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Ownership Concentration, Short-Sale Constraints and Limits to Arbitrage in the Norwegian Stock Market

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Abstract

This thesis examines whether high ownership concentration has an impact on short-sale constraints and therefore gives limits to arbitrage in the Norwegian Stock Market. With the use of methodology from Prado, Saffi, and Sturgess (2016), we investigate three different hypotheses: The first one is whether higher ownership concentration leads to higher short-sale constraints, the second is whether higher ownership concentration leads to larger negative abnormal returns following a positive demand shock in shorting, while the third hypothesis questions whether higher ownership concentration will create slower and milder reactions to negative earnings announcements. By investigating 69 firms from the Oslo Stock Exchange using data on ownership and equity lending, we are not able to find any results supporting our hypotheses. We are therefore not able to conclude that higher ownership concentration create short-sale constraints or limits to arbitrage in the Norwegian market.

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1. Introduction and background

The Securities and Exchange Commission (SEC) defines short-sales as follows: "A short sale is the sale of a stock that an investor does not own or a sale which is consummated by the delivery of a stock borrowed by, or for the account of, the investor. Short-sales are normally settled by the delivery of a security borrowed by, or on behalf of, the investor. The investor later closes out the position by returning the borrowed security to the stock lender, typically by purchasing securities on the open market." (SEC, 2017) The short-seller closes the position either when he chooses himself, or in more special cases, when the stock lender recalls the shares. When closing, the short-seller have earned, or lost, the difference between what he sold the stocks for when borrowing, and the amount he had to buy them for upon return.

Short-selling has been a debated topic since many consider it risky to sell something one does not own where the theoretical loss is infinite. It has often been accused of magnifying financial crises, due to its tendency to create downward pressure on stock prices and its strong negative signal effect to other investors. One of its most controversial moments was under the financial crisis in 2008, where several countries, including Norway, decided on a temporary ban of short-sales to stabilize its financial markets (Regjeringen, 2010).

Miller (1977) argue how "divergence of beliefs" is the reason that investors want to trade, and he emphasize the importance of letting investors with pessimistic views trade on their beliefs. He theorized that restrictions in short-selling led to overvalued stocks and argues that it enhances market efficiency[1]. This is likely to be true, since short-selling is an important tool for *arbitrage*, which is a fundamental concept in finance defined as "the simultaneous purchase and sale of the same, or essentially similar, security in two different markets for advantageously different prices" (Sharpe, Alexander, & Bailey, 1990). Arbitrageurs trades on mispricing in the markets, and effectively corrects it by creating upward or downward pressure on prices that brings them back to its fundamental value.

[1] By "Market Efficiency" we will, for the remainder of the thesis, refer to the Efficient Market Hypothesis which states that stock prices should reflect all available information (Bodie, Kane, & Marcus, 2014)

Short-selling is often used as a strategy by arbitrageurs to profit from overvaluation of stocks, but if the arbitrageur wishes to sell shares short, he must borrow them from an owner. This typically happens through a brokerage which helps the arbitrageur with locating shares and assist both the arbitrageur and the lender through the transaction. The market for borrowing and lending stocks will in this thesis be referred to as the "equity lending market", and the stocks available for borrowing are referred to as "lending supply".

Locating shares could be a demanding task, which may fail if no owners is willing to lend (i.e. restrict lending supply). In addition, there are other requirements that need to be in place to sell stocks short: To create security for the owner, the short-seller must post collateral in form of bonds, shares or cash in exchange for the shares. The lender also needs to be compensated through an interest on their lent shares, which in this thesis will be referred to as the "borrowing fee". This fee is negotiated between the lender and the borrower, and as described by D'avolio (2002) loan fees are not simply transaction costs, but also market-determined prices, and is set upon the borrowers' expectations, preferences and knowledge of the market.

High borrowing fees increase the cost of shorting and can make trading and potential arbitrage opportunities unprofitable, while difficulty to locate shares can make short-selling near impossible. This, together with the risk that the lenders might recall their shares, are examples of *short-sale constraints*, which again creates *limits to arbitrage*. In general, we will use this term for aspects that makes it hard to exploit existing arbitrage opportunities for an arbitrageur. Another central aspect is *arbitrage risk*, which essentially is a measure of the idiosyncratic risk of a share. For arbitrageurs to be able to exploit mispricing they must rely on stable prices, so the prices they identify are the one they face when completing the required transactions. If prices fluctuate a lot this could be challenging, and will be a source of considerable limits to arbitrage.

1.1.Hypothesis and problem description

Since shorting a stock relies on the owners, it is reasonable to look at the effects of ownership. Certain type of owners might have incentives to hold back shares from the equity lending markets. For instance, blockholders might withhold shares because of concerns that short-selling lead to a loss of monitoring control and create downward

price pressure that will devalue their investment. This means that stocks where investors have large holdings might have lower lending supply and higher short-sale constraints, as argued by Prado et al. (2016). In their paper "Ownership Structure, Limits to Arbitrage, and Stock Returns: Evidence from Equity Lending Markets", they investigated approximately 5000 U.S. stocks and found that higher institutional ownership concentration led to limits to arbitrage through lower lending supply, higher borrowing fees and greater arbitrage risk.

We want to use this study to find whether the same results apply for the Norwegian market, and will base our thesis on replicating three of their tests, which are chosen with basis in data availability and overall scope of the thesis. The tests are translated to three hypotheses, which are as follows:

(1) *"Higher ownership concentration leads to higher short-sale constraints"*
(2) *"Higher ownership concentration leads to larger abnormal negative returns following a positive demand shock in shorting"*
(3) *"Higher ownership concentration will create slower and milder reactions to negative earnings announcements"*

All these hypotheses are based on the same reasoning: investors with large holdings will hold back shares and restrict the lending supply. This will lead to short-sale constraints that again affect stock prices, since investors will be unable to trade on their negative beliefs and create downward pressure via shorting.

In our first hypothesis, we will test if ownership concentration has a direct effect on short-sale constraints represented by borrowing fee and arbitrage risk. Further, the second hypothesis will use equity loan data to investigate whether higher ownership concentration leads to delays in price corrections, and therefore larger negative abnormal returns the day after a positive demand shock in shorting. In the third hypothesis, we test for the same relations in abnormal returns following earnings announcements.

1.2 Short-selling in Norway

Shorting is a relatively new concept in the Norwegian stock market since short-selling for the general public was prohibited in Norway until 1997. Before this, short-selling

was regarded as "bad business practice", but this was changed to enhance market liquidity and the interaction between derivatives and its underlying assets. (Stortinget, 2010).

The differences between the Norwegian and the U.S. equity lending markets could affect shareholder behavior, since incentives for Norwegian equity lenders may differ from those in the U.S. While cash collateral highly applies for the U.S. market where among two-thirds of outstanding security loans are collateralized with cash, markets such as Europe, Canada, and Australia has non-cash as the dominant form (Market, 2014). Since non-cash collateral are not that liquid, the incentives for lending stocks in the Norwegian equity lending market have traditionally been different from the American market, as the lenders' motivation in Norway is to obtain money on the loan itself, rather than getting access to cheap funding (Hage, 2017).

1.3 Motivation and contribution

When choosing a topic, shorting was one of the fields we found most interesting. It is relatively controversial, and has been debated due to its practice of selling something one does not own, and the consequences this may have for financial markets. Shorting is more complex than purchasing stocks, and its complexity helped triggering our motivation to better understand the mechanisms behind it. The psychological aspects in the market is also something that fascinated us, and made us curious on how the owners and investors in equity lending affect the market.

