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Liquidity Providing

Study on liquidity providing in the Nordic stock markets

by

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Abstract

Risk and return go hand in hand, and one way for a firm to mitigate existing and potential investors' risk in a stock is to employ a financial service; liquidity providing. The value of liquidity provision has become relevant as market uncertainties and shocks in the market create disturbances. In addition, the market environment has changed with regulation and the increase of high-frequency traders. Investors evaluate risk in firms, and one apparent risk is liquidity risk caused by the stock itself. With risk comes higher return demands and thus the threshold for an investor to invest in a stock becomes higher.

This study examines liquidity providers' effect on stock performance, independent from the announcement date, in Nasdaq Nordic markets. I.e., we examine the period when liquidity provision is ongoing. Our theoretical foundation lies in the propensity score matching in which we estimate the effect of liquidity provision by examining a sample derived from Nasdaq Nordic firms. We compare samples of companies with liquidity providers and without. In the study, we find statistical significance for variables spread, volatility, turnover, and market cap. In our sample including all firms, we find an average decrease in spread by 11.6% and an increase in turnover by 13.3%. The study finds positive liquidity effects which stimulate a better price discovery in terms of volatility decreasing by 29% and market cap increasing by 21%. The results of this thesis show that there is a positive liquidity provision effect in the Nordic market during the period after the announcement.

Keywords: Liquidity Providing, Nordic Stock Exchange, Financial Service, Market Maker

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1. Introduction

Since 2014, the market has observed historically low interest rates, resulting in lower returns on interest-bearing securities (SEB, 2020). To ensure high enough expected returns, investors favor allocating capital toward the stock market. According to Sharpe (1964), the scarcity of diversification induces more systematic risk to the investor. In response, the investor can try to mitigate this risk by reducing the idiosyncratic risk in the portfolio by choosing less risky stocks. In addition to the low interest rates, the market has suffered severe shocks in the last two years, COVID-19 and the war in Ukraine, leading the market into uncertainty.

Investors will react to this uncertainty by assigning a higher risk premium to illiquid stocks, meaning that they require higher expected returns. Demsetz (1968), points out that the lack of possibility to predict if your trade falls through is an underlying problem in the financial markets. Amihud and Mendelson (1986b) suggest that it is extremely beneficial for a firm to invest in minimizing the bid-ask spread resulting in higher company value and decreased cost of capital. To help mitigate low liquidity and to attract both current and new investors, companies can introduce different actions. Actions such as investor awareness (e.g., investor communication and analyst coverage), share price level (e.g., stock split and reverse stock split), or shareholder value (e.g., dividend strategy, share buy-backs, and spin-offs). Another form of action a company can take is entering a liquidity providing (LP) program. In an LP program, a company enters a contract with a third party who guarantees to maintain a minimum liquidity supply (measured in the bid-ask spread and minimum share quote). The third party agrees to act as an affirmative market maker via committing to have a bid- and ask quotes in the market and maintaining a minimum spread via both buying and selling shares. The standard contract on Nasdaq Nordic main markets is three months, but in practice generally covers six months (Nasdaq, 2019).[1]

The idea is that, by guaranteeing minimum liquidity mitigating the liquidity risk for investors and gaining attraction for the stock. Also, information asymmetries cause investors to be more cautious since the pricing of the stock might fluctuate drastically. Furthermore, price discovery (i.e., process between seller and buyer to agree upon a price) is more efficient when investors trade actively and the cost of trade is less since LPs indirectly reduce this (Menkweld

[1]Features of LP contracts were discussed with Lago Kapital an industry practitioner. Generally, LP agents try to avoid a to short contract period because it can be too costly or too short to yield any effect. For example, only contracting an LP during an IPO can be very costly due to abnormal volatility. Hence, contracts tend to cover a minimum length of six months.

& Wang, 2013). Because of the current uncertainty in the market, investors are hesitant to invest in illiquid stocks since they value the opportunity to adapt quickly greater in uncertain times. Therefore, the question of a liquidity provider's ability to increase liquidity and stock performance is of particular interest. The absence of rigorous previous studies on the liquidity providers (LPs) influence on the Nordic markets prompts further studies. Consequently, the research question this paper aims to answer is; *How does liquidity providing influence stock performance in the Nordic equity markets?*

The market has increased in algorithmic trading with high-frequency traders (HFT) which transact within milliseconds large amounts of buy and sell orders. HFTs are considered to provide liquidity to the market in general, but some negative aspects exist as well. One may argue that HFTs create large gaps and spreads by entering trades quickly but also abandoning them fast which creates the gaps and pushes the stock into distress (Brogaard, Henderson & Riordan, 2013). There have been events in the market where HFTs have caused or amplified fast market dips such as the Flash Crash of 2010. Overall, the existence of HFTs can be considered as ‘‘Free’’ LP in a different form since they are not employed by a firm rather, they engage in stocks where they can spot book order imbalances and trade for profit. However, HFTs interest is mainly in large- and mid cap stocks which have high or moderate liquidity (Brogaard, 2010). This leads to the limited interest in small cap stocks which are illiquid since the risk and return requirement is higher for HFTs and thus might not be worth trading even if an opportunity exists by their standards. While LPs main purpose is not to trade for profit but rather to support the underlying stock within the contracted boundaries. An LP is interested in gaining profit from the agreement with the firm and gaining more investor attraction to the firm with less volatility, smaller spreads, and greater turnover value. [2] This causes obvious reasons that the market has evolved from the time of previous research with LPs. Interestingly, previous studies find support in both empirics and theory that LP foremost attracts small cap firms, and that the issued contracts last a period of approximately two-four months (e.g., Menkveld & Wang, 2009; Venkataraman & Waisburd, 2007). In contrast, our data does not seem to support this. Each month, of the examined period, around 100 firms had a contract with an LP, of which 69 firms had an LP for all 25 months. There is an equal use of LP amongst small- and mid cap, both in our sample and the population. What is interesting with these two observations, longer

[2] Discussion with Lago Kapital May 13th 2022. Discussed that the main revenue stream from the service is the contract terms. The objective of the service was also discussed. An LP seek to make the firms stock more attractive to investors by acting as a liquidity guarantee for investors.

use of LP and an equal amount of mid- and small cap firms, is that it indicates a shift in the equity market. This shift depicts a need for further clarification and studies on the market with LPs.

The paper aims to study this relationship by examining 228 publicly traded companies on the Nordic main market between December 2019 and December 2021, of which 66 companies have used an LP service. To investigate the effect of an LP, our foundation lies in propensity score matching (PSM) to match companies who would choose to use the service. By including all segments, up-to-date data, and focusing on the Nordic market this study aims to contribute to previous research with new information on specifically the Nordic markets. The study is also motivated since it is a topic that the Finnish company Lago Kapital suggested and sought to have more information on.

Our results manifest that in the current market space there is a benefit to utilizing an LP. The PSM shows, mostly, a decline in spread, volatility, and an increase in turnover and market cap. We find that the significance level varies across chosen variables but descriptive statistics between groups with and without LP show a benefit of LP usage during the LP contracted period. These findings are independent of the announcement date, depicting that during the employment of an LP there is still an increasingly positive effect. These results can be of use for firms operating in the stock market and investors for creating a better understanding of the long-term effects of LPs.

This thesis is structured in the following way: In section 2, we will present and study previous research on related topics disclosing their positives and negatives and highlighting their main findings. Section 3 develops our hypothesis and discusses relevant ideas surrounding how to answer the given hypothesis. Section 4, will present our methodology, discuss the chosen dataset, and disclose the properties of our model. Section 5 will disclose our results and summary statistics. Section 6 discusses and analyzes the results and how they relate to our hypotheses. Lastly, section 7 concludes the thesis.

1.1. Institutional background

In this section, we will display some general rules and requirements of LPs in Nasdaq Nordic. The whole section is summarized from the Nasdaq website providing information on how markets work (Nasdaq Liquidity Enhancement, 2022a; Nasdaq Nordic Auctions, 2022b Nasdaq Nordic Market Model, 2020). Nasdaq owns and operates 90 exchanges in 50 different countries in which they provide some general, but also country-specific requirements. Nasdaq issues an electronic limit order book in Finland, Stockholm, Copenhagen, and Iceland. Within this system, all of the orders have to be priced and for a transaction to occur the bid and ask must match, but the number of shares does not need to. During the timeframe of this paper December 2019 to December 2021 the stock market is open:

CPH: 09:00-17:00 CET
STH: 09:00:17:30 CET
HEL: 09:00-17:30 CET
ICE: 11:30-17:30 CET

Nasdaq offers auctions at the opening, during the day, and at the closing. The opening auction starts before the actual trading hours and lasts 15 minutes. The intra-day lasts for 5 minutes as well as the closing auctions. Within these hours, LPs do not offer liquidity but rather only during the continuous trading day after the uncrossing has occurred. Uncrossing is the distribution of shares to auction investors which happens randomly. Thereafter, the price equilibrium sets for the continuous trading. According to Nasdaq, usually 20% of the trades happen during auctions for illiquid stocks. This stems from the difficulty of large trades happening during the continuous trading day. Furthermore, if the liquidity of a stock is poor Nasdaq can intervene and suggest or require the firm to improve its liquidity by, for instance, employing an LP. LPs need to quote at least 85% of the time during the continuous trading, during this time the LP might choose to trade during the auction if the LP sees it necessary. Also, LPs are bound to specific maximum bid-ask spreads which are generally 4% on all Nasdaq exchanges. However, if firms have last paid less than 0.1 EUR then the maximum spread can be 8%, and if the last paid is below 0.05 EUR then the maximum spread can be 15%. The agreement requires LPs to initiate both buy and sell orders to guarantee the maximum spread. Despite the regulations from Nasdaq the firm and LP can agree upon a lower spread than required. If a market halt occurs, LPs are not allowed to trade outside the exchange during the suspension. The length of an LP agreement varies but Nasdaq dictates a minimum timeframe of 3 months. Nonetheless, market practitioners generally tend to agree on a 6-month minimum period[3]. Despite the regulations, the sample we have gathered contains 25-months of firms continuously using LP which

[3] Lago Kapital May 13th 2022 disclosed that there is a trend in the industry of moving towards longer agreements.

indicates that once a firm engages in a contract, they do so for a longer period than Nasdaq regulations require. During the period of LP, all transactions from the LP must be flagged or noted with a specific code. This procedure will allow investors and Nasdaq to evaluate the effect of the LP on a particular stock. Additionally, LPs need to follow MiFID-II regulation.

2. Literature review

Stocks in the publicly traded market attract investors with various methods and incentives. The idea of enhancing a firm's attraction by LP is as common as providing investors with analyst coverage since liquidity decreases the threshold for investors to engage in a firm. There is substantial evidence provided by multiple authors that LPs do improve the liquidity of a stock (Clapham, Gomber, Lausen & Panz, 2020). Furthermore, not surprisingly, the number of shares traded during a day is considered to affect positively on firm's stock price performance (Dey, 2005). However, there is hardly any research concluded about the Nordic equity market which experiences somewhat less investor activity, and lower turnover and might not enjoy the same results as in other equity markets.

Previous literature focuses mostly on small windows or events which are assumed to enjoy positive results. Clark-Joseph, Ye and Zi (2017) studied a glitch experienced in July 2015 in NYSE which dropped out all LPs for approximately four hours and found increased levels of bid-ask spreads which contribute to previous findings that LPs improve the cost of trade and liquidity. This narrow timeframe does not convey whether LP indicates superior results in the long term. Nonetheless, Venkataraman and Waisburd (2007) find that an LP leads to an increase in firm stock price and specifically at the moment of an LP introduction. To substantiate further, they find that during 6 months in 1998, LPs led to an increase in liquidity on the Paris bourse market which translated into a more efficient price discovery and recorded a 5% CAR.

In addition, Anand Tanggard, and Weaver (2009) studied 50 firms in the Stockholm stock exchange (SSE) and found a positive average CAR of 7.08% within 10 days after an LP introduction. This resulted in an average increase in firm value of $ 1.8 million. The study also conveyed that firms with wider spreads and higher information asymmetry are more likely to engage in a contract with an LP. However, Ananad, Tanggard and Weaver (2009) discuss why more firms are not engaging in LP since it has such great benefits, and reasons with the argument that firms experiencing extreme spreads are not able to attract the LP. They further argue that it is due to the risk that the LP might lose money during trading, and thus require a much higher price which the firms cannot match.

While LPs enhance liquidity and reduce bid-ask spreads, the firms reasoning to engage in LP might not only be to serve their current and future shareholders. Skjeltorp and Ødegaard (2014) argue that one of the reasons a firm decides to hire an LP is because it can aid the firm to access capital markets, engaging in share buybacks or IPOs. While this is true, the firm's liquidity becomes an important factor in terms of share buybacks and IPO underpricing.

Additionally, the acquisition of an LP helps the manager's decision-making in the aforementioned states. Anand, Tanggard and Weaver (2009) shed light on the fact that firms with low spreads have a low probability of employing an LP while firms with larger spreads are more likely to engage in an LP contract. Nonetheless, there can be other reasons to hire an LP such as a manager's compensation package, which is not discussed in previous literature. This ought to be an ambiguous reason to hire an LP and against common company policies.

These findings are relevant but due to the changed market circumstances and behavior such as HFTs and algorithms the research scope seems to have evolved, with information spreading faster around the world. HFTs, are nowadays quite common in every market and considered somewhat LPs, but in a different manner (Mollner, 2021). In contrast to LPs, HFTs do not have an affirmative market obligation. They use highly sophisticated automated algorithms to interact fast and make transactions based on pre-determined settings. HFTs have been criticized since they usually appear fast and disappear even faster (Breckenfelder, 2013). Korajczyk and Murphy (2018) argue that HFTs decrease the cost of trade but compete with institutional investors for trades which results in lower spreads and benefits the most market participants. What triggers institutional investors to engage in trades is usually due to limit-order book imbalances (Korajczyk & Murphy, 2018). However, Baldauf and Mollner (2021) argue that modernized fast trades occasionally lead to illiquidity and push spreads even higher. The most notable event happened in the US equity market in 2010 during the Flash Crash when the Dow Jones Industrial Average (DJIA), S&P 500, and Nasdaq Composite Index dived for a short moment. The DJIA dropped around 600 basis points at the time but recovered shortly after (Corporate Finance Institute, 2020). This was partly caused by imbalances in the order book, which in this case triggered HFTs to sell a lot and fast. However, Kirilenko, Kyle, Samadi and Tuzum (2011) studied the connection between HFTs and the flash crash and discovered that they did not cause the crash. Instead, they found that HFTs increase volatility and raise the general stress levels of the market. However, the event raised concerns about how to treat HFTs and research suggests that the benefits of HFTs outweigh the cons (Foucalt & Moinas, 2018). In addition, it is worth noting that HFTs are increasingly engaging in the cryptocurrency market but our research does not reach this scope.

