Broker and Institutional Investor Short Selling

Ben R. Marshall*
Massey Business School, Massey University, New Zealand

Nhut H. Nguyen
Department of Finance, Auckland University of Technology, New Zealand

Nuttawat Visaltanachoti
Massey Business School, Massey University, New Zealand

Jennifer Zhu
New Zealand Exchange, New Zealand

Abstract

Brokers have access to order-flow data, allowing them to earn larger returns than other investors from their short selling. However, our results indicate that they do not exploit this informational advantage. Returns following broker short selling are not more negative than they are following institutional investor (mutual and sovereign wealth fund) short selling. Rather, brokers appear to try and stabilize the market. Unlike institutional investors they short-sell more when there is an increase in buy-sell order imbalance or when stock-specific news is positive. Broker short selling improves market quality. Price efficiency and liquidity improve and volatility declines following broker short sales.

JEL Classification Codes: G12, G24
Keywords: Short Selling, Institutional Investor, Brokers

This Version: November 10, 2022

Preliminary Draft – Comments Welcome – Please Do Not Cite

Acknowledgments: Corresponding author: Ben Marshall, School of Economics and Finance, Massey University, Private Bag 11-222, Palmerston North, New Zealand. Tel. 646 951 7033; fax 646 350 5651; e-mail B.Marshall@Massey.ac.nz. We thank the New Zealand Exchange for providing data for this research, seminar participants at Massey University, and, Jeremy Anderson, Jayan Parbhu, Joesph Redpath, Philip Solaz, Brendon Tai, and for useful comments. All errors are our own.

1. Introduction

Brokers have an informational advantage over other investors due to their ability to observe order flow. They may know that one of their clients has a large order to execute or observe repeated trading by another broker and infer that there is more to come. However, it is not clear whether brokers exploit this advantage. Brokers might look to profit from this opportunity. Or they may be conscious of the need to prioritize the execution of client orders at the best possible price and not take advantage of their informational advantage.

We address the question of the extent to which brokers use their informational advantage using short-selling transaction data from the New Zealand Exchange (NZX). They provide us with a rich data set that records the type of buyer and seller for every transaction, and whether the transaction involves a short seller. There are five buyer and seller types. "Wholesale" includes professional money managers such as mutual and pension funds. We refer to these investors as "institutional" investors. "Broker" refer to stockbrokers buying on their own account. "Employee" are employees of the brokers purchasing or selling for their own personal reasons. "Market Maker" are the purchases and sales of market makers. "Retail" are the purchases and sales of non-professional investors. We merge this NZX transaction data with quote data from Refinitiv Datascope. To be clear, transactions marked "broker" in our dataset do not include the transactions they facilitate for other investors. Rather, they are limited to the transactions that brokers trade on their own behalf, which are sometimes referred to as "proprietary trades."

Market makers are limited to a small number of stocks on the NZX, with most stocks traded in a fully order-driven manner as per most markets around the world.[1] The total market

[1] See https://www.world-exchanges.org/our-work/statistics

capitalization of NZX companies places it 48 out of 96 countries included in World Bank data[2], while market characteristic data indicates that the NZX is representative of global markets. For instance, Fong, Holden, and Trzcinka (2017) find that the average effective spread for NZX companies is 1.7% which is identical to the average effective spread across the 38 countries in their sample. The richness of the available data draws us to the NZX setting, but we suggest there is good reason to believe that the results in this paper are more generally of interest.

Short selling is common on the NZX, representing 16% of total sell transactions over the 2012-2021 period. Short sales are 8% of sell trade value. By way of comparison, Boehmer, Jones, and Zhang (2008) report that short transactions represent 13% of total volume on the NYSE, while Engelberg, Reed, and Ringgenberg (2012) report this number as 20% for a different period. Short sale transactions are a natural segment of the market in which to consider whether brokers take advantage of their informational advantage. Retail investors execute approximately 34% of all transactions on the NZX. However, it is difficult for retail investors to borrow stock to short sell and naked short selling is not permitted, so retail short selling is close to 0% of total short selling. Short selling is also uncommon among broker employees and market makers. Taking advantage of stock overvaluation via short selling on the NZX is therefore largely the domain of brokers and institutional investors. Wholesale and broker short sales represent 16% and 84% of total short sales respectively by number and 41% and 59% of total short sales respectively by trade value.

We expect wholesale short sellers to be well-informed and for them to short sell prior to a decline in returns (e.g., Boehmer, Jones, and Zhang, JF, 2008). We find this is the case. Our results also indicate that brokers do not exploit their informational advantage over institutional investors. Returns following broker short sales are no more negative than returns following wholesale

[2] https://data.worldbank.org/indicator/CM.MKT.LCAP.GD.ZS?most_recent_value_desc=true

investor short sales. Rather, broker trades are consistent with an attempt to stabilize the market. Unlike wholesale investors, brokers short sell less on stock days when there is negative news and more on days when there is positive news. Furthermore, there is more broker short selling on days when there is an increase buy-sell order imbalance, while there is more wholesale short selling on days when there is a decrease buy-sell order imbalance.

