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Ownership Structure and Stock Market Liquidity

by

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Ownership Structure and Stock Market Liquidity

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Abstract

This paper studies the relationship between company ownership and market liquidity using a panel regression approach. The data sample contains detailed transactions data from a limit order driven stock market, and a full breakdown of company ownership into five distinct owner types as well as outside owner concentration and insider holdings. In line with theoretical predictions, owner concentration is found to be negatively related to spreads and information costs. A somewhat weaker negative relation is also found between spreads and insider holdings. No strong relationship can be documented between liquidity and institutional ownership. Ownership variables which affect spreads do not in general jointly affect depth in the predicted way, suggesting that spread and depth measure different dimensions of liquidity. Finally, a one-way Granger causality relation from ownership structure to liquidity is hard to document.

Keywords: Market Microstructure, Corporate Governance

JEL Codes: G10, G32

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1 Introduction

This paper examines empirically the relationship between ownership structure and market liquidity in the Norwegian equity market.

The Norwegian equity market is medium sized by European standards and among the 30 largest world equity markets by market capitalization value. The stock exchange has become increasingly liquid during the last two decades, and is currently operating a fully automated computerized trading system similar to the public limit order book systems in Paris, Stockholm, and Toronto. Compared with the typical European firm, Norwegian firms have a low personal ownership and a flat power structure among the major owners. Another notable characteristic is a high aggregated holding by foreign investors.

According to agency theory, the efficiency of a particular ownership structure depends on its ability to cope with the conflicts of interest raised by the separation of ownership and control. A positive relationship is predicted between performance and the ability to monitor firm managers (large owners and direct ownership), and between performance and a reduction in the *need* for monitoring (insider holdings). A central variable in both cases is informational asymmetry. Market microstructure theory predicts that informational advantages will be reflected in market liquidity through higher implicit costs of trading; the larger the fraction of owners with privileged access to information in a firm, the larger the adverse selection component of the bid-ask spread and the lower the quoted depth. Thus, the positive effect of monitoring is predicted to be mitigated by costs related to reduced liquidity. The relationship between ownership structure and liquidity is obviously important for traders searching cost efficient ways to trade. Empirical evidence on this subject also constitutes a valuable input to the problem of determining the net impact of ownership structure on economic performance. Finally, investigating the link between liquidity and company ownership relates to the important research issue of whether illiquidity has an impact on firms' costs of capital.

Existing empirical literature from the US equity market studies the liquidity effects of insider holdings, institutional holdings and block ownership. Two studies find a negative relationship between liquidity and insider holdings, while one study finds no significant relationship. The relationship between liquidity and institutional holdings are also mixed. One study finds evidence of a positive relationship between liquidity and block holder ownership.

The main contribution from this study is to investigate the issue based on much more comprehensive data on ownership structure than used in previous studies. We use monthly

data on ownership structure for the period from February 1999 to June 2001. In addition to owner concentration and insider holdings, we have access to a full breakdown of ownership into five owner types. Moreover, we are not aware of anyone who has been able to analyze this issue with panel regression models, and conduct tests of the Granger causality between ownership variables and liquidity measures. A second contribution is that our study is based on transaction data from a pure limit order-driven market, while existing studies are based on liquidity measures from trading systems with some form of dealer intermediation. Limit order-driven trading systems are becoming increasingly popular, and there is a growing interest in the properties of this trading arrangement.

Owner concentration is found to matter for liquidity, both measured by the spread and by the adverse selection component of the spread measured by Kyle's lambda. There is also a similar, but weaker negative relationship between insider holdings and spreads. We are not able to detect any significant Granger causality relation between owner concentration and spread nor between insider holdings and spread. Thus, one may suspect that there are some variables that determine jointly the two relations. Another interesting finding is that there is no general tendency for the ownership variables having significant effects on spreads also to have significant effects on market depth. This suggests that spread and depth are truly different dimensions of liquidity. The holdings of the two largest owner groups in the market, non-financial companies and foreign investors, have opposite effects on liquidity. While the aggregate holding of non-financial companies has a significant positive (negative) effect on the spread (the depth), the opposite is true for the aggregate holding of foreign owners. Our results with respect to the holdings of foreign investors are in accordance with the hypothesis that international owners invest mainly to capture gains from diversification.

The paper is organized as follows. Section 2 reviews some basic literature on the relation between ownership structure, performance, and liquidity. Section 3 describes the Norwegian equity market. Section 4 presents the data sample. Section 5 discusses the results from the analysis of the relationship between ownership structure and liquidity. Section 6 concludes the paper.

2 Literature

This section reviews the main theory and empirical evidence on the relationship between ownership structure, economic performance and market liquidity.

Both economic theory and public policy in most countries suggest that the structure of company ownership is important for economic performance. The standard theoretical predictions about the relative efficiency of different ownership structures are based on the principal-agent model.[1] According to this model, a monitoring problem arises because the owners of a firm (the principal) delegate the control over business decisions to the management of the firm (the agent). Thus, the main role of owners is monitoring. The incentives and capabilities to monitor a firm's business decisions are thought to depend on the *owner concentration* and the *owner type*. A third relevant characteristic of the ownership structure is the division between outside owners and the *insiders*. Insiders are owners or others who, for some reason, have access to privileged information about the firm, and who typically also have the power to make changes inside the firm. In addition to the monitoring problem viv-a-vis the firm management, there are potentially similar conflicts of interests among sub-groups of owners. These conflicts typically go along the dimensions small versus large owners, direct versus indirect owners, and outside owners versus insiders.

Large owners are assumed to have more resources and stronger incentives to monitor the managers than small owners, while small owners have incentives to free-ride on the monitoring of large owners. Direct owners, represented by personal investors who monitor the agent directly, are predicted to perform more efficient monitoring than indirect owners. Typical examples of indirect ownership are widely held private firms, or private or public institutional investors who make investment decisions on others' behalf. On the other hand, large indirect investors may potentially be more professional and have better access to information than small direct investors. For example, the holdings of institutional investors tend to be larger than the holdings of the typical shareholders. If so, the information acquisition costs are spread over a larger investment, and this creates an incentive for the institutions to acquire information. Domestic versus international ownership is another owner type dimension. Assuming that international investors have an informational disadvantage vis-a-vis domestic owners and invest mainly to capture diversification benefits, there will be a negative effect on performance from increased foreign ownership due to reduced monitoring.

As long as company insiders have the same incentives as the outside owners to maximize the value of the firm, theory predicts that insider holdings and performance are positively related ("the convergence of interest" hypothesis). On the other hand, an insider may also

[1]The theoretical arguments presented in the next three paragraphs are based on the classic ideas of the agency theory, see for example Jensen and Meckling [1976]. See also the survey article on corporate governance by Shleifer and Vishny [1997].

have incentives to expropriate wealth from the outside owners. Typically, it is assumed that an increase in insider holdings has a positive (negative) effect at low levels (high levels) of insider holdings. Note that the role of insiders is not so much to monitor as to reduce the *need* for monitoring.

In general, agency theory can not answer whether the expected net impact on performance from a certain constellation of ownership is positive or negative. Hence, the net effects must be determined empirically. Empirical studies on this subject are surveyed in Bøhren and Ødegaard [2003a]. Performance is typically measured by Tobin's Q, book return on assets, or market return on equity. Most papers analyze owner concentration, and a few analyze insider holdings. The results are inconclusive, but most studies find no link or a positive link between outside concentration and performance, and an initially increasing, but non-monotone relationship between insider holdings and performance. The studies assume that ownership structure is exogenously determined. This assumption is questioned in Cho [1998], who finds empirical evidence suggesting that corporate values affects ownership structure, and not vice versa.

Bhide [1993] and Maug [1998] deal explicitly with the relationship between liquidity and the efficiency of corporate governance mechanisms. Bhide [1993] argues that a liquid stock market is a hindrance to effective monitoring because it reduces the costs of "exit" by unhappy shareholders. Maug [1998] derives a theoretical model for investigating this negative liquidity effect against an opposite positive effect from reducing the problem of free-riding by small shareholders (better liquidity makes it less costly to hold large stakes). The model suggests that the positive effect dominates the negative, i.e. that a more liquid market makes corporate governance more effective.

A central variable behind the assumed ability to monitor firm management is informational advantages: insiders, large owners, and direct owners have an informational advantage relative to small owners and indirect owners, and domestic owners have an information advantage relative to international owners. Theoretical implications of informational asymmetries for financial market equilibrium is the essential topic in the market microstructure literature.[2] Market microstructure models derive how the fear of trading with someone with privileged access to information is reflected in the liquidity of stocks through higher implicit costs of trading.[3]

[2]Classical articles are Glosten and Milgrom [1985] and Kyle [1985].

[3]Holmstrm and Tirole [1993] derive a theoretical model where market liquidity and owner concentration are negatively related, without the assumption that large owners have an informational advantage. In this model, when a large owner decreases his or her ownership, liquidity increases because it opens up for an increasing number of liquidity traders in the stock. The increased liquidity makes it easier for privately informed investors to disguise their information and make money, which in turn encourages the search for information and increases the information content of the stock price.

Considerable effort is also expended to develop empirical techniques for measuring such costs.

Keim and Madhavan [1998] document that the implicit costs of trading, including spread costs, price impact costs, and timing costs, are economically significant.[4] Thus, detecting factors that effect market liquidity is important on its own grounds. Moreover, Amihud and Mendelson [1986] derive and find empirical support for a model where the expected return on a stock is an increasing and concave function of the spread. Brennan and Subrahmanyam [1996] find similar results using several empirical measures of the adverse selection component.[5]

Empirical studies from the US markets find mixed evidence on the hypothesis of reduced liquidity caused by informational asymmetries among company owners.[6] Using a sample of 75 NYSE stocks for 251 trading days from January through December 1973, Chiang and Venkatesh [1988] study how the market views corporate insiders and institutional holdings through their effects on the spread. Insider holdings are found to be positively related to the dealer's information costs after controlling for other holding costs and firm size, while institutional holdings are not found to have any impact on the spread. On the other hand, Glosten and Harris [1988] find an insignificant relation between spreads and insider holdings for a sample of 250 NYSE stocks in the period 1981-1983. Using a sample of 786 listed US stocks for the period from April to December 1985, Sarin et al. [2000] find that higher insider and institutional ownership are both associated with wider spreads and smaller quoted depth. Based on a sample of 260 listed US stocks with transactions data on the 1988 ISSM database, Heflin and Shaw [2000] find that firms with greater block holder ownership have larger quoted and effective spreads, a larger adverse selection spread component, and smaller quoted depths.

3 The Norwegian equity market

This section describes the Norwegian equity market. First, some general statistics on the size and trading activity in the market, and the main characteristics of the trading system are presented. Then, some main features of the corporate governance structure in the market are summarized, and a motivation for looking further into the relationship between ownership structure and liquidity in this market is provided.

[4] Implicit costs are significant both relative to explicit costs (commissions) and to portfolio returns.

[5] Chordia et al. [2001] find that there is a negative relationship between stock returns and the variability of dollar trading volume and share turnover, a result which does not support a hypothesis that agents care about the risk associated with fluctuations in liquidity.

[6] Another reduced liquidity hypothesis is based on a supply side argument; the more owners with large stakes in a company, the fewer number of stocks available for trading in the market.

General statistics

The Oslo Stock Exchange (OSE) is the only regulated market place for trading equities in Norway. Table 1 reports some general statistics on market values and trading activity for the companies listed on the exchange in the period from 1994 to 2003.

Table 1: The Norwegian stock market - 1989-2003

The table reports som general statistics for the companies listed on the OSE in the period 1997-2003. Numbers are presented in nominal terms and in fixed 1998 prices. The nominal numbers are official statistics obtained from the web site www.ose.no, while the fixed prices are based on an official price index obtained from the web site www.ssb.no. The table shows the number of companies listed at year-end, the market capitalization values, the number of transactions, turnover by value, and turnover velocity. The market values include all capital registered with the Norwegian Central Securities Depository (VPS). Before 1995, this only included Norwegian companies. Dividend values include dividends in companies listed at year-end. Turnover velocity is defined as the average of annualized turnover per month divided by market value at the end of each month.

Year	No of listed companies	Market value, NOK mill nominal	1998 prices	No of trans.	Turnover, NOK bill nominal	1998 prices	Turnover velocity
1994	146	246606	268342	304622	124.4	135.4	-
1995	165	289804	307648	394052	156.7	166.4	-
1996	172	389397	408601	569806	231.7	243.1	-
1997	217	556002	568509	829794	341.1	348.8	69.3
1998	235	413673	413673	846535	322.7	322.7	63.0
1999	215	582941	569835	1330674	445.6	435.6	88.6
2000	214	637856	604603	2418219	609.1	577.4	96.7
2001	212	677032	622845	2529182	566.4	521.1	86.4
2002	203	502938	456801	2047861	444.4	403.6	74.7
2003	178	689734	611466	2348086	552.5	489.8	97.7

The market has grown substantially during the last 10 years. Measured in real terms, the total market capitalization value at the end of 2003 was more than the double of the value at the end of 1994, and the turnover value in 2003 was 3.6 times the turnover value in 1994. Another notable characteristic of the market, which is not shown in the table, is a very high concentration of values and trading activity in a few large companies. At the end of 2003, the five largest companies (by market value) accounted for 64 percent of the market value of all listed firms, and around 53 percent of the total turnover value.

Trading at the OSE

Since January 1999, the OSE has operated a fully automated computerized trading system similar to the public limit order book systems in Paris, Stockholm, and Toronto. The trading day comprises two sessions; the "pre-trade" session starting at 9:30 and ending with an opening auction at 10:00, and the "continuous trading" session from 10:00 until the trading closes at 16:00. During the pre-trade session, brokers can register trades that were executed after the

close on the previous day as well as new orders. The opening auction at the end of the pre-trade session matches all registered orders at the price which maximizes the trading volume. During the continuous trading session, limit orders, market orders, and various customary order specifications are allowed. Automated order matching implies strict enforcement of the order handling rule. As is normal in most other electronic order driven markets, the order handling rule follows a price-time priority.[7]

The corporate governance structure

All listed firms in Norway must report every transaction of its outstanding equity to the Norwegian Central Securities Depository (VPS). The notification specifies the identity of the buyer and the seller, the exact time of the transaction, the number of securities traded, and the price per security. In addition, any change in the number of securities outstanding must be reported, such as stock splits, treasury stock issues, and issues of new shares.

