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Paying for Market Quality

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Paying for Market Quality

Abstract

Since the affirmative obligations of liquidity providers are costly, electronic markets have struggled with the means of providing compensation to liquidity providers in return for assuming these obligations. This problem is acute for small stocks, which benefit most from the presence of designated liquidity providers. In this study, we examine the 2002 decision by the Stockholm Stock Exchange to allow listed firms to directly negotiate with liquidity suppliers for a desired level of liquidity in exchange for a negotiated fee. We find that benefits accrue to firms that enter into such arrangements in the form of significant improvements in market quality as well as price discovery. Further, we find that a firm's stock price rises in direct proportion to the improvements in market quality. We study the determinants of the compensation for liquidity provision and document a link between contracted fees and the level of desired liquidity. By examining the trading of liquidity providers we find that their propensity to supply liquidity increases at times of large spreads, and against market movements. Our findings suggest that firms should consider these market quality improvement opportunities as they do other capital budgeting decisions, especially in light of the positive externalities that we find accrue to the liquidity of the firms' stocks.

1. Introduction

While much attention is given to the trading of relatively liquid stocks in the literature, a vast majority of stocks traded across the world tend to have low trading volumes and higher transaction costs. For example, in Lesmond (2005), the median bid-ask spread for 23 emerging markets is 4.65%, ranging from less than 1% for China to as high as 47% for Russia. The problem of illiquidity is severe even in the US markets for a large number of small stocks traded on the NYSE and NASDAQ. Furthermore, the inexorable trend in financial markets has been from floor-based intermediated markets towards electronic systems that match buyers and sellers.[1] The latest manifestation of this trend is the announcement by NYSE to lift limits on trade sizes for stocks traded in their electronic system.[2] This move towards electronic trading on the NYSE raises the question of how specialists might be compensated for taking on the affirmative obligations of providing a minimum level of liquidity, especially in small stocks. Traditionally, specialist compensation for costly affirmative obligations has come through informational or trading advantages (for example, by the NYSE, Toronto Stock Exchange, and Italy's Nouvo Mercato). Even with these advantages, specialists on the NYSE use the profits from trading in liquid stocks to subsidize losses incurred in trading illiquid ones (Cao, Choe and Hatheway (1997)). Hence, without cross subsidization, liquidity would be scarce for small firms. Unfortunately, these firms benefit most from the presence of liquidity providers (Grossman and Miller (1988), Neal (1992)). Given that intermediaries do not naturally arise in electronic markets (as in Domowitz and Steil (2002))[3], we focus on a unique innovation adopted by an electronic market, the Stockholm Stock Exchange (SSE), to compensate liquidity providers: a direct contract between the listing firm and the liquidity provider specifying a desired level of liquidity in exchange for a negotiated fee. Such an arrangement allows for the presence of

[1] Jain (2005) reports that of the 120 countries' exchanges in his sample 101 have some degree of electronic trading, and 85 are completely electronic.
[2] "Big Board Sets Expansion in Electronic Trading," *Wall Street Journal,* August 28, 2006.
[3] A TSX discussion paper on "Market Making Reform," (August 2002) raises this issue in, "Market making models in other jurisdictions, including the NYSE specialist model and the NASDAQ dealer model provide market makers with certain informational advantages and greater control of order flow, which contribute to the magnitude of capital provided for market making activities. TSX is seeking input concerning possible changes to the market making

a specialist in the stocks that need them, allows the listed firm to decide on its desired level of liquidity, and eliminates the need for special privileges (such as on the NYSE) to be bestowed on the liquidity provider by the exchange, thus circumventing possible conflicts of interest.

A direct agreement between the liquidity provider and the listing firm puts the onus of determining the level of liquidity for the firm on the firm's managers. It is well established in the literature that lower transaction costs lead to a lower cost of capital for the firm. Thus, a contractual arrangement with the liquidity providers allows managers to weigh the costs (fees paid by the firm to the liquidity provider) and benefits (improved market quality and price discovery) and decide on the optimal level of liquidity they desire for the firm's stock. Such a comprehensive analysis allows us to comment on the suitability of these contracts from a capital budgeting perspective. The explicit contract between the firm and the liquidity provider (in contrast to the implicit contract for an exchange like the NYSE, and a standard contract through the exchange for other electronic exchanges) also allows us to make progress on understanding the firm and market characteristics that factor into determining the level of compensation for liquidity providers. Further, we analyze whether the oft-cited maxim of "liquidity begets liquidity" leads to additional benefits beyond those which are negotiated. Finally we examine the trading behaviour of liquidity providers to gain insight into *how* and *when* liquidity providers trade to enhance the liquidity of their contracted stocks.

The liquidity providers on the SSE function much like "passive" specialists in that they have affirmative obligations to fulfil without any informational advantages. In this respect, they closely resemble the specialists envisioned by Glosten (1989) who are able to improve market quality for stocks with high risk of adverse selection due to their longer trading horizon. Our context of the Stockholm Stock Exchange (SSE) is unique since the exchange is not a party to the contract and does not mandate a set level of liquidity. Instead, listed firms directly contract with liquidity suppliers for a desired level of liquidity. This is different from other markets (such as the Paris Bourse and the Italian Stock Exchange)

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model to facilitate capital increases for market making activities in the interest of enhancing liquidity and the effectiveness of central price discovery."

where the exchange enters into standardized contracts with liquidity providers granting them a reduction in trading fees, or certain informational advantages, and the listed firms may pay a fee for additional services from the liquidity providers. [4]

There has been increasing interest in the literature on direct payments to liquidity providers to compensate them for taking on costly affirmative obligations. Bessembinder, Hao and Lemmon (2006) present a model wherein the presence of a designated market maker leads to an increase in uninformed as well as informed trading. They predict an improvement in price discovery due to the increased incentives for informed traders to gather and trade on information. Sabourin (2006) also models the impact of the presence of a designated market maker on market quality. The designated market maker in Sabourin (2006) is similar to ours in that the market maker possesses no informational advantages vis-à-vis other traders. Sabourin (2006) shows that, ex-ante, quoted spreads are expected to decline in the presence of the market maker if asset volatility is high, such as in the case of mid and small-cap stocks. We draw from these studies in developing our tests.

A recent empirical paper is closely related to our study. Venkataraman and Waisburd (2006), examines the benefits to firms of employing a liquidity provider in a call auction environment on the Paris Bourse. Venkataraman and Waisburd find support for the Glosten (1994) hypothesis that a designated market-maker may prevent market failure. They also find that this decreased probability of market failure is associated with a statistically significant positive return around the adoption of a liquidity provider, which supports the link between trading costs and required returns.[5,6]

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[4] Panayides and Charitou (2004) provide a detailed discussion of the different versions of this system implemented by different exchanges.

[5] Another study of an exchange introducing designated liquidity providers is Nimalendran and Petrella (2002). The authors find an improvement in market quality on the Italian Stock Exchange after specialists are introduced for thinly traded stocks. However, their study is set in the NYSE framework where the liquidity provider enjoys certain informational advantages. As discussed earlier, the liquidity provider in our study differs in very fundamental ways from the NYSE specialist. Nimalendran and Petrella (2002) also do not analyze the effect of specialist introduction on the cost of capital for the firms entering into a market-making arrangement for their stock.

[6] Empirically, the value of a specialist system has been studied by a number of authors. Madhavan and Smidt (1993), Madhavan and Sofianos (1998), and Madhavan and Panchapagesan (2000) study various issues related to the performance of NYSE specialists. Neal (1992), Mayhew (2002) and Anand and Weaver (2006) examine the value of a specialist in the options market. A number of other studies compare execution costs and depth on market maker and specialist (NYSE) systems (for example Grossman and Miller (1988), Bessembinder and Kaufman

Our study extends the existing literature in the following ways. First, we link market quality effects (changes in spreads, depth and volatility) to the compensation structure for liquidity provision. That is, while in previous studies, firms faced a binary choice of either contracting with a liquidity provider or not, in our sample, listing firms contract for a particular level of liquidity for their stocks, allowing us to conduct a cost-benefit analysis of these arrangements, as well as the interaction between contractual minimum market quality standards and the payments required for meeting those standards. Previous studies have not analyzed the costs associated with the agreements for liquidity provision. If the agreements are value adding then we should see an associated increase in stock price. Accordingly we examine the relationship between changes in market quality and equity returns. Second, we examine the role of a liquidity provider in a continuous market. Therefore, our focus is not on market failure but on the impact of market-maker adoption on conventional measures of market quality. We examine how liquidity providers specifically trade to fulfil their obligations. We also study whether price discovery is affected by the presence of a designated liquidity provider.

Our results suggest that firms reap significant benefits from their decision to contract with liquidity providers for market quality. Specifically, consistent with the predictions in Sabourin (2006), quoted dollar and percentage spreads experience an economically as well as statistically significant decline. Percentage quoted spreads for the listed firms after the liquidity provider starts making a market in the stock are less than half of the levels prior to such activity. We also find evidence that suggests that contractual liquidity attracts significant additional liquidity. We conjecture that this externality of liquidity attracting liquidity at no cost to either the listing firm or the liquidity provider makes such arrangements especially viable for illiquid stocks. The decline in spreads is accompanied by a significant increase in the quoted depth at the inside quotes. An analysis of a matched sample of stocks confirms our attribution of the improvement in market quality to the presence of a liquidity provider. We find that price discovery during the continuous trading period of the trading day increases significantly following

(1997), and Bessembinder(1999)).

the start of liquidity provider services. This result is consistent with the prediction in Bessembinder, Hao and Lemmon (2006) that reduced spreads due to the presence of an LP will encourage information gathering and informed trading.

We analyze the link between transaction costs and returns and find that prices increase following the contracting for market making services. This finding of statistically significant and positive abnormal returns complements the call market results in Venkataraman and Waisburd (2006). The documented abnormal returns are higher for stocks that experience a greater decline in transaction costs.