Our results could be due to brokers realizing that their brokerage revenue is sensitive to their reputations with clients and the execution costs they offer (e.g., Ben-Rephael and Israelsen, 2018; Di Maggio, Egan, and Franzoni, 2022). Therefore, brokers may be reluctant to use their informational advantage for their own benefit as this would likely result in inferior performance for their clients. Although this is the case for brokers in all jurisdictions, there is evidence that brokers use order flow information for their own benefit in other countries (e.g., Fecht, Hackethal, and Karabulut, 2018; Barbon, Di Maggio, Franzoni, and Landier, 2019). This suggests that there may be something else driving New Zealand broker actions.

New Zealand brokers are subject to the Advising Duty of Care Regulations in Section 9 of NZX Participant Rules. These state that "Each Client Advising Participant and its Advisers and any Employees: … b) must at all times place the interests of its clients before its own interests and in the case of Employees, those of his or her employer, or the person to whom he or she is contracted…. d) shall not place Client Assets at unreasonable risk from that Client Advising Participant's own business activities…" In contrast, U.S. stock broker-dealers are not typically considered as fiduciaries (e.g., Ayres and Fox, 2019). As Laby (2019, p. 4) notes, broker-dealers are "excluded from the definition of investment adviser [who do have a fiduciary duty] insofar as their advice is 'solely incidental' to brokerage services and the broker does not receive 'special

compensation' for providing advice." While we cannot be definitive regarding the link between regulation and our results, we do believe they are suggestive of this.

Our results indicate that broker short selling helps improve market quality. This is evident across all three market quality dimensions, being price efficiency, liquidity, and volatility (e.g., Boehmer, Fong, and Wu, 2021). We find that stocks traded on the NZX are, on average, not priced efficiently over 5-, 30-, and 60-minute intervals. Positive order imbalance in one interval predicts positive returns in the following interval. Short selling helps make pricing more efficient. Furthermore, the improvement in price efficiency is more evident with broker short selling over 5- and 30-minute intervals. Broker short-selling also improves market liquidity by reducing bid-ask spreads and volatility.

We contribute to several strands of the literature. The first is research into brokers and dealers. There are several papers that document the information advantage of brokers and dealers and what they do with this information. Di Maggio, Franzoni, Kermani, and Sommavilla (2019) find that U.S. stockbrokers that are central to broker and institutional investor networks pass on information that they obtain from executing trades to their best clients. Kondor and Pinter (2022) find that U.K. government bond dealers pass on information they obtain from their informed clients to their affiliates. Barbon, Di Maggio, Franzoni, and Landier (2019) show that U.S. brokers spread information relating to large portfolio liquidations to their clients. Li, Mukherjee, and Sen 2021) find that U.S. brokers benefit from placing the trades of company insiders and that analysts and mutual fund managers connected with these "inside brokers" benefit from this information advantage. McNally, Shkilko, and Smith (2017) also find evidence suggestive of some Canadian brokers tipping their clients of the insider trading of other clients. Fecht, Hackethal, and Karabulut (2018) show German banks make proprietary trades that profit at the expense of their clients. This

literature is consistent with the prior that NZX brokers will use their information advantage to earn larger returns from their short selling. There is also literature that is suggestive of broker concern for the quality of their trade execution. Ben-Rephael and Israelson (2018) find that clients who receive lower execution costs offer the reward of increased dollar trading volume. Di Maggio, Egan, and Franzoni (2022) show that investors are sensitive to both explicit and implicit trading costs.

The second literature we contribute to is that on short selling. The relative merits of short sales, which date back to the 1600s (e.g., Bris, Goetzmann, and Shi, 2007), have been the subject of debate. Allen and Gale (1992) suggest they can be used for stock price manipulation while Brunnermeier and Oehmke (2014) show that financial institutions can be vulnerable to predatory short selling. Given the leverage constraints in these entities, stock price declines induced by aggressive short selling can force the liquidation of investments that triggers further price declines. However, most of the literature suggests the benefits of short selling outweigh the costs. Saffi and Sigurdsson (2011) use a global data set of 12,600 stocks spanning 26 countries and find that stocks with fewer short-selling constraints have greater price efficiency. Furthermore, short selling is not associated with the occurrence of extreme negative returns or an increase in price instability. Beber and Pagano (2013) consider 17,000 stocks from 30 countries and find that the short-sale bans over the 2007-2009 period slowed price discovery, especially in bear markets, hurt liquidity, and did not support prices, except for U.S. financial stocks. In a U.S. study, Boehmer and Wu (2013) find that active short sellers make stock prices more accurate. For instance, post-earnings announcement drift is lower when there is greater shorting flow. Short selling also impacts company management. De Angelis, Grullon, and Michenaud (2017) show that the threat of short selling results in firms re-contracting with managers to avoid the underinvestment in firm-specific

human capital and/or risky projects. Grullon, Michenaud, and Weston (2015) find that small firms reduce equity issues and investment following a regulation change that relaxes short-selling constraints. Chang, Lin, and Ma (2019) show that short selling disciplines managers in merger and acquisition transactions, reducing the number of acquirers engaging in value destroying takeovers.