Based on a large data sample from the VPS for the period 1989-1997, Bøhren and Ødegaard [2000] and Bøhren and Ødegaard [2001] provide a detailed description of the ownership structure of Norwegian firms.[8] The two largest owner groups of Norwegian firms are foreign investors and non-financial domestic firms. On average, foreign investors, institutional investors, and the state invest in larger companies than individuals and non-financial domestic firms. Compared with the typical European firm, the ownership structure of Norwegian firms exhibits two special features: a low personal ownership and a flat power structure among the major owners. The authors suggest that these findings may be partly explained by "a long social-democratic tradition and strong legal protection of stockholders".[9] The average aggregate holdings of different owner types and average percentage holdings of the mean owner, the largest owner and the five largest owners over the sample period are provided in table 15 in the data appendix.

Motivation

Bøhren and Ødegaard [2003a] study the relationship between corporate governance structure and performance in the Norwegian market. Their findings support several predictions from

[7] A new, similar trading system was introduced in the spring 2002. The reason for replacing the 1999 system was an agreement signed by OSE with the stock exchanges of Stockholm, Copenhagen and Iceland to establish a joint Nordic marketplace, known as NOREX. The NOREX exchanges are still independent entities, but the alliance has made it possible to create a joint Nordic marketplace with a common trading platform and harmonized regulations. For more information about trading on the OSE, see www.ose.no.

[8] A summary of this work (in Norwegian) is found in Bøhren and Ødegaard [2003b].

[9] Bøhren and Ødegaard [2001], page 1.

agency theory. Insider ownership is value creating up to a holding fraction of 60 percent, and direct ownership implies a higher performance than indirect ownership through private or state intermediaries. On the other hand, a highly significant negative relationship is documented between outside ownership concentration and economic performance, suggesting that the negative effects from owner concentration outweights the benefits of monitoring.[10]

To the extent that these findings are caused by differences in monitoring efficiency resulting from informational asymmetries, they should be accompanied by liquidity effects in the market. The question of how performance effects and liquidity effects are interrelated is an important research issue. There is no straight forward way to compute the impact of illiquidity on performance or the cost of capital. However, the idea that liquidity is a priced factor in expected returns has theoretical as well as empirical support. In table 2 we show some rough calculations of the relationship between the bid-ask spread, measured as a percentage of the midpoint price, and returns for the Norwegian equity market in the period from 1980 to 2002.[11] The table shows average monthly percentage returns for five portfolios sorted on the relative bid-ask spread in the period from 1980 to 2002. Portfolios are grouped at the beginning of each year, using the average relative spread in the previous year as the criterion for grouping. The table shows an economically significant difference in returns for the portfolio with the lowest bid-ask spread (0.83 percent) and the portfolio with the largest bid-ask spread (3.03 percent). Table 16 in the data appendix verifies that this relationship is quite robust over five years sub-periods. The numbers also indicate that the higher bid-ask spread portfolios have higher volatility. Thus, there seems to be a positive relationship between the size of the bid-ask spread and expected returns, similar to the relationship documented for the US market in Amihud and Mendelson [1986] and Brennan and Subrahmanyam [1996]. This simple analysis does not prove the existence of such a relationship. However, it does provide a good motivation for making a first step and figuring out whether there are in fact liquidity effects from ownership structure in the market.

The relationship between liquidity and ownership structure in the Norwegian market is previously studied in Sjo [1998] and Tobiasson et al. [1999]. Using data for 1995, Sjo [1998] studies the liquidity of 61 industrial companies listed on the OSE. Liquidity, measured by the relative bid-ask spread, trade frequency, and turnover velocity, is found to be positively related to company size, low concentration of ownership, high fraction of foreign owners, high beta

[10]Negative effects of owner concentration include majority-minority conflicts, reduced manager initiatives, reduced benefits of diversification and reduced market liquidity.

[11]I am grateful to Bernt Arne Ødegaard for providing table 2 and table 16 in the data appendix.

Table 2: Monthly returns for liquidity based portfolios, 1980-2002

The table shows monthly returns and the number of securities for five portfolios sorted on relative spread in the period from 1980 to 2002. Portfolios are grouped at the beginning of each year, using the average relative spread in the previous year as the criterion for grouping. The sample includes all listed securities on the OSE which comply with the following three filtering criteria: (i) the stock price is above NOK 10, (ii) the total value outstanding of the company is at least NOK 1 million, and (iii) the security is traded at least 20 days during one year. The filtering criteria imply that, on average, a year contains 121 companies. Panel A(B) of the table shows the results for equally weighted(value weighted portfolios).

Panel A	Returns					No of securities		
EW Portfolios	mean	std	min	median	max	avg	min	max
1 (smallest)	0.83	6.93	-24.90	1.00	18.65	28.1	10.0	45.0
2	0.96	6.66	-22.45	1.63	18.80	27.2	10.0	44.0
3	1.38	6.44	-21.24	1.24	21.45	27.1	11.0	45.0
4	2.02	6.39	-15.51	1.51	21.87	27.0	10.0	44.0
5	3.03	7.22	-15.92	1.88	35.04	27.0	10.0	44.0

Panel B	Returns					No of securities		
VW Portfolios	mean	std	min	median	max	avg	min	max
1 (smallest)	1.42	6.89	-26.89	1.86	22.26	27.3	9.0	44.0
2	1.94	7.16	-25.53	2.49	31.11	27.0	10.0	44.0
3	2.15	7.29	-21.70	1.86	26.48	26.8	10.0	44.0
4	3.02	7.71	-15.08	2.26	45.79	26.8	10.0	44.0
5	4.10	8.50	-19.81	2.46	36.77	28.5	12.0	46.0

risk, and high market value relative to the book value of equity.[12] Moreover, relative bid-ask spread and turnover velocity are both positively related to returns. Tobiasson et al. [1999] study the relationship between liquidity and ownership structure using transaction data for two periods, 20 companies in the period from February 1 to March 20 1996, and 131 companies in the period from September 1 1997 to February 22 1998, and ownership data for year-end 1997.[13] A negative relationship is found between liquidity and the holdings of company insiders. The relationship between liquidity and the largest company owner is weak. No significant relation is found between liquidity and institutional ownership or the fraction owned by foreign investors.

Hence, existing studies show some evidence of a negative relationship between liquidity and insider holdings and some weak evidence of a negative relation between liquidity and owner concentration. A problem with both studies is that the data samples are quite limited. Neither of the papers have access to intraday data, meaning that they cannot focus on the most relevant liquidity measures (effective spread and the information component of the spread). Moreover, neither of the papers has access to time series data of ownership, and neither looks at the Granger causality issue. A final motivation is that the existing studies are based on trade data before the introduction of a fully decentralized trading system with a strict price-time priority

[12]Concentration of ownership is measured as the fraction of the company which is *not* owned by the three largest owners.

[13]Transactions data are from the OSE, and ownership data are from VPS, except the holdings of insiders which are prepared at the Norwegian School of Management BI.

rule.[14]

4 The data sample

Our transaction data consist of every order and trade at the OSE during the period from February 5, 1999, shortly after the implementation of the new trading system, through May 2001.[15] From the VPS we have monthly ownership data for the same period. The ownership data include a complete breakdown of firm ownership into five owner types as well as aggregated holdings of the 1-5 largest owners. We also have estimates of the aggregate holdings of primary insiders. Primary insiders include company managers and members of the Board of Directors. The holdings are estimated at the Norwegian School of Management BI based on statements given to the OSE by the insiders. We apply the following filter criteria on our data sample,

- We only look at the "continuous trading" session from 10:00 until 16:00.
- To avoid that infrequently traded firms introduce noise into our intraday liquidity measures, we filter out companies which were traded on less than two thirds of the trading days in the sample period.[16]
- Low valued stocks are problematic because they tend to have exaggerated returns. The exaggerated returns are caused by the minimum tick size and the fact that these stocks typically trade at prices close to zero. To avoid that such securities affect average returns, we exclude stocks that trade for less than NOK 10.

From the resulting data sample we remove two companies, one due to its special trading characteristics during the sample period[17], and the other one due to lack of data on ownership. This leaves us with a total of 94 securities in 88 companies.[18]

[14]The OSE has operated an electronic trading system with continuous trading in all listed securities since 1988. However, the old system did not enforce priority rules. A broker could freely choose what orders he or she wanted to match, independent of price. Moreover, since there was no time priority rule, traders had no incentives to submit orders "first". While competition among brokers implied that price priority was enforced in practice, the lack of time priority presumably had a negative impact on market depth.

[15]The order data contain a ticker, the time of submission, the quantity, the order side (buy or sell), the disclosed and hidden parts of the order volume, and a flag indicating whether it's a new order, a revision of an existing order or a cancellation of an existing order. If an order is revised, information on the previous price and volume of the order is attached to the observation. An order id enables us to track if different parts of the order is executed against several orders. The trade data include ticker, quantity, time, the member firms on each side of the trade, and an identification of the member firm initiating the trade.

[16]More specifically, we filter out companies which were traded on less than 400 of the total 597 trading days in the sample period.

[17]The stock was extremely volatile during the sample period with prices ranging from NOK 184 to NOK 2094

[18]Six companies are represented in the sample with both A and B-shares. In contrast to A-shares, B-shares do not give the owners a right to vote.

Estimation of adverse selection costs

There are many suggestions in the literature on how to estimate adverse selection costs.[19] A potential problem for this study is that the methods are designed for a different institutional setting (competitive quote-driven markets) than ours (order-driven market). We use a version of the Glosten and Harris [1988] method (hereafter the GH-method) without inventory costs and one of the methods suggested in George et al. [1991] (hereafter the GKN-method). The main difference between the two methods is that the GH-method assumes that the adverse selection component increases with order size, while the GKN-method assumes that the adverse selection component remains a constant proportion of the spread.[20]

The GH-method assumes competitive risk-neutral market makers, but not complex dealer strategies such as those allowed in the Madhavan and Smidt [1991] method.[21] The adverse selection component is estimated as a coefficient measuring the impact on intraday price changes from signed order flow ("Kyle"s lambda),

$$\Delta P_t = \lambda q_t + \psi[D_t - D_{t-1}] + y_t \tag{1}$$

where ΔP_t is the intra-day change in the transaction price P_t from $t-1$ to t, q is the order flow, D is a dummy variable taking the value $+1/-1$ if the trade at t is buyer-initiated/seller-initiated, and y is an information signal. λ is the adverse selection component, and ψ is a measure of the compensation for per share execution costs. Following Brennan and Subrahmanyam [1996], we proxy the variable proportional cost of transacting as $VC = \lambda\bar{q}/P$, where $\bar{q}$ is the average transaction size in the stock.[22]

The GKN-method is based on the method of measuring effective spreads, $\hat{S}_e$, from the serial covariance of price changes, which was first suggested by Roll [1984],

$$\hat{S}_e = 2\sqrt{-cov(\Delta P_t, \Delta P_{t-1})} \tag{2}$$

The assumptions underlying the above estimate of the effective spread estimate are no inventory costs, no information events, and a probability of trade reversals equal to 0.5. Since the

[19] See Glosten and Harris [1988], George et al. [1991], Madhavan and Smidt [1991], and Huang and Stoll [1997].

[20] If only the adverse selection component of the spread varies with trade size, then the GKN-measure will only be valid for small trades.

[21] In Madhavan and Smidt [1991], specialists use Bayesian updating to revise their quotes.

[22] Brennan and Subrahmanyam [1996] calculate a second proxy based on the firm's number of shares outstanding. This proxy overcomes the problem that very small trade sizes in very illiquid firms may yield a lower estimated variable cost for illiquid firms that for relatively liquid firms. Since our sample includes relatively liquid firms only, we do not calculate the second proxy.

information component is not included in the estimate, we can write,

$$\hat{S}_e = \psi S_q \tag{3}$$

where S_q is the quoted spread. The estimated adverse selection cost is found as one minus the estimated coefficient of ψ. The GKN-extension consists in an allowance for time varying expected returns. One of the suggested ways to implement this is by exchanging the serial covariance of price changes with the serial covariance of the *difference* in trade-to-trade returns and subsequent bid-to-bid returns. The point is to get a pure measure of the bid-ask bounce by extracting the change in expected returns.

Note that neither of the two estimation methods we use prevent the estimates of adverse selection costs from being negative. A more detailed description of the two methods is provided in appendix B.

Descriptive statistics

Table 3 shows some basic statistics on market liquidity during the sample period. The quoted spread measures the absolute "round trip" cost of trading a small amount of shares at the inner quotes. The effective spread takes into account that trades are often executed inside (price improvement) or outside the spread ("walking the book"). The effective spread is calculated as the absolute difference between the execution price and the bid-ask midpoint multiplied by two. This spread measure is considered the most appropriate measure of costs, especially for large trades.[23] The time weighted relative spread is measured relative to the spread midpoint. Following Sarin et al. [2000], we calculate time weights as the number of seconds a quote was outstanding divided by the total number of seconds during the trading day. Market capitalization values, prices, quoted spreads, effective spreads, and average daily trade volume are reported in Norwegian kroner (NOK). During the sample period USD 1 was equal to roughly NOK 8.5.

The average firm in our sample has a value of NOK 5.95 billion, an average share price of around NOK 102, and experience an average of 57 trades per day with an average trade size of 1826 shares. Measured by the effective spread, the average costs of trading during the sample period was NOK 1.30. As expected, this cost was lower than the average quoted spread. The average quoted depth is 10236 shares. For the GH-method, the adverse selection cost is reported

[23] See for example Angel [1997] and Bacidore et al. [1999].

Table 3: Market liquidity

The table reports statistics on market liquidity during the sample period from February 5 to June 30. The "quoted spread" is the average difference between the inside ask and bid prices for executed trades in a stock over the trading day. The "effective spread" is the average absolute difference between the execution price and the bid-ask midpoint multiplied by two. The "relative spread (time weighted)" is the time weighted quoted spread relative to the spread midpoint, where the time weights are calculated as the number of seconds the quotes were outstanding divided by the total number of seconds during the trading day. Adverse selection costs are estimated according to Glosten and Harris [1988] (GH) and George et al. [1991] (GKN). For the GH-method, the adverse selection cost is reported (in percent) as $\lambda q/P$, where λ is the estimated adverse selection component according to the Glosten and Harris [1988] method, q is the (monthly) average transaction size in the stock, P is the (monthly) average close price for the stocks. For the GKN-method, the adverse selection costs is reported as a percentage of the spread. The "quoted depth (time weighted)" is the time weighted sum of the depth at the best bid price and the best ask price divided by two, where the weights are calculated as described above for the relative spread. Market capitalization values, price, quoted spread, effective spread, and average daily trade volume are reported in Norwegian kroner (NOK). During the sample period USD 1 was equal to roughly NOK 8.5. Relative spread are in percent.

