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# Master's thesis

# Business development strategy of the Nasdaq OMX Riga

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# Executive Summary

The Latvian stock market is a part of integrated Baltic stock market, which is run by the Nasdaq OMX Group, the world's largest exchange company. For ages the main problem of Latvian stock market has been lack of liquidity. Turnover in the first eleven months of 2010 was just EUR 19.4 million, which translates into 2.0% turnover to market capitalization ratio and 0.1% turnover to GDP ratio. The problem has many important implications. Firstly, investments in this market are discouraged by liquidity risk. Secondly, potential IPO candidates are reluctant to perform an IPO on this market, as they want liquid secondary market and fear that investors might assign additional risk premium due to lack of liquidity. Thus, a vicious cycle is created – companies do not want to list their shares due to lack of liquidity, while investors do not want to invest in a market with so few liquidly traded stocks. Thirdly, on a corporate level Nasdaq OMX Riga as a company sees its revenues hardly growing at all and even declining.

Therefore, the problem addressed in this master thesis is: what can Nasdaq OMX Riga do to break the vicious circle of low liquidity on the Latvian stock market? The problem is important both from perspective of Latvian economy, which lacks reliable equity market as a source of financing (due to its extreme lack of liquidity) and from perspective of Nasdaq OMX Riga (the company) whose revenues are linked to liquidity of the market both directly and indirectly. The thesis relies on a combination of quantitative and qualitative research methods. First, the impact of recent selected events on the Baltic equity market on various dimensions of liquidity is evaluated using statistical tests. Events over which Nasdaq OMX Riga should have reasonable level of control have been chosen: changes to the liquidity providers program, trading hour extension, minimum tick size reduction and euro introduction as trading and settlement currency. Then, recommendations on how Nasdaq OMX Riga could improve liquidity and their implementation are developed, with input gathered from industry experts through several interviews.

Firstly, it was found that liquidity providers (LP) bring significant improvements to market liquidity and their activities also increase value of companies whose shares are covered; thus underlying the importance of this program. Introduction of the first liquidity provider to a company's shares has a positive impact on liquidity of these shares: intraday percentage bid ask spread declined, and market depth improved. Moreover, introduction of first LP results in cumulative abnormal return of 9.9% over the following 20 business days. The opposite effects hold when departures of the last LPs are examined. Intraday percentage spread widened from 5.32% to 5.76%, revealing a surprising discovery that in the last days before LP departure spread was not below 4% for 85% of time when continuous trading took place. Market depth also declined significantly. Departure of last LP also resulted in cumulative abnormal return, with companies on average experiencing -4.8% CAR over the next 20 business days.

Secondly, analysis of trading hour extension revealed that market liquidity indeed declined following these changes, but failed to confirm causal relationship, suggesting that liquidity declined due global market turmoil. Interviews with brokers, however, reflected generally positive feedback regarding trading hour changes from their and their clients' side. Statistical analysis revealed that intraday percentage spread widened on all exchanges, while changes in market depth were less homogenous. However, analysis failed to confirm expectations that liquidity decline was a result of trading hour extension. Firstly, trading turnover declined on all exchanges, and changes were statistically significant on Nasdaq OMX Tallinn and Nasdaq OMX Vilnius, giving signals of a general liquidity drain. Secondly, intraday volatility did not increase, failing to confirm hypothesis that market will be easier to move with less or same amount of money. Finally, trading activity as percentage of total daily trading activity during morning and afternoon auctions where liquidity is concentrated time-wise, declined, failing to confirm hypothesis that market participants will migrate temporally to liquidity oases.

Thirdly, evaluation of tick size reduction confirmed its positive effect on liquid stocks whose intraday percentage spread declined; reflecting lower trading costs for investors in these shares. Geographically, Nasdaq OMX Tallinn gained, while Nasdaq OMX Riga saw spread widening. Impact of combined tick size reduction and EUR introduction as trading and settlement currency on Nasdaq OMX Vilnius had positive impact on subgroup of most liquid companies, while the market in general did not experience statistically significant changes.

Given these results and input from industry specialists the following recommendations have been developed. With respect to Liquidity Providers program Nasdaq OMX Riga should (1) Eliminate requirement to provide liquidity to at least 6 companies; (2) Adjust compensation scheme to include a reasonable fixed part in addition to variable part; (3) Defer part of the compensation for several months and pay it only if there have not been breaches of liquidity providers program rules; (4) Provide higher incentives to "liquidity pioneers" or brokers who start providing liquidity to companies that do not yet have a LP.

With respect to Trading hours it should (1) Extend trading by an additional hour, till 17.00 that would create short, albeit permanent overlap with US trading session. With respect to EUR as trading and settlement currency and tick size it should (1) Introduce EUR as trading and settlement currency in order to stay on the radar of foreign investors; (2) Propose a solution to BoL where settlement in LVL should is also an option; (3) Hire a reputable, independent party to carry out an academic research about effects on stability lat exchange rate arising from migration to EUR as trading and settlement currency in the bourse; (4) Introduce a tick book, which would imply a higher tick size as the stock price increases, thus mitigating the negative effects on time priority. All above mentioned recommendations should help Nasdaq OMX Riga increase liquidity on the Latvian stock market, thus supporting its revenue growth.

## Anotācija latviešu valodā

Maģistra darba "Nasdaq OMX Riga biznesa attīstības stratēģija" ir noskaidrot, kādus soļus var spert Nasdaq OMX Riga vadība, lai uzlabotu likviditāti Latvijas akciju tirgū, tādejādi gan nodrošinot Latvijas uzņēmumus ar uzticamu kapitāla piesaistes avotu, gan veicinot savu ieņēmumu pieaugumu.

Lai rastu atbildes apskatītajai problēmai, maģistra darba ietvaros tiek veikta likviditāti ietekmējošu notikumu – izmaiņas likviditātes nodrošinātāju programmā, tirdzniecības stundu pagarināšana, kā arī kotēšanas soļa samazināšana un eiro kā tirdzniecības un norēķinu valūtas ieviešana Lietuvas akciju tirgū – statistiskā analīze, balstoties uz iepriekšējos ārvalstu pētījumos izmantotu metodoloģiju. Statistiskās analīzes rezultāti ir papildināti ar atziņām no intervijas ar vadošajiem investīciju nozares speciālistiem un Nasdaq OMX Riga pārstāvjiem.

Darbā secināts, ka (1) likviditātes nodrošinātāju programma pozitīvi ietekmē iesaistīto uzņēmumu akciju likviditāti, kā arī palielina to vērtību; (2) tirdzniecības stundu pagarināšanai seko likviditātes kritums, bet cēloņsakarība netiek apstiprināta; turklāt nozares speciālistu un to klientu atsauksmes ir pozitīvas; (3) kotēšanas soļa samazināšana pozitīvi ietekmē aktīvāk tirgoto akciju likviditāti, bet uz retāk tirgotām akcijām tai ir neitrāla vai negatīva ietekme; (4) eiro kā tirdzniecības un norēķinu valūtas ieviešana Lietuvas akciju tirgū vismaz tūlītējus acīmredzamus uzlabojumus nav nesusi.

Maģistra darbs ir angļu valodā, tā kopējais apjoms ir 94 lappaspuses (82 neskaitot pielikumus), un tajā ir 6 tabulas, 15 attēli, 15 formulas un 7 pielikumi.

# Table of Contents

# 1. Introduction

The Latvian stock market is a part of integrated Baltic stock market, which is run by the Nasdaq OMX Group, the world's largest exchange company. Even the Baltic market as a whole is small by world standards with its market capitalization standing at just EUR 6.6 billion at the end of November 2010 or 11.1% of cumulative GDP of three Baltic States; the Latvian market is even smaller with market capitalization of slightly less than one billion EUR that translates into 5.4% of Latvian GDP. However, its extremely thin liquidity is a much more important problem. Aggregate trading turnover during the first 11 months of 2010 stands at just EUR 450 million, which translates in turnover-to-market cap and turnover-to-GDP ratios of 6.9% and 0.8%, significantly lower than in developed markets and even in most emerging markets. The problem is particularly acute on the Latvian market, where turnover in the first eleven months of 2010 was just EUR 19.4 million, translating in 2.0% turnover to market capitalization ratio and 0.1% turnover to GDP ratio.

The problem has many important implications. First of all, investments in this market are discouraged by liquidity risk (the Baltic market has sometimes been referred to as "lobster trap" due to inability to get out of positions). Secondly, potential initial public offering (IPO) candidates are reluctant to perform an IPO on this market, as they want liquid secondary market and fear that investors might assign additional risk premium due to lack of liquidity. Thus, a vicious cycle is created – companies do not want to list their shares due to lack of liquidity, while investors do not want to invest in a market with so few liquidly traded stocks. Thirdly, on a corporate level Nasdaq OMX Riga as a company sees its revenues hardly growing at all and even declining.

Therefore, the problem addressed in this master thesis will be: **what can *Nasdaq OMX Riga* do to break the vicious circle of low liquidity on the Latvian stock market?** The problem is important both from perspective of Latvian economy, which currently lacks reliable equity market as a source of financing and from perspective of *Nasdaq OMX Riga* (the company) whose revenues are linked to liquidity of the market both directly (revenues from executed deals on the stock exchange and operations with securities) and indirectly (in long term better liquidity should increase number of issuers on the exchange, thereby increasing revenues from their annual fees, etc)

The analysis of problem statement mainly focuses on factors that are endogenous to Nasdaq OMX Riga and whose impact can be measured and tested for statistical significance. Thus, there are some general limitations to this thesis. Firstly, as it is limited to analysis of endogenous factors, exogenous factors like importance of IPOs, the outcome of privatization process in Latvia and their impact on stock market liquidity is not evaluated. Clearly, they are extremely important determinants of overall liquidity, but the purpose of thesis is to concentrate on factors under more direct control of Nasdaq OMX Riga. Secondly, some statistical limitations can be indentified as well. In some occasions observations partly overlap (although to a little extent), implying they are not completely independent. Moreover, event clustering is present, thus in some cases it is more difficult to separate impact of one event from impact of another event.

The thesis relies on a combination of quantitative and qualitative research methods. First, the impact of recent selected events on the Baltic equity market on various dimensions of liquidity (bid ask spread, market depth, trading activity) is evaluated using statistical tests. Then, opinions on the recommendations and implementation are gathered from industry experts through several interviews.

The research paper is structured as follows. First, introduction sets out the general information about the research, including the aim and scope of the research, relevance of the issue, and structure of the paper. Next, in the theoretical framework section, relevant literature is reviewed to come up with the methodology to be used in the research. Then, a general background of Latvian equity market is provided. The core part of the master's thesis follows and it is divided into three sub-parts, each focusing on a single liquidity related issue: (1) the role of liquidity providers, (2) extension of trading hours and (3) reduction of tick size and introduction of euro. The master's thesis is concluded with recommendations and implementation guidelines for Nasdaq OMX Riga to increase liquidity on the Latvian stock market.

**Glossary of terms and abbreviations**

AR – abnormal return

Ask – price at which somebody is willing to sell a security

Bid – price at which somebody is willing to buy a security

BoL – Bank of Latvia

Call market – a market in which each transaction takes place at predetermined intervals and where all of the bid and ask orders are aggregated and transacted at once

CAR – cumulative abnormal return

CBOT – Chicago Board of Trade

CME – Chicago Mercantile Exchange

Continuous market – a market where trades occur at any time the market is open

Dealer market – a market where individual dealers are obliged to provide liquidity by posting bid and ask price they are willing to honor

Effective spread – difference between highest bid and lowest ask order, expressed as percentage of midquote

FKTK – Financial and Capital Markets Commission (Finanšu un Kapitāla Tirgus Komisija)

Floor trading – type of trading where that involves physical interaction among market participants

IPO – initial public offering

LCD – Latvian Central Depository

Limit order book – a record of unexecuted limit orders maintained by the stock exchange or specialist

Liquidity provider (LP) – a contracted market participant that has to provide bid and ask quotes he is willing to honor

Limit order – an order to buy or sell a security at a specified price or better

Market maker – a market participant that quotes both bid and ask prices for a financial instrument hoping to make a profit on the bid ask spread

Market order – an order to buy or sell a security at the current market price

Midquote – average of best bid and best ask order

NYSE – New York Stock Exchange

RSE – Riga Stock Exchange

Order driven market – a market where bid and ask prices are submitted to a central location and orders are matched by specialist or automatically by the trading system

Quote driven market – see "Dealer market"

Quoted spread – difference between highest bid and lowest ask order in nominal terms

Percentage spread – see "Effective spread"

Pit – physical trading venue in open outcry markets

Price driven market – see "Dealer market"

Primary market – capital markets' part which deals with the issue of new securities

Secondary market – market where previously issued securities are traded

Specialist – broker in the order driven market who has monopoly on making the market on certain stock and responsible for maintaining market balance

Turnover – value of shares traded in a given period (volume x average price)

Volume – number of shares trades in a given period

# 2. Literature review

## *2.1. Liquidity and its dimensions*

Liquidity is usually defined as the degree to which an asset or security can be bought or sold on the market without affecting a price of the asset (Amihud, 1986). Yet, it is a multi-faceted concept: there is not one universal way how to evaluate or measure it. The overall liquidity of an asset consists of many dimensions.

On one hand, there is trading turnover or trading activity. Clearly, the higher it is, the better overall liquidity of an asset and the easier it is to buy and sell asset without affecting its price (because the particular deal is smaller compared to total turnover). The second dimension is the difference between the price at which the asset can be sold and the price at which it can be bough – or the bid-ask spread. Small bid-ask spread benefits the liquidity of an asset, because smaller costs are incurred at each trade. On the other hand, wide bid-ask spreads imply significant costs per each trade and trading is discouraged.

Moreover, transaction costs like broker commissions and transaction taxes also affect liquidity. In a sense, they increase the bid-ask spread – if, for example, the stock can be sold at $1.00 per share, but the broker commission is $0.01 per share, the investors effectively gets only $0.99. Bid-ask spread directly impacts price continuity – the narrower the spread, the less prices change from one transaction to next, ceteris paribus.

However, liquidity may be scarce even with narrow bid-ask spread and low brokerage costs, if the quantity for sale or for purchase is small – thus, the last liquidity dimension, market depth or volume of assets that can be sold or bought at a given price, impact the overall liquidity as well. Finally, in addition to ability to sell an asset without moving its prices, marketability – an asset's likelihood of being sold quickly – is a necessary, but not sufficient, condition to liquidity (*CFA, Level I Curriculum*).

## *2.2. Liquidity, company value and expected returns.*

In general, liquidity is a beneficial trait for any financial asset. It allows selling or buying it rapidly and at low cost. Thus, ceteris paribus, it is reasonable to expect that investors would prefer more liquidity to less. Moreover, if that statement is true, more liquid assets should trade at a premium to less liquid assets and have lower expected returns. There are two ways how to test this hypothesis – cross-sectional and through time. Cross-sectional liquidity premium would mean that stocks with better liquidity trade at higher valuations than their peers, while time-varying liquidity premium would mean that valuation of an asset increases as its liquidity improves through time.

Amihud and Mendelson (1986) tackle the former issue and analyse NYSE stocks during 1960-1979. They use bid ask-spread as a liquidity measure and find that less liquid stocks have higher returns (controlling the stock specific risk or beta), thus giving affirmation to existence of cross-sectional liquidity premium. In a later study Amihud (2000) uses longer time frame (1964-1997) and another liquidity measure, closely resembling market depth (average daily absolute price change, divided by trading volume) and again finds evidence that liquidity premium exists.

The second assertion, changes in valuation through time due to liquidity factors has been tackled by Poterba (1986). He reflects on the previous study by Long (1978) and the widely known Miller and Modigliani dividend irrelevance hypothesis. The latter states that in perfect capital markets a firm's value is solely dependent on firm's investment opportunities and not affected by its payout policies (dividends, stock buybacks, etc). Investors should be indifferent between receiving one dollar in dividends or selling part of their stocks to receive that same one dollar (also known as homemade dividend). However, markets are not perfect in many senses, one of them being transaction costs. Selling stocks to receive that one dollar is not costless and involves some costs (broker commissions, bid-

ask spread). Thus, in market with trading friction, stocks that pay cash dividends allow investors to satisfy their liquidity needs without trading the stocks and thus avoiding the transaction costs. If that is true, dividend-paying stocks should trade at higher valuation than stocks that do not pay dividends.

In order to avoid comparing apples with oranges Long compared two classes of shares – cash dividend class and stock dividend class – of one company, Citizens Utilities Company. He found that between 1956 and 1976 cash dividend class traded at premium to stock dividend class, affirming cross-sectional liquidity premium. However, Poterba in his 1986 study found that premium had disappeared in 1976-1984 period. As overall market liquidity increased during that period due to falling brokerage commissions, the finding is consistent with time-varying liquidity premium.

This relationship has been proved for other financial assets as well. Longstaff (2004) compared US treasury bonds with Refcorp bonds, whose principal repayment was fully collateralized by Treasury Bonds, and the Treasury guaranteed full payment of the coupons. So, Refcorp bonds had the same credit risk, same foreign exchange risk and differed from Treasury Bonds only with regard to liquidity. Longstaff found that average premium of Refcorp compared to Treasury Bonds were in range from 10 to 16 basis points (a basis point is 1/100 of one percentage) of yield, proving that bond investors indeed are willing to pay more for liquidity.

To sum up, existing literature provides plenty of evidence on the existence of liquidity premium. Financial assets with better liquidity trade at higher prices and have lower expected returns. And vice-versa – of liquidity is low, assets are expected to trade at a discount and companies in need of capital would face higher financing costs, if the secondary market for their shares or bonds was illiquid.

## *2.3. Efficiency & liquidity*

The efficient market hypothesis states that a market is efficient if prices of securities fully reflect all available information (Fama, 1970). There are several assumptions to this hypothesis, one of them being rationality of investors and another – absence of transactions costs. Thus, if price does not fully reflect all available information, the fully rational market participants will spot it and arbitrage it away in a frictionless market. But what if the market is not frictionless and there are transaction costs like broker commissions, bid-ask spread, etc or the market is very thin? Intuition says that such markets should be less efficient as some inefficiencies will be impossible or unprofitable to exploit.

Chordia, Roll and Subrahmanyam (2006) analyze the link between liquidity and market efficiency for NYSE stocks during 1993-2002. They find that stock prices resembled random walk benchmark more closely when decimal regime was used as compared to regimes with higher tick sizes (and thus wider spreads). Their findings support the hypothesis that liquidity stimulates arbitrage activity that on its hand improves market efficiency.

Thus, existing literature suggests that liquidity indeed improves the market efficiency. Is it good or bad for the investor? Although market inefficiencies, also know as market anomalies, present profit opportunities for knowledgeable traders, the majority of investors should prefer efficient market to less efficient one. As already discussed, prices in an efficient market fully reflect all available information, thus the investor can be more certain that he is selling or buying his assets at fair price and is not overpaying or getting too little.

## *2.4. Description of market microstructure and its effect on liquidity*

Although stock exchanges are similar in their purpose – providing the infrastructure for the buying and selling stocks on the secondary market – yet the means for reaching this purpose can vary in many regards.

### *2.4.1. Order-driven vs quote driven markets.*

In the order-driven market, also known as pure auction market (NYSE, OMX), interested buyers and sellers submit bid and ask prices for a given stock to a central location where the orders are matched by a broker who does not own the stock, but acts as a facilitating agent. The broker, also known as specialist on the NYSE, has a monopoly on making a market for shares of certain company. Yet, the specialist is also responsible for the maintenance of the balance on the market. This means that if there is some kind of imbalance, the specialist should fix it. There are cases in which this required the selling and buying against the market by using the resources of the specialist firm (www.stock-market-investors.com). This system is also referred to as price-driven market because shares are sold the investor with highest bid price and sold to the investors with the lowest offering price.

The other trading system is the dealer or quote-driven market (Nasdaq) where individual dealers provide liquidity for investors by providing bid and ask prices they are willing to honor (they are obliged to do so). Thus, their presence ensures that there always will be market for shares of particular company (contrary to order-driven markets, whose liquidity depends on investors' limit orders). And, as there is usually more than one market maker for each, competitive ensues and facilitates competitive prices.

Most of the existing literature tends to support quote-driven markets as more efficient and liquid. Madhavan, Glen and Domowitz (2001) argue that quote-driven markets are more

efficient than price driven markets, because in a quote-driven market, investors trade against the prices quoted by the market-makers and the price discovery happens quickly; whereas in an order driven market investors must submit order to create the book and the price discovery happens more slowly. Huang, Roger and Stoll (1996) use the competition argument: they say that competition from about 550 market makers in Nasdaq increases liquidity and flexibility, speeds up execution, and reduces bid-ask spreads. Reinganum (1990) is less strict and concludes that Nasdaq has a liquidity advantage over NYSE for small firms, but not for large companies.

### *2.4.2. Call vs continuous markets*

In call markets the intent is to gather all the bids and asks for the stock at a point in time and attempt to arrive at a single price where the quantity demanded is as close as possible to the quantity supplied. Call markets are usually used during the early stages of development of an exchange when there are few stocks listed or a small number of active investors. Exchange officials in the call markets determine the available buy and sell orders and then determine a single price that will satisfy most of the orders, and all orders are transacted at this price. On the other hand, in a continuous market trades occur at any time the market is open. Some stock exchanges combine both types: trading hours start and end with “auctions” that are held according to call market rules, but apart from that stock exchange operates as a continuous market.

### *2.4.3. Electronic vs pit*

The communication among market participants can be live (NYSE) – also known as open outcry market as well as pit trading – or electronic (Nasdaq, OMX). Nasdaq was the pioneer of electronic stock trading, but as a result rapid technological progress over the

past decades, more and more exchanges adopt electronic trading systems in addition or in replacement to physical trading. Consequently, significant amount of trading has shifted from open outcry markets to electronic platforms: for example, as New York Stock Exchange (NYSE) rolled out its "hybrid system" that allowed to place electronic order along side human-executed orders in February 2007, share of electronic trades as percentage of total volume surged from 19% to 82% just in few months (http://www.usatoday.com/money/markets/2007-07-11-nyse-traders_N.htm). Even, commodities trading which long was the last bastion of physical trading, has slowly surrendered to electronic trading. Chicago Mercantile Exchange launched CME Globex, the first platform designed to trade futures contracts electronically, back in 1992. Fifteen years later, in October 2007, electronic trading made up 80% of aggregate trading turnover of CME Group, a juggernaut created after CME and CBOT merger in July 2007 (http://news.medill.northwestern.edu/chicago/news.aspx?id=67753).

