Master's Thesis in Finance

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Enhanced Liquidity and Returns on the Emerging Baltic Market

PATRIK ADAMSON and GUSTAF BACKEMAR

19106@student.hhs.se 19534@student.hhs.se

Abstract:

Markets are ever evolving. By their very nature studies of them call for abstractions and assumptions, such as that of a frictionless market. But this assumption ignores what in practice is commonly referred to as the single most important feature of a well functioning market: liquidity. In order to investigate the plausibility of the assumption, of a frictionless market, the linkage between liquidity and returns on the emerging Baltic market is examined. On an emerging market liquidity effects could be expected to be particularly pronounced. The data sample consists of all 97 companies which were listed between 2000 and 2006. It is unique in both its level of detail and quality compared to other emerging markets. Liquidity is measured by the market adjusted variables activity and price impact. Abnormal return of individual securities is examined, taking both expected and unexpected liquidity into account. The results provide strong support for the proposition that average liquidity, on the Baltic market, is priced. In turn this is interesting since the results suggest that liquidity should be taken into account when determining the value of an asset.

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1. Introduction

Most asset pricing models start out with a brave assumption, that of a frictionless market.[1] In practice, however, transaction costs exist (Coase, 1937). These costs differ between asset classes, over time and among individual financial instruments. Many scholars have found substantial transaction costs and some argue that they are so prevalent that: "Asset pricing models need to be recast in broader terms to incorporate the transaction costs of liquidity and price discovery." (O'Hara, 2003, p. 1335). To counter this, some scholars have claimed that even though this is technically correct it is also practically unimportant.[2] This thesis will investigate this issue by linking return with the elusive concept of liquidity in an emerging market setting utilizing detailed transactional data.

Surprisingly, the growing body of research into liquidity focuses on the United States, perhaps the most liquid market in the world. The fact that liquidity on the US stock exchanges is relatively abundant makes any liquidity related effects less pronounced and perhaps more difficult to detect. On emerging markets the situation is quite different since these markets are often characterized by thin trading and limited liquidity. Many scholars therefore argue that emerging markets provide a perfect setting to study the impact of liquidity on expected returns.[3]

Emerging markets might hence provide new insight into the working of all markets. The problem with analyzing emerging markets, however, is twofold. Firstly, there is a distinct lack of detailed transactional data. Secondly, the available data are often not very reliable. This has, in turn, impaired almost all papers which examine emerging markets in general and liquidity on emerging markets in particular. This thesis circumvents the problem by examining the rapid developments in liquidity on an emerging market where the problem is not so prominent, namely the Baltic market.

The Baltic market, which consists of the Tallinn, Riga and Vilnius Stock Exchanges, has seen a phenomenal development both with regards to returns and improvements in market microstructure. The market is unique among emerging markets in both the quality and the level of detail of the available data. One major reason why this is the case is that the market is managed by the Swedish exchange operator OMX, which is a world leader in its field. On the Baltic market

[1] See for example Sharpe (1964), Lintner (1965), Merton (1973), Ross (1976) and Cox, Ingersoll and Ross (1985).
[2] See for example Eleswarapu and Reinganum (1993) and Chen and Kan (1995).
[3] See for example Bekaert and Harvey (2003) and Rouwenhorst (1999).

OMX applies the same rules and trading system (SAXESS) that are, for example, used on the Stockholm, Copenhagen and Helsinki Stock Exchanges. OMX claims that on the Baltic market: "A model marketplace is being created, based on integration, regional expertise and technological infrastructure that makes it a showcase of efficiency and increases liquidity." (OMX, 2005b, p. 22). Hence a study of the Baltic market provides a possibility to harness the benefits of studying liquidity on an emerging market and at the same time minimising the drawbacks of unreliable data and an uncertain market microstructure. This thesis uses the unique data set and a new methodology for the study of the linkage of liquidity and returns. It is hence the hope of the authors to examine this research area and contribute to the understanding of the relationship between liquidity and returns in general and on the emerging Baltic market in particular.

The thesis is subdivided into seven sections. Next, in section 2, a theoretical framework for the analysis is presented. Section 3 continues with a presentation of the data set and the characteristics of the Baltic market. Thereafter the hypotheses are outlined in section 4 and the methodology is presented in section 5. The empirical findings are discussed in section 6 and section 7 concludes. The interested reader can find additional information regarding the Baltic market and the methodology in appendices A-G.

2. Theoretical Framework

This section will provide a theoretical framework on which the analysis of the linkage between returns and liquidity on the Baltic market will be based. The concepts that are outlined below are the nature of liquidity, measuring liquidity, implications for asset pricing and finally liquidity and asset pricing on emerging markets.

2.1 The Nature of Liquidity

Any analysis of liquidity must start by confronting a very basic question: What is liquidity? On a very fundamental level a liquid market can, intuitively, be described as a market in which buyers and sellers can trade into and out of positions quickly without having large price impacts. The concept might seem simple enough, but this is only scratching the surface and the exact meaning of liquidity is far from apparent. At the same time liquidity is viewed as the single most important feature of a well functioning market. For the purposes of this thesis a more precise view of liquidity is necessary.

The concept of liquidity is notoriously difficult to define. One of the first scholars to discuss the liquidity of financial markets was Black (1971), but the earliest formal definition was made by Kyle (1985) who viewed liquidity as the impact of order flow on price. The impact is reflected as a part of the discount that a seller gets and the premium that a buyer pays in order to execute a trade. To be more precise, however, one has to realize that the concept of market liquidity encompasses a number of transactional properties of markets.[4] These include, but are not limited to, "immediacy" (the speed at which an order of a given size can be arranged at a given cost), "width" (the cost of doing a trade at a given size), "depth" (the size of an order flow innovation required to change prices a given amount) and "resilience" (how quickly the price reverts back to the fundamental value). These different dimensions of liquidity are important to keep in mind as they pose several challenges to the study of the concept. Specifically they imply, by definition, that no single measurement can capture all the different faces of liquidity.

Both Black (1971) and Kyle (1985) adopted what has later been labelled a microstructure based view of liquidity. This view of liquidity differs from the more traditional in that it argues that liquidity leads to stability. The reason for this is that investors, ceteris paribus, are more willing to hold securities which they can easily trade. An asset is hence liquid if there is a large number of

[4] This notion was introduced by Kyle (1985) and further developed by Harris (1990).

available buyers and sellers. This would then, by definition, imply that liquidity leads to stability since the price would be less affected by trades in a liquid market compared to an illiquid one. The traditional view on the other hand views liquidity as destabilising and has its roots in Keynes (1935) and was developed by Tobin (1978) and Summers and Summers (1989). The basis for this argument is that liquid markets leads to capital markets that are fixated on the short term and susceptible to instability. To in detail discuss the differences between the two schools of thought is beyond the scope of this thesis, but the conflict is at its core since the relationship between liquidity and asset pricing is investigated. If it is the case that investors demand higher returns to hold illiquid assets, then liquidity is a risk that is priced and hence more would be preferred to less.

2.2 Measuring Liquidity

The question of measuring liquidity is, as one would expect, difficult since no single measurement can capture all the different aspects of liquidity.[5] One ends up in a situation where one has to proxy for some aspects of liquidity and the quality of the results comes down to the quality of the proxy and the underlying data. These proxies can take many forms but, for practical purposes, one can roughly subdivide them into three categories. The categories are the bid-ask spread, trading activity and price impact.

2.2.1 The Bid-Ask Spread

The bid-ask spread is measured as the difference between what the buyer pays for a security and the price which the seller gets. In a dealer-driven market setting it can, for analytical purposes, be subdivided into two components (Harris, 2002). These are the transaction cost component and the adverse selection component. The transaction cost component measures the compensation to dealers for their normal costs of doing business. The adverse selection component, on the other hand, is directly related to the amount of private information in the market. Since dealers often do not have a clear view of fundamental values they will expose themselves to adverse selection when they offer liquidity to more informed traders. Indeed Bagehot (1971)[6] argues that a primary cause of illiquidity in financial markets is the adverse selection which arises from the presence of informed traders. In order to cover their losses to informed traders the dealers must widen their spreads and thereby regain their losses from so called noise traders (Black, 1986). A noise trader

[5] See for example Stoll (2000) and O'Hara (2003).
[6] The paper is Jack Treynor's classical article "The Only Game in Town", which was written under the pseudonym of Bagehot (1971).

operates without any fundamental information and does not cause the price to move towards the fundamental value. The effect of liquidity on the spread is rather straightforward. The transaction cost component is reduced in a liquid market since the cost can be allocated over a larger population of traders. The adverse selection component should also be reduced since the proportion of uninformed traders could be expected to be larger in a liquid market. The bid-ask spread is closely related to the market width dimension.

2.2.2 Trading Activity

Trading activity is another proxy for liquidity since more active trading in the marketplace usually implies a greater presence of buyers and sellers, which by definition leads to higher liquidity (Bekaert et al., 2005). There are several ways to measure the activity in a market. One obvious candidate is accounting for the number and size of transactions over a given time period. An example of this would be the daily turnover and investigating how it has changed. The traded value may not be that good of an indicator on an emerging market, however, since such markets are characterized by both days with no trading and days with extremely high trading activity (Lesmond, 2005). A more suitable measurement for an emerging market may be some measurement based on the number of active trading days. Nevertheless these measurements all account for an activity dimension of liquidity. One should keep in mind, however, that rapid bursts of trading activity may take liquidity by drying up the order book.

2.2.3 Price Impact

Finally the price impact of trading provides an insight into the market depth which resembles Kyle's (1985) definition of liquidity and is further developed by Amihud (2002). The price impact measurement relates the change in the price to the underlying activity in the stock. Hence a high price impact is a characteristic of an illiquid market and a low of a liquid one. Intuitively it can be thought of as a proxy of the order book depth since it measures the amount of buy and sell orders that can be absorbed without large price changes. Whereas the trading activity measurement is particularly suited to a very illiquid market setting, price impact and the bid-ask spread, on the other hand, may also capture liquidity in more active markets.

2.3 Implications for Asset Pricing

The simplifying assumption that financial markets are frictionless and efficient has a long tradition in financial theory. It is described by Stoll (2000) as a useful abstraction, but nevertheless an abstraction. Asset prices evolve in markets which are plagued by friction and

transaction costs such as illiquidity. Below the theoretical implications and previous empirical findings are outlined.

2.3.1 Theoretical Implications

If illiquidity carries a non-diversifiable risk component an investor has to be financially compensated to carry it. This, in turn, implies that illiquidity is priced and linked to returns. This assertion has far reaching consequences as it implies that standard asset pricing theories may not take an important part of the pricing component into account. If this is the case, O'Hara's (2003) claim that asset pricing models might have to be recast in broader terms to incorporate the transactional costs of liquidity might very well hold.

Even if one argues that liquidity is not that much of an issue on well developed markets it may still be the case that liquidity is a substantial issue on emerging markets and that asset pricing models that ignore the liquidity aspects are not as exact on these markets as on their more developed peers. Finally it may be the case that a liquidity perspective might have something to tell about the evolution of what today is seen as developed markets. The argumentation for this is, of course, that historically they have experienced similar stages of development.

2.3.2 Previous Empirical Findings

Empirical studies which investigate whether liquidity is priced have their roots in Amihud and Mendelson (1986). Up to that point the authors claim that "…despite its evident importance in practice, the role of liquidity in capital markets is hardly reflected in academic research." (p. 223) and the paper "…attempts to narrow the gap by examining the effects of liquidity on asset pricing" (p. 223). The authors used a cross-section of NYSE securities from 1960 to 1979 and proxy illiquidity by using the bid-ask spread. They argue that there is a clientele effect whereby long-term investors choose assets with higher spreads and higher expected returns in order to mitigate higher transaction costs. An example based on the findings says that the price of a stock that moves from the high-spread portfolio (with 3.2% spread) to the low-spread (with 0.5% spread) would appreciate by an astonishing 50%. This consequently suggests a strong incentive for firms to strive for undertaking liquidity increasing actions. As a final point, it is worth noting that a much less cited article by Chen and Kan (1995) uses the same data, but a different method for adjusting returns for risk and do not find a clear reliable relation like Amihud and Mendelson (1986). An overview of the most prominent articles that link liquidity and returns can be found in appendix F.