LPs and HFTs are considerably two of the largest contributors to market liquidity but in terms of small cap stocks, the interest of HFTs is slightly lower since the stock reactions and risks are greater for the HFT (Brogaard, 2010). Brogaard, Henderson and Riordan (2013) found that HFTs are engaging more in large cap stocks and less in small cap stocks. Furthermore, they found that HFTs have an imminent role in the price discovery of large cap stocks, specifically during volatile days the impact increases. Contrary, small cap stocks do more frequently employ LPs. Menkveld and Wang (2013) show that without LPs providing liquidity the required return for investors is higher. This traces back to the basic assumption that investors need to offset systematic risk with higher returns. Therefore, when market liquidity in a security is poor and bid-ask spreads high, Menkveld and Wang (2013) show higher LP participation to mitigate liquidity risk and control the boundaries of quotes to ensure a liquidity level satisfactory to the other market participants. The maximum spread and minimum book order depth are pre-determined in an agreement with the company at hand[4]. Furthermore, Nasdaq has regulative limits for LPs which they need to obey (Nasdaq, 2022). However, even with these limits' LPs might lose money on the trades when the market experiences extreme volatility Menkveld and Wang (2013).

Even though the research field might not be novel, the field is experiencing rapid changes as a consequence of the use of HFTs and interstate dependency, which causes liquidity shocks to spread between markets. Transformation is also occurring within the regulatory framework. When MiFID-II came into effect in 2018 it completely changed the game rules for equity markets. Arguably, one of the most impacting changes was the "unbundling". Before MiFID-II brokers could simply sell different services as a bundle, meaning that one could bundle, for example, analyses, brokerage, and advisory and price it as one unit. The "unbundling" required all different services to be priced individually. The changes that came with MiFID-II forced prices down since one could choose which service one wants instead of paying for a bundle, and profits went down. As the profits went down, firms had to niche, and specialist LP providers emerged.[5] There is a gap in previous literature covering the effect of LP ex-ante these transformations. These transformations of the LP market mandate further studies which are in coherency with today's market.

Furthermore, previous literature does not seem to cover the effect of LP on the Nordic markets, rather they focus on the central-European and US equity markets. To the best of our knowledge, this is the first study on the effect of LP in Helsinki, Copenhagen, and Iceland.

In addition to the imposed restrictions from MiFID-II, Nasdaq has continuously made efforts to harmonize the different Nordic exchanges, including harmonizing the LP market.[6] Anand, Tanggaard and Weaver (2009) examine the value of LPs by analyzing a data set from

[4] Discussed with Lago Kapital on how the industry establishes agreements with prospects on May 13th 2022.
[5] Discussion with industry practitioners, 13th May 2022. Establishing MiFID-II effects on the equity market and its influence on LP.
[6] Discussion with Lago Kapital, May 13th 2022. The disclosure affected plans of Nasdaq to synchronize Nordic markets e.g., same set of rules for all Nordic markets.

SSE between 2002-2004. In relation to their study, this paper aims to contribute with a contemporary study, taking into account the aforementioned changes, specifically in the Nordic markets. The keyword is Nordic markets, pointing out the fact that this paper also aims to test the assumption of harmonized Nordic markets and contribute to the missing literature.

Prevailing studies have engaged in short periods (data for LP covering between two and four months) or extreme events (for instance the Flash Crash). Clapham et al (2021) argues that previous research has prior noted problem, due to merely concentrating on one exchange, and falls prey to pitfalls due to specific market rebates. In our belief, this leaves the result open to potential pitfalls and biases. Abrupt shocks in the general market, specific industries, or even individual companies could result in erroneous interpretations and even abnormal results. To mitigate these potential market moods, temporary trends, or shocks this paper will instead engage in a longer time horizon, 25 months, using equally weighted averages.

3. Hypothesis development

The main purpose of LP, as a financial service, is to improve individual stock liquidity. With this service exists some other benefits that are not intended nor controlled for. LPs provide the service for a fixed amount of time depending on the contract, but the market reacts in different ways once the LP is announced, during, and after the LP service. Our study focuses on the effects during the LP service and is independent of the announcement date i.e., this research does not reach the before and after performance of the firm’s stock. Furthermore, LPs seek to attract firms by disclosing the positive effects of the service. One of the main technical objectives for an LP is to reduce the quoted bid-ask spread and decrease the transaction costs for outside investors. This, however, comes with a cost for the firm itself but most of the time is outweighed by the benefit for potential investors and stock owners since the liquidity enables investors to trade the stock. The firm's cost of capital may decrease if the bid-ask spread, and general volatility, are lower (Menkveld & Wang, 2009). In addition, research suggests the performance and value of the firm increase when the firm does not suffer from illiquidity (Brennan, Huh & Subrahmanyam, 2011).

First, before we lay out the hypotheses, it is necessary to disclose a distinction between this study and previous studies. The expected return of a stock (equation (1)) and the Gordon Growth model (equation (2)) are defined as follows:

$$E(r) = r_f + \beta ERP + \gamma ILRP \tag{1}$$

$$P = \frac{D}{E(r) - g} \tag{2}$$

Equation (1) where r_f is the risk-free rate, β is the market Beta, ERP is the equity risk premium, γ is the factor loading, ILRP is the illiquidity risk premium. Equation (2), where P is the stock price $E(r)$ is the expected return, and g is the growth to perpetuity. Given prior discussion and previous findings that an LP would increase liquidity (consequently decrease the factor loading), we find from equation (1) that hiring an LP will decrease expected return$E(r)$. Following the Gordon Growth model, we find that a lower expected return, ceteris paribus, yields a higher price. The assumption we state is that the stock price increases after the announcement of hiring an LP, and that the expected return is higher before a firm enters an LP contract. Consequently, the stock price has already enjoyed a positive CAR i.e., the announcement effect. Given these distinctions and the relationship between price and expected return, we can build our hypothesis for the studied period. Amihud and Mendelson (1986b) find evidence for the above derivation and emphasize a positive return-illiquidity relationship.

The stated research question is to examine how LP influences stock performance in the Nordic markets. To answer the question, we have established two subfields of hypotheses: stock performance and firm size. Firstly, the paper is aiming to explain how LP effect stock performance in terms of liquidity level and price discovery. Secondly, the paper is aiming to analyze how the effect of LP differs between segments.

Intuitively, the main principle of LP is to increase stock liquidity. The study applies two measures of liquidity (proxies), namely spread and turnover. The choice of these variables will be discussed in the methodology chapter. When we summarize our discussion on previous literature and stated research on the topic, we find that the prevailing assumption is that liquidity levels increase with the employment of an LP. Hence, the first hypothesis is that contracting an LP will increase turnover and decrease spread independently from the announcement effect. While this hypothesis may be intuitive, Dey (2005) exhibits that stock turnover improves with expected stock price return. They used a sample size of 36 stocks using an LP and a control group of 197 stocks which confirmed the assumption of decreasing volatility in the sample group versus the control group.

We also hypothesize that the price discovery of a firm engaging in LP will improve. By guaranteeing a minimum spread, consequently, mitigating the liquidity risk, LP seeks to increase trading activity as the transaction cost is lower. Venkataraman and Waisburd (2007) find evidence of a more efficient price discovery which in turn realizes a higher price. If investors are able to sell easier (buy) without an induced discount (premium), we assume a higher price realization follows. The logic was derived from equations (1) and (2). From a technical perspective, a higher price, consequently market cap, will occur and volatility will decrease during the period. Venkataraman and Waisburd (2007), manifest that immediately after a firm introduces an LP to the market volatility decreases. Menkveld and Wang (2009) show that hiring an LP will increase the price of a stock and cause a positive CAR in their measured three-week timeframe. However, as derived in equations (1) and (2), the expected return is lower in the period after the introduction of an LP. Because the spread affects the effectiveness of price discovery, volatility has a relationship with the spread. We expect that a lower spread leads to less volatility in price realization, i.e., a stock can be sold at the current price more easily with a more efficient price discovery (Menkveld & Wang 2009). We formalize the hypothesis that an LP results in better price discovery, indirectly measured by higher price and lower volatility.

The second subfield, how the effect of LP differs with firm size, stems from our observation of discrepancies between previous studies' results, that LP is overrepresented by small cap firms, and our data indicate that there is an equal preference for mid- and small cap firms. Furthermore, the fact that MiFID-II, following our previous discussion, induced higher prices and the emergence of “micro” small cap firms prompts a clarification on the effect for different segments. To examine the effect on different segments, we will investigate the effects for small cap and mid cap individually, as well as for small cap and mid cap jointly. Our additional hypothesis is that small cap firms will have greater effects than mid cap firms or the entire group of segments. We are not interested in investigating the effect on large cap firms since the number of companies using LP is insignificant and therefore, not of interest for this study.

4. Methodology

4.1. Methodology outline

The methodological approach in previous research varies to some extent, but most studies apply some version of regression on time series data (Anand, Tanggaard & Weaver, 2009; Bessembinder, Hao & Lemmon, 2011; Menkveld & Wang, 2009). As stated, this study is delimited to examine the effect of LP, after the introduction of an LP already happened, on a cross-sectional data set. Similar to Venkataraman et al. (2007), we control for systemic changes in the market by benchmarking against a control group based on market size, stock exchange, and the use of LP (meaning they don't employ an LP).

To the best of our knowledge, only one previous academic study has been conducted on the effect of LP on a Nordic market (SSE). To control for changes in the Nordic markets, discussed in previous literature, we apply contemporary data and differentiate between segments. Also, the choice of event window and the choice of a Propensity Score Matching model offers a new approach to analyzing the effect of LP. The use of a Propensity Score Model would, in optimal milieu, resolve self-selection bias, something that most likely is present in other models. The methodological approach of this study is aimed at generating generalized results which enable an overall interpretation of the Nordic markets. We also observe that previous literature studies a shorter period, which in our view exposes the results to bias due to potential market moods, trends, and shocks. This paper is aiming to mitigate this potential bias by employing averages estimated from the period of 25 months.

4.2. Delimitations

As a result of time constraints and the scope of the study, combined with some idiosyncratic variables, delimitations of the thesis are necessary. As stated at the beginning of the introduction, the study is restricted to a data set covering 25 months, with one treatment group (with an LP the whole period) and one control group (without an LP). Ideally, the data would have included individual contracts for LP, something which would have enabled the paper to study the event window before-during-after hiring an LP service. Additionally, the individual contract would have enabled us to control for contract-specific effects, such as different minimum spreads and order book depth.

Previous literature generally limits their studies to stock markets in one country (see e.g., Anand, Tanggaard & Weaver, 2009; Bessembinder, Hao & Lemmon, 2011; Menkveld &

Wang, 2009). Moreover, studies on the effect of LP on the Nordic markets are few and outdated. To contribute to existing literature, this paper aims to delimit itself to include all Nordic main markets. Menkveld and Wang (2009), found that LP services mostly are found amongst small cap companies. The data retrieved for this study indicates that there is an equal distribution of small- and mid cap companies employing LP services. Hence, this study will not limit itself to small cap firms, but rather examine the effect on stock performance for all segments as well as for individual segments. The choice of including all Nordic main markets and all segments also allows for a bigger and more general statistical inference. However, the sample contains too few large cap companies, so the study will be limited to testing, individual effect, on small cap and mid cap. Furthermore, the sample is delimited to only include publicly traded companies.

Worth mentioning is that the opted model is very dependent on selected predictors and sensitive to omitted variables. Hence, some reservations ought to be kept regarding predictors per data accessibility. The aforementioned limitations with access to the LP contracts delimit chosen predictors, e.g., book order depth. Furthermore, some unobservables, which are still assumed to explain variation in liquidity, fall out of our scope. Such unobservables are analyst coverage, shareholder value (for instance dividends), and share price value (for instance stock split). Given a greater time horizon, the creation of such unobservables could offer higher significance and superior predictions.

4.3. Sample

The sample universe stems from the Nasdaq Nordic main markets. A sample set is constructed, into a treatment group and control group, dependent on the criteria if they have used an LP. The scope of the study covers 25 months between December 2019 to December 2021, during which time roughly 700 companies were listed on the Nordic main markets. Out of these, 69 companies used LP during all 25 months. Due to missing observations, three of these are taken out of the sample, resulting in a final size of 66 companies in the treatment group. A control group is constructed from the same population. 170 companies, which had not used LP during the period, is randomly selected. There is no time dimension sample, however, the data collected is derived from daily observations and averaged to one point in time for this study. The ratios of companies in different segments (small-, mid-, and large cap) in the control group were restricted to meet the ratios of the treatment group (a list of the companies selected is provided in the appendix). Data limitations also impose some constraints on the control group, leaving eight companies omitted, and 162 companies are left. Yielding a final sample of 228 companies.

4.3.1. Sample representativeness

The aim of studying the effect of LP on all Nordic main markets imposes requirements on the data representativeness. For the results to allow a generalized interpretation, the sample ought to be a good reflection of the population, i.e., all the Nordic main markets, conditional on LP. However, the representativeness assumption stands in conflict with the level of significance. To ensure significance, enough firms need to be included in the sample. Given the number of firms contracting an LP across the markets, an equal distribution cannot be achieved while maintaining a large enough sample. To further enable a richer analysis, we examine the distribution over industries.

Table 1. Sample Distribution

	LP				WO LP				
	Small	Mid	Large	Tot	Small	Mid	Large	Tot	Tot
STO	18	14	4	36	29	47	14	90	126
CPH	3	2	1	6	16	7	8	32	37
HEL	4	2	0	6	21	16	4	41	47
ICE	3	13	2	18	0	0	0	0	18
Tot	28	31	7	66	66	70	26	162	228

The table above depicts the distribution of firms over different segments and stock markets for firms with LP and without LP.