Is electronic trading beneficial for liquidity? Supporters of electronic trading argue that the electronic trading system exhibits faster speed and accuracy in processing transactions than open outcry system. Clearly, the costs operating an electronic system are lower and there less hurdles to volume growth, as opposed to limits on human capabilities to execute a large number of trades rapidly. Finally, electronic trading offers open access to the limit order book and anonymity of trader identification. Based on these advantages, the advocates of automated trading believe that the electronic trading system would enhance market liquidity and result in a larger contribution to the price discovery process. But there is a dark side, too. Critics argue that electronic trading eliminates strategy-based informational advantages that market makers possess in the open-outcry trading pit. Furthermore, the liquidity suppliers face larger adverse information costs when submitting

their orders to the limit order book because of the possibility of trading with anonymous counterparts. Thus, it is believed that market makers would increase their effective bid-ask spreads in order to compensate for their potential losses to informed traders. As a result, trading costs may rise. This increase in trading costs reduces the liquidity of the contract market which, in turn, will cause the electronic trading system to make less of a contribution to the price discovery process.

CME with its Globex for electronic platform is an excellent laboratory for testing theories on liquidity differences between open outcry and electronic trading markets. Identical contracts have been traded simultaneously on GLOBEX and open outcry on CME since April 2001, thus allowing comparison of "apples with apples". Ates & Wang (2005) tackle the issue of bid-ask spreads by looking at intraday data from January 2, 2003 to March 5, 2004 of Japanese Yen, British Pound and Euro FX futures. Their findings are in favor of electronic trading systems – despite asymmetric information problem, bid-ask spreads are lower for automated trading, both before and after controlling for such variables as price volatility and volume.

### *2.4.4. Liquidity providers / market makers*

There is a significant amount of researches confirming the hypothesis that liquidity should improve after the introduction a liquidity provider. Tevanen (2006) analyzes the impact of liquidity providers on the Helsinki Stock Exchange and finds that spreads declined for 102 out of 108 companies that saw a liquidity provider being introduced; moreover, 78% experienced a substantial improvement. Trading volume increased almost fivefold, with 84% of companies experiencing an increase. Finally, share price of those companies increased by a statistically significant amount (4.2%), affirming that investors are wiling to

pay a premium for more liquid stocks (or demand a discount for less liquid – depends on the way how you look at it).

Venkataraman & Waisburd (2005) find similar findings on the Paris Bourse – around the announcement of dealer introduction, stocks experience an average cumulative abnormal return of nearly five percent that is positively correlated with improvements in liquidity. Moreover, they find that younger, smaller and less volatile firms are more likely to prefer a designated dealer. That makes sense, as younger companies typically are in greater need for capital, simultaneously liquidity of their shares is lower. Thus, investments in securing a market maker for their shares could offer the largest ROI, as compared to larger, better-established and more liquid companies.

Even more, according to Anand et al (2005), if listed companies take the matter in their own hands and start paying liquidity providers directly, improvements in liquidity are no worse than if the stock exchange pays them. Their study of Stockholm Stock Exchange decision taken in 2002 to allow listed firms to negotiate with liquidity providers to set maximum spread widths and minimum order depths shows a significant improvement in market quality, with declining quoted spreads and increasing quoted depth. Moreover, volatility declined and firm's stock price rose in direct proportion to the improvement in market quality, consistent with studies showing the link between liquidity and expected returns / company value.

# 3. Background and history of Nasdaq OMX Riga

## *3.1. History.*

Nasdaq OMX Riga, previously known as the Riga Stock Exchange, is the only regulated securities market in Latvia. The Riga Stock Exchange is young stock market by world standards and was founded shortly after Latvia regained its independence, in December, 1993. However, trading did not start until July 1995, while conceptual framework was developed. It was decided to use the model of the Paris Stock Exchange. Initially trading took place only once a week, as a single price auction. Moreover, the brokers' physical presence was at the RSE was needed to submit the order. So, at its infancy the RSE was significantly different from its current form and resembled a call market with a physical trading floor. As time passed by, trading sessions were held more frequently and already by the beginning of 1997 they were run each business day. Later in that year first remote terminals were installed, allowing RSE members to trade from their offices and thus making the presence of a broker on trading floor obsolete. Moreover, continuous trading was also introduced and it quickly emerged as the dominant form for making transactions. Thus, at the end of 1997 the microstructure of the RSE in general terms was similar to its current form – electronic continuous trading with a public order book.

The next five year marked closer co-operation with other Baltic exchanges, and investments in investments in expansion of infrastructure that allowed trading other financial assets (bonds, mortgage bonds, mutual funds). By 2002 both RSE and Latvian Central Depository had been transformed to for-profit entities from their previous not-for-profit status and had become more closely integrated. In August 2002 a major European stock exchange group, HEX Group (Finland), became the main shareholder of the RSE. With this acquisition HEX Group controlled stock exchanges and central securities

depositories in Finland, Estonia and Latvia. Simultaneously, the RSE became a 100% owner of the Latvian Central Depository. As a result, an integrated group had been created which provided securities trading, settlement and custody services in the Latvian market.

The first decade of the new millennia was marked by rapid consolidation of stock exchanges and not surprisingly HEX Group merged with Sweden's OMX Group less than a year after HEX Group had purchased RSE and LCD. The transaction created OMXHEX Group, which at that time was the leading market services and solutions provider in global financial and energy market and controlled 80% of the Nordic and 75% of the Baltic equity markets. Consolidation did not stop there, though. In April 2004 the NOREX agreement was signed between HEX Integrated Markets and Copenhagen Stock Exchange, Oslo Stock Exchange and Iceland Stock Exchange. Later that year OMXHEX changed its name to OMX Group and also introduced a new, common trading platform SAXESS in Helsinki, Riga and Tallinn Stock Exchanges, making another step closer to integrated Nordic and Baltic stock market.

In 2005 was selected by Ministry of Finance as the financial agent for primary placement of Government debt securities. The primary placement auctions of these securities are run on the SAXESS platform according to three models – competitive multiprice auction, fixed rate auction and taps. Later that year a new market segment for debt securities was added, allowing to trade both sovereign and corporate bonds issued by Baltic entities.

By that time significant amount of work had been done on integration of the Baltic stock markets and the following years were marked with efforts to raise the awareness of the general public and businesses of the benefits offered by the stock exchange as well as improving level of corporate governance of listed companies. Tradition to award companies with best investor relations in each Baltic market and across borders was started, Corporate Governance principles were introduced, first conferences where

investors could meet the representatives of listed companies were organized (CEO Meets Investor), and scholarships were awarded to best bachelor thesis with topical issues about the Latvian capital market. Moreover, the RSE started developing TOP 101 of the most valuable companies in Latvia in collaboration with local investment banks and press representatives.

In 2007 the RSE launched the Alternative securities market First North which was expected to bring capital raising opportunities to small and medium sized companies that previously faced limited access to equity financing before. However, the hopes and expectations tied to this market segment have not been realized so far. The failure most likely is related both to tough market environment following its launch as well as structural issues – although there have not been any IPOs on the First North market yet, local institutional investors have sometimes expressed criticism that a typical "Forst North company" would to be too small for investments of institutional investors. Retail investors' base, on its hand, is to small to absorb IPOs.

In 2008 the final consolidation step was made and OMX AB, the parent company of Baltic bourses, merged with the largest US electronic securities exchange NASDAQ, thus creating the world's largest exchange company, The NASDAQ OMX Group, Inc.

## *3.2. Current situation*

Although in terms of infrastructure and integration in the global financial markets Latvian equity market has evolved a lot during the last 10 years, the last decade can hardly be described as progress in terms of market growth. Firstly, market capitalization, albeit up from 676 million EUR in 2000 to 969 million EUR at the end of November 2010, has declined relative to Latvian GDP from 8.0% to 5.4%. That is approximately two times less than in Estonia and Lithuania, where market capitalization to GDP ratio is around 11%.

**Figure 1: Market capitalization of Baltic exchanges over the last 11 years**

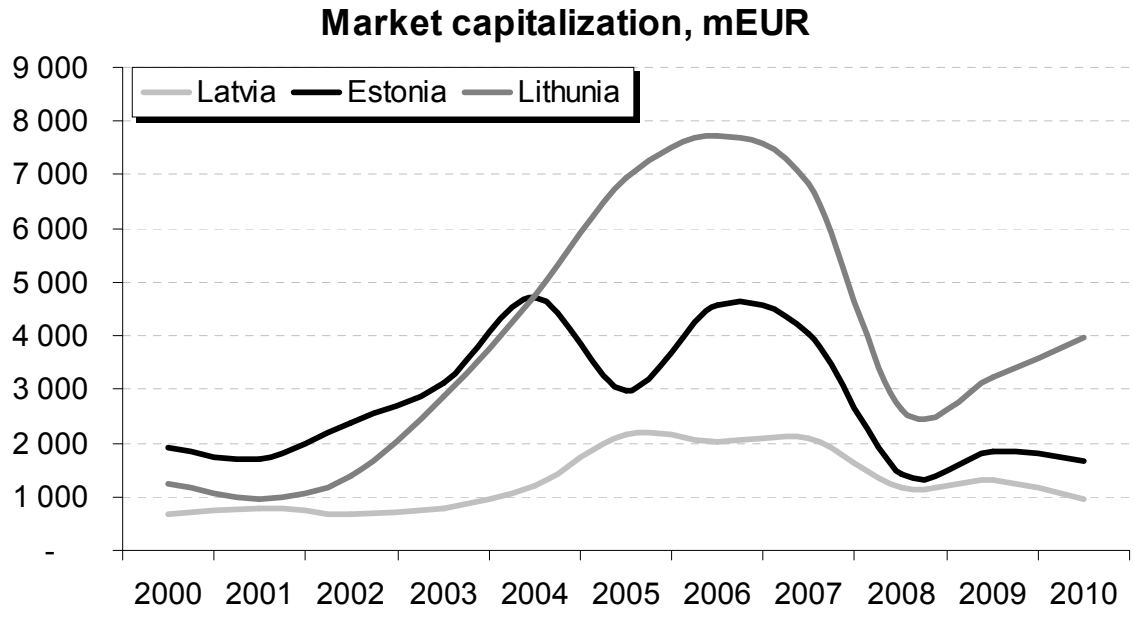
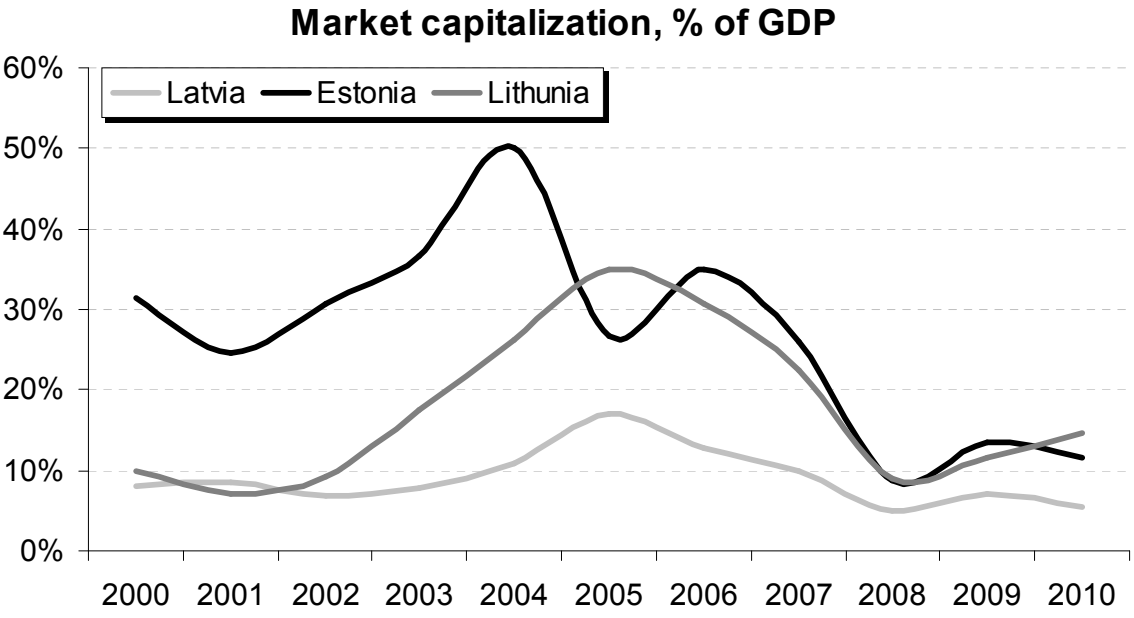


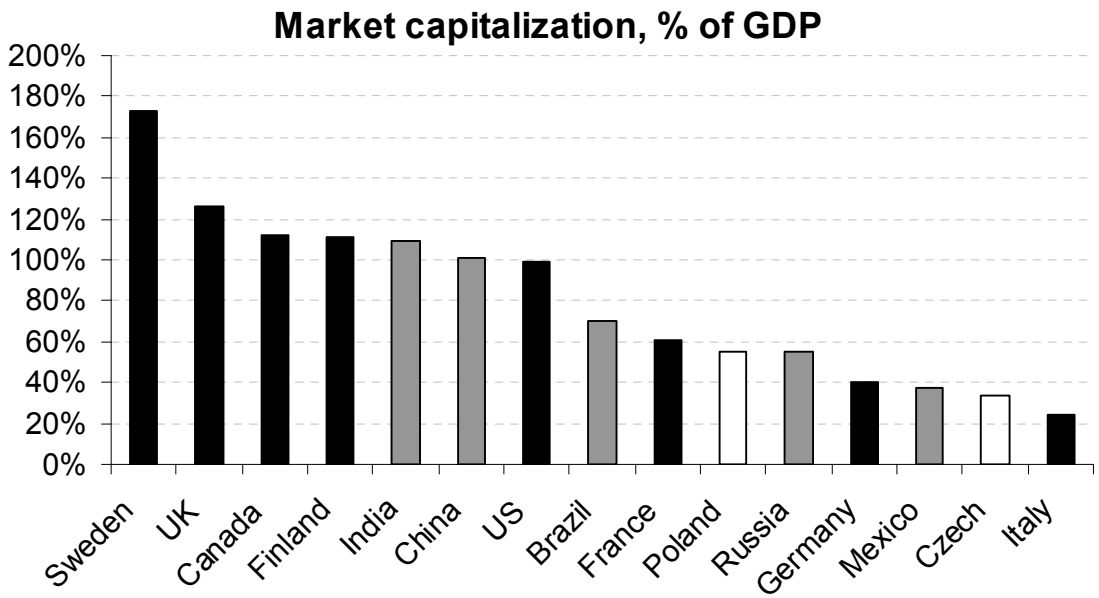

**Figure 2: Market capitalization as % of GDP of Baltic exchanges**




Moreover, that is way below numbers seen around the world, both in developed and emerging markets. In a sample of 8 developed markets average market capitalization to GDP is 93%, while in the BRIC countries (Brazil, Russia, India, China) it equals 67%; even in Poland and Czech Republic that in the European Union could be seen as countries

most similar to the Baltics, market capitalization to GDP is 44% on average. Number of listed companies is partly to blame, as it has decreased from 63 in 2000 to 33 in 2010. Albeit representing headwind to market size growth, this does not necessarily imply deterioration of market quality, as many of the companies that left the bourse were very illiquid and attracted little interest from investors. However, even now the average company is significantly smaller than on the neighboring stock exchanges: on Latvian market the average market capitalization is a mere 29.4m EUR, while on the Lithuanian market it's 75.9m EUR and 110.5m EUR on the Estonian.

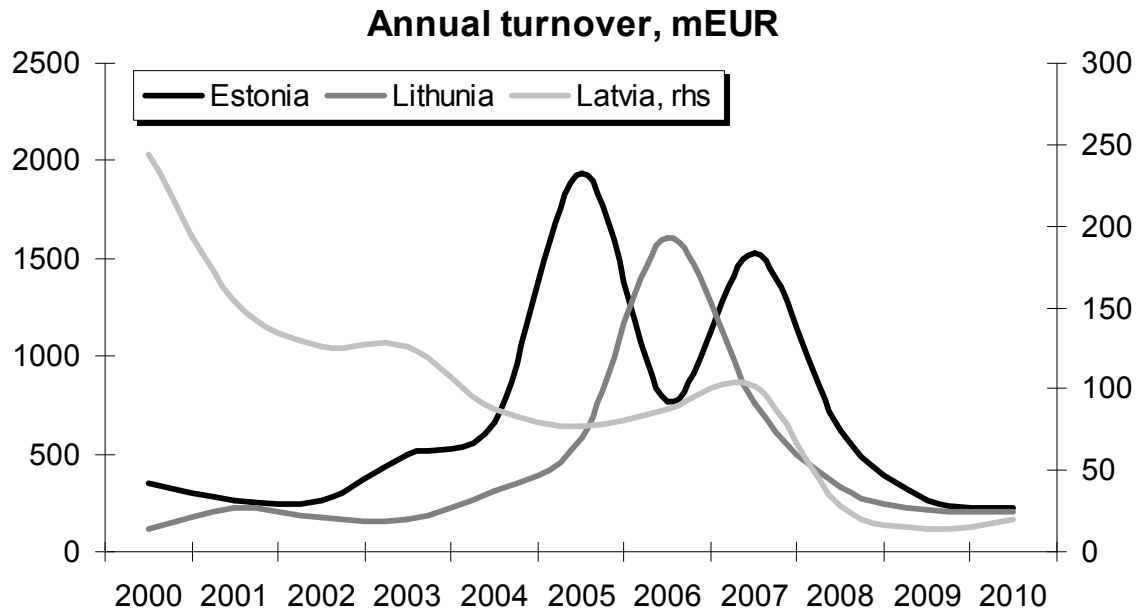
**Figure 3: Market capitalization of global exchanges as % of GDP**




However, the situation is much more worrisome in terms of liquidity. Despite significant investments in integration of Latvian stock market into Baltic, Nordic and lately global stock market, combined with efforts to raise the awareness of stock market both as a source of financing for companies and as a source of capital gains for individuals, Nasdaq OMX Riga has seen little success. Annual turnover has steadily declined from 243m EUR in

2000 to just 19.4m EUR in 2010[1], which translates into monthly turnover of 1.8m EUR. Certainly, part of the liquidity drain in 2008 and 2009 can be attributed to harsh drop in share prices, which is consistent with Chordia et al (2001) who find that liquidity plummets significantly in down markets, However, liquidity was low in the previous years as well. True, situation is not very rosy on neighboring stock market either, but at least on Lithuanian and Estonian bourses annual turnover has remained somewhat similar to levels seen 10 years ago; on the Latvian market it has declined more than 10 times.

**Figure 4: Annual turnover on Baltic exchanges**




The extent of lack of liquidity on the Nasdaq OMX Riga is staggering. Turnover-to-GDP on the Nasdaq OMX Tallinn in 2009 was just 1.6%, in Vilnius it was 0.8%, yet on the Nasdaq OMX Riga it was a meager 0.075%. In absolute numbers that's 267m EUR for Estonia, 215m EUR for Lithuania and a mere 14m EUR for Latvia (or 1.2m EUR on average per month). In developed economies turnover to GDP ratio is approximately 80% (although there is significant variation); in large emerging market economies (BRICs &

[1] As of the end of November

Mexico) it is 42% on average, while in smaller countries which are more similar to Baltics (Czech Republic & Poland) it is 14% on average. So, market turnover in Latvia is 20x lower than in the most liquid Baltic market (Estonia), 190x lower in than in Central European countries, 560x lower than in BRICs and 1000x lower than in developed markets.