Chordia et al. (2001) extend the analysis of liquidity to cover firms listed on the NYSE from 1988 to 1998 and examine the behaviour of liquidity over time. They find that liquidity, primarily measured by the bid-ask spread, is influenced by several factors. Some of the more important are returns, volatility and the spread on the short term interest rate. In addition, Chordia et al. (2001) also find strong day-of-the-week effects and that liquidity is lower in days adjacent to holidays. Further, the bid-ask spread increases dramatically in bear markets but only decreases marginally in bull markets.

Amihud (2002) introduces *ILLIQ* as a measurement of illiquidity and studies the effect of illiquidity over time on NYSE stocks from 1964 to 1997. *ILLIQ* is defined as the daily ratio of absolute stock return to its dollar volume averaged over some period. It serves as a rough measurement of price impact since it measures the price impact on underlying trading activity. Using an average *ILLIQ* for the market Amihud (2002) proposes that expected market excess return reflects compensation for expected market illiquidity. Investors are assumed to predict illiquidity in a period based on information available from previous periods and set market prices based on their predictions. Furthermore, Amihud (2002) finds that unexpected illiquidity lowers contemporaneous stock prices since expected illiquidity will become higher.

A recent article that uses *ILLIQ* is Acharya and Pedersen (2005) who derive a liquidity-adjusted CAPM. In their model a security's required return depends on its expected liquidity as well as on the covariance of its own return and liquidity with the market return and liquidity. A negative shock to liquidity results in low contemporaneous return and high predicted future returns. Additionally, the liquidity risk is decomposed into three components and they find that the most important one is the premium that investors are willing to pay for a liquid security when market return is low, something which is commonly referred to as "flight to liquidity".

2.4 Liquidity and Asset Pricing on Emerging Markets

Given that there exists a rich literature arguing over whether and to what extent liquidity is priced on developed markets the study of liquidity on emerging markets should be a natural complement to existing papers. Bekaert et al (2005) write that "…surprisingly, the growing body of research on liquidity primarily focuses on the United States, arguably the most liquid market in the world" (p. 1). The reason that this is surprising is, of course, that one would expect that any linkages between returns and liquidity would be particularly strong in emerging markets.

2.4.1 Benefits and Challenges Posed by Emerging Markets

The main benefit of studying liquidity on emerging markets is twofold. Firstly, any illiquidity effects are likely to be more pronounced. Secondly, the transition from an illiquid setting to a more liquid could potentially be rapid due to a catching up effect with developed markets. This in turn makes it possible to use emerging markets as proxies for the evolution of more developed markets since they often have gone through the same stages as the more developed markets. This has caused some scholars, for example Bekaert and Harvey (2003) and Rouwenhorst (1999), to argue that emerging markets provide an ideal setting to examine different aspects of finance.

Bekaert and Harvey (2002) present a literary overview of research into different aspects of finance conducted on emerging markets during the last 20 years and conclude that emerging markets provide a challenge to existing models and beg for the creation of new models. Primarily, it is a question regarding lack of both detail and quality in the data. Another problem is the general situation of uncertainty about the functioning of the markets. The latter is hard to fix ex post but the former should not be a problem given that the operators on a market, let it be an emerging or a developed, act in order to increase their wealth.

2.4.2 Previous Empirical Findings

The research area of returns and liquidity on emerging markets is quite young and limited in its scope. In order to overcome the lack of data proxy measurements have to be used, which inevitably reduces the robustness of the results. Lesmond (2005) outlines some possible liquidity measurements on emerging markets. He also intuitively argues that the substantial returns on emerging markets are gradually reduced by the decrease in risk which increased liquidity brings. The only comprehensive paper, to date, that links returns to liquidity on emerging markets is Bekaert et al. (2005). As a proxy for liquidity the authors use an activity measurement which is based on the instances of observed zero daily returns. The measurement is derived from Lesmond et al. (1999) and is calculated on a cross-section of 19 emerging markets. Bekaert, et al. (2005) find that their measurement is correlated with bid-ask spreads and turnover for the markets where it is available. They conclude that the zero return measurement significantly predicts returns in emerging markets, and that unexpected liquidity shocks are positively correlated with returns. Furthermore they find that the zero return measurement captures an aspect of liquidity that is not encompassed by turnover since turnover has an insignificant impact on returns when the measurement is included as an explanatory variable. This implies that liquidity on average is priced.

3. Data

As noted in the previous section, empirical studies on emerging markets pose a specific kind of challenge due to the fact that detailed transaction data are not readily available. This has lead to a mentality that: "While the data is not nearly as extensive [as in developed markets], it is better for the empiricist to use what is available than to use nothing." (Bekaert and Harvey 2003, p. 13). This results in many papers ending up in what resembles a catch 22 dilemma. Studies on emerging markets are very alluring since they are likely to provide new insights into the workings and development of markets, but in many cases the tests can not be performed at all or the robustness of the tests is severely hampered.

3.1 The Data Sample and Transformations

This study uses a new data sample for emerging markets, which to a large extent avoids the catch 22 dilemma. The data set is unique in that it is compiled by OMX and the reporting and trading on the Baltic market have lately adhered to OMX standards. Through manually collecting data for each firm a data set comprised of all stocks, in total 112, which have been traded on the Baltic Main list and I-list[7] between 2000 and 2006 has been created. The data for all companies have been manually adjusted for corporate actions such as splits and payments of dividends. For the splits official OMX adjustment factors have been used. When it comes to dividends official OMX information with regards to ex-dividend date and value has been used for stocks listed on the Tallinn and Riga Stock Exchanges. For Vilnius, however, dividend data are not readily available from OMX and hence Datastream, which is widely regarded as one of the most reliable secondary sources of information for financial data, have been used.

In addition to the transformations made due to corporate actions, two more have been made. The first is that 15 companies, which have been actively traded less than three months, approximated as 60 trading days, have been excluded from the sample, which reduces it to 97 stocks. The reason for this transformation is that OMX reports that these securities had "special listing needs" with very short listing periods. Including these securities will obviously bias the results. The second change that has been made is that a limited time period for five securities has been removed. After consultation with OMX these five periods have been investigated and the conclusion reached is that the securities have not been listed in a traditional sense during these periods.[8] An example of this is that more than 99% of Balta was owned by a single investor for an

[7] For a detailed presentation of the Main list and I-list see appendix A.
[8] The removed periods can be found at the end of appendix F.

extended period of time. If this was not adjusted for there would be an obvious risk that the results are biased.

It is important to note that OMX standards for data reporting have not been applied during the full period. After OMX took control of all three exchanges and introduced the SAXESS trading system, historical data starting from January 1, 2000, has been compiled based on data reported into the old systems. In total, the data set for the study after manual transformations and data drops amounts to observations from 104,938 days over 97 stocks.[9] The data set is unique in its kind for emerging markets and should allow for new insight into the relationship between liquidity and returns.

3.2 The Baltic Market - a Brief Overview

A brief overview of the Baltic market will follow and a reader, who is not familiar with the Baltic market, is encouraged to consult appendix A for a more thorough overview of the market microstructure, appendix B for a summary of the historical development and appendix C for a presentation of key descriptives. The need for a more detailed presentation of the market stems from the fact that emerging markets in general, and the Baltic market, in particular, are often overlooked by developed market investors and that emerging markets distinguish themselves on several areas. Bekaert and Harvey (1995) list four unique features of emerging markets: (i) average returns are higher, (ii) correlations with developed market returns are low, (iii) returns are more predictable and (iv) volatility is higher. The Baltic market exhibits several of these properties even though it has, over the last few years, implemented several "high quality" institutions of developed markets, as outlined in the appendix.

The concept of a Baltic market was first introduced on January 1, 2000. A pivotal event was the introduction of the common order-driven trading system SAXESS, which occurred in September 2004 in Tallinn and Riga and in May 2005 in Vilnius. Another important step was the accession into the European Union, which took place in May 2004 for all three countries and marked an end to a process of harmonization of local legislation to EU standards. All three national currencies are pegged to the Euro and the target is to switch to the Euro within the next two years.[10] There are many additional events that jointly create the continuous development of the Baltic market and one should hence not focus too much on the effect of a few events, but on the greater picture.

[9] See appendix F for a complete list of companies included in the sample.
[10] Estonia and Lithuania have targeted January 1, 2007, and Latvia has targeted January 1, 2008. But delays are likely since current inflation levels do not conform to the Maastricht inflation criterion.

The most distinguishing features of the Baltic market are the low market capitalization, limited free float and low level of integration with the world market. At the end of 2005, total market capitalization of the Baltic lists stood at 11.6 billion Euro, which represents 28% of the Baltic GDP. A normal share in developed countries is above 100%.[11] Regarding the free float, the listing requirements for the Main list and I-list require a free float of at least 25% and 15%, respectively. By the end of June 2005, the average free float was 37% for the Main list and 21% for the I-list.[12] Given the low market capitalization, the low free float might deter, for example, large foreign investors from entering the market. The low level of integration with the world market is marked by the high and consistent returns coupled with low volatility that the Baltic market has shown since 2000. Although the average foreign ownership share is above 40%, returns have shown a remarkable low correlation with returns of a world index. Average yearly correlation between OMX's benchmark BALTIX index and the MSCI World index during the six years is only 4.5%. In addition, yearly correlation with the MSCI Emerging Markets Eastern Europe index, which does not include any Baltic shares but covers a similar investment universe, is only 8.6% over the six years. The low level of correlation indicates that idiosyncratic risk on the market is high and that local events have a far greater impact on returns than global events. It is also worth noting that the low correlation provides a good opportunity for foreign investors to diversify their portfolios.

[11] According the World Bank (2006) the market capitalization as a share of GDP was 107% for OECD countries, with Sweden at 109% and the United States at 139% at the end of 2004.
[12] Derived from OMX estimates of the free float (OMX, 2005a).

4. Hypotheses

This thesis investigates the notion that liquidity is a priced risk and therefore linked to returns. In order to formalize this assertion two hypotheses, based on the characteristics of liquidity, are formed.

H_1: *Abnormal stock return is positive (negative) for securities with high (low) expected illiquidity.*

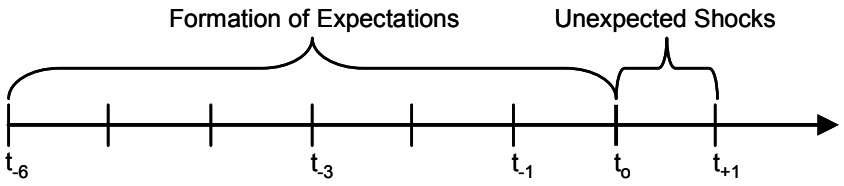
H_2: *Unexpected positive (negative) shocks to illiquidity generate negative (positive) contemporaneous abnormal return.*

The first hypothesis accounts for expected changes in liquidity. It is a natural consequence of the theory that illiquidity is priced and that there exists an illiquidity risk premium. The illiquidity risk premium stems from investors' expectations of liquidity. Specifically, if investors expect a stock to be illiquid (liquid) relative to the market they will price the stock so that it generates a relatively high (low) expected return compared to a less liquid security. In the model, investors are assumed to predict the liquidity in a particular month based on information available at the end of the preceding month. This calls for two simplifying assumptions regarding how investors form expectations of liquidity. The first assumption is that investors predict that the change in liquidity of an individual stock will be the same as for the overall market. The second assumption regards what historical period investors base their expectation on.

The second hypothesis captures the unexpected change in liquidity, which has not already been discounted into the risk premium component. Given investors' assumption about the liquidity of a stock changing with the market, an unexpected shock to illiquidity in one month will lead investors to reassess their expectation about liquidity in the following months. For example, higher expected illiquidity should cause a stock price to fall in conjunction with the unexpected shock and vice versa. Together the two hypotheses imply that investors carry with them expectations of future liquidity and react to unexpected shocks. This is visualized in figure 4.1.

Figure 4.1

Time line explaining the formation of expectations. Investors form expectations about liquidity in period t_o to t_{+1} based on liquidity in past periods. In addition, unexpected shocks can occur in the period t_o to t_{+1}.



5. Methodology

In this section the methodology for analyzing the two hypotheses stated in section 4 are outlined. This is done in two steps. Firstly, the explanatory liquidity variables and the dependent return variable are presented and secondly the econometric model is outlined.

5.1 Presentation of Variables

Liquidity is, as already mentioned, notoriously difficult to measure. Lesmond (2005) argues that "the estimation and use of specific liquidity proxies is unusually varied" (p. 413). Further he claims that "little consensus exists regarding the applicability or efficacy of any of the most commonly used liquidity proxies" (p. 412). The availability of detailed transaction data in emerging markets is far from as comprehensive as on developed markets, making measurements on emerging markets even more difficult to establish. In the previous sections it has been outlined that there are several reasons to expect that liquidity has increased on the Baltic market since the year 2000. In order to examine whether this has been the case a number of specific measurements which were possible to derive from the data, are presented in this section.