	Mean	Std	Min	Median	Max
Market cap (bill NOK)	5.95	11.82	0.12	2.29	89.13
Price	101.62	74.83	14.42	101.76	345.66
Quoted spread	1.75	1.29	0.16	1.50	7.90
Effective spread	1.30	0.98	0.11	1.13	5.75
Relative spread (time weighted)	1.91	1.12	0.23	1.78	5.47
Adverse selection component:					
- GH-method	0.02	0.08	-0.56	0.00	0.31
- GKN-method	0.53	0.90	-6.24	0.51	2.39
Quoted depth (time weighted)	10236	18597	1173	7708	124214
Avg daily trade size	1826	1315	501	1218	8330
Avg daily no of trades	57	68	7	48	366
Avg daily trade volume, in shares	134204	183693	3527	104494	1156907
- in 1000 NOK	10834.86	22193.73	478.49	8582.36	178323.19

as a percentage of the share price for a trade of average size, i.e. a trade of average size in a stock with the average price of NOK 102 yields an adverse selection cost of about NOK 2.[24] For the GKN-method, the costs are reported as a percentage of the spread.[25]

Firm size varies considerably in the sample from NOK 120 million to over NOK 89 billion. Firm size is of obvious importance for market liquidity. We therefore recalculate the liquidity measures for four portfolios of firms which are grouped based on their market capitalization value at the beginning of each year. The results of these calculations are provided in table 17 in the data appendix. The table shows that the firms in the group of the largest firms are much larger than the firms in the other three groups. The mean firm size of the largest companies varied from NOK 15.66 million in 1999 to NOK 19.62 million over the first half of 2001, while the mean market cap for the rest of the sample varied from NOK 0.34 million for the portfolio of the smallest companies in 1999 to NOK 3.47 million for the medium largest companies over

[24]For comparison, Glosten and Harris [1988] report an adverse selection cost of USD 0.0133 for a 1000 share lot.

[25]For comparison, George et al. [1991] find that the proportion of the spread due to adverse selection ranges between 8 and 13 percent.

the first half of 2001. Some typical features of market liquidity are also evident; spreads are reduced over time, and spreads are lowest/depths are highest for the largest firms. Average trade size does not vary a lot over the four size portfolios indicating that investors split large orders into a series of orders of smaller size.[26]

Table 4 shows some basic descriptive statistics of the average ownership structure over the sample period. A "state owner" represents the government (central or local) including their pension funds. "Institutional owners" consists of private Norwegian banks, insurance firms, pension funds, and mutual funds. "Non-financial" owners are private domestic firms which are not classified as institutional owners. An "individual owner" is a personal (non-corporate) investor with Norwegian residency. Finally, a "foreign owner" is any organization not registered in Norway or a non-resident individual.[27] On average, a firm in our sample had 11 state owners, 102 institutional owners, 354 company owners, 5531 individual owners, and 306 foreign owners. The median number of individual owners is half the mean number, suggesting that the variable has a positively skewed distribution. The weighted number of individual owners is almost three times larger than the mean number suggesting that large companies have a larger number of individual owners than small companies.

Compared with the ownership structure during the 1989-1997 period, the average aggregated holdings of the five owner types have been stable. Foreign investors and non-financial domestic firms are still the largest owner types, and individual holdings are small, especially in large firms. On average, 7.8 percent of a firm is owned by primary insiders. The value weighted mean holding is half this number, suggesting that primary insiders are concentrated in the smaller firms. The five largest owners hold on average 44 percent of a firm, while the largest owner hold around 20 percent. Hence, the power structure is fairly flat. In the cases where the largest owner is an institutional investor, the largest holding is on average 10 percent. This is much lower than for the other owner groups and suggests that institutional owners hold diversified portfolios. Table 18 provides descriptive statistics of the ownership structure for the four size portfolios over each year. The general picture is that the ownership structure has been stable over the sample period. Owner concentration is fairly similar over the size groups, while insider holdings are highest in the smallest firms. State ownership is concentrated in the largest firms, while individual investors are concentrated in the smallest firms.

[26] In addition, in an electronic trading system, large orders will generally be partially executed against smaller orders making the average trade size smaller the average order size.

[27] This group contains investors who are registered by their name and investors who own anonymously through a nominee account.

Table 4: The corporate governance structure

The table reports statistics of the number of owners and aggregate holdings of different owner types, as well as the holdings of five largest owners and the largest owner, including the cases where the largest owner belongs to a given owner type. Primary insiders is a subset of the corporate insiders and include company managers and members of the Board of Directors. The table shows the equally weighted average, the standard deviation, the value weighted average, the median observation, and the number of firms. The value weighted averages are weighted based on the value of the firm's equity. All holding numbers are in percent.

Ownership structure	EW mean	Std	Median	VW mean	n
Owner types					
No of owners:					
State	11	14	7	24	94
Institutional	102	66	89	178	94
Non-financial	354	323	243	660	94
Individual	5531	8527	2101	14728	94
Foreign	306	479	142	647	94
Aggregate holdings:					
State	6.57	12.22	2.38	17.57	94
Institutional	24.49	13.21	21.57	22.48	94
Non-financial	27.93	17.07	26.16	22.22	94
Individual	17.33	16.01	12.35	7.63	94
Foreign	23.84	18.22	21.52	30.02	94
Primary insiders	7.80	14.33	6.48	3.80	94
Owner concentration					
Five largest owners	44.01	16.85	42.87	47.95	94
Largest owner	20.21	13.02	15.44	25.31	94
- state	25.42	16.59	19.71	.	.
- institutional	10.00	5.37	9.26	.	.
- non-financial	20.37	11.67	18.43	.	.
- individual	28.60	21.15	22.21	.	.
- foreign	18.78	14.27	13.96	.	.

To check whether our data sample is biased against certain industry groups, we also split the sample according to the FTSE global classification system. Table 19 in the data appendix provides some descriptive statistics on liquidity and ownership structure based on this classification of the sample. The sample includes firms from all the 10 economic groups, the largest group, cyclical services, represent 22 percent of the sample. Measured by the effective spread, the costs of trading varies from an average of NOK 0.65 for resource companies to an average of NOK 1.98 for financial companies. Six companies are represented in the sample with both A and B-shares. Overall, the liquidity seems to be quite similar between these two types of shares.

Table 5 shows the relationship between the effective bid-ask spread, measured relative to the midpoint price, and monthly returns for our data sample. A positive relationship between costs and returns is evident, however, the relationship is not so strong as the one shown for the much longer time period in table 2 in section 3. Table 20 in the data appendix shows the results of similar calculations over 5 sub-periods of six months starting from the second half of

1999. A positive relationship is evident for the two first sub-periods. When the market starts to fall in the second half of 2000, the relationship disappears.

Table 5: Monthly returns for portfolios sorted on effective relative spread, 1999.2-2001.2
The table shows characteristics of the return distribution of monthly returns for four equally weighted liquidity portfolios. The companies included in the data sample are all firms with price greater than NOK 10 which are traded on at least 400 days out of the 597 trading days from February 5 1999 to June 30 2001. The portfolios are grouped at the beginning of each half year, using the average relative effective spread in the previous half year as the criterion for grouping. The portfolios are assumed to be held the whole period from 1999.2 to 2001.2 and rebalanced every half year.

	Effective spread					Return				
1999.2-2001.2	mean	std	min	median	max	mean	std	min	median	max
Portfolio 1	0.55	0.17	0.14	0.56	0.82	0.01	6.03	-19.92	0.77	15.26
Portfolio 2	1.06	0.18	0.74	1.06	1.39	0.05	6.03	-25.98	0.57	16.52
Portfolio 3	1.74	0.26	1.28	1.72	2.28	2.05	5.81	-12.35	1.74	17.07
Portfolio 4	3.42	1.26	2.06	3.04	9.66	1.47	8.38	-17.34	1.00	38.62

5 Results

This section presents the results from analyzing the relationship between ownership structure and liquidity. First, a reference model is estimated where we regress liquidity measures on common control variables only. We then present some predicted relationships between liquidity and company ownership, and report the results from three regression models; one where we include owner concentration and insider holdings, and two where we also include different owner type variables. Finally, we present the results from several tests of the Granger causality between the ownership variables and the liquidity measures.

A reference model

Table 6 shows the results from an estimated "reference model" where we regress several liquidity measures on common control variables. More specifically, we estimate five versions of a panel regression model with one-way fixed effects of the form,

$$LM = \sum_{k=1}^{K} \beta_k \boldsymbol{X}_{i,t,k} + \eta_{i,t} \tag{4}$$

where LM is the liquidity measure, $\boldsymbol{X}_{i,t,k}$ is the matrix of explanatory variables (k) over time (t) for each company (i), and $\eta_{i,t} = \nu_i + \varepsilon_{i,t}$ denotes the error structure with ν_i as the non-random fixed, firm-specific, effect. Since we use a one-way fixed effects specification, the estimation is analogous to a least-squares dummy variable (LSDV) regression with firm-specific constants

ν_i.[28] The liquidity measures used are the relative time weighted spread, the relative effective spread, the time weighted depth, and the two estimates of the information component of the spread, the GH-measure and the GKN-measure, as defined on page 12 in section 4. Spreads measure the costs per share of liquidity (market width), while depth measures the ability of the market to absorb a series of trades. We use a logarithm transformation of the percentage spread variables to reduce heteroskedacticity. We also take logarithms of the depth measure to reduce skewness. The control variables are firm size, stock price, return volatility, and trading frequency.[29] We use logarithms of market capitalization values to reduce skewness. Market volatility is measured as the standard deviation of daily returns (from midpoint prices), and trading frequency is the average daily number of trades.

A priori, we expect spreads to be decreasing in firm size, price, and trading activity, and increasing in volatility. If depth and spread are jointly determined (low spreads are accompanied by high depth end vice versa), we would expect depth to be positively related to firm size and trading activity, and negatively related to volatility. On the other hand, we expect a negative correlation between price and depth which makes the relation between firm value and depth hard to predict. Two hypotheses about the relationship between the information component of the spread and the control variables are that there is more private information in small firms than in large firms, and that private information is more valuable in high risk companies. If so, the coefficient for firm size should be negative, and the coefficient for return volatility should be positive.

The results of the estimation show that all the standard properties of market liquidity apply. Spreads are lower the larger the firm size, the higher the price, and the higher the trading frequency, and higher the higher the volatility. Depth increases with trading activity and decreases with price and volatility. The positive relation between trading activity and depth is in accordance with the result in Biais et al. [1995] that thick books at the inner quotes result in trades. The GH-measure of adverse selection costs decreases with firm size and increases with volatility, supporting the ideas that there is less private information in large firms, and more valuable information in risky firms. The explanatory power of the GKN-estimates of the information component is low. The results are fairly robust over annual sub-periods, cf table 21 in the data appendix.

[28] Since not all firms are traded every day, our sample is unbalanced. We use the TSCSREG procedure supplied with SAS v.8.2 for estimating the models. The procedure is capable of processing data with different numbers of time-series observations across different cross sections.

[29] These controls are typical in studies of spreads, see Chiang and Venkatesh [1988], Sarin et al. [2000], and Heflin and Shaw [2000].

Table 6: A reference model for market liquidity

The table reports results from estimating a panel regression model with one-way fixed effects (least squares dummy variable estimation) for five measures of liquidity as the dependent variable, and the logarithm of the market capitalization value, the average closing price, the standard deviation of daily returns, the average daily number of trades, and dummies for the fixed effect of each company as the independent variables. The dependent variables are the log(relative weighted spread), the log(relative effective spread), the log(weighted depth), and the adverse selection costs according to the GH-method (variable proportional costs), and the GKN-method. For each model, we report the estimated coefficients for the four control variables, R-squared, and the F-test for no fixed effects. *** denotes significance at the 1 percent level, ** denotes significance at the 5 percent level, and * denotes significance at the 10 percent level. The sample includes 29 time series observations covering 93 companies.

	Dependent variables				
Independent variables	Rel weighted spread	Rel eff spread	Weighted depth	GH info comp	GKN info comp
Market cap	−0.2165***	−0.1966***	−0.0820*	−0.0002***	0.0007
Price	−0.0009***	−0.0009***	−0.0044***	0.0000	0.0000 **
Return volatility	2.7521***	2.4857***	−1.1740*	0.0025***	−0.0144
Trades per day	−0.0020***	−0.0018***	0.0015***	0.0000 **	0.0000
R square	0.8410	0.8471	0.7812	0.2689	0.0991
F-test no fixed effects	26.63 ***	27.61 ***	19.99 ***	3.48 ***	2.30 ***

Predicted relationships between ownership structure and liquidity

Market microstructure theory suggests a negative relationship between liquidity and the holdings of investors with privileged access to information. From principal agent theory we suspect that these investors include large owners, direct owners and insiders. Concentrated ownership has a negative impact on liquidity also in the absence of informational asymmetries because there will be less available shares to trade.

Based on the predictions from the agency theory, one can discuss the likely effects of different owner types on market liquidity. What is regarded as a signal of informational asymmetry in the market is, however, ultimately an empirical question.

We have no clear prediction from theory on the net impact on liquidity from *institutional* owners. One the one hand, large institutional investors potentially have an informational advantage because they have resources to acquire and analyze information. On the other hand institutional ownership is indirect, and the typical investment policy is to hold diversified portfolios. The latter argument suggests that the causality may go from liquidity to institutional ownership and not vice versa. The typical prediction about *foreign* owners is that they have an informational disadvantage vis-a-vis domestic owners and mainly invest to obtain gains from diversification. If so, there should be a positive relationship between foreign ownership and liquidity, and possibly a causality from liquidity to foreign ownership rather than vice versa.

Theory predicts a negative effect on liquidity from large *individual* owners, while firms with many small individual investors should have high liquidity. A prediction which is gaining a lot of popularity in many political environments is that private ownership is more effective than *public* ownership. The inefficiency of public ownership is claimed to follow from factors such as a slow decision making process, too much focus on political goals, less familiarity with business management, a passive role in the board room, and conflicts between the dual role of being an owner and the governing authority. These factors are not based on asymmetric information (unless one argues that public owners for the reasons specified above have less *capacity* to acquire and analyze information). Thus a negative effect from inefficient public ownership should probably effect performance directly. However, it may also be reflected in the market liquidity. A problem with our ownership data is that the group of state owners includes the public pension funds, which probably have characteristics very similar to institutional investors.

Based on the discussion above we choose the following ownership variables:

- The holdings of the primary insiders.
- The aggregate holdings of the five largest owners. We occasionally use the "free float" variable equal to the aggregate holding which is *not* owned by the five largest owners instead.
- The holding of the largest owner split into five separate variables depending on which owner group the largest owner belongs to.
- The percentage aggregate holding and the number of owners for each owner group.
- The absolute value of the change in the number of owners. This variable should to some extent capture differences in trading activity among the owner groups.

Table 7 shows the correlation structure between liquidity measures and ownership variables. The spread measures are positively correlated with the holdings of primary insiders and owner concentration (except when the largest owner is public), and negatively related to the number of owners. As expected, depth and spread are negatively correlated. However, the correlation is not particularly strong. Generally weaker and less intuitive correlations for the market depth variable suggest that depth and spread are indeed different dimensions of liquidity. The GKN-measure is weakly correlated to the ownership variables as well as to the other liquidity measures.