Table 2. Industries

	LP		WO LP	
Basic Materials	4	6.06 %	5	3.09 %
Financials	19	28.79 %	14	8.64 %
Utilities	1	1.52 %	1	0.62 %
Industrials	21	31.82 %	37	22.84 %
Consumer Goods & Services	10	15.15 %	41	25.31 %
Technology	5	7.58 %	22	13.58 %
Oil & Gas	3	4.55 %	3	1.85 %
Health Care	1	1.52 %	30	18.52 %
Telecommunications	2	3.03 %	5	3.09 %
Real Estate			4	2.47 %
	66	100.00 %	**162**	100.00 %

The table above depicts the distribution of firms over different industries for firms with LP and without LP.

Table 1 depicts the sample distribution over markets and segments. Both groups have a similar ratio of companies in the different segments. What's important with this illustration is that the control group reflects the treatment group, dependent on LP, given the chosen model (Roberts & Whited, 2013). Important to observe is that the sample is overweighted in the Swedish market and that there are some inconsistencies between the groups with respect to the other markets. Note, that no firm from Iceland is included in the control group. Only one firm from Iceland, which does not use an LP can be found, but due to missing observations, it is excluded. The choice of including Iceland, even though it results in a less matching dataset, is because the treatment group would be on the verge of being too small otherwise.

Table 2 depicts the sample distribution over industries. The variation of distribution over industry is moderately comparable. Most firms, in the treatment group, are operating in industrials, consumer goods & services, or financials. In the control group, most firms are operating in industrials, consumer goods or services, or health care. Note, the difference in firms operating in financials and healthcare between the groups. Interestingly, many firms, which employ an LP, are operating in the financials. One explanation could be that firms active in the financial market "knows what they are doing" and realizes that LP, a financial service, has a positive effect. This explanation would support previous research findings, that LP has a positive effect since even practitioners choose the service. On the other hand, one could argue that it is easier to sell an LP service to a firm that understands the concept. Then, it does not necessarily indicate that LP induces positive effects.

This section aims to provide the reader with a better understanding of the sample, and the aforementioned observations should be reserved for when interpreting the results. Specifically, one should proceed with caution when drawing generalized conclusions about the Nordic market.

4.4. Liquidity providing dummy

The main event of the study is the effect of LP. Consequently, the choice of measure of LP carries extra weight. As acknowledged in delimitations, time- and data restriction only allows for a data set including whether a company employed LP or not. Hence, the chosen measure is a dummy variable, which will be the dependent variable in the model, taking the value 1 if the company had an LP service and 0 otherwise. In other words, we are using a binary choice model. Anand, Tanggard and Weaver (2009) use dummies as dependent and independent variables in a logistic regression to distinguish whether trades occur when spreads transcend wider than contractual obligations dictate. In addition, Menkveld and Wang (2013) studied whether a firm's liquidity level improves after a firm has exited an LP contract. They use a diff-in-diff method where dummies are independent variables capturing the effect in the post-event period. As the aim is to study how stocks are affected if firms choose to contract an LP, the dummy variable will serve as the dependent variable in the model. Information on whether a company has used LP is gathered from Nasdaq Nordic. Monthly firm observations are used to measure the binary variable.

4.5. Liquidity proxies

For the aim of this study, we want to examine how LP affects stock performance. The study is particularly interested in the effect on liquidity. For this purpose, proxies for liquidity need to be assigned. The designated proxies are *Turnover* and *Spread*. This section will disclose the selection criteria and how good a proxy the variables are.

Turnover and spread are two of the most frequently used, also applied in previous studies on LP, measures of stock liquidity (e.g., Anand, Tanggaard & Weaver, 2009; Menkweld & Wang, 2013; Venkataraman & Waisburd, 2007). Monthly daily average observations are used to calculate the average daily turnover for the whole period. Since stocks may differ widely in outstanding shares, independently of size, turnover is measured in the total value (EUR) of traded shares during the period (single counted), rather than using the number of shares. Equation (3) depicts how *Turnover* is estimated. In equation (3) TS_i is the monthly average daily traded shares for company i, and P_i is the monthly average daily price of company i. Data is collected from Nasdaq Nordic.

$$Turnover_i = \frac{\sum_{n=1}^{25} TS_{n,i} * P_{n,i}}{25} \tag{3}$$

Turnover is an indirect measure of the general interest in a stock and works as a measure of how easy it is to sell (buy) a stock without a discount (premium). Albeit, turnover is a measure of the quantity and not the quality. A high turnover means that price discoveries happen frequently and indirectly lead to truer price discoveries.

Quoted spread is the difference between bid- and ask price. For the investor, the spread is an indirect transaction cost and a type of liquidity risk premium. The higher the spread, the higher the transaction cost is for the investor (Amihud & Mendelson, 1986a). Daily observations of the difference between bid- and ask prices at the end of the day are used to calculate the average daily spread each month. Equation (4) is used to calculate the spread, in which, Bid_i is the biding price at the end of the day for company i and Ask_i is the asking price at the end of the day for company i.

$$Spread_i = \frac{(Bid_i - Ask_i)}{(Bid_i - Ask_i)/2} \qquad (4)$$

The average daily spread for the whole period is then calculated as an average of all 25 months. The data is collected from Nasdaq Nordic. The variable Spread has good feasibility and comparability across firms since it is measured in percentage and can be calculated in a standardized manner. The LP contract requires the spread to maintain a maximum distance, meaning that one of course would expect LP to have a decreasing effect on the spread. However, we aim to test the magnitude of the effect on the spread. Consequently, we pose the question of whether LP lowers the spread below the required maximum.

4.6. Liquidity and Volatility

Volatility is systematically applied as a measure of uncertainty and is estimated as the standard deviation of returns (%). The fact that volatility is measured in percentage offers good comparability across firms. Because spread affects the effectivity of price discovery, volatility has a relation with the examined variable spread. It is expected that a lower spread would lead to fewer changes in the price discovery (less uncertainty) since the stock could easily be sold at the current price (less pricy to sell off quickly) (Menkveld & Wang, 2009). Thus, it is assumed that an LP would result in lower volatility. To estimate the volatility, we first calculate the daily stock returns by applying equation (5), noting that the first observation will fall out. Secondly, the monthly standard deviation of returns is calculated. Lastly, the average monthly standard deviation is estimated. Previous literature found a negative relationship with firms employing LP, meaning that employing an LP would decrease volatility (Anand, Tanggaard & Weaver, 2009; Venkataraman & Waisburd, 2007). A potential drawback with return volatility, established on the transaction price, is that it can capture pricing errors. Albeit, the use of a 25-month average should alleviate this pitfall.

$$return_{t+1,i} = Price_{t+1,i} - Price_{t,i} \quad (5)$$

$$Volatility_i = \frac{\sum_{t=1}^{25} \sigma_{return_{t,i}}}{25} \quad (6)$$

Equation (6) is applied to compute the average monthly volatility. $\sigma_{return,i,t}$ is the standard deviation of monthly returns for company i. In equation (5), $Price_{t,i}$ is the daily price at time t for company i. Daily price observations are collected through Thomson Reuters Eikon in EUR.

4.7. Control variables

To control for self-selection, we include two control variables, market cap and price. The study assumes these variables affect the choice of whether to employ an LP or not. Given the model choice, which will be explained in further detail in the next section, variables that are assumed to affect the choice of employing LP should be included. The control variables are selected in coherency with previous studies and the overall consensus to ensure a high explanatory degree (e.g., Menkveld & Wang, 2013; Roberts & Whited, 2013; Venkatamaran & Waisburd, 2007).

Contracted LPs effectively guarantee a maximum bid-ask spread which suggests an efficient price discovery for investors. Bessembinder, Hao and Lemmon (2009) argue that when an LP is introduced to the market and functionally narrows the bid-ask spread the price discovery of the firm increases. This translates to more trading activity from informed investors. Furthermore, Anand, Tanggard and Weaver (2009) also show an increase in the proportion of price discovery for informed investors after the LP has been introduced. The intention of employing an LP is not to increase the price, but rather to improve price discovery. Of course, following earlier discussion, more efficient price discovery is assumed to yield a truer price realization with a smaller risk premium. Price will be used to estimate whether a firm chooses LP. We have obtained from Thomson Reuters Eikon daily closing prices for each stock and converted them to EUR currency for each day. The FX rate was directly converted through Thomson Reuters with the closing FX rate. We averaged the daily price to 25 monthly observations, which in turn are averaged to one price point.

Liquidity can broadly be considered as market quality. In other words, the liquidity level of a stock entails investors whether the stock conveys increased risk (Huang, 2002). As investors screen for companies, one main disadvantage for stocks is if it experiences low liquidity since return requirement becomes seemingly higher. LPs are trying to enhance the liquidity of a firm by assigning depth to the order book. LPs quote on both sides with the contractual maximum spread which forms a ‘‘push’’ for quotes to match. However, from our data, we are not able to differentiate between LPs and other traders. We only know that during the measured period LPs are present in the limit order book and obligated to quote on both sides. In other words, the number of trades from LPs is not considered but the general effect of how the liquidity improves through turnover is captured. To substantiate further, Anand, Tanggard and Weaver (2009) bring to light that other market participants' trading activity increases if the firm employs an LP. This essentially means that LP enhances liquidity and increases investor trading appetite.

There seems to be consensus, in previous literature, that small cap firms stand to gain the most from contracting an LP and subsequently are more prone to issue an LP contract (Menkveld & Wang, 2013; Roberts & Whited, 2013; Venkatamaran & Waisburd, 2007). Amihud and Mendelson (1986b) as well as Acharya and Pedersen (2005) find that illiquid stocks tend to suffer the most from liquidity risk and that small cap firms are more likely to experience low liquidity. Previous studies’ data sets find that there is an overweight of small cap firms contracting an LP. Thought-provoking is that our data set indicates an equal distribution of small- and mid cap firms. The disparity could derive from various reasons, but since we lack older data for the Nordic main markets it is difficult to specify the reason.

From the average daily price, the market cap is computed as an average over the whole period by multiplying with the average monthly number of shares outstanding, demonstrated in equation (7). The study will also examine the effect of LP on small- and mid cap firms separately. For this purpose, the firms are assigned small-, mid-, or large cap depending on their market cap. In equation (7), $Price_{t,i}$ is the daily price at time t for company i.

$$Market\ Cap_i = avg.Price_{t,i} * No.of\ shares\ outstanding_i \tag{7}$$

Small Cap: $Market\ Cap < €150mn$

Mid Cap: $€150mn > Market\ Cap < €1\ 000mn$

Large Cap: $Market\ Cap > €1\ 000mn$

4.8. Propensity score matching

Given the characteristics of the data sample and the aim of the study, to test for the effects of employing an LP, the suitable statistical approach is to use a matching principle (Roberts & Whited, 2013). Given that the data has no time dimension, one cannot use a standardized regression to find exogenous variation in the treatment, i.e., on LP. Instead, a propensity score matching model is selected. Propensity Score Matching (PSM) was first introduced by Rosenbaum and Rubin (1983). They established equation (8), which says that the propensity score (PS) is defined as the probability (Pr) of the dummy variable (d) being 1, dependent on the vector of predictors (X).

$$ps(x) \equiv Pr(d = 1|X) = E(d|X) \tag{8}$$

The general idea of PSM is to compare the average treatment effect by comparing units in the treatment group with units in the control group that has a similar probability of being assigned the treatment (Roberts & Whited, 2013). For this study, it means that we estimate the likelihood of a company receiving treatment, LP, given some covariates. According to how Roberts and Whited (2013) describe covariates, the covariates in this study are variables thought to be determinants of whether a company employs an LP. Following prior discussion, the variables *Market Cap*, *Price*, and *Turnover* are expected to be indicators of whether a company will use LP, meaning they are the covariates. The probability of receiving treatment, also referred to as PS, are estimated for both the treatment- and control group (Roberts & Whited, 2013). Roberts and Whited (2013) proclaim that various methods exist for estimating PS, E.g., OLS, maximum likelihood, and nonparametric models. We proceed using a maximum likelihood model, namely logistic regression, to estimate PS. Equation (9) illustrates our logistic regression, where LP_i is the dummy variable for LP. Furthermore, $Market\ Cap_i$ is the average monthly market cap for firm i, $Price_i$ is the monthly average daily price for firm i, $Turnover_i$ is the average daily turnover for firm i, ε_i is the error term.

$$LP_i = \gamma_0 + \gamma_1 Market\ Cap_i + \gamma_2 Price_i + \gamma_3 Turnover_i + \varepsilon_i \tag{9}$$

Subsequently, the treatment effect is estimated by comparing the effect between treated- and non-treated companies which has the most similar PS. This is referred to as matching (matching PS) with the nearest neighbor (NN) (Roberts & Whited, 2013). One treated company can be matched with one or more non-treated companies, NN. In order to see if there is a trend or discrepancy in the data set, matching is conducted with one to five NN.

To finally arrive at the average treatment effect (ATE), an average effect of all paired companies is calculated, referred to as the counterfactual outcome (Roberts & Whited, 2013). The effect of the treatment, LP, is estimated on the variables *Spread*, *Turnover*, *Price, Volatility* and *Market Cap*. Following is an example of the estimated ATE on *Spread*. Whereas the difference between treated and non-treated, the average effect of all matching NN, is estimated.

$$\Delta Spread = \frac{1}{66}\sum_{i=1}^{66}(Spread_{treated,i} - \frac{\sum_{n=1}^{NN} Spread_{non-treated,i}}{NN}) \quad (10)$$

In Roberts and Whited's (2013) text they state that for the PSM model to be robust, the sample data need to satisfy two requirements, unconfoundedness and overlapping. The unconfoundedness assumption can be understood as, all variables, covariates, influencing both the treatment and the outcome are observed. Unfortunately, one cannot test the unconfoundedness assumption.

