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Bachelor Thesis

THE IMPACT OF LIQUIDITY PROVIDERS ON THE BALTIC STOCK EXCHANGE

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Abstract

The aim of our paper is to analyze the impact of adapting a liquidity providers' system on the Baltic Stock Exchange. In the analysis we focus on comparison of market quality, trading volume, and share prices before and after the event. Previous research suggest that the introduction of the liquidity providers' system is followed by the improvement in market quality - a decrease in quoted spreads and volatility of a stock return as well as an increase in the quoted depth and trading activity. Our research is based on two types of data, daily and intra-day, for companies, which have contracted liquidity providers. To examine the impact of liquidity providers on the value of a company, we conduct an event study applying abnormal return and cumulative abnormal returns concepts. Our results show that the introduction of the liquidity providers' system has a positive impact on the overall quality of the Baltic market. We found that percentage closing and effective spreads diminished in the post event period by 1.98% and 1.41% respectively. The lowered bid-ask spreads promoted liquidity by the increased trading activity; but there was a drop in the trading volume. We found evidence that there is a positive relationship between liquidity and stock prices. The results are robust with respect to the influence of other factors and are not driven by the market trend.

Table of contents

1. Introduction

The liquidity of securities, that is, the relationship between volume of trading and changes in the market price, has won increasing recognition as an element of investment strategy in recent years. Relatively high liquidity is considered to be an attractive characteristic of a stock. One possibility to increase the liquidity of a company's stock is to use liquidity providers' services, where a liquidity provider (LP) can be defined as a market maker providing a contractual improvement in liquidity.

The Baltic Stock Exchange market has undergone several transformation stages. And since 2004 three formerly independent stock exchanges, the Riga, Vilnius and Tallinn Stock Exchanges, have been united into one and today they are part of the OMX Group, which offers access to approximately 80 percent of the Nordic and Baltic securities market.

According to the OMX Baltic Guide 2007, the Baltic market is in the stage of generating new growth and development opportunities and attracting new potential investors. At the same time the rational investor is looking for lower cost related to a new investment, i.e. liquid stock as lack of liquidity translates into a high cost for buyers and sellers. Liquidity in the context of stock markets means a market where large orders can be executed without incurring a high transaction cost (Banerjee and Ghosh, 2004). Thus, a reasonable level of liquidity reduces the risk for an investor. According to previous research in the developing or mature traded market, liquidity providers are expected to make a two-way market (a quoted bid and an ask prices) for a standardized size, provide tighter market spreads (the tightness depending on market conditions), and ensure liquidity making stock more desirable for a potential investor (Tevanen, 2006).

In order to enhance liquidity and thus the attractiveness of the Baltic market, the Baltic Stock Exchanges have introduced a liquidity provider or a market-making program. Today, the liquidity provider program is in place on the Tallinn and Riga Stock Exchanges (since October 2004), and recently it has been introduced on the Vilnius Stock Exchange (October, 2007) (OMX Group, 2007).

The purpose of our paper is to analyze the impact of adapting liquidity providers system to the market quality and share prices on the Baltic Stock Exchange market. Thus, our research question is whether **the introduction of liquidity providers has improved the market quality of the Baltic Stock Exchange.**

The motivation behind our research is to see whether a liquidity provider system has contributed to an improvement in market quality as happened in the case of more developed

OMX Group members such as the Helsinki and Stockholm Stock Exchanges. In addition, LPs are a relevant topic for the Vilnius Stock Exchange (VSE) as it has introduced this program recently. Therefore, research on this topic could provide valuable information for the companies contracting liquidity providers or planning to do so in the near future. Most previous studies have found evidence that companies should consider market quality improvement opportunities as companies make other capital budgeting decisions and that there are residual benefits beyond those contracted for a liquidity provider. Moreover, our paper is the first made on this subject using the Baltic Stock Exchange market data.

The paper is organized as follows: Section 2 defines the liquidity term and provides a brief overview of literature and the main findings in the field. Section 3 discusses the relevant institutional details of all three Baltic Stock Exchanges. Section 4 describes the data used in the analysis. Section 5 presents the research hypotheses and the methodology. Section 6 discusses the results of analysis and the impact of LPs on market quality. The final section concludes.

2. Literature Review

In the following section, we offer an overview of theories and literature that aim at explaining the benefit of introducing liquidity providers on stock exchanges. We start by introducing the concept of liquidity. We provide explanatory descriptions of the factors that have influence on liquidity and explain the link between liquidity and stock returns.

2.1. Liquidity

Liquidity is a complex concept. It is considered to be one of the components that forms the market quality of a particular stock exchange together with such factors as information asymmetry, disclosure etc. According to Amihud (1986), liquidity could be best described as the degree to which an asset or security can be bought or sold on the market without affecting a price of the asset.

In fact, there are many factors that can influence liquidity. One of them is transaction costs such as brokerage fees, order costs, taxes etc. An investor cannot avoid them as they are an integral part of every trading activity that takes place on the market. As a result, a rational investor takes them into account every time he or she acts as an agent on the market (Tevanen, 2006). Moreover, an investor has to consider the future costs of the bought security as well. Such costs include expenses related to the sale of the security in the future: the more risks involved with the share, the higher the compensation for those risks, i.e. the required rate of return is higher and the investor's price is lower.

Thus, if liquidity is a measure of risk or a cost then an investor will discount the share prices more; in other words, an investor will require larger expected return on the investment because of the illiquidity (Amihud, 1986). As a result, a company's cost of capital is directly related to the cost of trading its stock, meaning that a higher level of liquidity could be profitable for a company. This proposition was also empirically proved by Pastor and Stambaugh (2003) using data from US stock exchanges, namely NYSE and AMEX.

How can we measure liquidity? There are different propositions in the academic literature (Amihud, 2002, Tevanen, 2006, Anand, 2005, etc). Generally it is accepted that liquidity can be characterized by a high turnover; in other words, a high level of trading activity in a company's share. Another measure is the spread. The bid-ask spread is significant to investors because it is an indirect transaction cost as it is the cost between buying and selling a security at any given time. The spread is calculated as the difference between the bid and ask prices. It is obvious that a larger spread means higher transaction

cost for an investor. However, the order depth demonstrates the amount of shares that an investor can buy or sell at a given price. A high order depth minimizes the risk of a negative price movement when buying or selling shares. Consequently, a combination of a low spread and high order depth means lower costs for investors.

Based on the previous research three measurements – spread, order depth and turnover - are used to measure the liquidity in our analysis.

2.2. Liquidity and Stock Returns

A wide range of literature shows that there is a direct link between the liquidity of a particular share and the return of this share. For instance, Brennan and Subrahmanyam (1996) found a significant relation between required rates of return and liquidity after adjusting for Fama and French risk factors.

Amihud and Mendelson (1986) find a significant direct effect of quoted bid-ask spreads on stock returns, where the quoted bid-ask spreads are a measure of liquidity. Another work of Amihud (2002) discuss that expected returns are increasing for illiquid stock. The results suggest that illiquidity could explain differences in expected returns across stocks

Jones (2002) finds that bid-ask spreads and turnover can be used to predict stock returns one period ahead. He shows it by using annual data for 100 years of US stocks. In addition, Chalmers and Kadlec (1998) using a bid-ask spread as a measure of liquidity find that it positively affects stock returns. Nimalendran and Petrella (2002) find an improvement in market quality and increase in the price of a share on the Italian Stock Exchange after market makers were introduced for stocks with large bid-ask spreads. In addition, Venkataraman and Waisburd (2005) examine the impact of companies assigning a liquidity provider on the Paris Bourse. They find that a decreased probability of market failure is associated with a statistically significant positive return around adapting date of a liquidity provider. This finding supports an idea that there is a link between trading costs and required returns.

Moreover, there are two research papers that cover the Scandinavian stock market, namely the Helsinki and Stockholm Stock Exchanges, which trading mechanism is to a large extent similar to the one employed by the Baltic Stock Exchanges.

The first study is done by Anand et al. (2005). It analyzes the impact of liquidity providers on the Stockholm Stock Exchange. The sample consists of 50 previously illiquid companies that contracted liquidity provider's services offered on the Stockholm Stock

Exchange. As the above presented stream of literature, they also find empirical evidence that there is a relationship between liquidity and stock prices. All in all, their findings suggest that company can benefit from participating in the market making of its securities.

Tevanen (2006) made the second research that finds evidence for a direct relationship between liquidity and stock returns using data from the Helsinki and Stockholm Stock Exchanges. It can be considered as supplement research to Anand et al. (2005) work because the author uses the same sample of 50 companies listed on the Stockholm Stock Exchange and additional sample for the Helsinki Stock Exchange.

To sum up, if LPs provide an increase in liquidity for a stock it could affect the share price or, in other words, it could result in abnormal returns for a company. The main reasoning behind this is that the market on average predicts the share price changes correctly based on the overall market movement. Thus, in the ordinary environment, not taking into account any external shocks, there will not be any abnormal returns and daily returns would be evenly distributed around the market model predictions. However, the introduction of a liquidity providers system, which has an influence on the liquidity of the market, is expected to cause positive abnormal returns that are increasing over the time until the share price reaches its new equilibrium level. When the new price level is reached the effect of liquidity providers' introduction is eliminated and the abnormal returns are equal to zero. Tevanen (2006) has found evidence that LPs cause positive cumulative abnormal returns for the post - period when LPs have started making the market.

2.3. Liquidity and Market Efficiency

A performance of the financial market is judged by its pricing and transaction efficiency. The efficient market hypothesis states that a market is efficient if prices of securities fully reflect all available information and the information process is efficient, meaning that the amount of information collected is optimal for making an investment decision (Fama, 1970). However, it is important to bear in min that a financial market is considered to be efficient if transaction services are provided at minimum cost (Stoll, 1985).

According to the theory the presence of liquidity providers in the market should have an effect on the market efficiency as they ensure trading process. For instance, Chordia et al (2005) prove that there is a link between the liquidity and market efficiency. The analysis is based on a sample of all NYSE stocks that traded every day during the 1993-2002 decade. They show that liquidity plays an important role in efficiency creation because the higher is the level of liquidity the better is the ability of the market to absorb order imbalances.