5.1.1 The Bid-Ask Spread Measurement

The bid-ask spread is one of the most direct proxies of liquidity. For analytical purposes the bid-ask spread is often measured as the relative bid-ask spread (Chen and Kan, 1995). This is calculated as the quoted bid-ask spread divided by the average of the bid price and the ask price.

$$SPREAD = \frac{ask - bid}{(ask + bid)/2} \qquad \text{(Eq. 5.1.1.1)}$$

One problem with analyzing the relative bid-ask spread on the Baltic market is that the Vilnius Stock Exchange defined its bid and ask prices for any given day in an unconventional way up to the introduction of the SAXESS trading system.[13] The Tallinn and Riga Stock Exchanges, on the other hand, have used the conventional definition of bid and ask at the closure of trading throughout the six year time period. In order to solve for this problem stocks on the Vilnius Stock Exchange are excluded when it comes to the bid-ask spread variable.

By definition the relative bid-ask spread has some special characteristics. Intuitively, the relative bid-ask spread measures the spread's relative part of the average of the bid and the ask price

[13] Instead of using the traditional definition of the bid and ask prices as the last prices recorded on any given trading day, Vilnius defined its bid and ask prices as the highest recorded during the day.

(usually referred to as mid-market). Special cases occur when there does not exist either a bid or ask price since the value will in that case, by construction, equals 2 or -2. Such cases are, of course, interesting from a liquidity perspective since it represents a case of extreme illiquidity. The number of instances of such occurrences is shown in table 5.1.1.2.

Table 5.1.1.2

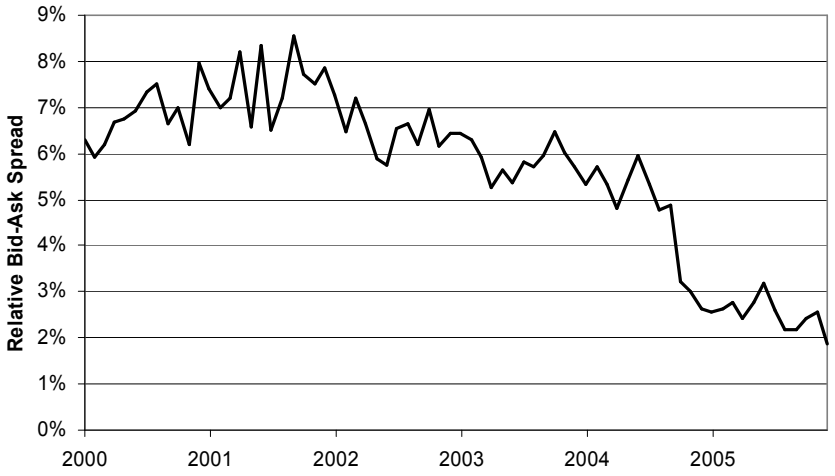
The number of instances when the relative bid-ask spread equals 2 or -2.

	2000	2001	2002	2003	2004	2005
Instances of 2 and -2	1,196	1,380	544	665	742	113
Share of possible trading days	6.4%	7.8%	3.1%	3.9%	4.4%	0.6%

When aiming to generate an exact figure for the magnitude of the spread, however, these instances are not that interesting. In such a case the relative bid-ask spreads that are equal to 2 or -2 have to be excluded which has been done in the *SPREAD* measurement. On the Baltic market the average monthly spread has undergone profound changes in the six year period, which can be seen in figure 5.1.1.3.

Figure 5.1.1.3

The average monthly relative bid-ask spread for all stocks on the Tallinn and Riga Stock Exchanges.



It is clear that the decline of the relative bid-ask spread variable is very pronounced as it goes from approximately 7.5% in 2001 to 2.5% in 2005. It is also interesting to note that the development is often erratic, perhaps as the market gradually adjusts to a lower bid-ask spread.

The development is also particularly pronounced in September 2004, coinciding with the introduction of the SAXESS trading system.

5.1.2 Activity Measurements

A stock can hardly be claimed to be liquid if it is not traded. It is especially common that developing countries suffer from problems with very thin trading. Bekaert et al. (2005) propose two basic measurements for trading activity on emerging markets. The first is simply the proportion of trading days which exhibit a zero return, which is used in order to proxy for no trading activity. The second measurement examines the number of consecutive days which exhibit a zero daily return. Both these measurements are, however, subject to uncertainty since Bekaert et al. (2005) do not have access to detailed transaction data and hence use the zero return as a proxy for trading activity. Information-less traders should, for example, not give rise to any price change in the market and hence any such trades would not be picked up by the proxy. In order to amend for this problem this study, on the other hand, utilizes detailed transaction data and uses the variable number of deals to establish whether any trades have taken place on any specific day as can be seen in table 5.1.2.1.

Table 5.1.2.1

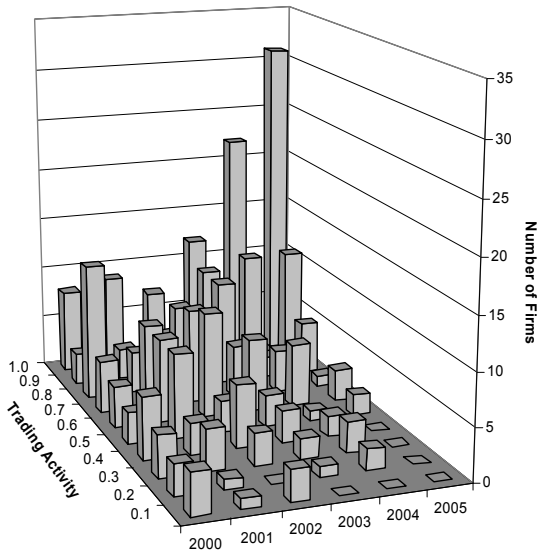
The yearly average proportion of the number of days in which no trading occurred.

	2000	2001	2002	2003	2004	2005
Proportion of days with no trades	44%	47%	45%	31%	28%	16%
Change		8%	-4%	-31%	-12%	-42%

The proportion of days with no trades has, on average, declined substantially. In 2000 44% of all companies were on any given day not traded compared to 16% in 2005. The development has been especially pronounced since 2002. This aggregate picture of a declining number of days with no trading is further enhanced when looking at the number of days with no trading on a stock level. Figure 5.1.2.2 allocates the 53 stocks that were traded for the full period into ten fixed ranges based on trading activity. In 2000 the number of stocks which were traded on more than 90% of all possible trading days amounted to 8. In 2005 this number had increased to 31 and not a single stock was traded on less than 60% of all possible trading days. Hence one can draw the conclusion that the increase in the number of active trading days is a result of the market becoming broader in the sense that more stocks are actively traded.

Figure 5.1.2.2

An allocation of stocks into fixed ranges of trading activity. Trading activity is defined as the fraction of active trading days.



This first rudimentary measurement does, however, ignore potential clustering of illiquidity. If a stock trades once every day for half a year and then does not trade at all for the remainder of the year this would show as 50% active trading days. The same figure would be true for a stock that trades every other day, but one can argue that the former is a much more serious case of illiquidity. An alternative measurement takes the length of a run of days with no trading into account. This is shown in table 5.1.2.3.

Table 5.1.2.3

The average length of a run of days with no trading, a measurement of the clustering of illiquidity.

	2000	2001	2002	2003	2004	2005
Mean	3.0	3.2	2.7	2.4	2.4	1.8
Std. dev.	5.4	5.8	4.7	3.6	3.1	1.9
Max	120	152	106	72	49	28
Number of stocks with inactive periods that exceed 20 trading days	34	39	36	15	8	2

In 2000 the average length that any company on the Baltic market was not traded was 3.0 days. Since then the length of the runs with no trading activity has, however, decreased to 1.8 days in 2005. The standard deviation and the number of stocks with inactive periods exceeding one month (proxied as 20 trading days) have both fallen substantially. This strengthens the conclusion that there has been a broadening of the market with respect to trading activity. In order to make

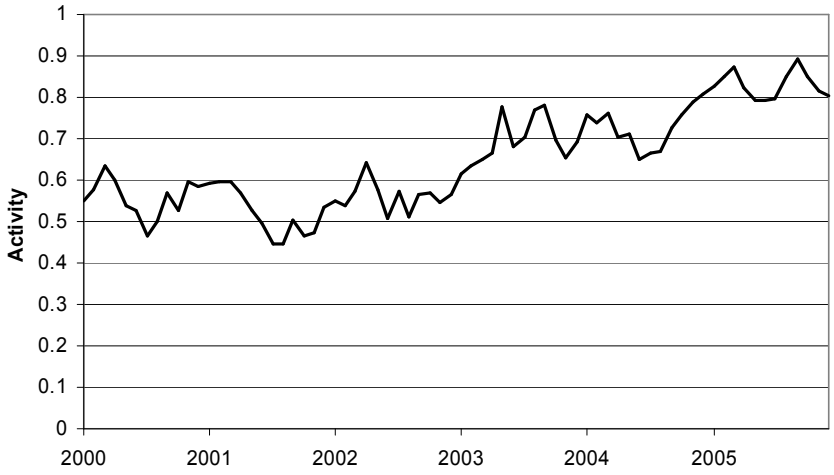
the activity measurement appealing for statistical analysis the activity variable *ACT* is constructed. The measurement is defined as:

$$ACT_{i,t} = \frac{\sum_{d=1}^{N_{i,t}} \delta_{i,t,d}}{N_{i,t}} \qquad \text{(Eq. 5.1.2.4)}$$

$N_{i,t}$ refers to the total number of possible trading days in the given period t for the company i. For analytical purposes the time period of study is subdivided into t periods each period consisting of a total of d days. It is hence possible to define the time period so that each t corresponds to one month. The variable $\delta_{i,t,d}$ is an indicator variable which takes the value 1 if there is a trade in security i at a given day d in period t or the value 0 if there is not any trade. On a monthly basis the variable *ACT* takes the shape shown in figure 5.1.2.5.

Figure 5.1.2.5

The development of the monthly average ACT for the Baltic market between 2000 and 2006.



It is clear that the activity in the Baltic market has increased over the six years. The *ACT* measurement has increased from approximately 0.55 in 2000 to approximately 0.85 in 2005. From figure 5.1.2.2 it can be inferred that the changes are even greater on an individual security level.

5.1.3 Price Impact Measurements

Finally the price impact of underlying trading activity makes an interesting proxy for liquidity. For this purpose Amihud (2002) proposed a measurement he labelled ILLIQ, a revised version of which is presented in equation 5.1.3.1 under the new name *PI* (Price Impact). Intuitively, it can be

thought of as a proxy of the order book depth since it is dependent on the amount of buy and sell orders that can absorb any price change.

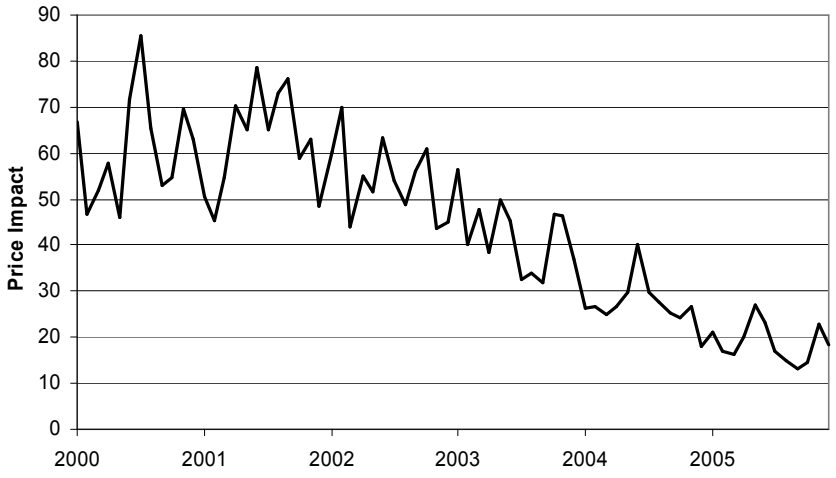
$$PI_{i,t} = \frac{1}{N_{i,t}} \sum_{d=1}^{N_{i,t}} \frac{\left| R_{i,t,d} \right|}{T_{i,t,d}} \qquad \text{(Eq. 5.1.3.1)}$$

$PI_{i,t}$ is the price impact of trading activity in period t for security i. For analytical purposes the time period is subdivided into t periods each period consisting of a total of d days. $R_{i,t}$ is hence the daily return of security i on day d in time period t. $T_{i,t,d}$ is the turnover of security i in Euro on day d in time period t. $N_{i,t}$ is the number of trading days for security i in time period t.