Furthermore, Roberts and Whited (2013) state that the overlapping assumption implies that the treatment- and the control group need to be somewhat homogenous, with similar characteristics, so that for each value of the covariates it is possible for a company to be in either group. For this study, the overlapping assumption states that, given the chosen covariates, companies in the control group should have fairly similar PS as companies with LP. Meaning they could be assigned treatment. Since both the treatment group and the control group are listed on the Nordic main markets and have the same ratios of different segments, they are expected to have fairly similar characteristics. In appendix Figure A1-A4 we provide scatterplots with the PS distributions for all segments, which illustrates the overlapping. Moreover, Roberts and Whited (2013) point out that the use of different numbers of NN can work as a control for the overlapping assumption. Hence, the use of different numbers NN can diminish the risk of violating the overlapping assumption.

4.9. Accounting for Self-Selection

The PSM model does not require any robust properties such as normality, homogeneity, or multicollinearity. The model relies on the covariates and the properties of the data set, meaning unconfoundedness and overlapping. Given the data set and the nature of LP, it is more than likely presence of a self-selection problem. Suppose that companies that know they would benefit from such a service chooses it, while companies that know they are better off do not acquire the service. Therefore, creating differences between the sample groups in terms of company characteristics.

The probable presence of self-selection motivates the choice of a PSM model. The PSM model inherently mitigates the self-selection problem via only matching treated companies with control companies with similar PS. Then, the degree, to which extent the PSM model reduces the self-selection problem, is dependent on how well covariates explain the choice of LP. To examine how well our model predicts the choice of LP we estimate and plot a Logit Confusion Matrix, LCM. LCM figures are found in appendix Figure A5.

However, the LCM only tells us how many correct predictions the model has. It can still be the case that we have endogeneity and that the predictions are a coincidence. Endogeneity arises from omitting variables that should be included as predicting variables. This is the unconfoundedness assumption and there is no test to see which variables should be included. Hence, the endogeneity problem is potentially present because the selection occurs on unobservables. A drawback with the potential predictors for this particular study, is that some of the variables we assume predict the choice of LP also is affected by LP itself, e.g., turnover, spread, and volatility. Choosing these variables will result in flawed estimations of the effect of LP on these variables. Since the use of only *Price* and *Market Cap* would be too few predictors, we choose to use turnover, even though it can weaken the results of the effect on *turnover*. We instruct the reader to bear this in mind when interpreting the results of *turnover*. Further, we will perform a one-sample t-test on the estimated ATE from the PSM model to test for significance.

5. Empirical results

In this section, we will present results and summary statistics from the selected samples. As mentioned before, we examined a sample with 228 companies of different industries, different market caps, and firms with and without LPs. In addition to examining the complete sample, we examine, separately, mid cap, small cap, and jointly mid- and small cap. The main area of interest is the sample including all segments. however, previous studies concentrate on small cap firms or firms which are known to use LPs. The differentiation will give us confirmation about how these groups differ from each other. To get a greater understanding of the effects we also utilize descriptive statistics of the examined samples.

5.1. Descriptive statistics

Table 3. Summary statistics – Large-, mid-, and small cap with LP

Large-, mid-, small cap with LP	*Price (EUR)*	*Market Cap*	*Turnover*	*Spread*	*Volatility*
Mean	8.30	601 MM	1.03 MM	0.00967	0.0233
Median	3.20	213 MM	318 238	0.00896	0.0233
Standard Deviation	14.11	1 687 MM	2.5 MM	0.00490	0.0072
Kurtosis	10.39	44.05	22.76	1.04	0.64
Skewness	3.09	6.27	4.53	0.78	0.80
Minimum	0.017	6.8 MM	7 017	0.00121	0.0124
Maximum	74.27	12 845 MM	16 MM	0.02528	0.0482
Count	66				

The table above presents the mean, median, standard deviation, kurtosis, skewness, minimum, maximum, and sample size of large-, mid-, and small cap firms with LP. MM (millions).

Table 4. Summary statistics – Large-, mid-, and small cap without LP

Large-, mid-, small cap without LP	*Price (EUR)*	*Market Cap*	*Turnover*	*Spread*	*Volatility*
Mean	15.34	1 475 MM	3.9 MM	0.00866	0.0275
Median	8.90	220 MM	322 709	0.00668	0.0257
Standard Deviation	19.00	4 930 MM	12 MM	0.0083	0.0113
Kurtosis	4.37	30.10	27.91	7.39	28.86
Skewness	2.10	5.33	5.05	2.43	3.87
Minimum	0.047	2.5 MM	1 576	0.0005	0.0121
Maximum	94.82	37 398 MM	89.95 MM	0.0492	0.1212
Count	162				

The table above presents the mean, median, standard deviation, kurtosis, skewness, minimum, maximum, and sample size of large-, mid-, and small cap firms without LP. MM (millions).

The table above represents the statistics of the whole sample differentiated by with and without LP. The most interesting parts are the variables mean, minimum and maximum. Table 3 shows the statistics from firms with LP. The mean price is €8.30 while the minimum is €0.017 and the maximum is €74.27. The mean market cap for firms with LP is €601 MM. The minimum market cap is €6.8 MM while the maximum is €12 845 MM. The maximum is a clear outlier in the sample group due to the next observations market cap being €3 917 MM. Table 3 shows a mean turnover value of €1.03 MM with a minimum of €7017 and a maximum of €16MM. Spread conveys a mean of 0.96% with a minimum of 0.12% and a maximum of 2.52%. The final variable volatility depicts a mean of 2.33% with a minimum of 1.24% and a maximum of 4.82%.

Table 4 is the whole sample without LP. Price, the first variable, shows a mean of 15.34 and a minimum of 0.047 following a maximum of 94.82. The market cap is 1 475 MM. The minimum market cap is 2.5 MM and the maximum is 37 398 MM. The turnover mean value is 3.9 MM with a minimum of 1576 following a maximum of 89.95 MM. The variable spread depicts a mean of 0.86% and a minimum of 0.05% with a maximum of 4.92%. Lastly, in Table 4 we have a volatility mean of 2.74% with a minimum of 1.21% and a maximum of 12.12%.

Now that we have in detail reviewed the parameters and variables of interest it is important to note the mean differences in the two groups. As we showed the price that without LP has higher mean price with 84.8%. This ought to be intuitive since this tie together with the mean market cap being higher in value as well. Market cap is in the sample without LP 145% larger than with LP. This is due to the distribution of large caps not using LPs and higher valued mid cap firms in the sample. Mean turnover value difference is 278.60% which corresponds to the fact that when market caps are higher, then turnover value follows. Spread is –10.4% lower in the group without LP which is not a large difference. This result conveys that the effect of an LP is effective. Volatility, on the other hand, is higher for the group without LP by 17.89% which is somewhat surprising. This might be because without an LP, the fluctuations during an intraday are bigger.

In Table A1 and Table A2 depicting mid cap, we find that the mean price is €8.93 for firms with LP and €15.23 for firms without LP. The mean market cap for firms with LP is €352.8 MM and €475.4 MM for firms without LP. The mean turnover is €61.1 MM for firms with LP and €15.5 MM for firms without LP. The mean spread is 0.90% for firms with LP and 0.53% for firms without LP. The mean volatility is 2.14% for firms with LP and 2.69% for firms without LP.

In Table A3 and Table A4 depicting small cap, we observe that firms with LP have a mean price of €5.12, a mean market cap of €73.5 MM, a mean turnover of €6.6 MM, a mean spread of 1.16%, a mean volatility of 2.57%. Firms without LP have a mean price of €8.62, a mean market cap of €53.5 MM, a mean turnover of €1.5 MM, a mean spread of 1.42%, a mean volatility of 2.94%.

In Table A5 and Table A6 depicting mid- and small cap, we observe that firms with LP have a mean price of €7.12, a mean market cap of €220 MM, a mean turnover of €35 MM, a mean spread of 1.02%, a mean volatility of 2.34%. Firms without LP have a mean price of €12.07, a mean market cap of €274 MM, a mean turnover of €8.8 MM, a mean spread of 0.96%, a mean volatility of 2.81%.

5.2. Propensity Score Matching – ATE of Liquidity Providing

This section will disclose the results for the different ATE estimation from the PSM model. First, will the base model, estimated on all segments, be presented. Secondly, will we present the results when including only mid cap in the PSM model. Following, will the results for including only small cap in the PSM model be presented. In each presentation will accompanying t-test be presented. Every presentation has associated scatter plots, depicting each covariates PS estimation, which are found in the appendix.

Table 5. ATE from PSM and corresponding t-test

Large-, mid-, small Cap			NN		
Variable	**1**	**2**	**3**	**4**	**5**
SPREAD (%)	-0.002 (0.089)*	-0.001 (0.143)	-0.001 (0.113)	-0.001 (0.120)	-0.001 (0.252)
	[-1.721]	[-1.482]	[-1.603]	[-1.571]	[-1.153]
PRICE (EUR)	-0.514 (0.403)	0.147 (0.801)	-0.039 (0.957)	0.160 (0.855)	0.565 (0.536)
	[-0.840]	[0.252]	[-0.054]	[0.182]	[0.621]
MCAP (EUR) Millions	340 (0.015)**	340 (0.050)**	348 (0.062)*	332 (0.084)*	214 (0.347)
	[2.485]	[1.997]	[1.899]	[1.750]	[0.945]
Turnover(EUR) Thousands	520 (0.019)**	373 (0.078)*	378 (0.073)*	326 (0.140)	91 (0.749)
	[2.386]	[1.790]	[1.818]	[1.492]	[0.320]
Volatility (%)	-0.006 (0.001)***	-0.009 (1.4e-05)***	-0.009 (2.2e-06)***	-0.008 (1.0e-06)***	-0.007 (1.4e-06)***
	[-3.423]	[-4.682]	[-5.195]	[-5.390]	[-5.298]

The table above presents the output of large-, mid-, and small cap segments off ATE and the corresponding t-test of the propensity score matching with the nearest neighbor NN up to five. The ATE is calculated by subtracting the non-LP firms (Average effect of all NN) with LP firms with respect to given variable. The reported values are ATE, p-value in parenthesis, and t-value in brackets. Degrees of freedom is 65 for all variables. *, ** and *** indicate significance level 10%-, 5%- and 1% level respectively.

5.2.1. Base model – ATE of Liquidity Providing

For the base model (Table 5), where all segments were included, we estimated the effect using one to five NN. Matching with one NN, yielded significant results for all variables except *Price*. The average effect, ceteris paribus, of LP on *Spread* is consistent over all NN, ranging between –0.001 and –0.002 percentage points. Indicating that LP has a negative effect on *Spread*. The variable *Spread* shows a negative t-value all over NN, ranging from –1.153 to –1.721. The model only shows significance (10% significance level) for *Spread* with one NN, the largest p-value being 0.252. The model predicts that LP has on average a negative effect, ceteris paribus, on *Price* for 1 and 3 NN, but for 2, 4, and 5 NN a positive effect. *Price* shows a negative t-value with one and three NN (positive values for two, four, and five NN), with p-values ranging from 0.403 to 0.957. Furthermore, LP has an average positive effect, ceteris paribus, on *Market Cap*. The model yielded positive t-values for *Market Cap* for all NN, the largest being 2.485 and decreasing with the number of NN. The p-values for *Market Cap*, similar to the t-value, decrease with the number of NN and range from 0.015 to 0.347 (being significant for 1 to 4 NN at a 10% significance level). The average treatment effect of LP is constant for the first two NN (340 million), after which it increases slightly to the highest value effect of 348 million. We observe a clear positive trend for *Market Cap*, which also seems to decrease over NN. The Model estimates that LP has an average positive effect, ceteris paribus, on *Turnover* over all NN. The average effect is highest for the first NN with 520k whereafter the effect decreases until the fifth NN with an effect of 91k. The model estimated a t-value of 2.386 to 1.492 for one to four NN and a drop to 0.320 for the fifth NN. Corresponding p-values are 0.019 (1 NN), 0.078 (2 NN), 0.073 (3 NN), 0.140 (4 NN), and 0.749 (5 NN). *Volatility* depicts a negative relation to LP, with an average effect, ceteris paribus, of approximately 0.008 percentage points. *Volatility* is significant at the 1% level and negative throughout the series of all NN with the largest t- value being at the fourth NN –5.390. T-values seem to increase over NN. We can observe a small decreasing trend in significance over NN.

The corresponding confusion matrix (see appendix Figure A5) depicts the estimated prediction of whether a firm receives treatment, given estimated PS. Quadrants one and two represent the control group, consequently quadrants three and four represent the treatment group. 0 indicates that a firm would not choose LP and 1 otherwise. Hence, the correct predictions are found in quadrants two and four. For the base model, it predicts right on 161 out of 162 firms (control group) and 1 out of 66 (treatment group). Correct predictions are 71.05%.

Table 6. ATE from PSM and corresponding t-test

Mid cap			NN		
Variable	**1**	**2**	**3**	**4**	**5**
SPREAD (%)	0.001 (0.031)**	0.001 (0.010)**	0.002 (0.005)***	0.002 (0.004)***	0.002 (0.005)***
	[2.249]	[2.748]	[2.962]	[3.062]	[2.997]
PRICE (EUR)	-1.523 (0.535)	-0.947 (0.686)	-1.456 (0.472)	-1.500 (0.491)	-1.709 (0.442)
	[-0.627]	[-0.408]	[-0.727]	[-0.695]	[-0.778]
MCAP (EUR) Millions	79 (0.009)***	46 (0.143)	60 (0.036)**	46 (0.081)*	38 (0.173)
	[2.777]	[1.502]	[2.185]	[1.805]	[1.392]
Turnover (EUR) Thousands	30 (0.813)	10 (0.934)	22 (0.844)	17 (0.885)	26 (0.832)
	[0.238]	[0.082]	[-2.075]	[0.145]	[0.212]
Volatility (%)	-0.005 (0.011)**	-0.004 (0.007)***	-0.004 (0.008)***	-0.004 (0.011)**	-0.003 (0.011)**
	[-2.687]	[-2.844]	[-2.814]	[-2.695]	[-2.681]

The table above presents the output of large-, mid-, and small cap segments off ATE and the corresponding t-test of the propensity score matching with the nearest neighbor NN up to five. The ATE is calculated by subtracting the non-LP firms (Average effect of all NN) with LP firms with respect to given variable. The reported values are ATE, p-value in parenthesis, and t-value in brackets. Degrees of freedom is 30 for all variables. *, ** and *** indicate significance level 10%-, 5%- and 1% level respectively.