Finally, we contribute to the literature that documents differences between investor types. Nofsinger and Sias (1999) find, using annual institutional holdings data, that institutional investors engage in more positive feedback trading than individual investors and that herding by institutional investors impacts prices more than herding by individual investors. Griffin, Harris, and Topaloglu (2003) consider intraday trade and quote data and find that stocks that have performed the best the previous day are more likely to be purchased by institutions and sold by individuals. Fong, Gallagher, and Lee (2014) show that there are differences in the informativeness of individual investor trades based on the type of broker they select. Trades via full-service brokers are more informative than trades via discount retail brokers. Kelly and Tetlock (2017) show that short selling by retail investors predicts negative stock returns, and this is not subsumed by institutional investor short selling. Retail short selling predicts returns best in small stocks. Boehmer, Jones, and Zhang (2008) find the short-selling of non-program-based institutional investors is the most informative. More recently, Boehmer, Jones, Zhang, and Zhang (2021) develop a method for determining whether transactions are marketable purchases and sales by retail investors. They note that many researchers use trade size as proxy for whether a transaction is conducted by a retail investor, so their approach provides a more accurate measure. Our contribution is documenting differences in conditions that exist prior to short selling by broker and wholesale investors and differences in the impact of short selling by these two investor groups.

The rest of the paper is organized as follows. Section 2 describes the data. Our methodological approach and results are explained in Section 3. Section 4 contains our conclusions.

2. Data

We obtain transaction data for all stocks from the NZX for the January 2012 to August 2021 and Refinitiv Datascope for the same period. As the results in Table 1 show, the dataset includes 6,012,798 short transactions and 31,277,403 non-short sale transactions. Short sales therefore represent 16% of total sales (short and non-short sales). This is broadly consistent with the U.S. Boehmer, Jones, and Zhang (2008) finding that short transactions represent 13% of total volume on the NYSE, while Engelberg, Reed, and Ringgenberg (2012) show this number is 20% in a different period. Most short transactions relate to either broker or institutional investors. Of the 6,012,798 short transactions in our data set just 847 are executed by either retail investors, market makers, or broker employees.[3]

As noted in the NZX Participant Rule Procedures[4], all trades entered into the NZX Trading System must include a flag in the "Account" field which indicates whether the order relates to a Retail Client (R), Wholesale Client (W) (we refer to these as institutional investors), Employee or Prescribed Person (E), the Trading Participant "Broker" Acting as a Principle (P) or a Market Maker (M). There is also a Short Sale field in the system that must be checked for all short trades.

[3] The results in Appendix 1 indicate retail investors are the most active of these three investors in general. Retail investors represent 34% of all sell transactions on the NZX and 18% of the value of sell transactions. Both employee and market maker trades represent less than 1% of number and value of trades on the NZX.
[4] https://www.nzx.com/regulation/nzx-rules-guidance/participant-guidance

So, while brokers place orders on behalf of other investors, transactions assigned as being "Broker" pertain to trades on their own behalf.

Brokers account for 16% of total short trades while wholesale investors account for 84% of short trades. Broker short trades are larger on average, so these represent 41% of short transaction value, with institutional investors comprising the remaining 59%. Short sales represent 24% of total broker sales. The corresponding percentage is 22% for institutional investors. These trades tend to be smaller than other transactions so short trades represent 16% and 7% of total broker and institutional sales by value, respectively.

The mean short-sale trade size for brokers is materially higher than the equivalent number for institutional investors. However, the median short trade size for brokers is lower than for institutional investors. This indicates that there are some particularly large broker short sale transactions in the sample.

[Insert Table 1 About Here]

Appendix 2 shows the trading patterns throughout a trading day. The number of short-sale transactions increases throughout the trading day. It is four times larger in the last trading hour of the day (4-5pm NZT) than it is in the first trading hour (10-11am NZT). This contrasts with the pattern evident in sales that are not short sales, which exhibits a "U" shape, with more trading activity in the first and last hour of the day than at other intervals. There is a major difference between the intraday short-selling activity of broker and institutional investors. Brokers trade half as many shares in the last hour of the day as they do in the first hour of the day, while institutional investors trade over 17 times more shares in the last hour of the day compared to the first hour.

The Appendix 2 results indicate that broker short sales comprise 80% of all short sales in the first hour of the day, then decline throughout the day to 41% of total short sales in the second hour and just 10% in the last hour of the day. While in value terms brokers trade more in the last hour of the day than the first hour of the day, this increase (around two-fold) is small compared to the increase in short selling by institutional investors who trade 21 times the value in the last hour of the day compared to the first hour.

In unreported results, we find that this pattern in institutional short selling is related to the opening hours of the Australian Stock Exchange (ASX). The NZX is the first market to open each day and the ASX, which is a larger market is the second market to open. The ASX typically commences trading two hours after the NZX. However, when there is a misalignment of daylight savings times, the difference in opening time is three hours. In unreported results, we find that institutional investors delay more of their daily trading during these periods. In other unreported results we find that both broker and institutional short selling are more than 15% lower on Mondays than other weekdays, but this is broadly consistent with the degree to which overall trading activity is lower on Mondays.

As Figure 1 shows, there has been an increase in short selling activity on the NZX over time. In 2012 it represented 9% of total stock sales, but by 2021 this has increased to 21%. This increase can be attributed to increased short selling by institutional investors. The proportion of institutional short selling to total selling by all investors has increased from 4% in 2012 to 18% in 2021. The equivalent percentage for broker short selling was 5% in 2012 and has been 2% or 3% in the years since.