The absolute value of the return can be viewed as a risk measurement similar to standard deviation. Intuitively a stock with large swings in its price will have a high average absolute return and standard deviation. This method of determining the price impact of trading activity, on a monthly level, yields the price impact curve shown in figure 5.1.3.2 for the entire Baltic market.

Figure 5.1.3.2

The average monthly PI for the Baltic market between 2000 and 2006. PI has been multiplied by 10^6.



It is obvious that the price impact of trading activity has declined substantially over the period of study. The decline has been particularly pronounced since 2001. The price impact curve hence lends strong support to the proposition that liquidity has substantially increased on the Baltic market.

5.1.4 Selection of Variables

It can be argued that price impact and the bid-ask spread measure approximately the same aspects of liquidity, i.e. the depth of the order book. The bid-ask spread is interesting since it provides an overview of the rapid increase in liquidity on the Baltic market, but poses two problems if it were to be included in conjunction with the price impact variable. Firstly, the correlation is 0.71 and pose a possible risk of multicollinearity, especially as they both measure the same aspect of liquidity. The second problem, which is the major one, is that Vilnius defined its bid-ask spread in an unconventional way up to the adoption of SAXESS. These two reasons imply that the bid-ask variable should be dropped in favour of price impact for further analytical purposes.

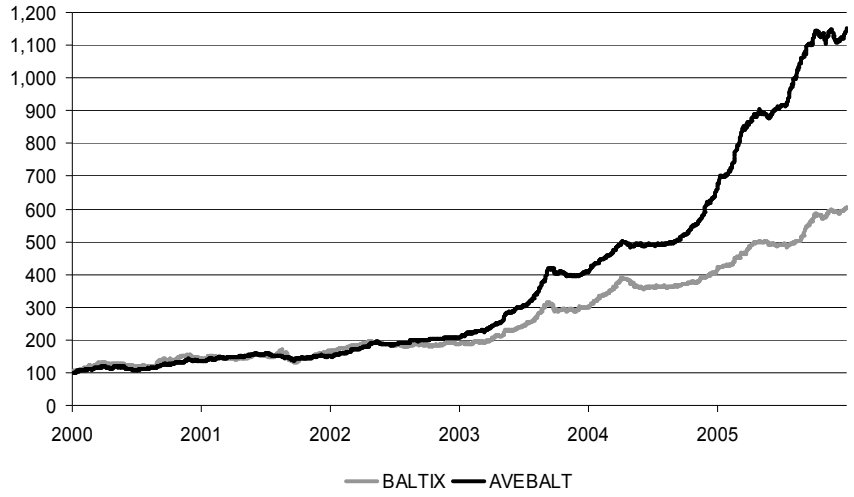
It is interesting to note that the activity and price impact should, theoretically, complement each other well since they measure two different aspects of liquidity. The reason for this is that one could expect activity to give a more accurate picture under very thin trading conditions at the same time as price impact describes liquidity better in a broadly traded market. It is ideal for the situation on the Baltic market to include both since it developed from a stage of very thin trading. Hence the price impact and the trading activity variables are chosen for the regression since they complement each other and provide unique insights. Obviously, there are also robustness issues with over-fitting a model with several variables that all measure liquidity.

5.1.5 Abnormal Return

Measuring returns is more straightforward than measuring liquidity. One is, however, faced with the problem of choosing a suitable market proxy. The major benchmark index for the Baltic market is the BALTIX index. It is a capitalization-weighted index and includes only Main list companies. Since this thesis focuses on liquidity on an individual stock basis the BALTIX index does not fully satisfy the needs of the analysis and an equally-weighted index, which includes all Main list and I-list companies, has been constructed and named AVEBALT. A graphical comparison between AVEBALT and BALTIX is shown in figure 5.1.5.1 on the next page. A detailed description of the methodology of AVEBALT and a comparison with the methodology of BALTIX can be found in appendix D.

Figure 5.1.5.1

BALTIX and AVEBALT since 2000 in Euro. Initial value on January 1, 2000, is 100.



The return during the period after 2000 has been remarkable and for AVEBALT it has been spectacularly high. Over the full period BALTIX and AVEBALT returned 459% and 1,051%, which implies compound annual returns of 33% and 50%, respectively.[14] From the difference in performance it is evident that I-list companies have outperformed their Main list peers and that BALTIX does not provide a true picture of the broad market.

For the purpose of the analysis abnormal return is used. It is calculated as the dividend adjusted return in Euro of an individual stock minus the AVEBALT return during a specific period, as in equation 5.1.5.2. By definition, *ABNRET* should average zero over all stocks during the full time period.

$$ABNRET_{i,t} = R_{i,t} - R_{AVEBALT_t} \qquad \text{(Eq. 5.1.5.2)}$$

5.2 Econometric Model

After having established trading activity (*ACT*) and price impact (*PI*) as proxy measurements of liquidity and constructed a suitable market proxy to calculate abnormal return (*ABNRET*) the next step is to formulate a model for the possible linkage between abnormal return and liquidity. The model chosen for this purpose is outlined on the next page.

[14] The stellar performance is not a unique phenomenon of the Baltic market. For example Antoninou et al. (1997) report an increase in the Istanbul Stock Exchange Index of 1,898% over the six year period from 1988 to 1993.

$$ABNRET_{i,t} = \alpha_0 + \beta_0 \frac{1}{m}\sum_{n=1}^{m} ACTMA_{i,t-n} + \beta_1 \Delta ACTMA_{i,t} + \beta_2 \frac{1}{m}\sum_{n=1}^{m} PIMA_{i,t-n} + \beta_3 \Delta PIMA_{i,t}$$

(Eq. 5.2.1)

The variables have been mean adjusted using the equations outlined below:

$$API_{i,t} = \frac{1}{N_{i,t}}\sum_{t=1}^{N_{i,t}} PI_{i,t} \quad \text{(Eq. 5.2.2)} \qquad PIMA_{i,t} = \frac{PI_{i,t}}{API_{i,t}} \quad \text{(Eq. 5.2.3)}$$

$$AACT_{i,t} = \frac{1}{N_{i,t}}\sum_{t=1}^{N_{i,t}} ACT_{i,t} \quad \text{(Eq. 5.2.4)} \qquad ACTMA_{i,t} = \frac{ACT_{i,t}}{AACT_{i,t}} \quad \text{(Eq. 5.2.5)}$$

The key advantage with mean adjusted variables is that the overall market trend of increasing liquidity is removed. Therefore, the first assumption about how investors form their expectations of liquidity is taken into account. The variables, $\frac{1}{m}\sum_{n=1}^{m} ACTMA_{i,t-n}$ and $\frac{1}{m}\sum_{n=1}^{m} PIMA_{i,t-n}$ are derived from H_1 and *m* (the length of the expectation formation period) should change according to the second assumption about how investors' form their expectations of illiquidity based on average liquidity over the preceding periods. The differenced variables, $\Delta ACTMA_{i,t}$ and $\Delta PIMA_{i,t}$, are derived from H_2 and describe unexpected illiquidity. Specifically, the unexpected illiquidity is the change in liquidity that is different from the change in liquidity of the market. The expected coefficients are summarized in table 5.2.6.

Table 5.2.6

Expected coefficients for equation 5.2.1 based on H_1 and H_2.

Variable	Referred to as	Coefficient	Comment
$\frac{1}{m}\sum_{n=1}^{m} ACTMA_{i,t-n}$	Expected activity	-	High expected activity causes lower abnormal return.
$\Delta ACTMA_{i,t}$	Shock to activity	+	A positive unexpected shock to activity causes higher abnormal return.
$\frac{1}{m}\sum_{n=1}^{m} PIMA_{i,t-n}$	Expected price impact	+	High expected price impact causes higher abnormal return.
$\Delta PIMA_{i,t}$	Shock to price impact	-	A positive unexpected shock to price impact causes lower abnormal return.

The choice of *m* is not straightforward. It is difficult to a priori determine over what time period investors form their expectations on the Baltic market, or any market for that matter. Before moving on to estimating a final model, however, a decision with regards to this assumption has to be made. Four possible assumptions of the length of the expectation window, *m,* is one, three, six and 12 months. Since the discussion is vital for the understanding of the analysis, but not at its core, it is outlined in detail in appendix E. The conclusion reached in the appendix is that six months is the most reasonable expectation window. This decision is of special importance when it comes to the coefficient of expected activity since its sign and significance depends on which assumption is made.

6. Empirical Findings

In this section, the empirical findings based on the methodology are outlined. The presentation of the results and their robustness is followed by a discussion about the implications of the findings. Finally suggestions with regards to possible areas for further research are proposed.

6.1 Estimation, Results and Robustness

The investigation of the econometric model (eq. 5.2.1) will be carried out in three steps. To begin with, the proposed model will be estimated using pooled OLS. The second step is to test the model for any signs of momentum, seasonal effects and structural breaks. Finally, the possibility of unobserved effects is examined.

6.1.1 Estimating a Final Model

Table 6.1.1.1 presents the results of the model (eq. 5.2.1) allowing for individual intercepts. By including the possibility of individual intercepts into the regression, differences among the stocks not related to liquidity are mitigated.

Table 6.1.1.1

Estimation of the model using pooled OLS and allowing for individual intercepts. The dependent variable ABNRET is in percent.[15]

$$ABNRET_{i,t} = \alpha_0 + \beta_0 \frac{1}{m}\sum_{n=1}^{m} ACTMA_{i,t-n} + \beta_1 \Delta ACTMA_{i,t} + \beta_2 \frac{1}{m}\sum_{n=1}^{m} PIMA_{i,t-n} + \beta_3 \Delta PIMA_{i,t} + \sum_{n=1}^{96} d_n S_n + \varepsilon$$

Model A: *m = 6 investors form their expectations on average liquidity in the preceding six months.*

Variable	Predicted sign	Coefficient	95% CI	p-value
Expected activity	-	-0.95	[-3.1 ; 1.2]	0.38
Shock to activity	+	9.52	[7.8 ; 11.3]	0.00
Expected price impact	+	0.80	[0.2 ; 1.4]	0.01
Shock to price impact	-	-0.56	[-0.9 ; -0.3]	0.00
Adj R^2		0.06		

The results are very encouraging since they indicate that there exists a link between liquidity and returns, which implies that illiquidity is indeed priced on the Baltic market. Expected price impact, shock to price impact and shock to activity are all highly significant and carry the expected signs. Expected activity has the expected sign, but is not significant at any reasonable level. Hence it

[15] The residuals from the regression have been examined and do not exhibit properties that would bias the results and can, for practical purposes, be considered normally distributed, although they exhibit some kurtosis.

does not seem to be as important for investors when predicting liquidity as the price impact is. It can very well be the case that the price impact, as discussed in appendix E, measures the cost of doing a trade and that this cost provides a better basis for forming expectations than activity. The activity measurement is to a larger extent determined by isolated events. Despite its insignificance, expected activity will remain in the model for robustness testing purposes.

6.1.2 Momentum and Seasonal Effects

Table 6.1.2.1 presents regressions on the final model (eq. 6.1.1.2) with different modifications in order to test the robustness of the results. A lagged abnormal return variable should capture autocorrelation in returns, which is present in the *AVEBALT* index and is likely to exist also for individual stocks. Year dummies allow for different intercepts between different years. A January dummy is included in line with the argumentation of Eleswarapu and Reinganum (1993) that the illiquidity premium found by Amihud and Mendelson (1986) was caused by a January effect.

Table 6.1.2.1

Tests for momentum and seasonal effects. Estimation of the model using pooled OLS and allowing for individual intercepts. The dependent variable ABNRET is in percent.

$$ABNRET_{i,t} = \alpha_0 + \beta_0 \frac{1}{6}\sum_{n=1}^{6} ACTMA_{i,t-n} + \beta_1 \Delta ACTMA_{i,t} + \beta_2 \frac{1}{6}\sum_{n=1}^{6} PIMA_{i,t-n} + \beta_3 \Delta PIMA_{i,t} + \sum_{n=1}^{96} d_n S_n + \varepsilon$$

Model B: *Lagged abnormal return*
Model C: *Year dummies*
Model D: *January dummy*

Variable	B	C	D
Expected activity	-0.91	-1.23	-0.91
Shock to activity	9.51***	9.45***	9.52***
Expected price impact	0.86***	0.81***	0.86***
Shock to price impact	-0.56***	-0.57**	-0.57***
Adj R^2	0.06	0.06	0.06

Significant at 1% (***), 5% (**) and 10% (*) level

The coefficients in table 6.1.2.1 are not economically different from model A. This indicates that the model is robust when it comes to lagged abnormal returns and seasonal effects. However, the coefficient of lagged abnormal return is significant at the 5% level indicating that there is a momentum effect. Moreover, neither the year dummies nor the January dummy are significant.