It is also proved by Anand et al. in 2005 and then by Tevanen in 2006 that the presence of liquidity providers on the Helsinki and Stockholm Stocks Exchanges has effect on the informational efficiency. The reason is that it is beneficial for liquidity providers to know the fair price of the company, which liquidity providers are monitoring closely.

3. Baltic Market in General

The Baltic Stock Exchange is relatively new and its history dates back to the beginning of the1990s (OMX Group, 2007). Today the Baltic Stock Exchange market is formed by three stock exchanges in Tallinn, Riga and Vilnius. Since 2004 all of them are part of the OMX Group that offers access to approximately 80 percent of the Nordic and Baltic securities market. Currently there are 101 companies listed in the main list of the Baltic Stock Exchange as on June, 2007 (OMX Baltic Guide, 2007). During the last 3 years the number of companies has not changed substantially. However, market capitalization has increase by more than 50%, from 10.67 bln EUR till 16.12 bln EUR starting from 2004 till the first half of 2007 (Table 1). Total Baltic Securities Market turnover has gone up by 20% starting from 2004, and share trading turnover from the first half of 2006 till 2007 on year to year basis was 1.31 bln EUR (OMX Baltic Guide, 2007).

All three Baltic Stock Exchanges employ the same electronic limit order book trading system called SAXESS as being part of the OMX Group the stock exchanges share the same trading system and harmonize rules in order to reduce the costs of a cross-border trading on the Baltic Market. The SAXESS trading model has been successfully launched by the Tallinn and Riga Stock Exchanges since September 2004; however, the Vilnius Stock Exchange has launched SAXESS trading model since May 2005. This trading system provides opportunity to make transactions simultaneously with securities traded in on different exchanges; in addition, multiple types of transaction orders can be used (OMX Group, 2007).

During the period of our study, all stocks were traded continuously from 10:00 AM till 14:00 PM (OMX Group, 2007). There is also an opening and closing call auction for all stocks. Until 2004, there was no official market making in stocks on the Baltic Stock Exchange; thus, the highest quoted bid and the lowest offer price among in a security trading were determined by public limit orders. As a result, wider spreads, one-side markets, or no quotes at all could be observed on the market. Consequentially, it made a stock less attractive for a potential investor because of the liquidity risk.

To improve the situation on the stock exchange, in 2004 the Riga Stock Exchange (RSE) introduced a liquidity providers system. On the Baltic Stock Exchange a LP status is assigned by the stock exchange and the main responsibility of the LP is to (OMX Group, 2007):

- Maintain the quotes at least 85% of trading time on a continuous basis
- Maintain minimum volume set by the stock exchange
- Maintain a limit of spread specified in the contract

The Tallinn Stock Exchange (TSE) and the Vilnius Stock Exchange (VSE) commenced it in 2005 and in 2007 respectively.

According to the regulation of liquidity providers operations, the stock exchange determines maximum spread widths and minimum depths, but companies are able to negotiate narrower spreads or larger depths. The Baltic Stock Exchanges monitor the performance of the liquidity providers based on the terms of the signed contract. It is essential to underline that despite the fact that the Riga, Vilnius and Tallinn Stock Exchanges are united into one Baltic market, which operates under the same regulations; there are still minor institutional differences that have an impact on data treatment and are taken into consideration during our analysis.

3.1. Riga Stock Exchange (RSE)

The total market capitalization of RSE was 2.19 bln EUR in the first half of 2007 and it is almost two times more than in 2004 (Table 1). However, a share turnover of RSE amounted to 62.6 mln EUR in 2007.

On RSE a liquidity provider status is assigned to a company by the stock exchange itself. To become a liquidity provider, a market maker has to sign an agreement with RSE and to choose at least six companies listed on RSE official or secondary list, provided that at least two companies are from the official list and at least two companies are from the secondary list (OMX Group, 2007). The liquidity provider has to maintain the quotes at least 85% of the trading time on a continuous basis. RSE specifies the minimum volume to be maintained by the liquidity provider and puts a limit to the spread of 4% or 0.01 LVL if the share price is relatively low. The official trading currency of RSE is the lat (LVL).

3.2. Vilnius Stock Exchange (VSE)

VSE has the largest market capitalization among all three Baltic Stock Exchanges, 8.697 bln EUR in the first half of 2007 (Table 1). There is a substantial increase in market turnover starting from 2004 suggesting that investors are willing to participate in the trading activity

on VSE. The introduction of LPs on VSE could result in maintaining growth and making market even more attractive for investors.

The regulations concerning a liquidity provider system on VSE is similar to those on RSE. A company can start its activities as a liquidity provider only after signing a market maker's agreement with VSE. According to VSE requirements the maximum spread should not exceed 4 % or not exceed 0.02 LTL, if the reference price of the securities is less than 0.50 LTL (OMX Group, 2007). The liquidity provider has to keep the quotes at least 85% of the time of the trading session on a continuous basis. The official trading currency of VSE is the lit (LTL).

3.3. Tallinn Stock Exchange (TSE)

TSE is the most liquid market among the Baltic Stock Exchanges, its market turnover was equal to 0.79 bln EUR with market capitalization equal to 5.2 bln EUR in the first half of 2007 (Table 1).

Starting from 2005, all new listed companies on TSE have been required by the Listing and Surveillance Committee to sign a market making agreement on certain conditions and to introduce LPs' services for 1 or 2 years after first trading day. This has been done in order to improve liquidity during the very beginning of trading, when the need is the highest.

We do not include data from TSE in making our main analysis because of institutional differences that exist compared to RSE and VSE in employing LPs' services. There is no pre-event trading information and it is impossible to observe the difference before and after introduction of a liquidity providers system. However, we can not totally ignore the presence of this system on TSE and an additional analysis is performed focusing on the effect when the market making contract has expired. The official trading currency of the TSE trading system is the euro (EUR).

4. Data

For our research we obtain data about the companies that employ liquidity providers' services from the OMX website and database. On the whole Baltic Market, namely on the Riga, Tallinn and Vilnius Stock Exchanges, there are 19 companies that during the period from 2004 till 2008 have signed contracts with market makers or a liquidity provider status was assigned to a company by the stock exchange. Market capitalization of the companies included in our sample made up 28.84% of capitalization of the total Baltic Equity Market and turnover was approximately 41.58% of the total Baltic market turnover as on June, 2007 (Table 2). In Table 4 we present the whole sample of the companies along with a name of a liquidity provider, date when an agreement was signed, and date when the agreement came into force. As the latter two dates differ, we use the actual date when a liquidity provider started making a market for each stock in the analysis. The OMX Group provides data on the period for LPs' effective date for each company.

We employ two types of data in our study. First of all, daily trading data is obtained from the OMX database for the whole sample. We use 70 trading days before and after the introduction of liquidity providers' services for daily data. A wider time range appears to be impossible because "City Service" (CTS1L) has started to use liquidity providers' services only since December 3, 2007 (Table 4). However, the mentioned time frame is consistent with pervious research done in this field (see Anand et al, 2005; Tevanen, 2006) and should provide reliable results for the analysis.

In addition, RSE has provided intra-day data for the pre- and- post event period of the liquidity providers' services effective date for each company listed on RSE. In our analysis we use 20 trading days before and after the adoption of a liquidity provider for each company. We suppose that 20 trading days before and after the event is an indicative number based on the fact the previous research papers have used the same period for the analysis (for example, Anand et al., 2005).

The intra-day data set contains snapshots of the price and depth levels of each company's limit order book at 30 minute intervals during the trading day. Previous studies (see Anand et al., 2005) used a narrower time interval for their analysis; however, the trading activity on RSE is not frequent and we use a wider interval in order to avoid missing values and moments when trading did not take place. As RSE employs an opening and closing call auction for all stocks, we only include data during the continuous trading period on the market from 10:00 AM to 14:00 PM (OMX Group, 2007). The event date is not included in

analysis of either sample to avoid noise that could exist during the day when a system has been implemented.

Liquidity providers have begun making a market for companies in our sample on 4 different dates over a 3 year time period. Thus, dates are quite highly concentrated and there is a probability that any observed changes are due to market wide factors. We consider it is necessary to introduce a robustness check and to make additional analysis by constructing a control sample using RSE daily trading data. In control sample we include companies that are listed and traded on RSE from June, 2004 till January, 2005 as during this time period the main proportion of companies have introduced market maker services (Table 4).

We present the main findings of the impact of the liquidity providers based on daily data from RSE and VSE. However, taking into consideration the institutional differences of TSE, where a company is required to sign a market making agreement at the very beginning of a trading activity we do not include it in the main analysis. Therefore, a complementary analysis of a liquidity providers' system on TSE is done in order to cover the whole Baltic market. As the Baltic Stock Exchanges have different trading currency, we have converted all input data for our analysis in euro (EUR) using either prices in euro that are available on the OMX Group website or converting at fixed exchange rates – 0.702804 LVL/EUR and 3.4528 LTL/EUR.

5. Methodology

5.1. Hypotheses

The aim of the paper is to analyze the impact of implementation of a liquidity providers system to market quality and share prices on the Baltic Stock Exchange. Taking into consideration previous studies done in this field we state 3 hypotheses that help us to answer the research question.

Prior empirical research (Anand, 2005; Tevanen, 2006, etc.) has found that the implementation of a liquidity providers' system has improved market quality. Thus, our first hypothesis is that *the emergence of liquidity providers on the Baltic Market has resulted in thinner bid-ask spread and higher depth for stocks.* According to Tevanen (2006), a lower bid-ask spread, in other words smaller investment cost, should influence the trading volumes of security. Consequentially, our second hypothesis is that *the lowered bid-ask spreads have promoted an increase in trading volumes.* Finally, improved liquidity is expected to increase securities values because rational investors discount securities less when trading costs are lower (Amihud and Mendelson, 1986). So thirdly, we hypothesize that *stock price have increased following the adoption of liquidity providers by a company*.

5.2. Models

To test the above stated hypotheses models are chosen based on economic theory and previous empirical studies Tevanen (2006), Anand et al. (2005), The theoretical background is mostly applied from the similar studies exploring the impact of introduction of LP on Stockholm and Helsinki Stock Exchanges due to the trading system similarity..

We start our analysis with measuring the changes in market quality after the introduction of liquidity providers. At the next step we analyze the abnormal and cumulative abnormal returns for the post-event period.