In Appendix 3 we document the number of short trades and trading value across stocks that are grouped by market capitalization, book-to-market ratio, return volatility, and liquidity,

respectively. In each instance we form sub-samples based on firms that are above and below the median of each characteristic. The results show that both broker and institutional investors' short trades exhibit a larger proportion to total trades of large firms compared to small firms. They are also more likely to short sell more volatile stocks and liquid stocks. The liquidity characteristic is particularly important to institutional investors.

[Insert Figure 1 About Here]

3. Results

The first step in our analysis is determining the returns following short selling by broker and institutional investors. Short sellers can make a profit when they can buy back shares at a lower price than they sold them at. However, we do not have data related to individual short sellers, so we do not know when a particular short seller buys shares back. We, therefore, follow other researchers (e.g., Boehmer, Jones, and Zhang, 2008) and use the returns following short selling as a proxy for the profits that short sellers can make.

The main question we want to address is whether brokers make a larger profit from their short selling than institutional investors. Our regression specification is:

$$Return_{i,t+h} = \alpha + \beta_1 Broker_t + \beta_2 Trade\ Size_t + \beta_3 Spread_t + \beta_4 Pre\ ASX\ Open_t + \varepsilon_{i,t} \qquad (1)$$

where $Return_{i,t+h}$ is the stock return based on quote midpoints at trade time t and h minutes after the trade. We measure returns for 5-minute, 30-minute, and 60-minute intervals following each

short sale transaction. $Broker_t$ is a dummy variable that equals one if the return is following a short sale by a broker and zero otherwise. $Trade\ Size_t$ is the natural logarithm of short trade value. $Spread_t$ is the short trade's effective spread. $Pre\ ASX\ Open_t$ is a dummy variable that equals one if a short sale occurs in the period prior to the open of the Australian Stock Exchange (ASX) and zero otherwise. The regression is run with firm and day fixed effects and, following Petersen (2009), standard errors are adjusted for clustering by firm and day.

The results presented in Table 2 show that the intercept, which reflects the profits of institutional short seller, are consistently negative and statistically significant, except for column 2 of the 5-minute interval. The broker dummy variable is not statistically significant, which indicates that there is no difference in the returns following broker and institutional investor short selling. Hence, we conclude that there is no evidence that brokers use their informational advantage to earn higher profits. There is some evidence that short sales profits are larger when trade sizes and spreads are smaller. Profits are also larger when short sales occur prior to the open of the ASX. There is likely to be more information asymmetry at this time which appears to provide an environment in which short sellers can earn larger returns.

Many stocks are dual listed on the NZX and ASX and it is possible that exploiting arbitrage opportunities is a motivation for some of the short selling. We therefore apply the regression specified in equation 1 separately to stocks that are and are not dual listed. The results indicate that our conclusions hold in both sub-samples. Institutional investors earn profits following short sales in both dual listed stocks and stocks that are nor dual listed. Furthermore, the profits earned by brokers are not larger than institutional investor profits. There is no evidence that brokers exploit their informational advantage in either sub-sample.

[Insert Table 2 About Here]

The fact that brokers do not use their informational advantage for their own benefit suggests they may have other motivations. For instance, it is possible that their short selling is conducted in such a way that it stabilizes the market and allows opportunities for better execution of client orders. We commence our investigation into this by considering if there is a relation between company news and the short selling. We obtain all news items for companies in our sample from the NZX Company Research database. There are 158,798 in total. We then follow Engelberg, Reed, and Ringgenberg (2012) and assign each news item as "positive" ("negative") if the stock return on the day of the announcement is positive (negative). As these authors note, this approach captures the impact of the news on market pricing, whereas other approaches, such as measuring the sentiment of words in the announcement, do not. It is possible that an announcement with many positive words would still lead to price declines if the prior expectation were of an even more positive nature.

We calculate the short sale ratio for each type of trader *p* per stock *i* on day *t* as:

$$Short_{i,p,t} = Short\ Trade\ Value_{i,p,t} / Total\ Trade\ Value_{i,p,t} \quad (2)$$

In Appendix 4 we present further summary statistics. We also calculate the percentage of short trades as the number of short trades across all stocks / (the number of short and non-short trades across all stocks) on a daily basis. The mean and median broker short percentages are 11.3% and 8.9% respectively, while the mean and median institutional investor short percentages are 8.3% and 8.0% respectively.

We then run the following regressions:

$$Short_{i,t+k} = \alpha + \beta_1 Neg\_News_{i,t} + \beta_2 Ret_{i,t+k-1} + \beta_3 Ret_{i,t+k-2} + \varepsilon_{i,t+k} \quad (3a)$$

$$Short_{i,t+k} = \alpha + \beta_1 Pos\_News_{i,t} + \beta_2 Ret_{i,t+k-1} + \beta_3 Ret_{i,t+k-2} + \varepsilon_{i,t+k} \quad (3b)$$

Our objective is determining the level of short selling on the *k*th day relative to the news event day where $k \in [-2, 2]$. The one- and two-day lagged returns are relative to the day of short activity. Each regression is run with firm and day fixed effects and, following Petersen (2009), standard errors are adjusted for clustering by firm and day.