6.1.3 Structural Breaks

The Baltic market has seen substantial developments over time and there is, obviously, a possibility of structural breaks in time. Since three markets have been brought together there is a likelihood of cross sectional discrepancies as well. In table 6.1.3.1 the results from four tests of structural breaks (models E to H) are presented. An interaction variable has been introduced into the regression and is used to perform an alternative Chow test as suggested by Wooldridge (2006).

Table 6.1.3.1

Tests for structural breaks in the coefficients. Estimation of the model using pooled OLS and allowing for individual intercepts. The dependent variable ABNRET is in percent.

$$ABNRET_{i,t} = \alpha_0 + \beta_0 \frac{1}{6}\sum_{n=1}^{6} ACTMA_{i,t-n} + \beta_1 \Delta ACTMA_{i,t} + \beta_2 \frac{1}{6}\sum_{n=1}^{6} PIMA_{i,t-n} + \beta_3 \Delta PIMA_{i,t} + \sum_{n=1}^{96} d_n S_n + \varepsilon$$

Model E: *Main list interaction dummy*
Model F: *Tallinn and Riga interaction dummy*
Model G: *Time interaction dummy*
Model H: *Liquidity provider interaction dummy*

Variable	E	F	G	H
Expected activity	-1.93	-1.69	-2.31*	-0.70
Shock to activity	9.37***	10.56***	8.43***	9.51***
Expected price impact	0.70**	1.15***	0.17	0.91***
Shock to price impact	-0.56***	-0.35*	-1.42***	-0.55***
Adj R^2	0.07	0.06	0.07	0.06
F-test p-value	0.54	0.04	0.01	0.84

Significant at 1% (***), 5% (**) and 10% (*) level

There is a possibility that the liquidity effect captured by activity and price impact is only a proxy for other effects in the market. One such effect that has been frequently discussed is the small firm effect. Unfortunately, historical market capitalization data are not readily available for all listed companies during the whole period. Instead, a suitable proxy for a company's market capitalization is its listing. The Baltic Main list is supposed to hold blue chip companies and the I-list should hold companies with lower market capitalization and smaller free float. As an example, the average market capitalization was 231 million Euro for Main list companies and 135 million Euro for I-list companies at the end of 2005. Model E, where an indicator variable for companies that were traded on the Main list in a given month has been introduced, does not suggest that the coefficients change. As expected, however, the intercept is different and the Main list companies have, on average, returned 3.5 percentage points less per month.

Although the national stock exchanges were close to fully integrated into the Baltic market by the end of 2005, there have existed several discrepancies between the markets during the period. These discrepancies are particularly common between Vilnius and the other two exchanges. Model F shows that coefficients for Tallinn and Riga are somewhat different from Vilnius as indicated by the F test. However, the only indicator coefficient that is significant at the 10% level is the shock to price impact and it implies that stocks listed on the Tallinn and Riga exchanges have a coefficient of -0.90, which is lower than the overall coefficient of -0.35. Price impact thus appears to be more important on the Tallinn and Riga markets.

A structural break in time is suggested by model G. Interestingly, expected activity becomes significant at the 10% level with the predicted sign, whereas expected price impact is no longer significant. This implies that expected activity becomes less important and expected price impact becomes relatively more important during the second half of the period. It is consistent with the fact that many stocks reach activity levels above 90% towards the end of the period. At such levels of activity it is likely to play a minor role, whereas price impact, in line with earlier predictions becomes more important.

Some securities listed on the Riga and Tallinn Stock Exchanges have been part of liquidity provider programs. A detailed description of the programs can be found in appendix A.3. Liquidity provider programs could, potentially, result in major improvements in the liquidity of a stock. Model H does, however, not indicate any effect on returns of the programs. One likely reason is that the programs are new and that their coverage is still very limited. [16]

6.1.4 Unobserved Effects Models

The data set used in this study is longitudinal and this opens for more advanced unobserved effects estimation methods than the pooled OLS that has been used in the previous three sections. The main advantage of unobserved effects models is that they are able to correct for omitted variables. Table 6.1.4.1, on the next page, presents the final model estimated with pooled OLS plus fixed effects and random effects models.

[16] According to an official at OMX the program mainly covers stocks that are already relatively liquid and the specific effect of the program has therefore been limited.

Table 6.1.4.1

Unobserved effects estimation compared to the pooled OLS estimation. The dependent variable ABNRET is in percent.

$$ABNRET_{i,t} = \alpha_0 + \beta_0 \frac{1}{6}\sum_{n=1}^{6} ACTMA_{i,t-n} + \beta_1 \Delta ACTMA_{i,t} + \beta_2 \frac{1}{6}\sum_{n=1}^{6} PIMA_{i,t-n} + \beta_3 \Delta PIMA_{i,t} + \varepsilon$$

Model I: *Pooled OLS*
Model J: *Fixed effects model*
Model K: *Random effects model*

Variable	I	J	K
Expected activity	-1.03	-0.95	-0.78
Shock to activity	9.58***	9.52***	9.50***
Expected price impact	0.61***	0.80**	0.85***
Shock to price impact	-0.59***	-0.56***	-0.56***
Overall R^2	0.04	0.04	0.04

Significant at 1% (***), 5% (**) and 10% (*) level

As can be seen in table 6.1.4.1 the results are unchanged. For the fixed effects model an F test indicates that there exist fixed effects and that it is to be preferred compared to a pooled OLS. A Breusch and Pagan Lagrangian multiplier test for the random effects model indicates that the crucial assumption of no variance in the unobserved effect is not fulfilled and a pooled OLS is favoured. Since estimation with unobserved effects models does not alter the results, particularly in the case of the fixed effects model, there is no evidence for that unobserved effects or an omitted variable could alter the results regarding liquidity.

6.2 Discussion

The estimated models above indicate that illiquidity is a priced risk and linked to returns on the Baltic market. The final estimated model is stated below.

$$ABNRET_{i,t} = \underset{(0.89)}{-0.2} \underset{(0.38)}{-1.0}\frac{1}{6}\sum_{n=1}^{6} ACTMA_{i,t-n} + \underset{(0.00)}{9.5}\Delta ACTMA_{i,t} + \underset{(0.01)}{0.8}\frac{1}{6}\sum_{n=1}^{6} PIMA_{i,t-n} - \underset{(0.00)}{0.6}\Delta PIMA_{i,t} + \sum_{n=1}^{96} d_n S_n$$

All coefficients except the coefficient of expected activity are highly significant. The coefficient of shocks to activity is by far the largest. It implies that a security that is traded as actively as the market average and experiences a shock in one month that makes it 50% more active will have a positive abnormal return of some 4.7%. The coefficient of shocks to price impact is much smaller and implies that a security with a price impact that becomes 50% lower than the market in a

month will have a positive abnormal return of approximately 0.3%. The coefficient of expectations of price impact is slightly larger and a security that has a 50% higher expected price impact than the market average will have a positive abnormal return of roughly 0.4% per month. The relationship is in line with the predictions of hypothesis two (that abnormal stock return is positive for securities with high expected illiquidity) and to some extent of hypothesis one (that unexpected positive shocks to illiquidity generate negative contemporaneous abnormal return). As already discussed in section 6.1.1, activity does not seem to be as important as price impact for expectations of liquidity. This is further strengthened by the fact that expected activity is significant at a 10% level at the beginning of the sample period, when its role could be expected to be the most prominent given the relatively low activity and narrowness of the market.

The robustness tests give reason to have a very high confidence in the results. The only two issues that call for further explanation are the structural break in time and the structural break between Vilnius and the other two exchanges. These two breaks are not a problem, however, as the coefficients remain significant. The only thing that changes is the magnitude of the coefficients, which is to be expected given the rapid development and past and present differences between the three national exchanges.

It is obvious that important variables may have been omitted from the model. In particular, asset pricing variables such as systematic risk or firm specific characteristics such as book-to-market or size, have been omitted. Firm specific characteristics have been tested for by introducing individual intercepts and using dummy variables for market capitalization. With regards to omitting risk variables, the approach used is similar to previous research, such as Amihud (2002). In addition, measuring risk is a special challenge when it comes to the Baltic market. At the beginning of the period of study many stocks traded only a couple of times a month, if even that, making conventional risk measurements, such as standard deviation or beta, not applicable. When it comes to risk it is also important to note that the limited integration of the Baltic market into the global market probably gives rise to a high idiosyncratic risk for individual stocks. Finally, it is noteworthy that the application of unobserved effects models did not provide evidence for omitted variables that would change the significance of those variables already included.

The findings of this thesis are, of course, primarily applicable to emerging markets in general and the Baltic market in particular. It is difficult to generalize the results to well developed markets as it may be the case that the magnitude of the illiquidity is, most of the time, so small that it lacks

economic significance. This thesis has shown, however, that when one abstracts from frictions in a market one runs the risk of missing out on a variable which indeed is priced. The exact size of the coefficients is hence treacherous since it is dependent on the market of study and it is better to draw conclusions from sign and relative size. The conclusion remains that in the Baltic market liquidity is priced and should be incorporated into asset pricing models. There is no reason to expect that this is not extendable to other emerging markets.

6.3 Further Research

Any study of empirical finance always leaves room for some improvements. In future works one could further develop this thesis' findings in mainly two areas. The first area involves applying the proposed model to other markets and different time periods. It would be especially interesting to examine other OMX operated markets as the market microstructure is virtually identical to the Baltic one. This provides an opportunity to examine the differences between the effect of liquidity on returns in developed and less developed markets. Another possibility is to extend the data sample to include other emerging markets such as the Istanbul Stock Exchange, which is known for its generally high quality data. The second area concerns making technical improvements to the model as more detailed data become available. The assumption of liquidity changing with the market is, for example, very rough. Including a liquidity beta that would allow for the liquidity of individual stocks to change more or less than the market is an interesting extension of the model. It would also be interesting to include the cost of capital, through for example a beta against a benchmark index, as an explanatory variable to construct a liquidity adjusted CAPM.

It would also, of course, be interesting to continue to follow the development on the Baltic market with the methodology proposed. Extending the analysis to a longer time period would strengthen the results. It is possible that the characteristics of the market and the relative importance of liquidity measurements change in, for example, a bear market. Another interesting discussion concerns what factors generate liquidity on emerging markets. Such factors could be the amount of private information, presence of foreign investors and prosperity of the inhabitants. After all, liquidity is the single most important characteristic of a well functioning market and its origin is of uttermost importance.

7. Conclusion

This thesis has found very strong evidence for the proposition that illiquidity is a priced risk and linked to returns on the Baltic market. It thus lends support for the rapidly growing branch of research that argues that average liquidity is priced and calls for it to be included in asset pricing models, in particular on emerging markets. Therefore this thesis provides new insight into the nature of liquidity.

Surprisingly few articles have linked return to liquidity on emerging markets. The main reason for this is probably that attempts tend to end up in a catch 22 dilemma. Even though the effects of liquidity on returns should be particularly pronounced on an emerging market the lack of detail and quality of the data make studies of the linkage hard to perform. The Baltic market offers an opportunity to construct a data set that circumvents this dilemma. In total a data set with transaction data for 97 companies over the period 2000 to 2006 have been manually put together and adjusted with regards to corporate actions.

The findings are built upon revised market adjusted versions of the acknowledged liquidity measurements: price impact (*PI*) and activity (*ACT)*. The methodology takes both expected and unexpected liquidity, on a security level, into account in order to better accommodate the behaviour of investors and fully utilize the available data. Price impact is found to capture both expected and unexpected liquidity, whereas activity is more pronounced as a measurement of unexpected liquidity. The implications of liquidity measured by price impact on abnormal returns can be shown by a simple example which is more illustrative than it claims to be exact. A stock that is expected to be 50% less liquid than the market will have an abnormal return of 0.4% per month (which implies 4.9% per annum) If an unexpected shock makes illiquidity 50% higher than the market, the stock will exhibit a negative abnormal return of 0.3%.