Spread

Firstly, we evaluate changes in the quoted spread and depth for stocks. According to Annand et al. (2005) quoted spreads are defined as the best ask minus the best bid observed on the market. We calculate the spread for each stock, for each period: before and after the introduction of LPs, and then average over all stocks in our sample. Then we test the significance of the difference between pre and post spread values using paired *t*-statistics test with the null hypothesis that the mean difference between the two variables ($d = X - Y$)

where X is the average pre spread and Y is the average spread after the event day, is equal to 0, against the alternative that it is not:

H0: $d = X - Y = 0$

H1: $d = X - Y \neq 0$

Following research of Pankaj Jain (2006) we estimate the effective spread in order to evaluate the real changes in the spread that are captured by investors; moreover, it allows us to eliminate a value effect and assess a real change that could be applicable for the whole sample analysis and further result comparison. The effective spread is calculated based on the quoted midpoint:

$$\frac{BestAsk - BestBid}{(\frac{BestAsk + BestBid}{2})} \quad [1]$$

This measure is widely used in market microstructure research in order to avoid significant bounces of bid and ask prices (Pankaj et al., 2006). For example, McInish and Wood (1992) used the quote midpoint as the reference point for normalizing bid-ask spreads. Stoll (2000) uses the midpoint as the basis for estimating market frictions.

Thus, if there is improvement in market quality, quoted spreads are expected to decrease.

Depth

Next we examine a change in the quoted depth. It is measured in a number of shares in order to capture a real change and not to be misstated by a change in price. The total depth for each company is calculated as the sum of a number of shares on the bid and ask sides. The received amount is averaged across companies; furthermore, statistical significance of changes between two periods is analyzed using the two tailed t-test with the Ho that the difference is equal to zero, against alternative that it is not. It is expected that the quoted depth will increase after the introduction of LPs. According to Annand et al. (2005) the larger depth is better able to absorb liquidity shocks; hence, resulting in lower return volatility leading to increased market quality. Consequently, we next examine changes in volatility of stock's return for our sample, and we expect it to decrease.

Robustness Check

However, based on the results of performed tests we cannot state that all changes in the quoted spread, depth, and return volatility take place due to the introduction of LPs. Therefore, we test whether improved market quality is not due to factors other than the

adoption of a liquidity provider system. For this purpose we employ a model from Stoll (1985) research paper. The author showed that the relative spread is inversely related to price and volume, and positively related to volatility. Therefore, the following control regression is performed:

$$S'_{i,t} = \beta_0 + \beta_1 Price'_{i,t} + \beta_2 Volum'e_{i,t} + \beta_3 \sigma_{i,t} + \beta_4 Dummy_{i,t}, \quad [2]$$

where

- Si,t is the mean spread for firm i in period t;
- $Price_{i,t}$ is the mean closing price for firm i during period t;
- $Volume_{i,t}$ the mean daily share volume for firm i during period t;
- $\sigma_{i,t}$, is the standard deviation of daily return for firm i during period t;
- $Dummy_{i,t}$ is a dummy variable assigned the value of 1 if the period is after a company introduced a liquidity provider; otherwise zero.

In this model, we are interested in the dummy variable, we expect it to be negative and significant; in other words, the observed decrease in the spread can be assigned to the introduction of the liquidity providers system. We are not going to focus on the impact of other variables - price, volume and volatility - as it is out of the scope of our analysis.

Adjustment

Before the analysis of abnormal and cumulative abnormal returns there are important adjustments that should be made. We adjust the share prices for dividends and splits that took place from 2004 till 2008. In order to adjust daily return for corporate actions we use the following calculations:

$$R_{i,t} = \ln\left(\frac{S_{i,t}}{S_{i,t-1}}\right) \quad [3]$$

$$R_{i,t} = \ln\left(\frac{S_{i,t} + D_{i,t}}{S_{i,t-1}}\right) \quad [4]$$

$$R_{i,t} = \ln\left(\frac{S_{i,t}}{S_{i,t-1} * R_{split}}\right) \quad [5]$$

Accordingly, we use equation (3) for all stock prices when there were no dividends and stock splits during our analysis. The formula (4) is used when there was a dividend payment at date t. Finally, we use (5) to adjust for the stock splits when day t was the stock split day; R_{split} stands for a split ratio. We obtain information about dividend dates, gross dividends (taxes

and transaction costs were not taken into consideration), split dates and split ratios from OMX database.

The adjusted daily return can also be considered as continuously compounded return (formula 6). We use log-return because we can capture the non-linear relationships in the changes of stock prices (Patell, 1976).

$$R_{i,t} = \ln\left(\frac{adjusted\_S_{i,t}}{adjusted\_S_{i,t-1}}\right) \quad [6]$$

Cumulative Abnormal Returns

In order to test our third hypothesis we analyze the relationship between stock price and returns, we use the abnormal returns (AR) and the cumulative abnormal returns (CAR) concepts applying the market model based on the Capital Asset Pricing Model (CAPM) with the return on the OMX benchmark index for each Baltic market employed as a proxy for the market return.

Tevanen (2006) suggests that it is possible to measure CARs by estimating the following models. The first step is to estimate the market model regression for the period before introduction where no external shocks occur and abnormal returns are equal to zero:

$$R'_{i,t} = \beta_0 + \beta_1 RM'_t + \varepsilon_{i,t} \quad [7]$$

where $R_{i,t}$ is the logarithmic return on stock *i* on day *t* and RM_t is logarithmic daily total return on the chosen market indices. β_0 and β_1 are a constant and a coefficient, respectively, and ε_{it} is a residual term. The model suggests that a sum of residuals ($\varepsilon_{i,t}$) is an indicator of abnormal returns. If the sum is not equal to zero there are abnormal returns on the market. Observation deviations, error terms, from model's prediction are assumed to be normally distributed with mean equal to zero. The period for the estimation of the market model parameters is from –70 day till –5 day, where days from -4 till 5 are assumed to be an event window. Betas are computed using a simple Ordinary Least Squares (OLS) regression estimation. Using the estimated logarithmic return in equation [7] the following estimation of abnormal returns is proposed for the period when LPs are introduced:

$$AR'_{i,t} = R'_{i,t} - (\beta_0 + \beta_1 RM'_t) \quad [8]$$

where the parameters β_0 and β_1 have been estimated by the market model [7] and R_{it} is the real logarithmic return for a security *i* at time *t*. Based on the obtained results it is possible to estimate CAR for the stock *i* for the event days from – 4 to + 40 meaning that A is equal to T - 4 and S is equal to T + 40:

$$CAR'_{i,s} = \sum_{t=A}^{S} AR'_{i,t} \quad [9]$$

Then, the CARs are averaged across all shares in the sample on the daily basis to obtain average CARi,s for the market for the event days from – 4 to + 40. And the evidence of an increase in prices would be a rise in CARs after the adoption of a liquidity provider system, suggesting that price has increased more after the introduction of LP than it was expected assuming normal environment. The period of -4 days before the starting date of liquidity providers services is chosen as the information about LPs' introduction becomes available at the date when a contract was signed (Table 4); however, by assumption real changes are expected to be observed at period T=0 (starting date). However there is a possibility that noise could appear around the dates when liquidity providers were introduced. Thus, by choosing the event window of 10 days we control for possibility that the effect of introduction of LP could appear in the market prior the event or after that will result in positive or negative CAR prior the event day. If the evidence of significant fluctuations will be found then the event window will be widened so that to identify the period when fluctuation arise so that to assess whether these changes are related to the introduction of LP or changes in prices are caused by another factor.

6. Empirical Results

As the main target of a contract with LPs is to narrow the spread width and to increase the depth, we start our analysis by examining spread and depth of the companies before and after the event date where a spread and depth are measures of market quality. The results for overall market quality are followed by empirical evidence of the relationship between liquidity and stock returns.

6.1. Market Quality: RSE and VSE

Closing spreads

A bid-ask spread can be considered as a cost for the investor. If the spread is large it is more expensive for the investor to trade because buying at one price a person could sell the stock back only at relatively lower price. Thus, larger spread makes shares less attractive than shares with thinner spread, i.e. more liquid stock. Accordingly, in previous studies it has been shown that spreads play a substantial role in pricing of the security and trading (Madhavan et al., 2002).

We present our main findings based on daily data using the entire sample. Therefore, closing spreads are used for the analysis of 12 companies listed on RSE and VSE with the estimation window of 70 trading days before and after the event day. We analyze spread both in absolute (euro) and in relative (percentage) terms. A percentage spread is calculated based on a midpoint of the spread. In order to compare a closing spread before and after the introduction of LPs we present an average spread for pre- and post- event date in Table 6, Panel A. We see that the closing spreads are significantly narrowed in the whole sample. We find that the average spread width dropped from 0.23 EUR to 0.08 EUR with a statistically significant drop of 0.15 EUR. Analyzing the percentage closing spreads we see that they have dropped on average from 3.68% to 1.70% with a statistically significant at 1% level decrease of 1.98%.

Additionally, in Table 7 the closing spreads of shares of all companies before and after the event are presented. It is obvious that there is a decrease in the closing spread for the whole sample. All the reductions with one exception for City Service (CTS1L) are highly statistically significant at 1% significance level. Overall, after the liquidity providers' system has been introduced, 11 companies out of 12 have experienced a statistically significant decline in their spreads.

Our results provide evidence that the closing spread have diminished after the introduction of LPs. However, it is important to underline that the closing spreads represent only a snapshot value of the trading day; however, they do not represent the overall effective spreads. The reason behind it is that the quoted closing spread is the spread observed in the market at a single point in time, while the effective spread is measured through time and reflects the economic cost of trading (Duffy, 2006). Therefore, the analysis of the closing spreads does not provide strong evidence of improvement in market quality. This means that if the closing spreads have diminished it would vaguely suggest that launching of LPs had an influence on market quality. Taking into consideration this feature and in order to control for a decline in the effective spread we make an additional analysis using an intra-day data for RSE.

Effective spreads

The quote intra-day data that we use for our study is based on snapshots of the limit order book of RSE at every 30 minutes throughout the trading day. We calculate the arithmetical average spread for each stock and then average over all stocks in our sample for 20 trading days before and after the event. Additionally, we calculate the effective quoted spread in euro as the best ask price minus the best bid price during 30 minutes interval as well as the percentage spread that is calculated based on the midpoint of the spread.