To examine the relationship between the above documented benefits and contract costs we identify corresponding factors such as the contracted improvement in market quality, firm specific characteristics (volatility and price), and existing relationships with LP firms. Results of a regression analysis indicate that contracted liquidity parameters, and pre-existing relationships are significant determinants of liquidity provider contract cost.

An analysis of how liquidity providers deliver the contracted improvements reveals that liquidity providers trade more passively after entering into liquidity providing contracts, and their propensity for passive trading increases in times when spreads are wider than the contracted maximum. Liquidity providers are also more likely to trade passively against contemporaneous market movements after entering into these contracts. Thus, we provide direct evidence of liquidity provision in the contracted stocks.

Overall, our findings show that the decision to explicitly contract for market making services can be value enhancing for the firm. In the next section we briefly discuss the relevant institutional details of the Stockholm Stock Exchange. Section 3 describes the data used in this study. This is followed by our results, the conclusion, and suggested avenues for further research.

2. Institutional Details

The Stockholm Stock Exchange (SSE) is a subsidiary of the OMX group which owns several exchanges in the Nordic and Baltic countries and is a provider of trading platforms to several exchanges around the world. The SSE uses an electronic limit order book trading system called SAXESS. The system works as a typical limit order book, wherein all orders are required to have a reservation price attached to them. A trade occurs when a buy and sell limit order can be matched based on their reservation prices. Trades can also be executed upstairs and crossed on the system. Over 80% of all trades occur against the book.

During the period of our study, all stocks trade continuously from 9:30 AM to 5:20 PM. There is also an opening and closing call auction for all stocks. Like other exchanges that represent the only market in their country, the SSE has several "sections" for stocks with differing liquidity levels. Until recently, there was no official market making in stocks. Therefore inside quotes were determined by public limit orders. This led to occasional situations of wide spreads, one-sided markets, or no quotes whatsoever. Obviously, these problems were a function of trading interest in the stock. To remedy this situation for less liquid stocks, the SSE, beginning in 2002, allowed firms to contract with liquidity providers to make markets in their stocks. The exchange sets maximum spread widths and minimum depths, but firms are free to negotiate narrower spreads or larger depths. The SSE monitors the performance of the liquidity providers based on the contract between the firm and the liquidity provider (henceforth LP). The contracts do not have a specified date on which they expire. However, most are subject to review after six months of liquidity provision by the LP firm.

3. Data

We obtain from the SSE, the list of firms that enter into contracts with LPs between September, 2002 and March, 2004, as well as the actual start dates for market-making services (the start date is later than the contract date). These 50 firms, along with the date on which the LP started making a market in the stock are listed in Table 1. Liquidity providers begin making markets for firms in our sample on 38 different dates over a 21 month period. The dispersion of dates greatly reduces the probability that any observed changes are due to market wide factors. However, to rule out the possibility of any market wide trends affecting our results, we compare our results with a matched sample of stocks that traded without an LP. To identify matched stocks, we first create a subsample of SSE stocks that did not contract with a liquidity provider during our entire sample period. Then, since we have multiple event dates for each sample stock *i,* we compute the following score (similar to Huang and Stoll (1996)) for all stocks in our non-LP subsample for stock *i* in the pre period:

$$score_{ij} = \sum_{t=1}^{3}\left(\frac{x_j^{non-LP} - x_i^{LP}}{\left(x_j^{non-LP} + x_i^{LP}\right)/2}\right)^2 \tag{1}$$

where *x* is the average standard deviation of 15 minute returns based on quote midpoints; the average price; and the average daily share volume, respectively. We then choose, without replacement, the subsample stock that results in the lowest score as the match for stock *i*. The average score for matched and sample firms is 0.33. We find that in comparison with our sample firms, matched firms have lower average price (42.7 SEK versus 45.7), volume (34,562 versus 48,183), and standard deviation of return (0.0628% versus 0.0788%).

The SSE provided us with data for a period surrounding the LP effective date for each firm. We use data for the 20 trading days before and after the start of contracted services for each firm. The adoption date is not included in either sample. We further restrict our sample to the continuous trading portion of the market from 9:30 AM to 5:20 PM. We use two types of data in this study. The first is a data set that contains the first five price levels of each firm's limit order book along with the cumulated size at each price level at 15 minute intervals throughout the day. Second, we use trade records for our stocks. Each trade record contains the time stamp of each trade along with the price and volume; as well as an identifier classifying each trade as buyer or seller-initiated. The data also identify the submitting broker for both sides of each trade. Since LPs are brokerage firms we are able to directly observe the contribution of LPs, which allows us to analyze the trading behaviour of LPs.

Finally, we obtain from the SSE, copies of the contracts that each listed firm entered into with their LP firm. Firms are not required to reveal the compensation terms of the contract, but almost half of the sample firms (23 of the 50) do. Table 1 provides the contracted maximum spreads as well as the average percentage quoted spread for the 20 trading days prior to the start of the market maker's obligations. Comparing the two reveals that some firms will experience a very large reduction in average spreads as a result of the LP contracts, while others will not. For instance, MSC Konsult has an average percentage spread of over 16% in the 20 days preceding contracting with an LP, while Bejer AB has a spread of 2.5%. Both contracts stipulate a maximum spread of 4%. This suggests that some firms may be concerned with an overall reduction in average spread width, while others may be more concerned with setting a ceiling on the spreads observed in the stock.

4. Results

We begin our analysis of the impact of company specific contracting with a liquidity provider by examining the benefits that accrue to listing firms. In particular, we examine overall changes in market quality and price discovery. To determine if these changes are value adding for the firm and its shareholders, we analyze company returns as a function of market quality changes. Following our analysis of the benefits of contracting for liquidity provision, we seek to identify factors related to contract cost. We then turn to an analysis of how and when liquidity providers trade to deliver the contracted benefits promised in their contracts.

4.1 Overall Market Quality

Sabourin (2006) theorizes that the presence of a designated liquidity provider leads to higher competition for limit order traders and can lead to higher or lower spreads depending upon asset volatility. Thus, for low and mid-cap stocks (which typically have higher volatility), spreads are expected to decline while for large cap stocks spreads are expected to increase. Since our sample of stocks is composed of small stocks we expect a reduction in spreads. We begin our analysis by examining quoted spreads, as well as quoted depths. The quote data that we use for this study is based on snapshots of the limit order book every fifteen minutes throughout the day. Thus, we calculate the simple average spread for each stock and then average over all 50 stocks in our sample. We calculate quoted spread in Swedish kronor (SEK) as well as a percentage based on the midpoint of the spread.[7] Table 2 contains the results for quoted spreads. We find that the average spread width drops from SEK 1.67 to SEK 0.78 following contract initiation, a statistically significant drop of SEK 0.89. Percentage quoted spreads drop by over half (from 4.47% to 2.06%), to a level that is almost two full percentage points below the exchange set maximum of 4%. Such a marked reduction in spreads due to the introduction of an uninformed liquidity provider is unique in the literature. We also compare the change in spreads in the LP sample to the change in spreads for the matched sample. Matched stocks experience an insignificant 0.27 percentage point decline in quoted spreads. Furthermore, the paired difference between the changes in sample and matched stocks is significant at the 1% level of significance.

Since some firms already have average spreads lower than the contracted maximum spreads, we examine the dispersion of spreads. It is likely that these firms aim to reduce the incidence of wider spreads by entering into LP contracts. In particular, we measure the percentage of spread observations in each period that are wider or narrower than the contractual percentage spread. We expect the proportion of spreads wider than the contractual maximum to decline in the post period. Table 2 shows that this is indeed the case. The percentage of spreads wider than the contracted maximum declines from 50% in the pre period to 8% in the post period. Furthermore, the reduction seen in the LP sample is significantly greater than that in the matched sample at the 1% level of significance. We study quoted depth to complete the picture on the supply schedule of liquidity. Total inside depth (sum of the number of shares at the best bid and ask quotes) increases significantly from 13,545 shares to 20,396 shares following contract initiation. We confirm that this increase in depth is significantly higher than that seen for the matched sample. Depth away from the inside (up to four price levels available in the data) increases, but not significantly, following the contracting of liquidity providers. The combined results on spreads and depth indicate an unequivocal improvement in liquidity for the sample stocks.

We analyze whether guaranteeing a minimum level of liquidity to the market through the contract

[7] The contracts specify the spread limit based on the ask price.

with the LP leads to any positive externalities for the firms' stocks. We conduct a preliminary analysis of the presence of such externalities by examining the percentage of observations where percentage spread is narrower than the contractual maximum. The LP firms agree to maintain a maximum spread and the results above suggest they do so. However, an improvement beyond the contracted maximum spreads could be attributed to additional public orders.[8] This is consistent with the widely held belief that "liquidity begets liquidity," as well as with the theoretical model in Sabourin (2006) where non-LP traders submit more aggressive limit orders in the presence of an LP. If the public is adding additional liquidity then we would expect the percentage of time that spreads are narrower than the contracted spreads to increase significantly in the post period. Table 2 presents the results. We find that, in the post period, percentage spreads are narrower than the contractual maximum over 90% of the time. This compares to approximately 50% in the period prior to the start of the LP contract. The difference between the post and pre-periods is statistically significant. Part of this large number of quote observations narrower than the maximum may not be economically significant. That is, a percentage spread of 1.999% is indeed less than 2% but not economically so. Therefore, we calculate the percentage of observations in the post period where the observed spread is narrower than *Contract-X*, where *Contract* is the percentage contractual spread and *X* is a number less than *Contract*. We find that when X=0.005 (i.e., observed spreads are 50 basis points smaller than contractual amounts), 70% of the observed spreads in the post are less than *Contract-X*. When we increase *X* to 0.01, we still find that a substantial 51% of the observed spreads in the post period are smaller than a full percentage point below the contracted amounts. Using the same maximum spread benchmark for the matched sample, we find that the result of spreads narrowing beyond the contracted maximum is limited to the LP sample only. The difference between the LP and the matched sample is significant at the 1% level. We cautiously view the large percentage of spreads that are significantly less than the contractual amount as evidence that the introduction of LPs

[8] We are unable to directly test this conjecture since our quote data do not provide the identities of the limit order traders setting the quote. However, we examine the liquidity supplied by non-LP traders through an examination of the identities of parties to each trade. The results of the analysis are reported in section 3.5.

brings other benefits not detailed in the LP contract. This suggests that contracting with an LP is value adding, not only for the firm but for the market as well.