To conclude, one can infer from the results that liquidity is something desirable and that both stock exchange operators and listed companies should strive to enhance liquidity. The findings have implications for asset pricing in general and on emerging markets in particular. It may very well be the case that the proposition that asset pricing models have to be recast in order to incorporate the costs of illiquidity holds.

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9. Appendix

A. Market Microstructure

Market microstructure analysis is the branch of financial economics that investigates trading and the organization of markets. It is of great importance because it determines the rules that investors have to adhere to. The most evident feature of the Baltic market microstructure is that it has fully integrated the three national exchanges in Tallinn, Riga and Vilnius. Stocks on each national exchange are brought together in a cross country Baltic list. For listed stocks there is a Main list and an I-list.

The Main list comprises all "blue-chip" companies listed on the Tallinn, Riga and Vilnius Stock Exchanges. A company traded on the Main list has several years of operating history, an established financial position and a market capitalization of no less than 4 million Euro. The Baltic I-list includes midsize companies with stable operations, consolidated positions and a market capitalization of no less than 1 million Euro. In addition, there exists a Free list for companies with short term listing needs and its admissions requirements are less strict compared to those of the Main list and I-list. Apart from local listings it is common on emerging markets that stocks are listed on a foreign exchange through depositary receipts. The Baltic market, however, has had few such cases and at the end of 2005 the only example was Lietuvos Telekomas that had a Global Depository Receipt traded on the International Order Book at the London Stock Exchange.

The Swedish stock exchange operator OMX has acquired a controlling stake in all three Baltic exchanges and has integrated them into its own trading system SAXESS (Stockholm Automated Exchange). The Baltic exchanges have, similarly to other OMX operated exchanges, joined the NOREX alliance. The members of the NOREX alliance are eight Nordic and Baltic exchanges, which have implemented a joint system for equity trading and harmonized rules for trading and membership.[17] The SAXESS system, hence, provides a single access point to the Baltic market as well as for example the Stockholm, Copenhagen and Helsinki Stock Exchanges. Cross-border trading on the Baltic market is also facilitated by the integration of the national central securities depositories.

[17] For further information see http://www.norex.com/ (2006-02-05).

A.1 The Trading System

SAXESS is an order-driven trading system where bids and asks are automatically matched. The trading day starts at 8.30 with a pre-trading session. Trading is then carried out in a continuous trading session which is followed by a closing call that ends at 14.30 (see table A.1.1 on the next page). Negotiated trades can be carried out during the continuous trading session, but any such trades have to be reported to the trading system within five minutes of their completion. Securities from Tallinn are quoted in Euro, while securities from Riga and Vilnius are quoted in their national currencies Lats (LVL) and Litas (LTL). All three currencies are, however, pegged to the Euro within the ERM II exchange rate mechanism, which minimizes currency risks for an Euro-investor. The tick size for all securities is one hundredth and the minimum lot is one share. Any order in the SAXESS system is positioned firstly on a price and then on a time priority basis. Hence the small price increment, especially for securities with higher price, leads to that time precedence becomes less important relative to price.

A.2 Information Disclosure

Information disclosure is standardized and hence the listed companies have to adhere to specific requirements. Any information that may have an effect on the price of their securities needs to be disclosed without any delay and the information is disseminated to investors via the website of the Baltic market in the local language as well as in English. The financial reporting procedure is also standardized and in line with EU legislation. This implies that any financial information has to be prepared in accordance with IFRS. Accessibility to the information should be high since disclosures and real-time quotes are distributed via all major local and international data vendors.

A.3 Liquidity Providers

Recently, the Tallinn and Riga Stock Exchanges have assigned market makers to certain stocks. Tallinn does not have a formalized market maker program and the only stocks that are currently covered are Tallinna Vesi, Starman and Tallink. The common denominator between these shares is that they all made initial public offerings in 2005. The market maker has an obligation to constantly display bids and asks at a stipulated minimum quantity as well as keeping the maximum spread between 0.5% and 2.5% for the three stocks. Riga, on the other hand, is operating a formalized program, which was introduced on October 1, 2004. A liquidity provider has to maintain bids and asks with a maximum spread of 4% in at least six stocks. Currently, market makers have chosen ten different stocks, of which some has as many as four different market makers. The exchange offers a 50% discount on trading commissions as an incentive for

market makers. In contrast to many other stock exchanges, issuers do not pay for the service. According to officials at the exchange, the effect of the program has this far been limited.

Table A.1.1

An overview of a trading day on the Baltic market (OMX, 2005a, p.15).

Session	*Time*
Pre-trading session (PRTR)	08:30 - 09:45
Transaction orders are entered, changed or cancelled. Only own orders are visible to the brokers.	
Opening call (CLIN)	09:45 - 10:00
During the opening call, the brokers can see the cumulative best five price levels displayed in the order book. Transaction orders are entered, changed or cancelled.	
Uncross	10:00
Transaction orders are matched in the order book according to the equilibrium price. The equilibrium price is achieved only if the prices of buy and sell orders entered in the order book are crossing or equal. An auction is not held unless there are truncation orders with crossing prices.	
Continuous trading (COTR)	10:00 - 13:50
The trading period is the period for entering transaction orders in the trading system and negotiating transactions. Transactions can be negotiated in two ways: * Automatic matching – buy and sell orders are matched in the trading system automatically. The orders are matched first by price, then by time * Negotiated (manual) trades –these trades can be made during the trading period at prices within the spread, i.e. the difference between the best buy order and sell order prices at the time of the transaction. Manual trades are negotiated between stock exchange members outside the trading system. Brokers must report manual trades to the trading system within 5 minutes after its conclusion. The default static price deviation range for equities is +/- 15%. The acceptable percentage deviation for any individual security can be changed on an intraday basis by the exchange.	
Pre-closing call period (PRCL)	13:50 – 13:51
Transaction orders are entered, changed or cancelled. Only own orders are visible to the brokers.	
Closing call (CLIN)	13:51 – 14:00
During the closing call, brokers can see the cumulative best five price levels displayed in the order book. Transaction orders are entered, changed or cancelled. Only own orders are visible to the brokers.	
Uncross	14:00
Transaction orders are matched in the order book according to equilibrium price. The equilibrium price is achieved only if the prices of buy and sell orders entered in the order book are crossing or equal. An auction is not held unless there are transaction orders with crossing prices.	
Post-trading session (POTR)	14:05 – 14:30
Only negotiated transactions may be carried out during the post-trading session. As opposed to negotiated transactions carried out during the trading period, transactions in this session are subject to different price rules.	

B. Historical Development

The current market structure, which was presented in appendix A, puts the Baltic market on par, in a technical sense, with its more developed market peers. This is the result of substantial improvements over the last couple of years. Key events can be divided into sub-periods before and after year 2000, when the concept of a Baltic market was first introduced.

B.1 Key Events Before 2000

The end of the Soviet occupation in 1991 and the re-establishment of independence of the Baltic states provided an opportunity to establish domestic stock markets. Already in 1991 the Baltic countries had launched a policy of mass privatization of state property. This development gradually evolved to the establishment of exchanges for secondary trading in privatized assets. By 1996 stock exchanges had been established in all three countries and within two years all three exchanges had adopted continuous trading. Ever since the independence various legislative restrictions on foreign ownership have been in place. New investment laws, however, lifted virtually all restrictions for foreign investment in Latvia by 1996 and in Lithuania by 1999. Estonia was largely open to foreign investments already at the establishment of its stock exchange.[18] At the end of 1999 fully functioning stock markets had been established and foreigners could trade listed securities freely. In the framework of emerging market studies on market integration the Baltic market could be considered a fully liberalized market.[19]

B.2 Key Events After 2000

Bekaert (1995) mentions a number of barriers to integration into the world market. The legislative condition for liberalization belongs to the first kind of barriers. The second kind of barriers refers to corporate governance and the third refers to investors' perception of country specific risk, both of which are more subtle and difficult to date. The development after 2000 features a number of defining events. Rather than a liberalization process the effect of these events can be characterized as a harmonization of the market with its neighbours. A complete time line of events can be found in table B.2.1, on page 42, and a selection of the most important will follow.

To begin with, the year 2000 marked an important shift for the Baltic market as a joint Baltic list was launched with the ambition to integrate the local Baltic markets and make them more

[18] See "A Chronology of Important Financial, Economic and Political Events in Emerging Markets", which is compiled by G. Bekaert and C. R. Harvey. http://www.duke.edu/~charvey/Country_risk/chronology/chronology_index.htm (2006-04-12)
[19] See for example Henry (2000) for a discussion on stock market liberalization.

accessible to foreign investors. Other defining events that followed suit were that the Baltic exchanges joined NOREX in 2001, the inclusion of the countries in the European Union in May 2004 and the acquisition of a majority position in each of the three exchanges by, what is today, OMX in 2001 and 2004. The OMX takeover was followed by the introduction of the SAXESS trading system in September 2004 in Tallinn and Riga and in May 2005 in Vilnius.

The countries had early strived for membership in the European Union and they were officially invited to join by the Copenhagen summit in December of 2002. Adoption to the European legal structure started earlier and brought with it an increased transparency and stricter corporate governance and accounting standards. Integration into the European community will increase further with the adoption of the Euro. Estonia and Lithuania pegged their currencies to the Euro within ERM II in June 2004 and Lithuania followed in May 2005.

The composition of the Baltic market has seen some changes since 2000, primarily in the form of de-listings, but also a few IPOs have taken place. The most important de-listing occurred in June 2005, when the Swedish bank Swedbank made a buy-out offer for the final shares in Hansapank, which it had been holding a majority stake in since 1998. Hansapank was the largest company by market capitalization and a major blue-chip on the Baltic market. IPOs have been relatively scarce and after the IPO of Lietuvos Telekomas in June 2000 almost four years passed until SAF Tehnika was listed in May 2004. After this IPO three more have followed among which Tallink in December 2005 was the largest.

Table B.1

A timeline of the major events on the Baltic market after the year 2000.

	Tallinn	*Riga*	*Vilnius*	*Common Changes*
2000				Jan: Baltic lists launched May: signed letter of intent to join NOREX by mid 2001.
2001	Apr: the HEX group acquired strategic ownership in the Tallinn Stock Exchange.	Apr: the HEX group acquired strategic ownership in the Riga Stock Exchange.		
2002				Dec: EU Copenhagen Summit invited the countries to join in May 2005.
2003				Sep: the HEX Group merged with the OM Group.
2004	Sep: introduction of SAXESS. Jun: EEK pegged to the Euro	Sep: introduction of SAXESS.	May: OMHEX acquired a majority ownership in the Vilnius Stock Exchange. Jun: LTL pegged to the Euro	May: EU entry. Sep: daily calculation of BALTIX index.
2005	Jun: Hansapank de-listed	May: LVL pegged to the Euro	May: introduction of SAXESS.	

C. Key Descriptives

Bekaert and Harvey (1997) list four unique features of emerging markets: (i) average returns are higher, (ii) correlations with developed market returns are low, (iii) returns are more predictable and (iv) volatility is higher. The Baltic market, which is fast approaching the level of developed markets, still exhibits many of these distinguishing features.

C.1 Market Capitalization

Despite the strong appreciation, market capitalization is still relatively low. By year-end 2005 the total market capitalization of the Baltic Main list and I-lists stood at 11.6 billion Euro (of which Lithuania accounted for 60%, Estonia for 25% and Latvia for 15%). Market capitalization as a share of GDP is frequently used to characterize a market and the historical development is shown in table C.1.1. The share of market capitalization of GDP for the Baltic market has gone from 15% to 28% over the six year period, an increase of 83%, which is far behind the appreciation reflected in the indices. A major reason is de-listings, in particular Hansapank, but strong GDP growth during the period has also helped decrease the ratio.[20] Many developed countries have ratios above 100% and it appears as if there is still much room for the market to grow.

Table C.1.1

Market capitalization at year end as a share of GDP.

	Estonia	Latvia	Lithuania	Baltic
2000	32%	8%	12%	15%
2001	25%	8%	8%	12%
2002	31%	7%	9%	14%
2003	37%	9%	17%	19%
2004	50%	10%	26%	27%
2005	29%	15%	35%	28%

C.2 Free Float

Free float is an important characteristic of a market since it is a measurement of the number of shares that are available for trading. For the Baltic market, which has a relatively low market capitalization, it is of even greater importance since an insufficient value of shares available for trading might deter new investors from entering the market. The listing requirements for the Main

[20] Joint GDP growth over the six years for the Baltic countries was 59%, which corresponds to a compound annual growth of 8.1%.

list are a 25% free float and a market capitalization of no less than 4 million Euro, and listing on the I-list requires a 15% free float and market capitalization of no less 1 million Euro. As of June 30, 2005, the actual average free float for the Main list stood at 37% and for the I-list it was 21% (OMX, 2005a).