**Figure 5: Annual turnover on Baltic exchanges as % of GDP**

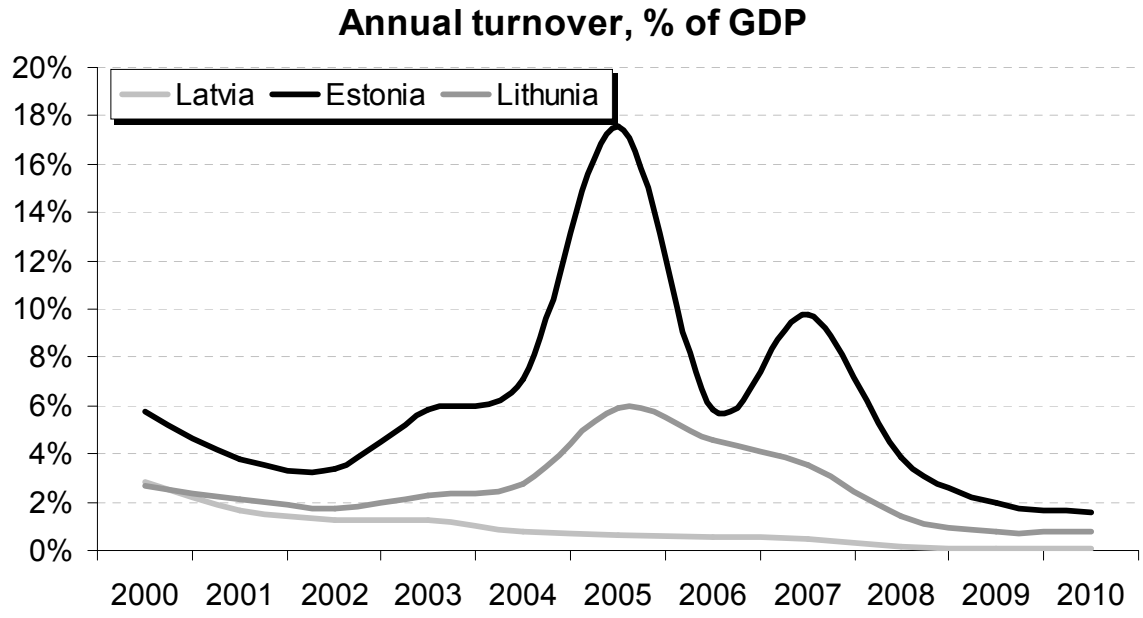
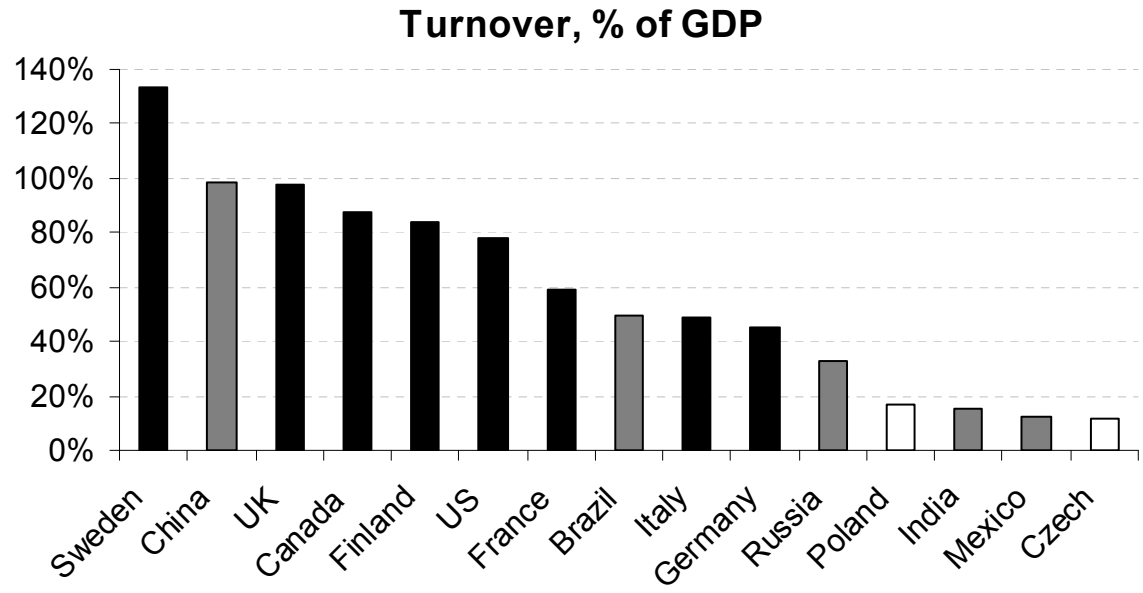



**Figure 6: Annual turnover on global exchanges as % of GDP**



It is no surprise that Latvian companies have been reluctant to raise financing via the stock exchange in this low liquidity environment. However, the extent is again significant: there has been only one initial public offering on the Latvian stock market, when SAF Tehnika attracted 24m EUR back in 2004. Meanwhile, there have been 4 IPOs on the Lithuanian market with companies raising 56.6m EUR, and 8 IPOs on the Estonian market, with 487m EUR raised (large part of it attributed to Tallink IPO in 2005, which raised 183m EUR); both neighboring market had an IPO in 2010 – Premia Foods went public in Estonia and Linas Agro Group listed its shares in Lithuania. To put in a nutshell, the Latvian stock market resembles a ghost town – although the companies are there, activity is almost non-existent and many years have passed since the last newcomer (more detailed information about Baltic market statistics and recent IPOs can be found in Appendix I).

## *3.3. Nasdaq OMX Riga – the company*

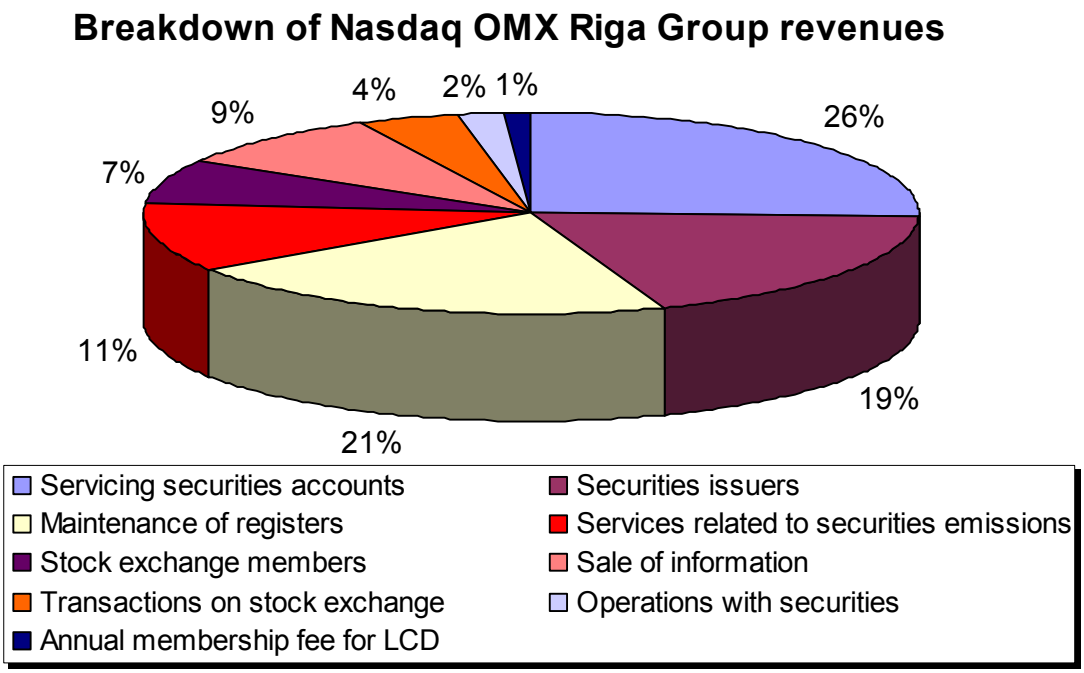
The main business operations of the NASDAQ OMX Riga Group (NASDAQ OMX Riga and its 100%-owned daughter company Latvijas Centrālais Depozitārijs (LCD)) are development and maintenance of the infrastructure for the financial instruments market. The main business services of NASDAQ OMX Riga are organization of the securities market for financial instruments, provision of open and fair trading facilities for the financial instruments listed on NASDAQ OMX Riga, quotation of the financial instruments (equities, debt securities and other financial instruments) on a regular basis, dissemination of market information, fulfillment of any other functions assigned to a regulated market organizer by the Law on Financial Instruments Market. In addition, NASDAQ OMX Riga actively takes part in implementation of privatization projects, as well as provides infrastructure for public offering for cash of state-owned property objects. The main business services of LCD are provision of securities custody, clearance and

settlement, as well as development and maintenance of different data registers. The NASDAQ OMX Riga Group companies are fully integrated in terms of personnel and structure on all corporate levels; however, the entities maintain segregation of core business operations.

The major owner with 92.98% shares in NASDAQ OMX Riga and Latvian Central Depository is "NASDAQ OMX Nordic Ltd.", which is owned by “NASDAQ OMX Group, Inc.”. Other shareholders of the NASDAQ OMX Riga are AS “Rietumu Banka” with 3.51% of shares and AS “RB Securities” IBS with 3.51%.

The NASDAQ OMX Riga generated 1.72m LVL in revenues in 2009, 8% less than in 2008. On it, the Group earned a 486 thousand LVL profit, which was 3% more than in 2008. However, only a minor part of revenues is directly affected by liquidity. The NASDAQ OMX Riga Group derives majority of its revenues from activities like servicing securities accounts, annual fees from securities issuers and stock exchange members. Only revenues from operations with securities and transaction on stock exchange are directly related to liquidity – and they form just 6.2% of Group’s revenues. Does that mean that liquidity is not that relevant for NASDAQ OMX Riga Group and it can free-ride on it? Not at all. As previously mentioned, the main business of the Group is organization of securities market, thus a high level of liquidity may be viewed as a very important part of the market infrastructure that investors and issuers would demand. Albeit its revenues are not directly tied to liquidity the indirect link is there and is very strong. Improved liquidity would make the market more attractive to actives that are willing to raise capital, thereby increasing revenue from securities issuers. More companies on their hand would attract more investors to the market – and that would lead to higher revenues from servicing securities account, maintenance of registers, etc. Clearly, there would be a virtuous circle for the Nasdaq OMX Riga Group if liquidity increased significantly.

**Figure 7: Breakdown of Nasdaq OMX Riga Group revenues**



# 4. Liquidity providers on the Nasdaq OMX Riga

## *4.1. The rise and fall of liquidity providers*

Liquidity provider program was started in October 2004 on the Estonian and Latvian markets and in October 2007 on the Lithuanian market with an aim to improve liquidity and make the stock market more attractive to investors; particularly those interested in larger deals sizes. The main responsibilities of the liquidity providers since then have been to:

1) Maintain the quotes at least 85% of trading time on a continuous basis
2) Maintain minimum bid-ask volume set by the stock exchange (varies from stock to stock and from time to time)
3) Maintain a spread below 4% or 0.01 LVL in case of very low share prices

On the Latvian stock market the program was pioneered by Hansabanka (now known as Swedbank), Parex Banka (now known as Citadele Banka) and Suprema that started making market for 10 stocks (Latvijas Kuģniecība, SAF Tehnika, Venstpils Nafta, Ditton Pievadķēžu Rūpnīca, Grindeks, Liepājas Metalurgs, Olainfarm, Rīgas Kuģu Būvētava, Valmieras Stikla Šķiedra, Latvijas Balzams) as of October 1st, 2004 in different combinations: for five stocks only one liquidity provider was present, one company had one liquidity provider, while the remaining four had the whole trio of liquidity providers backing the liquidity of their shares. After the introduction of program some migration of LPs could be observed, as they added and discontinued liquidity provision to several stocks. Yet, those were minor changes, and the most important milestones to the program were:

September 2005 – SEB joins the LP program

April 2007 – Suprema leaves the LP program

November 2008 – Parex leaves the LP program

December 2008 – Hansabanka leaves the LP program

January 2009 – SEB, the last LP, leaves the program

As it can be seen, the liquidity providers program virtually disappeared in two months, during the height of global credit crisis. Parex Banka, which was bailed out by Latvian government on November 8th, quit the LP program after 2 business day, with no prior notice at all, referring to force majeure clause that included provision for state bailout. The reason was the limitation imposed by Financial and Capital Markets Commission (FKTK) on bank's trading book. After less than two weeks Hansabanka followed suit and issued a statements it would cease making market as of December 12th. According to an interview with Swedbank broker[2], Juris Jankovskis, this was due to general risk reduction in bank's trading book and widespread restrictions on risk taking activities in general. Finally, in a less than month's time SEB also filed an application on canceling its liquidity provision activities and the already illiquid Latvian stock market was left with no contracted parties at all to provide liquidity. Reasons for SEB's departure were rather similar, and in addition to that it did not really see a business case in continuing participation in the liquidity providers program, according to an interview with Head of Brokerage department at SEB, Natalja Tocelovska.

[2] List of all interviews can be found in Appendix I

## *4.2. Previous researches*

The impact of introduction of liquidity program on the Baltic equity market has already been studied by Grecuhina and Timefejeva (2008). Their sample contains ten Latvian and two Lithuanian traded companies that witnessed an introduction of liquidity providers in the period from 2004 to 2007. Majority of their findings are consistent with previous research and expectations – after the introduction of liquidity providers, daily closing and effective spreads decreased by 1.98% and 1.41% respectively. These findings are reassured by intraday data that confirm lower effective quoted and percentage spread throughout the day, not just at the end of the trading session. Market depth and number of deals increased as well; however, that was accompanied by a peculiar drop in trading volume as well. Finally, stocks experienced positive abnormal returns after the introduction of liquidity providers; average cumulative abnormal return was 3%.

However, the sample used in the abovementioned research paper is incomplete, as it includes only those companies that still had a liquidity provider in 2008. There are several important consequences to that. Firstly, companies that had a liquidity provider, but saw its departure, are excluded from the sample (eg, Liepājas Metalurgs). Secondly, in some companies where the liquidity provider was introduced and afterwards chose to discontinue the coverage; another liquidity provider appeared after some time (Latvijas Balzams) – only the first introduction is included in sample Grecuhina and Timofejeva. Thirdly, the sample does not include occasions where a liquidity provider has been added to a company that already has (at least) one; thus it leaves unanswered an interesting question – does only the first liquidity provider have a positive impact on liquidity or do the consecutive LPs share the same trait? Finally, the departure cases, both those that leave a company “alone in the dark” with no one to ensure reasonable level of liquidity and those where at least one liquidity provider remains have been overlooked.

## *4.3. Questions investigated*

Therefore, the scope of this paper will be expanded to include the omitted changes in liquidity program and analyze the effect of departure of liquidity providers. That will allow answering the main question – do liquidity providers on Latvian stock market improve liquidity via lower bid-ask spread and higher market depth – as well as these four sub-questions:

1) Does introduction of the first liquidity provider improves liquidity?
2) Does introduction of additional liquidity providers improves liquidity?
3) Does departure of the last liquidity provider worsen liquidity?
4) Does departure of a liquidity provider worsen liquidity, if at least one liquidity provider remains?

The answers to these sub-questions may provide important information for decision makers at Nasdaq OMX Riga. If for example, additional liquidity providers do not provide statistically significant improvement in liquidity, Nasdaq OMX Riga should not stretch itself too hard to attract more than one for each stock. If however, additional liquidity providers can increase liquidity significantly, Nasdaq OMX Riga should be motivated to attract as more as possible of them.

Moreover, the effect of critical changes in liquidity providers program on company value will be estimated as well:

1) Does introduction of the first liquidity provider increase company value (results in statistically positive significant CAR)?
2) Does departure of the last liquidity decrease company value (results in statistically significant negative CAR)?

## *4.4. Methodology*

### *4.4.1. Spread*

As a first step, average daily quoted and percentage spreads and 20 days before and after the changes in liquidity providers program will be compared (event date will be excluded to avoid any noise that might be present in that day). Quoted spread is calculated as best ask price minus best bid price, while percentage spread is calculated as best ask price minus best price divided by midquote (average of best bid and ask price). Average spread (both quoted and percentage) for pre-event and post-event periods will be computed for each company, using only those days where a two-sided market existed at the end of the trading session, and then averaged across all companies. Paired t test will be used to check for statistical significance in differences between average spread observed before changes in LP program and average observed spread after changes in the program:

$$t = \frac{\overline{X_1} - \overline{X_2}}{\sqrt{\frac{S_{X_1}^2 + S_{X_2}^2}{n}}}, \text{ ( Equation 1)}$$

where numerator is the difference between average spread before and after changes in LP program, and $S_{X_1}^2$ in the denominator is standard deviations pre-change spreads, $S_{X_2}^2$ is standard deviation of post-change spreads, and n is number of observations in pre or post change sample (which equals the number of companies in the sample multiplied by number of days in the event window). Degrees of freedom equal *n-2*, where *n* is number of observations in any of those two samples.

Although percentage spread is a more meaningful measure of liquidity, nominal or quoted spread has to be calculated as well. Liquidity providers left amidst the largest financial crisis in generations when stock prices were plummeting; in such an environment

percentage spread for a relatively liquid company might increase even if nominal spread remained the same. For example, if stock price decreased by 20%, from 0.50 LVL to 0.40 and bid-ask quotes changed from 0.50-0.51 to 0.40-0.41, percentage spread would increase from 2.0% to 2.5% even though in nominal terms it remained constant.

Afterwards, intraday quoted and percentage spreads 20 days before and after the changes in liquidity providers program will be compared; opening and closing call auctions will be excluding and only data from continuous trading will be used. Although Grečuhina and Timofejeva (2008) used 30 minute intervals, one hour intervals will be used in this paper. Firstly, intraday data is accessible only in raw form and requires a lot of manual formatting and adjustments to transform it in a format that can be used in regressions; the shorter the interval, the more adjustments are needed. Secondly, trading is relatively thin on the Latvian stock market and there are many intraday observations when no trading takes place and bid ask spread does not change, even when using one hour interval. Thus, shorter time interval might not provide much value added. Finally, usage of different time interval will allow checking robustness of Grecuhina's and Timofejeva's findings.

The observation window and event window is consistent with previous researches: Anand et al (2006) used the same 20 days for their tests with intraday data (yet with 15 min frequency); Grecuhina and Timofejeva did the same for intraday tests, yet used much longer period (70 day estimation period and 70 event window) for tests involving daily data. Tevanen (2006) who uses only daily data relies on similar estimation periods – 65 days for trading volume tests and 45 days for liquidity ratios. The author of this paper thinks that emphasis should be put on intraday data, as it better represents the „big picture" of trading conditions, and are not just a snapshot at the end of the trading session. Intraday data provide higher data frequency, thus estimation period and event window that are at the short end of periods used in previous researches are justified. Moreover, all three main

liquidity providers departed at the end of 2008 / beginning of 2009 in a rapid succession (Swedbank ceased to provide liquidity 18 days after Parex's departure, and after another 18 business days SEB left as well), therefore shorter event windows are an insurance against data overlap. Another argument for shorter estimation periods and event windows is the global credit crisis that unfolded in the background as the liquidity providers ceased to make market for Latvian listed companies. The period was characterized by plummeting liquidity, thus longer estimation periods and event windows (when pre-crisis period of relatively ample liquidity is compared to crisis period of scarce liquidity) might make it harder to separate the effect of liquidity providers departures.

### *4.4.2. Depth*

Market depth will be evaluated similarly to spread – firstly, intraday market depth 20 days before and changes in liquidity providers program will be evaluated. However, analysis will concentrate solely on intraday depth, as daily data was not accessible through Bloomberg data terminal.

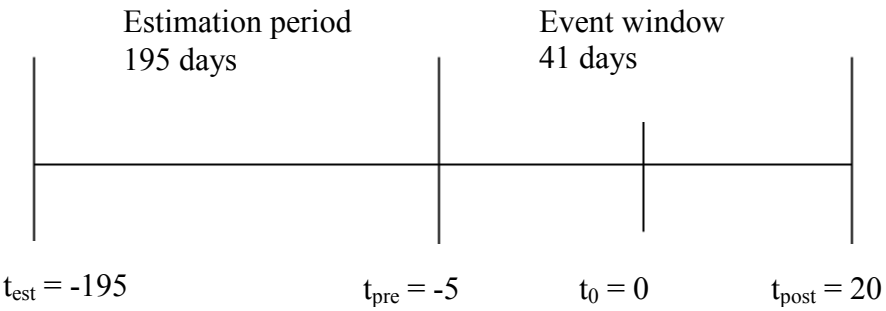
### *4.4.3. CAR*

To answer the question regarding the impact of changes in liquidity providers program on company's value, event studies will be used. According to MacKinlay (1997), an event study measures the impact of a specific event on the value of a firm using financial market data. This means, that the impact of a particular event is reflected in stock prices and it can be measured using the event study methodology.

In order to construct an event study, the period during which the particular event has impact on stocks return has to be specified. The period is later divided into two parts – the estimation period and the event window (Figure 1). Data from the estimation period is used

to calculate normal returns, which are then compared with the actual returns in the event window to notify abnormal returns.

**Figure 8: Timing of the event study**




The choice of the estimation period is tricky and rather subjective issue. In general event studies it has ranged from 100 to 300 days, while in previous liquidity-related researches it has varied from day 70 days (Grecuhina and Timofejeva) to 120 (Anand), with Tevanen using 90 days. In this paper a 195 day estimation period, which is somewhere in the middle of periods used in most event studies, is chosen. Therefore, the methodology will be most consistent with "gold standard" of event studies; moreover, it should provide more reasonable estimates of each stock's sensitivity to market risk. In addition, 195 days make a time period equal to approximately one year (working days), which is sufficient to capture and iron out any possible seasonality effects on stock prices. As seen in Figure 1, $t_0$ represents the day when the event (here –introduction or departure of LP) has occurred. $t_{est}$ is the beginning day of the estimation period. The event window lies between $t_{pre}$ and $t_{post,}$ which are set 5 days before and 20 days after the event has occurred respectively. Most of the previous liquidity-related researches (Tevanen, Anand, Mann, Grecuhina and Timofejeva) use an event window that starts 5 days before the event and lasts 10 days after it; yet as the author of this paper suspects that Latvian equity market might be less efficient and incorporate new information slower (judging from anecdotal evidence), a longer event window that stretches 20 days after the event is chosen.

Application of the event study methodology requires calculation of abnormal returns in the event window. According to MacKinley (1997), the abnormal return (AR) is the actual ex post return of the security over the event window minus the normal return of the firm over the event window. The normal return is defined as the expected return without the specific event (e.g. announcement or inclusion) taking place. For stock i and event date t the AR is calculated as:

$$AR_{it} = R_{it} - E(R_{it}|X_t), \text{ (Equation 2)}$$

where $AR_{it}$ are abnormal returns, $R_{it}$ are actual returns and $E(R_{it}|X_t)$ are normal returns. The term $X_t$ is the conditioning information for calculation of normal returns.

Normal returns can be calculated using various models, which can be grouped into two distinct groups – statistical models (like Constant Mean Return model and Market model) and economic models (like CAPM, APT, Fama Three Factor model etc). Statistical models assume that returns are normally and independently distributed. In addition to the previously mentioned statistical assumptions, economic models are based also on economic arguments like investor behavior. Another difference between the models is that the economic models impose a restriction that the intercept (alpha) is zero. The intercept measures the risk adjusted performance of a security. As argued by MacKinlay (1997), employing the Market model for estimation of normal returns is the most appropriate choice as it represents a potential improvement over the Constant Mean Return model by removing the portion of return that is related to return of the market portfolio. The Market model assumes linear relationship between the market return and the return of a particular stock.

Thus, a statistical model, the Market model, will be applied as it is argued by researchers (for example, Brown and Warner, 1985) to be more applicable in cases of event clustering,

which is exactly the case with changes in liquidity providers program, as they tended to happen in several waves. The Market model assumes that asset returns are normally distributed. According to MacKinlay (1997) for any stock *i* the normal returns can be expressed as:

$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it}$ (Equation 3)

$E[\varepsilon_{it}] = 0 \qquad Var[\varepsilon_{it}] = \sigma^2_{\varepsilon i}$,

where $R_{it}$ and $R_{mt}$ are period *t* returns on stock *i* and market portfolio respectively. $\varepsilon_{it}$ is the zero mean residual. $\beta_i$, $\alpha_i$ and $\sigma^2_{\varepsilon i}$ are the parameters of the model, that have to be estimated, where $\sigma^2_{\varepsilon i}$ represents the variance of residuals $\varepsilon_{it}$.