We learned about the study of Prado et al. (2016) through our current supervisor, Costas Xiouros, who suggested that someone should do analyses similar to theirs. The article was relatively new and they were one of the first to pair ownership structure with short-selling and highlight its implications for arbitrage. It was intriguing to see how they tried to explain mispricing and slow price reactions with something else than the "standard" financial factors, and we thought their rationale behind the hypotheses were reasonable.

We chose to replicate large parts of their study and decided that it would be most interesting to perform these analyses on Norwegian stock data, since there was a low amount of research on shorting in Norway. This was also an additional motivational

factor since we hoped to find something that could add value to the existing research on Norwegian stocks.

To the extent of our knowledge, similar research has not yet been conducted or published in Norway, and hopefully this thesis will contribute to extend the knowledge about factors such as ownership structure, arbitrage and shorting in Norway. Furthermore, we hope that our combination of various data sources could motivate others to use similar material for further research on the Norwegian market.

2. Literature Review

For someone to use short selling as a trading-strategy, there must be investors with a belief that the securities are overvalued. At the same time, there must exist a buyer with opposite beliefs, which is willing to buy the shares that the shorting investor has borrowed. In his theoretical study, Miller (1977) refers to this as "divergence of beliefs", and with basis in this he argued that stocks will be overvalued in a market where short-selling is restricted. The lack of pessimistic investors will make the optimistic investors overvalue the stocks, as they do not take their absence into consideration.

This research is supported by Hong and Stein (2003) who developed a theory of market crashes based on differences of opinions among investors. They showed that under short-sale constraints, where only long positions on stocks were possible, bad news will reveal prior hidden information in prices when the market is falling, thus revealing more negative information in total. This, together with a conception of contagion where the correlation of individual stock returns increases sharply when the market is falling, will give return asymmetries that are negatively skewed.

Geczy, Musto, and Reed (2002) found in their empirical study a positive relation between underpricing and the bond's rate, when it was below the general collateral rate in the Repo market. They showed that immediately after an IPO, the borrowing fees are relatively high, and they will on average decline over time as the float increases.[2] The reason fees are high after IPO's is because this is a time where the heterogeneity of opinions may be at its highest, which corresponds with the theory of Miller (1977). They also put forth that the borrowing costs for small-size stocks are five times higher than big-size stocks, but that these fees have no economic impact on the returns earned from shorting the former and buying the latter.

Duffie, Garleanu, and Pedersen (2002) takes into account delays in arranging lending agreements, and suggest that increases in the securities' borrowing fees impact the expected returns demanded from IPOs. They created a theoretical model where short-sellers must search for the security lenders and bargain over the fee if they want to sell

[2] Float refers to the number of shares that are freely tradeable among investors (Bodie et al., 2014)

short. Larger differences in opinions imply larger gains from a lending agreement, i.e. larger borrowing fees. Institutional investors are the preferred lenders since they tend to hold stock positions over long periods of time, and are relatively unlikely to recall the stocks. They further show that higher float, while other factors remain equal, always implies lower borrowing fees.

2.1 Short-selling constraints

A vital part of our thesis is short-selling constraints, as they limit arbitrage opportunities. Asquith, Pathak, and Ritter (2005) describe these constraints in the following way: "(Short-sale) constraints exist when investors wish to sell short but either are unable to borrow shares or can only do so by receiving a low rebate rate on the proceeds from their short sales". They found empirical evidence that stocks which were constrained by limited lending supply, significantly underperformed in the market. Jones and Lamont (2002) also recognizes imperfections in the shorting market, and found that stocks with high valuations are expensive to short and yield low subsequent returns.

Diamond and Verrecchia (1987) theorize that short-selling constraints reduces the speed of adjustment to private information and that it especially applies to bad news. It eliminates some informative trades but does not pressure the prices upwards. They also predict that announcements day returns are more left skewed, and returns have larger absolute values, when there are constraints in short-selling. This is also strengthened by Bris, Goetzmann, and Zhu (2007) which find empirical evidence that in countries where short-selling are practiced, prices incorporate negative information faster than positive information. Saffi and Sigurdsson (2010) finds that stocks with limited lending supply and high borrowing fees respond more slowly to market shocks, while Mendenhall (2002) finds that the magnitude of the post-earnings announcement drift increase with higher arbitrage risk.

Further evidence on arbitrage limits caused by short-sale constraints is shown and tested by Reed (2007) who finds that prices become less informative, trading volume falls, and price reaction on the announcement day are smaller when short-selling is constrained. Just as Diamond and Verrecchia (1987), Reed also finds announcement day returns to be left-skewed. Cohen, Diether, and Malloy (2007) prove that an increase

in shorting demand leads to negative abnormal returns the next month. In addition, they find that the results are stronger in markets with less information available for the public, meaning that the shorting market is a significant factor for private information revelation. Hong and Stein (2003) report that elevated trading volume should be associated with increased negative skewness, i.e. negative skewness is most present when the trading volume is high.

In the study of Shleifer and Vishny (1997), they argue that both systematic and idiosyncratic risk matters for arbitrageurs. They show that limits to arbitrage, such as short-selling costs and arbitrage risk, hinder arbitrage activity and lead to mispricing and anomalies. Pontiff (2006) also argues that idiosyncratic risk is one of the largest costs for arbitrageurs. The paper theorize that arbitrageurs never take positions that are large enough to remove all mispricing in securities, and they are unable to hedge idiosyncratic risk as arbitrageurs often are not fully diversified. Thus, market efficiency will not be fully obtained.

Kaplan, Moskowitz, and Sensoy (2013) finds that lending supply impact short sale constraints, such as borrowing fees, through creating exogenous shocks to lendable stocks, without affecting the price of the security. However, they find no evidence that returns, volatility, skewness or bid-ask spreads are affected. Their result therefore suggests that fund managers can earn money on their fees, without creating adverse effects on the price of their holdings. Regarding equity lending supply and short-sale constraints, Jain, Jain, McInish, and McKenzie (2010) find and argues that short-selling is significantly lower in a country that impose restrictions compared to those who do not.

2.2 Ownership

In our thesis we want to see how ownership structure corresponds with short-selling constraints. Aggarwal, Saffi, and Sturgess (2015) provide results indicating that investors value their right to vote and therefore restrict lendable supply and/or recall loaned shares prior to the record date to exercise voting rights. This especially applies to investors with greater incentives to monitor, such as Private Equity-funds. This is further supported by X. Chen, Harford, and Li (2007) who investigate post-merger performance and finds evidence that independent institutions with long-term

investments (ILTIs) will focus on monitoring and influencing efforts rather than trading, which makes it more likely that bad bids are not accepted.

Evans, Ferreira, and Prado (2014) focus on the lenders and argue that passive investors are more likely to lend their securities, as they are focused on tracking an index. They show that actively managed funds that lends equities, are usually from larger fund families, and underperform compared to similar funds that do not lend. This is due to lending restrictions, where the funds that lend cannot act on short-selling signals and must comply with the families' overall investment objectives. Dechow, Hutton, Meulbroek, and Sloan (2001) argue that transactions costs will be lower for stocks with higher institutional ownership, as they are easier to borrow and are less exposed to short squeezes.

J. Chen, Hong, and Stein (2002) looks at how breadth of ownership (number of owners) affect stock returns. They find that stocks, whose change in breadth in the prior quarter are in the lowest decile of the sample, underperform those in the top decile by 6.38% in the twelve months after formation. This indicate that low breadth leads to overpricing and subsequent low returns. This is similar to results by Asquith et al. (2005) which empirically showed that a high level of institutional ownership made the presence of short-selling constraints unlikely. Also Nagel (2005), who use residual institutional ownership as a proxy for shorting demand, argues that short-sale constraints should mainly affect stocks with low *institutional* ownership, since they tend to have low lending supply and high shorting-costs. However, in Brunnermeier and Nagel (2004) short-constraints were not the crucial limit to arbitrage under the burst of the technology bubble in the year 2000. Though this period can be said to be a special case.