C.3 Volatility

Despite the high returns, volatility has been remarkably low, which distinguishes the Baltic market from other emerging markets as characterised by Bekaert and Harvey (1997). Average yearly standard deviation of the BALTIX index has been 11.9% while the broader AVEBALT index was even lower at 9.1%. The trend has been decreasing and the standard deviations were 17.2% and 12.5%, respectively, in 2000 and 7.7% for both indices in 2005. One obvious reason for the low observed volatility is that the market exhibits an increasing trend over the whole period and accordingly only a few dips could be seen in figure 5.1.5.1. The average annual volatility and the compound annual return imply very impressive Sharpe ratios of 2.4 and 5.1, for the BALTIX and AVEBALT indices, respectively.[21]

C.4 Integration

The low volatility and extraordinary consistent returns paint a picture of a market that is different from most other traditional developed markets. It appears as if the market and investors have been unaffected by world events, which indicates that it is a closed market. A good indicator to determine whether the market actually was in a post-liberalization stage by 2000 is the share of foreign ownership. The historic development is presented in table C.4.1 and all three exchanges had a high share of foreign ownership at the beginning of 2000. For Tallinn the share of foreign ownership was as high as 73%. The trend, however, is decreasing and it appears as if domestic investors have become relatively more important on the market.

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[21] $S = \frac{r_m - r_f}{\sigma_m}$ using 12 month EURIBOR as the risk free rate.

Table C.4.1

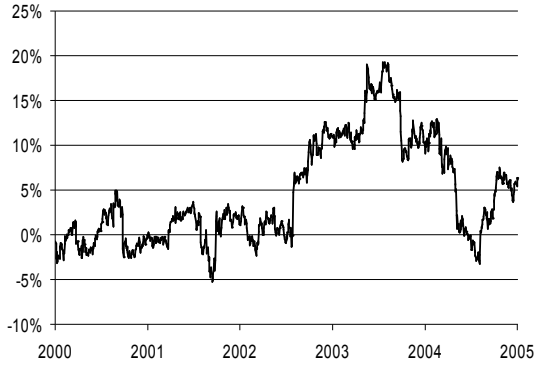
Year-end share of foreign ownership for the three national stock exchanges (source: National Central Securities Depositories).

	1999	2000	2001	2002	2003	2004	2005
Tallinn	73%	76%	76%	80%	80%	83%	54%
(excl. Sweden) [22]	*34%*	*31%*	*31%*	*31%*	*27%*	*28%*	*28%*
Riga	39%	49%	44%	46%	42%	43%	41%
Vilnius	44%	55%	46%	52%	52%	55%	39%

Correlation of local returns with world market returns is a suitable measurement to study the level of integration of a market in a post-liberalization stage. Despite the high share of foreign ownership the returns of the Baltic market exhibit a low correlation with world market returns. Graph C.4.2 shows the one year correlation over time between the official BALTIX index and the MSCI World index.[23] Correlation starts around zero and increases during 2002 and 2003 to reach a maximum of 19.3%. From there on the trend is decreasing. Average correlation for the period is only 4.5% and, as a comparison, the Stockholm Stock Exchange OMXS30 index had an average correlation with the MSCI World index of 60.2% over the same period.

Figures C.4.2 (left) and C.4.3 (right)

Figure C.4.2 shows the one year correlation between the BALTIX index and the MSCI World index. Figure C.4.3 shows the one year correlation between the BALTIX index and the MSCI EM EE index.



It may, however, be the case that correlation does not increase although a market becomes more integrated. A country could have a different mix of publicly traded companies than the world average due to certain country specific characteristics. As a result, returns of an index of local companies will be affected by other events than a world index and correlation will stay low. The

[22] The reason for excluding Sweden is that the figures are severely distorted by Swedbank's ownership in Hansapank. The remaining shares in Hansapank were acquired in spring 2005 and the share was de-listed on June 30 2005, which brought a substantial decrease in the level of foreign ownership that year.

[23] MSCI World index is a capitalization-weighted index that holds more than 1,500 stocks from 23 developed markets.

Baltic market is part of an Eastern European investment universe that includes markets that have emerged following the fall of the Soviet Union and the MSCI Emerging Markets Eastern Europe index (MSCI EM EE) covers this universe.[24] Graph C.4.3 shows that the yearly correlation with this index has a pattern similar to the pattern of the correlation with the world index. It starts from below zero and exhibits an increasing trend to reach a maximum of 21.6% but falls towards the end of the period. Average correlation is higher at 8.6% but it appears as if returns on the Baltic market are uncorrelated with returns on neighbouring markets as well. MSCI EM EE, on the other hand, shows a much higher correlation with the world index. The correlation is rather stable over the period and has an average of 55.4%.

[24] MSCI EM EE is a capitalization-weighted index that covers a selection of the largest and most liquid stocks in Russia, Poland, Hungary, Slovakia and the Czech Republic.

D. Methodology of AVEBALT and BALTIX

The AVEBALT index is constructed to reflect the price development of all listed shares on the Baltic market and is an alternative to the official BALTIX index. The index is calculated from the daily price change in all the securities that were listed on the Baltic Main list and I-list on a given day. The daily price change is adjusted for dividends and corporate actions such as share splits and bonus issues. No adjustment for rights issues with an issue price below market capitalization has been made. AVEBALT is an equally-weighted index and is rebalanced every trading day. AVEBALT is calculated in Euro according to equation D.1 below.

$$AVEBALT_t = \frac{\sum_{n=1}^{n_t}\left(a_{i,t}\left(\frac{p_{i,t}+d_{i,t}}{p_{i,t-1}}-1\right)\right)}{n_t} AVEBALT_{t-1} \qquad \text{(Eq. D.1)}$$

where

$AVEBALT_0 = 100$ is the base value.

n_t is the number of listed securities at the Baltic Main and I-lists on day *t*.

$p_{i,t}$ is the closing price for security *i* day *t* in Euro.

$d_{i,t}$ is the dividend paid for security *i* day *t*.

$a_{i,t}$ is a corporate action adjustment factor for security *i* day *t*.

The major difference between the indices is that the BALTIX index is a capitalization-weighted index of the shares listed on the Baltic Main list. BALTIX also has a 10% weight limit that is applied quarterly. Both indices are adjusted for dividends and corporate actions. The indices exhibit substantial differences in returns and volatility, which is also shown in table D.2. A major reason for the difference is that AVEBALT is a broader index that includes small cap stocks from the I-list and gives them the same weighting as large caps.

Table D.2

Summary statistics for the BALTIX and AVEBALT indices.

		2000	2001	2002	2003	2004	2005	Average
Return	BALTIX	44%	17%	12%	59%	40%	44%	33%
	AVEBALT	37%	11%	37%	96%	66%	70%	50%
Std. dev.	BALTIX	17%	19%	9%	11%	7%	8%	12%
	AVEBALT	12%	11%	8%	9%	6%	8%	9%
Constituents,	BALTIX	22	17	15	18	20	23	
year-end	AVEBALT	75	68	67	67	67	69	

E. Assumptions about Formation of Expectations

The choice of which assumptions to use when simulating investors' expectations of liquidity is not clear-cut. In section 5.2 regarding the econometric model it was suggested that one (A1), three (A2), six (A3), and 12 (A4) months were possible expectation windows. Having a set of four different assumptions on how investors form expectations of illiquidity calls for a decision on which to proceed with.

It can be argued that there is more or less a draw between the assumptions, but there are intuitive reasons for choosing A3 and assuming a six months expectation window. It seems implausible that investors form expectations on such a short time period as one or three months. At the same time on a market which is changing as quickly as the Baltic market, 12 months seems to be a very long period. Finally, a choice of a 12 month period would lead to a loss of an additional six months of data. None of these arguments is strong enough to lead to the choice of A3 beyond doubt. To investigate the expectation assumptions further table E.1 presents regressions of the model (eq. 5.2.1) using all four assumptions.

Table E.1

Estimation of the model under four different assumptions about expected liquidity. Pooled OLS. Individual intercepts.

$$ABNRET_{i,t} = \alpha_0 + \beta_0 \frac{1}{m}\sum_{n=1}^{m} ACTMA_{i,t-n} + \beta_1 \Delta ACTMA_{i,t} + \beta_2 \frac{1}{m}\sum_{n=1}^{m} PIMA_{i,t-n} + \beta_3 \Delta PIMA_{i,t} + \sum_{n=1}^{96} d_n S_n + \varepsilon$$

Model A1: m = 1, investors form their expectations on average liquidity in the preceding month.
Model A2: m = 3, investors form their expectations on average liquidity over the preceding 3 months.
Model A3: m = 6, investors form their expectations on average liquidity over the preceding 6 months.
Model A4: m = 12, investors form their expectations on average liquidity over the preceding 12 months.

Variable	Predicted Sign	A1	A2	A3	A4
Expected activity	-	3.82***	0.87	-0.95	-0.98
Shock to activity	+	12.84***	10.41***	9.52***	8.97***
Expected price impact	+	0.52**	1.10***	0.80**	1.19***
Shock to price impact	-	-0.39**	-0.40***	-0.56***	-0.52***
Adj R^2		0.06	0.06	0.06	0.05

Significant at 1% (***), 5% (**) and 10% (*) level

The results in table E.1 show that expected price impact, shock to price impact and shock to activity are all highly significant and carry the expected signs regardless of the length of the expectation window. When it comes to expected activity the results are mixed. It is interesting to

note that the coefficients carry the predicted negative sign in models A3 and A4. Notably, under model A1, the coefficient is significant and carries the "wrong" sign.

One possible reason behind this divergence might be that activity, as a measurement of liquidity, has some special properties. One such property could be that activity exhibits a momentum effect, where high activity has a positive impact on liquidity in the next period. This stems from the possibility that high activity in a month might be driven by specific events that are likely to lead to higher activity during the subsequent month, but not resulting in a higher activity in the following months. Examples of such specific events are major news announcements or disclosures of financial information that cause trading in the stock based on new fundamental data. Since mainly informed traders will be active a possible effect is, in fact, reduced liquidity due to the adverse selection that keeps uninformed traders way from the market.

On the back of the intuitive argumentation together with the results from the regression an expectation window of six months seems like the most feasible choice. The fact that expected activity carries a significant coefficient under an assumption of one month could give reason to argue that it is a better choice. It is likely, however, that the momentum effect it captures is the result of the unexpected activity shock and therefore it does not contribute to the understanding of the problem.

$$ABNRET_{i,t} = \alpha_0 + \beta_0 \frac{1}{6}\sum_{n=1}^{6} ACTMA_{i,t-n} + \beta_1 \Delta ACTMA_{i,t} + \beta_2 \frac{1}{6}\sum_{n=1}^{6} PIMA_{i,t-n} + \beta_3 \Delta PIMA_{i,t}$$

(Eq. E.2)

F. Literary Overview

An overview of the most prominent articles that link liquidity and returns.