#### *4.4.3.1. Market Returns*

Although the focus of this research paper is Latvian equity market, a pan-Baltic index, OMX Baltic Benchmark Gross Capped will be used to estimate market returns. The first reason is the relatively large weight in the local OMX Riga index assigned to a handful of companies, all of which haven been a part of LP program. Latvijas Gāze constitutes 32.0% of OMX Riga, Ventspils Nafta makes up 18.3% and Latvijas Kuģniecība represented 17.3% of aggregate index. If one of these companies was indeed experiencing abnormal returns due to changes LP program, they would have a large impact on OMX Riga as well, thus making it harder to detect and statistically prove such abnormal returns. Secondly, changes to LP program occasionally took place for several companies simultaneously (for example, SEB ceased to make market for 6 companies at once, affecting a whooping 75% of market capitalization of Latvian stock market. Under such circumstances it would be impossible to detect any abnormal return using OMX Riga index.

The second reason for choosing OMX Baltic Benchmark Gross Caped index is because it is a total return index, which means that dividends are assumed to be reinvested. Therefore, it gives a more precise indication of what an investor who invested in a market portfolio would earn. Yet, for the sake of consistency, individual stock returns must also be measured on a total return basis. Thus, dividend-adjusted prices will be used.

#### *4.4.3.2. Estimation of Model Parameters*

According to MacKinlay (1997), under general conditions ordinary least squares (OLS) is a consistent estimation procedure for the Market model parameters. However, in this case several assumptions are violated, thus the model has to be adjusted. Namely, the issue of *thin trading* has to be addressed. This means that stocks are traded infrequently, which is a harsh reality on the Latvian equity market. Scholes and Williams (1977) have developed a solution, which is applied in this study.

Using the standard OLS regressions, the abnormal returns of each stock can be calculated as:

$$AR_{it} = R_{it} - \hat{\alpha} - \hat{\beta}R_{mt}, \text{ (Equation 4)}$$

where $\hat{\alpha}$ and $\hat{\beta}$ stand for the Market model parameters estimated by regressing individual stock's returns on market returns and they are assumed to be constant for the whole estimation period. $AR_{it}$ represents the abnormal returns of stock *i* at time *t*, which are the residuals. $R_{it}$ and $R_{mt}$ are the actual returns of each stock and market during the event window respectively.

The variance $\hat{\sigma}_{\varepsilon i}^2$ of excess returns according to MacKinlay (1997) is calculated as:

$$\hat{\sigma}_{\varepsilon i}^2 = \frac{\sum_{t=1}^{T_1} (\hat{\varepsilon}_{it}^2)}{T_i - 2}, \text{ (Equation 5)}$$

where T is the number of days in estimation period. In order to calculate the variance of abnormal returns, adjustments have to be made, because $\hat{\alpha}$ and $\hat{\beta}$ are calculated using data from the estimation period, but the variance includes data from the event window. The variance of abnormal returns is then calculated as:

$$\sigma^2(AR_{it}) = \sigma^2_{\varepsilon t}\left(1 + \frac{1}{T} + \frac{(R_{mt} - \overline{R}_m)^2}{\sum_{r=1}^{T}(R_{mr} - \overline{R}_m)^2}\right), \text{ (Equation 6)}$$

where $\sigma^2_{\varepsilon t}$ comes from equation (4) and $\overline{R}_m$ is the average market return during the estimation period, $R_{mt}$ is the market return on day t in the event window and $R_{mr}$ is the market return on day $r$ in the estimation period.

#### *4.4.3.3. Adjustments Due to Thin Trading*

As mentioned before, the standard OLS model is not applicable in case thin trading exists. To overcome this obstacle, the solution proposed by Scholes and Williams (1977) is employed, which involves running the three following OLS regressions:

$R_{it} = \alpha_{i1} + \beta_{i1}R_{mt} + \varepsilon_{1t}$ for t=1,2,…,T

$R_{it} = \alpha_{i2} + \beta_{i2}R_{mt+1} + \varepsilon_{2t}$ for t=1,2,…,T (Equation 7)

$R_{it} = \alpha_{i3} + \beta_{i3}R_{mt-1} + \varepsilon_{3t}$ for t=2,3,…,T

Then the Scholes-Williams beta ( $\hat{\beta}_{iSW}$ ) is calculated as:

$$\hat{\beta}_{iSW} = \frac{(\beta_{i1} + \beta_{i2} + \beta_{i3})}{1 + 2\hat{\rho}_m}, \text{ (Equation 8)}$$

where $\hat{\rho}_m$ is the estimated first order serial correlation of $R_{mt}$ (market returns) from t=2 to t=T-1.

The Scholes-Williams intercept $\hat{\alpha}_{iSW}$ is calculated as:

$$\hat{\alpha}_{iSW} = \frac{1}{T-2}\sum_{t=2}^{T-1} R_{it} - \hat{\beta}_{iSW}\frac{1}{T-2}\sum_{t-2}^{T-1} R_{mt} \quad \text{(Equation 9)}$$

As a result, the abnormal return $A\hat{R}_{itSW}$ of any stock *i* is calculated as:

$$A\hat{R}_{itSW} = R_{it} - \hat{\alpha}_{iSW} - \hat{\beta}_{iSW}R_{mt} \quad \text{(Equation 10)}$$

#### *4.4.3.4. Testing for Significance of Abnormal Returns*

To check whether the abnormal returns in the event window are significant, two different types of J-statistic are employed. First the orthodox test initially developed by Patell (1976) is applied. This is a standardized parametric test, which assumes constant variance of stock returns before and after the event. The statistic is calculated as:

$$J_{iP} = \frac{1}{\sqrt{N}}\sum_{t=1}^{N}\frac{A\hat{R}_{itSW}}{\sigma(AR_{it})} \quad \textit{approx. N (0,1),} \text{ (Equation 11)}$$

where N stands for number of observations, $A\hat{R}_{itSW}$ comes from equation (9) and $\sigma(AR_{it})$ comes from equation (5). **The null hypothesis of the test is that abnormal returns during the event window are equal to zero.** That is, nor does introduction of the first liquidity provider increase company value in a statistically measurable way and nor does departure of the last liquidity provider decrease company value in a statistically measurable way.

However, several studies (for example, Campbell and Wasley (1993), Maynes and Rumsey (1993)) find that the Patell's test for abnormal returns rejects a true null hypothesis too often leading to upward biased significance of abnormal returns, and it is misleading for thinly traded stocks. To avoid this bias the significance of abnormal returns will be tested using a stricter J-statistic as well, proposed by Boehmer, Musumeci, and Poulsen (1991).

This version of testing for abnormal returns is derived from the test developed by Patell (1976), and the authors of it have developed a standardized cross-sectional test which allows for event-induced changes in abnormal return variance, meaning that the return variances are allowed to differ between the estimation period and the event window. According to Cowan and Sergeant (1996), this test is particularly useful for samples of thinly traded stocks. The test statistic is calculated as:

$$J_t = \frac{\frac{1}{N}\sum_{i=1}^{N} SAR_{it}}{\sqrt{\frac{1}{N(N-1)}\sum_{i=1}^{N}\left(SAR_{it} - \frac{1}{N}\sum_{i=1}^{N} SAR_{it}\right)^2}} \quad approx.\ N(0,1), \text{ (Equation 12)}$$

where $SAR_{it} = \frac{AR_{it}}{\sigma(AR_{it})}$. (Equation 13)

N denotes the number of securities in the sample, and SAR (standardized abnormal returns) are calculated by dividing $AR_{it}$ by its standard error. **The null hypothesis of the test is that abnormal returns during the event window are equal to zero**. That is, nor does introduction of the first liquidity provider increase company value in a statistically measurable way and nor does departure of the last liquidity provider decrease company value in a statistically measurable way.

## *4.5. Data description*

Sample consists of 13 stocks on the Latvian equity market that have been a part of the liquidity providers program. Information on changes on liquidity providers program has been obtained from the Nasdaq OMX Riga homepage. There have been 48 changes to the program (liquidity provider introduction or departure), out which 47 will be used in regressions (in case of Rīgas Transporta Flote liquidity provision was ceased because the

company was delisted a result of final share buyback). Out of those, 25 cases were „critical" – either addition of first liquidity provider (13 cases) or departure of the last (12 cases). 22 cases were „non-critical": addition of additional liquidity providers (7 cases) or departure of a liquidity provider with at least one liquidity provider continuing to make market for the particular company (12 cases). The first liquidity provider was introduced on October 1st, and the last one departed on January 15th, 2009. Complete sample of all changes to the LP program can be found in Appendix III.

Trading data was obtained from two sources. Daily dividend-adjusted closing prices for CAR calculation, daily bid and ask prices as well as daily OMX Baltic Benchmark Gross Capped index closing values have been obtained from Bloomberg data terminal. Intraday bid and ask prices, intraday market depth and daily market depth has been obtained from Nasdaq OMX Riga representatives. Intraday data consists of four observations (10:01, 11:00, 12:00, 13:00) from continuous trading. Number of observations increases to six for days starting with February 2nd, 2009, when trading hours were extended by two hours.

## *4.6. Results*

### *4.6.1. Spread*

#### *4.6.1.1. Daily spreads*

The results of analysis clearly support hypothesis that introduction of the first liquidity provider (*critical additions*) results in lower spreads (more detailed information can be found in Appendix IV). Average spread at the end of the trading session declined from 0.116 LVL before the addition of LP to 0.041 LVL after the addition, a change that is statistically significant at 99% confidence interval (t-test -3.49). Percentage spread declined from 4.1% to 1.87%, and this change is also statistically significant at 99%

confidence interval, yet t-test is even higher (t-test -9.36). That can be explained by the lower standard deviation of percentage spreads in the samples – unlike quoted spreads they do not differ wildly between the so-called penny stocks (companies who share price is very low in absolute terms) and stocks with higher share price. Ceteris paribus, if standard deviation is lower, the statistical significance is higher. Another important observation is that percentage spread declined significantly below the maximum allowed spread (4.0%) for liquidity providers program. Although one might be willing to conclude that liquduity providers themselves narrowed the spread (either voluntary or as a result of competition with other LPs in stocks where there was more than LP), interviews with brokers from largest banks do not approve this statement, as they assert that spread was usually kept at the mentioned 4% (unless there was a need to increase or decrease inventory)[3]. Therefore, it can be concluded that introduction of the first LP leads to virtuous circle of liquidity, with other market participants narrowing the spread even more.

In case of non-critical additions or occasions where additional liquidity providers were introduced, results are not so clear-cut. Quoted spread declines from 0.025 LVL to 0.021, yet this decline is not statistically significant (t test 1.19). However, percentage spread declined from 1.37% to 1.15%, a decrease which is statistically significant at 90% confidence interval (t test 2.14). Thus, even the additional LPs further improve liquidity by narrowing quoted spread.

Critical departures of liquidity providers (departure of the last liquidity provider for a particular company), contrary to expectations, result in minor quoted spread increase, from 0.060 to 0.058 LVL, which is not significant even at 90% confidence interval (t test 0.24). Percentage spread, on its hand, increases from 4.24% to 4.62%, which also is not

[3] No interviews were held with former representatives of Suprema, which was among three initial participants of liquidity providers program

statistically significant even at 90% confidence interval (t test 1.30). This is an excellent illustration why both types of spreads should be evaluated – even though spreads did not decrease in nominal terms, they increased as a percentage of share price (because almost all critical departures took place in time less than 40 business days in November 2008 – January 2009, when stock prices were plummeting), thus increasing the costs for investors. However, another revelation is much more startling – the average percentage spread was above the 4% ceiling even before the departure of last LPs! Thus, at least daily data give an impression that liquidity providers were not honestly fulfilling their obligations in the last days of LP program.

As for the non-critical departures – they resulted in a tiny quoted spread increase from 0.040 LVL to 0.042, not statistically significant even at 90% confidence interval (t test 0.29). Yet again, percentage spreads paint a rather different picture – increase is much bigger, from 2.29% to 3.09%, and is statistically significant even at 99% confidence interval (t test 4.57). Thus, departure of liquidity provider increases the percentage spread even if there remains at least one liquidity provider.

#### *4.6.1.2. Intraday spread*

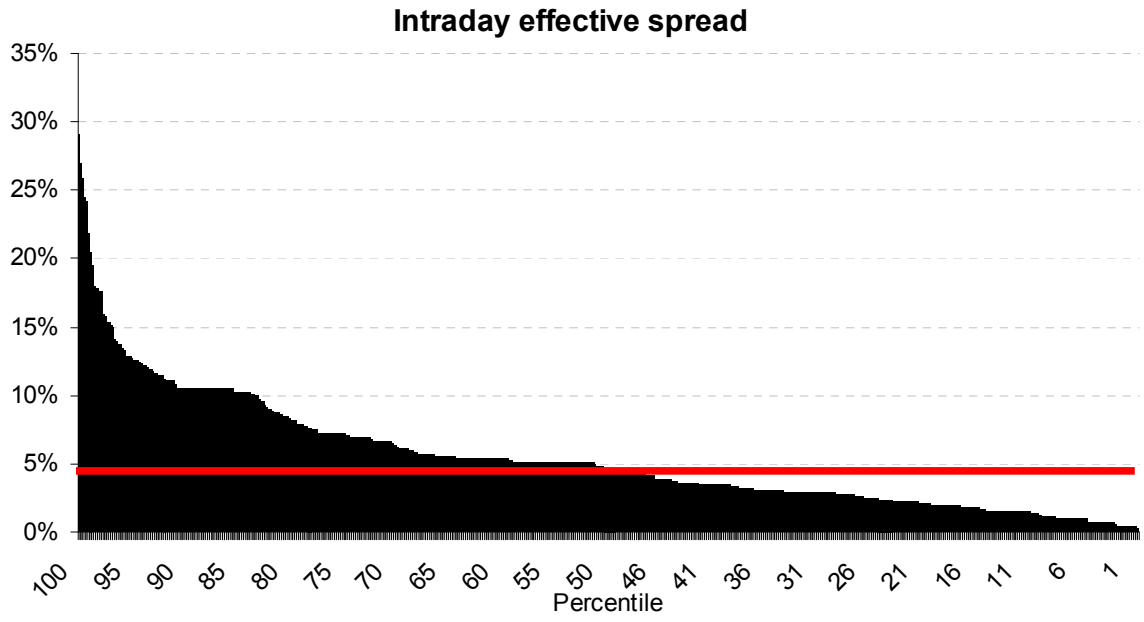
Similarly to closing spread, intraday spread declined significantly after introduction of the first liquidity provider, from 0.095 LVL to 0.062 LVL (statistically significant at 99% confidence level, t test -5.50). Changes in the percentage spread exhibit even higher statistical significance, with spread decreasing from 3.39% to 2.08% and t value equaling -11.1 (which implies statistical significance at 99% confidence level).

In the case of non-critical additions quoted spread surprisingly increases from 0.028 LVL to 0.031, a move which is statistically significant at 90% (t test 1.81). Most non-critical additions were performed in 2005 during a strong bull market, thus growing share price might be partly responsible for this effect. Percentage spread gives inconclusive evidence –

it also increased (from 1.57% to 1.67%), but this widening is very small and is not statistically significant (test 1.17).

Critical departures on their hand widened intraday spread from 0.079 LVL to 0.083 LVL; yet the change is not statistically significant (t test 0.55). Changes in the percentage spread are significant though, with widening from 5.32% to 5.76% (t test 2.37, significant at 95% confidence interval). Intraday numbers underline the ugly truth suggested already by daily data: liquidity providers were not diligently fulfilling their responsibilities in the last days before the departure. If all observations of hourly intraday bid ask spread 20 days before critical departures are aggregated, it can be seen that effective spread was below the required 4% only 46% of time, not 85% as set in the LP agreement.

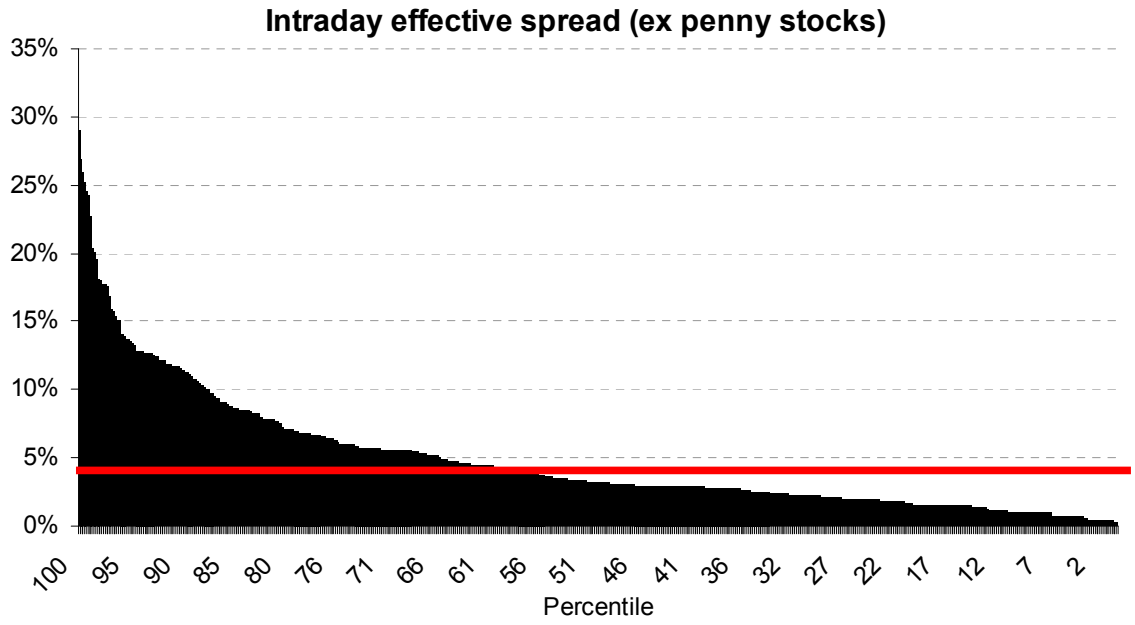
**Figure 9: Intraday percentage spread 20 days before critical departures**




However, the contract required liquidity providers to keep spread no wider than 4% or 0.01 LVL if the share price is very low. If share price was as low as 0.20 LVL (0.25 LVL is the borderline below which it is impossible to have a spread below 4% if minimum tick size is 0.01 LVL), even the 0.01 LVL nominal spread would translate into 5% effective spread, giving an illusion that LPs are not up to their task. Given that almost all critical departures

took place in the end of 2008, it is reasonable expect there was a number of such companies. That indeed is the case, as share price of Ditotn Pievadkezu Rupnica fluctuated around 0.20 LVL, Rigas Kugu Buvetava traded in the range from 0.18 to 0.20 LVL, while Valmieras Stikla Skiedra was dangerously close to 0.25 LVL level. Yet, even if these penny stocks are excluded, average pre-event spread for critical departures is still above required minimum and stands at 4.77%. It was below 4% only 58% of time.

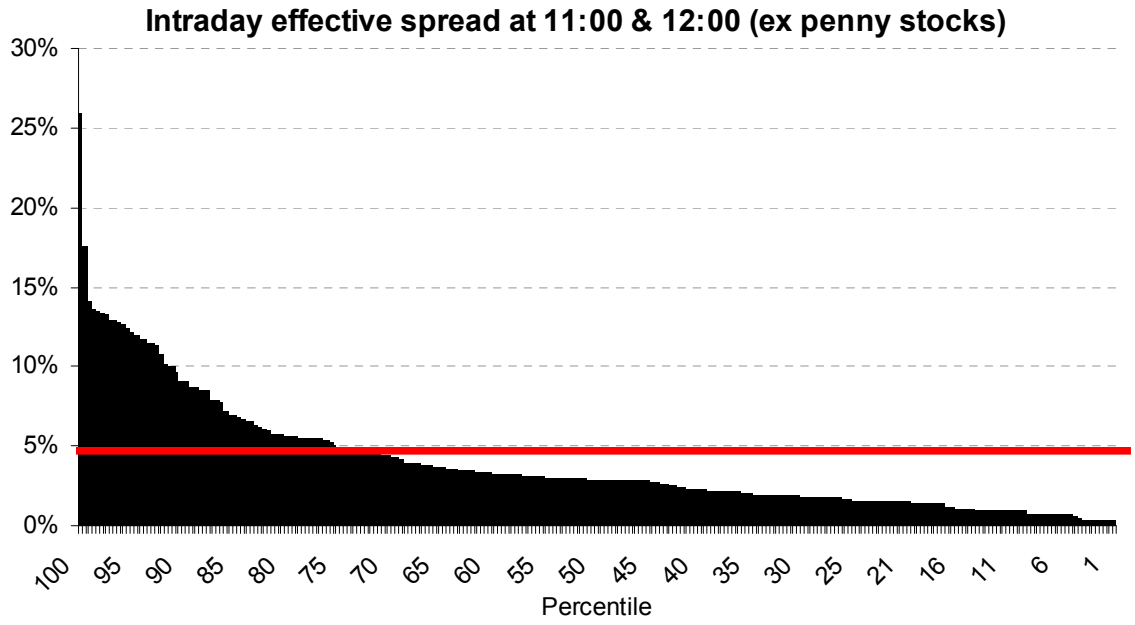
**Figure 10: Intraday percentage spread (ex penny stocks)**




There are two potential excuses left, though. Firstly, hourly data may not be representative of real environment, but that is highly unlikely as it would imply a great coincidence with brokers widening spreads at the end of each hour and then immediately narrowing them back. Secondly, a highly one sided market could have existed in the final days before critical departures, where brokers bid or ask quotes get hit three times in a row, that according to the contract gives them wild card to remove their quotes for the end of the day. That is more believable explanation as share prices for the critical departures sample declined on average by 9% over the 20 days before departure (-11.4% if penny stocks are excluded) and brokers also confirm that were many days at the end of 2008 where they had

three hits to their bid orders and thus ceased to make market for the rest of the day. In order to test that, the second aggregate is constructed, which consists only of non-penny stocks and only observations at 11:00 and 12:00 are taken into account. Observations at 13:00 (and at 14:00 and 15:00 for the extended trading hours) are excluded as they have the highest probability of three hit rule being reached (which allows brokers to withdraw their market making orders). The first observation at 10:01 is also excluded, as brokers might have not put their orders in the system yet. However, even this, the most cherry-picked sample still gives an indication brokers did not keep quoted spread below 4% for 85% of the time; instead they did for 69% of time. In other words, spread was wider than 4% twice as often as it should have been. Nasdaq OMX Riga had monitoring systems to ensure liquidity providers are fulfilling their duties, but the liquidity providers contract did not contain no penalties for failure to quote bid and ask prices for at least 85% of continuous trading time Nasdaq OMX Riga, except for breach of the contract. Thus, it had no means of enforcing fulfillment of duties for brokers who already had stated their intention to leave in a matter of weeks.