3. Theory

3.1 Hypothesis 1:

"Higher ownership concentration leads to higher short-sale constraints"

We will examine how ownership concentration affect two types of short-sale constraints; the stock's *borrowing fee*, which is a direct form of short-sale constraint, and the *arbitrage risk*, which depicts the idiosyncratic risk that constrains short-sale by price uncertainty, which in turn decrease the ability to exploit arbitrage opportunities. Below follows the theoretical foundation for the hypothesis for each of the explanatory variables.

3.1.1 Borrowing Fee:

A higher borrowing fee means higher limits to arbitrage for the investor, since the increased cost will limit the potential profits gained from exploiting an arbitrage opportunity where shorting is necessary.

In our hypothesis we expect, as in Prado et al. (2016), that higher *ownership concentration* will lead to higher borrowing fees. There are several reasons for this; a shareholder with a large part of the outstanding shares will have higher bargaining power and might be able to set a higher fee. Aggarwal et al. (2015) also shows that shareholders with a large stake could hold back shares to not lose their right to vote in the proxy voting process, which in turn restrict supply and increase the borrowing fee.

3.1.2 Arbitrage Risk:

Arbitrage is an important and fundamental concept in finance and is a transaction where a rational agent tries to profit from mispricing (Pontiff, 2006). In the article "The Limits of Arbitrage" (Shleifer & Vishny, 1997), it is stated that the typical "text-book" approach to arbitrage is not realistic; while theoretical arbitrage requires no capital and entails no risk, it is different in reality, where even the simplest arbitrage transactions entails risk and requires capital.

Arbitrage opportunities are mostly exploited by specialized professionals who do large trades with other people's money (i.e. funds). Since arbitrage investments require time and prices could change instantly, a very volatile arbitrage position will heighten the risk of losses. In addition, the investors in the funds are likely to put pressure on

liquidating the position if prices are very volatile, since extreme fluctuations could lead to a larger need for capital. Therefore, the professional arbitrageurs tend to avoid high-risk arbitrage opportunities, where prices are volatile and the idiosyncratic risk is high.

We define arbitrage risk as the standard deviation of the residuals from the Carhart (1997) four-factor model of returns. This measures the idiosyncratic risk of stocks, and is proven to be relevant by Pontiff (2006) who states that "idiosyncratic risk appears to be the single largest cost faced by arbitrageurs". Prado, Saffi, and Sturgess (2014) found that higher ownership concentration led to higher arbitrage risk, and therefore higher short-sale constraints. This is consistent with Miller (1977) and Jones and Lamont (2002) which argue that under short-sale constraints stocks are overpriced. The overpricing is a deviation from the fundamental value, which again will be expressed through high arbitrage risk.

3.2 Hypothesis 2:

"Higher ownership concentration leads to larger abnormal negative returns following a positive demand shock in shorting"

Many studies have found that short-sale constraints lead to lower returns [e.g. Jones and Lamont (2002) and Duan, Hu, and McLean (2010)], and this could be due to the investors that short stocks demand compensation in form of larger negative returns when the cost of shorting is higher, as argued in Prado et al. (2016) and Drechsler and Drechsler (2014). If high ownership concentration creates short-sale constraints, we should expect more frequent mispricing to occur, and abnormal returns in the following period to be more negative as prices will take longer to adjust. As stated earlier, prices will adjust slower because owners with large holdings restrict shorting and delays the price reaction.

In our hypothesis, the empirical strategy of Cohen et al. (2007) is relevant, where they test stocks below the NYSE median market capitalization because of high liquidity and high fees for small stocks. They observe the effect of price-quantity pairs on stock returns to identify shifts in shorting demand. Price-quantity shifts refer to movements in a stock's loan price and loan quantity, and not its actual share price or shares outstanding. The study finds that shorting demand is an important predictor of future stock returns, both economically and statistically.

The short-selling market also shows how private information revelation affect prices: They state that if shorting costs are high enough, negative information can be prevented from being impounded into the security prices, and this may cause prices to deviate from their fundamental value. They also find that increases in shorting demand plays a more dominant role than decreases in shorting supply. We will therefore focus on shorting demand and how this, together with institutional ownership concentration, affects abnormal returns.

As Cohen et al. (2007), we will introduce the terms DOUT and DIN which are dummy variables for outward and inward demand shocks. The terms will be explained more extensively in the methodology section, but in short DOUT is an increase in borrowing fee and the volume of shares lent the day before, while DIN is a decrease in both. They find that the effect of DIN on abnormal returns is smaller than DOUT. One explanation for this is that positive expectations probably will lead to the stock being purchased on the open market, which will affect abnormal returns differently than short-selling.

The study of Cohen et al. (2007) were the first to use actual data on loan fees and loan amounts to decompose the effect on stock prices that is due to shorting demand and shorting supply. They tested whether prices depended on shorting demand or public information, and showed that it is unlikely that prices are driven by public information flow, as there are cases where outward demand shifts in lending activity are unrelated to private information.

They further argue that it is problematic to use short interest as a proxy for shorting demand since it represents the intersection of supply and demand. This is because low shorting demand may not be due to a low level of short interest. The shorting cost of stocks that are impossible to short, might be infinite, while the short interest level at the same time will equal zero. This is also the reason we will use borrowing fee and loan volume as a direct proxy for demand, instead of short interest.

3.3 Hypothesis 3:

"Higher ownership concentration will create slower and milder reactions to negative earnings announcements"

The rationale behind this hypothesis is that high ownership concentration will create short-sale constraints that will make it harder for investors with pessimistic views to trade on their beliefs, which in turn could lead to overpricing [Miller (1977) and Jones and Lamont (2002)]. This also means that limits to arbitrage could lead to slower and milder price adjustments, especially after negative earnings announcements [e.g. Reed (2007), Diamond and Verrecchia (1987) and Saffi and Sigurdsson (2010)] because of the inability to create downward price pressure.

By looking at earnings announcements we introduce an alternative way to investigate short-sale constraints which helps us show the actual effects it could have on stock prices and returns. With this we can strengthen the evidence we have from the other hypotheses and see if the potential short-sale constraints have real effects on the stock market.

4. Methodology

4.1 Hypothesis 1:

In hypothesis 1, we wish to look at how various factors affect short-sale constraints. As mentioned in our theory-section, we will express short-sale constraints through borrowing fee and arbitrage risk; which will be two separate dependent variables in the regressions we run. The equations will be as follows:

(1) $Borrowing\ Fee_{i,t} = \beta_1 Total_{inst\ i,t} + \theta_2 HHI_{inst\ i,t} + \gamma_3 Top5_{i,t} + \gamma_4 Top5LT_{i,t} + \beta_2 ControlVariables_{i,t} + \epsilon_{i,t}$

(2) $Arbitrage\ Risk_{i,t} = \beta_1 Total_{inst\ i,t} + \theta_2 HHI_{inst\ i,t} + \gamma_3 Top5_{i,t} + \gamma_4 Top5LT_{i,t} + \beta_2 ControlVariables_{i,t} + \epsilon_{i,t}$

Where β indicate variables that are tested in all regressions, θ indicate those variables only tested in the second regression, and γ only the third regression for both explanatory variables. *ControlVariables* include $\Delta(Breadth)$, $MarketCap$, $Amihuds\ ILLIQ$, $Turnover$, $PBValue$, $No.of\ Analysts$ and $Momentum$ (for definitions of all variables see table 1 in the Appendix).