Author(s)	*Data*	*Time Period*	*Liquidity Measurements*	*Results*	*Illiquidity Premium*
Amihud and Mendelson (1986)	NYSE/AMEX	1960 to 1979	Bid-ask spread	Average liquidity is priced.	√
Amihud (2002)	NYSE	1964 to 1997	Price Impact (ILLIQ)	Liquidity is correlated with returns.	√
Acharya and Pedersen (2005)	NYSE/AMEX	1962 to 1999	Price Impact (ILLIQ)	Expected stock returns increase in illiquidity.	√
Bekaert, Harvey and Lundblad (2005)	19 Emerging markets	1993 to 2003	Incidents of zero daily return	The liquidity measurement significantly predicts future returns.	√
Brennan and Subrahmanyam (1996)	NYSE	1984 to 1988	Glosten- Harris and Hasbrouck-Foster-Viswanathan liquidity parameters	Finds a significant relationship between required rates of returns.	
Chordia, Roll and Subrahmanyam (2001)	NYSE	1988 to 1998	Aggregate liquidity measures	Finds strong day of the week effects for liquidity. Unclear linkage to returns.	
Chen and Kan (1995)	NYSE	1960 to 1979	Bid-ask spread	No clear reliable relationship.	√
Eleswarapu and Reinganum (1993)	NYSE/AMEX	1960 to 1979	Bid-ask spread	No clear relationship. Amihud and Mendelson picks up a seasonal phenomenon.	
Pastor and Stambaugh (2003)	NYSE/AMEX	1966 to 1999	Aggregate liquidity measures (order flow proxy)	Return sensitivity to market liquidity is priced.	√

G. Sample Overview

Ticker	Company Name	Main list	I-list	Active Trading Days	Stock Exchange	Industry
ALT1L	Alita		2000-01-04 to 2005-12-30	918	Vilnius	Beverages
ANK1L	Anyksciu Vynas		2000-01-04 to 2005-12-30	779	Vilnius	Beverages
APG1L	Apranga	2005-10-24 to 2005-12-30	2000-01-04 to 2005-10-21	604	Vilnius	Specialty Retail
ATK1L	Alytaus Tekstile		2000-01-04 to 2005-12-30	487	Vilnius	Textiles, Apparel & Luxury Goods
BAL1R	Latvijas balsams		2000-01-03 to 2005-12-30	1,378	Riga	Beverages
BLTA	Balta		2000-01-03 to 2001-12-28	223	Riga	Insurance
BLT1T	Baltika	2003-02-17 to 2005-12-30	2000-01-04 to 2001-02-28	995	Tallinn	Textiles, Apparel & Luxury Goods
DKR1L	Dvarcioniu keramika		2000-01-04 to 2005-12-30	646	Vilnius	Building Products
DPK1R	Ditton pievadkezu rupnica		2000-01-03 to 2005-12-30	1161	Riga	Machinery
ESOET	Estiko		2000-01-03 to 2004-06-30	485	Tallinn	Containers & Packaging
EKR1L	Ekranas	2001-03-01 to 2005-12-30	2000-01-01 to 2001-02-28	1,178	Vilnius	Electronic Equipment & Instruments
ETLAT	Eesti Telekom	2000-01-03 to 2005-12-30		1,520	Tallinn	Diversified Telecommunication Services
EYP	Eesti Uhispanga		2000-01-03 to 2001-01-05	252	Tallinn	Commercial Banks
GRD1R	Grindeks		2000-01-03 to 2005-12-30	1,179	Riga	Pharmaceuticals
GRG1L	Grigiskes		2000-01-04 to 2005-12-30	1,130	Vilnius	Paper & Forest Products
GTTA	Gutta		2000-01-03 to 2001-12-28	86	Riga	Food Products
GUB1L	Gubernija		2004-09-13 to 2005-12-30	224	Vilnius	Beverages
GZE1R	Latvijas Gaze	2000-01-03 to 2005-12-30		1,450	Riga	Oil, Gas & Consumable Fuels
HAE1T	Harju Elekter	2003-02-17 to 2005-12-30	2000-01-03 to 2003-02-14	1,048	Tallinn	Electrical Equipment
HPA1T	Hansapank		2000-01-03 to 2005-06-30	1,391	Tallinn	Commercial Banks
IVL1L	Invalda	2000-01-04 to 2005-12-30		1,093	Vilnius	Diversified Financial Services
KAIJ	Kaija		2001-01-03 to 2004-05-10	522	Riga	Food Products
KBL1L	Klaipedos baldai		2000-01-01 to 2005-12-30	899	Vilnius	Household Durables
KJK1L	Klaipedos juru kroviniu komp		2000-01-04 to 2005-12-30	673	Vilnius	Transportation
KLEAT	Klementi		2000-01-03 to 2005-12-30	777	Tallinn	Specialty Retail
KLV1T	Kalev		2000-01-03 to 2005-12-30	1,038	Tallinn	Food Products
KNF1L	Klaipedos Nafta		2000-02-28 to 2005-12-30	822	Vilnius	Oil, Gas & Consumable Fuels
KNR1L	Kauno energija		2000-02-04 to 2005-12-30	152	Vilnius	Utilities
KTK1L	Kauno tiekimas		2003-06-31 to 2005-12-30	195	Vilnius	Trading Companies & Distributors
KYLM	Tallinna Kulmhoone		2000-01-03 to 2002-02-22	163	Tallinn	Food Products
LBS1L	Lisco Baltic Service		2001-07-06 to 2005-12-30	943	Vilnius	Marine
LDJ1L	Lietuvos dujos		2000-01-04 to 2005-12-30	1,278	Vilnius	Oil, Gas & Consumable Fuels
LJL1L	Lietuvos juru laivinikyste		2001-07-09 to 2005-12-30	967	Vilnius	Marine
LEL1L	Lietuvos elektrine		2002-02-01 to 2005-12-30	813	Vilnius	Utilities

Ticker	*Company Name*	*Main list*	*I-list*	*Active Trading Days*	*Stock Exchange*	*Industry*
LEN1L	Lietuvos energija		2000-01-04 to 2005-12-30	1139	Vilnius	Utilities
LLK1L	Limarko laivininkystes kompanija		2000-06-20 to 2005-12-30	701	Vilnius	Marine
LME1R	Liepajas metalurgs		2000-01-03 to 2005-12-30	1,109	Riga	Metals & Mining
LNS1L	Linas		2000-01-03 to 2005-12-30	1,098	Vilnius	Textiles, Apparel & Luxury Goods
LOD1R	Lode		2000-01-03 to 2001-02-28	133	Riga	Construction Materials
LSC1R	Latvijas kugniechiba	2002-06-26 to 2005-12-30		871	Riga	Marine
LTK1L	Lietuvos telekomas	2000-06-12 to 2005-12-30		1,394	Vilnius	Diversified Telecommunication Services
MKO1T	Merko Ehitus	2000-01-03 to 2005-12-30		1,188	Tallinn	Construction & Engineering
MNF1L	Mazeikiu Nafta		2000-01-04 to 2005-12-30	1,242	Vilnius	Oil, Gas & Consumable Fuels
MZE1R	Mazeikiu Elektrine		2002-02-01 to 2005-12-30	614	Vilnius	Utilities
NDL1L	NORD/LB Lietuva		2000-01-04 to 2005-12-30	260	Vilnius	Commercial Banks
NRM1T	Norma	2000-01-03 to 2005-12-30		1,481	Tallinn	Auto Components
OLF1R	Olainfarm		2000-01-03 to 2005-12-30	1,107	Riga	Pharmaceuticals
PRO	Pro Kapital Grupp	2000-02-03 to 2001-09-28	2000-01-03 to 2000-02-02	285	Tallinn	Real Estate
PZV1L	Pieno Zvaigzdes	2002-01-03 to 2005-12-30	2000-01-04 to 2001-12-29	1,118	Vilnius	Food Products
REVAL	Reval Hotelligrupi		2000-01-03 to 2000-11-02	134	Tallinn	Hotels, Restaurants & Leisure
PRM1L	Pramprojektas		2003-06-13 to 2005-12-30	105	Vilnius	Construction & Engineering
PTR1L	Panevezio statybos trestas		2000-01-04 to 2005-12-30	476	Vilnius	Construction & Engineering
RPKK	Rczeknes piena konservu kombinats		2000-01-03 to 2000-12-29	74	Riga	Food Products
RKB1R	Rigas kugu buvetava		2002-01-02 to 2005-12-30	1,177	Riga	Machinery
RLK1T	Rakvere lihakombinaat		2000-01-03 to 2005-12-30	754	Tallinn	Food Products
RST1L	Rytu skirstomieji tinklai		2002-02-01 to 2005-12-30	903	Vilnius	Utilities
RSU1L	Rokiskio Suris	2000-01-04 to 2005-12-30		1,205	Vilnius	Food Products
RTF1R	Rigas transporta flote		2002-01-02 to 2005-12-30	1,055	Riga	Marine
SAF1R	SAF Tehnika	2004-05-26 to 2005-12-30		264	Riga	Communications Equipment
SAN1L	Sanitas	2005-11-21 to 2005-12-30	2000-01-07 to 2005-11-18	798	Vilnius	Pharmaceuticals
SAB1L	Siauliu bankas		2000-01-04 to 2005-12-30	780	Vilnius	Commercial Banks
SKU1T	Saku olletehas		2000-01-03 to 2005-12-30	1,389	Tallinn	Beverages
SMN1T	Starman	2005-06-28 to 2005-12-30		131	Tallinn	Media
SNG1L	Snaige	2000-01-04 to 2005-12-30		1,150	Vilnius	Household Durables
SPO1T	Sampo Panga		2000-01-03 to 2002-08-16	378	Tallinn	Diversified Financial Services
SRS1L	Bankas Snoras		2000-01-04 to 2005-12-30	792	Riga	Commercial Banks
STBR	Staburadze		2000-01-03 to 2001-12-14	339	Riga	Food Products
STU1L	Stumbras		2000-06-02 to 2005-12-30	751	Riga	Beverages
TFA1T	Tallinna farmaatsiatehas		2000-01-03 to 2005-12-30	681	Tallinn	Pharmaceuticals
TKM1T	Tallinna Kaubamaja	2000-01-03 to 20005-12-30		1,086	Tallinn	Multiline Retail
TVEAT	Tallinna Vesi	2005-06-01 to 2005-12-30		150	Tallinn	Water Utilities
UKB1L	Ukio bankas		2000-01-04 to 2005-12-30	1,024	Vilnius	Commercial Banks

Ticker	*Company Name*	*Main list*	*I-list*	*Active Trading Days*	*Stock Exchange*	*Industry*
UNIB	Latvijas Unibanka		2000-01-03 to 2001-03-12	296	Riga	Commercial Banks
UTR1L	Utenos Trikotazas	2000-01-04 to 2005-12-30		706	Vilnius	Textiles, Apparel & Luxury Goods
VDG1L	Vilniaus degtine		2002-04-03 to 2005-12-30	322	Vilnius	Beverages
VNF1R	Ventspils nafta	2000-01-03 to 2005-12-30		1,499	Riga	Oil, Gas & Consumable Fuels
VNG1L	Vilniaus Vingis	2002-02-01 to 2005-12-30	2000-01-04 to 2002-01-30	1,303	Vilnius	Electronic Equipment & Instruments
VNU1T	Viisnurk		2000-01-03 to 2005-12-30	986	Tallinn	Household Durables
VSS1R	Valmieras stikla skiedra		2000-01-03 to 2005-12-30	1,181	Riga	Building Products
VST1L	VST		2002-02-01 to 2005-12-30	823	Vilnius	Utilities
V10062	Hansabankas		2000-01-04 to 2002-03-28	302	Vilnius	Commercial Banks
V10134	Vilniaus bankas	2000-01-04 to 2001-01-30		226	Vilnius	Commercial Banks
V10545	Kalnapilis		2000-01-06 to 2001-07-31	348	Vilnius	Beverages
V11120	Trinyciai		2000-01-27 to 2003-06-13	252	Vilnius	Textiles, Apparel & Luxury Goods
V11166	Naftos terminalas		2001-01-08 to 2003-07-22	265	Vilnius	Oil, Gas & Consumable Fuels
V11311	Panevezio pienas		2000-01-06 to 2004-10-01	334	Vilnius	Food Products
V11627	Lietuvos juru laivininkyste		2000-01-04 to 2001-06-22	349	Vilnius	Marine
V11869	Siauliu stumbras		2000-01-04 to 2002-12-30	81	Vilnius	Textiles, Apparel & Luxury Goods
V12194	Lietuvos draudimas		2000-01-04 to 2002-06-28	120	Vilnius	Insurance
V10282	Naujieji Verkiai		2002-02-25 to 2003-12-19	89	Vilnius	Paper & Forest Products
V11069	Sema		2000-01-04 to 2002-06-28	69	Vilnius	Beverages
V10923	Birzu akcine pieno bendrove	2000-05-22 to 2001-04-27		166	Vilnius	Food Products
V11029	Ragutis		2000-01-04 to 2002-06-17	152	Vilnius	Beverages
ZMP1L	Zemaitijos pienas		2000-01-04 to 2005-12-30	914	Vilnius	Food Products
XXL	XXL.EE		2000-01-03 to 2002-02-22	132	Tallinn	Media

The following periods have been removed (as discussed at length in section 3.1):
ATK1L (2000-01-04 to 2002-12-30), KNF1L (2000-02-28 to 2002-01-01) KNR1L (2000-01-04 to 2004-12-30) BLTA (2000-01-03 to 2001-06-05) V11120 (2000-01-27 to 2000-06-23).