**Figure 11: Intraday percentage spread (ex penny stocks, ex-early and late hours)**



Non-critical departures resulted in counterintuitive quoted spread narrowing, from 0.058 LVL to 0.051 LVL, statistically significant at 90% (t test -1.68). Yet, percentage spread saw much more significant increase, from 2.92% to 3.93%, with t value of 7.98, which clearly is significant at 99% confidence interval. Thus, non-critical departures effectively approved results gained from analysis of daily data that these departures also widen percentage spread.

#### *4.6.1.3. Intraday depth*

Critical additions improved another dimension of liquidity, market depth. It increased from 15273 to 18130 shares, statistically significant at 99% confidence interval (t test 2.58). Market depth also increased after non-critical additions, from 24418 shares to 27985 shares; yet the increase was not statistically significant

(t test 1.61). Departures had just the opposite effect: statistically significant drain on market depth, with number of shares in the bid and ask orders declining from 10552 to 7662 after critical additions (t test -6.51, significant at 99%) and smaller, statistically insignificant (t test -1.50) decrease from 17261 to 16072 shares after non-critical departures.

### *4.6.2. CAR*

The introduction of the first liquidity provider has a positive effect on company's value as well. Its share price starts exhibiting abnormal returns on day -2 and day -1 before the introduction of LP, most likely reflecting market participants' expectations that improved liquidity will increase company's value (as the changes to the LP program are always announced beforehand). As expected, the largest abnormal returns occur on day 0 and day 1 (1.34% and 1.41% respectively), when liquidity improvements get realized. The

abnormal returns continue to mount in the remainder of event window, albeit at a lower pace and over these 25 business days they sum up to 9.9%.

When using the standard J test many of the daily abnormal returns in the even window days are deemed statistically significant; both those with positive abnormal returns (days -2, 0, 1, 4, 5, 11, 16, 17, 18, 19) and with negative returns (days -7, -9, -14). However, when the more stringent Boehmer J test is applied, only two days with positive abnormal returns (days 11 and 17)and two days with negative abnormal returns (days 9 and 14) are deemed statistically significant.

**Figure 12: Abnormal returns around critical introductions**

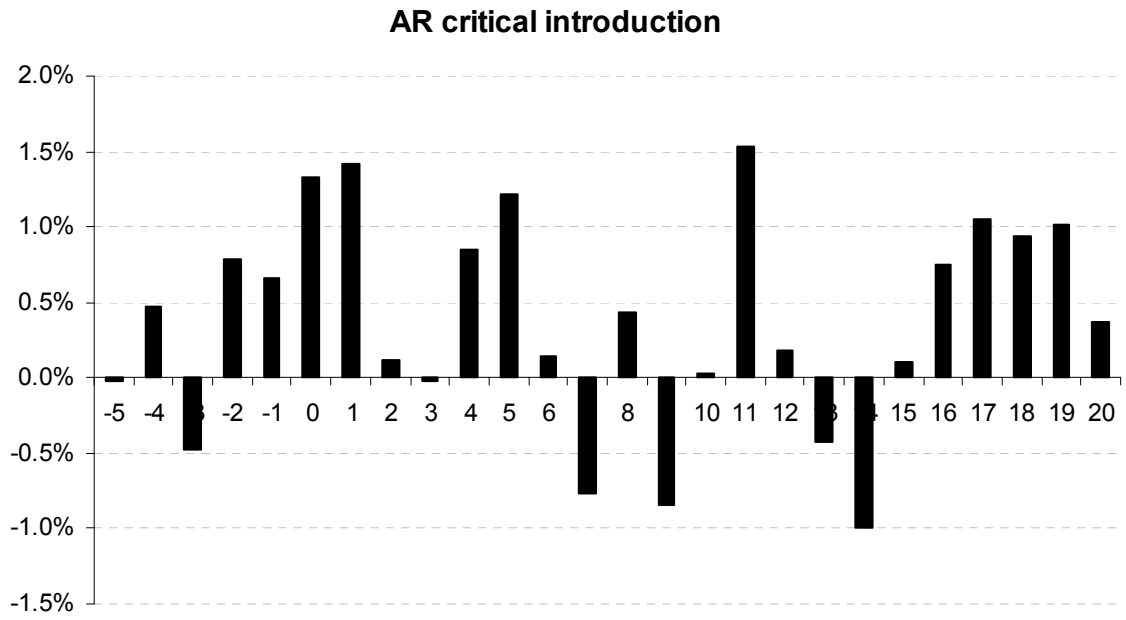
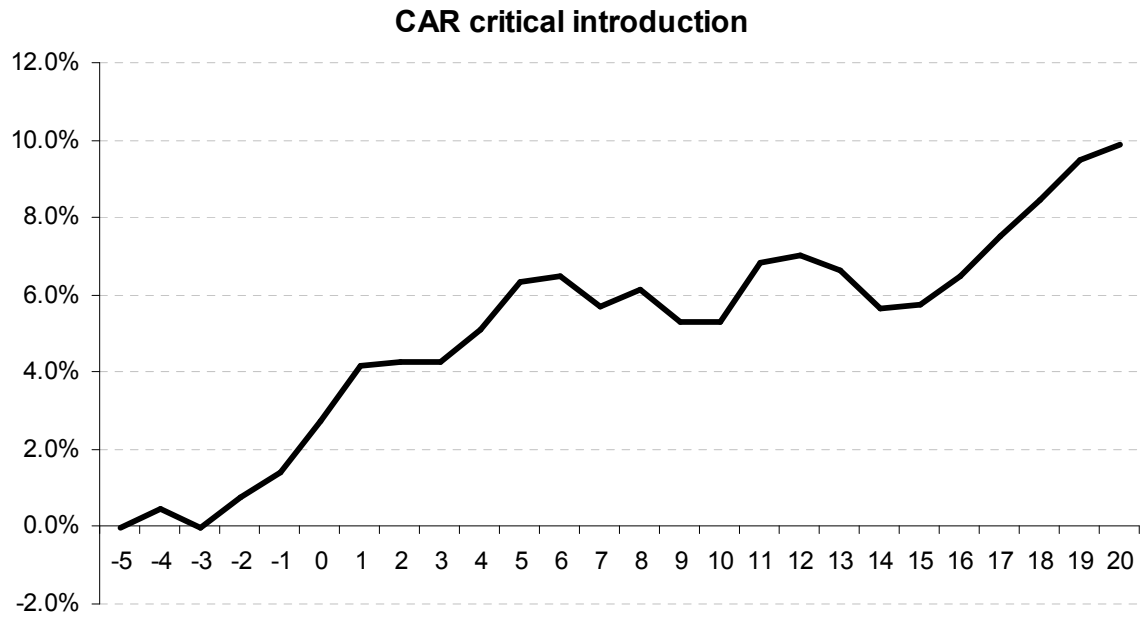


**Figure 13: Cumulative abnormal return around critical introductions**




Departure of the last liquidity providers, on their hand exhibit a negative effect on the company's value, albeit it is not a perfect mirror image of critical additions and is less pronounced. Although on day 0, when the last LP leaves, and the following three days abnormal returns negative, they generally are much more volatile and cumulative abnormal return even returns in positive territory briefly afterwards. However, over the whole event window cumulative abnormal return is negative and equals -4.8%. Significance of abnormal returns in event period is even trickier. As critical departures took place in the height of financial crisis, volatility on the stock market was extremely high, with extremely bad days mixing up with short, strong rebounds. Thus, almost every day is flagged as generating a significant abnormal return, be it positive or negative; moreover, these returns are deemed significant under both J tests (standard and more stringent, Boehmer J test).

**Figure 14: Abnormal returns around critical departures**

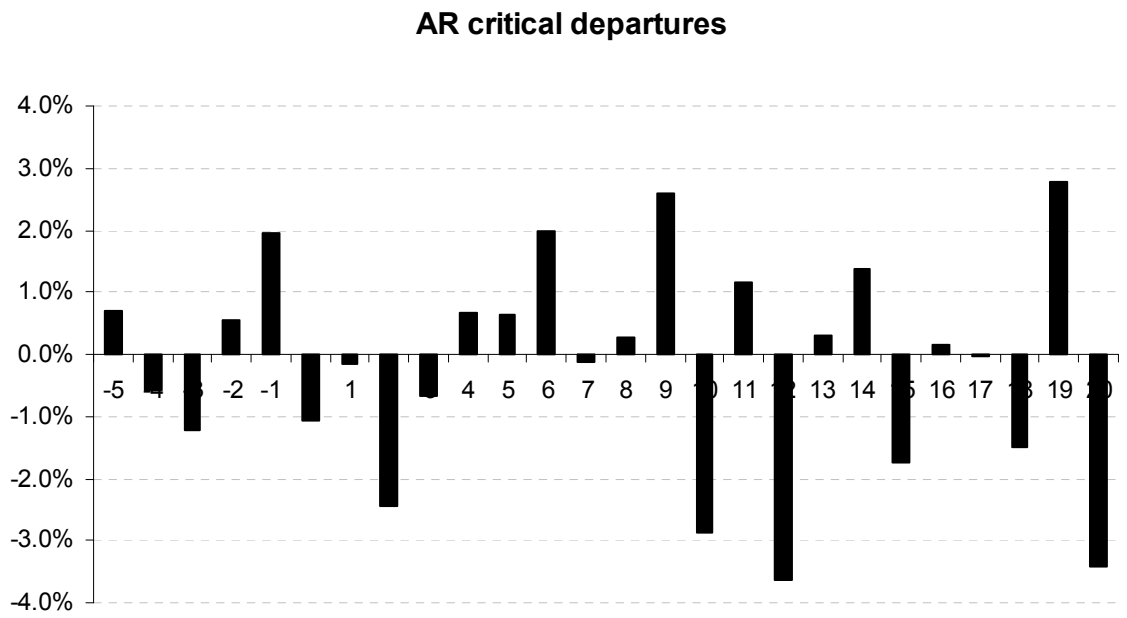
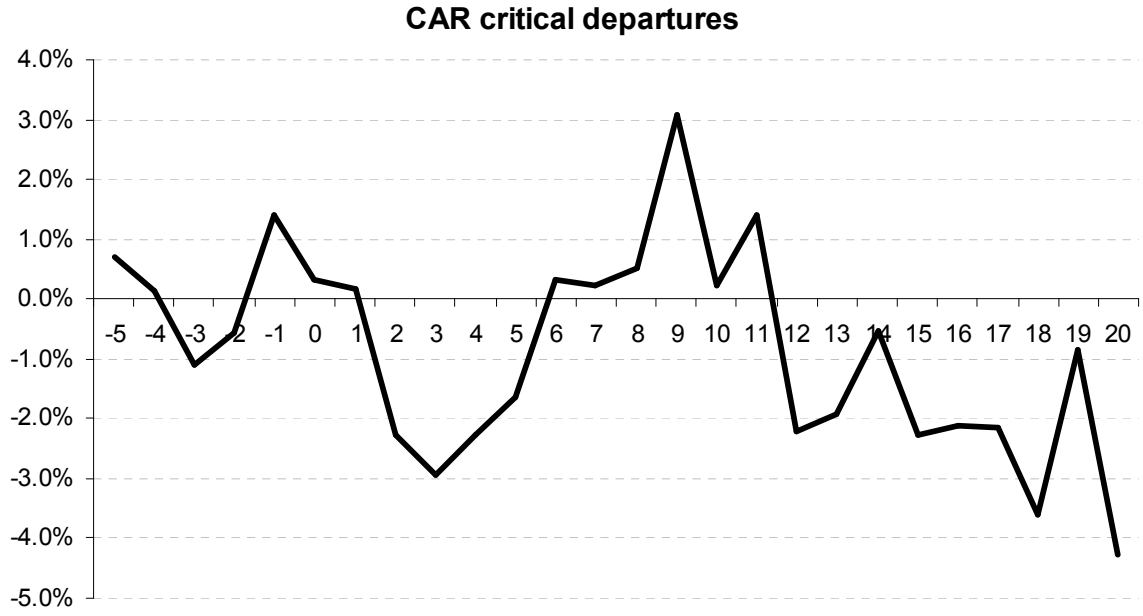



**Figure 15: Cumulative abnormal return around critical departures**




Thus, these findings are in line with expectations approve existence of liquidity premium on the Nasdaq OMX Riga. When the first liquidity provider is added (which, as proven in parts above, has a statistically significant positive impact on its liquidity), company's value experiences almost 10% abnormal return over the following 20 business days. On the other

hand, when the last liquidity provider leaves (and thus exerts a statistically significant negative effect on liquidity), company's value experiences abnormal 4.8% decrease over the next 20 business days.

# 5. Trading hour extension

## *5.1. Background*

Contrary to other stock exchanges, trading on the Latvian, Lithuanian and Baltic equity markets was initially squeezed into a significantly shorter sessions. The market opened at 10.00 and trading took place for four hours, till 14.00. However, that was changed on February 2nd, 2009, when all three Baltic exchanges extended trading hours by two hours, till 16.00. According to the press release, the aim of trading hour extension was to increase turnover *over the long term* on the Baltic stock market and attract more foreign investors. In the years before the Baltic markets had become closely intertwined with other European stock markets thanks to a wide range of local and international members. Thus, the new working hours would better correspond to working hours of European exchanges and foreign investors would be able to trade longer. Moreover, local investors would be able to react sooner to events across the globe. Interestingly, even with the extended hours Baltic stock markets still have slightly shorter trading hours than most European trading hubs; however they are almost as long as on the NYSE (6.5 hours) and even longer than on Tokyo Stock Exchange, where continuous trading takes place only for 4.5 hours (2 hours in the morning sessions + 2.5 hours in the afternoon session)

Stockholm 9.00 -17.20

Copenhagen 9.00 – 16.50

Helsinki 10.00 – 18.20

Warsaw 9.00 – 16.10

Moscow 10.30 – 18.00

According to Nasdaq OMX Riga, it had discussed the issue with its members beforehand and received the necessary support; some members had even expressed support in the previous Client surveys.

## *5.2. Previous researches*

There have not been many documented trading hour extensions, even less researches that have analyzed the impact of these extensions. Trading hours were extended on the Bombay Stock Exchange in 2009, yet operational issues like process of giving margins and limits to clients as well as trivial things like problems created for brokers who will have to get up one hour earlier and will not be able to attend their yoga classes were in spotlight, not liquidity implications (http://www.moneycontrol.com/news/marketoutlook/trading-hour-extensionis-corporate-governance-issue-_431358.html). Tokyo Stock Exchange also has been considering expanding trading hours in 2010 by shortening its midday break. In order to understand the opinions of market participants on this issue, it published a "Discussion Paper Regarding the Extension of Trading Hours". Interestingly, those few respondents that commented on liquidity implications of such changes expected no improvements in liquidity at best, some said it would decrease liquidity.

Although the author of paper is not aware of scientific researches that analyze the impact of trading hour extensions, a framework developed by Economides and Schwartz (1993) can be used to understand this issue. They start with an evident observation that buyers and sellers need to meet in two dimensions for a trade to be realized: time and place. And for a given market size, trading can be stipulated by consolidating the order flow, which can be done geographically (in one place) or temporally (over time). For the most part, recent discussions concerning market design have focused on the geographic consolidation of orders in a continuous market environment. But temporal consolidation also strengthens a

transactions network by enabling counterparties to find and to trade with each other more easily. Unfortunately, order flow is inherently fragmented in continuous trading, thus this type of market exhibits little inherent liquidity. In continuous trading market a large part of liquidity has to be provided by special intermediaries like liquidity providers and specialists; moreover, this artificial creation of liquidity increases trading costs in such markets. In contrast, call markets inherently exhibit higher liquidity because they squeeze orders together over time, thus providing time consolidation. Therefore, Economides and Schwartz propose opening and closing call auctions as a way of providing time consolidation in a continuous market (Nasdaq OMX Riga already organizes call auctions at the opening and closing of each trading session).

So the decision of Baltic stock exchanges to extend trading hours can be seen as an action that increases order fragmentation over time that on its hand makes it harder for the market participants to meet in time. Moreover, its timing coincided with departure of all liquidity providers. Thus in addition to losing these artificial means of improving liquidity, the Baltic Stock Exchanges also adopted changes that made it harder to exploit natural means of liquidity (time-wise concentrated liquidity). Although the opening and ending call auctions were not affected by the changes, it still can be argued that these changes made the market less “dense”, stretching the already scarce liquidity over a longer time period.

Moreover, when explaining the reasons for extended trading hours, the stock exchange officials cited improved immediacy in trade execution as one of the main benefits. It is indeed generally assumed that market participants’ demand for immediacy is an inherent need, but Economides and Schwartz argue that it is partly endogenous to the continuous market. Once a participant decides to seek a trade, that individual might wish to trade quickly in order to gain anonymity and to avoid having his or her order front-run. Moreover, some market participants do not choose to pay the price for immediacy when

they have an alternative. These participants include limit order traders, passive investors, and others for whom lower trading costs are more important than transactional immediacy. For individual traders, the price of immediacy is the bid-ask spread, market impact, and higher commissions; for the market as a whole, it also includes less accurate price discovery and greater short-run price volatility. They find proof for that in their survey of 150 equity traders that indicate they typically do not trade with maximum possible speed and work their order patiently over time. For instance, nearly 25% of the respondents indicated that, for a $50 stock, they would regularly or frequently accept a trading delay of three hours if they could thereby save 25 cents in trading costs. Nearly 50% indicated that they regularly or frequently take more than one day to execute a large order broken into smaller pieces. Thus, the ability to execute trades with greater immediacy may not be as valuable as one might expect.

## *5.3. Methodology*

Similarly to the previous part of this paper, evaluation of impact of trading hours extension will start by comparing daily quoted and percentage spreads 20 before and after the extension of trading hours. Spreads will be averaged for each company for pre and post event periods and then averaged accross all companies in each exchange; their statistical significance will be tested using the same t-test as in Equation 1. Then intraday spreads will be compared; however, as sample size of post-event period is larger due to more intraday observations, slightly adjusted t-test, which is more applicable to such situations, will be used:

$$t = \frac{\overline{X_1} - \overline{X_2}}{\sqrt{\frac{S_{X_1}^2}{n_1} + \frac{S_{X_2}^2}{n_2}}}, \text{ (Equation 14)}$$

with degrees of freedom equal to:

$$d.f. = \frac{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n2}\right)^2}{\frac{\left(\frac{s_1^2}{n_1}\right)^2}{n_1 - 1} + \frac{\left(\frac{s_2^2}{n_2}\right)^2}{n_2 - 1}}, \text{ (Equation 15)}$$

Afterwards, daily market and depth and intraday market depth before and after the extension of trading hours will be compared using similar tests. However, even if both bid ask spread market depth demonstrated deteriorating liquidity conditions on the Baltic stock markets it would not automatically imply that it is a result of trading hour extension, because these changes took place amidst market turmoil. Limit order can also be seen as a real option to execute an order at given price and given amount, which is handed to the marketplace. The longer the order is valid, the more valuable this option (and also the riskier it is to use it, as there is higher probability it will be exploited by an informed trader); thus, trading hour extension should decrease market participants' willingness to use these orders.

However, volatility of the underlying asset also increases the value of an option; thus, willingness to use limit order could have also declined as result of market turmoil. Thus, additional tests should be used to clarify it. Traded volume on each stock exchange before and after the trading hour extension will be compared, with its statistical significance tested by t-test from Equation 1. This is done in order to check if spread and market depth has not declined together with traded volume, which would suggest that market is not only getting "thinner", but also generally less active – such a combination most likely would arise from general market shock (financial crisis in this case), not adjustments to changes in bourse's trading model. The second "double check" will be performed via comparison of intraday volatility. If the trading hour extension had indeed made the market less dense, stretching

the same amount of activity over a longer time period throughout a day, it could be expected that intraday volatility had increased (but necessarily daily liquidity), as now smaller deals might have a market impact. Thus, hourly volatility 20 business days before and after trading hour extension will be compared.

## *5.4. Questions investigated*

Analysis of liquidity conditions before and after trading hour extension on the Nasdaq OMX Riga will allow answering the following questions:

1) Did extension of trading hours result in larger quoted and percentage bid ask spreads for the listed companies on all Baltic exchanges? The expectations are for wider spread due market participants' decreased willingness to use limit orders.

2) Did depth also decrease after extension of trading hours? As cost of real option of putting a limit order rose after extension of trading hours, investors are expected to use limit orders to a lesser extent and instead try hit the bid or ask themselves.

3) Did turnover on the exchanges decrease? Longer trading hours should not lead to overall reduction in trading activity; just the same amount of activity might be stretched over a longer time period and investors' preferred way of trading might be affected. Thus, it is expected to see no changes in turnover.

4) Did intraday volatility of on all Baltic exchanges increase? If market had indeed become shallower in terms of market depth and bid ask spread had widened, it could be expected that less money will be needed to move the market if the same amount of trading activity is stretched over longer time period. °

5) Did trades executed during the auctions made up larger part of total daily volume after the trading hour extension than they did before? if decompression of trading over time is a

concern to investors, they should become more inclined to use opening and closing auctions, where liquidity is concentrated in time; thus the proportion of trades executed during auctions is expected to go up.