Arbitrage risk is the idiosyncratic risk of the stocks, and following Wurgler and Zhuravskaya (2002), we define it as the standard deviation of the residuals from the Carhart (1997) four-factor model. HHI_{inst} measure the institutional ownership concentration using the Herfindahl-Hirschman Index on the percentage ownership of firms.

The results will be found with a pooled ordinary least squares (OLS) regression. We follow the approach of Petersen (2009b) with firm and monthly fixed effects, and double-clustered standard errors on both firm and time. Since we are only interested in looking at how our variables affect the firms, and not cross-firm effects, it motivates the use of fixed effects on firm-level. Our explanatory variables could change a lot within a short time-frame, and we also wish to avoid potential trends in the data, which makes it reasonable to have fixed effects on time.

All variables are standardized such that the impact of each variable is easier to compare. This means that the effect of our coefficients in this hypothesis could be found in the following way;

$$\%\ change\ from\ mean\ \ in\ explanatory\ variable = \frac{\beta_{indep.variable} * SD_{explanatory\ variable}}{Mean_{explanatory\ variable}} * 100$$

We expect to find results that confirms our hypothesis, meaning that HHI_{inst} should be positively related to borrowing fee and arbitrage risk. Since high ownership concentration could lead to short-sell constraints, it should raise borrowing fees and lead to higher deviations from the fundamental value. Furthermore, we expect that higher *institutional ownership* will lead to lower borrowing fees and arbitrage risk, which is similar to the results of Nagel (2005) and Asquith et al. (2005), and that a positive change in breadth will lead to lower fees and risk, as in J. Chen et al. (2002).

The control variables are included to absorb known relations that could bias our results. Geczy et al. (2002) found results indicating that large firms and high book-to-market-value firms have lower borrowing fees and arbitrage risk. Diether, Lee, and Werner (2008) found that short-selling increased after higher returns in the previous week (higher borrowing demand), and therefore we include this to control for momentum-effects. Number of analysts are included to control for visibility, while Amihud's ILLIQ and Turnover should absorb effects related to the stock's liquidity and trading activity.

The regression will be performed using Stata and the REGHDFE-command, as written by Correia (2017). Fixed effects will be implemented using the "absorb"-function, while clustering is obtained using the "VCE"-command. Since Norway banned short-selling from the 8th of October 2008 until the 27th of September 2009, we have excluded all data ranging from the 4th quarter of 2008 until the 4th quarter of 2009.

4.2 Hypothesis 2:

To test this hypothesis, we must compare the abnormal returns for firms with higher ownership concentration to those with low concentration. We will use the methodology proposed by Prado et al. (2016) and Cohen et al. (2007) to measure abnormal returns, given an outward demand shift (DOUT) to institutional ownership structure (HHI). First, we want to check with a cross-sectional study, whether abnormal returns are more negative for outward demand shocks when ownership concentration is high. Then, we run a standard OLS-test to investigate the same relations in combination with other ownership factors.

The outward demand shift (DOUT) is specified by an increase in both *borrowing fee* and *volume of shares on loan*. For the tests, we will use this pairing as a dummy variable to describe an outward demand shock, which is defined as:

$$DOUT_{i,t-1} = 1 \; if \; borrowing \; fee_{t-1} - borrowing \; fee_{t-2} > 0$$
$$\boldsymbol{and} \; volume_{t-1} - volume_{t-2} > 0$$
$$DOUT_{i,t-1} = 0 \; if \; otherwise$$

Here i is the stock, t stands for days, *borrowing fee* is the cost of shorting, and *volume* is the number of shares on loan. We check whether both borrowing fee and volume of shares has increased the previous trading day compared to the day before, which would indicate that there has been an outward demand shock the previous trading day. The economic interpretation behind this formula is that even though the borrowing cost has increased, more investors are betting for the price of the share to decrease. We further want to see how this shock responds to institutional ownership concentration (HHI).

We sort HHI into quartiles, where the variable indicator $HHI = 1$ is the top quartile, and $HHI = 0$ is the remaining 75 percentiles of ownership concentration for a stock. We place stocks in categories of $DOUT = 1$ and $DOUT = 0$, where the demand shift for the stocks are formed in day $t - 1$. These are combined with HHI, which is based on data from the previous month. Based on theory, and the results of Prado et al. (2016), we expect HHI to show larger negative returns when ownership concentration is high and there is a positive demand shock. To take into account that our results may derive from correlation with total institutional ownership, we also regress HHI with Total, save the residuals, and then perform a similar test, if the first test showed satisfactory results.

In the second test, we will use DOUT with a wide set of other variables and observe the effect of ownership concentration on abnormal returns in a multivariate regression, as done in Cohen et al. (2007) and Prado et al. (2016). The baseline of the regression will look like this:

$$R_{i,t} = \alpha + \beta_1 \theta_t + \beta_2 DOUT_{t-1} + \beta_3 Top(OWN_{i,t-1}) + \beta_4 Total_{i,m-1}$$
$$+\beta_5 DOUT_{t-1} * Top(OWN_{i,m-1}) + \beta_6 CTRLS_{i,m-1} + \varepsilon_{i,t}$$

$R_{i,t}$ is the abnormal return for stock i in week t, θ_t is a calendar month dummy, $Top(OWN_{i,t-1})$ is a dummy variable that equals 1 if the ownership characteristics we test are in the top quartile for the previous month, and $Total_{i,m-1}$ is the top quartile of total institutional ownership the previous month. $CTRLS_{i,m-1}$is a set of control variables, which includes the average of $Amihuds\ ILLIQ$, $Turnover$ and $No.of\ Analysts$ from the previous month. To take multiple dimensions of both time and firm into account, we include double-clustered standard errors ($\varepsilon_{i,t}$). In addition, we include abnormal returns from the previous day to control for momentum effects. This is to avoid spurious correlation between the demand shocks in lending and reversals.

The top ownership characteristics we want to use as independent variables are arbitrage risk, HHI, Top5 and Top5LT. We also introduce an inward demand shift as a variable, defined as:

$$DIN_{i,t-1} = 1\ if\ borrowing\ fee_{t-1} - borrowing\ fee_{t-2} < 0$$
$$and\ volume_{t-1} - volume_{t-2} < 0.$$
$$DIN_{i,t-1} = 0\ if\ otherwise$$

DIN equals 1 if there is a decrease in both the borrowing costs and the amount that investors borrow, and zero otherwise.

The first test we run in the OLS-regression is only with DOUT and DIN as independent variables. Based on other studies, we should expect more negative abnormal returns from DOUT than DIN. The second regression includes the bottom quartile of Total and the top quartile of HHI, and we test this to see whether shorting a stock gives larger price adjustments when lending supply is lower. Therefore, we should observe larger negative abnormal returns from HHI given DOUT. We also control in the same regression for Total, where Prado et al. (2016) finds that total ownership should relieve supply constraints. In the third regression, we are including Arbitrage risk to see how it affects HHI, and here we should also expect larger abnormal returns given DOUT. In the fourth regression, we are excluding HHI, but including the top quartiles of Top5 and Top5LT. We test what effect the investment horizon has for the firms and its effect on abnormal returns. Based on Prado et al. (2016) we should expect that Top5 give

more negative abnormal returns after DOUT, and that the effect diminishes when looking at Top5LT given DOUT.

To perform the regressions, we use Eviews and STATA for calculating the results. We also use an .ado-file written by (Petersen, 2009a) to include for double-clustered standard errors ($\varepsilon_{i,t}$).

4.3 Hypothesis 3:

In hypothesis 3, we will investigate how ownership affects stock prices by looking at surprises in earnings announcements. High ownership concentration could create short-sale constraints that again leads to mild and slow reactions to negative news. We follow Prado et al. (2016) and use a difference-in-differences approach to test how the various factors affect abnormal returns following earnings surprises. The methodology and our choices in the calculations are described below.