Table 7: Correlation between liquidity measures and ownership structure

The table shows Pearson correlation coefficients between liquidity measures and ownership variables. "Rel spr. weig." is the average time weighted NOK spread, in percent of the midpoint price, where the weights are equal to the number of seconds the quotes were outstanding divided by the total number of seconds during the trading day. "Rel spr. eff." is the average absolute NOK difference between the execution price and the bid-ask midpoint multiplied by two, in percent of the midpoint price. "Depth weig." is the average time weighted sum of the volume at the inner bid and ask quotes divided by two, where the weights are as defined for the relative weighted spread above. "GH info. comp" and "GKN info comp." are costs of adverse selection according to the methods of respectively Glosten and Harris [1988] and George et al. [1991]. "Prim insid" is the aggregate holdings of the primary insiders (managers and board members). "Five lar. own." is the aggregate holding of the five largest owners. "Large, state", "Large, inst.", "Large, comp.", "Large, ind.", and "Large, for." are the holding of the largest owner when the owner is respectively the government (central or local) including their pension funds, institutional investors (private Norwegian banks, insurance firms, pension funds, and mutual funds), private domestic firms, personal (non-corporate) Norwegian investors, and organizations not registered in Norway or non-resident individuals. Finally "No of" are the number of owners of each of the five owner groups defined above. Correlation coefficients in **bold** are significant at the 5 percent level.

	Rel. spr. weig.	Rel. spr. eff.	Depth weig.	GH info. comp.	GKN info. comp.	Prim. insid.	Five lar. own.	Large State	Large Inst.	Large comp.	Large ind.	Large for.	No of state	No of inst.	No of comp.	No of ind.	No of for.
Spr. w.	**1.0000**																
Spr. e.	**0.9491**	**1.0000**															
Depth	**-0.0634**	**-0.0571**	**1.0000**														
GH	**0.4639**	**0.4331**	-0.0431	**1.0000**													
GKN	**0.0482**	**0.0508**	0.0158	-0.0333	**1.0000**												
Insid.	**0.1313**	**0.1004**	-0.0365	**0.0654**	**-0.0614**	**1.0000**											
5 L.	**0.2787**	**0.2822**	**0.0769**	**0.1173**	0.0020	0.0323	**1.0000**										
L. sta.	**-0.0763**	**-0.0690**	**0.0670**	**-0.0791**	0.0142	**-0.1664**	**0.3009**	**1.0000**									
L. inst.	**0.0488**	0.0280	-0.0114	-0.0159	0.0082	**-0.1104**	**-0.1060**	**-0.1002**	**1.0000**								
L. com.	**0.0586**	**0.0624**	**-0.0447**	0.0050	0.0073	-0.0053	**0.3633**	**-0.2195**	**-0.1793**	**1.0000**							
L. ind.	**0.1708**	**0.1596**	-0.0156	**0.1811**	0.0360	**0.1655**	**0.1330**	**-0.0571**	**-0.0467**	**-0.1023**	**1.0000**						
L. for.	**0.0737**	**0.0835**	**0.1262**	**0.0514**	-0.0365	**0.0459**	**0.2837**	**-0.1807**	**-0.1476**	**-0.3234**	**-0.0842**	**1.0000**					
No sta.	**-0.4139**	**-0.4264**	0.0286	**-0.2037**	-0.0282	**-0.1807**	**-0.1257**	**0.1398**	**0.1243**	**-0.1289**	**-0.1270**	**-0.1118**	**1.0000**				
No inst.	**-0.5925**	**-0.6168**	0.0318	**-0.3203**	-0.0425	**-0.1417**	**-0.1214**	**0.2194**	**0.0995**	**-0.0504**	**-0.1948**	**-0.1594**	**0.7425**	**1.0000**			
No com.	**-0.4899**	**-0.4992**	0.0861	**-0.2419**	-0.0377	**-0.1624**	**-0.1613**	**0.1569**	**0.0713**	**-0.1295**	**-0.1338**	**-0.1120**	**0.7006**	**0.7798**	**1.0000**		
No ind.	**-0.3757**	**-0.7181**	**0.1079**	**-0.1740**	**-0.0477**	**-0.1053**	**-0.0927**	**0.2631**	0.0322	**-0.1537**	**-0.0934**	**-0.1032**	**0.6181**	**0.5485**	**0.8192**	**1.0000**	
No for.	**-0.3300**	**-0.3402**	**0.0450**	**-0.1443**	**-0.0535**	**0.0587**	**-0.1128**	**0.1086**	0.0077	-0.0300	**-0.0882**	**-0.0864**	**0.4400**	**0.4040**	**0.5314**	**0.7843**	**1.0000**

Outside owner concentration and primary insiders

In table 8, we present the results from including the aggregate holding of the five largest owners and the aggregate holdings of the primary insiders in the regression model. Table 22 shows the results for estimation of this model for each of the years 1999 to 2001.

Table 8: Market liquidity, owner concentration and holdings of primary insiders

The table reports results from estimating a panel regression model with one-way fixed effects (least squares dummy variable estimation) for five measures of liquidity as the dependent variable: log(relative weighted spread), log(relative effective spread), log(weighted depth), adverse selection costs according to the GH-method (variable proportional costs), and the adverse selection component of the spread according to the GKN-method. The independent variables are the aggregate holdings of the five largest owners, the aggregate holdings of the primary insiders, the logarithm of the market capitalization value, the average closing price, the standard deviation of daily returns, the average daily number of trades, and dummies for the fixed effect of each company. For each model, we report the estimated coefficients (except the coefficients for the fixed effect dummies) , R-squared, and the F-test for no fixed effects. *** denotes significance at the 1 percent level, ** denotes significance at the 5 percent level, and * denotes significance at the 10 percent level. The sample includes 28 time series observations covering 93 companies. To check the residuals of the panel regression models, we estimate a standard OLS regression model for each company and test, for each company, whether the residuals are autocorrelated. We then re-estimate the panel regression models without the companies with autocorrelated residuals. At the 1 percent level (5 percent level), the number of companies with autocorrelated residuals vary from 1-2 companies (7-9 companies). Removing these companies does not seriously change our results.

	Dependent variables				
Independent variables	Rel weighted spread	Rel eff spread	Weighted depth	GH info comp.	GKN info comp
Five largest	1.1527***	1.3796***	0.2030	0.0008***	0.0089
Primary Insiders	0.2579***	0.2149***	−0.1700	−0.0001	0.0006
Market cap	−0.2387***	−0.2244***	−0.0893***	−0.0003***	0.0005
Price	−0.0009***	−0.0009***	−0.0044***	0.0000	0.0000 **
Return volatility	2.4423***	2.1032***	−1.2628***	0.0022***	−0.0163
Trades per day	−0.0018***	−0.0015***	0.0016***	0.0000	0.0000
R square	0.8501	0.8592	0.7817	0.2748	0.1039
F-test no fixed effects	24.31 **	26.17 **	19.42 **	3.22 **	2.30 **

As hypothesized from theory, there is a significant relationship between outside owner concentration and liquidity measured by the spread. This result is also quite robust over subperiods. Assuming the mean effective spread of 1.63 percent, a coefficient estimate of 1.3796 predicts that a 1 percent increase in the holdings of the five largest owners increases the effective spread by around 2.2 basis points. For the average trade size value of around NOK 200000, this means increased execution cost of NOK 44. Assuming a daily number of trades of 50, this corresponds to NOK 550000 annually. Outside owner concentration is also positively related to adverse selection cost measured by the GH-method; a 1 percent increase in concentration leads to an increase in the variable proportional costs of 8 basis points.

There is also a significant positive relationship between the spread measures and the holdings

of the primary insiders. The coefficient estimate here is smaller though, and the result is not robust over sub-periods. Depth does not seem to be related to either owner concentration nor insider holdings.

Owner types

So far, we have found evidence that owner concentration matters for liquidity. Table 9 shows the results from an estimation where we try to determine whether the type of the largest owner also matters. In addition, we include variables for the number of owners of each owner type. Table 23 shows the results from estimating this model over annual sub periods.

Table 9: Market liquidity and owner types

The table reports results from estimating a panel regression model with one-way fixed effects (least squares dummy variable estimation) for five measures of liquidity as the dependent variable: log(relative weighted spread), log(relative effective spread), log(weighted depth), adverse selection costs according to the GH-method (variable proportional costs), and the adverse selection component of the spread according to the GKN-method. The independent variables are the aggregate holdings of the primary insiders, the holding of the largest owner split on owner type, the logarithm of the number of owners of each owner type, the logarithm of the market capitalization value, the average closing price, the standard deviation of daily returns, the average daily number of trades, and dummies for the fixed effect of each company. For each model, we report the estimated coefficients (except the coefficients for the fixed effect dummies), R-squared, and the F-test for no fixed effects. *** denotes significance at the 1 percent level, ** denotes significance at the 5 percent level, and * denotes significance at the 10 percent level. The sample includes 28 time series observations covering 93 companies. To check the residuals of the panel regression models, we estimate a standard OLS regression model for each company and test, for each company, whether the residuals are autocorrelated. We then re-estimate the panel regression models without the companies with autocorrelated residuals. At the 1 percent level (5 percent level), the number of companies with autocorrelated residuals vary from 4-12 companies (15-22 companies). Removing these companies does not seriously change our results.

	Dependent variables				
Independent variables	Rel weighted spread	Rel eff spread	Depth	GH comp.	GKN comp
Primary Insiders	0.1907 * *	0.1194	−0.0829	−0.0002	0.0002
Largest owner, state	0.7328***	0.4763***	−0.5073*	0.0007*	−0.0100
Largest owner, institutional	0.1556	0.2068	−0.0849	−0.0004	−0.0009
Largest owner, non-financial	0.9647***	1.1285***	−0.7727 * *	−0.0002	0.0098
Largest owner, individual	0.5580 * *	0.5288 * *	0.4743	0.0030***	0.0136
Largest owner, foreign	0.2551*	0.4170***	−0.1636	0.0001	0.0078
No of state owners	−0.0149	−0.0017	0.0007	0.0000	0.0014
No of institutional owners	−0.0202	−0.0863*	−0.2653***	−0.0002 * *	−0.0020
No of non-financial owners	−0.2059***	−0.3072***	0.1014	0.0002 * *	−0.0028
No of individual owners	−0.1216***	−0.0493	−0.1833 * *	−0.0001	0.0035
No of foreign owners	−0.0152	0.0313	0.1369 * *	−0.0001	−0.0013
Market cap	−0.1574***	−0.1440***	0.0199***	−0.0001 * *	0.0013
Price	−0.0015***	−0.0014***	−0.0048***	0.0000	0.0000 * *
Return volatility	2.7464***	2.4089***	−1.6021***	0.0024***	−0.0110
Trades per day	−0.0012***	−0.0009***	0.0017	0.0000*	0.0000
R square	0.8615	0.8722	0.7770	0.2982	0.1047
F-test no fixed effects	18.86 * **	22.41 * **	15.37 * **	3.57 * **	1.91 * **

As expected, the coefficients of the largest owners are all positive for the spread measures.

The most "costly" largest owner seems to be a private, non financial company. When we re-estimate the model and evaluate the other owner types relative to this group, they are all significantly negative. When the largest owner is an institutional investor, the effect on liquidity is not significant. Table 4 in section 4 showed that the average largest holding is much lower for this group. Hence, the reason for the lack of significance is most likely that these firms are more widely held. Large individual owners have a significant impact on the GH-measure of adverse selection.

A potential problem with the number of owners variables is that they are all highly correlated with firm size as well as with each other. To check the robustness of our results, we re-estimate the model without the firm size variable. Removing firm size does not seriously change our results. Potential problems with the high mutual correlations among the variables still remain though. The reason for keeping them all in the model is to include the total composition of the ownership structure. As expected, the number of owners has a negative effect on the spread. The numbers of institutional and individual owners have a negative effect on the market depth, while the depth is positively related to the number of foreign investors. These results are not very easy to interpret. The number of institutional investors in a company seems to reduce information costs, while the number of non-financial company owners has the opposite effect. This result may be explained by the tendency for institutional investors to invest less in smaller firms.

The percentage aggregate holdings of the owner types are also problematic due to their mutual correlation structure. We therefore study the effects on liquidity of the total holdings of different owner groups separately. Table 10 presents the results from estimating five regression models where we include the aggregate holding of each owner group at a time. The other independent variables in the models are the free float variable, insider holdings, and the four control variables.

Institutional ownership does not significantly affect any of the liquidity measures. Hence, neither of the two opposite hypothesized effects on liquidity from this type of ownership seem to dominate the other. State ownership is negatively related to market depth, and positively related to information costs. These results are a bit surprising given that the state generally invests in the largest companies. Non-financial company ownership has a positive effect on the spread, and a negative effect on information costs, while individual ownership has a (weakly significant) negative effect on the relative quoted spread and a significant positive effect on information costs. It is hard to come up with very good explanations for these patterns. Finally,

Table 10: Market liquidity and aggregate holdings of owner groups

The table reports results from estimating five panel regression model with one-way fixed effects (least squares dummy variable estimation) for five measures of liquidity as the dependent variable: log(relative weighted spread), log(relative effective spread), log(weighted depth), adverse selection costs according to the GH-method (variable proportional costs), and the adverse selection component of the spread according to the GKN-method. The independent variables are the total holding which is *not* owned by the five largest owners ("free float"), the aggregate holdings of the primary insiders, the aggregate holding of a particular owner group, the logarithm of the market capitalization value, the average closing price, the standard deviation of daily returns, the average daily number of trades, and and dummies for the fixed effect of each company. For each model, we report the estimated coefficients (except the coefficients for the fixed effect dummies). *** denotes significance at the 1 percent level, ** denotes significance at the 5 percent level, and * denotes significance at the 10 percent level. The sample includes 28 time series observations covering 93 companies. To check the residuals of the panel regression models, we estimate a standard OLS regression model for each company and test, for each company, whether the residuals are autocorrelated. We then re-estimate the panel regression models without the companies with autocorrelated residuals. At the 1 percent level (5 percent level), the number of companies with autocorrelated residuals vary from 1-9 companies (4-19 companies). Removing these companies makes the foreign ownership variable no longer significant in the relative weighted spread model and more significant in the relative effective spread model. For the GKN information component model with individual ownership, the free float variable becomes highly significant when we remove the companies with autocorrelated residuals. For the other models, removing these companies does not seriously change our results.