The results in Table 3 indicate that brokers take a contrarian approach and trade against the return direction induced by news, while institutional investors adopt a momentum approach and trade in the same direction as the news. On positive news days when prices increase there is a sharp increase in broker short selling.[5] The coefficient is 1.047, which indicates an increase of 105%. This is statistically significant at the 1% level. The equivalent coefficient for the institutional investor regression is -0.189, which suggests that institutional investors reduce their short selling by 19% on days when there is a positive news story. This coefficient is also statistically significant at the 1% level. A similar pattern is evident on negative news days when prices decline. Brokers reduce their short selling by 40% (coefficient -0.407, *t*-statistic -2.409), while institutional investors increase their short selling by 42% (coefficient 0.419, *t*-statistic 5.468). Institutional investors appear to be adept at anticipating negative news. Their short selling

[5] Our results are similar when we divide each party's total daily short value by total trade value across parties for a stock in a day.

is higher than normal on each of the two days prior to the news and this continues in the two days following the news.

[Insert Table 3 About Here]

We now consider whether broker and institutional investor short selling are influenced by order imbalance. We assign transactions as buyer-initiated or seller-initiated using the Lee and Ready (1991) algorithm. If a trade occurs at the ask price or closer to the ask price than the bid price the trade is assigned as being a buyer-initiated trade. If a trade takes place at the bid price or closer to the bid price than the ask price the trade is designated as a seller-initiated trade. We apply the tick rules for trades at the midpoint. We run the following regression:

$$Short_{i,t} = \alpha + \beta_1 OIB_{i,t} + \beta_2 OIB_{i,[t\text{-}5,t\text{-}1]} + \beta_3 Spread_{i,t} + \beta_4 Std\ Dev_{i,t} + \beta_5 Std\ Dev_{i,[t\text{-}5,t\text{-}1]} + \beta_6 Turnover_{i,[t\text{-}5,t\text{-}1]} + \varepsilon_{i,t} \quad (4)$$

where $OIB_{i,t}$ is order imbalance, calculated as the difference between buyer-initiated and seller-initiated trades divided by the total trades for stock *i* on day *t*; and $OIB_{i,[t\text{-}5,t\text{-}1]}$ is the average of order imbalance over the previous five days. $Spread_{i,t}$ is the daily average of value-weighted effective spread, $Std\ Dev_{i,t}$ is the daily standard deviation for stock *i*, which is measured as the difference between maximum and minimum prices divided by the maximum price on day *t. Std* $Dev_{i,[t\text{-}5,\ t\text{-}1]}$ is the average standard deviation over the previous five days. $Turnover_{i,[t\text{-}5,t\text{-}1]}$ is the average turnover over the previous five days where turnover is daily traded volume divided by total shares outstanding. Each regression is run with firm and day fixed effects and, following Petersen (2009), standard errors are adjusted for clustering by firm and day.

The results in Table 4 provide more evidence of brokers taking a contrarian approach to their short selling and of institutional investors taking a momentum approach. The positive coefficient of 0.460 for the OIB_t variable for broker short sales suggests that brokers short sell 4.6% more on stock days when there is a 10% increase in buying pressure relative to selling pressure. The equivalent coefficient for institutional short selling is -0.733, which indicates 7.3% less short selling by institutional investors on stock days when order imbalance reduces by 10%. Both brokers and institutional investors short sell more on days when volatility is higher and on days following a period of heightened volatility. Institutional investors short sell less following a period of higher trading volume.

[Insert Table 4 About Here]

We now turn our attention to addressing whether broker short selling has an impact on market quality. As Boehmer, Fong, and Wu (2021) note, there are three dimensions to market quality. An improvement in market quality is characterized by an increase in price efficiency and liquidity, and a decline in volatility.

The first aspect of market quality we consider is price efficiency. Miller (1977) predicts that short-selling restrictions can be expected to result in stocks being overpriced. He suggests that prices will reflect the beliefs of investors with a "bullish" expectation but investors with a "bearish" expectation who do not own the stock are unable to reflect their views in stock prices. Diamond and Verrecchia's (1987) model predicts that short selling restrictions inhibit informed investors with a negative view on stock prices from having this view reflected in stock price, and this leads to inefficient pricing. The empirical evidence from other markets is consistent with this. Bris,

Goetzmann, and Zhu (2007) find, using data from 46 countries, that countries that allow short selling have securities that reflect negative information more quickly. Saffi and Sigurdsson (2011) find that stocks with higher short-selling constraints have lower price efficiency in a data set including 26 countries. Boehmer and Wu (2013) find that stock prices being more accurate, and post earnings announcement drift is lower when there are active short sellers.

We, therefore, consider whether there is a relation between the amount of short selling and price efficiency. We follow Chordia, Roll, and Subrahmanyam (2005) and measure price efficiency by the extent to which order imbalance in one interval can be used to forecast returns in the next interval. If prices are weak-form efficient then past trading information should not be able to be used to predict prices (e.g., Fama, 1970). However, complete efficiency cannot be expected to happen instantaneously as investors need time to react to new information and impound it into price. Chordia, Roll, and Subrahmanyam (2005) find that order imbalance predicts future returns over intervals of a few minutes, but information is impounded into the price of NYSE stocks over five-minute to 1-day intervals.