4.3.1 Earnings surprises:

The earnings surprises are created with basis in the approach of Livnat and Mendenhall (2006), where we calculate the Standardized Unexpected Earnings (SUE) as in their paper:

$$SUE_{jt} = \frac{(X_{jd} - FX_{jd-60})}{P_{jd}}$$

$$X_{jd} = Actual\ Earnings\ Per\ Share\ (EPS) for\ firm\ j\ at\ announcement\ date$$

$$FX_{jw-6} = The\ median\ of\ IBES\ EPS\ forecasts\ 60\ days\ prior\ to\ the\ announcement\ date$$

$$P_{jd} = Share\ price\ at\ announcement\ date$$

The Actual Earnings Per Share less the forecast 60 days prior to the event, depicts the earnings surprise. The forecasts are the median of all broker estimates in IBES and we have chosen to use the forecast about 8 weeks (≈60 days) before the announcement date, since IBES forecasts close to the actual announcement often is updated with post-announcement data. This would then give the wrong picture of what information the investors actually had on the announcement day (Livnat & Mendenhall, 2006). The earnings surprises are scaled by the stock price on the announcement day.

4.3.2 Abnormal Return:

We use the Carhart (1997) four-factor model to calculate abnormal returns. They are estimated for each event with an estimation window of 250 to 20 working days before the event $(t-250, t-20)$. This means that each market factor is regressed individually for each event date and firm, to create the beta's used to model abnormal returns. The cumulative abnormal return (CAR) will be our dependent variable, and for different regressions they are divided into three event windows:

Variable	Event Window
CAR1	$(-1, 1)$
CAR2	$(2, 10)$
CAR3	$(2, 10\ days\ before\ next\ announcement\ date)$[3]

CAR1 will catch the actual announcement day reaction, CAR2 captures the post-earnings announcement drift while CAR3 attempts to catch the long-term post-announcement drift.

4.3.3 Regression:

The data consists of 1886 events, where the criteria is that the required variables to calculate SUE_{jt} is available and could be combined with ownership data. Fundamentals and ownership data is connected to the events based on the values the month before $(t-1)$.

To find our results, we use pooled ordinary least squares (OLS) with dummy-variables indicating the top- or bottom quartiles of the factors. This is a typical difference-in-differences approach where we only look at the most extreme quartiles of earnings surprises. In our model, this means that only the top and bottom quartiles of SUE are kept and the rest of the dataset is excluded.

With this approach, we have a sample that only consists of good and bad news. The reason for doing this is that we are only interested in the extreme values of earnings

[3] CAR3 are set to end at a maximum of 60 working days after the announcement date

announcements and ownership, since the effects we are looking for only are present when the news is bad and the ownership concentration is high.

For SUE, a dummy-variable of 1 indicate the bottom quartile of surprises $\left(D_{i,t}^{SUE} = 1 = bad\ news\right)$ and 0 represents the top quartile ($D_{i,t}^{SUE} = 0 = good\ news$). For all other variables, the dummies are 1 if in the top quartile of the distribution (e.g. $D_{i,t}^{HHI} = 1 = high\ ownership\ concentration$), and 0 otherwise.

The method could be illustrated by the following equation:

$$CAR_{i,t} = \beta_1 + \beta_2 D_{i,t}^{SUE} + \left(\beta_3 + \beta_4 D_{i,t}^{SUE}\right) * D_{i,t-1}^{HHI} + \left(\theta_1 + \theta_2 D_{i,t}^{SUE}\right) D_{i,t-1}^{Arbitrage\ risk} + \left(\gamma_1 + \gamma_2 D_{i,t-1}^{SUE}\right) D_{i,t-1}^{Total_{inst}} + \epsilon_{i,t}$$

The interpretation of the variables will then be as follows; for each stock i at time t, β_1 captures the mean abnormal return for good earnings announcements and lower ownership concentration ($D_{i,t-1}^{HHI} = 0$), which is expected to be positive. $\beta_1 + \beta_2$ is the abnormal return for bad news when ownership concentration is lower. β_3 catches the effect on CAR from good news when ownership concentration is high ($D_{i,t-1}^{HHI} = 1$) and $\beta_3 + \beta_4$ shows bad news with high ownership concentration and so on.

As suggested by Bertrand, Duflo, and Mullainathan (2004), our differences-in-differences approach are adjusted with yearly fixed effects and have clustered standard errors on the firm-level. The same STATA-code are used here as in Hypothesis 1, and we remove events from the period of the shorting ban.

4.3.4 Expected findings

We expect to find significant results that confirm our hypothesis. This means that CAR1 should be positive for negative earnings announcements when the ownership concentration is high, which indicates an underreaction. This would be in accordance with the theories of Diamond and Verrecchia (1987). Furthermore, we should then see that CAR2 and CAR3 tends towards negative values, which would implicate reaction delays, as suggested by Saffi and Sigurdsson (2010). The same results are likely to appear for the variable $Top5$.

Furthermore, we expect to see slow reactions for the top quartile of arbitrage risk, as in Mendenhall (2002), while high institutional ownership should mean less short-sale

constraints and more immediate reactions, which should be expressed through insignificant results for CAR2 and CAR3.

5. Data

The data used is primarily gathered from the Thomson Reuters' Eikon database, and is formed and customized into an array of variables to answer the different hypotheses. We will in the following paragraphs explain how they are collected and formed. Descriptive statistics could be found in table 2 in our appendix.

5.1 Equity Data:

Our data on equity lending includes the variables "Volume", which shows the daily sum of shares currently on loan, and "Borrowing Fee", that is the value-weighted daily average cost of borrowing the share expressed as an annualized fee. This data was available from November 2015 until December 2016 through Thomson's Reuters Eikon Database, with numbers from FIS Astec Analytics. For hypothesis 1 we recalculate the daily borrowing fee to a monthly average, while hypothesis 2 use the daily borrowing fee and volume as an indicator for demand changes.

From the descriptive statistics, we can see that the monthly average of the annualized borrowing fee is about 5%, which is relatively high if we for instance compare to the US market and Prado et al. (2016), where the mean value of borrowing fee is 0.7%.

5.2 Ownership Data:

The ownership data is extracted from Thomson Reuters Eikon database. The data shows information on most public owners of a stock, including the *investor's full name*, *historical holdings percentage* and *investor type description*. Ownership data with monthly frequency ranges from 01.01.2006 to 31.12.2016 for 69 Norwegian firms listed at Oslo Stock Exchange. The data are manually adjusted for stock splits and repurchases with the use of data on outstanding shares from Eikon, and is also double-checked against the firm's own quarterly reports. The ownership data lays the foundation for our variable sample, since the only firms we include are those with available ownership data.

In our variables HHI_{inst} and $Total_{inst}$ we have only looked at firms we categorize as "institutional" with basis in Thomson Reuters variable "investor type description". We see from the descriptive statistics that on average 30% of the investors are institutional, which means that we will investigate 30% of the available ownership data in these

variables. The median number of owners per firm are 41 ($Breadth$) and the 5 largest investors on average owns 43% of the shares, which indicates that the variable $Top5$ and $Top5LT$ will add valuable information to our regressions.

5.3 Price and earnings announcement data:

The price data and fundamentals are extracted from Compustat and the Thomson Reuters Eikon Database.

5.3.1 Stock prices, abnormal returns and arbitrage risk

Daily stock prices for all firms are extracted in NOK from Eikon, and with this data we calculated stock returns.

Abnormal Returns are calculated using the Carhart (1997) four-factor model for expected returns with market factors based on portfolios from Oslo Stock Exchange extracted from Bernt Ødegaard's resource page (Ødegaard, 2016). The same data lays the basis for calculating arbitrage risk.