Liquidity provision includes making market stabilizing trades, i.e. trading in the direction opposite to market movements, which would cause a decline in volatility in the presence of an LP. Accordingly, we examine changes in volatility for our sample. We define volatility as the standard deviation of 15 minute returns based on quote midpoints.[9] We find that intra-day volatility drops from 0.0788% to 0.0576%, a statistically significant decline, after LPs start making a market in the assigned stocks. Improved liquidity and the presence of an LP can cause trading activity to increase. Table 2 shows that although number of trades increase significantly (9.18 to 14.82 trades a day), the increase in the number of shares traded is not significantly different from that in the matched sample.

We combine the daily volume in the post period with the reduction in percentage spread to calculate the savings in transaction costs enjoyed by investors after firms adopt a LP. Based on a 250 day trading year, the annual cost savings to investors for these 50 firms is in excess of SEK 74,762,149 (US$10,680,311.)[10]

Finally, we test whether the improved market quality we find is due to firm specific factors other than the introduction of liquidity providers.[11] For example, Stoll (1985) shows that relative spread is inversely related to price and trading activity, and directly related to volatility. Therefore, we perform regressions of the form:

$$\overline{S}_{i,t} = \beta_0 + \beta_1 (1/\overline{Price_{i,t}}) + \beta_2 \overline{LogVolume}_{i,t} + \beta_3 \sigma_{i,t} + \beta_4 Dummy_{i,t} + \varepsilon \qquad (2)$$

[9] Quote midpoints are used to mitigate the problem of bid-ask bounce. In 0.4% of the cases in the pre-period and 0.2% of cases in the post period, we do not find a two-sided spread in our sample. We exclude these 15 minute periods from our volatility calculations.

[10] We multiply the average percentage quoted spread reduction by the average daily Swedish Kronor (SEK) volume (not reported here but available upon request) in the post period to get a daily SEK cost savings. We then multiply by 250 trading days, then by the number of sample firms. We convert to US$ by assuming an exchange rate of 7 SEK to 1 US$. We realize that we use quoted spreads as approximations for effective spreads which would be a better measure of transaction costs incurred by investors. However, we do not have the data to calculate effective spreads. In electronic markets the possibility of price improvement is moot since there is no intermediary with a last-mover advantage as in the NYSE. There still remains the possibility that orders walk up the book and incur effective spreads that are higher than quoted spreads. Given the larger depths in the post period, we believe we understate the cost savings here as orders are less likely to walk up the book.

to control for confounding factors, where: $\overline{S_{i,t}}$ is the mean quoted spread (currency or percentage) for firm *i* in period *t* (pre or post); $\overline{Price_{i,t}}$ is the mean closing price for firm *i* during period *t*: $\overline{LogVolume_{i,t}}$ the mean daily log of share volume for firm *i* during period *t*; $\sigma_{i,t}$ is the standard deviation of intra-day return for firm *i* during period *t*; $Dummy_{i,t}$ is a dummy variable assigned the value of 1 if the period is post, otherwise zero. If the observed decrease in quoted spreads can be attributed to the introduction of liquidity providers, we would expect the parameter estimate for *Dummy* to be negative and significant. The results are reported in Table 3. We find that the parameter estimate for the *Dummy* variable is of the expected negative sign and statistically significant at acceptable levels for both quoted kronor and percentage spreads. This analysis further confirms that our findings are associated with the introduction of liquidity providers for firms in our sample, and not a result of other firm specific changes.

As a further check of robustness, we test for the influence of outliers on our results. Specifically, we have four firms in the sample that experience a ten-fold increase in volume. We run all our tests excluding these four firms and find that all the market quality results still hold, i.e., market quality improves significantly.[12] Therefore, we conclude that outliers are not driving our results.

We are also sensitive to the possibility that the firms that choose to contract with an LP self-select to do so and possibly have higher benefits of LP presence than firms that do not make this choice. We use the Heckman (1978) approach outlined in Maddala (1983) to analyze if our results hold after accounting for the possible self-selection bias. The Heckman approach involves a two step procedure. In the first step we employ the following probit specification to model the probability of contracting with an LP:

$$LP_i = \beta_0 + \beta_1 1/Price_i + \beta_2 Ln(Size_i) + \beta_3 StdDev_i + \beta_4 Turnover_i + \beta_5 DaysTraded_i + \beta_6 MTB_i \qquad (3)$$

where the variable *LP* equals 1 for firms that contract with an *LP* and 0 otherwise, *1/Price* is the inverse of the average price of the stock, *Size* is the market capitalization of the stock, *StdDev* is the

[11] Tests involving our matched sample control for market wide conditions.
[12] Detailed results are available from the authors.

standard deviation of daily returns, *Turnover* is the total volume traded as a proportion of the market capitalization, *DaysTraded* is the number of days a stock traded during the period of the analysis, and *MTB* is the market-to-book ratio of the stock. We run this analysis towards the end of our sample period – January to March of 2004. We exclude five stocks that contracted with an LP during these three months. *Turnover* and *DaysTraded* are calculated by the Stockholm Stock Exchange and we use these in our analysis. The comparable set of stocks that do not have an LP contract includes the relatively illiquid stocks on "O List" of the Stockholm Stock Exchange. "A list" stocks tend to be the larger, liquid firms which would not be a good comparison for our firms with LPs. In our analysis period there are a total of 226 "O list" firms. We include stock characteristics such as size, price, turnover and volatility. *DaysTraded* proxies for the level of investor interest in the stock, and the market-to-book ratio measures the growth opportunities for the firm. Venkataraman and Waisburd (2006) propose that growth opportunities play a role in a firm's decision to contract with an LP, since part of LP compensation can come from future investment banking opportunities.

In the second step of the implementation of the Heckman (1978) procedure, we estimate the following equation using OLS:

$$S_i = \beta_0 + \beta_1(1/Price_i) + \beta_2 Ln(Size_i) + \beta_3 StdRet_i + \beta_4 Turnover_i + \beta_5 IMR_i + \beta_6 LP + \varepsilon \quad (4)$$

Apart from the variables in equation 3 above, the dependent variable S_i is the average percentage spread for stock i during the analysis period, and the explanatory variable *IMR* is the inverse mills ratio calculated from the first stage probit (equation 3) described above.[13] The inclusion of the inverse mills ratio controls for selection bias, and ensures that our coefficient and standard error estimates are consistent and unbiased. The results of the analysis are presented in Table 4.

Table 4, Panel A shows the results of the first stage probit estimation. We find that firm size is the most significant variable in explaining LP choice. *Volatility* and *DaysTraded* also show

[13] We also run this analysis for currency spreads (in SEK) and find qualitatively identical results.

limited significance (at the 10% level). For our analysis, the second stage estimation (presented in Table 4, Panel B) is more relevant. We find that the coefficient on the inverse mills ratio is highly significant indicating that self-selection does play a role in our estimation. However, the LP dummy is negative and highly significant (at the 1% level). Therefore, firms that contract with a liquidity provider display lower spreads after controlling for firm characteristics and the effects of self-selection.

4.2 Impact of LP presence in periods of high volatility

Sabourin (2006) shows that, for highly volatile stocks, a market with an LP will have narrower spreads than a pure limit order market. We argue that this result can be extended to inter-temporal changes in volatility for stocks, i.e., since volatility differs from day to day for stocks, individual stocks will benefit more from having contracted with an LP on volatile trading days. The effect of LP presence may be especially relevant for our sample because the contracted spread is not always a binding constraint for many stocks in our sample (Table 1). On days of high volatility, the spread may increase such that the contracted spread does become binding for these stocks, causing the LP to play a more prominent role. Thus, we expect that the benefits of an LP are greater on high volatility days.

We test the effects of the presence of an LP on volatile days, by regressing daily percentage spreads, *SP%*, against that day's volatility, σ, and a dummy variable, *Dum*, with the value 1 if the day occurs in the post period. Consistent with previous literature, we predict a direct relationship between percentage spread and volatility. Based on our previous results, we expect an inverse relationship between spreads and the dummy variable. To test whether the reduction in spread is greater on volatile days we create an interaction variable, $\sigma * Dum$. If the benefits of an LP are higher on volatile days, we would expect the parameter estimate for this variable to be negative and significant. To add more power to the test (we need to capture volatile days in our sample) we perform our regression cross-sectionally. The parameter estimates are listed below, with the associated t-statistics.

$$SP\% = \underset{27.87^{***}}{0.033} + \underset{13.80^{***}}{0.018\sigma} \underset{-10.27^{***}}{-0.017 Dum} \underset{-4.67^{***}}{-0.009\sigma * Dum} \quad adj.R^2 = 0.24$$

All of the regression coefficients are highly significant and of the expected sign. Higher volatility is associated with higher spreads; and the negative coefficient for *Dum* confirms our earlier analysis that spreads decline in the post-period. Our coefficient of interest in this regression, the parameter estimate for the interaction variable σ*Dum* is negative and statistically significant. We view this as evidence consistent with the predictions from Sabourin (2006), that the benefits of LPs are directly related to a stock's volatility level.

