesting to study further.

1. We have studied the firm characteristics and effects of the termination of liquidity provider services on market quality. It would be interesting to study the companies that have contracted a liquidity provider further to find common characteristics. Thus, a study on the attributes that these firms have in common besides poor liquidity would make an excellent area for further research.

2. Our study of liquidity providers' effect on firm value focuses solely on returns in the short term. It would be interesting to study if the abnormal performance we found persists over longer time periods or if it is mainly a short term effect.

3. As the Nordic Exchange allows firms to decide the fee paid for the liquidity providing service individually, this provides for another interesting are to analyze further. For example, it would be interesting to study whether there is a correlation between the fee paid for the liquidity service and the level of improvement of the market quality.

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Appendix

Appendix I

Below follows an illustrative example of why investors consider liquidity as a transaction cost when making investment decisions.

Assume that an investor is about to buy 1000 shares in Company X. Below the order book for company X is presented. It contains the total amount of shares that investors are willing to buy or sell at various price levels.

Volume (#)	Bid ($)	Ask ($)	Volume (#)
500	100	105	200
200	95	110	500
1000	90	115	500

Spread – The difference between the best ask and bid price, hence $5

Theoretical price – The average of the best ask price and the best bid price, hence $102.50

Cost of spread – $2.5

Liquidity premia – 2.4%

The investor wants to buy 1,000 shares, however in the order book there are only 200 shares available at $105. Hence, to buy the additional 800 the investor will have to pay up to $115. The average price paid for the 1,000 shares is $110.50. By buying all the available shares at $105 and $110 the investor has moved the best available ask price to $115. Hence causing a significant movement in the asset's price. The 1,000 shares in Company X cost $110,500 instead of the $102,500 as the theoretical price would indicate. The difference of $8000 is the cost for low liquidity.

In the next example company X has contracted a liquidity provider. The same investor is considering buying 1,000 shares, the same amount as in the previous example. This will demonstrate the potential impact of a liquidity provider.

Volume (#)	Bid ($)	Ask ($)	Volume (#)
1000	101	104	5000
2000	100	105	5000
10000	99	116	5000

Spread – $3

Theoretical price – $102.50

Cost of spread – $1.5

Liquidity premia – 1.5%

When the investor buys the shares this time all 1,000 shares can be bought at the $104 price level as the depth is 5,000 shares at this level. Hence, the transaction does not cause any price movement. The investor pays $104,000 for the 1,000 shares which is $6,500 less than in the previous example with lower liquidity. The investor still suffers from a liquidity premium, but this effect is significantly smaller in the case with better liquidity.

Appendix 2

Below we present the definitions of our proxies for liquidity which are tested in section 6 and appendix 3.

Average Spread is calculated per pre-defined time period. Each time period is split into different segments depending on when the spread (best ask – best bid) changes during the time period and where the order book is in continuous trading. If the spread changes *n* times during the period, t_0 to t_n indicates the times when the spread changes occurred. The definition of *Average Spread* is as follows:

$$Average\ Spread = \frac{\sum_{i=1}^{n}\left[\left(t_i - t_{i-1}\right) * \left(BestAskP_i - BestBidP_i\right)\right]}{t_n - t_0}$$

Where $BestAskP_i$ is the best quoted ask price, and $BestBidP_i$ is the best quoted bid price, which subtracted is the $AbsoluteSpread_i$ from time t_{i-1} to t_i.

Average Relative Spread is calculated according a principle similar to the *Average Spread*:

$$Average\ Relative\ Spread = \frac{\sum_{i=1}^{n}\left[\left(t_i - t_{i-1}\right) * \left(2 * \frac{BestAskP_i - BestBidP_i}{BestAskP_i + BestBidP_i}\right)\right]}{t_n - t_0}$$

Value of All Levels is defined as:

$$Value\ of\ All\ Levels = \frac{\sum_{i=1}^{n}\left[\left(t_i - t_{i-1}\right) * \left(\frac{AskVal_{i\_AllLevels} + BidVal_{i\_AllLevels}}{2}\right)\right]}{t_n - t_0}$$

Where $AskVal_{i\_AllLevels}$ is the value of all ask orders in the order book and $BidVal_{i\_AllLevels}$ is the value of all bid orders in the order book at time *i*.

Value of Best Level is defined as:

$$Value\ of\ Best\ Level = \frac{\sum_{i=1}^{n}\left[\left(t_i - t_{i-1}\right) * \left(\frac{AskVal_{i\_BestLevel} + BidVal_{i\_BestLevel}}{2}\right)\right]}{t_n - t_0}$$

Where $AskVal_{i\_BestLevel}$ is the value of all ask orders at the best level in the order book and $BidVal_{i\_BestLevel}$ is the value of all bid orders at the best level in the order book at time *i*.