	Dependent variables				
Independent variables	Rel weighted spread	Rel eff spread	Depth	GH comp.	GKN comp
Free float	−1.1177***	−1.3902***	−0.3254*	−0.0008***	−0.0092
Primary Insiders	0.2677***	0.2034 * *	−0.1502	−0.0001	0.0013
State ownership	0.2333	−0.2137	−1.3654***	0.0008 * *	−0.0020
Market cap	−0.2396***	−0.2138***	−0.0465	−0.0003***	0.0011
Price	−0.0008***	−0.0009***	−0.0046***	0.0000	0.0000***
Return volatility	2.9033***	2.5957***	−1.3415***	0.0024***	−0.0131
Trades per day	−0.0018***	−0.0015***	0.0015***	0.0000	0.0000
Free float	−1.1494***	−1.2800***	−0.1039	−0.0009***	−0.0054
Primary Insiders	0.2701***	0.2098 * *	−0.1600	−0.0001	0.0016
Institutional ownership	0.0344	−0.2190	−0.2850	0.0000	−0.0085
Market cap	−0.2327***	−0.2233***	−0.0881***	−0.0002***	0.0009
Price	−0.0008***	−0.0008***	−0.0044***	0.0000	0.0000***
Return volatility	2.9269***	2.5477***	−1.4912***	0.0024***	−0.0145
Trades per day	−0.0018***	−0.0015***	0.0016***	0.0000*	0.0000
Free float	−1.2268***	−1.4841***	−0.1982	−0.0008***	−0.0091
Primary Insiders	0.2168***	0.1350	−0.1557	0.0000	0.0012
Non-financial ownership	0.5068***	0.5997***	−0.1591	−0.0005 * *	−0.0001
Market cap	−0.2321***	−0.2181***	−0.0835***	−0.0002***	0.0010
Price	−0.0008***	−0.0008***	−0.0044***	0.0000	0.0000***
Return volatility	2.9818***	2.6480***	−1.4702***	0.0024***	−0.0133
Trades per day	−0.0018***	−0.0014***	0.0016***	0.0000*	0.0000
Free float	−1.1329***	−1.3736***	−0.2307	−0.0009***	−0.0092
Primary Insiders	0.2757***	0.2029 * *	−0.1823	−0.0001	0.0010
Individual ownership	−0.2953*	−0.2169	0.6719 * *	0.0011***	0.0199*
Market cap	−0.2460***	−0.2288***	−0.0543	−0.0002***	0.0019
Price	−0.0008***	−0.0008***	−0.0044***	0.0000	0.0000*
Return volatility	2.9174***	2.5753***	−1.4407***	0.0024***	−0.0129
Trades per day	−0.0018***	−0.0015***	0.0016***	0.0000*	0.0000
Free float	−1.3202***	−1.4727***	0.0214	−0.0010***	−0.0101
Primary Insiders	0.2202***	0.1727 * *	−0.1041	−0.0001	0.0010
Foreign ownership	−0.2909***	−0.1534*	0.3893***	−0.0002	−0.0015
Market cap	−0.2234***	−0.2143***	−0.0965***	−0.0002***	0.0011
Price	−0.0008***	−0.0008***	−0.0044***	0.0000	0.0000***
Return volatility	2.9660***	2.6019***	−1.5101***	0.0025***	−0.0130
Trades per day	−0.0018***	−0.0015***	0.0015***	0.0000	0.0000

the aggregate holding of foreign ownership is negatively related to spreads and positively related to depth in line with the theoretical prediction. Table 24 in the data appendix shows that the relationships between owner type holdings and liquidity are not very robust over sub-periods.

Table 11 presents results from a model where we have included the absolute value of the change in the number of owners as explanatory variables in addition to owner concentration, proxied by the five largest owners, and primary insider holdings. The absolute change in the number of owners should capture turnover in ownership structure. As expected, this variable has a negative impact on the spread and a positive impact on the depth. The coefficients are highly significant for state ownership and institutional ownership. A possible explanation for the significant effect from state ownership is that it reflects the activity of the public pension funds.

To sum up, a large non-financial company owner has a more negative effect on liquidity then a large owner of any other type. Neither a dominating institutional owner nor a highly aggregated institutional ownership has any significant effect on liquidity. The number of owners has a positive effect on liquidity measured by the spread, while the effects on market depth are mixed and hard to interpret. Ownership turnover affects both spread and depth in the expected way.

Granger causality

A potential problem with our regression approach is that it does not account for the possibility that the causality may run the other way around, i.e. liquidity may affect ownership. In fact it is hypothesized that some investors, most notably foreign investors and institutional investors, tend to purchase stocks with low spread and high depth. Another potential problem is that we do not control for the possibility that ownership structure and liquidity are simultaneously determined by the same variables.

In this sub-section, we investigate whether ownership variables can forecast liquidity and vice versa by estimating some simple Granger tests of the form $x_{i,t} = f(y_{i,t-1}, x_{i,t-1}, ..)$ and $y_{i,t} = f(x_{i,t-1}, y_{i,t-1}, ..)$, where we use 12 lags to determine the autocorrelation structure of the dependent variables, and include all the significant lags.[30] Table 12, Table 13, and table 14 show the results from these tests for respectively liquidity versus insider holdings and owner concentration, liquidity versus the aggregate holdings of the owner groups, and liquidity versus

[30]Note that we do not address the general causality problem with these tests. A liquidity measure may affect an ownership variable even though it cannot be used to forecast it.

Table 11: Market liquidity and ownership turnover

The table reports results from estimating a panel regression model with one-way fixed effects (least squares dummy variable estimation) for five measures of liquidity as the dependent variable: log(relative weighted spread), log(relative effective spread), log(weighted depth), adverse selection costs according to the GH-method (variable proportional costs), and the adverse selection component of the spread according to the GKN-method. The independent variables are the aggregate holdings of the five largest owners, the aggregate holdings of the primary insiders, the absolute value of the change in the number of owners for each owner type, the logarithm of the market capitalization value, the average closing price, the standard deviation of daily returns, the average daily number of trades, and dummies for the fixed effect of each company. For each model, we report the estimated coefficients (except the coefficients for the fixed effect dummies), R-squared, and the F-test for no fixed effects. *** denotes significance at the 1 percent level, ** denotes significance at the 5 percent level, and * denotes significance at the 10 percent level. The sample includes 28 time series observations covering 93 companies. To check the residuals of the panel regression models, we estimate a standard OLS regression model for each company and test, for each company, whether the residuals are autocorrelated. We then re-estimate the panel regression models without the companies with autocorrelated residuals. At the 1 percent level (5 percent level), the number of companies with autocorrelated residuals vary from 0-8 companies (2-9 companies). For the effective spread model, removing these companies makes all variables significant. For the GKN information component model, removing these companies makes the five largest variable significant. For the other models, removing these companies does not seriously change our results.

	Dependent variables				
Independent variables	Rel weighted spread	Rel eff spread	Depth	GH comp.	GNK comp
Five largest	1.2452***	1.4885***	−0.1258	0.0010***	0.0098
Primary insiders	0.2819***	0.2139**	−0.2008	−0.0001	0.0014
|Δ| no of owners, state	−0.0122***	−0.0172***	0.0232***	0.0000	−0.0002
|Δ| no of owners, institutional	−0.0034***	−0.0027**	0.0098***	0.0000*	0.0000
|Δ| no of owners, non-financial	−0.0002	−0.0005	0.0008**	0.0000	0.0000
|Δ| no of owners, individual	0.0000*	0.0000	0.0000	0.0000	0.0000**
|Δ| no of owners, foreign	−0.0002**	−0.0003	0.0001	0.0000	0.0000
Market cap	−0.2354***	−0.2215***	−0.0722**	−0.0002***	0.0010
Price	−0.0007***	−0.0007***	−0.0047***	0.0000	0.0000***
Return volatility	2.873**	2.5162***	−1.2980***	0.0024***	−0.0134
Trades per day	−0.0017***	−0.0014***	0.0012***	0.0000	0.0000
R square	0.8523	0.8610	0.7845	0.2810	0.1044
F-test no fixed effects	22.35**	24.63**	17.92**	3.20**	2.13**

the number of owners in each group.

There is no significant Granger causality relation between liquidity and insider holdings or between the spread measures and owner concentration measured by the aggregate holdings of the five largest owners. For the owner concentration, this result might seem surprising given the strong relationship found between the variables in the estimation without lags.[31] No significant Granger causality suggests that the variables are determined simultaneously, possibly by the same variables. The aggregate holding of the five largest owners is found to forecast market depth, and vice versa.

Turning to the *type* of the largest owner, the Granger causality is found to go both ways between spreads and owner concentration if the owner is a non-financial company. If the largest owner is the state, the Granger causality is found to go one way only from ownership to liquidity. If the largest owner is foreign, there is a one-way Granger causality from spread to ownership, while the Granger causality against depth goes both ways.

The estimated Granger causality relations between the aggregate holding of different owner types and liquidity show that; (i) the aggregate holding of non-financial companies forecasts the relative spread, (ii) the aggregate holding of foreign investors forecasts both spread measures, (iii) the spread measures forecast the aggregate holding of individual ownership, and (iv) the market depth forecasts the aggregate holding of the state, the institutional investors, and the foreign owners. Finally, when we focus on the number of owners, there are in general one-way Granger causality relations from ownership to spread, and two-ways Granger causality relations between ownership and depth.

[31] Both variables are highly autocorrelated, and when we estimate a causality without removing the autocorrelation there is a strong two ways relationship.

Table 12: Granger causality: liquidity, insider holdings, and owner concentration

The table reports results from estimating a panel regression model of the form $x_t = f(y_{t-1}, x_{t-1}, ..)$ and $y_t = f(x_{t-1}, y_{t-1}, ..)$ with one-way fixed effects (least squares dummy variable estimation). 12 lags are used to determine the autocorrelation structure of the dependent variables, and the significant lags are included in the model. The model is estimated for three liquidity measures: log(relative weighted spread), log(relative effective spread), and log(weighted depth), and seven ownership variables: aggregate holdings of primary insiders, aggregate holdings of the five largest owners, and the holding of the largest owner, split on the five owner types. The independent variables also include dummies for the fixed effects of each company. For each model, we report the estimated coefficients (except the coefficients for the fixed effect dummies). *** denotes significance at the 1 percent level, ** denotes significance at the 5 percent level, and * denotes significance at the 10 percent level. The sample includes 17 time series observations covering 87 companies .

	Insider holdings and owner concentration (t-1)						
Liquidity (t)	Prim insid	Five larg	Larg, state	Larg, institut	Larg, non-fin	Larg, individ	Larg, foreign
Rel spread	0.1907	0.1574	1.0993*	−0.3662	0.8383***	0.8961	−0.2298
Rel eff spread	0.0352	0.3517	1.1526 **	−0.5176	0.7226***	1.1846	−0.2223
Depth	−0.1116	−1.3275***	0.5327	−0.5947	−0.3815	−0.3899	−0.6028 **

	Liquidity (t-1)		
Ownership structure (t)	Rel weighted spread	Rel eff spread	Weighted depth
Prim insiders	0.0040	0.0038	−0.0024
Five largest	−0.0016	−0.0004	0.0114***
Largest, state	−0.0016	−0.0022	−0.0042
Largest, institut	0.0024 **	0.0013	−0.0007
Largest, non-financial	0.0040*	0.0051 **	0.0032 **
Largest, individ	0.0060*	0.0076 **	0.0008
Largest, foreign	−0.0116 **	−0.0120*	0.01286***

Table 13: Granger causality: liquidity and aggregate holdings of owner types

The table reports results from estimating a panel regression model of the form $x_t = f(y_{t-1}, x_{t-1}, ..)$ and $y_t = f(x_{t-1}, y_{t-1}, ..)$ with one-way fixed effects (least squares dummy variable estimation). 12 lags are used to determine the autocorrelation structure of the dependent variables, and the significant lags are included in the model. The model is estimated for three liquidity measures: log(relative weighted spread), log(relative effective spread), and log(weighted depth), and five ownership variables: the aggregate holdings of each owner group. The independent variables also include dummies for the fixed effects of each company. For each model, we report the estimated coefficients (except the coefficients for the fixed effect dummies). *** denotes significance at the 1 percent level, ** denotes significance at the 5 percent level, and * denotes significance at the 10 percent level. The sample includes 17 time series observations covering 87 companies.

	Aggregate holding (t-1)				
Liquidity (t)	State	Institutional	Non-financial	Individual	Foreign
Rel spread	0.0598	0.0896	0.6974***	0.6427	−0.4226 **
Rel effective spread	−0.0071	−0.1877	0.7040	0.4290	−0.2689*
Depth	−0.2007	−0.1250	0.5100	−0.1022	−0.1443

	Liquidity (t-1)		
Aggregate holding (t)	Rel weighted spread	Rel eff spread	Weighted depth
State	−0.0012	−0.0020	−0.0044***
Institutional	0.0041	0.0032	−0.0089***
Non-financial	0.0035	0.0035	−0.0009
Individual	0.0090***	0.0117***	−0.0001
Foreign	−0.0082*	−0.0054	0.0172***

Table 14: Granger causality: liquidity and the number of owners

The table reports results from estimating a panel regression model of the form $x_t = f(y_{t-1}, x_{t-1}, ..)$ and $y_t = f(x_{t-1}, y_{t-1}, ..)$ with one-way fixed effects (least squares dummy variable estimation). 12 lags are used to determine the autocorrelation structure of the dependent variables, and the significant lags are included in the model. The model is estimated for three liquidity measures: log(relative weighted spread), log(relative effective spread), and log(weighted depth), and five ownership variables: the number of owners in each group of owners. The independent variables also include dummies for the fixed effects of each company. For each model, we report the estimated coefficients (except the coefficients for the fixed effect dummies). *** denotes significance at the 1 percent level, ** denotes significance at the 5 percent level, and * denotes significance at the 10 percent level. The sample includes 17 time series observations covering 87 companies.

	Number of owners (t-1)				
Liquidity (t)	State	Institutional	Non-financial	Individual	Foreign
Rel spread	−0.1051***	−0.2984***	−0.1064	−0.0479	−0.2395***
Rel effective spread	−0.1028***	−0.3923***	−0.1903***	−0.1049*	−0.2306***
Depth	0.2360***	0.1852 **	0.3706***	0.3478***	0.4045***

	Liquidity (t-1)		
No of owners (t)	Rel weighted spread	Rel eff spread	Weighted depth
State	−0.0413*	−0.0289	−0.0370 **
Institutional	0.0142	0.0032	−0.0595***
Non-financial	−0.0040	−0.0242	−0.0507***
Individual	0.0047	−0.0083	−0.0381***
Foreign	0.0070	0.0031	−0.0359***

6 Concluding remarks

In this paper, we analyze the relationship between ownership structure and liquidity in the Norwegian stock market using a panel regression approach. Our main findings are summarized below.