We measure order imbalance as the difference between buyer-initiated and seller-initiated volume scaled by total traded volume over a *h*-minute interval and run the following regressions:

$$Return_{i,h} = \alpha + \beta_1 OIB_{i,h-1} + \beta_2 OIB_{i,h-1} * Short_{i,h-1} + \varepsilon_{i,h} \quad (5a)$$

$$Return_{i,h} = \alpha + \beta_1 OIB_{i,h-1} + \beta_2 OIB_{i,h-1} * BmW\_Short_{i,h-1} + \varepsilon_{i,h} \quad (5b)$$

where $Return_{i,h}$ is the interval midpoint return, where *h* is either 5-minute, 30-minute, or 60-minute interval. *Short* is a dummy variable that equals one of there is short selling in interval *h*-1 and zero

otherwise, and *BmW_Short* is a variable that equal to one when the net or broker minus institutional short selling in interval *h*-1 is positive and zero otherwise. We test two alternative specifications. The first is based on difference in the number of shares traded, while the second is based on the difference in the value of shares traded.

The results in Table 5 indicate that there is a positive relation between order imbalance in each of the three intervals and returns in the following interval. This indicates that NZX stocks are not efficiently priced over 5-, 30-, and 60-minute intervals with respect to order imbalance on average. However, in intervals when there is short selling this inefficiency is reduced. Furthermore, the inefficiency is reduced further in 5- and 30-minute intervals when broker short selling is higher than institutional investor short selling. This indicates that short selling improves market efficiency, and the improvement is more pronounced for broker short selling.

[Insert Table 5 About Here]

We next consider whether short selling in general or short selling by either brokers or institutional investors influences liquidity. The Diamond and Verrecchia (1987) model suggests that short-selling restrictions increase the bid-ask spread due to delaying price discovery and resolving uncertainty about company fundamentals. However, as Beber and Pagano (2013) point out, this outcome assumes that short-selling restrictions impact informed and uninformed investors equally. If short sale restrictions reduce the proportion of informed traders on the sell side, it is possible that they will reduce bid-ask spreads and therefore increase liquidity. Beber and Pagano (2013) find that short-selling bans around the world during the global financial crisis resulted in a decline in liquidity, especially for smaller firms with no listed options. This result is also evident

in the study of Boehmer, Jones, and Zhang (2013) who focus on the U.S. Securities and Exchange Commission's (SEC) ban on short selling of U.S. financial stocks. However, there is also evidence of the reverse relationship. Charoenrook and Daouk (2005) use data for 111 countries and measure the impact of short selling restrictions on liquidity at the market level. They find liquidity is higher when short selling is permitted.

We measure liquidity as the average quoted spread on each stock in a 5-, 30-, and 60-minute intervals and regress it on the short variables in the lagged interval. The regression results are reported in Table 6. The insignificant coefficient for the *Short* dummy indicates that short selling in general has no impact on liquidity. However, the coefficients of *BmW_ShortTrade* and *BmW_ShortValue* are negative and statistically significant, indicating that when broker short selling is higher than institutional investor short selling, spreads decrease, and liquidity improves. This is evident in all three intervals.

[Insert Table 6 About Here]

Chang, Cheng, and Yu (2007) consider the impact of short selling by investigating the outcome following Hong Kong listed stocks being added to a list where short selling is permitted. They find that the volatility of stocks increases when they can be short sold. We regress stock price volatility, which is measured as the difference between max and min prices scaled by the max price in the 5-, 30- or 60-minute interval, on the short variables as in Table 6. We find consistent evidence that short selling leads to a reduction in volatility. Furthermore, the coefficients of *BmW_ShortTrade* and *BmW_ShortValue* are consistently negative and statistically significant.

This suggests that the volatility decrease is larger when broker short selling is larger than institutional investor short selling.

[Insert Table 7 About Here]

4. Conclusions

Brokers have access to order flow data which gives them an informational advantage over other investors. We consider whether brokers exploit this advantage through their proprietary trading or whether they prioritize the execution of client orders at the best possible price and do not take advantage of their informational advantage. We address these issues using short selling data for broker investors who are trading on their own account and institutional investors which include mutual and sovereign wealth funds from the New Zealand Exchange (NZX).

Our results indicate that institutional investors profit from their short-selling activity. However, brokers do not use their informational advantage to earn larger profits. Rather, broker trades are consistent with a motivation of attempting to stabilize the market. Specifically, we find that brokers short sell less on stock days where these is negative news, while institutional investors short sell more on these days. On days when there is positive news brokers short sell more and institutional investors short sell less. This indicates that broker short sales are against the prevailing price movement while institutional short selling is in the same direction. This pattern is also evident in the relation between buy-sell order imbalance sand short selling. Brokers sell more when buy-sell order imbalance increases while institutional investors short sell more when it decreases.

Broker short selling improves market quality. We show that NZX stocks are not priced efficiently with respect to order imbalance over 60-minute intervals. Rather, positive order imbalance in one interval predicts positive returns in the following interval. However, short selling helps make pricing more efficient. Moreover, this improvement is greater broker short selling. Broker short-selling also improves market liquidity by reducing bid-ask spreads and volatility.

The actions of NZX maybe due to them determining that it is in their business interests to prioritize client order execution so as to obtain more or maintain their current market share in the competitive broking business. However, there is international evidence that shows that brokers do use order flow information for their own benefit. This suggests that the result we document may be attributable to regulation. NZX Participant Rules require brokers to "all times place the interests of its clients before its own interests." This contrasts with U.S. legislation which states that brokers do not generally have a fiduciary duty of care to their clients.

References

Allen, Franklin, and Gale, Douglas. (1992). Stock-price manipulation. *Review of Financial Studies*, 5(3), 503–529.