4.3 Impact of LP presence on Price Discovery

Bessembinder, Hao, and Lemmon (2006) consider the impact of LPs on price discovery. They argue that the narrower spreads that arise from the presence of an LP will make informed trading more profitable, in turn encouraging information production and informed trading. These higher levels of information based trading lead to an improvement in price discovery in their model. We use a modified version of the Barclay and Hendershott (2003) measure to test for changes in price discovery due to the introduction of an LP.[14,15] The measure decomposes the total price change in a market over a 24-hour period into price changes attributable to two periods. The first, is the period during which trading occurs continuously (when LPs would make markets); and the second is from the close of continuous trading to the opening of continuous trading the next day. The second period includes the overnight non-trading period as well as the opening and closing call auctions conducted by the exchange. This analysis draws on the intuition that informed traders will trade on their information when the value of their information is higher than the transaction costs of trading on the information. Hence, as transaction costs of trading fall due to the presence of an LP, the incentives to gather information (with relatively lower value), and

[14] Barclay and Hendershott investigate the proportion of price discovery that occurs after hours on the NASDAQ market, so they partition the after hours period into three periods. In this study we use only one after hours period.
[15] Data constraints do not allow us to calculate other measures of price discovery that require a contemporaneous quote associated with each trade.

trading on such information increase. Thus, relatively more information will be revealed through the trading of informed traders, increasing the proportion of price discovery attributable to the continuous trading period following the introduction of the LP. Specifically, we calculate the following weighted price contribution (WPC) measure:

$$WPC_i = \sum_{s=1}^{S}\left(\frac{|ret_s|}{\sum_{s=1}^{S}|ret_s|}\right) * \left(\frac{ret_{i,s}}{ret_s}\right)$$

where S is the total number of stocks observed in period i, ret_s is the open to open return, and period i is either the open to close return on day t, or the close to next day open return, both based on quote midpoints.[16] Zero returns are excluded from the analysis. The WPC measure is calculated for each period each day and then averaged across days to obtain statistical inference. Table 5 shows that price discovery attributable to the trading day increases following the start of LP activities. In particular, the portion of price discovery during this time period increases from 64.4% to 73.0% after LPs begin contracted services. The difference is statistically significant at acceptable levels, providing support for the hypothesis of Bessembinder, Hao, and Lemmon (2006). In contrast, our sample of matched firms experiences a statistically insignificant decrease in the proportion of price contribution attributable to the period the market is open. We also compare the difference in the price discovery in the LP and the matched sample and find that the change in the price discovery attributable to the trading day is significantly higher for the firms that contract with the LP than for the matched sample.[17]

4.4 Impact of Spread Reduction on Returns

We find significant improvements in liquidity as a result of an LP making a market in the stock.

[16] Barclay and Hendershott (2003) examine the 250 highest volume stocks on NASDAQ. Our sample trades far less frequently than their sample. We therefore use opening and closing quote midpoints to calculate returns rather than trade prices.

[17] Since the measure is a weighted cross-sectional daily average, our comparison of LP and matched sample is based on the daily differences of the entire samples, instead of the difference between each sample and matched stocks in the rest of the analysis.

This improvement in liquidity, combined with the established result in the literature that liquidity is priced (see Amihud and Mendelson (1986), Brennan and Subrahmanyam (1996), Amihud (2002), among others, for details), suggests that prices of the affected stocks should increase following the adoption of liquidity providers by firms. However, in our particular context, the contractual improvement in liquidity comes at a cost to the firms. Thus, it is possible that liquidity providers negotiate a fee equivalent to the benefit to the firm making it a zero net present value decision. On the other hand, the positive externalities documented earlier could lead to benefits to the firms that outweigh the payments made to the LPs. It is then an empirical question whether these investments enhance the value of the firm.

We examine the impact of liquidity providers on firm value, using an event study methodology with the date the LP begins providing market making services (the start date) as the event date.[18] As is now standard in event studies we estimate abnormal returns and cumulative abnormal returns (CARs). Our event window encompasses the period from 5 days before to 10 days after the introduction of a liquidity provider. We calculate daily abnormal returns using the market model with the return on the OMX benchmark index used as a proxy for the market return. Parameters are estimated, using daily data, over the trading days t-106 to t-6, where t is the date LP services began. We estimate Scholes and Williams (1977) betas to remove biases arising from infrequent trading. Table 6 presents the results for the abnormal return on each day in the event window as well as the cumulative abnormal return. As a control, we also estimate the abnormal returns and CARs for our matched sample over the same periods.

We find an abnormal return of +1.01%, for our original sample, on the day LPs begin making markets in firms' stocks. All but two of the abnormal daily returns are positive on the days following the LP start date. In contrast to our sample of firms that began LP services, our matched sample (last two columns of Table 6) exhibits no statistically significant CARs. In particular, the day t+10 CAR for the matched sample is an insignificant 0.58% versus 6.18% for our original sample. The difference in day

[18] For most firms, the start date coincides with the announcement date but for a few firms the announcement date is a significant number of days before the start date. For a few firms the official announcement came after the liquidity provider began his services. Therefore we use the start date, not the announcement date, as our event date. Note also that the announcement date is later than the contract date.

t+10 CARs for the two samples is significant at the 1% level. We note that our tests of significance are one-sided in that they test the null hypothesis that the CARs are greater than zero, against the alternative hypothesis that these CARs equal zero. The tests are consistent with our hypothesis development. Our results provide strong support for the notion that the market reacts positively to the start of market making services and indicate that the decision to contract with an LP has a positive net present value, on average.

To examine whether this increase in firm value is related to the reduction in transaction costs noted in Table 2, we regress on the day t+10, CAR_i, against the relative change in percentage quoted spread from the pre to post period., $\left[\frac{S_{i,post} - S_{i,pre}}{S_{i,pre}}\right]$. Extant literature predicts that the slope parameter estimate should be negative, indicating that reductions in spread have a positive effect on the stock price. The parameter estimates are reported below, with *t* statistics below the estimates:

$$CAR_i = \underset{-0.95}{-5.66} + \underset{-2.26^{**}}{-27.74} \left[\frac{S_{i,post} - S_{i,pre}}{S_{i,pre}}\right], \tag{5}$$

The slope parameter estimate indicates a negative relationship between the reduction in spread and the increase in firm value, consistent with existing literature.

4.5 Determinants of LP Compensation

The analysis above establishes that the decision to contract with an LP, on average, has a positive net present value. In this section, we conduct a more in-depth investigation of costs of these contracts, the determinants of the costs as well as of how the costs compare to the benefits of increased liquidity. As mentioned earlier, 23 of the 50 sample firms reveal not only the maximum spread width and minimum depth each LP firm agreed to provide, but also the negotiated cost of each contract. The 23 firms in this sub-sample are distributed among three different LP firms. We find variation in contract terms, not only between LP firms but also among listed firms using the same LP firm. Table 7, Panel A displays the frequency of contract terms (spread and depth) for the 23 firms. We see that the distribution of maximum spread widths is fairly even: 2, 2.5, 3, and 4%. Of the 23 firms in our sample, 20 explicitly state the minimum depth the LP firm guarantees for the listed firm. We find that eight of the firms chose a minimum depth of between 1,600 and 2,000 shares while five choose a depth level between 4,000 and 10,000 shares. The remainder chose amounts as little as 800 shares to as much as 40,000 shares.

We examine the remuneration that listed firms agree to pay LPs for their services (Table 7, Panel B). 19 of the 23 firms have both a fixed and variable cost component. Both costs are collected on a monthly basis. Table 7, Panel B shows that the average fixed monthly cost of the contract is 16,000 SEK (about US$2,300) per month. This number seems inexpensive when we consider that overall traders in firms with an LP experience a reduction of almost SEK1.5 million a year in transaction costs. However, there is considerable variation in the contract amounts. The maximum fixed portion is 5 times greater than the minimum, suggesting either variation in firm characteristics or differences in negotiating power among firms. We examine this issue later in the paper. Some contracts also include a variable cost portion, which is a fee that the firm pays LP firms for each trade in which they provide liquidity. The costs are calculated on a per-share or per-trade basis. In all cases there is a cap agreed to on the variable portion of the contract. Like fixed costs, there is dispersion among the variable costs, from 5,000 SEK to 15,000 SEK. The total costs row sums together the fixed and variable portion of each contract. We find that there is a similar amount of variation among total costs.

We perform a cost-benefit analysis for each firm and aggregate the results across firms. We caution the reader that this is not the standard version of the cost-benefit analysis in that the benefits accrue to the investors in the firm, while the costs are incurred by the firm itself. While the firm benefits from a lower cost of capital due to the reduced trading costs, we note that these benefits may not have a one-to-one relationship with the reduction in trading costs. With that caveat, we still believe that such an analysis is useful for firms considering entering into LP contracts. We also note that this analysis complements our earlier results on abnormal returns, which show that the decision to contract with an LP has positive net present value for the firm.

To do this analysis, we first estimate the average daily cost saving in trading costs for the investors of each firm by multiplying its reduction in percentage spread against its average daily Swedish kronor volume in the post period. The results are contained in the first row of Panel C. We observe that on average investors in these 23 firms save over SEK 11,000 a day in transaction costs. Not every firm seems to benefit equally since the minimum cost savings is only SEK 88 while the maximum is over SEK 100,000. We assume a 20 trading day month and multiply the average daily savings by 20 to get a monthly savings number. From this number we then subtract the total monthly contract cost for the firm. We report the numbers in Swedish kronor (US dollars) in the second (third) row of Panel C. We see that the average monthly benefit to investors in excess of contract cost is almost $30,000. However we find a wide dispersion around the average. For 6 of the 23 firms, the benefits are lower than the costs. We realize that our analysis does not take into account other benefits that the LP firm might provide to the listing firm, that it measures benefits with some degree of noise, and that not all variable costs might be incurred by the firm. The analysis is also fundamentally different from a traditional NPV analysis in that it does not make projections about the future and the increases in volume that might come about as a result of the lower transaction costs. However, it does make clear that the decision to contract with an LP is a capital budgeting decision that each firm needs to analyze given its particular circumstances.

The fact that firms experience a reduction in total transaction costs for the investors in the firm that far exceeds the costs to arrange the contract (the median firm's costs savings are 4 times the LP contractual fees) suggests that even if the correspondence between the savings for investors and the resulting benefits to the firm are not one-to-one, the adoption of an LP is likely to be a positive NPV project for the firm. Evidence consistent with this conjecture was presented in Table 6 which shows positive CARs following the start of market making services.