Basically we perform the same analysis as for daily data and the results of the analysis are presented in Table 8, Panel A. According to the results the average spread width dropped from 0.61 EUR to 0.24 EUR with a statistically significant drop of 0.37 EUR. The percentage spread dropped on average from 4.98% to 3.57% with a statistically significant drop of 1.41%. Thus, the post-event percentage spread is below the maximum width set by requirements of a liquidity provider's agreement that is equal to 4 % throughout the sample. These findings are in line with the results of the previous studies about a liquidity providers' system. For instance, Anand et al (2005) also found that the spread width declines more in the post period than it is set by agreement requirements.

Making a deeper analysis and examining each stock separately (Table 9) we see that on average the percentage of observed spreads in the post period are narrower for 7 stocks out of 10 than the maximum, which is established by the agreement. This analysis captures the dispersion of the quoted spreads and shows whether traders made an additional contribution to the market after the adoption of liquidity providers' system. It is important to admit that in the case of GRD1R, VNF1R and VSS1R the pre-event percentage spread is narrower than the

contractual maximum and the post-event spread has decreased significantly as well. For example, a pre-event effective spread of VNF1R is 3.62% that is narrower than LPs' contractual maximum of 4%. The post-event spread becomes even thinner (2.50%) compare to the pre-event spread. It is obvious that LPs prefer to maintain a maximum contractual spread set in the agreement and they do not have any incentive to narrow it because it will result in higher cost for them. As a result, such reductions in the spread can be attributed to additional public orders meaning that the liquidity provided by LPs leads to additional contribution from the investors' side (Anand et al., 2005). This shows that contracting LPs not only results in a narrower closing and effective spread but it is also value adding to the company as it gains more in the reduction of a spread then it is set by the contract terms and it reduces the liquidity risk.

Depth and Return Volatility

Next step is to see whether LPs have an impact on another measure of liquidity - depth. The analysis for a quoted depth is performed using intra-day data. We measure the depth in a number of shares. To calculate the total depth we compute a sum of the number of shares on the bid and ask sides when there is a two-side market. The two-side market exists when both bid and ask price for each security are quoted.

Based on the results presented in Table 8, Panel B we can see that the depth has increased significantly from 2035.19 shares till 3516.66 shares. This suggests that the presence of LPs in the market is associated with a higher depth for a stock and consequentially with higher market liquidity.

The previous studies proposed that an increase in the depth should have an impact on variability of returns and should provide evidence for smaller volatility as higher depth better absorbs market shocks (Anand et al., 2005). Thus, we next analyze whether the observed increase in the depth reduces the bounces of a stock price.

We examine changes in volatility of a stock return for our sample. According to Anand et al. (2005), we define volatility as the standard deviation of 30 minute returns based on the quote midpoint when a two-sided quoted spread exists for a 30 minute time window in our study. In case when a two-sided quoted spread does not exist for the chosen time window the return is calculated for a period that exceeds it.

The results of intra-day volatility are presented in Table 8, Panel B. We see a slight decrease in volatility meaning lower variation of returns. Venkataraman and Waisburd (2005) empirically showed that firms with narrower spread can be characterized by a smaller

volatility as the observed increase in depth reduces the impact of price shocks. However, our results are not significant even at 10% significance level and do not support the evidence from previous research. One of the possible explanations could be that investors do not associate a larger depth and narrower effective spread with more stable returns on the Baltic Market.

Trading Activity

A number of studies have shown that a spread width is inversely related to trading activity (for example, Stoll, 1985). There are several measures for the trading activity; we define it as the average daily number of deals and the average daily trading volume of a security, measured in both a number of shares and euro. Based on the previous studies we expect these measures to increase following the adoption of market making activities of LPs.

The results for measures of trading activity are reported in Table 6, Panel B. We find that the average daily number of deals increases from 5.67 to 7.84 deals per trading day and the increase is statistically significant at 1% significance level. However, the raise in a number of deals is accompanied with a statistically significant 2 time decrease in average daily trading volume, measured in both number of shares and currency. At this point our results are not consistent with the majority of studies, for example, Tevanen (2006) and Anand et al. (2005) have found that the introduction of LPs was followed by a statistically significant increase in traded volumes both in currency units and number of shares. In the Baltic Market case we have a significant increase in the number of deals; however, the trading volume has decreased.

Analyzing our data at pre- and post-event periods, we find that before the introduction of LPs there was a substantial number of large transactions and we cannot exclude them from the analysis as outliers because it would result in biased estimations and would not reflect true changes in the market. Thus, our results suggest that adoption of liquidity providers' system is followed by an increase in a number of deals on the market with relatively smaller transaction amounts, meaning smaller investors entered the market realizing that trading cost became lower as the bid-ask spread decreased. It resulted in more dispersed and liquid trading process. Similar evidence was found in empirical analysis made by Haris (1994) using data of NYSE and AMEX shares in 1989. He assumed that the minimum price variation and smaller spread will positively affect trading volumes as the large bid-ask spreads make trading expensive. However, this hypothesis was not supported as the declines in spreads were associated with decreased trading and deepened market depth.

Robustness Check

An important issue is to check whether the improvement in market quality is influenced by other factors than the adoption of LPs. Therefore, based on the previous studies we run a regression [2] to see the effect of introducing LPs.

We expect a parameter estimate for a dummy to be negative and significant, meaning that there is an additional effect in the post-event period and the observed decrease in spreads can be attributed to the introduction of liquidity providers. The results are reported in Table 11. We find that the parameter estimate for the dummy variable, as it was expected, has a negative sign and it is statistically significant at 1% significance level for both absolute and percentage spread. The signs of other coefficients are statistically significant at 10% level and are in line with theory proposed by Stoll (1985), i.e. a relative spread is inversely related to price and directly related to volatility. Trading activity appeared to be statistically insignificant.

The results of regression provide evidence that the introduction of liquidity providers for companies has an impact on overall improvement of market quality.

Control sample

The date of contracting LPs by the companies is concentrated around October, 2004 in our sample as eight companies listed on RSE that are contracting LP signed the contract in this period. Therefore, we suppose that it is necessary to control our analysis for this time period in order to state that our results do not represent the general trend on the market.

To capture this possible bias, if it exists, we construct a control sample of 11 listed on RSE companies during the following period – from June 2004 till January 2005 (Table 3). We have performed an analysis of all listed companies on RSE at this period and created a sample of most frequently traded companies. All in all we have constructed a control sample that consists of 11 companies. In Table 3 we see that they are rather illiquid in comparison to our main sample and they accounts for less than 3% of total RSE turnover however at the same time they represent almost 13% of market capitalization in the corresponding period, thus we consider this to be indicative sample that can provide evidence of the average market trend. In addition it was impossible to choose other companies as for other listed companies' trades occur rather infrequently once per several days thus it couldn't provide us any meaningful results on overall market performance, moreover during the preliminary analysis no evidence of any changes in trade frequency was found for other listed companies.

Using daily data we perform the same analysis as for our main sample, and compare the spread width and trading volume before and after the event day. The results that are presented in Table 12 appear to be substantially different from those we get from our main analysis. There is an increase in the spread width from 18.99 % to 27.35 %, such large spread can be explained by the fact that the control sample mainly consists of illiquid companies. Additionally, we do not find any evidence for the change in trading volumes as the results are statistically insignificant even at 10 % significance level. The analysis performed using the control sample implies that our main findings are not driven by the overall market trend.

Summary

Based on the robustness check and on the analysis of the control sample, the above findings imply that the introduction of a liquidity providers' system has a positive impact on market quality on the Baltic Stock Exchange. Thus, we do not reject the first hypothesis as empirical analysis showed that the closing and effective spreads diminished in the post event period as well as depth of the market has increased. The second hypothesis can not be fully rejected as even though the trading volumes have decreased, the number of deals has increased in the post-event period that also promotes liquidity.

All in all, we conclude that the adoption of LPs on RSE and VSE led to the increase in market quality - lower bid-ask spreads and increased market depth promoted liquidity by increased trading activity accompanied by a drop in trading volumes.

6.2. Market Quality: TSE

The institutional differences on TSE, where a company is required to sign a market making agreement during the very beginning of trading, does not allow us to test the stated hypotheses. In this particular case an event date is the date when an agreement with a LP has been terminated. For a complementary analysis, we draw two additional hypotheses and we expect the effect of terminating agreement with LPs will have an inverse effect on the sample comparing to previously discussed results. The first hypothesis is as follows: *the expiration of liquidity providers' services on TSE has resulted in larger bid-ask spread for stocks.* The second hypothesis is *larger bid-ask spreads have promoted a decrease in trading volumes.*

For the analysis we use the same measures and methodology as for our main sample. From the results that are presented in Table 10, we find that the closing spread has increased by 0.015 EUR in absolute terms or by 0.45% in relative terms. This increase is statistically significant at 10% significance level. However, we see that an increase in the effective spread

is relatively small as changes by 0.11% will not make a substantial loss or gain for an investor until he or she does not invest a substantial amount of money. At this point we cannot reject the first additional hypothesis and we have to admit that the liquidity providers contributed to the liquidity of a stock during the very beginning of trading.

Despite our expectations trading volumes have increased that contradicts to our second additional hypothesis and we reject it. After the expiration date of the contract there is a considerable increase in number of deals, from 36.89 to 64.09, and daily trading volume, from 64879.7 to 178647.3 shares. However, taking into consideration that there was no dramatic increase in the spread after companies stopped contracting a LP then increase in volumes could reflect the market growth, which is a part of developing markets.

All in all, we consider that the introduction of a liquidity providers' system on TSE at the very beginning of trading has an impact on companies' liquidity and establishing strong relationships with potential investors. And according to our results, terminating an agreement with a LP does not significantly influence the liquidity of a stock.

6.3. Cumulative Abnormal Returns: RSE and VSE

In our study we have found evidence that the introduction of liquidity providers resulted in an increase in liquidity and enhanced better market quality. We expect that this would lead to a permanent increase in a share price after the event date. Particularly for the shares with larger increase in the spread and in trading volumes we expect a higher rise in the price.