5.3.2 Earnings announcement data:

The earnings announcement data are extracted from IBES via Eikon, and consist of all quarterly earnings announcements for 66 firms from 2006 until 2016 measured in earnings per share. For the same firms in the same time frame we have IBES median of forecasts, which shows the median of all broker estimates in the IBES Database. The data consists of 1886 earnings announcements.

5.4 Fundamentals:

5.4.1 Amihud's Illiquidity (ILLIQ)

This illiquidity measure is from Amihud (2002) and is calculated the following way in our sample:

$$ILLIQ_{im} = \left(\frac{1}{D_{im}} \sum_{t=1}^{D_{im}} \frac{|R_{imd}|}{VOLN_{ivmd}} \right) * 10^6$$

$$D_{im} = Number\ of\ days\ for\ which\ the\ data\ are\ available\ for\ stock\ i\ in\ month\ m$$

$$|R_{imd}| = absolute\ return\ on\ stock\ i\ on\ day\ d\ of\ month\ m$$

$$VOLN_{ivmd} = The\ daily\ volume\ in\ NOK$$

$$Measured\ for\ firm\ i, in\ month\ m\ for\ days\ d$$

5.4.2 Turnover:

Our variable «Turnover» are calculated with data from Eikon, using the following equation:

$$Turnover_{im} = \frac{1}{D_{im}} \sum_{t=1}^{D_{im}} \frac{Volume_{id}}{Outstanding_{id}}$$

$$Volume_{id} = No. of\ stocks\ traded\ on\ day\ d\ for\ firm\ i$$

$$Outstanding_{id} = Outstanding\ shares\ on\ day\ d\ for\ firm\ i$$

5.4.3 Other data:

Data on market capitalization, PB-value and number of analysts are directly extracted from Eikon. The average market capitalization of the firms in our sample are 21.55 billion NOK, where the least valuable are worth 300 million NOK and the most valuable 600 billion NOK.

Data cleaning, structuring and creation of variables were mainly done in Excel 2016 and Stata.

6. Analysis

6.1 Hypothesis 1:

For hypothesis 1, we ran two regressions where borrowing fee and arbitrage risk were the dependent variables. We investigated whether "*higher ownership concentration leads to higher short-sale constraints"*, with the explanatory variables expressing our short-sale constraints.

[Results: Table 3 in Appendix]

For Borrowing Fee, in column (1) to (3). we see no significant variables. None of our variables on ownership are statistically significant and only two of our control variables has a p-value below 10%, which is too weak evidence for variables that are not relevant to our hypothesis.

The absence of significant variables in this regression are likely to be a consequence of our limited access to data on borrowing fee, which led to few observations in our regression. Further, we use fixed effects and clustered standard errors that could reduce the efficiency of our regressions, but removing these aspects could lead to biased results, which we prefer to avoid.

In column (4) to (6), where Arbitrage Risk is the explanatory variable, we see statistically significant variables. However, none of the variables on ownership are significant except $\Delta(breadth)$, where an increase in the variable leads to lower arbitrage risk. A one standard deviation increase in $\Delta(breadth)$ leads to a change of -1.67% [(-0.025*0.02)/0.03] from the mean value of arbitrage risk, which means that an increase in the number of owners reduce the idiosyncratic risk. This is consistent with our expectations and the results of J. Chen et al. (2002), and could be an indication that more owners reduce short-selling constraints.

For the control variables, we see that higher illiquidity (Amihud's ILLIQ) leads to higher arbitrage risk, which is expected, since low liquidity hinders trading activity and keeps the price from obtaining its fundamental value. Furthermore, we see that turnover are positively correlated with arbitrage risk, which is reasonable since high trading activity are likely to cause more frequent deviations from the expected returns.

A one standard deviation increase in the number of analysts leads to an -14.2% [(-0.252*0.02)/0.03] change in arbitrage risk, which indicate that visibility of the stock significantly reduces the idiosyncratic risk. A reason for this could be that more visible stocks cause well-informed investors which results in less divergence of beliefs. This again, will lead to less deviations from the stock's fundamental value.

None of the results from our regressions confirm our hypotheses about the effect ownership concentration have on short-sale constraints.

6.2 Hypothesis 2:

In this hypothesis, we wanted to check the relation between institutional ownership concentration and demand shifts in shorting to see if *"higher ownership concentration leads to larger abnormal negative returns following a positive demand shock in shorting"*.

[Results: Table 4.1 in Appendix]

We see that abnormal return is more negative (-0.085%) for high concentration stocks (HHI=1) given an outward shift in demand (DOUT=1), and the difference-in-differences across the combinations of dummies is -0.169%. However, none of the results are statistically significant, and it does not support our hypothesis. Since the test did not show any significant results, it does not motivate any further tests on the residuals.

However, we can still try to identify the effects of ownership structure on demand shocks using OLS-regression:

[The results are documented in table 4.2 in the appendix]

Although some betas show the correct directions, our multiple regression yielded very low t-statistics and we are not able to draw any conclusions in support of our hypothesis with basis in these results. As we have no evidence for our hypothesis, a more timely discussion will be why this is the case.

Apart from the selection of model, one explanation could be insecurity around the raw data. Data on shorting is very hard to measure, as brokerages who lend out shares do not know how much of the shares is sold to a third party by the investor. There is little

publicly available information on borrowing fees, as the security lending occur mostly on a bilateral basis instead of trading through an exchange (ISLA, 2015). In addition, the volume of shares lent out can also be used for market-making activities and hedging, and this could be a source of "noise" in the data. Another reason could of course be that hypothesized relationship between ownership concentration and shorting demand shifts do not exist in the Norwegian stock market.

6.3 Hypothesis 3:

In this regression, we look at the Cumulative Abnormal Return (CAR) following earnings surprises, and try to find evidence for the hypothesis that *"higher ownership concentration will create slower and milder reactions to negative earnings announcements".*

[Results: Table 5 in Appendix]

At the event date, denoted as CAR1 in our regression, we first see that CAR is significantly negative for bad news $\boldsymbol{D^{SUE}}$ and positive for good news (intercept). Since only extreme surprises are present in our tests, the overreaction to the announcements are expected. We see that the positive overreaction to good news is mostly corrected during the 10 days following the event, since CAR2 shows significance for a negative abnormal return. However, the even stronger negative reaction to bad news does not seem to be corrected in the same way, which indicates that bad news gives more persistent price reactions.

In regression (2) we observe that when ownership concentration (HHI) is high there is no sign of overreactions, which is the case when ownership concentration is lower. This could be an indication that high HHI pose short-selling constraints, but we deem this as too uncertain and there is not enough statistical evidence to draw any conclusions.

In regression (3) we observe that the top quartile of $Top5$ have significant effects on abnormal returns in the event window, CAR1. When the five largest owners hold large parts of the outstanding shares we see a statistically significant underreaction to both good and bad news. Since we see an underreaction in both ends it is hard to argue that high $Top5$ only causes short-sale constraints, as it seems to constrain trading in general.

The reason for this could be that blockholders will not immediately trade upon new information and are more long-term in nature, which restrict the float and the possible price pressure the remaining investors could create. Edmans (2009) argue that blockholders have "incentives to ask question first and not automatically sell upon losses" since it is valuable for them to investigate if bad earnings announcements are caused by beneficial investments or low firm-quality, since good investments could be a long-term benefit. Furthermore, it is reasonable to assume that large investors will keep their position if the news are good.

The results from our regressions does not provide any conclusive evidence that support our hypothesis that high ownership concentration creates milder and slower reactions to negative earnings announcements.