Volume at All Levels is defined as:

$$Volume\ at\ All\ Levels = \frac{\sum_{i=1}^{n}\left[\left(t_i - t_{i-1}\right)*\left(\frac{AskVol_{i\_AllLevels} + BidVol_{i\_AllLevels}}{2}\right)\right]}{t_n - t_0}$$

Where $AskVol_{i\_AllLevels}$ is the volume of all ask orders in the order book and $BidVol_{i\_AllLevels}$ is the volume of all bid orders in the order book at time *i*.

Volume at Best Level is defined as:

$$Volume\ at\ Best\ Level = \frac{\sum_{i=1}^{n}\left[\left(t_i - t_{i-1}\right)*\left(\frac{AskVol_{i\_BestLevel} + BidVol_{i\_BestLevel}}{2}\right)\right]}{t_n - t_0}$$

Where $AskVol_{i\_BestLevel}$ is the volume of all ask orders at the best level in the order book and $BidVol_{i\_BestLevel}$ is the volume of all bid orders at the best level in the order book at time *i*.

Number of Orders All Levels is defined as:

$$Number\ of\ Orders\ All\ Levels = \frac{\sum_{i=1}^{n}\left[\left(t_i - t_{i-1}\right)*\left(\frac{NbrAskO_{i\_AllLevesl} + NbrBidO_{i\_AllLevels}}{2}\right)\right]}{t_n - t_0}$$

Where $NbrAskO_{i\_AllLevesl}$ is the number of ask orders at all levels in the order book and $NbrBidO_{i\_AllLevels}$ is the number of bid orders at all levels in the order book at time *i*.

Number of Orders Best Level is defined as:

$$Number\ of\ Orders\ Best\ Level = \frac{\sum_{i=1}^{n}\left[(t_i - t_{i-1})*\left(\frac{NbrAskO_{i\_BestLevel} + NbrBidO_{i\_BestLevel}}{2}\right)\right]}{t_n - t_0}$$

Where $NbrAskO_{i\_BestLevel}$ is the number of ask orders at the best level in the order book and $NbrBidO_{i\_BestLevel}$ is the number of bid orders at the best level in the order book at time *i*.

Appendix 3

Below we present some robustness tests for the analysis of the impact of contract termination on market quality. We provide robustness to our results by re-examining the same hypotheses as before but with additional and slightly different measures. All tests for market quality and trading activity are summarized in table VI below.

Table VI. Complete results for tests of market quality and trading activity.

Measure	Pre-Event	Post-Event	Diff. (%)	t-Statistic	p-Value	N
Market Quality						
Average Relative Spread (%)	0.841	0.833	-0.88	0.043	0.483	9
Average Spread (SEK)	0.655	0.764	16.64	-1.726*	0.061	9
Value of All Levels	4,607,886	4,779,087	3.72	-0.450	0.332	9
Value of Best Level	228.274	231.150	1.26	-0.092	0.465	9
Volume at All Levels	33.446	35.767	6.94	-0.670	0.261	9
Volume at Best Level	2.063	2.140	3.71	-0.248	0.405	9
Number of Orders All Levels	37.427	38.548	3.00	-0.321	0.378	9
Number of Orders Best Level	2.126	2.115	-0.52	0.068	0.474	9
Trading Activity						
Daily Trading Value	42,578,892	51,196,075	20.24	-0.916	0.193	9
Daily Number of Trades	295	390	32.23	-1.042	0.164	9
Average Trade Value	86.780	80.755	-6.94	0.702	0.251	9

**Significant at 10%*

The first hypothesis tested was:

H_1: Market spread stays the same following the removal of a liquidity provider

This was tested using the relative spread, hence we also test the absolute spread by performing a paired t-test on the average quoted spread in SEK for the pre and post periods. Our results show that the absolute spread widens with SEK0.11 after the termination of the liquidity provider contract. The results are significant at the 10% level. This is in line with our initial expectations but contradicts the change in relative spread. Since the relative spread and all other hypotheses could not be rejected, it is likely the case that increased stock prices caused the minimum tick sizes to increase which resulted in a natural increase in absolute spreads but leaving the relative spread, which is of greater importance, unchanged. The second hypothesis for testing market quality was:

H_2: Market depth measured as the total value of all orders stays the same following the removal of a liquidity provider

We also test this hypothesis for the first level of the order book instead of only testing market depth for the entire order book. An increase in the market depth after the termination is observed, however it is not statistically significant. We also test market depth for the volume and number of orders at all levels and at the best level. The results show an increase in number of orders and increased volumes except for the number of orders on the first level of the order book. However, none of the results are significant.