Before evaluation of the CARs trend on the Baltic Market we perform a test on market model estimation, assuming that in the normal environment where no external shocks occur, abnormal returns are equal to zero. Our null hypothesis in this case is that a sum of all errors is equal to zero. Results for market model estimation are presented in Table 13. The model stands for all companies included in the sample and ARs, mean for sample average is equal to zero. Thus, we conclude that the sum of mistakes is not statistically different from zero.

Based on the obtained results of market model estimation we calculate CARs for companies that have singed an agreement for market-making services. In Figure 1 we depict the overall trend for the sample. Despite our expectations that abnormal returns are observed after the introduction of LPs and not necessarily at the first day of beginning their operations the positive cumulative returns appear in the period T – 2, i.e. two days before starting day of LP operations; therefore, it supports the idea that the information about the introduction of LPs also plays a significant role and could create positive expectations about possible gains in

the future on the market because on average for our sample there are from 2 to 4 days from signing the contract and coming it into force. However, after the day 5 there is a significant increase in CARs that amount to approximately 3.5% per day (Figure 1). This number on average is similar to previous research. For example, Anand et al. (2005) found that the average return at the day when LPs started their services is a positive number and it is equal to1.08%. CARs for the tenth post-event day are 6.19% on the Stockholm Stock Exchange. Following up their research Tevanen (2006) found evidence of increased prices after the introduction of LPs' system and a rise in the price is about 4.2% for all shares in the sample for the Stockholm and Helsinki Stock Exchanges.

CARs keep rising until the thirtieth day and after this date they cancel out as no external shocks occur in the market (Figure 1), suggesting that new equilibrium level is reached. And starting from day 13 the pattern stabilizes and no significant fluctuations occur. The upward sloping pattern of CARs suggests that prices have started to increase close to event date, namely T -2 and keep rising until a new equilibrium level is reached. Based on this evidence it is possible to conclude that an increase in the price is permanent and it is caused by the introduction of LPs on the market.

As the next step, we perform analysis of CARs based on changes in the spread. We divide our sample in two sub-samples according to the magnitude of the decrease in the spread. We define a large change in the spread as a decrease higher than 2% in post-event period (Table 7); otherwise, it is considered to be a small change. The results are presented in Figure 2. For the first sub-sample, the companies experiencing a larger change in the spread, there is a high instant effect, during the first 4 days CAR rises till 6%, suggesting that higher liquidity caused ARs for a company. This means that a decrease in relative trading costs is higher for those companies; thus, due to decrease in trading cost, which is caused by improved liquidity there is a possibility of a higher gain for investors. In our sample the companies that have gained more in liquidity had a relatively large spread in the pre-event period and it is around 3-4% (Table 7). However after the twelfth day CARs started to decrease. Reasoning behind this is that market expectations about the decrease in the spread are higher than the actual decrease; thus, CARs dropped till the level that really reflects gains in liquidity for the companies. The pattern for the second sub-group, the companies with a smaller decrease in the spread, is different comparing to the first one. The main difference is that these companies have been already relatively liquid before the event date thus, a decrease in the spread is not so substantial and liquidity has been improving gradually. The results

suggest that the effect on the price after the introduction of LPa is more stable for companies, which have a smaller decrease in the spread. All in all the evidence that there is higher price increase for liquid companies contracting LP is obtained however there are positive price changes also for other companies.

In addition, we analyze whether ARs and CARs are statistically significant on the market. The reasoning behind this is that if ARs are not statistically significant then CARs can not be considered meaningful. Results are presented in Table 14 and they show that ARs for all changes in the spread are statistically significant at 10% significance level and on average are equal to 0.13% per day.

Furthermore, we compare CARs among the companies based on the change in a number of deals per day. We expect that companies with a higher change in the level of liquidity, in this case as a measure of liquidity we use a number of deals per day (if a number of deals per day is increasing then company's securities become more liquid and vice versa). The pattern of CARs depicted on Figure 3 supports our idea, meaning that for companies with a higher change in the number of deals per day there are higher CARs. However, from the results presented in Table 15 we see that for a small change in the number of deals ARs are not statistically significant and for a large change ARs are significant only at 10% level. Thus, we do not find strong evidence that a price change is higher for companies with a larger number of deals in the post-event period.

Based on the performed analysis we have shown that the introduction of LPs on the RSE and VSE resulted in positive CARs on the market, suggesting that share prices for the companies included in our sample have increased than they would have increase without an introduction of LP. Additionally, we have found evidence that for companies with a higher decrease in the spread there is a larger instant effect, but a rise in the price for companies with a relatively smaller change has a more stable pattern. The analysis of dependency between price change and number of deals per day proved that this effect is statistically significant for companies with a higher change in a number of deals. To sum up, we can not reject our third hypothesis as empirical evidence shows that prices have increased following the introduction of a liquidity providers' system.

7. Conclusion

In this paper, we examine the impact of adapting a liquidity providers' system on market quality of the Baltic Stock Exchange.

Our paper is the first made on this subject using trading data of the Baltic Stock Exchange. Moreover liquidity providers are a relevant topic for the Vilnius Stock Exchange because it has introduced this system in October 2007 as well as for Riga Stock Exchange that currently experiencing a problem of low investors' activity due to low market quality. Therefore, research on this topic could provide valuable information for the companies contracting liquidity providers or planning to do so in the near future. According to previous studies, companies should think about market quality improvement opportunities as it is one of the capital budgeting decisions and that there are residual benefits beyond those contracted for a liquidity provider.

On the whole Baltic Market, namely in the Riga, Tallinn and Vilnius Stock Exchanges, there are 19 companies: 10 listed on RSE, 2 listed on VSE and 7 companies listed on TSE that during the period from 2004 till 2008 have signed contracts with market makers where an exchange imposed maximum for stocks employing liquidity providers.

In our analysis we use two types of data in our study - daily trading data for estimation window of 70 trading days before and after the event and intra-day data for 20 trading days before and after the event. We present the main findings of the impact of the liquidity providers based on daily data from RSE and VSE, and perform comparative analysis for TSE.

In our work we find evidence that the closing and effective spreads for RSE and VSE are significantly narrowed in the post-event period - the percentage closing and effective spreads dropped by 1.98% and 1.41% respectively. The post-event percentage spread is below the maximum width set by requirements of a liquidity provider agreement that is equal to 4 % throughout the sample. Such reductions in the spread can be attributed to additional contribution from the investors. We also find that depth increases for RSE intra-day sample.

Regarding trading activity on RSE and VSE, we find that the average daily number of deals increases from 5.67 to 7.84 deals per trading. However, this raise is accompanied with a decrease in average daily trading volume, measured in both number of shares and currency. It is inconsistent with previous empirical findings and can be explained that the adoption of liquidity providers' system is followed by an increase in a number of deals on the market

with relatively smaller transaction amounts. Smaller investors entered the market realizing the beneficial opportunity of decreased trading cost as the bid-ask spread became narrower.

Based on CARs estimation for pre- and post-event period for RSE and VSE we have found evidence that LPs resulted in a permanent increase in the price on the market that on average is equal to 3%. A higher increase in the price is observed for companies with thinner spread and a larger number of deals.

Our results for TSE on changes in market quality were not fully consistent with our expectations suggesting that even though there is a slight increase in effective spread by 0.11% after the termination of the agreement with a LP there is almost two time increase in the number of trades and daily trading volumes. These findings imply that LPs services provided from the beginning of trading has an impact on companies' liquidity and establishing strong relationships with potential investors.

All in all, the liquidity providers have a positive effect on market quality of the Baltic Stock Exchange. However the results on VSE do not provide strong evidence on impact of liquidity providers on the market as not in all cases obtained results were consistent with our expectations thus the only conclusion is that there could be a positive impact on VSE market quality thanks to LP introduction, however unless more companies enter into contract with LP no stronger evidence could be provide. In addition we have found out that companies listed on TSE are the most liquid in the Baltic Stock Exchange, thus it could be reasonable to employ similar requirements for LP services for VSE and RSE so that to promote higher liquidity. All the obtained results are robust with respect to the influence of other factors and are not driven by the market trend that could be concluded based on control sample analysis, performed for RSE ,where no evidence of similar trend in liquidity were found for companies that are not contracting LP.

Further Research

This paper is the first attempt to explore the effect of the introduction of a liquidity providers system on the Baltic Stock Exchange. There were no papers trying to evaluate the magnitude of this impact and the benefits for a company that has signed an agreement with a liquidity provider.

As the study is a starting point in exploring this field, it raises several questions for further research. First of all, our study does not evaluate the value of a market maker for the most actively traded stocks and it does not examine the profitability of liquidity agreements with market making companies. And it could be interesting to analyze a relationship between

contract costs to the contractual improvement in market quality, company's specific characteristics and existing relationships with a liquidity provider. Secondly, it could be worth examining trading profits of a liquidity provider and to see whether they obtain compensation other than the fees from the contracts. We believe that these questions provide an interesting ground for future research.

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Appendix 1: Descriptive Statistics of Sample

Table 1 - Descriptive Statistics of Baltic Market

The table contains information about the Baltic Stock Exchange in general and information about VSE, TSE and RSE separately. The table includes information on Market Capitalization, Market Turnover, a number of companies participating in the market and average company size. In the statistics for individual stocks ratio on market capitalization to GDP is presented. All figures are presented in EUR for the period from 2004 till the 1st half of 2007.

	2004	2005	2006	1H2007
Baltic Market Total				
Market Capitalization (mEUR)	10667	12075	14340	16118
Market turnover (mEUR)	1064.2	2602.8	2460.7	1307.2
Number of companies	95	104	98	101
Average company size (mEUR)	160.10	131.60	173.67	188.97
Riga Stock Exchange (RSE)				
Market Capitalization (mEUR)	1208	2177	2034	2192
Market turnover (mEUR)	87.2	76.8	87.7	62.6
Number of companies	39	45	40	42
Average company size (mEUR)	31	48.4	50.9	52.2
Market cap (% of GDP)	10.80%	17%	12.60%	11.20%
Vilnius Stock Exchange (VSE)				
Market Capitalization (mEUR)	4753	6937	7728	8697
Market turnover (mEUR)	314	588	1607	453.4
Number of companies	42	43	42	42
Average company size (mEUR)	113.2	161.3	184	207.1
Market cap (% of GDP)	26.20%	33.60%	32.50%	32.50%
Tallinn Stock Exchange (TSE)				
Market Capitalization (mEUR)	4706	2961	4578	5229
Market turnover (mEUR)	663	1938	766	791.2
Number of companies	14	16	16	17
Average company size (mEUR)	336.1	185.1	286.1	307.6
Market cap (% of GDP)	50.20%	26.80%	35%	34%

(source: OMX Baltic Guide, 2007)

Table 2 - Descriptive Statistics of Sample

The table presents descriptive statistics of companies that are included in our main analysis. All figures are calculated in EUR for the period from 30 June 2006 till 1 July 2007.