## *5.5. Data description*

The sample consists of 11 stocks on the Latvian equity market, 9 on the Estonian market and 8 on Lithuanian market (see Appendix V for more detailed infomation). Trading data was obtained from two sources. Daily bid and ask prices for individual stocks and daily volumes for all three Baltic indexes (OMX Riga, OMX Tallinn, OMX Vilnius) have been obtained from Bloomberg data terminal. Intraday bid and ask prices for individual stocks, intraday market depth and daily market depth for individual stocks as well intraday price data for all indexes has been obtained from Nasdaq OMX Riga representatives.

Intraday data reflect best bid and ask price as well as market depth at the end of the each hour. As opening and closing auctions are excluded from the sample, there are three observations per day in the pre-event window (at 10.59, at 11.59 and at 12.59), while the post-event window contains two additional observations per day (at 13.59 and at 14.59). Observations where only a one-sided market existed have been excluded from the sample, as they make the calculation of spread impossible[4].

[4] Timing of observations differs by one minute from observations used for analysis of liquidity providers program, because the former was compiled by the author of this paper, while the latter was compiled by representatives from Nasdaq OMX Riga Group.

## *5.6. Results*

### *5.6.1. Spread*

Daily quoted spread increased on three Baltic exchanges, following extension of trading hours. The average quoted spread for 11 Latvian companies grew from 0.056 LVL in the 20 business day before trading hour extension to 0.068 LVL in the following 20 business days; for 9 Estonian companies it widened from 0.054 EUR to 0.056 EUR and 8 Lithuanian companies saw an average increase of 0.015 LTL (from 0.014 EUR to 0.029 EUR or from 0.0483 LTL to 0.100 LTL). However, none of these increases was statistically significant (t values were respectively 1.12, 0.21 and 1.29). Yet again, similarly to results of analysis of liquidity providers' impact, percentage spreads paint much more confident picture. Latvian companies saw percentage spread increasing from 5.14% to 6.66%, a change which is statistically significant even at 99% confidence interval ( t value 4.75), and Lithuanian companies experienced spread widening from 2.50% to 5.49%, also significant at 99% confidence interval (t test 3.72). Estonian companies saw much smaller and statistically insignificant (t test 0.79) impact, with spread increasing from 3.15% to 3.42%.

Intraday data support these findings. Intraday quoted spread in the continuous trading on the Latvian market widened from 0.069 LVL to 0.074 LVL, on the Lithuanian bourse it widened from 0.088 LTL to 0.105 LTL and remained unchanged at 0.063 EUR on the Estonian market; none of these changes is statistically significant, with t values standing at 0.83, 1.50 and at -0.02. Intraday percentage spread, however, reflects statistically significant increases in all bourses: from 5.8% to 7.1% on the Latvian market, from 4.2% to 5.6% on the Lithuanian market and even on the Estonian market from 3.7% to 4.1% (t values 7.20, 4.33 and 2.01). It can be seen that intraday spread is somewhat higher than

closing spread, suggesting there might market participants who are not active during continuous trading, but activate during the closing call auction, where liquidity is more concentrated time wise. These findings also warn that closing bid and ask prices might overestimate liquidity conditions during the trading session. Another interesting observation is the increase of "quiet hours" (hours where no trading takes place) following trading hour extension. Although it hints of liquidity being stretched, it is not a negative symptom per se.

Thus, quoted spread increased by statistically insignificant amount after trading hours were extended, while percentage spread saw statistically significant increase. So, results generally confirm expectations that bid ask spread increased following the trading hour extension.

### *5.6.2. Market depth*

Results on changes in market depth are rather contradictory, though. Firstly, 11 selected Latvian companies saw average total market depth (bid and ask orders combined) increase from 7592 shares to 9417; an increase which is statistically significant at 99% confidence interval (t test 5.63). Estonian and Lithuanian companies, however experienced market depth decline from 70825 to 65770 and from 269128 to 213988; the latter is statistically significant at 99% confidence interval (t value -3.04). Thus, Latvian equity market saw statistically significant increase in market depth (contrary to author's expectations), while Lithuanian market saw statistically significant decrease in market depth; such results can be treated as inconclusive although it is rather tempting to assign larger importance to changes on the Lithuanian and Estonian market that are more liquid and where trading activity fluctuates less from week to week.

### *5.6.3. Intraday volatility and traded volume*

Contrary to expectations, intraday hourly volatility declined on all three Baltic markets: it decreased from 1.20% to 0.85% on the Latvian market, from 0.63% to 0.58% on the Lithuanian market and from 0.72% to 0.62% on the Estonian market. Moreover, results are robust (volatility still declines), if pre and post event periods are lengthened from 1 month to 2 months.

Daily traded volume, on its hand, declined on all three exchanges: from 36 thousand shares to 29 thousand shares a day on the Latvian market, from 1.27 million shares to 0.66 millions shares on the Lithuanian market and from 4.0 million shares to 2.1 million shares on the Estonian market. Changes on the Latvian market are not statistically significant (t value -0.55); moreover, if one positive extreme outlier where 247 thousand shares changed hands (most likely as a result of block deals) is excluded from the pre-event window, volume actually increases from 25 thousand shares to 29 thousand shares (yet, also statistically insignificant). Changes on the Lithuanian market are significant at 95% confidence interval (t value 2.31), while changes on the Estonian market are significant even at 99% confidence interval (t value 4.65). Thus, the evidence is mounting against initial expectations that liquidity (measured as bid ask spread and market depth) had decreased as a result of trading hour extension. Rather, the market was experiencing a general liquidity drain due to market turmoil across the world.

### *5.6.4. Trading activity during auctions*

Auctions' share of total daily trading decreased in all three Baltic markets – from 10.7% to 7.2% on the Latvian bourse, from 14.5% to 13.8% on the Estonian bourse and from 11.4% to 7.3% on the Lithuanian bourse; however, only changes on the Lithuanian are statistically significant (and only at 90% confidence level with t value equal to -1.78),

while changes on two other exchanges are not statistically significant (t values -1.42, -0.27). Albeit contrary to author's expectations, these numbers confirm observation of Swedbank broker, Juris Jankovskis, who asserts that investors generally trade lightly during the auctions; for example, in the morning auctions many have not yet entered their orders and marked is rather thin. Contrary to expectations, investors became more active during the continuous trading, failing to confirm author's expectations of increased trading in auctions where liquidity is concentrated time-wise. Finally, trading activity during added hours (14.00-16.00) constituted 31.4% on the Latvian market, 36.2% on the Estonian market and 31.0% on the Lithuanian market in the first two weeks after trading hour extension. As time wise new hours constitute 33% of total continuous trading, it can be seen that investors trade just as actively in the new hours as in the old hours.

Overall, the findings approve that liquidity declined after extension of trading hours (spreads increased, and depth declined on some exchanges), but fail to confirm causality between longer trading hours and wider spreads combined with lower market depth. Traded volume decreased as well, suggesting overall decline in liquidity was a result of generally tough market conditions. Intraday volatility also did not increase as forecasted, failing to approve hypothesis that less money will be needed to move the market after trading hour extension. Finally, trading activity during auctions did not increase, suggesting that trading hour extension did not force investors to retreat to opening and closing call auctions where liquidity is more concentrated time wise. The most suitable conclusions is that overall decline in liquidity was a result of generally tough market conditions, not the decision of Baltic stock exchanges to extend trading hours.

# 6. EUR as a trading currency, tick size

## *6.1. Trading currency background*

National currency is a natural starting point to a discussion in what currency trading should take place on a stock exchange and Baltic countries were no exception. Equity market on all three of them started with national currencies, Estonian kron, Latvian lat and Lithuania lit, as their trading currencies. However, it is not the only option. Many countries, particularly emerging markets have opted to offer trading and settlement both in local currency and one of the so-called hard currencies (USD, EUR, JPY). For example, trading on Russian RTS Stock Exchange's Classica can be done both in roubles and US dollars; China's Shanghai Stock Exchange offers "A" shares quoted in renminbi for local investors[5] and "B" shares quoted in USD for foreign investors. Clearly, the main reason why stock exchanges are willing to undertake this additional inconvenience is willingness to attract more foreign investors. Trading and settlement in one of the hard currencies eliminates currency transaction costs. Moreover, a need for separate currency account is also eliminated, thus foreign investors find it much easier to start investing in a new market, as they do not need to open local currency account in of the local banks. And trading becomes easier from operational point of view, as there is no need to worry about currency positions. Moreover, for some less experienced investors trading and settlement in hard currency it might give an illusion of protection against devaluation of emerging markets' currency, which of course is not really true, as devaluation would still be reflected in company's share price, if its business was affected. Positive effects of introducing hard

[5] Access to external investors to these shares is limited: they must be a part of Qualified Foreign Institutional Investors list and quotas on amounts of shares available are issued. The reason is China's willingness to maintain strict capital control

currency as trading and settlement currency (yet combined with general adoption of EUR) are approved at least verbally by Andrej Rant, Deputy Governor of the Bank of Slovenia, who points out that "Accession to the EU and adoption of the Euro increased the openness of the Slovene capital market, broadened the investor base, reinforced the awareness of Slovene companies about different financing opportunities and brought more integrated and safe trading and post-trading infrastructures" (http://www.ceeseg.com/group-exchanges/ljubljana-stock-exchange/slovene-capital-market/euro-boost-and-liquidity-hike.html)

Given these expectations of improved liquidity, Tallinn Stock Exchange decided to change its trading currency to euros, when it migrated to HEX trading system back in the beginning of 2002[6]. From that point, orders could only be given in euros, yet investors still were able to transact with brokers in krons, with currency exchanged at the official exchange rate of the Central Bank of Estonia. In the following years Baltic exchanges become more and more closely integrated, yet each still had separate trading currency that gave significant headache to Pan-Baltic investors. If for example a Lithuanian investor wanted to buy a Latvian company, he / she he would incur currency exchange costs of approximately 2.5% in addition to brokerage commission[7] (0.2-0.35%, if the deal size is reasonable and it is executed through an electronic platform) and bid ask spread (ranging from 0.5% for most liquid companies, ~2% moderately liquid companies and more for less liquid companies). Although exchange rate could be negotiated for larger deals (usually starting with ~5 thousand EUR) currency exchange costs still made up bulk of total trading costs of a Pan-Baltic investor.

[6] Actual implementation date was postponed from January 28 to February 25

[7] Based on average bid and ask quotes of EUR/LVL, EEK/LVL and LTL/LVL currency pairs given by Swedbank, Citadele Banka and SEB for non-cash transactions on December 20, 2010.

Only in 2010 the next Baltic stock exchange was ready to adopt euro as trading currency, with Nasdaq OMX Vilnius making this step on November 22, 2010. In addition to mentioning the already-discussed ability to attract more foreign investors its press release also stated that only 10% of Lithuanian investors invested purely in Lithuanian companies; the remaining 90% invested the whole Baltic market. Clearly, for Lithuanian investors these changes meant significant cost savings and greatly improved flexibility to move capital across borders. Baltic market, on its hand, had come one step closer to becoming a single marketplace.

Nasdaq OMX Riga, however, did not join the party. Although all three Baltic exchanges had made a common press release on November 18, 2009 stating their intent to create a single marketplace for trading in euros, Nasdaq OMX Riga was not able to implement this project simultaneously with Nasdaq OMX Vilnius. Although there has been no finger pointing, it seems that there has been lack of support from some of the regulatory authorities. Yet, Financial and Capital Market Commission (FKTK) agrees that trading in EUR should attract more investors and increase trading volume and poins out that “it has already previously stated its support to initiative of Nasdaq OMX Riga on EUR as trading and settlement currency”. FKTK also states that the opinion of BoL will be taken into account; yet no opinion of BoL appears in the article. Given that Law on Bank of Latvia explicitly states that lat is the only legitimate payment currency BoL might be reluctant to agree to such a proposition as that would restrict local investors from paying for their transactions in LVL. Moreover, trading and settlement in euros, would enable foreign investors to invest in Latvian companies without buying lats and thus potentially worsening balance of supply and demand for Latvian lats, which clearly is a the most sensitive topic for BoL. Also, BoL would have less oversight over investment flows into Latvia. In order to find out official opinion of BoL on introduction of EUR as trading and

settlement currency, a list of questions was mailed to their official e-mail. Unfortunately, it received no response at all, not even a notification that BoL had declined to answer these questions.

## *6.2. Tick size background*

However, shift to euro as trading currency was not the sole change that took place on November 22. All Baltic bourses decreased minimum tick size: in Latvia and in Estonia it was reduced tenfold (from 0.01 LVL to 0.001 LVL and form 0.01 EUR to 0.001 EUR), while Lithuania in Lithuania it was decreased ~2.9 times due to combined effect of trading currency change and tick size reduction.

Previous researchers like Harris (1991, 1994), Seppi (1997) and MacKinnon & Nemiroff (1999) find that lowering of tick size generally leads to tighter bid ask spreads, irrespective of which stock exchange is examined. However, there is a drawback to smaller tick size, too. Of course, usually market depth at the best quote and at each individual quote declines, as aggregate volume of shares for that investors are willing to buy are sell is simply divided into a larger number of "compartments". That may not be a bad thing though, as investors still could execute their trades at lower weighted average spread, if market depth at subsequent levels is adequate. For example, Bourghelle and Declerck (2002) find average cost for large orders did not increase on the Paris Bourse, when it decreased tick size in 1999, implying that market depth did worsen.

However, tick size reduction leads to devaluation of time priority, which is a serious drawback. Orders normally have time priority which means that at any given price orders that were put in the system earlier, will be executed the first. In other words – first come, first served. If some investors would like to get in front of this queue, they would have to enter the order at a better price. So, when tick is smaller, traders can front run large limit

orders at much smaller cost, because they can enter their order at price which is just incrementally better. Investors who use large limit order are worse and that may lead to decreased willingness to use (visible) limit orders and thus to an overall decline in market depth. Harris (1996) finds that this indeed is the on the Toronto Stock Exchange and Paris Bourse, where investors are more willing to expose their orders for stocks with larger minimum tick size. Bourghelle and Declerck (2002) also find that investors were more inclined to use hidden orders following the tick size reduction on Paris Bourse in 1999.

Even though there are drawbacks to tick size reduction, particularly to large investors who use limit orders, most researchers are proponents of reasonably low tick sizes, as at worst it has no effect while at best it can decrease spread, improve market depth and increase volume traded (Goldstein & Kavajecz).

## *6.3. Methodology*

Similarly to the previous part of this paper, evaluation of impact of tick size reduction will be done by comparing quoted and percentage spreads 20 days before and after the extension of trading hours; however only intraday spreads will be compared, as previous parts of the paper have shown that both intraday and daily data generally paint identical pictures. Spreads will be averaged for each company for pre and post event periods and then averaged across all companies in each exchange; their statistical significance will be tested using the same t-test (Equation 14). Firstly, changes to intraday spreads on Estonian and Latvian equity market will be evaluated, thus analyzing the impact of pure tick size reduction. Next, half of Latvian companies and half of Estonian companies will be merged in the “liquid subset”, while the remaining 50% of companies from both exchanges will be merged in the “illiquid subset” (see Appendxi V for more detailed information). That will

allow checking if the effect of tick size reduction depends on liquidity of underlying stocks.

Finally, intraday spreads pre and post combined tick size reduction and trading currency change will be evaluated on the Nasdaq OMX Vilnius. Companies on that exchange will also be divided in liquid and less liquid subset to evaluate if liquidity affects the impact tick size reduction and euro adoption. Finally, average change in quoted and percentage spread on Nasdaq OMX Vilnius will be compared with changes on the Nasdaq OMX Tallinn and Nasdaq OMX Riga. If introduction of EUR as trading and settlement currency had a positive impact, Lithuanian market should have experienced larger decline in spreads.

However, the second dimension of liquidity, market depth, will not be evaluated, as aggregate market depth (both daily and intraday) was not available for this period, as the Nasdaq OMX had recently changed its IT system. Therefore, analysis will be limited to intraday quoted and percentage spreads.

## *6.4. Questions investigated*

Analysis of intraday spreads before and after tick size reduction on all three Baltic exchanges and EUR introduction as trading and settlement currency on Nasdaq OMX Vilnius will allow answering the following questions.

1) Did quoted and percentage spread decline on Nasdaq OMX Riga and Nasdaq OMX Tallinn as a result tick size reduction? Given the findings of previous researches on the subject, spread is expected to decline.

2) Was liquidity impact different for liquid stocks and less liquid stocks? It is expected that changes will be the most evident for liquid stocks where spreads already were rather low and quoted spread was very close or equal to previous minimum tick size. If spread of

companies shares was not artificially wide due to previously larger tick size, there is little reason for spread to decline, thus it is expected that these companies experienced smaller improvements.

3) Did quoted and percentage spread decline on Nasdaq OMX Vilnius as a result of combined tick size reduction and EUR introduction? Given the findings of previous researches on the subject, spread is expected to decline.

4) Was liquidity impact from EUR introduction and tick size reduction on the Nasdaq OMX Riga different for liquid stocks and less liquid stocks? It is expected that changes will be the most evident for liquid stocks where spreads already were rather low and where foreign investors are most active.

5) Did Nasdaq OMX Riga experience larger improvements in liquidity due to its migration EUR as trading and settlement currency?

## *6.5. Results*

Following the tick size reduction, quoted spread increased on the Latvian market from 0.072 LVL to 0.075 LVL, however the increase was not statistically significant even at 90% confidence interval (t test 1.12). On the Estonian market it was largely unchanged and inched down from 0.045 EUR to 0.044 EUR. Percentage spreads, on their hand, moved in the same direction as quoted spreads, yet both these moves were statistically significant at 99% confidence interval. Percentage spread decline from 2.18% to 1.95% on the Estonian market (t test -2.63), while on the Latvian market it widened from 4.04% to 4.70% (t test 4.82),

When Latvian and Estonian companies were divided in two subgroups of liquid and less liquid companies (with half of Latvian companies going into liquid subgroup and the other half going into illiquid subgroup), somewhat similar results were obtained. Firstly, quoted

spread marginally declined for liquid companies (from 0.066 EUR to 0.065 EUR, not statistically significant, with t test equal to -0.07), while less liquid companies saw their quoted spread increasing from 0.074 EUR to 0.080 EUR (statistically significant at 90%, t test 1.79). Secondly, percentage spreads moved in the same direction, but changes were not statistically significant: percentage spread of liquid companies declined from 2.45% to 2.39% (t test -0.45), and for illiquid companies it increased from 4.04% to 4.20% (t test 1.21). However, it should be mentioned that these two subgroups are rather heterogeneous, as a company which is relatively liquid on the Latvian stock market would look extremely illiquid on the Estonian market. If for example Ventspils Nafta, which is generally more liquid DPK, GZE, LME, RKB & VSS and thus is a part of the liquid subgroup, is excluded from it, results change a lot: percentage spread for adjusted liquid group declined from 2.16% to 1.56%, with t value equal to -5.31, which is highly significant even at 99% confidence interval.

Thus, these results albeit somewhat contradictory, generally confirm the expectations that tick size reduction and is the most relevant and beneficial to liquid stocks, as percentage spread declined significantly for the adjusted liquid subgroup and on the Estonia stock market in general, which is more liquid than Latvian market. Simultaneously, for less liquid stocks where old tick size did not force artificially wide spreads, and Latvian stocks tick size reduction had negative or no statistically significant effect. For less liquid companies percentage spread declined by statistically not significant amount, while Latvian equity market, which mostly consists of illiquid companies, saw percentage spread widen from 4.04% to 4.70% (results remain significant if Ventspils Nafta which was excluded from the liquid sample is excluded from Latvian sample as well).

On the Lithuanian equity market, where tick size reduction coincided with adoption of euro as trading and settlement currency, quoted spread increased from 0.036 EUR (converted

using EURLTL=3.45 exchange rate) to 0.038 EUR, but the change is not statistically significant (t value 0.85). Percentage spread, however, slightly increased from 1.27% to 1.31%, which also was not statistically significant (t value 0.19). Thus, at least for the Lithuanian market as a whole EUR adoption and tick size reduction did not bring any significant changes. When the market is divided into liquid and less liquid subgroups, a clear distinction can be seen. Percentage spread for liquid companies declined from 0.69% to 0.54%, a statistically significant move at 99% confidence level (t value -5.17), while less liquid stocks saw percentage spread widening from 1.84% to 2.07%, a change not significant even at 90% confidence interval (t value 0.60).

When compared to neighboring exchanges that changed just their tick size, spread changes on the Nasdaq OMX Vilnius do not differ much. Thus, expectations that combined effect of tick size reduction and introduction of euro as a trading currency would have greater positive effect than tick size reduction alone have not been confirmed. Except for liquid subgroup Lithuanian equity market did not see significant changes in spreads of listed companies. Given that tick size reduction had positive effect on liquid companies listed on Estonian and Latvian market and the fact that Lithuanian sample was reasonably liquid (average intraday spread as 1.27% before the changes), the most reasonable conclusion that euro introduction for trading and settlement purposes did not have any effect on the Lithuanian market. However, as changes in spread on the Nasdaq OMX Vilnius cannot be broken down with certainty, it is possible that the tick size reduction component was much smaller on the Lithuanian market, implying that positive changes to the liquid subgroup were brought by euro introduction. Unfortunately, it is impossible to test this claim and it is rather speculative.

There are several possible explanations why euro introduction did improve liquidity situation on the Lithuanian stock market. Firstly, euro introduction might have brought

additional costs to local investors, who now had to exchange currency to trade on their home market. In order to compensate for these costs, local investors might have increased their ask quotes and decreased their bid quotes, effectively widening the spread. However, given that 90% of Lithuanian investors are pan-Baltic investors who benefited from these changes, it is unlikely that the remaining 10% had so significant impact on the market. Secondly, in addition to making investing in Lithuanian stock market easier for foreign investors, these changes also made foreign markets easier to invest in for Lithuanian investors, as they did not need to convert their proceeds from selling Lithuanian investments to euros. Thus, some investors might have chosen to sell their Lithuanian investments and move to other stock exchanges where trading takes place in euros, thus draining some of the liquidity from Lithuanian market. However, this is also a rather unlikely scenario, as costs of single currency exchange are far too small to be the main reason holding back investors from moving their capital to another country. Thirdly, and this is most likely explanation, it takes time for the positive effects of trading and settlement in euro to be realized. It is not very likely that foreign investors who did not invest in Lithuanian market before the changes followed its newsflow on day to day basis and kept their finger on the trigger, waiting for the euro to be adopted. Rather, these positive effects will play out over medium to long term, as foreign investors learn about the changes and re-evaluate investments in Lithuania in the light of new conditions.