7. Conclusion

In this thesis, we have investigated how ownership concentration could create short-sale constraints and possible limits to arbitrage. We wanted to see if the results from Prado et al. (2016) for the US market also applied for the Norwegian market. They found that higher ownership concentration led to higher short-sale constraints, which again created limits to arbitrage. They provided evidence of these limits by showing that high ownership concentration led to slow price reactions after negative earnings announcements and positive shorting demand shocks. In addition, they found results indicating that high ownership concentration led to underreactions to negative news.

Our research and tests on the Norwegian stock market did not find the same relations. By replicating three of the tests performed by Prado et al. (2016) we were not able to find convincing evidence that ownership concentration had any effects on short-sale constraints or price reactions, and we ended up with having no support for our hypotheses.

There could be several reasons for these results and one of them could of course be that the ownership structure does not have any effects on short-selling or stock prices in Norway. An argument for this is the difference in incentives for the equity lenders in the Norwegian market versus those in the U.S. As mentioned, Norwegian lenders usually get assets as collateral, while most of the U.S. lenders receive cash. Consequently, U.S. owners often lend shares to get access to cheap funding while Norwegian owners are more driven by the proceeds from the borrowing fee. This difference could lead to other mechanisms driving borrowing fees and potential short-selling constraints.

Another reason for our lack of significance could be the statistical approach or data shortages. Data from the equity lending markets is very hard to acquire, and even after contacting numerous Norwegian bank and brokers, in addition to other providers of equity lending data, we were left with close to no relevant research material on short-selling. The solution was to use data from Eikon's provider, Astec Analytics, but with only 15 months of daily data on borrowing fee and volume for a limited number of listed companies, the data was restricted. The relatively low amount of observations made it challenging to find potential relations.

In the tests that did not require data on equity lending, we had a chance to perform tests with more observations. However, the variability in firms compared to Prado et al. (2016) is small, considering that our data consist of approximately 70 firms compared to their sample of over 5000.

Our statistical approach could also be criticized, since the use of fixed effects and clustered standard errors may lead to inefficient tests. However, we chose this approach to ensure that we achieved unbiased results, but it could be argued whether this decision was the best alternative.

Further research

Although our results did not generate any conclusive results, it is still an area that could be interesting to investigate further in the Norwegian market. There is relatively little research on short-selling in Norway, and this makes it a field open for exploration.

A new short-sale register was introduced in Norway from January 2017, which publish data on all shorting positions above 0.5% of the outstanding shares (Finanstilsynet, 2016). The published data is not yet extensive enough to do proper research, but could be interesting to investigate in relation to studies on the Norwegian shorting market in the future.

An interesting research topic could be to investigate the differences in incentives for the equity lenders in the European and U.S. market, and how this affect borrowing costs and possible short-sale constraints.

Appendix

Table 1: Definition of variables

Variable	Definition
$Borrowing\ Fee$	Monthly average of the annualized daily cost to borrow shares in %
$Volume$	Monthly average of the daily quantity of shares on loan
$Total_{inst}$	Percentage ownership by investors defined as Institutional
HHI_{inst}	The concentration of institutional investors measured by the Hirschman-Herfindahl Index
$Top5$	Percentage of shares held by the largest five shareholders
$Top5LT$	Percentage of Top5 held by investors with a long investment horizon. Defined as minimum one year of ownership as in X. Chen et al. (2007)
$Breadth$	Number of Institutional Investors
$\Delta(Breadth)$	Change in breadth relative to the last month
$MarketCap$	The Market Capitalization of the firms in billion NOK
$Arb.Risk$	The Mean Squared Error of Residuals from Carhart (1997) four-factor model using daily stock returns within a month
$Turnover$	Average daily stock turnover within a month (x100)
$Amihud's\ ILLIQ$	Average absolute return over NOK volume within a month
$PBValue$	Price to Book Ratio
$No.of\ Analysts$	Natural log of 1 plus the number of analyst estimates in IBES for that month. Missing values will then be 0
$Momentum$	Cumulative Return in the six months prior to the observation (months t-7 to t-1)

Table 2: Descriptive Statistics

	Obs.	Mean	Median	Std. Dev.	Min	Max	Skewness	Kurtosis
$\boldsymbol{Borrowing\ Fee}*$	727	0.05	0.03	0.05	0.00	0.34	2.55	13.53
$\boldsymbol{Borrowing\ Fee}**$	18437	0.05	0.03	0.05	0.00	0.87	3.81	34.94
$\boldsymbol{Volume}**$	18437	11 500 000	721 204	39 000 000	22	351 000 000	5.91	41.41
$\boldsymbol{Total_{inst}}$	6476	0.30	0.25	0.23	0.00	0.97	0.86	2.84
$\boldsymbol{HHI_{Inst}}$	6476	0.04	0.01	0.08	0.00	0.45	3.04	11.93
$\boldsymbol{Top5}$	6476	0.43	0.43	0.21	0.00	0.94	-0.03	2.23
$\boldsymbol{Top5LT}$	6476	0.38	0.37	0.23	0.00	0.90	0.18	2.01
$\boldsymbol{Breadth}$	6749	83.68	41.00	102.10	0.00	616.00	1.95	6.69
$\Delta(\boldsymbol{Breadth})$	6408	0.03	0.00	1.53	-0.63	122.00	79.11	6305.86
$\boldsymbol{MarketCap}$	6476	21.55	6.11	53.08	0.03	600.74	5.72	44.01
$\boldsymbol{Arbitrage\ Risk}$	6476	0.03	0.02	0.02	0.00	0.28	3.93	34.87
$\boldsymbol{Turnover}$	6475	0.33	0.17	0.47	0.00	8.54	4.78	49.91
$\boldsymbol{Amihud's\ ILLIQ}$	6475	0.55	0.00	10.73	0.00	634.90	43.58	2250.64
$\boldsymbol{PB-Value}$	6468	2.60	1.58	8.48	-12.54	286.72	23.78	679.23
$\boldsymbol{No.of\ Analysts}$	6476	2.20	2.30	0.79	0.00	3.71	-0.52	3.06
$\boldsymbol{Momentum}$	6468	0.08	0.05	0.50	-0.95	19.16	13.27	413.27

*Monthly average **daily data

Table 3: Results from Hypothesis 1

This table displays a regression of short-sale constraints as a function of institutional ownership ($Total$), ownership structure (HHI) and other control variables. Columns (1)-(3) present evidence for Borrowing Fee for monthly data between 2014 and 2016 and columns (4)-(6) present evidence for Arbitrage Risk with a monthly frequency from 2006 to 2016. A description of all variables could be seen in table 1 in the appendix. The data has fixed effects on firm and month-level with double-clustered standard errors on firm and time. Coefficients are reported below with standard errors in brackets and significance levels are indicated as follows: ***=1%-level **=5%-level and *=10% level.