- Both owner concentration, measured by the aggregate holdings of the five largest owners, and insider holdings, measured by the aggregate holdings of primary insiders, are found to increase the spread. These results are in accordance with theoretical predictions. The result for owner concentration is stronger than the result for insider holdings. Moreover, while owner concentration has a negative impact on GH-estimates of adverse selection as well, this is not the case for insider holdings. Our results concerning the effects of insider ownership seem weaker than reported in some other empirical studies.

- The negative effect on spreads from the holding of the largest owner is found to be strongest when the largest owner is a non financial company, and not significant if the largest owner is an institutional investor.

- In contrast to some other studies, we do not find any special effects on liquidity from the ownership of institutional investors. We do find support for the hypothesis that foreign investors concentrate their holdings in liquid stocks.

- Ownership variables which are found to affect the spread do not in general jointly affect the depth in the predicted way.

- In general, the assumption of a one-way Granger causality from ownership to liquidity is dubious. There are no significant Granger causality relations between owner concentration measured by the five largest owners and the spread measures, suggesting that the these variables are determined simultaneously, possibly by the same variables. We do find a significant one-way Granger causality from the aggregate holdings of non financial companies to the relative spread. Some support is provided for the hypothesis that foreign investors buy stocks with low spreads and high depth, but the Granger causality goes both ways.

The data sample underlying this study is more comprehensive than the data samples used in comparable studies, and the results therefore make a robust contribution to the existing results. The study also represents a natural starting point for some further work.

First, the documented effects on liquidity from ownership structure are interesting inputs to the study of ownership structure and performance. Bøhren and Ødegaard [2003a] find that the negative effects from owner concentration outweight the benefits of monitoring, and that the holdings of insiders are value increasing. Linking these results with the results in this study, suggests that the effects on performance corroborate the liquidity effects; owner concentration is more costly in the form of reduced liquidity than insider holdings. A natural topic for further work on this topic is the link between liquidity, expected returns, and measures of performance.

Second, widely used methods for estimating adverse selection costs are based on some form of dealer intermediation, and the relevance of these methods for a fully automated limit order market is unclear. The significant difference in explanatory power for the two estimates of adverse selection chosen in this study suggests that the choice of method makes a difference. Moreover, Næs and Skjeltorp [2003] find evidence that the average trade size explains little of the price changes in this market.[32] Since asymmetric information is a central variable in all studies of liquidity, and given the increasing role of limit order trading arrangements, the validity of the empirical method used for decomposing the spread is an important issue. One possible starting point is to investigate the relationship between ownership and estimates of the probability of informed trading according to Easley et al. [1996]. Their method is not based on optimizing behavior of competitive dealers. Rather it estimates the probability of information events by observing the total buys and the sells during each trading day, and combines them with assumed arrival rates of buyer and sellers.[33]

[32]This result applies in a competitive dealer environment as well, according to Jones et al. [1994].

[33]The probabilities and arrival rates are unobservable but assumed to be determined by a mixture model where the probabilities reflect their probability of occurring in the data.

A Data Appendix

Table 15: The corporate governance structure in Norway, 1989-1997

The table reports statistics of aggregate holdings of different owner types as well as the holdings of the mean owner, the largest owner and the five largest owners of all companies listed at the OSE in the period 1989-1997. All numbers are taken from the data appendix in Bøhren and Ødegaard [2000]. All data except insider holdings are from the VPS. Insider holdings are estimated on the basis of statements given by the insiders to the OSE. The table shows the equally weighted average, the standard deviation, the value weighted average, the median observation, and the number of firms. The value weighted averages are weighted based on the value of the firm's equity. All number are in percent. Averages over years are based on values which are transformed into 1997 kroner.

Ownership structure 1989-1997	EW mean	Std	VW mean	Median	n
Owner types:					
State	5.00	14.00	18.00	0.00	1189
Institutional	17.00	15.00	18.00	15.00	1189
Non-financial	38.00	24.00	24.00	36.00	1189
Individual	18.00	16.00	10.00	12.00	1189
Foreign	22.00	22.00	31.00	15.00	1189
Insiders	14.00	25.00	7.00	1.00	1197
Owner concentration:					
Mean owner	0.15	0.32	0.06	0.08	1189
Largest owner	28.00	19.00	29.00	22.00	1189
Five largest owners	55.00	19.00	53.00	54.00	1189

Table 16: Monthly returns for liquidity based portfolios - Sub-periods

The table shows monthly returns and the number of securities for four five years periods and one two years period between 1980-2002. Portfolios are grouped at the beginning of each year, using the average relative bid-ask spread in the previous year as the criterion for grouping. The sample include all listed securities at the OSE which comply with the following three filtering criteria: (i) the stock price is above NOK 10, (ii) the total value outstanding of the company is at least NOK 1 million, and (iii) the security is traded at least 20 days during one year. The filtering criteria imply that, on average, a year contains 121 companies. All portfolios are equally weighted.

Panel A	Returns					No of securities		
1980-1984	mean	std	min	median	max	avg	min	max
1 (smallest)	1.64	5.41	-14.14	0.79	17.38	16.1	10	23
2	1.61	5.86	-16.01	1.47	13.2	15.8	10	23
3	3.41	6.16	-9.87	2.25	18.41	16.2	11	23
4	4.41	7.01	-13.08	3.28	21.87	15.8	10	23
5	5.24	9.67	-15.92	2.56	35.04	15.8	10	23

Panel B	Returns					No of securities		
1985-1989	mean	std	min	median	max	avg	min	max
1 (smallest)	1.37	7.09	-24.9	2.45	18.65	27.4	23	32
2	0.95	6.41	-20.04	2.3	18.8	26.8	22	31
3	1.15	5.94	-17.25	2.05	21.45	26.7	21	31
4	1.53	5.13	-11.61	1.76	19.19	26.5	23	31
5	3.08	4.96	-6.66	2.64	16.7	26.5	20	31

Panel C	Returns					No of securities		
1990-1994	mean	std	min	median	max	avg	min	max
1 (smallest)	0.44	7.75	-20.74	1.09	14.61	27.4	24	31
2	0.26	7.56	-19.41	1.24	14.65	26.5	22	31
3	0.65	7.73	-19.29	-0.24	16.78	26.1	22	30
4	1.87	7.37	-12.48	0.75	21.25	25.5	21	31
5	2.61	8.27	-9.51	1.52	30.85	25.7	19	30

Panel D	Returns					No of securities		
1995-1999	mean	std	min	median	max	avg	min	max
1 (smallest)	1.42	5.85	-23.47	1.42	14.35	36.9	30	45
2	1.96	5.56	-20.23	2.02	15.45	35.6	29	44
3	1.56	5.63	-21.24	1.74	14.12	35.2	26	45
4	1.49	5.68	-15.51	1.69	21.85	35.6	26	44
5	2.64	5.07	-10.92	1.57	22.66	35.1	28	44

Panel E	Returns					No of securities		
2000-2002	mean	std	min	median	max	avg	min	max
1 (smallest)	-1.78	8.3	-20.81	-0.71	14.26	35.6	31	42
2	-0.61	7.9	-22.45	-1.37	15.71	34	29	39
3	-0.74	5.57	-13.04	-0.11	10.54	33.8	29	41
4	-0.01	5.36	-11.29	-0.1	11.68	34.7	30	41
5	0.64	5.63	-11.96	0.28	13.78	34.8	30	41

Table 17: Liquidity over time and across size portfolios

	1999		2000		2001	
	mean	**median**	**mean**	**median**	**mean**	**median**
Largest companies						
Market cap (bill NOK)	15.96	16.04	18.80	18.60	19.98	20.01
Price	139.29	139.03	147.46	147.40	137.92	138.74
Quoted spread	1.49	1.18	1.33	1.07	1.12	0.88
Effective spread	0.98	0.85	0.97	0.81	0.81	0.71
Relative spread (time weighted)	1.11	1.04	1.12	1.06	0.81	0.78
Adverse selection component	0.016	0.015	0.007	0.007	0.005	0.005
Quoted depth (time weighted)	15201	12685	26341	14659	14644	12042
Avg daily trade size	2474	1592	2091	1191	2067	1266
Avg daily no of trades	85	76	123	108	136	113
Avg daily trade volume, in shares	289981	235788	262003	208508	320374	237936
- in 1000 NOK	27855.463	22979.697	30155.068	24503.628	34203.766	25881.279
N	25		24		24	
Medium large companies						
Market cap (bill NOK)	2.58	3.65	3.65	3.65	3.57	3.57
Price	114.12	114.22	125.29	125.94	91.85	92.71
Quoted spread	2.23	1.58	2.57	2.14	2.01	1.74
Effective spread	1.58	1.37	1.95	1.68	1.65	1.52
Relative spread (time weighted)	1.64	1.50	1.81	1.64	1.85	1.75
Adverse selection component	0.023	0.025	0.000	0.017	0.000	0.006
Quoted depth (time weighted)	6523	5741	5010	4401	6835	5776
Avg daily trade size	1550	1035	1166	766	1528	1005
Avg daily no of trades	36	30	57	49	77	66
Avg daily trade volume, in shares	105636	81639	92437	74280	129176	101573
- in 1000 NOK	4907.489	3740.188	7149.697	5700.717	9977.332	7732.947
N	23		22		22	
Medium small companies						
Market cap (bill NOK)	1.09	1.05	1.69	1.57	1.39	1.38
Price	74.38	74.16	106.63	106.79	102.19	102.18
Quoted spread	1.49	1.26	1.98	1.62	1.88	1.56
Effective spread	1.08	0.98	1.51	1.32	1.50	1.28
Relative spread (time weighted)	1.92	1.81	1.72	1.58	1.65	1.57
Adverse selection component	0.046	0.034	0.020	0.020	0.015	0.023
Quoted depth (time weighted)	7953	7049	5254	4443	6654	5989
Avg daily trade size	2295	1647	1342	894	1313	941
Avg daily no of trades	24	20	38	31	27	22
Avg daily trade volume, in shares	68446	52121	61299	44383	46141	35275
- in 1000 NOK	2684.397	2073.844	4277.765	3164.938	2572333.679	1993471.793
N	24		24		23	
Smallest companies						
Market cap	0.32	0.32	0.58	0.57	0.49	0.48
Price	51.22	51.28	60.47	60.68	46.16	46.05
Quoted spread	1.60	1.35	1.77	1.51	1.79	1.60
Effective spread	1.12	1.00	1.33	1.14	1.36	1.24
Relative spread (time weighted)	3.46	3.25	2.84	2.65	3.17	3.00
Adverse selection component	0.110	0.072	0.058	0.045	-0.286	-0.284
Quoted depth (time weighted)	6059	5453	5974	4877	8057	7075
Avg daily trade size	2094	1539	1746	1218	1921	1418
Avg daily no of trades	14	12	38	31	36	29
Avg daily trade volume, in shares	33581	26935	83689	62094	96967	75594
- in 1000 NOK	1023.883	812.440	2638339.398	1862235.877	1936.782	1418.752
N	23		23		24	

Table 18: Ownership structure over time and across size portfolios

	1999		2000		2001	
	mean	**median**	**mean**	**median**	**mean**	**median**
Largest companies						
Owner types:						
State owners	0.1380	0.1373	0.1475	0.1506	0.1214	0.1224
Institutional owners	0.2525	0.2545	0.2305	0.2329	0.2276	0.2325
Non-financial owners	0.2402	0.2383	0.2018	0.2014	0.2266	0.2272
Individual owners	0.0686	0.0686	0.0682	0.0691	0.0799	0.0805
Foreign owners	0.3012	0.2977	0.3526	0.3459	0.3449	0.3349
Insider holdings	0.0606	0.0.0672	0.0544	0.0630	0.0359	0.0.0341
Owner concentration:						
Largest owner	0.2069	0.2036	0.2499	0.2422	0.2152	0.2119
Five largest owners	0.4596	0.4564	0.4844	0.4816	0.4309	0.4230
N	25		24		24	
Medium large companies						
Owner types:						
State owners	0.0676	0.0662	0.0845	0.0849	0.1000	0.1002
Institutional owners	0.3030	0.3067	0.2841	0.2870	0.2311	0.2322
Non-financial owners	0.2835	0.2860	0.2915	0.2853	0.3080	0.3089
Individual owners	0.1147	0.1157	0.1144	0.1133	0.1117	0.1111
Foreign owners	0.2326	0.2221	0.2278	0.2313	0.2508	0.2469
Insider holdings	0.1014	0.0943	0.0505	0.0447	0.0691	0.0712
Owner concentration:						
Large owners	0.2160	0.2122	0.2346	0.2315	0.2579	0.2577
Five largest owners	0.4476	0.4418	0.4636	0.4597	0.5156	0.5143
N	23		22		22	
Medium small companies						
Owner types:						
State owners	0.0398	0.0324	0.0302	0.0314	0.0431	0.0434
Institutional owners	0.2921	0.2952	0.2763	0.2794	0.2647	0.2707
Non-financial owners	0.3021	0.3046	0.3069	0.3060	0.2907	0.2898
Individual owners	0.1902	0.1911	0.1999	0.1982	0.2222	0.2224
Foreign owners	0.1764	0.1692	0.1906	0.1834	0.1812	0.1759
Insider holdings	0.0486	0.0496	0.0642	0.0663	0.0696	0.0664
Owner concentration:						
Largest owner	0.1633	0.1576	0.1671	0.1624	0.1671	0.1624
Five largest owners	0.4070	0.4019	0.4056	0.3993	0.3957	0.3915
N	24		24		23	
Smallest companies						
Owner types:						
State owners	0.0046	0.0042	0.0044	0.0042	0.0042	0.0042
Institutional owners	0.1727	0.1757	0.1776	0.1768	0.1934	0.3446
Non-financial owners	0.2938	0.1757	0.3123	0.3097	0.3447	0.3446
Individual owners	0.3561	0.3456	0.3058	0.3071	0.2585	0.2579
Foreign owners	0.1742	0.1710	0.2026	0.2017	0.2010	0.2021
Insider holdings	0.1185	0.1038	0.1415	0.1367	0.1166	0.1153
Owner concentration:						
Largest owner	0.1752	0.1743	0.1910	0.1937	0.1937	0.1932
Five largest owners	0.4250	0.4186	0.4193	0.4215	0.4381	0.4377
N	23		23		24	

Table 19: Descriptive statistics over industry groups

The table provides some descriptive statistics for the data sample split into A and B shares. The A shares are further split into the FTSE global classification system: RESOR = Resources, BASIC = Basic Industries, GENIN = General Industrials, CYCGD = Cyclical Consumer Goods, NCYCG = Non-Cyclical Consumer Goods, CYSER = Cyclical Services, NCYSR = Non-Cyclical Services, UTILS = Utilities, TOTLF = Financials, and ITECH = Information Technology. All stocks were traded at least 400 out of 597 trading days during the period from February 5 1999 to June 30 2001.