As mentioned earlier, the observed dispersion of cost of contracts may be a result of variation in firm characteristics, negotiating power, or may reflect the fact that listed firms pay more to obtain more benefits. To test this hypothesis, we regress contract costs against variables which are indicative of increased benefits provided by LP firms and firm characteristics. First we expect that the narrower the maximum spread expected from the LP firm, the more they will charge to provide it. We include two independent variables to test for this effect. The first variable, *MaxSpread*, is defined as the maximum contract spread width specified in the contract. Recall that for many contracts the average spread is already lower than the maximum, hence the contract serves a more significant purpose by reducing the incidence of high spreads than by reducing the average spread. Hence, we include a second variable to capture the dispersion of spreads - percentage spreads wider (*%Wider)*, defined as the percentage of the pre period percentage spread observations that are wider than the contractual maximum spread. Since higher contractual minimums for depth require a larger capital commitment on the part of LP firms, we would expect there to be a positive relationship between contracted depth and contract cost. The variable $Depth_i$ is the contract specified minimum depth.

In terms of firm characteristics, we would expect price and volatility to be directly related to the capital commitment of LP firms and thus also directly related to the negotiated contract fee. We therefore examine σ_i , defined as firm *i*'s intraday standard deviation of quote midpoints in the pre-LP period and $Price_i$ which is the average closing quote midpoint for firm *i* in the pre-LP period. We normalize price, by taking its inverse.

LP firms may give discounts to firms that they do other business with, for example investment banking clients. We proxy for other business relationships by including a dummy variable, $Already_i$, which is assigned the value 1 if the LP firm trades the listed firm before they begin market making services (9 of the 23 firms). We also explore whether LP compensation is influenced by the possibility of future business opportunities with the listed firm, i.e. whether LPs require less compensation if they expect investment banking business from the firm in the future. We proxy for future business opportunities by the growth opportunities of the firm as measured by the market-to-book (*MTB*) ratio. We then perform the following regression:

$$C_i = \beta_0 + \beta_1 \sigma_i + \beta_2 1/Price_i + \beta_3 MaxSpread + \beta_4 \%Wider + \beta_5 Depth_i + \beta_6 Already_i + \beta_7 MTB + \varepsilon \tag{6}$$

where C_i is the natural log of the total monthly contract cost for firm *i*.

The parameter estimates are listed in Table 8. The standard errors are calculated using the White (1980) correction for heteroskedasticity. We find support for the relationship of capital commitment to contract cost. In particular, we find that total costs are significantly higher for stocks that have a higher proportion of spreads in excess of the contracted maximum spread in the pre period. Specifically, we find that LP compensation increases by 0.29 percent for each percentage point increase in the proportion of spreads wider than the maximum in the pre-period (note that our dependent variable is the natural log of the contract cost). We also find that LP compensation is higher when a higher minimum depth is contracted for. The coefficient on log(contract minimum depth) implies that a 1% increase in the contracted depth leads to a 0.43% increase in LP compensation. Our measure of spread width does not yield statistically significant results suggesting that spread dispersion is more important than spread levels. We also find that pre-existing relationships (proxied by the LP firm trading the stock in the pre-period) have a significant negative effect on the total costs of liquidity provision. Specifically, for listed firms already traded by LP firms, the LP compensation is 0.36 percentage points lower than that for the listed firms which do not have any LP trading in the pre-period. The coefficient on *MTB* ratio is of the expected sign but it is not statistically significant. Firm characteristics do not significantly affect LP compensation above and beyond contractual features. We note that the regression estimation is based on a small sample. Thus, our inability to find significance for some coefficients could be a result of the limited power of the tests and may not necessarily imply a lack of a relationship between the variable and LP compensation. However, given the small sample size, the significant coefficients do establish an unambiguous relationship between those variables and LP compensation.

In addition to the contractual payment for liquidity provision, LPs may earn profits from trading the stocks. Previous literature finds that even when specialists have an informational advantage, they lose money by trading illiquid stocks. Therefore we would expect that SSE LPs will not earn any compensation beyond that in the contract. If they do earn other profits, we may be missing an important component of our analysis. To test this hypothesis we estimate the incremental trading profits that LPs earn in the period following the agreement start date. Our data identify both the buying and selling firm in each trade and whether the trade was buyer or seller initiated. Since we know which firm is the LP for each stock we are able to extract and sign trades involving the LP firm.[19] In particular we estimate two versions of LP firm total trading profits (TP):

$$TP_i = \sum_{t=1}^{n} p_{it} x_{it} + p_{in} I_{in} - p_{i0} I_{i0} \, , \qquad (7)$$

where, for stock i and transaction t, x_{it} is the LP firm signed volume for trade t, p_{it} is the price, I_{it} is the LP firm inventory, p_{in} is the last trade price for the period, and $I_{in} = \sum_{t=1}^{n} x_{it}$. Initial inventory I_{i0} is not observed, and consistent with Hansch, Naik, and Viswanathan (1999), we set this value to zero. The first measures short term trading profits and only includes the summation on the right hand side of the equation, i.e. $\sum_{t=1}^{n} p_{it} x_{it}$. The second includes changes in inventory. Only those trades involving the LP firm are included.

We find no evidence of significant positive profits (with or without inventory) before or after the LP contract. Specifically, for the 14 firms with no LP trading in the pre-period, LP profits including inventory are a statistically insignificant SEK 2,651 per stock in the post-period. Excluding inventory effects, the absolute amount is higher (SEK 108,682) but statistically insignificant. The results are similar for the 36 stocks with LP trading in the pre-period. Including inventory, profits decline from SEK 12,319 per stock in the pre-period to a loss of SEK 35,064 in the post-period. Excluding the effects of inventory, profits increase from SEK 830,198 in the pre-period to SEK 2,879,062 in the post-period. However, neither of the two changes (with or without inventory) is statistically significant. This is

[19] We do not have identifiers to let us know whether the LP firm is acting as principal or agent. However, unless the clients of the LP firms are systematically informed, we would expect the trading profits from them to be zero. We are not aware of any reason that would cause such informed traders to systematically choose to route their orders through the LP firm. Consequently including agency trades in our anaylsis should not assign any bias to our measure.

consistent with our expectation that LP firms earn no excess trading profits following the institution of market making services.

4.6 Liquidity Provider Contribution and Trading

In the final portion of our study, we examine the direct contribution of liquidity providers to the observed improvement in market quality. Our data do not allow us to identify the source of quotes in the limit order book. However, we can identify LPs in the trade data, so we concentrate our analysis on the contributions LPs make to trading activity. We find that 36 LP firms traded the listed firm's stock prior to contracting to be their LP, while 14 others did not trade the listed company's stock before the contract date. The fact that 14 LP firms are induced to trade the firm's stock through contracting attests to the improved market quality provided by LPs. We conduct additional analysis to examine the extent of involvement in the trading process of each listed firm's LP. The results for trading activity by LPs are contained in Table 9.

Panel A examines the trading activity of LPs in the post period for the 14 firms that had no LP trading in the pre period. We find that liquidity providers added over 7,939 shares to the average daily volume for these 14 firms which is a significant 32.4% of the average number of shares traded each day in the post period. This represents an average of 4.19 trades a day for an average trade size of 1,621 shares. The number of trades per day, the average daily volume, and average trade size are statistically significant at acceptable levels. Panel B shows that, on average, liquidity providers who traded the firms in the pre period increase their contribution to share volume to an even larger degree than that found for firms in Panel A. In particular, liquidity providers add 2.08 trades on an average day, which adds 17,704 shares to the average daily volume observed in the post period for these 36 firms. This represents 39.5% of the average traded share volume for the sample firms in the post period.

Given the differential contribution of LPs just described, a natural question is whether this differential contribution to liquidity impacts market quality measures. Accordingly, we partition our data into those firms that had prior LP trading and those that did not and calculate the market quality measures reported in Table 2 for each group. We find that although there are differences between the groups, market quality improves significantly for both. However, no clear pattern emerges of one group experiencing a greater improvement than the other.[20]

Liquidity providers, by definition, should be passive traders who post bids and offers which can then be lifted or hit by other traders seeking immediacy. The existence of a sample with LP activity in the pre and post period allows us to test this hypothesis by explicitly testing for changes in the trading behavior of the LPs. Two characteristics of our data make this analysis possible – the presence of identifiers for LP trades, and the existence of a marker indicating whether the trade was buyer or seller initiated. Specifically, we compare LP passive trades as a proportion of all LP trades, in the pre and post periods. We find that in the pre period, LP passive trades represent 56.97% of all their trades. In the post period, consistent with our hypothesis, we find that the percentage increases to 65.17% of LP trades. The increase in LP passive trades is statistically significant at the 10% level.

We also examine the propensity of other non-LP traders to submit limit orders. Sabourin (2006) predicts that spread improvements are likely to come from non-LP traders as these traders have to post more competitive quotes in the presence of an LP. If non-LP traders post more quotes at the best prices in the market then we are likely to see these orders taking the passive side of trades in our analysis. We find that non-LPs economically increased the supply of passive liquidity after LPs began providing services. In particular, we find that the daily number of trades where non-LP trades supply liquidity increase from 8.33 per day in the pre-period to 12.70 per day in the post-period (significant at the 5% level). These trades represent an increase from 38,084 shares per day to 88,474 shares per-day in the post-period (significant at the 1% level). These results bolster our earlier conclusions that the presence of an LP has positive externalities of attracting additional liquidity provision from other non-LP traders.

We further explore the passive trades of LPs to understand *how* and *when* LP firms supply liquidity to cause the documented improvement in liquidity. Such an analysis furthers our understanding

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[20] Results not reported here, but available from the authors upon request.

in the literature of the liquidity providing behavior of specialists. In particular, we examine the market conditions under which we observe passive LP trades versus those market conditions that do not lead to a passive LP trade. We only examine those 36 stocks that have LP trading activity before and after the start of the contract.