# 7. Recommendations and Implementation

## *7.1. Liquidity providers*

Analysis of liquidity conditions around changes to the liquidity providers revealed their importance. Introduction of first liquidity provider decreases percentage spread on company's stock, and so does introduction additional liquidity providers. Positive effects are not limited to just this dimension of liquidity, as market depth increases as well, with the most significant changes after critical additions. Moreover, introduction of first liquidity provider leads to almost 10% cumulative abnormal returns over the next 20 business days. Unfortunately, the opposite of effects happens liquidity provider departs: spread increases, market depth declines and company's value experiences decline in value.

Given these findings, it is clear that Nasdaq OMX Riga should try reviving liquidity providers program. However, there is a number of challenges, the first being corporate politics. Although the largest banks have lately been speaking about returning to risk taking activates, like mortgage lending, that has not transformed into tangible actions – taking an example outside brokerage business, credit mass outstanding in Latvia is still shrinking by approximately 100m LVL each month. This reluctance to add more risk to banks' operations can also be felt in the interviews with representatives of former liquidity providers. Most say it is unlikely a proposal to restart liquidity providing activities would be approved by local and mother banks' boards, as the risk level of trading books is maintained low, but LP program requires holding an inventory of rather illiquid and deemed risky Latvian companies. At the same they acknowledge that investment in inventory is not that big – usually 6-8 minimum quoted amounts for each stock are enough. Taking the case of Grindeks that traded at ~5.50 LVL in August 2008 and had minimum quoted amount of 500 stocks, the required inventory is approximately LVL 20'000 –

certainly not a huge amount for any of the largest banks in Latvia. Even assuming liquidity provision for 6 companies, as requested by current LP program rules, required investment stands at reasonable LVL 120'000.

Secondly, former liquidity providers do not really see a business case for liquidity providers with its current structure. Firstly, the need to provide liquidity to at least 6 companies is criticized. As there are not that many liquid companies with good corporate governance practices, it resembles an "ugly contest" – picking the lesser evil. Interestingly, the chicken and egg problem appears even here – companies are in need of liquidity (that could be provided by liquidity providers), but liquidity providers are hesitant to join because these companies are illiquid! Moreover, in order to participate in liquidity providers' program brokerage departments need to get exposure limits to companies they cover – which might rather hard to do for companies with weak CG practices. Thus, brokers suggest eliminating the six company minimum. In that way banks could provide liquidity only to those companies they wish to, for example, their corporate banking clients. In such case it would also be easier to get the limits approved. *So, the first recommendation is to eliminate requirement to provide liquidity to at least 6 companies.*

Brokers suggest that lack of business case also arises from weak monetary incentives (trading commission discounts), which is in direct contradiction to views of Indars Ascuks, vicechairman of the Nasdaq OMX Riga board. According to him, there are several ways how the bourse might apply discounts to liquidity providers. The most narrow one would be to provide discounts only to market making deals. Second, a broader one, would be to provide discounts to all deals with stocks of those companies where the broker provides liquidity. Finally, the most wide reaching one, is to provide discounts for all deals with all stocks on the exchange – and this one is used by Nasdaq OMX Riga. Moreover, the discount is very substantial and stands at 50%. However, brokers claim it still is too little

and claim there was little business case even in the more liquid years, when the value of this discount was much more valuable due to larger traded amounts. One of their suggestions is to expand the application of discounts even further, to all Baltic exchanges; however that would complicate things on both sides of the negotiation table. On one hand, Nasdaq OMX Riga would have to get agreements from Nasdaq OMX Tallinn and Nasdaq OMX Vilnius. Although they are all a part of the Nasdaq OMX Group they might be hard pressed to agree to such discounts. Moreover, Swedbank Latvia does not carry out deals on neighboring exchanges itself, but hands them over to Swedbank Estonia or Swedbank Lithuania. Therefore, the Latvian branch would see no increase on its P/L due to such changes; the bourse, on its hand, would have apply discounts to all deals executed by all three Swedbank Baltic branches on all three exchanges – clearly not a valid option.

Some exchanges (Stockholm, Vilnius) encourage issuers to pay market makers for proving liquidity to their shares, but such strategy is only feasible if the company aims to raise capital on the stock exchange in nearer future or already has a wide shareholder base (who trades its shares on the market) and is interested in maximizing shareholder value. Clearly, very few companies qualify to these criteria on the Latvian equity market and this would not be a viable way of improving liquidity for the overall market.

So, it seems that the previous liquidity providers cannot or do not want to return to providing liquidity under current terms. Nasdaq OMX Riga of course could try approaching its other members, but it is even less likely they would agree, as the value of monetary sweeter, commission discounts, is even smaller for them due to their low activity on the stock market. Does that mean that liquidity providers program is gone for good? Not necessarily. The main obstacles currently is the combination of corporate politics in the former LPs combined with less attractive conditions. Although Nasdaq OMX Riga cannot influence the former factor, it can alter the latter. The compensation currently is purely

variable – the more the LP trades, the larger the monetary gains. *Thus, the second recommendation is to adjust compensation scheme to include a reasonable fixed part (for example, discount to annual member fee) in addition to variable part.* That would make the program interesting to smaller, currently less active members (who would otherwise even not consider it). More attractive compensation might cause a re-evaluation of business case of LP program in the former LP banks, too.

In addition to improved carrots, Nasdaq OMX Riga should also include some sticks in the liquidity providers agreement. A situation that ensued in the final days of liquidity providers program, when market makers were not fulfilling their obligation of providing bid and ask quotes at least 85% of the time is not justified and harms its credibility among investors, as it implies that liquidity will disappear when needed the most. *Thus, the third recommendation is for Nasdaq OMX Riga to defer part of the compensation for several months and pay it only if there have not been breaches of liquidity providers program rules.* Making the rules harsher when there is no immediate candidates for liquidity provider's role might sound peculiar, but not doing it could cause and irreversible harm to program's reputation if tough market conditions were to strike again.

Finally, Nasdaq OMX Riga should not spend too much resources on securing several liquidity providers to each stock. Statistical tests prove that impact from the first liquidity provider is much stronger than from subsequent ones. *Thus, the recommendation is to provide higher incentives to "liquidity pioneers" or brokers who start providing liquidity to companies that do not yet have a LP; simultaneously lower incentives should be offered to subsequent LPs*. Such system would also compensate LPs for higher risk of being the only LP for a particular stock.

## *7.2. Trading hours*

Analysis of liquidity conditions and trading patterns before and after trading hour extension revealed generally lower liquidity after trading hour extension, but failed to confirm author's expectation of causal relationship between these two issues. In addition, all brokers that were interviewed view these changes in a positive light. Despite some initial doubts about "stretched liquidity" (particularly because of bad timing of changes) they have now become supporters of extended hours. Firstly, feedback from local retail clients is positive, as they have more flexibility when placing their trades. As most of these small investors are not full time traders trading hour extension translates into less missed opportunities for this group. Feedback from foreign investors has been more mixed, ranging from support due to larger trading hour overlap (for example, before the extension Baltic trading was over 12.00 London time) to somewhat emotional nostalgia for times when "it was possible to get things on the Baltic market done early in the workday and concentrate on the major markets". The opinion of brokers is summarized in the statement that *decision of trading hour extension was a matter of "when", not "if"*, as that was a natural step to become more integrated in the "global trading day".

*Given these findings, it is clear that the first recommendation to Nasdaq OMX Riga is not to go back to the old trading hours*. As liquidity did not "stretch out" and was able to hold (or even improve) during the turbulent February of 2009, there is no reason to expect adverse turns of events in "normal" conditions. Thus, Nasdaq OMX Riga is well positioned to bear fruits of these changes, as the Latvian market has become easier accessible to foreign investors, particularly those from Western Europe.

However, there is still no overlap between Latvian and US trading sessions[8]. According to Nasdaq OMX Riga representative Indars Ascuks, stock exchanges all around the world try organize their trading in a way that would allow at least some overlap with US trading hours, as US stock market is the largest stock market in the world and has the biggest impact on other stock markets. *Thus, the second suggestion to Nasdaq OMX Riga is to go one step further and extend trading by an additional hour, till 17.00 that would create short, albeit permanent overlap with US trading session and make the Latvian equity market more accessible to US investors.* Conceptually, brokers are supportive of such changes, yet operational issues like back-office's ability to settle the deals by the end of banks' working hours are a concern for some them; however, others did not see any problems with settlements. Still, in order to successfully expand trading session by an additional hour Nasdaq OMX Riga should gather feedback from major stock exchange members as well as recognize potential concerns and ways how to solve them. Discussions with neighboring bourses also should be started, as the positive impact of such step will be maximized if all three Baltic stock exchanges extend trading hours simultaneously.

## *7.3. EUR & tick size*

Analysis of tick size reduction revealed their positive impact on stocks where liquidity was already high and previous, larger tick size, was a constraint. However, for less liquid stocks effect ranged from neutral to negative. On Nasdaq OMX Vilnius, where tick size reduction was complemented with change of trading and settlement to EUR, results were similar, but effect was not stronger than on neighboring exchanges where only tick size was changed.

[8] With the exception of a short time period each spring, when US switches to summer daylight saving time 2-3 weeks before Latvia, creating a temporary 30 minute overlap between trading sessions in these two countries,

Despite lack of clear supportive evidence that euro introduction was beneficial for Nasdaq OMX Vilnius, the author of this research paper argues there is a number of reasons why Nasdaq OMX Riga still should do so. Firstly, it may take time for positive results from adopting euro as trading and settlement currency to play out (that would explain absence of such effects in analysis carried in this paper). Secondly, 60-70% of deals on the Nasdaq OMX Riga are already carried out by foreign investors (according to Nasdaq OMX Riga representative Indars Ascuks), thus such changes would be clearly beneficial for majority of market participants. Thirdly, on January 1st 2011 when Estonia will adopt euro (and thus settlement on the bourse will also take place in euros) the situation on the integrated Baltic stock market will change from one where it is beneficial to have euro as trading or settlement currency to one where it is very detrimental not to have it. As long as all three Baltic exchanges had different trading and settlement currencies, costs associated with opening currency accounts and exchanging currencies were cost of doing business on the Baltic bourses that could not be avoided. However, with both EUR adopted both at Nasdaq OMX Vilnius and Nasdaq OMX Tallinn that account for 85% of market capitalization and 95% of trading turnover, Nasdaq OMX Riga risks being left out. Investors who'll decide to start investing in the Baltics will almost certainly overlook niche segment of Latvian companies due to additional costs and inconveniencies caused by trading and settlement in lats. The existing investors on their hand could become even less active or cease to trade on the Latvian market at all.

Thus, in order to remain on the radar, *the recommendation is for Nasdaq OMX Riga to introduce EUR as trading and settlement currency*. However, this is not a decision that Nasdaq OMX Riga can make in isolation, and it requires approval of regulatory authorities. Currently, it seems that Bank of Latvia is the only party, which is reluctant to give its blessing to EUR introduction as trading and settlement currency on the bourse. In

order to get agreement from BoL, Nasdaq OMX Riga should start with finding out what are the main concerns and reservations BoL has against EUR as trading and settlement currency. Then, it should work towards a solution that alleviates BoL's concerns. Judging from information in mass media and interviews with industry representatives, BoL might be particularly concerned about an outcome where even for local investors willing to transact in LVL there is no other option as settlement in EUR. Although it could be argued there are very few investors who invest only locally, BoL's concern for these investors is justified. At least as long as LVL is the official currency in Latvia, these investors still should not be discriminated against. *Therefore, the second recommendation is to propose a solution to BoL where settlement in LVL should is also an option (perhaps even in a situation where only one of the transacting parties wants it)*. Despite more difficulties and higher costs associated with such solution, it should make it easier to win BoL's support, as Nasdaq OMX Riga will have shown respect for its concerns and willingness to cooperate. The concerns about stability of lat (if there are such) are clearly overblown given the low level of activity on the Latvian equity market, but they could be refuted by a research carried out by an independent, reputable party. *Thus, the third recommendation is to hire a reputable, independent party to carry out an academic research about effects on stability lat exchange rate arising from migration to EUR as trading and settlement currency in the bourse.* Finally, Nasdaq OMX Riga should use the example of Lithuania where trading and settlement in EUR was introduced with backing o regulatory structures as an argument in negotiations with BoL.

As for the tick size, *the recommendation for Nasdaq OMX Riga is to introduce a tick book*, which would imply a higher tick size as the stock price increases. For example, for shares that trade below 0.50 LVL it should be 0.001 LVL, for stocks traded between 0.51 and 1.00 LVL it should be 0.0025 LVL, etc. That would preserve positive impact on liquid

stocks that were constrained by previous tick size; yet, it also would minimize the negative effect of time priority devaluation created by tick size reduction. Therefore, with cost of front running higher, investors would feel safer to use large limit orders.

# 8. Conclusions

Similarly to structure of the core part of this thesis, conclusions are broken down into three sections.

Firstly, it was found that introduction of the first liquidity provider to a company's shares has a positive impact on liquidity of these shares: intraday percentage bid ask spread declines 3.39% to 2.08%, and market depth improves from 15273 shares to 18130 shares on average. Introduction of additional LPs have less profound impact, with most of the changes not being statistically significant. Moreover, introduction of first LP results in cumulative abnormal return of 9.9% over the following 20 business days,

The opposite effects hold when departures of the last LPs are examined. Intraday percentage spread widened from 5.32% to 5.76%, revealing a surprising discovery that in the last days before LP departure spread was not below 4% for 85% of time when continuous trading took place. Market depth also declined significantly from 10552 shares to 7662 shares on average. In cases where LP who was leaving was not the last one, intraday spread also widened from 2.92% to 3.93%, while changes to market depth were not statistically significant. Departure of last LP also resulted in cumulative abnormal return, with companies on average experiencing -4.8% CAR over the next 20 business days,

Secondly, analysis of trading hour extension revealed that market liquidity indeed declined following these changes. Intraday percentage spread climbed statistically significantly from 5.8% to 7.1% on Nasdaq OMX Riga, from 4.2% to 5.6% on Nasdaq OMX Vilnius and from 3.7% to 4.1% on Nasdaq OMX Tallinn. Changes in market depth were less homogenous, as it increased from 7592 shares to 9417 on Nasdaq OMX Riga, declined from 269128 to 213988 shares on Nasdaq OMX Vilnius and declined on Nasdaq OMX Tallinn by an amount which was not statistically significant.

However, analysis fails to confirm expectation that liquidity decline was a result of trading hour extension. Firstly, trading turnover declined on all exchanges (from 1.27 million shares to 0.66 million shares on Nasdaq OMX Vilnius and from 4.0 million shares to 2.1 million shares on Nasdaq OMX Tallinn), and changes were statistically significant on Nasdaq OMX Tallinn and Nasdaq OMX Vilnius, giving signals of a general liquidity drain. Secondly, intraday volatility did not increase, failing to confirm hypothesis that market will be easier to move with less or same amount of money. Finally, trading activity as percentage of total daily trading activity during morning and afternoon auctions where liquidity is concentrated time-wise, declined, failing to confirm hypothesis that market participants will migrate temporally to liquidity oases.

Thirdly, evaluation of tick size reduction revealed its positive effect on liquid stocks that saw their intraday percentage spread decline from 2.16% to 1.56%. Geographically, Nasdaq OMX Tallinn gained, as its average intraday percentage spread narrowed from 2.18% to 1.95%, while Nasdaq OMX Riga saw spread widening from 4.04% to 4.70%. Impact of combined tick size reduction and EUR introduction as trading and settlement currency on Nasdaq OMX Vilnius had positive impact on subgroup of most liquid companies (narrowing from 0.69% to 0.54%), while the market in general did not experience statistically significant changes.

Given these results and input from industry specialists the following recommendations have been developed:

**Liquidity providers**

1. Eliminate requirement to provide liquidity to at least 6 companies.
2. Adjust compensation scheme to include a reasonable fixed part (for example, discount to annual member fee) in addition to variable part.

3. Defer part of the compensation for several months and pay it only if there have not been breaches of liquidity providers program rules.
4. Provide higher incentives to "liquidity pioneers" or brokers who start providing liquidity to companies that do not yet have a LP.

**Trading hours**

1. Trading hour extension was a success; return to the old trading hours is not recommended.
2. Extend trading by an additional hour, till 17.00 that would create short, albeit permanent overlap with US trading session and make the Latvian equity market more accessible to US investors.

**EUR as trading and settlement currency; tick size**

1. Introduce EUR as trading and settlement currency in order to stay on the radar of foreign investors.
2. Propose a solution to BoL where settlement in LVL should is also an option
3. Hire a reputable, independent party to carry out an academic research about effects on stability lat exchange rate arising from migration to EUR as trading and settlement currency in the bourse.
4. Introduce a tick book, which would imply a higher tick size as the stock price increases, thus mitigating the negative effects on time priority.

# 9. Appendices

## *9.1. Appendix I. List of interviews*

**Indars Aščuks**, Vicechairman of the Nasdaq OMX Riga board. Interview date: 30.11.2010

**Nataļja Točelovska**, Head of Brokerage at SEB. Interview date 03.12.2010

**Juris Jankovskis**, Broker at Swedbank. Interview date 03.12.2010

**Jānis Bērziņš**, Head of Brokerage at Citadele Banka. Interview date 20.12.2010

**Inga Martinsena**, Compliance analyst at Citadele Banka, former Broker. Interview date 21.12.2010.

## *9.2. Appendix II. Baltic equity market statistics*

Table I. Baltic equity market statistics

| EUR | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Riga Stock Exchange** | | | | | | | | | | | |
| Market capitalisation, m | 676 | 784 | 682 | 776 | 1208 | 2177 | 2034 | 2098 | 1166 | 1317 | 969 |
| Market turnover, m | 243.4 | 153.6 | 126.4 | 125.5 | 87.2 | 76.8 | 87.7 | 102 | 28.4 | 14.0 | 19.4 |
| Average monthly turnover, m | 20.3 | 12.8 | 10.5 | 10.5 | 7.3 | 6.4 | 7.3 | 8.5 | 2.4 | 1.2 | 1.8 |
| Number of companies | 63 | 63 | 62 | 56 | 39 | 45 | 40 | 41 | 35 | 34 | 33 |
| # of IPOs | - | - | - | - | *SAF* | - | - | - | - | - | - |
| Average company, m | 10.7 | 12.4 | 11.0 | 13.9 | 31.0 | 48.4 | 50.9 | 51.2 | 33.3 | 38.7 | 29.4 |
| Market cap, % of GDP | 8.0% | 8.4% | 6.9% | 7.8% | 10.8% | 17.0% | 12.7% | 9.9% | 5.0% | 7.0% | 5.4% |
| Market turnover, % of market cap | 36.0% | 19.6% | 18.5% | 16.2% | 7.2% | 3.5% | 4.3% | 4.9% | 2.4% | 1.1% | 2.0% |
| Market turnover, % of GDP | 2.87% | 1.65% | 1.28% | 1.26% | 0.78% | 0.60% | 0.55% | 0.48% | 0.12% | 0.07% | 0.11% |
| **Tallinn Stock Exchange** | | | | | | | | | | | |
| Market capitalisation, m | 1915 | 1704 | 2386 | 3117 | 4706 | 2961 | 4578 | 4042 | 1403 | 1850 | 1658 |
| Market turnover, m | 348.6 | 259 | 262.6 | 494 | 663 | 1938 | 766 | 1523 | 618 | 267 | 227 |
| Average monthly turnover, m | 29.1 | 21.6 | 21.9 | 41.2 | 55.3 | 161.5 | 63.8 | 126.9 | 51.5 | 22.2 | 20.6 |
| Number of companies | 21 | 18 | 15 | 15 | 14 | 16 | 16 | 18 | 18 | 16 | 15 |
| # of IPOs | - | - | - | - | - | 3 | 2 | 2 | - | - | *Premia Foods* |
| Average company, m | 91.2 | 94.7 | 159.1 | 207.8 | 336.1 | 185.1 | 286.1 | 224.6 | 77.9 | 115.6 | 110.5 |
| Market cap, % of GDP | 31.4% | 24.6% | 30.8% | 36.7% | 50.2% | 26.8% | 35.0% | 25.9% | 8.8% | 13.5% | 11.6% |
| Market turnover, % of market cap | 18.2% | 15.2% | 11.0% | 15.8% | 14.1% | 65.5% | 16.7% | 37.7% | 44.0% | 14.4% | 13.7% |
| Market turnover, % of GDP | 5.7% | 3.7% | 3.4% | 5.8% | 7.1% | 17.5% | 5.9% | 9.7% | 3.9% | 1.9% | 1.6% |

(table continued in the next page)

(table continued)