Variable	All A-shares	RESOR	BASIC	GENIN	CYCGD	NCYCG	CYSER	NCYSR	UTILS	TOTLF	ITECH	B-shares
N	88	10	3	8	3	7	19	4	3	15	16	6
Firm size (bill NOK):												
-mean	5.97	12.44	8.44	4.73	1.11	13.84	4.96	5.25	2.45	5.76	2.10	5.71
-median	1.85	12.48	8.29	4.16	1.11	13.65	4.72	4.84	2.23	5.66	2.24	4.69
Price:												
-mean	103.15	101.49	192.44	94.39	46.20	75.63	95.02	171.02	69.71	151.22	61.14	79.20
-median	103.27	101.70	193.67	94.40	46.05	75.62	95.14	170.90	69.78	151.13	61.35	79.47
Trades per day:												
-mean	59	101	45	57	24	70	34	49	49	36	96	19
-median	51	88	40	47	19	61	29	41	43	32	80	16
Trade size:												
-mean	1817	1792	1117	1463	2146	2311	1754	1014	1525	1991	2104	1962
-median	1207	1194	777	1064	1508	1456	1227	706	1113	1202	1365	1362
Return volatility:												
-mean	0.0327	0.0293	0.0296	0.0379	0.0340	0.0350	0.319	0.0414	0.0427	0.0196	0.0412	0.0285
-median	0.0274	0.0279	0.0192	0.0345	0.0291	0.0301	0.0284	0.0354	0.0419	0.0176	0.0352	0.0271
Rel spread (weighted):												
-mean	0.0189	0.0114	0.0107	0.0236	0.0238	0.0190	0.0232	0.0220	0.0337	0.0133	0.0190	0.0210
-median	0.0177	0.0107	0.0101	0.0220	0.0223	0.0181	0.0215	0.0204	0.0313	0.0122	0.0180	0.0192
Effective spread (NOK):												
-mean	1.3090	0.6483	1.4538	1.2459	0.9042	0.9114	1.6092	1.6985	1.2446	1.9847	0.8673	1.1749
-median	1.1431	0.5642	1.1953	1.0347	0.8162	0.8149	1.4160	1.3965	1.1112	1.7772	0.7543	1.0013
Depth:												
-mean	11073	9261	7896	5807	7687	14471	12304	3798	6022	16698	11022	18650
-median	9734	7628	4347	5169	6913	11128	12878	3171	5376	15009	8463	5804
Five largest owners:												
-mean	0.4417	0.4688	0.4235	0.4590	0.3496	0.4273	0.5367	0.5220	0.6178	0.3461	0.3673	0.4190
-median	0.4212	0.4716	0.4172	0.4619	0.3503	0.4164	0.5353	0.5189	0.6408	0.3442	0.3684	0.4354
Prim insiders:												
-mean	0.0771	0.0640	0.0001	0.0872	0.0450	0.0587	0.1664	0.1633	0.0047	0.0033	0.0678	0.0898
-median	0.0.0034	0.0684	0.0001	0.1006	0.0460	0.0288	0.1437	0.1926	0.0065	0.0038	0.0660	0.0387
State owners												
-mean	0.0655	0.0684	0.0763	0.0980	0.0027	0.0734	0.0242	0.0876	0.1833	0.0995	0.0431	0.0689
-median	0.0262	0.0699	0.0742	0.1026	0.0014	0.0719	0.0238	0.0879	0.1992	0.0970	0.0499	0.0330
Institutional owners												
-mean	0.2318	0.2199	0.3624	0.2788	0.2937	0.2500	0.2330	0.2330	0.1695	0.1894	0.2159	0.4364
-median	0.2122	0.2232	0.3642	0.2703	0.2995	0.2501	0.2360	0.2307	0.1683	0.1875	0.2132	0.3833
Non-financial owners												
-mean	0.2846	0.3264	0.2920	0.1981	0.3403	0.2509	0.3833	0.2138	0.2792	0.2448	0.2412	0.1996
-median	0.2692	0.3265	0.2989	0.1938	0.3421	0.2526	0.3782	0.2177	0.2697	0.2507	0.2343	0.1828
Individual owners												
-mean	0.1798	0.1079	0.0862	0.2169	0.1602	0.2486	0.0896	0.0740	0.1802	0.2965	0.2314	0.0783
-median	0.1229	0.1067	0.0848	0.2239	0.1546	0.2447	0.0876	0.0671	0.1856	0.2962	0.2177	0.0675
Foreign Owners												
-mean	0.2401	0.2811	0.1833	0.2087	0.2035	0.1779	0.2709	0.3980	0.1892	0.1706	0.2729	0.2177
-median	0.1946	0.2753	0.1827	0.2105	0.1948	0.1762	0.2767	0.3714	0.1897	0.1651	0.2718	0.2007

Table 20: Monthly returns for portfolios sorted on effective relative spread - Sub-periods

The table shows characteristics of the return distribution of monthly returns for four equally weighted liquidity portfolios. The companies included in the data sample are all firms with price greater than NOK 10 which are traded on at least 400 days out of the 597 trading days from February 5 1999 to June 30 2001. The portfolios are grouped at the beginning of each half year, using the average relative effective spread in the previous half year as the criterion for grouping. The panels show the return characteristics for portfolios which are held one half year.

Sub-period	Effective spread					Return				
1999.2	mean	std	min	median	max	mean	std	min	median	max
Portfolio 1	0.59	0.18	0.21	0.58	0.82	3.95	3.65	-1.27	2.97	15.26
Portfolio 2	1.07	0.12	0.86	1.07	1.28	4.19	4.71	-3.50	3.04	16.52
Portfolio 3	1.84	0.36	1.28	1.89	2.28	5.72	4.81	-5.35	5.01	14.54
Portfolio 4	3.76	1.63	2.30	3.41	9.66	6.68	9.72	-4.91	3.62	32.13

Sub-period	Effective spread					Return				
2000.1	mean	std	min	median	max	mean	std	min	median	max
Portfolio 1	0.53	0.16	0.14	0.55	0.76	0.44	6.64	-11.76	1.64	12.85
Portfolio 2	1.02	0.18	0.77	0.98	1.35	0.41	5.02	-10.88	0.45	8.24
Portfolio 3	1.78	0.22	1.37	1.77	2.15	1.86	8.08	-11.09	-0.70	17.07
Portfolio 4	3.21	0.98	2.16	2.88	5.45	4.79	9.28	-7.52	2.40	38.62

Sub-period	Effective spread					Return				
2000.2	mean	std	min	median	max	mean	std	min	median	max
Portfolio 1	0.58	0.17	0.19	0.59	0.80	-1.86	6.01	-19.77	-1.63	7.60
Portfolio 2	1.13	0.16	0.84	1.13	1.39	-0.66	5.47	-16.38	0.10	7.95
Portfolio 3	1.68	0.21	1.41	1.62	2.03	-0.30	5.35	-12.35	-0.71	9.23
Portfolio 4	2.80	0.55	2.06	2.75	4.17	-1.20	7.41	-17.34	0.49	13.76

Sub-period	Effective spread					Return				
2000.2	mean	std	min	median	max	mean	std	min	median	max
Portfolio 1	0.52	0.15	0.19	0.49	0.72	-1.18	6.16	-19.92	-0.58	8.86
Portfolio 2	1.05	0.21	0.74	1.08	1.39	-1.02	6.87	-25.98	0.11	7.20
Portfolio 3	1.69	0.21	1.40	1.62	2.04	2.00	4.88	-7.43	1.62	14.65
Portfolio 4	3.46	1.35	2.14	3.08	6.73	-1.79	6.40	-14.40	-0.06	6.93

Sub-period	Effective spread					Return				
2001.2	mean	std	min	median	max	mean	std	min	median	max
Portfolio 1	0.51	0.17	0.17	0.52	0.75	-1.53	5.77	-17.05	-0.54	9.70
Portfolio 2	1.02	0.20	0.77	0.98	1.39	-3.08	5.99	-18.64	-1.59	3.67
Portfolio 3	1.71	0.25	1.39	1.73	2.22	0.79	3.00	-4.67	0.62	7.49
Portfolio 4	3.91	1.33	2.26	3.43	6.45	-1.18	4.34	-10.42	-0.14	7.36

Table 21: A reference model for market liquidity - Sub-periods

The table reports results from estimating the relation between liquidity and four control variables using a panel regression model with one-way fixed effects (least squares dummy variable estimation). The model is estimated for the whole sample period as well as for each of the years 1999-2001. The control variables are the logarithm of the market capitalization value, the average closing price, the standard deviation of daily returns, and the average daily number of trades. In addition, the model includes dummies for the fixed effect of each company. The model is estimated for five liquidity measures: log(relative weighted spread), log(relative effective spread), log(weighted depth), adverse selection costs according to the GH-method (variable proportional costs), and the adverse selection component of the spread according to the GKN-method. For each model, we report the estimated coefficients (except the coefficients for the fixed effect dummies), R-squared, and the F-test for no fixed effects. *** denotes significance at the 1 percent level, ** denotes significance at the 5 percent level, and * denotes significance at the 10 percent level.

	Dependent variables				
Independent variables	Rel weighted spread	Rel eff spread	Weighted depth	GH info comp	GKN info comp
1999					
Market cap	−0.1542***	−0.1576***	−0.2048***	−0.0003***	−0.0045
Price	−0.0017***	−0.0014 * *	−0.0038***	0.0000	0.0000
Return volatility	0.7754***	0.6348 * *	−0.6770	0.0026***	−0.0230
Trades per day	−0.0019***	−0.0018***	0.0024***	0.0000	0.0000
R square	0.9069	0.9046	0.8718	0.4012	0.1525
F-test no fixed effects	20.09 * **	17.97 * **	10.62 * **	3.03 * **	1.44 * **
2000					
Market cap	−0.0955 * *	−0.1057 * *	0.0817	−0.0001	−0.0010
Price	−0.0017***	−0.0015***	−0.0029***	0.0000	0.0000
Return volatility	3.8889***	3.8297***	−3.0266***	0.0031***	−0.0171
Trades per day	−0.0016***	−0.0016***	0.0021***	0.0000 * *	0.0000
R square	0.8779	0.8769	0.7923	0.3920	0.1729
F-test no fixed effects	16.94 * **	16.70 * **	9.59 * **	3.79 * **	1.86 * **
2001					
Market cap	0.0480	−0.0737	−0.0492	−0.0001	0.0080
Price	−0.0021 * *	−0.0030***	−0.0049***	0.0000	−0.0001
Return volatility	6.0876***	6.0211***	−0.2987	0.0009	0.0438
Trades per day	−0.0014***	−0.0010***	0.0011***	0.0000	0.0000
R square	0.8686	0.9262	0.8366	0.3992	0.2414
F-test no fixed effects	6.74 * **	13.28 * **	8.73 * **	2.18 * **	1.32*

Table 22: Market liquidity, owner concentration and holdings of primary insiders - Sub-periods

The table reports results from estimating the relation between liquidity and ownership structure using a panel regression model with one-way fixed effects (least squares dummy variable estimation) for each of the years 1999-2001. The ownership structure variables are the aggregate holdings of the five largest owners, and the aggregate holdings or the primary insiders. The control variables are the logarithm of the market capitalization value, the average closing price, the standard deviation of daily returns, and the average daily number of trades. In addition, the model includes dummies for the fixed effect of each company. The model is estimated for five dependent variables: log(relative weighted spread), log(relative effective spread), log(weighted depth), adverse selection costs according to the GH-method (variable proportional costs), and the adverse selection component of the spread according to the GKN-method. For each model, we report the estimated coefficients (expect the coefficients for the fixed effect dummies), R-squared, and the F-test for no fixed effects. *** denotes significance at the 1 percent level, ** denotes significance at the 5 percent level, and * denotes significance at the 10 percent level.

	Dependent variables				
Independent variables	Rel weighted spread	Rel eff spread	Depth	GH comp.	GKN comp
1999					
Five largest	0.8965***	0.8398***	0.8881 * *	0.0024***	−0.0333*
Primary Insiders	−0.1122	−0.0307	0.2453	0.0001	−0.0113
Market cap	−0.1889***	−0.1900***	−0.2390***	−0.0004***	−0.0032
Price	−0.0015***	−0.0013 * *	−0.0036***	0.0000	0.0000
Return volatility	0.5665*	0.4554	−0.8058*	0.0021***	−0.0186
Trades per day	−0.0019***	−0.0018***	0.0024***	0.0000	0.0000
R square	0.9092	0.9062	0.8730	0.4147	0.1571
F-test no fixed effects	16.04 * **	14.15 * **	9.48 * **	2.78 * **	1.46 * **
2000					
Five largest	1.0595***	1.3430***	0.7898 * *	−0.0002	0.0303 * *
Primary Insiders	−0.0502	−0.0472	0.1062	0.0001	−0.0076
Market cap	−0.1020 * *	−0.1134***	0.0819	−0.0001	−0.0014
Price	−0.0019***	−0.0017***	−0.0031***	0.0000	0.0000
Return volatility	3.7596***	3.6668***	−3.1159***	0.0032***	−0.0211
Trades per day	−0.0015***	−0.0013***	0.0022***	0.0000 * *	0.0000
R square	0.8816	0.8826	0.7935	0.3922	0.1796
F-test no fixed effects	15.45 * **	15.49 * **	9.61 * **	3.51 * **	1.87 * **
2001					
Five largest	−0.0671	0.0970	0.8005*	0.0001	−0.0031
Primary Insiders	0.4215	0.7562	1.1534	−0.0018*	0.0170
Market cap	0.0558	−0.0696	−0.0740	−0.0001	0.0076
Price	−0.0023 * *	−0.0033***	−0.0048***	0.0000	0.0000
Return volatility	5.9352***	5.7689***	−0.5071	0.0008	0.0577
Trades per day	−0.0014***	−0.0009***	0.0011***	0.0000	0.0000
R square	0.8683	0.9274	0.8402	0.4060	0.3038
F-test no fixed effects	5.93 * **	12.00 * **	8.87 * **	2.16 * **	1.75 * **

Table 23: Market liquidity and owner types - Sub-periods

The table reports results from estimating the relationship between liquidity and ownership structure using a panel regression model with one-way fixed effects (least squares dummy variable estimation) for each of the years 1999-2001. For each model, we report the estimated coefficients (except the coefficients for the fixed effect dummies). *** denotes significance at the 1 percent level, ** denotes significance at the 5 percent level, and * denotes significance at the 10 percent level.