To test our hypotheses that the trading behavior of LPs will change following the start of contracted services, we perform the following logit regression separately for periods with passive LP buy and sell trades (buy and sell trading periods are analyzed separately since it is crucial to capture the directionality of the LPs' passive trades):

$$\begin{aligned} Trade_{it} = \gamma_0 + \gamma_1 AbsRet_{it-1} + \gamma_2 WideDummy_{it} + \gamma_3 CurrentReturn_{it} + \Delta\gamma_1 D_{it} AbsRet_{it-1} + \\ \Delta\gamma_2 D_{it} WideDummy_{it} + \Delta\gamma_3 D_{it} CurrentReturn_{it} + \varepsilon_{it} \end{aligned} \tag{8}$$

where $Trade_{it}$ is a dummy variable that takes the value 1 if a LP trade of the type (buy or sell) occurs for firm *i* during time interval *t*. $AbsRet_{it-1}$ is the absolute return (a measure of volatility), calculated using quote midpoints at the beginning and end of the period, for firm *i* in time interval *t-1*; $WideDummy_{it}$ is a dummy variable indicating whether the inside percentage spread at the beginning of time interval *t* is wider than the maximum contracted spread width (1 if wider, otherwise 0); $CurrentReturn_{it}$ is the return for firm *i* in time interval *t;* and D_{it} is a dummy variable assigned the value 1 if the observation is from the post period, otherwise it is assigned a 0. Δ indicates the change in the parameter in the post contract period. In our model, γ_1 through γ_3 measure the impact of the independent variables on the log-odds ratio of trading versus not trading in a particular 15-minute period prior to the LP contract, while $\Delta\gamma_1$ through $\Delta\gamma_3$ measure the change in the impact of these variables following contract initiation. Since our quote data is observed at 15 minute intervals, we use these 15 minute intervals to define our time intervals. We establish immediate past market conditions as those that exist in the previous quarter hour. For example, for a trade occurring at 9:51 we consider conditions during the period 9:30 to 9:45 as time interval *t-1* and conditions that occur during the period 9:45 to 10:00 as time interval *t*.

$WideDummy_{it}$ is directly relevant as an included variable in the LP contract. Since LPs are required to maintain maximum spread widths we expect that spreads wider than the contract maximum will result in LPs placing spread narrowing orders resulting in a higher probability of passive trades. $AbsRet_{it-1}$ captures short-term volatility in the period preceding the interval the trade is observed in. LP intervention in the market is likely to be beneficial in periods of high volatility. Thus, even though we always expect more limit orders to be picked off during volatile periods, the liquidity supplying role of LPs after LP contracting implies that we should see a further increase in the probability of passive trades in times of higher volatility. We also include the contemporaneous return in the 15 minutes encompassing the trade. If LPs increase their liquidity providing activities after entering into LP contracts then we expect them to trade more in the direction opposite to market movements. Thus, we expect the probability of a passive trade *against* market movements to increase. To ensure that we capture this increased probability we multiply contemporaneous returns by -1.0 for passive buy trade regressions.[21] LP trades occur in a minority of time intervals leading to disproportionate sample sizes between intervals with and without LP trades. To correct for this we follow the methodology suggested by Maddala (1988) and extract a random sample of non-LP trading intervals equal to twice the number of LP trading intervals in each period (pre and post) as the control sample.

The results (presented in Table 10) provide support for the increased provision of liquidity on the part of LP firms. Recall that we multiply returns by -1.0 for buy logit regressions to indicate trading in the opposite direction of the market. Consistent with the contractual provision of liquidity, we find that a percentage point increase in the contemporaneous return increases the log odds ratio of trading passively in the direction opposite to the market (i.e., the LP buying as prices drop and selling as prices rise), versus not trading by 0.45 percentage points prior to the LP contract. After the LP begins market making services, the log odds ratio of trading in the opposite direction increases by 1.42 percentage points (0.45 + 0.97 percentage points) for each percentage point increase in contemporaneous return. The incremental effect of the presence of an LP is significant at the 1% level. Consistent with our hypothesis, we also find

[21] This convention also allows coefficients for buys and sells to be interpreted similarly.

that the log odds ratio of trading passively by LPs increases if spreads are wider than the contract maximum following the start of contracted services. In particular, the coefficient for *ΔWideDummy* indicates that, in the presence of an LP, the log odds ratio for trading passively in a 15 minute period (versus not trading) is higher when spreads are wider than the maximum contracted spreads. These results provide strong evidence of increased liquidity provision by LPs following the start of contracted services. We do not find a change in the relationship between the propensity to trade passively and short-term volatility.[22]

5. Conclusions and Further Research

The increasing prevalence of electronic markets exacerbates the problem of illiquidity for smaller firms. For instance, in a recent development the NYSE has announced its intention to allow greater electronic trading in its listed stocks. Existing NYSE specialists are granted certain exclusive privileges, which they use to subsidize trading in illiquid stocks from their profits from trading liquid stocks. In an electronic system, such privileges are unlikely to exist, thus the subsidy for illiquid stocks is likely to diminish. How then should the specialist be motivated to provide liquidity for the less active stocks? We study one solution to this problem adopted by the Stockholm Stock Exchange: allowing listed firms to directly contract with a liquidity provider to provide market making services for its stock. With the SSE model, listed firms can specify their desired market quality parameters and negotiate a fee with the liquidity provider in exchange for providing market making services. Given the link between stock prices (and consequently firms' cost of capital) and liquidity, the decision to contract with a liquidity provider is a capital budgeting decision. We analyze whether contracting for market making services improves a firm's liquidity, whether there are benefits beyond those contracted for, and whether such arrangements are value adding for the listed firm. Furthermore, we conduct a comprehensive analysis of the costs and

[22] We note that we are not able to discriminate between client and proprietary trades of LPs in our data. We understand that this mixing up of client and LP trades has the potential to confound our results. However, we argue that the liquidity supplying behavior we document in this section is at least partly attributable to LP proprietary trading. Our logit results are especially likely to be driven by LP proprietary trades given the increased liquidity

benefits of such arrangements.

We study 50 firms that enter into contracts with liquidity providers on the Stockholm Stock Exchange between September 2002 and March 2004. We find that spreads narrow by a statistically significant amount following the beginning of market making services. The reduction in spreads is especially pronounced on days of high volatility. We also find that depth increases after LP introduction. Accompanying the increase in depth, we find a significant increase in average trade size, suggesting that traders no longer find it necessary to break up their orders to accommodate low market depth. We find that daily as well as intra-day volatility declines following the beginning of market-making services. We also find limited evidence that the improvement in liquidity is associated with an increase in trading activity. The results show that the presence of an LP significantly improves the price discovery process for the concerned stocks.

Given the large body of literature that finds a relationship between liquidity and stock prices, we examine abnormal returns and CARs over a period spanning the initiation of market maker services. We find that the average CAR of 6.18% is associated with the event of contract initiation. Also, CARs are higher for firms with the largest improvements in quoted spreads.

We directly establish the role of liquidity providers in the provision of liquidity by examining their trading behaviour. We find that liquidity providers trade significantly more after contract initiation; and that a higher proportion of their trades tend to be liquidity supplying (instead of demanding). Furthermore, the probability of these liquidity providing passive trades tends to be higher when spreads are higher than the contracted maximum trades; and in a direction opposite to market movements after contract initiation. Finally, we find a significant relationship between the compensation for liquidity provision and contracted liquidity parameters, i.e. as expected, better contracted liquidity costs more. However, pre-existing relationships between the liquidity provider and the listed firm lead to lower costs of liquidity provision.

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supply against market movements after the LP contract, since such trades are likely to be unprofitable, and are the quintessential liquidity supplying trades.

In this paper we examine the results of a listed firm contracting with a single LP firm. Recent research examines whether adopting multiple designated market makers improves market quality and firm value beyond that obtained from just one (see Menkveld (2006.) As data become available, additional insight can be gained by examining the development of LP contracts over time. Do contract costs change as listed and LP firms are better able to ascertain the costs and benefits of each contract? Does a small subset of LP firms come to dominate LP service provision over time? We find that the larger firms on the SSE did not contract with LP firms during the period of our study. Are there additional benefits that can accrue to larger listed firms by contracting with an LP firm beyond those examined here? Finally, as the number of listed firms increases and data becomes available, researchers may be able to shed light on the optimal compensation terms of LP contracts.

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Table 1: Descriptive Statistics

This table contains the names of 50 Stockholm Stock Exchange listed firms that contract with liquidity providers to make markets in their firm's stock along with the date the contract becomes effective. Also reported are the average percentage spread in for the 20 trading days prior to the start date and the contractual maximum spread.

Company Name	Liquidity Provider	Start Date	Avg. % Spread	Contract Max % Spread
A-Com AB	Kaupthing Bank	22-Oct-03	7.51%	4.00%
Addtech AB	REMIUM	30-Jun-03	3.31%	2.00%
Ångpanneföreningen, AB	Öhman	31-Oct-03	1.89%	4.00%
Beijer AB, G & L	Öhman	11-Jun-03	2.51%	4.00%
Beijer Alma AB, ser B	REMIUM	17-Nov-03	3.72%	2.50%
Beijer Electronics AB	Öhman	13-May-03	1.37%	2.00%
Berg & Co, AB, C F	Svenska Handelsbanken	12-May-03	6.53%	4.00%
Borås Wäfveri AB, ser B	REMIUM	15-Dec-03	5.65%	3.00%
BTS Group AB	REMIUM	8-May-03	3.86%	4.00%
Capona AB	Carnegie	17-Jun-03	1.53%	2.00%
Cherryföretagen AB	REMIUM	1-Oct-03	7.47%	4.00%
Consilium AB	Öhman	24-Sep-03	5.56%	2.00%
Daydream Software AB	REMIUM	2-Jan-04	2.98%	2.50%
Diamyd Medical AB	REMIUM	22-May-03	11.42%	3.00%
Digital Vision AB	Kaupthing Bank	9-Mar-04	3.77%	4.00%
Frango AB	Svenska Handelsbanken	11-Jun-03	5.79%	4.00%
HQ Fonder AB	H & Q Fondkommission AB	21-Jul-03	3.50%	2.00%
ITAB Industri AB	REMIUM	22-May-03	7.41%	2.50%
Klövern AB	H & Q Fondkommission AB	2-May-03	3.11%	4.00%
Ledstiernan AB	H & Q Fondkommission AB	2-Dec-02	5.46%	4.00%
LjungbergGruppen AB ser. B	Carnegie	2-Jan-04	2.11%	3.00%
Modul 1 Data AB	REMIUM	17-Nov-03	1.81%	3.00%
MSC Konsult AB	REMIUM	9-May-03	16.05%	4.00%
MultiQ International AB	Öhman	1-Nov-03	4.36%	2.00%
Nefab AB	REMIUM	8-May-03	1.97%	2.50%
Novestra, AB	REMIUM	8-May-03	1.96%	2.50%
Onetwocom AB	Öhman	1-Nov-03	3.05%	4.00%
Opcon AB	Carnegie	8-Sep-03	7.75%	4.00%
OptiMail AB	REMIUM	8-May-03	2.98%	3.00%
Öresund, Investment AB	H & Q Fondkommission AB	28-Jul-03	0.96%	2.00%
PartnerTech AB	Carnegie	1-Nov-03	1.63%	4.00%
Poolia AB	Enskilda	19-May-03	10.62%	2.50%
Prevas AB, ser. B	Öhman	3-Mar-04	4.40%	4.00%