	BORROWING FEE			ARBITRAGE RISK		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
$Total_{inst}$	0.113	0.137	0.329	-0.065	-0.053	-0.073
	(0.090)	(0.149)	(0.233)	(0.076)	(0.086)	(0.079)
HHI_{inst}		-0.079			-0.044	
		(0.240)			(0.137)	
$Top5$			0.148			-0.237
			(0.378)			(0.194)
$Top5LT$			-0.480			0.288
			(0.413)			(0.186)
$\Delta(breadth)$	0.025	0.024	0.020	-0.025***	-0.025***	-0.024***
	(0.024)	(0.024)	(0.024)	(0.006)	(0.006)	(0.005)
$MarketCap$	-0.505*	-0.510*	-0.551*	-0.139	-0.142	-0.130
	(0.281)	(0.287)	(0.296)	(0.086)	(0.087)	(0.085)
$Amihud's\ ILLIQ$	-0.027*	-0.027*	-0.026*	0.075**	0.075**	0.075**
	(0.013)	(0.013)	(0.013)	(0.035)	(0.035)	(0.034)
$Turnover$	-0.044	-0.045	-0.044	0.516***	0.516***	0.516***
	(0.052)	(0.053)	(0.053)	(0.075)	(0.075)	(0.075)
$PBValue$	-0.043	-0.043	-0.038	-0.095	-0.095	-0.076
	(0.058)	(0.058)	(0.059)	(0.087)	(0.088)	(0.071)
$No.Of\ Analysts$	0.219	0.216	0.168	-0.213***	-0.214***	-0.211***
	(0.226)	(0.225)	(0.213)	(0.053)	(0.053)	(0.051)
$Momentum$	0.060	0.060	0.059	-0.038	-0.038	-0.041
	(0.035)	(0.035)	(0.035)	(0.037)	(0.037)	(0.035)
OBS.	727	727	727	5851	5851	5851
FIRMS	54	54	54	69	69	69

Table 4: Results from hypothesis 2

The tables show daily abnormal returns given the combination of outward demand shocks (DOUT) the previous trading day and top institutional ownership (HHI) from the previous month. The data is gathered from the period between 2015 and the end of 2016. Abnormal return is calculated by using Carhart's four factor model (1997). DOUT is a dummy variable for outward equity lending demand shocks. and equals 1 if the upper 25 percentiles had an increase in both borrowing fee and volume loaned the previous trading day. and 0 otherwise. HHI equals 1 if the ownership concentration is in the upper quartile. and 0 otherwise. Table 4.1 shows cross sectional results of abnormal return. based on the regression of DOUT and HHI. The columns/rows with "difference" show the differences in the dummy variables. dummy=1 is subtracted with dummy=0. Results are shown in percentage. Significance level are given as: *. ** and *** which indicates significance level of 10%. 5% and 1%. respectively.

Table 4.1

	Top HHI		
DOUT	0	1	Difference
0	-0.022	0.027	0.049
1	0.035	-0.085	-0.120
Difference	0.057	-0.112	-0.169

Table 4.2:

This table shows the multivariate regression of abnormal returns as a function of demand shocks in shorting the previous trading day and a set of ownership variables from the previous. The data is gathered from the period between 2015 and the end of 2016. DOUT is a dummy variable for outward equity lending demand shocks. and equals 1 if the upper 25 percentiles had an increase in both borrowing fee and volume loaned the previous trading day. and 0 otherwise. DIN is a dummy variable equaling 1 if the upper quartile had a decrease in borrowing fee and volume loaned. Total is all the institutional ownership. Arbitrage risk is the mean squared error of residuals from Carhart' (1997) four-factor model. In addition. all regressions include calendar month dummies and a control set of Amihud's illiquidity measure. average daily turnover. number of analysts following the stock the last period. momentum and last week's abnormal return. The results show the coefficients. with standard errors in brackets. Significance level are given as: *. ** and *** which indicates significance level of 10%. 5% and 1%. respectively.

Table 2.3

Variables	(1)	(2)	(3)	(4)
DOUT	-0.026	-0.009	-0.019	-0.075
	[0.053]	[0.054]	[0.052]	[0.062]
DIN	-0.007	-0.067	-0.065	-0.065
	[0.017]	[0.054]	[0.054]	[0.053]
Bottom($Total_{inst}$)		0.006	0.009	0.026
		[0.046]	[0.045]	[0.050]
DOUT*Bottom($Total_{inst}$)		-0.082	-0.108	-0.084
		[0.079]	[0.095]	[0.104]
Top(Arb.risk)			0.019	0.023
			[0.099]	[0.098]
DOUT*Top(Arb.risk)			0.144	0.156
			[0.145]	[0.142]
Top(HHI)		-0.025	-0.028	
		[0.044]	[0.044]	
DOUT*Top(HHI)		-0.073	-0.077	
		[0.110]	[0.115]	
Top(Top 5)				-0.049
				[0.136]
DOUT*Top(Top 5)				-0.123
				[0.250]
Top(Top 5-LT)				-0.118
				[0.102]
DOUT*Top(Top 5-LT)				0.247
				[0.243]
Obs.	15521	15521	15521	15521
Firms	57	57	57	57

Table 5: Results from hypothesis 3

This table show regressions of cumulative abnormal returns (CAR) following earnings announcements. The different CAR-measurements indicate the following time frames, with t indicating the announcement day: $CAR1 = (t-1, t+1)$, $CAR2 = (t+2, t+10)$ and $CAR3 = (t+2,$ $next\ announcement\ date$ $[\max 60\ business\ days])$ and is multiplied with 100, meaning 1 = 1%. SUE is standardized unexpected earnings, and its dummy variable equals 1 if in the bottom quartile (bad news) and 0 if in the top quartile (good news). All other variables equal 1 if in the top quartile the month before the earnings announcement and 0 otherwise. Variables are defined in table 1 in the appendix. All regressions include yearly fixed effects and clustered standard errors at firm-level. Coefficients are reported below with standard errors in brackets and significance levels are indicated as follows: ***=1%-level **=5%-level and *=10% level.

	CAR1			CAR2			CAR3		
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\boldsymbol{Intercept}$	1,448**	1,526**	1,959***	-1,021**	-1,140***	-0,934*	-0,444	-0,474	-0,440
	(0,626)	(0,631)	(0,684)	(0,412)	(0,413)	(0,481)	(1,277)	(1,279)	(1,634)
$\boldsymbol{D^{SUE}}$	-3,254***	-3,412***	-4,056***	-0,632	-0,505	-0,547	0,244	0,493	0,511
	(0,717)	(0,717)	(0,777)	(0,560)	(0,574)	(0,663)	(1,835)	(1,835)	(2,203)
$\boldsymbol{D^{Arb.Risk}}$	-1,462	-1,350	-1,712	0,684	0,501	0,641	4,349	4,328	4,347
	(1,423)	(1,389)	(1,414)	(1,345)	(1,337)	(1,391)	(4,005)	(4,101)	(3,992)
$\boldsymbol{D^{SUE} * D^{Arb.Risk}}$	0,317	0,161	0,761	0,076	0,269	0,011	-5,567	-5,425	-5,746
	(1,787)	(1,711)	(1,764)	(1,729)	(1,672)	(1,806)	(4,594)	(4,662)	(4,605)
$\boldsymbol{D^{Total_{inst}}}$	0,655	1,726	0,691	0,025	-1,656	0,032	0,205	-0,141	0,210
	(0,734)	(1,136)	(0,754)	(0,646)	(1,498)	(0,649)	(1,866)	(3,633)	(1,846)
$\boldsymbol{D^{SUE} * D^{Total_{inst}}}$	0,167	-1,823	-0,131	0,150	1,912	0,299	-3,067	-0,127	-2,821
	(0,909)	(1,592)	(0,916)	(0,873)	(1,718)	(0,897)	(2,399)	(4,505)	(2,335)
$\boldsymbol{D^{HHI_{inst}}}$		-1,376			2,158			0,441	
		(1,162)			(1,622)			(3,665)	
$\boldsymbol{D^{SUE} * D^{HHI_{inst}}}$		2,613*			-2,273			-3,938	
		(1,545)			(1,811)			(4,177)	
$\boldsymbol{D^{Top5}}$			-1,783**			-0,305			-0,024
			(0,820)			(0,977)			(1,831)
$\boldsymbol{D^{SUE} * D^{Top5}}$			2,950***			-0,407			-1,140
			(0,871)			(1,445)			(2,159)
Obs.	898	898	898	894	894	894	840	840	840
Firms	66	66	66	66	66	66	66	66	66

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