5.2.2. **ATE of Liquidity Providing for Mid Cap**

Table 6 above depicts the outcome of the model when strictly including mid cap firms. Recall the mid cap segment includes firms with a market cap between €250mil and €1 000mil. The variable *Spread* manifests a positive mean value of 0.001 and two first NN with a significance level within 5% which after the significance level is within 1% and the trend average value is slightly increasing towards the last NN. To substantiate further, employing an LP all ceteris paribus will on average increase by 0.001 percentage units. *Price* depicts negative average values and insignificant throughout all NN and t-values follow the negative scope. We can spot an increasingly negative trend after the second NN which is decreasing the mean price from –0.947 to –1.709. The variable *Market Cap* mean values are positive through all five NN with the first, second, and third NN being significant. The first NN average treatment effect is 79 million with a 1% significance level and the third NN mean value is 60 million with a 5% significance level and the fourth NN mean value of 46 million with a significance at the 10% level. We can see a slightly decreasing trend while moving further on the NN scale. Turnover manifests a positive mean but with insignificant p-values through all NN. There is no clear trend indicator since mean values move inconsistently between 30k to 10k. Volatility is negative and significant at the 1% level through all NN. The mean value decreases from –0.005 to –0.003 percentage units until the fifth NN.

The corresponding confusion matrix (see appendix Figure A5) manifests the model predicting the right 69 times out of 72 firms in the control group. Respectively the treatment group predictions are correct 25 times out of 31 firms. Correct predictions are 72.82%.

Table 7. ATE from PSM and corresponding t-test

Small cap	NN				
Variable	**1**	**2**	**3**	**4**	**5**
SPREAD (%)	3.7e-04 (0.763)	9.4e-05 (0.943)	2.3e-04 (0.858)	1.4e-04 (0.902)	-5.3e-05 (0.962)
	[0.304]	[0.072]	[0.180]	[0.124]	[-0.047]
PRICE (EUR)	-2.132 (0.111)	-1.516 (0.213)	-1.224 (0.303)	-1.225 (0.325)	-1.119 (0.262)
	[-1.647]	[-1.272]	[-1.049]	[-1.001]	[-1.144]
MCAP (EUR) Millions	-3.3 (0.388)	1.1 (0.752)	2.5 (0.474)	3.4 (0.320)	3.6 (0.267)
	[-0.875]	[0.318]	[0.725]	[1.012]	[1.132]
Turnover (EUR) Thousands	32 (0.427)	41 (0.323)	31 (0.401)	32 (0.397)	36 (0.332)
	[0.805]	[1.005]	[0.853]	[0.860]	[0.986]
Volatility (%)	-0.001 (0.426)	-0.003 (0.129)	-0.002 (0.112)	-0.002 (0.146)	-0.002 (0.114)
	[-0.807]	[-1.562]	[-1.641]	[-1.493]	[-1.630]

The table above presents the output of large-, mid-, and small cap segments off ATE and the corresponding t-test of the propensity score matching with the nearest neighbor NN up to five. The ATE is calculated by subtracting the non-LP firms (Average effect of all NN) with LP firms with respect to given variable. The reported values are ATE, p-value in parenthesis, and t-value in brackets. Degrees of freedom is 27 for all variables. *, ** and *** indicate significance level 10%-, 5%- and 1% level respectively.

5.2.3. ATE of Liquidity Providing for Small Cap

For the third PSM model, we estimate the effect of contracting an LP for strictly small cap firms. We can quickly note that no variable is significant (10% significance level). However, the most important is to observe the direction (positive/negative) and magnitude of the average treatment effect. Table 7 depicts the results discussed in this section.

The model indicates that the variable *Spread* has a positive over all NN except for the fifth NN. The variable depicts low magnitude and high p-values for all NN, indicating that there is little difference from zero. The model finds the variable *Price* to have a fairly significant difference from zero, indicating that the stock price on average decreases for small cap firms that employ an LP. The average treatment effect value for *Price* ranges from –2.132 to –1.119 and remains negative at all times. *Market Cap* has to some extent significance for one, four and five NN (p-values 0.388; 0.320; 0.267). The first NN estimates the average effect is –3.3 million however, the effect trends increasingly positive for the remaining NN. We find that the average effect of LP on *Turnover* is consistent over all NN with an average value ranging between 31-41k. This indicates that contracting an LP increases *Turnover* for small cap firms. For V*olatility,* the model depicts p-values between 0.323 and 0.427, which varies over NN. The average treatment effect manifests a decrease in volatility for all NN. The t-test estimates a t-value of –0.807 for one NN, with a corresponding p-value of 0.426. As the model increases NN to two or more, the absolute t-value increases.

In Figure A5, the corresponding LCM yields a true prediction ratio of 75.53%. Again, we observe the same distribution of predictions for the treatment- and the control group. 6 out of 28 predictions (treatment group) and 1 out of 65 predictions (control group). Repeatedly, the model seems to underestimate the number of firms choosing LP.

Table 8. ATE from PSM and corresponding t-test

Mid- & small cap			NN		
Variable	**1**	**2**	**3**	**4**	**5**
SPREAD ((%)	4.960e-04 (0.538)	-2.418e-04 (0.770)	-4.167e-04 (0.596)	-0.001 (0.233)	-0.001 (0.158)
	[0.592]	[-0.298]	[-0.533]	[-2.418]	[-1.427]
PRICE (EUR)	0.988 (0.458)	1.658 (0.215)	0.267 (0.813)	0.388 (0.746)	0.449 (0.666)
	[0.746]	[1.252]	[0.236]	[0.324]	[0.433]
MCAP (EUR)	-7 (0.838)	13 (0.644)	25 (0.357)	31(0.213)	41 (0.113)
	[-0.203]	[0.463]	[0.927]	[1.258]	[1.606]
Turnover (EUR)	-80 (0.390)	-83 (0.346)	9 (0.909)	9 (0.899)	21 (0.759)
	[-0.864]	[-0.949]	[0.113]	[0.126]	[0.308]
Volatility (%)	-0.011 (0.002)***	-0.009 (2.6e-04)***	-0.007 (4.1e-04)***	-0.006 (1.2e-04)***	-0.006 (4.4e-05)***
	[-3.150]	[-3.884]	-3.744]	[-4.101]	[-4.415]

The table above presents the output of large-, mid-, and small cap segments off ATE and the corresponding t-test of the propensity score matching with the nearest neighbor NN up to five. The ATE is calculated by subtracting the non-LP firms (Average effect of all NN) with LP firms with respect to given variable. The reported values are ATE, p-value in parenthesis, and t-value in brackets. Degrees of freedom is 58 for all variables. *, ** and *** indicate significance level 10%-, 5%- and 1% level respectively.

5.2.4 ATE of Liquidity Providing for Mid Cap & Small Cap

Lastly, we estimate the PSM excluding large cap firms from the dataset. The results discussed in this section are depicted in Table 8. We can easily see that only one variable *Volatility* is significant. *Spread* experiences a positive mean value but an insignificant p-value in the first NN. As NN increases *Spread* turns negative meaning the model estimates a decreasing *Spread* but remains insignificant. *Spreads* mean values are small indicating little difference from zero. The model estimates for *Price* mean values are positive but vary in magnitude across NN. The first NN average treatment effect manifests a 0.988 increase and the second NN increases by 1.658 but the third NN drops to 0.236 which after the mean *Price* slightly increases. *Market* C*ap* average estimate is negative in the first NN (-7 million) with the lowest significance level (-0.838) in the series. The series trends higher *market cap* average treatment effect, and increases in significance level to the fifth NN with 41 million and 0.113 respectively. Estimates for *Turnover* are insignificant and mean values range from negative (-83k) to positive (21k) when the series progress. The significance level is lowest for the first two NN (0,390, 0,346) while the average *Turnover* effect is negative respectively (-80k and -83k). Model estimate for *Volatility* is significant within the 1% level and average treatment effect values are negative throughout the series indicating a positive effect. The trend is decreasing in negative values throughout the series and remains significant.

In appendix Figure A5, the LCM for mid- and small cap firms estimates that the model predicts correctly all 136 firms in the control group. The treatment group is correctly predicted 57 times out of 59 companies in the sample. The Correct predictions are 71.06%.

6. Analysis and Discussions

In this section, we will analyze and discuss the result with respect to the hypotheses. Given the scope of the study and the fact that we did not get a hold of the contracts between the firms and the LPs, the purpose is not to reach too far into specific mechanics or individual effects. Rather, the purpose is to try to dissect and resolve the implied effects of LP and estimate fundamental values of LP. Deriving from observed gaps in previous literature (particularly the minimal number of studies on the Nordic markets and contemporary data) and fundamental changes within the equity market (particularly the emergence of HFTs, the enforced MiFID-II regulation, and LPs change of trading engines to algorithmic engines), we established two subfields of research questions, namely stock performance and firm size effect. The two first sections will analyze the effect on stock performance in terms of liquidity and price discovery. The third section will discuss how the effect of LP differs between segments.

6.1. Liquidity Providing's Effect on Liquidity

LP's sole objective is to reduce the bid-ask spread and offer book order depth. That is, by regulative instructions as discussed in chapter 1.2, and the contract with a firm in which the parties agree on a maximum spread percentage, which is usually under the regulative 4%, and a euro amount of the book order depth for bid and ask. From our earlier derivation, liquidity proxies are spread and turnover. Our hypothesis states that by employing an LP the bid-ask spread should reduce, and the stock turnover value should increase.

What we can see from our dataset, specifically summary statistics, is that the mean spread of the control group is under the contractual obligation with a 0.86% spread (see Table 4). The maximum spread in the sample is 4.92% which is over the contractual obligation. While we match and estimate the spread, we can see a decrease (-0.001% points) in the spread on the first NN with a 10% significance level. Compared to the control group mean, this translates to a decrease in the spread of 11.6%. Even when the spread is initially under the contractual obligation, it seems that there is a positive effect when an LP engages in a stock and guarantees a maximum spread. Investors react and trade the stock more actively. Therefore, the LP might not engage as much in trading since the guaranteed spread from an LP activates informed traders and they acknowledge the reduced transaction cost and risk. As more matching occurs the significance level slightly decreases, but the effect remains the same throughout all estimated NN indicating a decrease in spread. These results, to some extent, do correspond to our expectations and initial hypothesis about reducing the spread but not in the most significant outcome.

The turnover mean euro value for the control group, in descriptive statistics (see Table 4) is €3.92 million. The minimum is €1575 turnover value while the maximum is approximately €89.95 million. The estimated results convey that turnover is significant within the three first NN which supports an increase in turnover. The significance of the first NN is within a 5% confidence level depicting a €520k increase in turnover. Compared to the control group mean, an increase of €520k equivalates an increase of 13.3% in turnover. Further, the second and third NN show an increase of €373k and €378k respectively. The increase in turnover, additionally, supports our hypothesis that an LP induces a liquidity guarantee, resulting in more trading activity from investors, which in turn increases liquidity even more. Again, this finding is valuable since the effect increases even when the LP is already employed, entailing that uninformed investors react later to trade the stock.

6.2. Liquidity Providing's Effect on Price Discovery

The applied theoretical assumption was that LP would have a positive effect on price discovery, foremost equation (1) and (2). Consequently, more efficient price discovery is assumed to diminish the transaction cost due to a lower liquidity risk premium, yielding a higher stock price and lower stock volatility.

Referring to the results in Table 5, the study finds ambiguous results of the effect an LP has on price, as the model shows some negative and some positive results across different NN. The t-test also estimates low significance (p-values) for the effect on price being different from zero. These results do not support our hypothesis that an LP would contribute to more efficient price discovery. On the other hand, the model confirms that there is a positive effect on market cap, with statistical significance (p-values) up to four NN. If we compare the average effect across all NN to the mean of the control group (see Table 4), we find that employing an LP on average increases the market cap by 21%. Market cap is determined by the number of shares outstanding and stock price. We observed, that firms in the sample have not made enough changes in their number of shares to make a significant difference on the market cap. Instead, we argue that the increase in the market cap can be isolated to a higher price. If this is the case, the study finds support that LP induces a more efficient price discovery.

The study also finds that LP has a, with statistical significance, negative effect of 0.008 percentage points on volatility. Compared to the mean volatility of the firms without LP (see

Table 4), this change translates to a 29% decreased volatility. The results support the assumption that an LP would contribute to a less volatile price realization. Venkataraman and Waisburd (2007), manifest that immediately after a firm introduces an LP to the market volatility decreases. In contribution to their findings, our results indicate that the effect of an LP persists even after the announcement effect. The finding of lower volatility indicates that a lower spread leads to less volatility in price realization. I.e., a stock can be sold at the current price easier with more efficient price discovery.

Two out of three variables support the hypothesis, of more efficient price discovery. Trying to resolve the fundamental effect, one can argue that it, in fact, stems from the LP functioning as a calming presence. Where the investor can enjoy less uncertain trading due to the guarantee from the LP. Note, the authors want to remind the reader that the variables *Price* and *Market Cap* were used to estimate the PS, resulting in potential bias. Albeit, this should lead to an underestimation of the effect since matching would be done with control firms with better market cap and price.

6.3. Firm Size Effect on Liquidity Providing

In this section, we will compare, evaluate, and interpret the differences in LP's effect on small- and mid cap segments. Firstly, we will look at the liquidity effect within spread and turnover. Spread in small cap (Table 7), depicts no significance and very little difference from zero in the average values throughout all NN. The mid cap segment exhibits significance for the first two NN within the 5% level and further with 1% significance for the remaining NN (Table 6). The mid cap segment displays a positive increase in spread as does the small cap segment, which is surprising. The main effect of an LP is to guarantee a maximum spread, and it seems that when separating the segments there is a change in the estimation. Nonetheless, the mean spread within the small cap groups with- and without LP, is 1.16 % for the LP group and 1.42% for the group without LP (Table A3 and Table A4 in appendix). This indicates that firms who employ an LP will benefit from the effect which is not seen in the estimation due to the average increase being close to 0.000%. For mid cap firms, it is the opposite within groups, in Table A1 we can see that the average spread for firms with LP is 0.90%. Additionally, the group without LP has an average spread of 0.53% (Table A2), and we find that an average increase in the spread if one employs an LP is 29.70%. This then again indicates that firms with LP need the service a benefit from it since the group without LP already experiences a lower spread. The group with LP has tried to raise their attractiveness and competitive advantage in terms of spread.