Table 1
(continued)

Company Name	Liquidity Provider	Start Date	Avg. % Spread	Contract Max % Spread
ProAct IT Group AB	REMIUM	25-Feb-03	3.90%	2.00%
Proffice AB	Carnegie	12-Jun-03	5.99%	4.00%
ProfilGruppen AB	REMIUM	15-Oct-03	3.19%	2.50%
RaySearch Laboratories AB	Öhman	8-Jan-04	2.51%	2.00%
Sapa AB	Svenska Handelsbanken	1-Jul-03	2.04%	2.00%
Sintercast AB	E. Penser Fondkommission	2-Jan-04	3.11%	4.00%
Strålfors AB, ser B	Danske Markets	26-Nov-03	1.98%	2.00%
SWECO AB, ser. B	H & Q Fondkommission AB	2-Feb-04	1.80%	3.00%
Teligent AB	Carnegie	17-Jun-03	6.02%	4.00%
Transcom WorldWide S.A.	REMIUM	15-Sep-03	1.91%	2.00%
Tricorona Mineral AB, ser B	REMIUM	15-Dec-03	6.97%	3.00%
TV4 AB	Carnegie	10-Nov-03	3.76%	2.50%
VBG AB	REMIUM	1-Oct-03	12.49%	3.00%
VLT AB	Svenska Handelsbanken	12-May-03	2.72%	2.80%
Vostok Nafta Investment Ltd	H & Q Fondkommission AB	13-May-03	1.66%	4.00%
Wedins Skor & Access. AB	Öhman	1-Sep-03	2.32%	4.00%
XponCard Group AB	REMIUM	1-Jun-03	7.29%	2.50%

Table 2: Market Quality Measures

This table contains changes in various market quality measures for the common stocks of a sample of 50 Stockholm Stock Exchange listed firms that contract with liquidity providers to make markets in their firm's stock. The pre (post) sample period is the 20 trading days before (after) the start date. The start date is not included in either sample. Spread and depth measures are the average of limit order book data observed every 15 minutes throughout the day. Quoted spreads are defined as the best ask minus the best bid observed at 15 minute intervals. Percentage quoted spread is measured relative to the midpoint of the best bid and ask. We also include two measures of the dispersion of quoted percentage spread: the percentage of time that quoted percentage spread is either wider, or narrower than the contractual maximum spread. We report the depth at the inside as well as for the four price levels away from the inside. For intra-day volatility, spread and depths only 15 minute intervals for which a two-sided spread exists are included. The daily number of trades, trading volume, and trade size are self-explanatory. The last row lists the percentage of quote observations in which there is both a bid and an ask price. Data are averaged by firm and then across firms. For each measure, we list the pre and post firm averages as well as the change. We also present the change for the matched sample for each measure.

Measure	Pre	Post	Change Pre to Post	
			Original sample	Matched sample
Quoted spread (%)	4.47%	2.06%	-2.41%***	-0.27%^{a}
Quoted spread (SEK)	1.67	0.78	-0.89***	-0.02^{a}
Depth at the best price (shares)	13,545	20,396	6,851	-576^{c}
Depth away from the inside (shares)	57,736	80,306	22,569	10,665
Percentage of quotes wider than contract maximum	49.3%	8.1%	-41.2%***	-2.1%^{a}
Percentage of quotes narrower than contract maximum	50.3%	91.3%	40.9%***	2.3%^{a}
Intra-day Return volatility (%)	0.0788	0.0576	-0.0213***	-0.0102^{*,c}
Daily Number of Trades	9.18	14.82	5.64***	-0.32^{a}
Daily Trading Volume (shares)	48,153	135,894	85,869**	57,396

***,**,* Denote significant at the 0.01, 0.05 and the 0.10 level respectively.
^{a,b,c} indicate that the difference between change in original sample and the change in matched sample is significant at the 0.01, 0.05 and 0.10 level respectively.

Table 3
Control Regressions for Execution Costs

This table reports the results of regressions of the form:

$$\overline{S_{i,t}} = \beta_0 + \beta_1 (1/\overline{Price_{i,t}}) + \beta_2 \overline{LogVolume_{i,t}} + \beta_3 \sigma_{i,t} + \beta_4 \ Dummy_{i,t}$$

where: $\overline{S_{i,t}}$ the mean quoted spread (currency or percentage) for firm *i* in period *t* (pre or post); $\overline{\text{Price}_{i,t}}$ the mean closing price for firm *i* during period *t*; $\overline{LogVolume_{i,t}}$ the mean daily log of share volume for firm *i* during period *t*; $\sigma_{i,t}$ is the standard deviation of intra-day return for firm *i* during period *t* (based on mid-quotes); $Dummy_{i,t}$ is a dummy variable assigned the value of 1 if the period is post, otherwise zero.

	Intercept	**Price**	**Volume**	**Volatility**	**Dummy**	**F–Statistic (R^2)**
Quoted Spread (SEK)	5.36 *7.34****	0.25 *0.55*	-0.40 *-4.64****	-2.36 *-0.65*	-0.68 *-2.21***	10.87 (0.29)
Quoted Spread %	0.06 *5.71****		-0.004 *-3.48***	0.30 *6.03****	-0.02 *3.78****	25.25 (0.42)

***, **, * Denote significant at the 0.01, 0.05 and the 0.10 level respectively.

Table 4

This table summarizes the results of the two-stage model to correct for selection bias. The analysis is run over the last 3 months of our sample period – January to March of 2004. Panel A presents the results of the probit model with a dummy variable, LP, as the dependent variable. LP equals 1 for stocks which trade with an LP, and 0 otherwise. Independent variables include the inverse of the average stock price during the analysis period, the log market capitalization, the standard deviation of daily returns, stock turnover, number of days the stock trades during the 3 month period and the market to book ratio. Panel B presents the results of the second stage OLS regression with the average percentage spread as the dependent variable. The explanatory variables include stock characteristics (price, size volatility and turnover), the inverse mills ratio from the first stage and an LP dummy variable.

Panel A: Probit analysis of the decision to contract with an LP

Intercept	1/Price	Ln(Size)	Volatility	Turnover	Days Traded	Market-to-Book ratio
0.8033	0.4519	-0.3476***	-23.6267*	-0.0015	0.0125*	-0.0113

Panel B: Stage 2 OLS regression

Intercept	1/Price	Ln(Size)	Volatility	Turnover	Inverse Mills Ratio	LP dummy
0.1761***	0.0123	-0.0171***	-0.2434*	-0.0001***	0.0912***	-0.1670***

***,* denote significance at the 1% level and the 10% level respectively.

Table 5
Price Discovery

This table contains changes in the average weighted price contribution (WPC) for the common stocks of a sample of 50 Stockholm Stock Exchange listed firms that contract with liquidity providers to make markets in their firm's stock. The pre (post) sample period is the 20 trading days before (after) the start date. The start date is not included in either sample. Two time periods are examined: the open to close return (based on quote midpoints) on day t; and the return from the close on day t to the open following day.

$$WPC_i = \sum_{s=1}^{S} \left(\frac{|ret_s|}{\sum_{s=1}^{S} |ret_s|} \right) * \left(\frac{ret_{i,s}}{ret_s} \right)$$

where S is the total number of stocks observed in period i, $ret_{i,s}$ is the return on stock s during period i (open to close of continuous trading, or close to next day open), and ret_s is the open to next day open return. The returns are calculated using quote midpoints. Zero returns are excluded from the analysis. The WPC measure is calculated for each period each day and then averaged across days to obtain statistical inference. Listed are each period's WPC before and after LPs began providing services, as well as the change between the periods. Panel A lists results for our sample of firms contracting with an LP, Panel B. lists the results for our matched sample, and Panel C compares the changes in the LP sample with those in the matched sample.

Time Period	**Pre**	**Post**	**Difference**
A. Firms contracting with an LP			
Open to Close	0.644***	0.730***	0.086*
Close To Next Day Open	0.356***	0.269***	-0.086*
B. Matching Firms			
Open to Close	0.676***	0.634***	-0.041
Close To Next Day Open	0.324***	0.365***	0.041
C. Original-Matching Firm Differences			
Open to Close	-0.032	0.094**	0.126**
Close To Next Day Open	0.032	-0.094**	-0.126**

***,**,* Denote significant at the 0.01, 0.05 and the 0.10 level respectively.

Table 6: Abnormal Returns

This table reports abnormal returns for a sample of 50 Stockholm Stock Exchange listed firms that contract with liquidity providers to make markets in their firm's stock. Abnormal returns are defined as those in excess of returns predicted by the market model each period. Market model parameters are estimated using daily return and index values over trading days t-106 to t-6 where t is the date the liquidity provider begins providing services. Abnormal returns are then calculated each day for each firm for the period t-5 to t+10. Scholes-Williams betas are estimated to correct for infrequent trading and the daily return on the OMX benchmark index is used as the market return. Listed below are each period's abnormal return and cumulative abnormal return (CAR). We present the results for our original sample, matched sample (that did not begin LP services), and the difference between our original and matched samples. Tests of significance for the original minus matched samples are based on matched pairs. Levels of significance are indicated for a one-sided *t* test.