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Vilnius Stock Exchange** | | | | | | | | | | | |
| Market capitalisation, m | 1232 | 964 | 1392 | 2862 | 4753 | 6937 | 7728 | 6834 | 2608 | 3220 | 3978 |
| Market turnover, m | 119.3 | 226.5 | 176.4 | 165.6 | 314 | 588 | 1607 | 755.2 | 332 | 215 | 207 |
| Average monthly turnover, m | 9.9 | 18.9 | 14.7 | 13.8 | 26.2 | 49.0 | 133.9 | 62.9 | 27.7 | 18 | 18.8 |
| Number of companies | 47 | 46 | 51 | 43 | 42 | 43 | 42 | 41 | 40 | 40 | 39 |
| # of IPOs | | | | | | | *1* | *1* | *1* | - | *1* |
| Average company, m | 26.2 | 21.0 | 27.3 | 66.6 | 113.2 | 161.3 | 184.0 | 166.7 | 65.2 | 80.5 | 102.0 |
| Market cap, % of GDP | 10.0% | 7.1% | 9.3% | 17.4% | 26.2% | 34.9% | 30.7% | 22.5% | 8.9% | 11.5 % | 14.7 % |
| Market turnover, % of market cap | 9.7% | 23.5% | 12.7% | 5.8% | 6.6% | 8.5% | 20.8% | 11.1% | 12.7% | 6.7% | 5.2% |
| Market turnover, % of GDP | 1.0% | 1.7% | 1.2% | 1.0% | 1.7% | 3.0% | 6.4% | 2.5% | 1.1% | 0.8% | 0.8% |
| **Aggregate Baltic market** | | | | | | | | | | | |
| Market capitalisation, m | 3823 | 3452 | 4460 | 6755 | 10667 | 12075 | 14340 | 12974 | 5177 | 6386 | 6605 |
| Market turnover, m | 711.3 | 639.1 | 565.4 | 785.1 | 1064.2 | 2602.8 | 2460.7 | 2380.2 | 978.4 | 495.1 | 453.4 |
| Average monthly turnover, m | 59.3 | 53.3 | 47.1 | 65.4 | 88.7 | 216.9 | 205.1 | 198.4 | 81.5 | 41.3 | 41.2 |
| Number of companies | 131 | 127 | 128 | 114 | 95 | 104 | 98 | 100 | 93 | 90 | 87 |
| # of IPOs | - | - | - | - | *1* | 3 | 3 | 3 | *1* | - | *2* |
| Average company, m | 29.2 | 27.2 | 34.8 | 59.3 | 112.3 | 116.1 | 146.3 | 129.7 | 55.7 | 71.0 | 75.9 |
| Market cap, % of GDP | 14.2% | 11.6% | 13.6% | 19.3% | 27.6% | 27.6% | 26.4% | 19.3% | 7.6% | 10.6 % | 11.1 % |
| Market turnover, % of market cap | 18.6% | 18.5% | 12.7% | 11.6% | 10.0% | 21.6% | 17.2% | 18.3% | 18.9% | 7.8% | 6.9% |
| Market turnover, % of GDP | 2.6% | 2.1% | 1.7% | 2.2% | 2.8% | 5.9% | 4.5% | 3.5% | 1.4% | 0.8% | 0.8% |

Sources: OMX, Eurostat, CAM, Focus Economics estimates

## *9.3. Appendix III. List of changes in the Liquidity Providers program*

Table II. List of changes in the LP program

| Ticker | Date | Action | Critical? | Name of LP(s) in action | LP structure after changes |
|---|---|---|---|---|---|
| LSC1R | 01.10.2004 | LP added | Y | HB, Parex, Suprema | HB, Parex, Suprema |
| SAF1R | 01.10.2004 | LP added | Y | HB, Parex, Suprema | HB, Parex, Suprema |
| VNF1R | 01.10.2004 | LP added | Y | HB | HB |
| DPK1R | 01.10.2004 | LP added | Y | Parex | Parex |
| GRD1R | 01.10.2004 | LP added | Y | HB, Parex, Suprema | HB, Parex, Suprema |
| LME1R | 01.10.2004 | LP added | Y | Suprema | Suprema |
| OLF1R | 01.10.2004 | LP added | Y | Parex | Parex |
| RKB1R | 01.10.2004 | LP added | Y | HB, Suprema | HB, Suprema |
| VSS1R | 01.10.2004 | LP added | Y | HB, Parex, Suprema | HB, Parex, Suprema |
| BAL1R | 01.10.2004 | LP added | Y | HB | HB |
| GRD1R | 01.02.2005 | LP added | | HB | Parex, HB |
| BAL1R | 01.02.2005 | LP removed | Y | HB | - |
| LME1R | 04.04.2005 | LP removed | Y | Suprema | - |
| OLF1R | 04.04.2005 | LP added | | Suprema | Parex, Suprema |
| LSC1R | 01.09.2005 | LP added | | SEB | HB, Parex, Suprema, SEB |
| GZE1R | 01.09.2005 | LP added | Y | SEB | SEB |
| RTF1R | 01.09.2005 | LP added | Y | SEB | SEB |
| RKB1R | 01.09.2005 | LP added | | SEB | HB, Suprema, SEB |
| VSS1R | 01.09.2005 | LP added | | SEB | HB, Parex, Suprema, SEB |

| | | | | | |
|---|---|---|---|---|---|
| BAL1R | 01.09.2005 | LP added | Y | SEB | SEB |
| RTF1R | 12.04.2006 | LP removed | delisted | SEB | Company delisted |
| OLF1R | 12.04.2006 | LP added | | SEB | Parex, Suprema, SEB |
| OLF1R | 02.04.2007 | LP removed | | Suprema | Parex, SEB |
| VSS1R | 02.04.2007 | LP removed | | Suprema | HB, Parex, SEB |
| RKB1R | 02.04.2007 | LP removed | | Suprema | HB, SEB |
| LSC1R | 02.04.2007 | LP removed | | Suprema | HB, Parex, SEB |
| GRD1R | 02.04.2007 | LP removed | | Suprema | HB, Parex |
| SAF1R | 02.04.2007 | LP removed | | Suprema | HB, Parex |
| VSS1R | 01.09.2008 | LP removed | | Parex | HB, SEB |
| VNF1R | 01.09.2008 | LP added | | Parex | HB, Parex |
| VNF1R | 14.11.2008 | LP removed | | Parex | HB |
| SAF1R | 14.11.2008 | LP removed | | Parex | HB |
| GRD1R | 14.11.2008 | LP removed | | Parex | HB |
| LSC1R | 14.11.2008 | LP removed | | Parex | HB, SEB |
| OLF1R | 14.11.2008 | LP removed | | Parex | SEB |
| DPK1R | 14.11.2008 | LP removed | Y | Parex | - |
| VNF1R | 12.12.2008 | LP removed | Y | HB | - |
| SAF1R | 12.12.2008 | LP removed | Y | HB | - |
| GRD1R | 12.12.2008 | LP removed | Y | HB | - |
| LSC1R | 12.12.2008 | LP removed | | HB | SEB |
| VSS1R | 12.12.2008 | LP removed | | HB | SEB |
| RKB1R | 12.12.2008 | LP removed | | HB | SEB |
| LSC1R | 15.01.2009 | LP removed | Y | SEB | - |
| VSS1R | 15.01.2009 | LP removed | Y | SEB | - |
| RKB1R | 15.01.2009 | LP removed | Y | SEB | - |
| OLF1R | 15.01.2009 | LP removed | Y | SEB | - |
| BAL1R | 15.01.2009 | LP removed | Y | SEB | - |
| GZE1R | 15.01.2009 | LP removed | Y | SEB | - |

**SEB stands for SEB Unibanka, Parex - for Parex Banka, HB for Hansabanka*

## *9.4. AppendixIV. Liquidity provider program results*

Table III. Results of analysis LP program.

**DAILY SPREAD**

**Additions**

| | Percentage spread | | | | Quoted spread | | | |
|---|---|---|---|---|---|---|---|---|
| | Critical | | Non critical | | Critical | | Non critical | |
| | PRE | POST | PRE | POST | PRE | POST | PRE | POST |
| | 4.09% | 1.88% | **1.37%** | **1.15%** | **0.116** | **0.041** | **0.025** | **0.021** |
| Difference | -0.022 | | -0.22% | | - 0.074 | | - 0.004 | |
| Pooled st.dev | 0.24% | | 0.10% | | 0.021 | | 0.003 | |
| T value | -9.30 | | -2.14 | | - 3.49 | | - 1.19 | |
| Significance | *** | | ** | | *** | | | |

**Departures**

| | Percentage spread | | | | Quoted spread | | | |
|---|---|---|---|---|---|---|---|---|
| | Critical | | Non critical | | Critical | | Non critical | |
| | PRE | POST | PRE | POST | PRE | POST | PRE | POST |
| | **4.24%** | **4.62%** | **2.29%** | **3.09%** | **0.060** | 0.058 | **0.040** | **0.042** |
| Difference | 0.37% | | 0.80% | | -0.002 | | 0.002 | |
| Pooled st.dev | 0.29% | | 0.17% | | 0.010 | | 0.006 | |
| T value | 1.30 | | 4.57 | | - 0.24 | | 0.29 | |
| Significance | | | *** | | | | | |

**INTRADAY SPREAD**

**Additions**

| | Percentage spread | | | | Quoted spread | | | |
|---|---|---|---|---|---|---|---|---|
| | Critical | | Non critical | | Critical | | Non critical | |
| | PRE | POST | PRE | POST | PRE | POST | PRE | POST |
| | **3.39%** | **2.08%** | **1.57%** | **1.67%** | **0.095** | **0.062** | **0.028** | **0.031** |
| Difference | -1.30% | | 0.11% | | - 0.034 | | 0.004 | |
| Pooled st.dev | 0.12% | | 0.09% | | 0.006 | | 0.002 | |
| T value | -11.10 | | 1.17 | | - 5.50 | | 1.81 | |
| Significance | *** | | | | *** | | * | |

**Departures**

| | Percentage spread | | | | Quoted spread | | | |
|---|---|---|---|---|---|---|---|---|
| | Critical | | Non critical | | Critical | | Non critical | |
| | PRE | POST | PRE | POST | PRE | POST | PRE | POST |
| | **5.32%** | **5.76%** | **2.92%** | **3.93%** | **0.079** | **0.083** | **0.058** | **0.051** |
| Difference | 0.44% | | 1.01% | | 0.004 | | - 0.007 | |
| Pooled st.dev | 0.19% | | 0.13% | | 0.007 | | 0.004 | |
| T value | 2.37 | | 7.98 | | 0.55 | | - 1.68 | |
| Significance | ** | | *** | | | | * | |

**INTRADAY DEPTH**

**Additions**

| | # of shares | | | |
|---|---|---|---|---|
| | Critical | | Non critical | |
| | PRE | POST | PRE | POST |
| | 15 273 | 18 130 | 24 418 | 27 985 |
| Difference | 2 857 | | 3 567 | |
| Pooled st.dev | 1 108 | | 2 219 | |
| T value | 2.58 | | 1.61 | |
| Significance | *** | | | |

**Departures**

| | # of shares | | | |
|---|---|---|---|---|
| | Critical | | Non critical | |
| | PRE | POST | PRE | POST |
| | **10 552** | 7 662 | 17 261 | 16 072 |
| Difference | -2890 | | -1189 | |
| Pooled st.dev | 444 | | 795 | |
| T value | - 6.51 | | - 1.50 | |
| Significance | *** | | | |

## *9.5. AppendixV. Sample for tests of impact of trading hour extension and tick size reduction*

Table IV. Sample used for tests of impact of trading hour extension and tick size reduction

| | Liquid | Less liquid |
|---|---|---|
| **Latvian sample** | GRD1R | DPK1R |
| | LSC1R | GZE1R |
| | OLF1R | BAL1R |
| | VNF1R | VSS1R |
| | SAF1R | RKB1R |
| | | LME1R |
| **Estonian sample** | ETLAT | VSN1T |
| | OEG1T | HAE1T |
| | TAL1T | JRV1T |
| | TVEAT | MRK1T |
| | BLT1T | EEG1T |
| **Lithuanian sample** | TEO1L | STU1L |
| | UKB1L | LNS1L |
| | SRS1L | LEN1L |
| | SNG1L | VBL1L |
| | APG1L | |

## *9.6. AppendixVI. Trading hour extension results*

Table V. Results of analysis of trading hour extension

**DAILY SPREAD**

| **Trading hour extension** | Quoted spread | | | | | |
|---|---|---|---|---|---|---|
| | Riga | | Tallinn | | Vilnius | |
| | PRE | POST | PRE | POST | PRE | POST |
| | **0.056** | **0.068** | **0.054** | **0.056** | **0.014** | **0.029** |
| Difference | 0.012 | | 0.002 | | 0.015 | |
| Pooled st.dev | 0.011 | | 0.009 | | 0.012 | |
| T value | 1.12 | | 0.21 | | 1.29 | |
| Significance | | | | | | |

**DAILY SPREAD**

| **Trading hour extension** | Percentage spread | | | | | |
|---|---|---|---|---|---|---|
| | Riga | | Tallinn | | Vilnius | |
| | PRE | POST | PRE | POST | PRE | POST |
| | 5.14% | 6.66% | **3.15%** | **3.42%** | **2.50%** | **5.49%** |
| Difference | 0.015 | | 0.27% | | 2.99% | |
| Pooled st.dev | 0.003 | | 0.34% | | 0.80% | |
| T value | 4.75 | | 0.79 | | 3.72 | |
| Significance | *** | | | | *** | |

**INTRADAY DEPTH**

| **Additions** | # of shares | | | |
|---|---|---|---|---|
| | Critical | | Non critical | |
| | PRE | POST | PRE | POST |
| | 15 273 | 18 130 | 24 418 | 27 985 |
| Difference | 2 857 | | 3 567 | |
| Pooled st.dev | 1 108 | | 2 219 | |
| T value | 2.58 | | 1.61 | |
| Significance | *** | | | |

| **Departures** | # of shares | | | |
|---|---|---|---|---|
| | Critical | | Non critical | |
| | PRE | POST | PRE | POST |
| | **10 552** | 7 662 | 17 261 | 16 072 |
| Difference | -2890 | | -1189 | |
| Pooled st.dev | 444 | | 795 | |
| T value | - 6.51 | | - 1.50 | |
| Significance | *** | | | |

**INTRADAY SPREAD**

| **Trading hour extension** | Quoted spread | | | | | |
|---|---|---|---|---|---|---|
| | Riga | | Tallinn | | Vilnius | |
| | PRE | POST | PRE | POST | PRE | POST |
| | **0.069** | **0.074** | **0.063** | **0.063** | **0.088** | **0.105** |
| Difference | 0.006 | | 0.000 | | 0.017 | |
| Pooled st.dev | 0.007 | | 0.005 | | 0.011 | |
| T value | 0.83 | | -0.02 | | 1.50 | |
| Significance | | | | | | |

**INTRADAY SPREAD**

| **Trading hour extension** | Percentage spread | | | | | |
|---|---|---|---|---|---|---|
| | Riga | | Tallinn | | Vilnius | |
| | PRE | POST | PRE | POST | PRE | POST |
| | **5.77%** | **7.08%** | **3.72%** | **4.11%** | **4.18%** | **5.59%** |
| Difference | 1.30% | | 0.39% | | 1.41% | |
| Pooled st.dev | 0.18% | | 0.19% | | 0.33% | |
| T value | 7.20 | | 2.01 | | 4.33 | |
| Significance | *** | | ** | | *** | |

## *9.7. AppendixVII. Tick size reduction, EUR introduction results*

Table VI. Results of analysis of tick size reduction & EUR introduction

**INTRADAY SPREAD**

| **Tick size reduction** | Quoted spread Tallinn | | Percentage spread Tallinn | | Quoted spread Riga | | Percentage spread Riga | |
|---|---|---|---|---|---|---|---|---|
| | PRE | POST | PRE | POST | PRE | POST | PRE | POST |
| | **0.045** | **0.044** | **2.18%** | **1.95%** | **0.101** | **0.107** | **4.04%** | **4.70%** |
| Difference | 0.000 | | -0.24% | | 0.006 | | 0.67% | |
| Pooled st.dev | 0.003 | | 0.09% | | 0.004 | | 0.14% | |
| T value | -0.14 | | -2.63 | | 1.57 | | 4.82 | |
| Significance | | | *** | | | | *** | |

**INTRADAY SPREAD**

| **Tick size reduction** | Quoted spread Liquid | | Percentage spread Liquid | | Quoted spread Illiquid | | Percentage spread Illiquid | |
|---|---|---|---|---|---|---|---|---|
| | PRE | POST | PRE | POST | PRE | POST | PRE | POST |
| | **0.066** | **0.065** | **2.45%** | **2.39%** | **0.074** | **0.080** | **4.04%** | **4.20%** |
| Difference | 0.000 | | -0.05% | | 0.006 | | 0.16% | |
| Pooled st.dev | 0.004 | | 0.11% | | 0.003 | | 0.14% | |
| T value | -0.07 | | -0.45 | | 1.79 | | 1.21 | |
| Significance | | | | | * | | | |

**INTRADAY SPREAD**

| **Tick size reduction & EUR introduction** | Quoted spread Vilnius | | Percentage spread Vilnius | |
|---|---|---|---|---|
| | PRE | POST | PRE | POST |
| | **0.036** | **0.041** | **1.27%** | **1.31%** |
| Difference | 0.005 | | 0.04% | |
| Pooled st.dev | 0.006 | | 0.21% | |
| T value | 0.85 | | 0.19 | |
| Significance | | | | |

**INTRADAY SPREAD**

| **Tick size reduction & EUR introduction** | Quoted spread Liquid | | Percentage spread Liquid | | Quoted spread Illiquid | | Percentage spread Illiquid | |
|---|---|---|---|---|---|---|---|---|
| | PRE | POST | PRE | POST | PRE | POST | PRE | POST |
| | **0.005** | **0.005** | **0.69%** | **0.54%** | **0.067** | **0.077** | **0.69%** | **0.54%** |
| Difference | 0.000 | | -0.15% | | 0.010 | | -0.15% | |
| Pooled st.dev | 0.001 | | 0.03% | | 0.008 | | 0.03% | |
| T value | 0.65 | | -5.17 | | 1.19 | | -5.17 | |
| Significance | | | *** | | | | *** | |

# 10. Bibliography

**Research papers**

Amihud and Mendelson (1986). Asset Pricing and the Bid-Ask Spread. Journal of Financial Economics 17, 223-249.

Amihud (2000). Illiquidity and Stock Returns: Cross-Section and Time-Series Effects. Working Paper

Anand, Tanggaard, and Weaver (2008). Paying for market quality. Working Paper

Ates and Wang "Liquidity and Price Discovery on Floor versus Screen-Based Trading Systems: An Analysis of Foreign Exchange Futures Markets (2005).

Brown and Warner (1985). Using daily stock returns: The case of event studies. Journal of Financial Economics 14 (1985): 3-31.

Boehmer, Musumeci, and Poulsen (1991). Event-Study Methodology Under Conditions of Event-Induced Variance. Journal of Financial Economics 30 (1991): 253- 272.

Bourghelle and Declerck (2002). Why Markets Should Not Necessarily Reduce Tick Size. Working Paper.

Campbell and Wasley (1993). Measuring Security Price Performance Using Daily NASDAQ Returns. Review of Quantitative Finance and Accounting, 6(3), 309–326.

Chordia, Roll and Subrahmanyam (2006). Liquidity and Market Efficiency. Journal of Financial Economics 56, 3-28.

Chordia, Roll and Subrahmanyam (2001). Market Liquidity and Trading Activity.

Economides and Schwartz (1993). Electronic Call Market Trading. Working paper

Fama (1970). Efficient Capital Markets: A Review of Theory and Empirical Work. The Journal of Finance, 25 (2), 383-417.

Goldstein & Kavajecz (1999). Eighths, Sixteenths and Market Depth: Changes in Tick Size and Liquidity Provision on the Nyse. Working Paper.

Harris, L. (1991). Stock Price Clustering and Discreteness. Review of Financial Studies 4, 389-415.

Harris, L.(1994). Minimum Price Variations, Discrete Bid-Ask Spreads, and Quotation Sizes, Review of Financial Studies 7, 149-178.

Healy, Hutton, and Palepu (1999). Stock performance and intermediation changes surrounding sustained increases in disclosure. Journal of Accoutning and Economics,. 31, 405-440

Huang and Stoll (1996). Dealer versus auction markets: A paired comparison of execution costs on NASDAQ and the NYSE. Journal of Financial Economics 41, 313-357.

Hopewell, Schwartz (1978). New York Stock Exchange Trading Halts and Volatility. Journal of Finance, Vol. 33, pp.1355-1373.

Grečuhina and Timofejeva (2008). The Impact of Liquidity Providers on the Baltic Stock Exchange. Bachelor Thesis.

Long (1978). The Market Valuation of Cash Dividends: A Case to Consider. Journal of. Financial Economics, 6, 235–64

Longstaff (2004). Liquidity and Bond Pricing. Journal of Business 77 (3), 511–526.

Mackinlay (2007). Event Studies in Economics and Finance. Journal of Economic Literature, 35 (1997): 13-39.

MacKinnon, Greg and Howard Nemiroff (1999). Liquidity and Tick Size: Does Decimalization Matter? Journal of Financial Research 22:3.

Maynes and Rumsey (1993). Conducting event studies with thinly traded stocks. Journal of Banking and Finance 17, 145–157.

Patell (1976). Corporate forecasts of earnings per share and stock price behaviour: Empirical tests. Journal of Accounting Research, 14 (2), 246-276.

Poterba (1986). Interpreting Ex-Dividend Evidence: The Citizens Utilities Case Reconsidered. Working Paper

Reinganum (1990). Market Microstructure and Asset Pricing: an Empirical Investigation of NYSE and NASDAQ Securities. Journal of Financial Economics 28, 127-47.

Scholes and Williams (1977). Estimating Betas From Nonsynchronous Data. Journal of Financial Economics 5 (1977): 309-27.

Seppi, D. (1997. Liquidity Provision with Limit Orders and a Strategic Specialist. Review of Financial Studies, 10, 103–150.

Tevanen, P. (2006). The Impact of Liquidity Providers: Evidence from Helsinki Exchange and Stockholmsbörsen. Master's Thesis

**Books**

CFA Institute Level I Curriculum. Equity and Fixed Income. Boston, Pearson Custom Publishing.

Kothari and Warner (2004). Handbook of Corporate Finance: Empirical Corporate Finance. Ed. Espen Eckbo. North-Holland: Elsevier, 2007.

**Online resources**

http://news.medill.northwestern.edu/chicago/news.aspx?id=67753

http://www.usatoday.com/money/markets/2007-07-11-nyse-traders_N.htm

http://www.nasdaqomxbaltic.com/market/?lang=lv

http://www.stock-market-investors.com

http://www.ceeseg.com/group-exchanges/ljubljana-stock-exchange/slovene-capital-market/euro-boost-and-liquidity-hike.html

http://www.moneycontrol.com/news/marketoutlook/trading-hour-extensionis-corporate-governance-issue-_431358.html).

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Name of the author in full:

**Jānis Praņevičs**

Title of the Thesis as approved by the RBS Council:

**Business Development Strategy of the Nasdaq OMX Riga**

I confirm that my Master of Business Administration (MBA) Thesis has been prepared by myself. The data, definitions, citations that are taken from other sources are indicated in my work. This work, nor any part of it, in one form or another has never been handed in to some other commission and has never been published.

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Jānis Praņevičs

Date

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