	Ticker	Company Name	Market Cap (mEUR)	As % of Total Baltic Equity Cap	Turnover (mEUR)	As % of Total Baltic Turnover
Riga Stock Exchange (RSE)						
	BAL1R	Latvijas Gāze	48.00	0.30%	2.26	0.17%
	DPK1R	Latvijas Kuģniecība	4.11	0.03%	3.97	0.30%
	GRD1R	SAF Tehnika	102.15	0.63%	16.12	1.24%
	GZE1R	Ventspils nafta	596.11	3.70%	1.92	0.15%
	LSC1R	Ditton PKR	355.72	2.21%	11.94	0.92%
	OLF1R	Grindeks	56.57	0.35%	3.72	0.29%
	RKB1R	Latvijas balzams	14.28	0.09%	3.61	0.28%
	SAF1R	Olainfarm	25.15	0.16%	9.14	0.70%
	VNF1R	Rīgas Kuģubūvētava	398.41	2.47%	7.53	0.58%
	VSS1R	Valmieras stikla šķiedra	71.42	0.44%	6.29	0.48%
Vilnius Stock Exchange (VSE)						
	CTS1L	City Service	74.10	0.46%	3.24	0.25%
	VLP1L	Vilkyškių pieninė	14.09	0.09%	0.43	0.03%
Tallinn Stock Exchange (TSE)						
	ARC1T	Arco Vara	153.87	0.95%	10.65	0.82%
	EEG1T	Ekspress Group	111.93	0.69%	28.85	2.21%
	EEH1T	Tallinna Vesi	415.95	2.58%	87.40	6.71%
	OEG1T	Starman	906.00	5.62%	113.88	8.74%
	SMN1T	Tallink Group	65.40	0.41%	3.60	0.28%
	TAL1T	Eesti Ehitus	970.30	6.02%	166.50	12.78%
	TVEAT	Olympic Entertainment Group	265.00	1.64%	60.40	4.64%
		Total	***4648.56***	***28.84%***	***541.45***	***41.58%***

(source: OMX Baltic Guide, 2007)

Table 3 - Descriptive Statistics of Control Sample

The table presents descriptive statistics of companies that are included in the control sample. All figures are calculated in EUR for the period from June 2004 till January 2005.

Ticker	Company Name	Market Cap (mEUR)	as % of total RSE	Turnover (mEUR)	as % of Total RSE
	RSE	**688**	**100%**	**96**	**100.000%**
BLZ1R	Baloži	0.210	0.031%	0.010	0.010%
FRM1R	Rīgas Farmaceitiskā Fabrika	0.690	0.100%	0.010	0.010%
GRZ1R	Grobiņa	0.750	0.109%	0.060	0.063%
KA11R	Kurzemes atslēga	0.390	0.057%	0.070	0.073%
LAP1R	Liepājas autobusu parks	0.360	0.052%	0.020	0.021%
LJM1R	Latvijas jūras medicīnas centrs	1.370	0.199%	0.020	0.021%
LME1R	Liepājas metalurgs	52.660	7.654%	1.450	1.510%
LOD1R	Lode	20.320	2.953%	0.320	0.333%
LOK1R	Daugavpils Lokomotīvju Remonta Rupnīca	2.070	0.301%	0.030	0.031%
LTT1R	Latvijas Tilti	0.670	0.097%	0.180	0.188%
RAR1R	Rīgas Autoelektroaparatu Rupnīca	1.960	0.285%	0.100	0.104%
Total		**81.450**	**11.839%**	**2.270**	**2.365%**

(source: OMX Group, 2008)

Table 4 - Descriptive Statistics of Companies Listed on RSE and VSE

The table contains 10 listed companies on RSE and 2 companies on VSE that have contacted liquidity providers; the date when a contract was signed and become effective. An average closing percentage spread for 70 trading days prior to the starting date of LP services and a contractual maximum spread are reported.

RSE						
Ticker	**Issuer**	**Liquidity provider**	**Agreement signed**	**Starting Date**	**Average Spread (%)**	**Contract Spread (%)**
GZE1R	Latvijas Gāze	SEB Unibanka	05.08.2005	01.09.2005	2.85%	4%
LSC1R	Latvijas Kuģniecība	Hansabanka, Parex banka, SEB Unibanka	29.09.2004	01.10.2004	6.29%	4%
SAF1R	SAF Tehnika	Hansabanka, Parex banka	29.09.2004	01.10.2004	4.21%	4%
VNF1R	Ventspils nafta	Hansabanka	27.09.2004	01.10.2004	3.32%	4%
DPK1R	Ditton PKR	Parex banka	29.09.2004	01.10.2004	3.39%	4%
GRD1R	Grindeks	Hansabanka, Parex banka	29.09.2004	01.10.2004	5.31%	4%
BAL1R	Latvijas balzams	SEB Unibanka	05.08.2005	01.09.2005	3.52%	4%
OLF1R	Olainfarm	Parex banka, SEB Unibanka	29.09.2004	01.10.2004	3.09%	4%
RKB1R	Rīgas Kuģubūvētava	Hansabanka, SEB Unibanka	27.09.2004	01.10.2004	4.36%	4%
VSS1R	Valmieras stikla šķiedra	Hansabanka, Parex banka, SEB Unibanka	29.09.2004	01.10.2004	2.48%	4%
VSE						
Ticker	**Issuer**	**Liquidity provider**	**Agreement signed**	**Starting Date**	**Average Spread (%)**	**Starting Date**
CTS1L	City Service	UAB FMĮ "Orion Securities"	27.11.2007	03.12.2007	0.88%	4%
VLP1L	Vilkyškių pieninė	UAB FMĮ "Orion Securities"	15.10.2007	29.10.2007	3.62%	4%

(Source: OMX Group, 2008)

Table 5 - Descriptive Statistics of Companies Listed on TSE

The table contains 7 listed companies on TSE that have been required to sign an agreement with LP by the Listing and Surveillance Committee.

TSE				
Ticker	**Issuer**	**Liquidity provider**	**Starting Date**	**Expiration Date**
ARC1T	Arco Vara	AS SEB Eesti Ühispank	21.06.2007.	N/A
EEG1T	Ekspress Group	AS Suprema Securities	05.04.2007.	N/A
TVEAT	Tallinna Vesi	AS Hansapank	01.06.2005.	01.06.2007.
SMN1T	Starman	AS Hansapank	28.06.2006.	28.06.2007.
TAL1T	Tallink Group	Suprema Securities	09.12.2005.	09.12.2006.
EEH1T	Eesti Ehitus	AS Suprema Securities and AS Hansapank	18.05.2006.	18.05.2007.
OEG1T	Olympic Entertainment Group	AS Hansapank	23.10.2006.	23.10.2007.

(Source: OMX Group, 2008)

Appendix 2: Market Quality Measures

Table 6: Market Quality Measures for the Whole Sample using Daily data

The table presents the results for changes in market quality measures for a sample of 10 RSE and 2 VSE listed companies that have signed a contract for liquidity providers' services. The pre (post) sample period is the 70 trading days before (after) the starting date of the agreement. The starting date is not included in either sample.

A percentage quoted spread is calculated as quoted spread divided by average of quoted bid and quoted ask prices (midpoint). Quoted spread is calculated as quoted ask minus quoted bid prices. Inter-day volatility is a standard deviation of continuously compounded daily returns computed from closing trade prices. Daily number of trades is defined as number of deals during a day.

Data is averaged by a company and then across companies. Test of significance of the difference between pre- and post- values is presented using a paired t-test. The null hypothesis for a paired t-test is that the difference is equal to zero. For testing volatility, the null hypothesis is that ratio of a standard deviation of pre-event returns to a standard deviation of post-event return is equal to one.

(*), (**) and (***) indicates that coefficients are significant at 10, 5 and 1 percent level respectively, testing the relevant null hypotheses.

Measure	Pre	Post	Change	t-Statistic
Panel A: Spread				
Quoted spread (%)	3.68	1.70	-1.98	16.13***
Quoted spread (EUR)	0.23	0.08	-0.15	4.48***
Panel B: Liquidity measures				
Inter-day Return volatility	13.03%	6.24%	-6.79%	4.36***
Daily Number of Trades	5.67	7.84	2.17	6.10***
Daily Trading Volume (Shares)	17300.74	9452.72	-7848.02	1.69*
Daily Trading Volume (EUR)	40167.16	21016.66	-19150.5	2.93***
Number of observations	*812*	*818*		

(Source: Compiled by the authors according to the results of econometric analysis, STATA output)

Table 7: Quoted Spread for the Each Company using Daily data

The table presents the results for changes in quoted spread for measures for a sample of 10 RSE and 2 VSE listed companies that have signed a contract for liquidity providers' services. The pre (post) sample period is the 70 trading days before (after) the start date of the agreement. The start date is not included in either sample.

A percentage quoted spread is calculated as quoted spread divided by average of quoted bid and quoted ask prices (midpoint). Quoted spread is calculated as quoted ask minus quoted bid prices.

Data is averaged by a company. Test of significance of the difference between pre- and post-spread values is presented using a paired t-test. The null hypothesis for a paired t-test is that the difference is equal to zero.

(*), (**) and (***) indicates that coefficients are significant at 10, 5 and 1 percent level respectively, testing the relevant null hypotheses.