Barbon, Andrea, Di Maggio, Marco, Franzoni, Francesco and Landier, Augustin. (2019). Brokers and order flow leakage: Evidence from firm sales. *Journal of Finance*, 64(6), 2707-2749.

Beber, Alessandro, and Pagano, Marco. (2013). Short-selling bans around the world: Evidence from the 2007–09 crisis. *Journal of Finance*, 68(1), 343–381.

Ben-Rephael, Azi and Israelsen, Ryan. (2018). Are some clients more equal than others? An analysis of asset management companies' execution costs. *Review of Finance*, 1705-1736.

Boehmer, Ekkehart, Fong, Kingsley, and Wu, Juan Julie. (2021). Algorithmic trading and market quality: International evidence. *Journal of Financial and Quantitative Analysis*, 56, 2659-2688.

Boehmer, Ekkehart, Jones, Charles M., and Zhang, Xiaoyan. (2008). Which shorts are informed? *Journal of Finance*, 63(2), 491–527.

Boehmer, Ekkehart, Jones, Charles M., Zhang, Xiaoyan, and Zhang, Xinran. (2021). Tracking retail investor activity. *Journal of Finance*, 76(5), 2249–2305.

Boehmer, Ekkehart, and Wu, Juan Julie. (2012). Short selling and the price discovery process. *Review of Financial Studies*, 26(2), 287–322.

Boehmer, Ekkehart, Jones, Charles M., and Zhang, Xiaoyan. (2013). Shacking short sellers: the 2008 shorting ban. *Review of Financial Studies*, 26(6), 1363-1400.

Boehmer, Ekkehart, Jones, Charles M., Zhang, Xiaoyan, and Zhang, Xinran. (2021). Tracking retail investor activity. *Journal of Finance*, 76(5), 2249–2305.

Bris, Arturo, Goetzmann, William N., and Zhu, Ning. (2007). Efficiency and the bear: Short sales and markets around the world. *Journal of Finance*, 62(3), 1029–1079.

Brunnermeier, Markus K., and Oehmke, Martin. (2013). Predatory short selling. *Review of Finance*, 18(6), 2153–2195.

Chang, Eric C., Lin, Tse-Chun, and Ma, Xiaorong. (2019). Does short-selling threat discipline managers in mergers and acquisitions decisions? *Journal of Accounting and Economics*, 68(1), 101223.

Chang, Eric C., Cheng, Joseph W. and Yu, Yinghui. (2007). Short-sales constraints and price discovery: Evidence from the Hong Kong market. *Journal of Finance*, 62(5), 2097-2122.

Charoenrook, Anchada. and Daouk, Hazem. (2005). A study of market-wide short selling restrictions. SSRN Working Paper: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=687562

Chordia, Tarun, Roll, Richard, and Subrahmanyam, Avanidhar. (2005). Evidence on the speed of convergence to market efficiency. *Journal of Financial Economics*, 76(2), 271–292.

De Angelis, David, Grullon, Gustavo, and Michenaud, Sébastien. (2017). The effects of short-selling threats on incentive contracts: Evidence from an experiment. *Review of Financial Studies*, 30(5), 1627–1659.

Diamond, Douglas W., and Verrecchia, Robert E. (1987). Constraints on short-selling and asset price adjustment to private information. *Journal of Financial Economics*, 18, 277-311.

Di Maggio, Marco, Egan, Mark and Franzoni, Francesco. (2022). The value of intermediation in the stock market. *Journal of Financial Economics*, 145, 208-233.

Di Maggio, Marco, Franzoni, Francesco, Kermani, Amir, and Sommavilla, Carlo. (2019). The relevance of broker networks for information diffusion in the stock market. *Journal of Financial Economics*, 134, 419-446.

Engelberg, Joseph E., Reed, Adam V., and Ringgenberg, Matthew C. (2012). How are shorts informed? *Journal of Financial Economics*, 105(2), 260–278.

Fama, Eugene F. (1970). Efficient capital markets: A review of theory and empirical work. *Journal of Finance*, 25(2), 383–417.

Fecht, Falko, Hackethal, Andreas, and Karabulut, Yigitcan. (2018). Is proprietary trading detrimental to retail investors? *Journal of Finance*, 73(3), 1323-1361.

Fong, Kingsley Y. L., Gallagher, David R., and Lee, Adrian D. (2014). Individual investors and broker types. *Journal of Financial and Quantitative Analysis*, 49(2), 431–451.

Fong, Kingsley Y. L., Holden, Craig W., and Trzcinka, Charles A. (2017). What are the best proxies for global research? *Review of Finance*, 1355–1401.

Griffin, John M., Harris, Jeffrey H., and Topaloglu, Selim. (2003). The dynamics of institutional and individual trading. *Journal of Finance*, 58(6), 2285–2320.

Grullon, Gustavo, Michenaud, Sébastien, and Weston, James P. (2015). The real effects of short-selling constraints. *Review of Financial Studies*, 28(6), 1737–1767.

Jain, Archana, Jain, Pankaj K., McInish, Thomas H., and McKenzie, Michael. (2013). Worldwide reach of short selling regulations. *Journal of Financial Economics*, 109(1), 177–197.