Turnover in small cap firms (Table 7) indicates no significance through all NN, but a positive effect on turnover. Mid cap segment (Table 6), likewise, indicates no significance but a positive increase in turnover through all NN. However, the significance level is lower on the NN series for small cap firms but the effect of LP is higher. When investigating the descriptive statistics for mid cap firms with- and without LP (Table A1 and Table A2), we observe that the average turnover for firms with LP is approximately €61.1 million while firms without LP have an average of approximately €15.5 million. This would entail that firms with LP benefit from the service as trading activity is higher and liquidity in turnover is higher valued. However, according to our estimation, the average increase would only be 0.14% for mid cap firms. Small cap firms with LP have an average turnover value of approximately €6.6 million (Table A3), while small cap firms without LP have approximately €1.47 million in turnover (Table A4). We estimated an average increase in turnover of 2.34% for firms that would employ an LP. This could entail that firms without LP either can't afford the service or that they choose another service over LP such as analyst coverage. Given these distinctions between groups, it does seem that the effect is already encountered and not of significance during the LP period. In other words, independent of the announcement effect, firms employing an LP have already experienced the benefit of an LP liquidity-wise.

Secondly, we will examine differences in the effects on price discovery by comparing Table 6 and Table 7. Interestingly, the results indicate that mid cap firms enjoy a more efficient price discovery. Comparing the average effect on *market cap* (Table 7) with the average size of small cap without an LP (Table A4) we observe a 5% increase, compared to an average increase of 11% for mid cap (Table 6 and Table A2). Furthermore, comparing the effects on *Price* with each segment's control groups mean we observe a decrease of 9% for small cap and 16% for mid cap (Table 7/A4 and Table 6/A2). The effect on price has a higher significance for small cap than mid cap. We observe a greater negative effect on volatility for mid cap than for small cap, and that the result for mid cap is significant. When again comparing the mean of volatility with the estimated effect, we observe that volatility for mid cap decreases by 14.8% and for small cap decreases by 6.9% (Table 6/A2 and Table 7/A4).

Summarizing the above results, the model estimates that LP has a greater positive effect on mid cap than on small cap. Comparing our study's findings with previous studies' findings, we instead find results that indicate that mid cap firms would enjoy more benefits from LP, in terms of market cap, and volatility. This precludes, that LP seems to have a better effect on price discovery for mid cap firms. Arising from our discussion on the effects on liquidity and price discovery, is the question of whether some kind of shift has occurred. Previously, we discussed the emergence of the so-called “micro” small cap and higher pricing due to the “unbundling”.

Interestingly, in Table A2 and Table A1, we can see that the average market cap for mid cap firms without LP is approximately €475 million, and with LP approximately €352 million. This could entail that lower market cap firms prefer an LP over firms with higher market cap since the stock performance is efficient and the stock enjoys a better overall turnover and spread. In Table A4 and Table A3, we can see that the average market cap for small cap without LP is approximately €54 million, and for firms with LP approximately €74 million. This is the opposite of mid cap firms and could suggest that firms with a lower market cap cannot choose an LP because they cannot afford the service.

7. Conclusion

This thesis studied the effects of LP during the contracted period, independent of the announcement effect, in the Nordic markets. The study has its foundation in the Propensity Score Matching model, to assess the effect of LP on publicly traded firms' stock performance. The study also emphasizes observed market changes and aims to map LP's dependency on firm size.

In contribution to previous findings, we find that LPs induce positive liquidity effects during the contracted period, even after the announcement effect. We find that LP on average decrease spread by 11.6% and increase turnover by 13.3%. Also, the study finds evidence indicating that LP, via positive liquidity effects, stimulates a more efficient price discovery. We find that LP on average decrease volatility by 29% and increased market cap by 21%. The findings of increased trading activity, suggest the LP, in fact, alleviates uncertainty for investors by acting as a guarantee. The alleviated uncertainty attracts investors to participate due to a lower transaction cost and more efficient price discovery. Additionally, the findings confirm that the market does not fully rely on HFT's provided liquidity. If investors would have been contempt with the presence of only HFTs, LPs would not have induced a lower liquidity risk.

To substantiate our findings on firm size effects, small cap firms not employing an LP displayed a larger increase in spread and a lower decrease in market cap compared to firms with an LP. We find that LP on average decreases volatility by 6.9% for small caps and by 14.8% for mid cap. Also, we find that market cap increases by 5% for small cap and by 11% for mid cap. These findings further support our thoughts that the emergence of "micro" small caps stocks can't afford to pay for LP or they choose an alternative solution. The argument that higher prices, due to "unbundling", also aligns with the observation of the emergence of "micro" small caps.

We see that LPs have a positive impact in the long term. It is evident that even with surprising macroeconomic conditions and market fluctuations the effect remains and might be even better in terms of spread and volatility. Additionally, volatility remained significant throughout most estimations suggesting a distinct effect. In general, this study finds further support for existing literature, manifesting the contribution of LPs. The idiosyncratic characteristic of LPs is the obligation of guaranteeing a certain maximum spread, which induces a reaction in the market resulting in greater effects outside of the LPs' direct target.

Suggestions for future research could concentrate explicitly on the announcement date effect and investigate the reaction in the Nordic markets. This would support the investigation of LP's effect in the modern Nordic market. This would be achieved be examining LP contracts, something that also would enable a more in-depth analysis.

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Appendix

Table A1. Summary statistics – Mid cap with LP

Mid cap with LP	*Price (EUR)*	*Market Cap*	*Turnover*	*Spread*	*Volatility*
Mean	8.94	353 MM	61 MM	0.00902	0.0214
Median	2.74	365 MM	10 MM	0.00843	0.0200
Standard Deviation	14.71	147 MM	79 MM	0.00375	0.0069
Kurtosis	6.62	1.75	0.55	-1.04	1.18
Skewness	2.56	1.15	1.25	0.08	1.02
Minimum	0.017	178 MM	72 114	0.00242	0.0125
Maximum	58.07	805 MM	271 MM	0.01689	0.0424
Count	31				

The table above presents the mean, median, standard deviation, kurtosis, skewness, minimum, maximum, and sample size of mid cap firms with LP. MM (millions).

Table A2. Summary statistics – Mid cap without LP

Mid cap without LP	*Price (EUR)*	*Market Cap*	*Turnover*	*Spread*	*Volatility*
Mean	15.23	475 MM	15 MM	0.00539	0.0269
Median	10.80	406 MM	6.5 MM	0.00520	0.0257
Standard Deviation	16.62	300 MM	24 MM	0.00300	0.0082
Kurtosis	9.29	3.83	10.48	1.42	0.56
Skewness	2.77	1.58	2.97	1.12	0.74
Minimum	0.21	123 MM	29 676	0.00155	0.0127
Maximum	94.82	1759 MM	132 MM	0.01502	0.0536
Count	72				

The table above presents the mean, median, standard deviation, kurtosis, skewness, minimum, maximum, and sample size of mid cap firms without LP. MM (millions).

Table A3. Summary statistics – Small cap with LP

Small cap with LP	*Price (EUR)*	*Market Cap*	*Turnover*	*Spread*	*Volatility*
Mean	5.13	74 MM	6.6 MM	0.01163	0.02585
Median	2.91	65 MM	0.9 MM	0.01095	0.02583
Standard Deviation	7.58	43 MM	15.6 MM	0.00536	0.00862
Kurtosis	12.71	-1.20	8.73	0.60	0.27
Skewness	3.19	0.24	3.01	0.94	0.47
Minimum	0.07	6.9 MM	7 000	0.00428	0.01289
Maximum	37.74	145 MM	66 MM	0.02528	0.04827
Count	28				

The table above presents the mean, median, standard deviation, kurtosis, skewness, minimum, maximum, and sample size of small cap firms with LP. MM (millions).

Table A4. Summary statistics – Small cap without LP

Small cap without LP	*Price (EUR)*	*Market Cap*	*Turnover*	*Spread*	*Volatility*
Mean	8.62	53.5 MM	1.5 MM	0.01421	0.0295
Median	3.38	47.6 MM	0.3 MM	0.01131	0.0274
Standard Deviation	15.21	38.2 MM	5.1 MM	0.00945	0.0149
Kurtosis	8.40	0.48	56.00	4.33	21.73
Skewness	2.98	0.81	7.25	2.04	3.79
Minimum	0.05	0.79 MM	5 581	0.00357	0.0121
Maximum	68.58	179 MM	40.4 MM	0.04925	0.1213
Count	66				

The table above presents the mean, median, standard deviation, kurtosis, skewness, minimum, maximum, and sample size of small cap firms without LP. MM (millions).

Table A5. Summary statistics – Mid- & small cap

Mid & small cap with LP	*Price (EUR)*	*Market Cap*	*Turnover*	*Spread*	*Volatility*
Mean	7.13	220 MM	35 MM	0.01026	0.0235
Median	2.90	180 MM	3.1 MM	0.01029	0.0240
Standard Deviation	11.93	178 MM	64 MM	0.00473	0.0080
Kurtosis	10.16	0.80	4.02	1.19	0.46
Skewness	3.04	1.01	2.14	0.91	0.76
Minimum	0.02	6.9 MM	7 000	0.00242	0.0125
Maximum	58.07	805 MM	271 MM	0.02528	0.0483
Count	59				

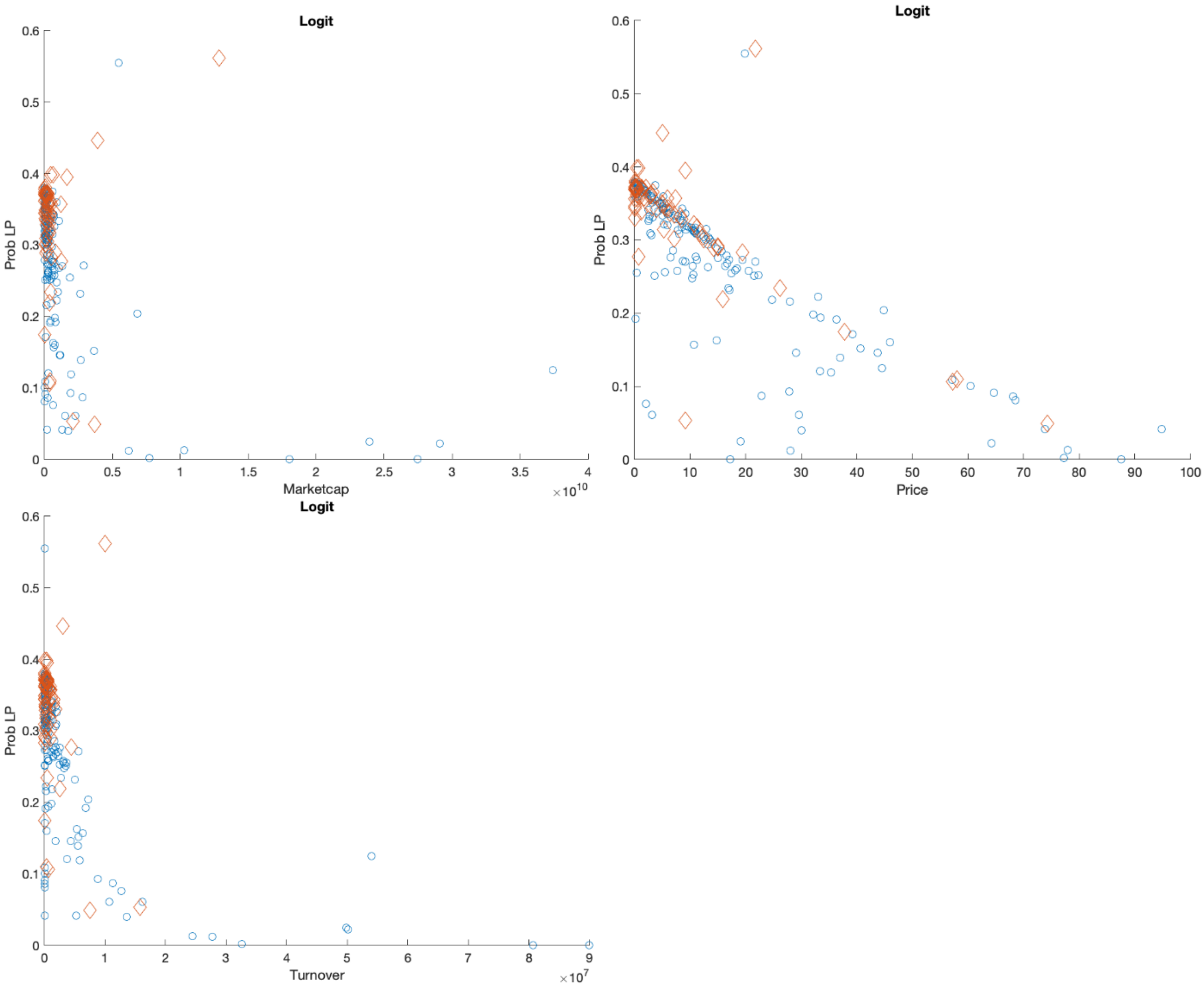
The table above presents the mean, median, standard deviation, kurtosis, skewness, minimum, maximum, and sample size of mid- and small cap firms with LP. MM (millions).