Ticker	Pre-Spread (EUR)	Post-Spread (EUR)	Change (t-statistics)	Pre-Spread (%)	Post-Spread (%)	Change (t-statistics)
BAL1R	0.109	0.090	-0.02 (1.64*)	2.85%	1.78%	-1.07% (3.78***)
DKP1R	0.027	0.016	-0.01 (4.15***)	6.29%	2.70%	-3.59% (6.54***)
GRD1R	0.116	0.089	-0.03 (1.69**)	4.21%	1.96%	-2.25% (4.42***)
GZE1R	0.349	0.187	-0.27 (4.94***)	3.32%	1.59%	-1.73% (5.82***)
LSC1R	0.020	0.015	-0.006 (3.53***)	3.39%	2.35%	-2.87% (3.91***)
OLF1R	0.043	0.023	-0.02 (4.24***)	5.31%	1.93%	-3.38% (6.93***)
RKB1R	0.048	0.020	-0.03 (6.62***)	3.51%	1.45%	-2.07% (6.71***)
SAF1R	2.065	0.561	-1.50 (4.21***)	3.09%	0.82%	-2.27% (4.27***)
VNF1R	0.094	0.044	-0.050 (4.66***)	4.36%	2.01%	-2.35% (4.85***)
VSS1R	0.053	0.030	-0.023 (4.48***)	2.48%	1.14%	-1.34% (5.81***)
CTS1L	0.04	0.03	-0.01 (1.87*)	0.88%	0.78%	-0.1% (0.72)
VLP1L	0.058	0.021	-0.037 (6.75***)	3.62%	1.21%	-2.41% (7.02***)

(Source: Compiled by the authors according to the results of econometric analysis, STATA output)

Table 8: Market Quality Measures for the RSE using Intra-Day Data

The table presents the results for changes in market quality measures for 10 companies listed on RSE that have signed a contract for liquidity providers' services. The pre (post) sample period is the 20 trading days before (after) the start date of the agreement. The start date is not included in either sample.

A percentage quoted spread is calculated as quoted spread divided by average of quoted bid and quoted ask prices (midpoint). Quoted spread is calculated as the best quoted ask minus the best quoted bid observed at every 30 minutes interval. The depth measures are sampled when a two-sided market exists. Spread and depth measures are the average of limit order book data observed every 30 minutes throughout the trading day. Inter-day volatility is a standard deviation of daily returns every 30 minute intervals when two-side market existed.

Data is averaged by a company and then across companies. Test of significance of the difference between pre- and post- values is presented using a paired t-test. The null hypothesis for a paired t-test is that the difference is equal to zero. For testing volatility, the null hypothesis is that a ratio of a standard deviation of pre-event returns to a standard deviation of post-event return is equal to one.

(*), (**) and (***) indicates that coefficients are significant at 10, 5 and 1 percent level respectively, testing the relevant null hypotheses.

Measure	Pre	Post	Change	t-Statistic
Panel A: Spread				
Quoted spread (%)	4.98%	3.57%	-1.41%	8.34***
Quoted spread (EUR)	0.61	0.24	-0.37	6.23***
Number of observations	*1198*	*1168*		
Panel B: Liquidity measures				
Intra-day Return volatility	2.75%	2.66%	-0.09%	1.07
Depth (Shares)	2035.19	3516.66	1481.47	5.69***
Number of observations	*573*	*578*		

(Source: Compiled by the authors according to the results of econometric analysis, STATA output)

Table 9: Quoted Spread for the RSE using Intra-Day Data

The table presents the results for changes in quoted spread for 10 stocks listed on RSE that have signed a contract for liquidity providers' services. The pre (post) sample period is the 20 trading days before (after) the start date of the agreement. The start date is not included in either sample.

Spread measures are the average of limit order book data observed every 30 minutes throughout the trading day. A percentage quoted spread is calculated as quoted spread divided by average of quoted bid and quoted ask prices (midpoint). Quoted spread is calculated as the best quoted ask minus the best quoted bid observed at every 30 minutes interval.

Data is averaged by a company. Test of significance of the difference between pre- and post-spread values is presented using a paired t-test. The null hypothesis for a paired t-test is that the difference is equal to zero.

(*), (**) and (***) indicates that coefficients are significant at 10, 5 and 1 percent level respectively, testing the relevant null hypotheses.

Ticker	Pre-Spread (EUR)	Post-Spread (EUR)	Change (t-statistics)	Pre-Spread (%)	Post-Spread (%)	Change (t-statistics)
BAL1R	0.15	0.13	-0.02 (1.66*)	5.13%	3.13%	-2.01% (1.65*)
DKP1R	0.02	0.02	-0.003 (1.39)	7.42%	3.99%	-3.42% (2.05**)
GRD1R	0.08	0.09	0.01 (1.11)	3.39%	3.22%	-0.1% (1.27)
GZE1R	0.35	0.27	-0.08 (2.69***)	4.82%	3.49%	-1.32% (3.22***)
LSC1R	0.03	0.02	-0.01 (4.26***)	6.20%	4.04%	-2.03% (3.92***)
OLF1R	0.032	0.03	-0.002 (1.68*)	5.09%	3.26%	-1.98% (3.63***)
RKB1R	0.03	0.02	-0.01 (0.82)	2.10%	2.13%	-0.07% (0.75)
SAF1R	3.68	1.31	-2.37 (8.09***)	8.39%	2.69%	-5.69% (8.77***)
VNF1R	0.048	0.033	-0.015 (3.04***)	3.62%	2.50%	-1.05% (2.68***)
VSS1R	0.031	0.026	-0.005 (1.67*)	2.12%	1.65%	-0.38% (1.89*)

(Source: Compiled by the authors according to the results of econometric analysis, STATA output)

Table 10 – Market Quality Measures for TSE

The table presents the results for changes in quoted spread for 5 TSE listed companies, whose LP agreement has been terminated. The pre (post) sample period is the 70 trading days before (after) the expiration date of the agreement for closing spread and 20 trading days for effective spread. The expiration date is not included in either sample.

A percentage quoted spread is calculated as quoted spread divided by average of quoted bid and quoted ask prices (midpoint). Quoted spread is calculated as quoted ask minus quoted bid prices.

Data is averaged by a company and then across companies. Test of significance of the difference between pre- and post-spread values is presented using a paired t-test. The null hypothesis for a paired t-test is that the difference is equal to zero.

(*), (**) and (***) indicates that coefficients are significant at 10, 5 and 1 percent level respectively, testing the relevant null hypotheses.

Measure	Pre	Post	Change	t-statistic
Panel A: Spread				
Closing spread (%)	0.66%	1.11%	0.45%	7.36***
Closing spread (EUR)	0.052	0.067	0.015	2.62***
Number of observations	*350*	*350*		
Quoted effective spread (%)	1.29%	1.40%	0.11%	1.73*
Quoted effective spread (EUR)	0.11	0.09	-0.02	2.23**
Number of observations	*662*	*541*		
Panel B: Liquidity measures				
Daily Number of Trades	36.89	64.09	27.20	4.69***
Daily Trading Volume (Shares)	64879.7	178647.3	113767.6	5.37***
Number of observations	*350*	*350*		

(Source: Compiled by the authors according to the results of econometric analysis, STATA output)

Appendix 3: Robustness Check

Table 11: Control Regression

The table presents the results of regressions:

$$S'_{i,t} = \beta_0 + \beta_1 Price'_{i,t} + \beta_2 Volum'e_{i,t} + \beta_3 \sigma_{i,t} + \beta_4 Dummy_{i,t},$$

where $S_{i,t}$ is the mean spread for company i in period t; $Price_{i,t}$ is the mean closing price for company i during period t; $Volume_{i,t}$ the mean daily share volume for company i during period t; $\sigma_{i,t}$, is the standard deviation of inter-day return for company i during period t; Dummyi,t is a dummy variable assigned the value of 1 if the period is after a company introduced a liquidity provider; otherwise zero.

(*), (**) and (***) indicates that coefficients are significant at 10, 5 and 1 percent level respectively, testing the relevant null hypotheses.

	Intercept	Price	Volume	Volatility	Dummy	R^2
Quoted Spread (EUR)	0.12***	- 0.02***	-0.0004	2.76***	-0.08***	0.368
Quoted Spread %	0.07**	- 0.001*	-0.0003	0.42*	-0.06***	0.233

(Source: Compiled by the authors according to the results of econometric regression, STATA output)

Table 12: Market Quality Measures for Control Sample

The table presents the results for changes in quoted spread for the control sample of 11 RSE listed companies. The pre (post) sample period is the 70 trading days before (after) 01.10.2004; 01.10.2004. is not included in either sample.

A percentage quoted spread is calculated as quoted spread divided by average of quoted bid and quoted ask prices (midpoint). Quoted spread is calculated as quoted ask minus quoted bid prices.

Data is averaged by a company and then across companies. Test of significance of the difference between pre- and post-spread values is presented using a paired t-test. The null hypothesis for a paired t-test is that the difference is equal to zero.

(*), (**) and (***) indicates that coefficients are significant at 10, 5 and 1 percent level respectively, testing the relevant null hypotheses.

Measure	Pre	Post	Change	t-Statistic
Panel A: Spread				
Quoted spread (%)	18.99%	27.35%	8.36%	6.28***
Quoted spread (EUR)	0.17	0.31	0.14	9.11***
Daily Number of Trades	1.69	1.88	0.19	0.91
Number of Observations	*394*	*787*		
Panel B: Liquidity measures				
Daily Trading Volume (Shares)	1475.54	1111.47	364.08	0.58
Daily Trading Volume (EUR)	2379.78	1506.79	872.59	0.70

(Source: Compiled by the authors according to the results of econometric analysis, STATA output)

Appendix 4: Cumulative Abnormal Returns

Table 13 – Test for Market Model Estimation

The table presents the results for testing market model estimation for the period T – 70 till T -5.

$$R'_{i,t} = \beta_0 + \beta_1 RM'_{,t} + \varepsilon_{it,}$$

where *Rit* is the logarithmic return on stock *i* on day *t* and *RMt* is logarithmic daily total return on the chosen market indices. β_0 and β_1 are a constant and a coefficient, respectively, and ε_{it} is a residual term. The model suggests that sum of residuals (ε_{it}) is an indicator of the abnormal returns.
The *t* statistics for testing Ho $\sum \varepsilon_{it} = 0$ for the period T - 70 till T -5.

(*), (**) and (***) indicates that coefficients are significant at 10, 5 and 1 percent level respectively, testing the relevant null hypotheses.