	Dependent variables				
Independent variables	Rel weighted spread	Rel eff spread	Depth	GH comp.	GKN comp
1999					
Primary Insiders	−0.0201	0.0510	0.3210*	0.0002	−0.0152
Largest owner, state	0.6675***	0.4677*	0.7848**	0.0024***	−0.0189
Largest owner, institutional	−0.4955	−0.6184	2.4091**	0.0010	−0.0263
Largest owner, non-financial	0.9856**	1.3274***	1.4814***	0.0003	−0.0556
Largest owner, individual	0.6602	0.4367	2.2566**	0.0108***	−0.0461
Largest owner, foreign	−0.2160	−0.2438	1.4087	0.0018**	−0.0569*
No of state owners	−0.0211	−0.0473	−0.0599	−0.0001	0.0053*
No of institutional owners	−0.0159	−0.0854	0.1224	−0.0005**	0.0110
No of non-financial owners	−0.2136**	−0.1440	−0.0257	0.0007**	−0.0103
No of individual owners	−0.2241***	−0.2030**	−0.1999	−0.0004	0.0017
No of foreign owners	0.1887***	0.1523***	0.1857*	−0.0001	0.0059
Market cap	−0.2789***	−0.2452***	−0.2279**	−0.0002	−0.0084*
Price	−0.0005	−0.0003	−0.0037***	0.0000	0.0000
Return volatility	0.9138***	0.9488***	−1.2179**	0.0017**	−0.0120
Trades per day	−0.0012***	−0.0011***	0.0023***	0.0000	0.0000
2000					
Primary Insiders	−0.0242	−0.0197	0.2818	0.0001	−0.0079
Largest owner, state	0.6072	0.5034	−1.5096	−0.0014	−0.0002
Largest owner, institutional	0.7491	1.1186*	−1.3900	−0.0021	0.0230
Largest owner, non-financial	0.4325	0.4198	−1.2099*	−0.0010	0.0404*
Largest owner, individual	0.5108*	0.7018**	−0.1829	0.0004	−0.0030
Largest owner, foreign	0.3011	0.3780	−1.5851***	−0.0010*	0.0273
No of state owners	0.0311	0.0191	0.0005	0.0002**	0.0010
No of institutional owners	0.1077	0.0154	−0.6074***	−0.0002	−0.0063
No of non-financial owners	−0.2895***	−0.2742**	−0.1293	−0.0002	0.0037
No of individual owners	−0.0828	−0.0624	0.3261*	0.0001	0.0045
No of foreign owners	0.0332	0.0449	−0.3438**	0.0000	−0.0095*
Market cap	−0.0684	−0.0607	0.3536***	−0.0001	0.0005
Price	−0.0025***	−0.0023***	−0.0034***	0.0000	0.0000
Return volatility	3.4113***	3.3924***	−2.9669***	0.0030***	−0.0192
Trades per day	−0.0013***	−0.0012***	0.0026***	0.0000	0.0000
2001					
Primary Insiders	0.3777	0.7916	1.6015*	−0.0020**	0.0136
Largest owner, state	−1.7543	0.1745	−2.4102	0.0006	0.0262
Largest owner, institutional	−3.3955*	−0.6112	−2.5363	0.0002	−0.0004
Largest owner, non-financial	−0.2513	0.8092	−4.0408***	0.0005	−0.0299
Largest owner, individual	−3.4791	−1.1408	−7.2773	0.0022	−0.4419
Largest owner, foreign	−0.5254	0.0553	−1.8028**	0.0004	−0.0268
No of state owners	−0.0822	−0.0170	0.1937	−0.0001	−0.0046
No of institutional owners	−0.3078	−0.1248	−0.5423**	−0.0001	−0.0078
No of non-financial owners	0.6505*	0.4226	−0.7553*	0.0006	−0.0175
No of individual owners	0.1292	−0.1742	−0.5582	−0.0003	0.0182
No of foreign owners	−0.6687*	−0.2975	−0.1410	0.0005	0.0137
Market cap	0.0863	−0.0956	−0.1008	0.0000	0.0127
Price	−0.0024**	−0.0032***	−0.0060***	0.0000	0.0000
Return volatility	6.0250***	5.7900***	−1.5162	0.0008	0.0637
Trades per day	−0.0014***	−0.0009***	0.0013***	0.0000	0.0000

Table 24: Market liquidity and aggregate holdings of owner groups - Sub-periods

The table reports results from estimating five panel regression model with one-way fixed effects (least squares dummy variable estimation) for each of the years 1999-2001 for five measures of liquidity as the dependent variable: log(relative weighted spread), log(relative effective spread), log(weighted depth), adverse selection costs according to the GH-method (variable proportional costs), and the adverse selection component of the spread according to the GKN-method. The independent variables are the total holding which is *not* owned by the five largest owners ("free float"), the aggregate holdings of the primary insiders, the aggregate holding of a particular owner group, the logarithm of the market capitalization value, the average closing price, the standard deviation of daily returns, the average daily number of trades, and fixed effect dummies for each company. For each model, we report the estimated coefficient for the aggregate holding of the particular owner type. *** denotes significance at the 1 percent level, ** denotes significance at the 5 percent level, and * denotes significance at the 10 percent level.

	Dependent variables				
Owner groups	Rel weighted spread	Rel eff spread	Depth	GH comp.	GKN comp
1999					
State	0.1903	−0.0502	−0.2342	0.0004	0.0421∗
Institutional	−0.7120∗∗∗	−0.6308 ∗ ∗	0.5162	−0.0015∗∗∗	0.0223
Non-financial	0.3239	0.5011∗	−0.1450	−0.0011∗	−0.0258
Individual	−0.2301	−0.1311	−0.0474	0.0045∗∗∗	0.0130
Foreign	0.2151	0.1450	−0.1007	−0.0003	−0.0229
2000					
State	−0.0501	−0.2157	−2.7078∗∗∗	−0.0001	−0.0444∗
Institutional	0.5522 ∗ ∗	0.4332	−0.7774	0.0005	0.0116
Non-financial	0.2207	0.1716	1.0798 ∗ ∗	0.0000	0.0011
Individual	−0.6152 ∗ ∗	−0.4667	0.8586∗	0.0008	−0.0249
Foreign	−0.0558	−0.0531	−0.0448	−0.0004	0.0050
2001					
State	1.0532	−0.8752	−4.9653 ∗ ∗	−0.0002	−0.0281
Institutional	−0.5195	−0.1122	−0.2537	0.0007	−0.0585
Non-financial	1.6895∗∗∗	1.8967∗∗∗	−2.5697∗∗∗	0.0008	0.0142
Individual	1.1795	−1.4937	1.5165	−0.0006	0.0539
Foreign	−1.3400∗∗∗	−1.2433∗∗∗	2.3548∗∗∗	−0.0008	0.0072

Table 25: Market liquidity and changes in ownership - Sub-periods

The table reports results from estimating the relation between liquidity and ownership structure using a panel regression model below with one-way fixed effects (least squares dummy variable estimation) for each of the years 1999-2001. The independent variables are the aggregate holdings of the five largest owners, the aggregate holdings or the primary insiders, the absolute value of the change in the number of owners for all owner groups, the logarithm of the market capitalization value, the average closing price, the standard deviation of daily returns, the average daily number of trades, and dummies for the fixed effect of each company. The model is estimated for five dependent variables: log(relative weighted spread), log(relative effective spread), log(weighted depth), adverse selection costs according to the GH-method (variable proportional costs), and the adverse selection component of the spread according to the GKN-method. For each model, we report the estimated coefficients (except the coefficients for the fixed effect dummies). *** denotes significance at the 1 percent level, ** denotes significance at the 5 percent level, and * denotes significance at the 10 percent level.

	Dependent variables				
Independent variables	Rel weighted spread	Rel eff spread	Depth	GH comp.	GKN comp
1999					
Five largest	0.8142***	0.7476***	0.5616	0.0032***	−0.0210
Primary insiders	−0.1174	−0.0534	0.1941	0.0002	−0.0107
|Δ| no of owners, state	−0.0111 **	−0.0115*	0.0126	0.0000	0.0004
|Δ| no of owners, institutional	−0.0001	0.0007	0.0045	0.0000	−0.0003
|Δ| no of owners, non-financial	−0.0001	−0.0001	0.0000	0.0000	0.0000
|Δ| no of owners, individual	0.0000	0.0000	0.0000	0.0000	0.0000
|Δ| no of owners, foreign	0.0000	−0.0001	0.0000	0.0000	0.0000
Market cap	−0.2292***	−0.2351***	−0.2388***	−0.0003***	−0.0031
Price	−0.0006	−0.0002***	−0.0036***	0.0000	0.0000
Return volatility	1.0076***	1.0027	−0.8439	0.0026***	−0.0157
Trades per day	−0.0016***	−0.0014***	0.0019***	0.0000	0.0000
2000					
Five largest	1.3124***	1.5294***	−0.5526	−0.0001	0.0078
Primary insiders	−0.0666	−0.0857	0.1692	0.0001	−0.0070
|Δ| no of owners, state	−0.0130*	−0.0115	0.0360***	0.0000	0.0003
|Δ| no of owners, institutional	−0.0037***	−0.0034***	0.0102***	0.0000	0.0001
|Δ| no of owners, non-financial	−0.0005	−0.0006	0.0003	0.0000	0.0000*
|Δ| no of owners, individual	0.0001***	0.0001***	0.0000	0.0000	0.0000***
|Δ| no of owners, foreign	−0.0015 **	−0.0015 **	0.0047***	0.0000	0.0000
Market cap	−0.1164***	−0.1295***	0.1175*	−0.0001	−0.0016
Price	−0.0016***	−0.0015***	−0.0036***	0.0000	0.0000
Return volatility	3.6414***	3.5382***	−2.8491***	0.0032***	−0.0246
Trades per day	−0.0013***	−0.0012***	0.0016***	0.0000 **	0.0000*
2001					
Five largest	−0.3064	0.1335	0.8155	0.0004	−0.0044
Primary insiders	0.4949	0.8229*	1.1628	−0.0018*	0.0050
|Δ| no of owners, state	−0.0023	−0.0117	0.0197	0.0000	−0.0008
|Δ| no of owners, institutional	0.0029	0.0027	−0.0034	0.0000	0.0000
|Δ| no of owners, non-financial	−0.0014	−0.0027 **	0.0042***	0.0000	0.0000
|Δ| no of owners, individual	0.0003	0.0002*	−0.0003	0.0000	0.0000
|Δ| no of owners, foreign	−0.0027 **	−0.0008	0.0001	0.0000	0.0002***
Market cap	0.0693	−0.0610	−0.0858	−0.0001	0.0089
Price	−0.0025 **	−0.0030***	−0.0051***	0.0000	−0.0001
Return volatility	6.1505***	5.6563***	−0.4675	0.0006	0.0276
Trades per day	−0.0016***	−0.0010***	0.0012 **	0.0000	0.0000

B Decomposing the spread

We decompose the spread according to a version of the Glosten and Harris [1988] method without inventory costs, and one of the methods suggested in George et al. [1991].

C The Glosten and Harris [1988]-method

Our description of this method is largely based on the description in Brennan and Subrahmanyam [1996]. Let m_t be the expected value of a stock, conditional of the information set at time t. The GH-method is based on a Kyle [1985] type of price formation, i.e. it allows for a linear price adjustment rule to capture the information effect (Kyle's lambda) and a fixed cost of executing a trade[34],

$$m_t = m_{t-1} + \lambda q_t + y_t \tag{5}$$

where q_t is the order flow and y_t is an informational signal. Let ΔP_t be the intra-day change in the transaction price P_t from time $t-1$ to t, and let D_t be a dummy variable taking the value $+1/-1$ if the trade at time t was buyer-initiated/seller-initiated. Assuming no inventory costs, the transaction price can be written,

$$P_t = m_t + \psi D_t \tag{6}$$

where ψ is a measure of the compensation for per share execution costs and possible costs related to price discreteness and rents. Substituting out m_t using equation 5, we have

$$P_t = m_{t-1} + \lambda q_t + \psi D_t + y_t \tag{7}$$

The change in the the price of a stock from one transaction to the next can then be decomposed in the following way,

$$\Delta P_t = \lambda q_t + \psi[D_t - D_{t-1}] + y_t \tag{8}$$

The empirical version of the model is

$$\Delta P_t = \beta_0 + \beta_1 q_t + \beta_2[D_t - D_{t-1}] + e_t \tag{9}$$

[34]Equations 1-4 below are taken from Brennan and Subrahmanyam [1996], page 444.

where e_t is an error term. The information component of the spread will be reflected in the parameter β_1, i.e. we should find that $\beta_1 > 0$.

D The George et al. [1991]-method

George et al. [1991]'s method (GKN-method) is largely based on the empirical measure of the effective spread introduced by Roll [1984]. The underlying assumptions are no inventory costs, no private information, and no serial dependence in transaction type (i.e. the probability of a trade reversal is 0.5). The special feature in the GKN-method is that the "true" expected return of a security is allowed to vary through time. Let E_t be the unobservable expected return for the period between transaction t and $t-1$ conditional of the information set at time $t-1$, let S_q be the quoted spread, and let M_t be the "true" price conditional on the information set immediately following transaction t. The model of transaction prices is given by,

$$P_t = M_t + \psi(S_q/2)D_t \tag{10}$$

and

$$M_t = E_t + M_{t-1} + (1-\psi)(S_q/2)D_t + y_t \tag{11}$$

It follows that,

$$\Delta P_t = E_t + \psi(S_q/2)[D_t - D_{t-1}] + (1-\psi)(S_q/2)D_t + y_t \tag{12}$$

The first-order serial covariance of successive price changes is given by,

$$cov(\Delta P_t, \Delta P_{t-1}) = cov(E_t, E_{t-1}) - \psi S_q^2/4 \tag{13}$$

Thus, the relation between the serial covariance of trade-to-trade returns and the quoted spread is given by

$$\sqrt{\psi}S_q = 2\sqrt{-[cov(\Delta P_t, \Delta P_{t-1}) - cov(E_t, E_{t-1})]} \tag{14}$$

This version of the model of the effective spread developed by Roll [1984] includes time varying expected returns. Assuming that the time varying expected returns follow a first-order autoregressive process, George et al. [1991] suggest two techniques for taking the time variation in

expected returns into account. In this study, we use the technique for extracting E_t based on bid quotes. Let PB_t be the bid quote subsequent to transaction t. The change in price calculated from bid quotes is given by,

$$\Delta PB_t = E_t + (1 - \psi)(S_q/2)D_t + y_t \tag{15}$$

Let DP be the difference between ΔP and ΔPB. The serial correlation in DP is given by,

$$cov(DP_t, DP_{t-1}) = -\psi^2(S_q^2/4) \tag{16}$$

which gives the relation,

$$2\sqrt{-cov(DP_t, DP_{t-1})} = \psi S_q \tag{17}$$

Setting $\hat{S} = 2\sqrt{-cov(DP_t, DP_{t-1})}$, the empirical versions of the model is,

$$\hat{S} = \beta_0 + \beta_1 S_q + e_t \tag{18}$$

where e_t is an error term, and the estimate of adverse selection costs is given by $1 - \beta_1$.

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