Table A6. Summary statistics – Mid & small cap

Mid & small cap without LP	*Price (EUR)*	*Market Cap*	*Turnover*	*Spread*	*Volatility*
Mean	12.07	274 MM	8.8 MM	0.00961	0.0282
Median	7.64	160 MM	1.6 MM	0.00734	0.0262
Standard Deviation	16.24	303 MM	18.7 MM	0.00816	0.0119
Kurtosis	8.18	4.05	19.29	7.89	26.52
Skewness	2.71	1.76	3.96	2.50	3.76
Minimum	0.05	0.8 MM	5 581	0.00155	0.0121
Maximum	94.82	1 759 MM	132 MM	0.04925	0.1213
Count	138				

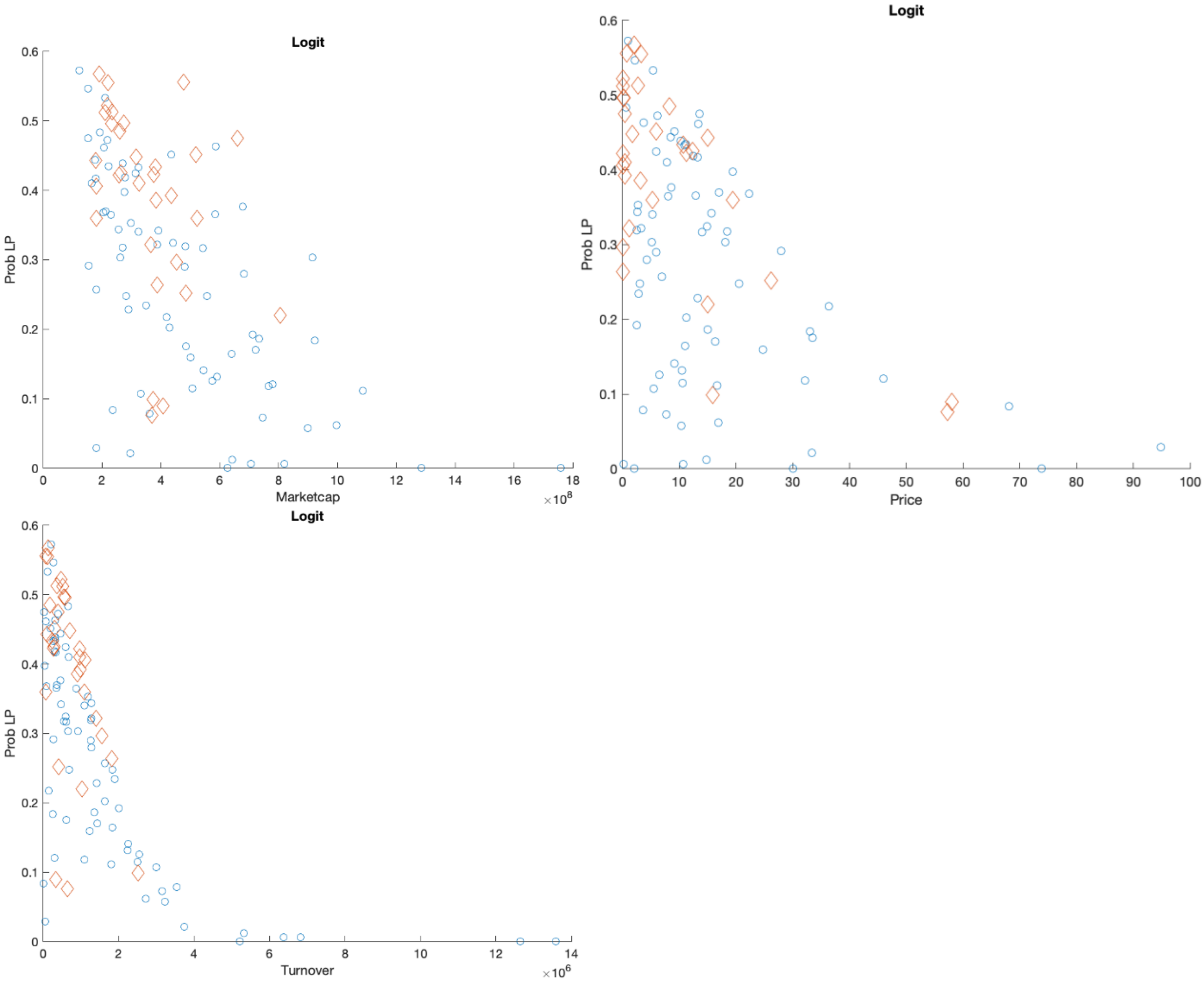
The table above presents the mean, median, standard deviation, kurtosis, skewness, minimum, maximum, and sample size of mid- and small cap firms without LP. MM (millions).

Figure A1. Scatter plot of logit regression on large, mid & small cap - propensity scores



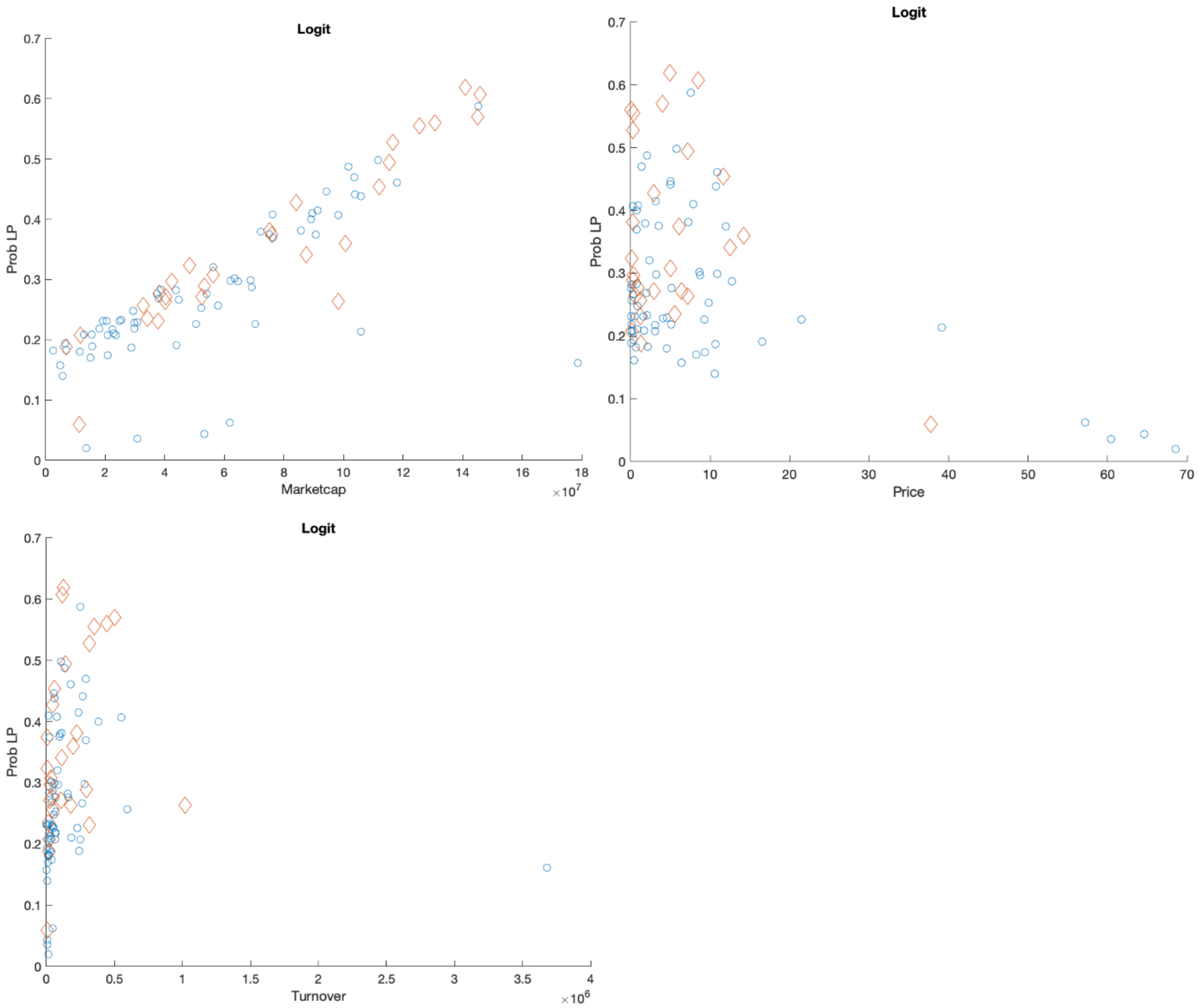
The figures depict the distribution of estimated PS (y-axis) for all large-, mid-, and small cap firms, given each covariate (x-axis). A circle represents the estimated PS for a firm without LP and a diamond represents the estimated PS for a firm with LP. The scatter plot is included to illustrate overlapping given each covariate.

Figure A2. Scatter plot of logit regression on mid cap - propensity scores



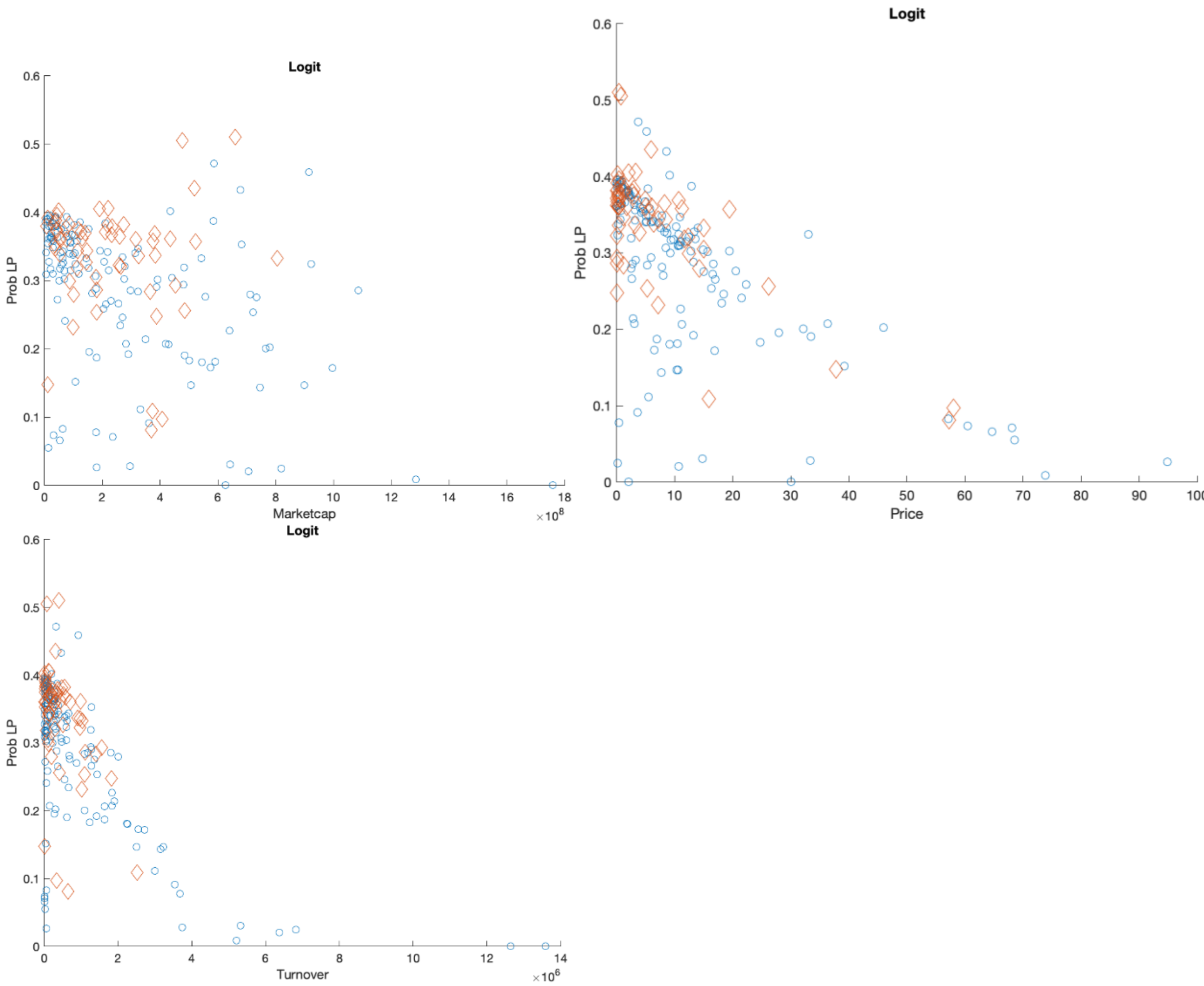
The figures depict the distribution of estimated PS (y-axis) for all large-, mid-, and small cap firms, given each covariate (x-axis). A circle represents the estimated PS for a firm without LP and a diamond represents the estimated PS for a firm with LP. The scatter plot is included to illustrate overlapping given each covariate.

Figure A3. Scatter plot of logit regression on small cap - propensity scores



The figures depict the distribution of estimated PS (y-axis) for all large-, mid-, and small cap firms, given each covariate (x-axis). A circle represents the estimated PS for a firm without LP and a diamond represents the estimated PS for a firm with LP. The scatter plot is included to illustrate overlapping given each covariate.

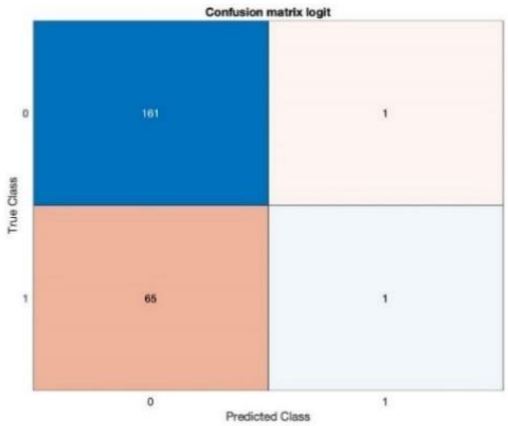
Figure A4. Scatter plot of logit regression on mid- & small cap - propensity scores



The figures depict the distribution of estimated PS (y-axis) for all large-, mid-, and small cap firms, given each covariate (x-axis). A circle represents the estimated PS for a firm without LP and a diamond represents the estimated PS for a firm with LP. The scatter plot is included to illustrate overlapping given each covariate.