	N	Abnormal Returns	St.Dev	t-statistics
Sample Average	780	**0.0000**	**-0.0024**	**-0.0024**

(Source: Compiled by the authors according to the results of econometric analysis, STATA output)

Table 14 – CAR and AR Based on Spread Improvement

The table presents the statistics for the Daily Abnormal returns (AR) and Cumulative Abnormal Returns (CAR) for sample average CAR and AR as well as for companies with a large and small change in the spread for the days T 0 till T +30. T-statistics is for the null hypothesis that CAR and AR is equal to zero in this time interval. Test of significance of the AR and CAR values is presented using a paired t-test

(*), (**) and (***) indicates that coefficients are significant at 10, 5 and 1 percent level respectively, testing the relevant null hypotheses.

		Sample average	Large change in spread	Small change in spread
	N	360	210	150
CAR	Mean	2.78%	2.77%	2.80%
	St. dev	0.01	0.01	0.02
	T stat	14.45***	10.79***	7.18***
AR	Mean	0.13%	0.10%	0.17%
	St. dev	0.0010	0.0017	0.0009
	T-stat	1.74*	1.67*	1.82*

(Source: Compiled by the authors according to the results of econometric analysis, STATA output)

Table 15 – CAR and AR Based on Change in Number of Deals:

The table presents the statistics for the Daily Abnormal returns (AR) and Cumulative Abnormal Returns (CAR) for sample average CAR and AR as well as for companies with a larger and small change in the number of deals for the days T 0 till T +30. T-statistics is for the null hypothesis that CAR and AR is equal to zero in this time interval. Test of significance of the AR and CAR values is presented using a paired t-test

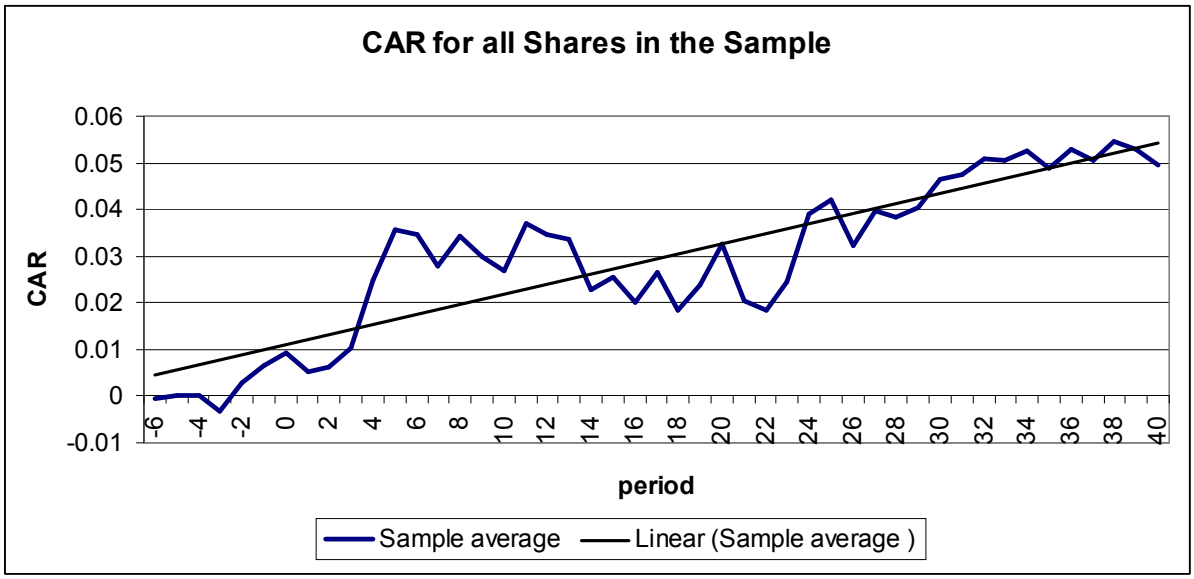
(*), (**) and (***) indicates that coefficients are significant at 10, 5 and 1 percent level respectively, testing the relevant null hypotheses.

		Sample average	Big change in number of deals	Small change in number of deals
	N	360	180	180
CAR	Mean	2.78%	8.01%	-2.45%
	St. dev	0.01	0.02	0.01
	T stat	14.45***	23.72***	11.76***
AR	Mean	0.13%	0.15%	0.11%
	St. dev	0.0010	0.0015	0.0072
	T stat	1.74*	1.83*	0.86

(Source: Compiled by the authors according to the results of econometric analysis, STATA output)

Figure 1 - CAR Average for the Sample

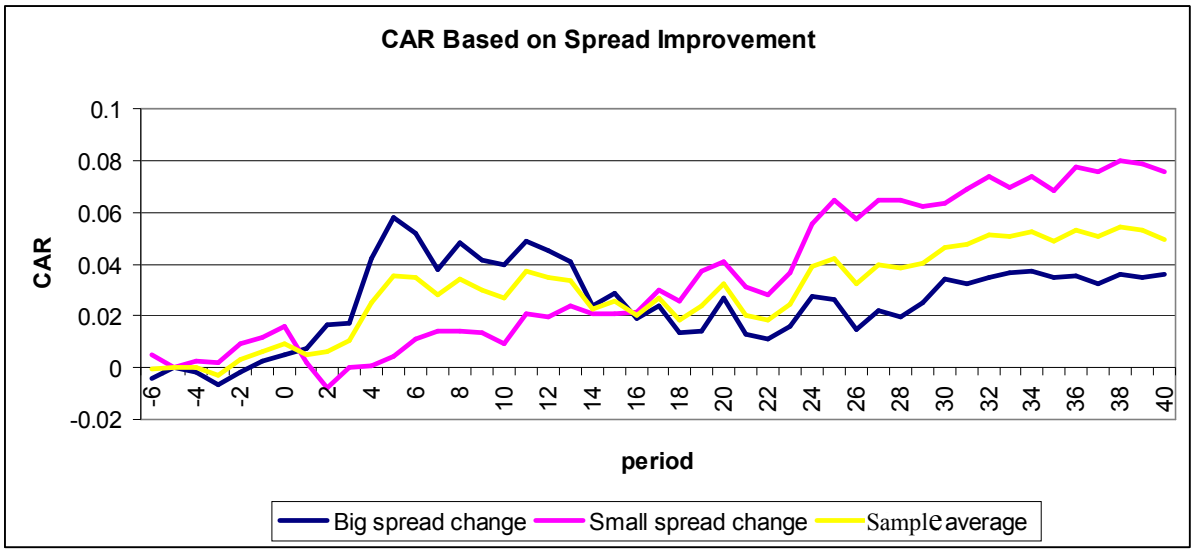
This figure depicts the average CARs for 12 companies on RSE and VSE contracting LPs for the period T-6 till T+ 40 based on the market model estimation for the period T-70 till T-5. On the vertical axis, CAR in value terms are represented, the horizontal axis shows a number of days before and after the introduction of LPs; 0 represents the starting day of the contract with LP.



(Source: Made by the authors)

Figure 2 - CAR Based on Spread Improvement

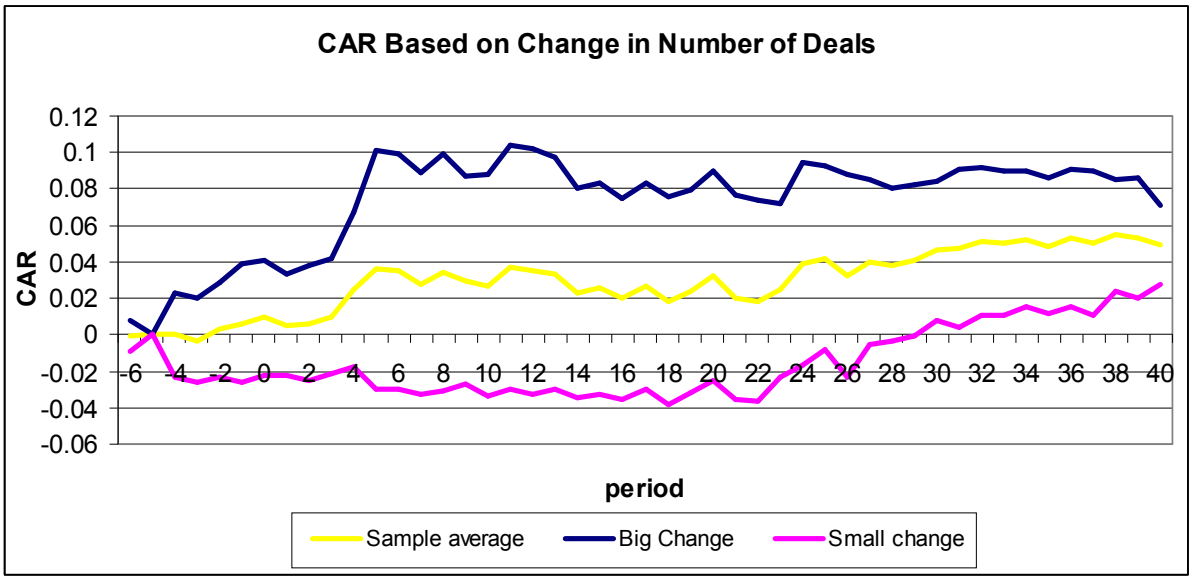
This figure depicts the average CARs for 12 companies listed on RSE and VSE contracting LPs for the period T -6 till T+40 based on the market model estimation for the period T-70 till T-5. CARs for 7 companies that have the largest decline in the spread of more than 2% and, 5 companies with smaller change are represented. On the vertical axis, CARs in value terms are depicted, the horizontal axis shows the number of days before and after the introduction of LPs; 0 depicts the starting day of the contract with LPs.



(Source: Made by the authors)

Figure 3 CAR Based on Change in Number of Deals

This figure depicts the average CARs for 12 companies listed on RSE and VSE contracting LPs for the period T -6 till T+40 based on the market model estimation for the period T-70 till T-5. CARs for 6 companies that have the largest increase in the number of deals per day (more than 3 deals) and, 6 companies with a smaller change are presented. On the vertical axis, CARs in value terms are depicted, the horizontal axis shows the number of days before and after the introduction of LPs; 0 depicts the starting day of the contract with LPs.



(Source: Made by the authors)