	Original Sample		Matched Sample		Original Minus Matched	
Day	Abnormal Return	Cumulative Abnormal Return	Abnormal Return	Cumulative Abnormal Return	Abnormal Return	Cumulative Abnormal Return
-5	0.23	0.23	-0.23	-0.23	0.46	0.46
-4	0.16	0.39	-0.14	-0.37	0.30	0.76
-3	-0.29	0.11	-0.02	-0.39	-0.26	0.49
-2	0.47	0.58	0.18	-0.20	0.29	0.78
-1	-0.50	0.08	0.62	0.41	-1.12	-0.34
0	1.01	1.08	-0.03	0.38	1.04	0.71
1	0.77	1.86*	0.60	0.98	0.18	0.88
2	-0.26	1.60*	0.01	0.99	-0.27	0.61
3	0.20	1.80*	-0.13	0.85	0.33	0.94
4	0.28	2.08**	-0.68	0.18	0.96	1.90*
5	1.11	3.19***	0.53	0.70	0.58	2.49**
6	-0.14	3.05**	-0.87	-0.17	0.74	3.22**
7	1.01*	4.06***	0.24	0.07	0.77	3.99***
8	0.69	4.75***	-0.02	0.05	0.71	4.70***
9	1.23	5.98***	0.58	0.63	0.66	5.36***
10	0.19	6.18***	-0.05	0.58	0.24	5.60***

***, **,* Denote significant at the 0.01, 0.05 and the 0.10 level respectively.

Table 7: Comparison of Contract Terms

In this table we compare contract terms and stockholder execution cost savings for a sample of 50 Stockholm Stock Exchange listed firms that contract with liquidity providers to make markets in their firm's stock. Contract cost terms are available for 23 of our sample firms, representing three different liquidity providers. Panel A lists the frequency counts for the contractual maximum spread width (listed individually in Table 1) and minimum depth. Three firms do not specify minimum depth amounts in their contracts. Panel B reports the mean, median, minimum, and maximum for the monthly costs specified in the contracts. All have a fixed monthly cost component. Nineteen firms also have a variable cost component which specifies that listed firms will pay the LP firm a fee per trade that the LP is involved in as principal. All 19 place a cap on the maximum variable cost of the contract. Total costs sum the fixed and the maximum variable components. Panel C compares the total maximum cost of the contracts to the monthly benefits defined as execution cost savings. The first row of Panel C lists the daily average execution cost savings after the firm adopted a LP in Swedish kronor. Also listed is the difference between monthly benefits (based on a 20 day month) and the total monthly maximum contract cost, expressed in both Swedish kronor and US dollars. The final row contains the relative benefit level to the monthly cost.

A. Contract Terms					
Term	**N**	**Values** ***Frequency***			
Maximum Spread width	23	2% *4*	2.5% *7*	3% *6*	4% *6*
Minimum Depth Range (in shares)	20	800 – 1,000 *3*	1,600 -2,000 *8*	4,000 – 10,000 *5*	>10,000 *4*
B. Contract Costs					
Cost	**N**	**Mean**	**Median**	**Minimum**	**Maximum**
Fixed Monthly Cost	23	16,000	12,000	10,000	50,000
Maximum Variable cost	19	8,895	10,000	5,000	15,000
Total Maximum Monthly Cost	23	23,348	20,000	15,000	50,000
C. Cost/Benefit Analysis					
	N	**Mean**	**Median**	**Minimum**	**Maximum**
Daily Trade Cost Savings (SEK)	23	11,398.63	3,932.34	88.23	106,124.59
Monthly Benefit-Cost (SEK)	23	204,624.85	53,646.86	-19,141.90	2,106,491.75
Monthly Benefit-Cost (US$)	23	29,232.12	7,663.84	-27,34.56	300,927.39
Monthly Benefit/Cost	23	11.6	4.2	0.1	132.7

Table 8: Relationship between Contract Terms and Firm Characteristics

This table reports the results of regressions of contract costs against various firm characteristics for 23 firms that contracted with a liquidity provider and for which contract terms are available. In particular we perform the following regression:

$$C_i = \beta_0 + \beta_1 \sigma_i + \beta_2 1/Price_i + \beta_3 MaxSpread + \beta_4 \%Wider + \beta_5 Depth_i + \beta_6 Already_i + \beta_7 MTB + \varepsilon$$

where C_i is the natural log of the monthly total contract cost for firm *i*; σ_i is firm *i*'s intraday standard deviation of quote midpoints in the pre-LP period; $Price_i$ is the average closing quote midpoint for firm *i* in the pre-LP period, $MaxSpread_i$ is the maximum percentage spread width listed in the contract; $\%Wider_i$ is the percentage of observations in the pre-period where percentage spread is wider than the contracted maximum spread width, $Depth_i$ is the contract specified minimum depth. $Already_i$ is a dummy variable assigned the value 1 if the LP firm traded the stock in the pre-period, otherwise zero, and *M/B* is the market-to-book ratio of the firm as of 12/31/2002. Significance tests are based on heteroskedasticity corrected (White (1980) standard errors.

	Total Costs
Intercept	9.75***
Volatility	0.12
1/Price	-0.09
Contract Maximum Spread Width	-12.42
Percentage Wider Spreads	0.29*
log (Contract Minimum Depth)	0.43***
Already Trade Firm	-0.36**
Market-to-Book ratio	-0.03
F–Statistic **(Adj. R^2)**	3.92 (0.52)

***, **, * Denote significant at the 0.01, 0.05 and the 0.10 level respectively.

Table 9: Liquidity Provider Contribution

This table examines all trades involving the liquidity provider for the common stocks of a sample of 50 Stockholm Stock Exchange listed firms that contract with liquidity providers to make markets in their firm's stock. The measures considered are the daily number of trades, daily trading volume (in shares and Swedish kronor (SEK)), and trade size. Only those trades involving the LP firm are included. The Pre column lists the average for the 20 trading days prior to the introduction of an LP, while the post column lists the average for the 20 trading days after the introduction. Also listed are the changes from the pre to the post period. The dates LP firms began providing services are not included in either period. Panel A reports only post results for the 14 firms that had no liquidity provider activity before contracting, while Panel B includes the 36 firms that had trading activity before contracting with a liquidity provider. In Panel A, tests of significance are of the LP contribution in the post-period being different from zero. In Panel B, tests of significance are of the difference between pre- and post-values using a paired *t*-test.

Measure	**LP Provided Pre**	**LP Provided Post**	**Change**
A. Firms with *no* prior activity by the liquidity provider (14 firms)			
Daily Number of Trades	-	4.19	4.19***
Daily Trading Volume (shares)	-	7,939	7,939**
Daily Trading Volume (SEK)	-	81,320	81,320***
Trade Size (shares)	-	1,621	1,621***
B. Firms with prior activity by the liquidity provider (36 firms)			
Daily Number of Trades	1.50	3.59	2.08***
Daily Trading Volume (shares)	10,512	28,216	17,704**
Daily Trading Volume (SEK)	91,549	251,048	159,499**
Trade Size (shares)	3,593	6,153	2,561**

***, **,* Denote significant at the 0.01, 0.05 and the 0.10 level respectively.

Table 10: Probability That LPs Will Trade Passively

This table reports the results of the following Logit regression to estimate the probability that an LP will trade based on current and immediate past market conditions:

$$Trade_{it} = \gamma_0 + \gamma_1 Abs\,\mathrm{Re}\,t_{it-1} + \gamma_2 WideDummy_{it} + \gamma_3 CurrentReturn_{it} + \Delta\gamma_1 D_{it} Abs\,\mathrm{Re}\,t_{it-1} + \Delta\gamma_2 D_{it} WideDummy_{it} + \Delta\gamma_3 D_{it} CurrentReturn_{it} + \varepsilon_{it}$$

where $Trade_{it}$ is the type of passive LP trade examined for that model (buy or sell) for firm *i* in time period *t*. If the regression examines buy (sell) trades then Trade is assigned the value 1, otherwise 0. $|AbsRet_{it-1}|$ is the absolute value of the return for firm *i* in time period *t-1; $CurrentReturn_{it}$* is the return for firm *i* in time period *t; $WideDummy_{it}$* is a dummy variable indicating whether the inside percentage spread at the beginning of time period *t* is wider than the maximum contracted spread width (1 if wider, otherwise 0), and D_{it} is a dummy variable assigned the value 1 if the observation is from the post period, otherwise it is assigned a 0. Δ indicates the change in the parameter period in the post contract period. Buy and sell trades are examined separately. Panel A lists the number of LP trades and control group trades for each category. Panel B contains results for trades with passive LP involvement (i.e., the LP was a liquidity supplier.) Liquidity supplying passive LP trades will be in the opposite direction of the market so for passive buy trade regressions contemporaneous and past returns are multiplied by -1.0. For each maximum likelihood regression we list the parameter estimate and indicate whether the estimate is statistically significant based on a Wald Chi-Square test. The last column of Panels B lists the pseudo-R^2 for each model.

A. Number of Observations

	LP Sample	Control Sample
Number of Observations	2,705	5,410

B. Parameter Estimates

Trade Type	Intercept	Absolute Value of Past Return	Contemporaneous Return	Wide Dummy	Δ Absolute Value of Past Return	Δ Contemporaneous Return	Δ Wide Dummy	Pseudo R^2
Buy	-1.59^{***}	0.37^{***}	0.45^{***}	-1.04^{***}	-0.06	0.97^{***}	0.41^{*}	0.33
Sell	-1.74^{***}	0.31^{***}	0.77^{***}	-1.14^{***}	0.03	0.42^{***}	0.69^{***}	0.34

***,**,* Denote significant at the 0.01, 0.05 and the 0.10 level respectively.

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