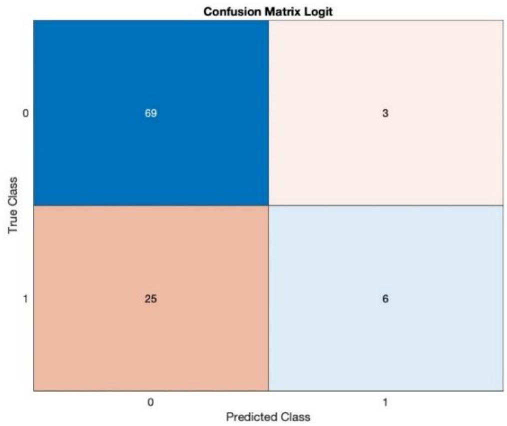
Figure A5. LCM for PSM model predictions

Large-, mid-, & small cap



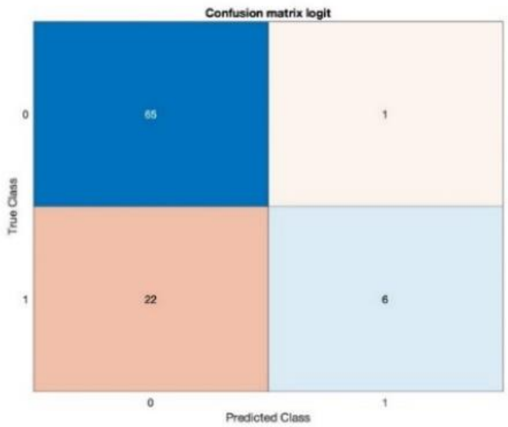
Correct predictions = 71.05%

Mid cap



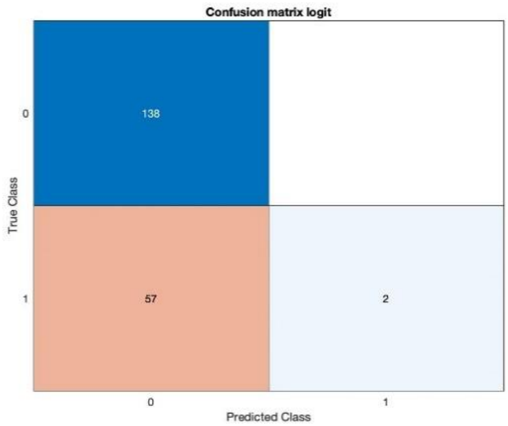
Correct predictions = 72.82%

Small cap



Correct predictions = 75.53%

Mid- & small cap



Correct predictions = 71.06%

The LCM depicts whether the PSM model predicts if a company gets assigned LP or not in relation to actual belonging. 1 is with LP and 0 without LP. Quadrant two and four represents true predictions, vice versa, quadrant one and three represents false predictions. Correct predictions are calculated as the ratio true predictions. LCM are included to indicate the accuracy of the model.

Tabel A7. List of companies included in the study

Companies					
Without LP			**With LP**		
Abliva AB	STO	Small Cap	Arctic Paper S.A.	STO	Small Cap
Actic Group AB	STO	Small Cap	Arion banki hf.	ICE	Large Cap
AddLife AB ser. B	STO	Large Cap	Arise AB	STO	Small Cap
Alligo AB ser. B	STO	Mid Cap	AS Tallink Grupp FDR	HEL	Mid Cap
Ambu A/S	CPH	Large Cap	Aspo Plc	HEL	Mid Cap
Anoto Group AB	STO	Small Cap	BankNordik P/F	CPH	Small Cap
Apetit Plc	HEL	Small Cap	Beijer Alma AB ser. B	STO	Mid Cap
Ascelia Pharma AB	STO	Small Cap	Beijer Electronics Group AB	STO	Small Cap
Aspocomp Group Plc	HEL	Small Cap	Bergs Timber AB ser. B	STO	Small Cap
Atlantic Petroleum P/F	CPH	Small Cap	Brdr.Hartmann A/S	CPH	Mid Cap
Atlas Copco AB ser. A	STO	Large Cap	Brim hf.	ICE	Mid Cap
Attendo AB	STO	Mid Cap	Brinova Fastigheter AB ser. B	STO	Mid Cap
Bactiguard Holding AB ser. B	STO	Mid Cap	BTS Group AB ser. B	STO	Mid Cap
Bank of Åland Plc B	HEL	Mid Cap	Catella AB ser. B	STO	Mid Cap
Basware Corporation	HEL	Mid Cap	Cavotec SA	STO	Mid Cap
Bavarian Nordic A/S	CPH	Large Cap	Concordia Maritime AB ser. B	STO	Small Cap
Bergman & Beving Aktiebolag ser. B	STO	Mid Cap	Dantax A/S	CPH	Small Cap
Besqab AB	STO	Mid Cap	Duroc AB ser. B	STO	Small Cap
Better Collective A/S	STO	Mid Cap	EAB Group Oyj	HEL	Small Cap
Biotage AB	STO	Large Cap	Eik fasteignafélag hf	ICE	Mid Cap
Bittium Corporation	HEL	Mid Cap	Eimskipafélag Íslands hf.	ICE	Mid Cap
Bonava AB ser. A	STO	Small Cap	Elanders AB ser. B	STO	Mid Cap
Bonava AB ser. B	STO	Mid Cap	Empir Group AB ser. B	STO	Small Cap
BONESUPPORT HOLDING AB	STO	Mid Cap	Eolus Vind AB ser. B	STO	Mid Cap
Boule Diagnostics AB	STO	Small Cap	Episurf Medical AB B	STO	Small Cap
Brdr. A & O Johansen præf. A/S	CPH	Small Cap	eWork Group AB	STO	Small Cap
Brøndbyernes IF Fodbold A/S	CPH	Small Cap	Fastpartner AB ser. A	STO	Large Cap
Bulten AB	STO	Mid Cap	Festi hf.	ICE	Mid Cap
Byggmax Group AB	STO	Mid Cap	FM Mattsson Mora Group AB, ser. B	STO	Mid Cap
Calliditas Therapeutics AB	STO	Mid Cap	Gaming Innovation Group Inc.	STO	Small Cap
Cantargia AB	STO	Mid Cap	Hagar hf.	ICE	Mid Cap
Cargotec Oyj	HEL	Large Cap	Iceland Seafood International hf.	ICE	Mid Cap
CellaVision AB	STO	Mid Cap	Icelandair Group hf.	ICE	Mid Cap
ChemoMetec A/S	CPH	Large Cap	Image Systems AB	STO	Small Cap
Chr. Hansen Holding A/S	CPH	Large Cap	Investors House Oyj	HEL	Small Cap
Clas Ohlson AB ser. B	STO	Mid Cap	Josemaria Resources Inc.	STO	Small Cap
Cloetta AB ser. B	STO	Mid Cap	Kindred Group plc	STO	Large Cap
Collector AB	STO	Mid Cap	Kvika banki hf.	ICE	Mid Cap
Columbus A/S	CPH	Small Cap	Lagercrantz Group AB ser B	STO	Large Cap
Componenta Corporation	HEL	Mid Cap	Latour, Investmentab. ser. B	STO	Large Cap
CTT Systems AB	STO	Mid Cap	Lundin Gold Inc.	STO	Small Cap
Djurslands Bank A/S	CPH	Small Cap	Marel hf.	ICE	Large Cap
DORO AB	STO	Small Cap	NAXS AB	STO	Small Cap
Eastnine AB	STO	Mid Cap	Netcompany Group A/S	CPH	Large Cap

Egetis Therapeutics AB	STO	Small Cap
Elecster Oyj A	HEL	Small Cap
Electrolux, AB ser. A	STO	Mid Cap
Evolution AB	STO	Large Cap
Exel Composites Plc	HEL	Small Cap
Fagerhult, AB	STO	Mid Cap
Fast Ejendom Danmark A/S	CPH	Small Cap
Ferronordic AB	STO	Mid Cap
Fingerprint Cards AB ser. B	STO	Mid Cap
FirstFarms A/S	CPH	Small Cap
FLSmidth & Co. A/S	CPH	Large Cap
F-Secure Corporation	HEL	Mid Cap
Fynske Bank A/S	CPH	Small Cap
G5 Entertainment AB	STO	Mid Cap
Gabriel Holding A/S	CPH	Mid Cap
GHP Specialty Care AB	STO	Mid Cap
Glaston Corporation	HEL	Small Cap
Gyldendal B A/S	CPH	Small Cap
Hansa Biopharma AB	STO	Mid Cap
Harboes Bryggeri B A/S	CPH	Small Cap
HEXPOL AB ser. B	STO	Large Cap
Honkarakenne Oyj B	HEL	Small Cap
Humana AB	STO	Mid Cap
I.A.R Systems Group AB ser. B	STO	Mid Cap
Immunicum AB	STO	Small Cap
Immunovia AB	STO	Mid Cap
Incap Corporation	HEL	Mid Cap
Infant Bacterial Therapeutics AB ser. B	STO	Small Cap
International Petroleum Corporation	STO	Mid Cap
Intrum AB	STO	Large Cap
INVISIO AB	STO	Mid Cap
Inwido AB	STO	Mid Cap
JM AB	STO	Large Cap
Keskisuomalainen Oyj A	HEL	Small Cap
Kesla Oyj A	HEL	Small Cap
Knowit AB	STO	Mid Cap
KONE Corporation	HEL	Large Cap
Lammhults Design Group AB ser. B	STO	Small Cap
Lassila & Tikanoja Plc	HEL	Mid Cap
Lehto Group Oyj	HEL	Small Cap
LeoVegas AB	STO	Mid Cap
Lollands Bank A/S	CPH	Small Cap
Lundbergföretagen AB, L E ser. B	STO	Large Cap
Luxor B A/S	CPH	Small Cap
Lån og Spar Bank A/S	CPH	Mid Cap
Matas A/S	CPH	Mid Cap
MedCap AB	STO	Mid Cap
Mekonomen AB	STO	Mid Cap
OEM International AB ser. B	STO	Mid Cap
Origo hf.	ICE	Small Cap
Proact IT Group AB	STO	Small Cap
PunaMusta Media Oyj	HEL	Small Cap
Reginn hf.	ICE	Mid Cap
Reitir fasteignafélag hf	ICE	Mid Cap
Sagax AB A	STO	Mid Cap
Sagax AB D	STO	Mid Cap
Siili Solutions Oyj	HEL	Small Cap
Síminn hf.	ICE	Mid Cap
SinterCast AB	STO	Small Cap
Sjóvá-Almennar tryggingar hf.	ICE	Mid Cap
Skeljungur hf.	ICE	Small Cap
Solar B A/S	CPH	Mid Cap
Strategic Investments A/S	CPH	Small Cap
Strax AB	STO	Small Cap
Studsvik AB	STO	Small Cap
Sýn hf.	ICE	Small Cap
Systemair AB	STO	Mid Cap
Tethys Oil AB	STO	Mid Cap
TF Bank AB	STO	Mid Cap
Vátryggingafélag Íslands hf.	ICE	Mid Cap

Midsona AB ser. A	STO	Small Cap
Moberg Pharma AB	STO	Small Cap
Modern Times Group MTG AB ser. A	STO	Small Cap
Modern Times Group MTG AB ser. B	STO	Mid Cap
Moment Group AB	STO	Small Cap
MultiQ International AB	STO	Small Cap
Net Insight AB ser. B	STO	Small Cap
NGS Group AB	STO	Small Cap
Nilfisk Holding A/S	CPH	Mid Cap
Nilörngruppen AB ser. B	STO	Small Cap
Nixu Oyj	HEL	Small Cap
NKT A/S	CPH	Large Cap
NNIT A/S	CPH	Mid Cap
Nobina AB	STO	Mid Cap
NoHo Partners Oyj	HEL	Small Cap
Nordic Entertainment Group AB ser. B	STO	Large Cap
Nordic Shipholding A/S	CPH	Small Cap
North Media A/S	CPH	Mid Cap
NOTE AB	STO	Mid Cap
Oasmia Pharmaceutical AB	STO	Mid Cap
Olvi Plc A	HEL	Mid Cap
Oma Säästöpankki Oyj	HEL	Mid Cap
Oncopeptides AB	STO	Mid Cap
Ortivus AB ser. A	STO	Small Cap
Pandora A/S	CPH	Large Cap
Panostaja Oyj	HEL	Small Cap
PARKEN Sport & Entertainment A/S	CPH	Small Cap
Ponsse Oyj 1	HEL	Mid Cap
Poolia AB ser. B	STO	Small Cap
Precise Biometrics AB	STO	Small Cap
Pricer AB ser. B	STO	Mid Cap
Probi AB	STO	Mid Cap
Projektengagemang Sweden AB ser. B	STO	Small Cap
QPR Software Plc	HEL	Small Cap
Rapala VMC Corporation	HEL	Mid Cap
Raute Corporation A	HEL	Small Cap
Revenio Group Corporation	HEL	Large Cap
Rias B A/S	CPH	Small Cap
Robit Oyj	HEL	Small Cap
Rovio Entertainment Corporation	HEL	Mid Cap
Saga Furs Oyj C	HEL	Small Cap
Sandvik AB	STO	Large Cap
SAS AB	STO	Mid Cap
Scandinavian Brake Systems A/S	CPH	Small Cap
Serneke Group AB B	STO	Small Cap
Softronic AB ser. B	STO	Small Cap
Solteq Oyj	HEL	Small Cap
Soprano Oyj	HEL	Small Cap

Sotkamo Silver AB	HEL	Small Cap
SSAB AB ser. B	STO	Large Cap
SSH Communications Security Oyj	HEL	Small Cap
Starbreeze AB ser. B	STO	Small Cap
Stockwik Förvaltning AB	STO	Small Cap
Tecnotree Corporation	HEL	Mid Cap
Teleste Corporation	HEL	Small Cap
Tobii AB	STO	Mid Cap
Tokmanni Group Oyj	HEL	Mid Cap
Topdanmark A/S	CPH	Large Cap
TORM plc A	CPH	Mid Cap
Traction AB ser. B	STO	Mid Cap
Troax Group AB	STO	Large Cap
Viking Line Abp	HEL	Mid Cap
Volati AB	STO	Mid Cap
Volvo, AB ser. B	STO	Large Cap
Wihlborgs Fastigheter AB	STO	Large Cap
Wise Group AB	STO	Small Cap
Wulff Group Plc	STO	Small Cap
Xbrane Biopharma AB	STO	Mid Cap
YIT Corporation	HEL	Large Cap
Öresund, Investment AB	STO	Mid Cap