Kelley, Eric K., and Tetlock, Paul C. (2016). Retail short selling and stock prices. *Review of Financial Studies*, 30(3), 801–834.

Kondor, Peter and Pinter, Gabor. (2022). Clients connections: Measuring the role of private information in decentralized markets. *Journal of Finance*, 67, 505-544.

Lee, Charles M. C., and Ready, Mark J. (1991). Inferring trade direction from intraday data. *Journal of Finance*, 46(2), 733–746.

McNally, William, Shkilko,Andriy, and Smith, Brian. (2017). Do brokers of insiders tip other clients? *Management Science*, 63(2), 317-332.

Massa, Massimo, Zhang, Bohui, and Zhang, Hong. (2015). The invisible hand of short selling: Does short selling discipline earnings management? *Review of Financial Studies*, 28(6), 1701–1736.

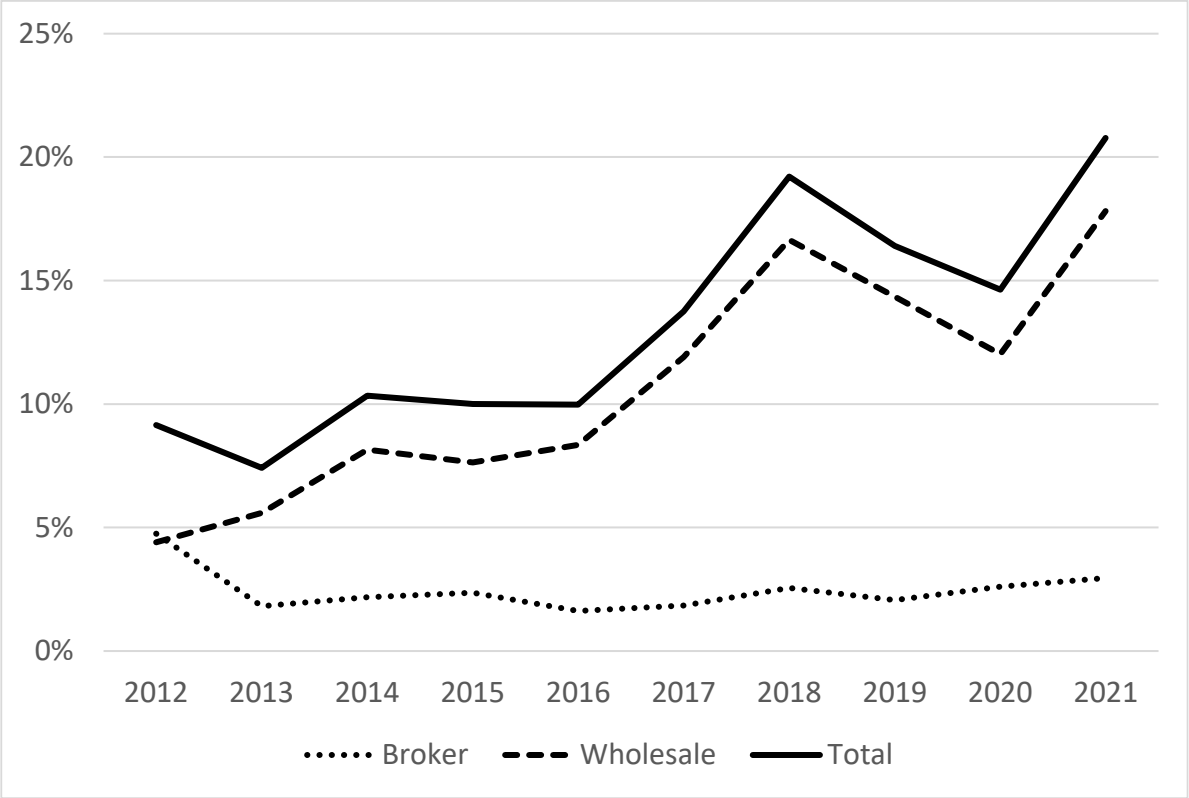
Miller, Edward. (1977). Risk, uncertainty, and divergence of opinion. *Journal of Finance*, 32, 1151-1168.

Nofsinger, John R., and Sias, Richard W. (1999). Herding and feedback trading by institutional and individual investors. *Journal of Finance*, 54(6), 2263–2295.

Petersen, Mitchell A. (2008). Estimating standard errors in finance panel data sets: Comparing approaches. *Review of Financial Studies*, 22(1), 435–480.

Saffi, Pedro A. C., and Sigurdsson, Kari. (2010). Price efficiency and short selling. *Review of Financial Studies*, 24(3), 821–852.

Figure 1
Short Selling Trades as a Percentage of All Sale Transactions



These results are based on transaction data from the New Zealand Exchange and quote data from Refinitiv Datascope for all New Zealand stocks for the January 2012 to August 2021 period. The "Other" category includes transactions from retail investors, broker employees, and market makers.

Table 1: Descriptive Statistics

		Broker	Wholesale	Other	Total
Panel A: Number of Trades					
Short Trades		950,146	5,061,805	847	6,012,798
Buy Trades		2,506,112	21,980,048	12,804,041	37,290,201
Sell Trades		2,963,623	17,748,853	10,564,927	31,277,403
Short Trades as % of Short + Sell Trades		24%	22%	0%	16%
% of Total Short Trades		16%	84%	0%	100%
% of Total Sell Trades		9%	57%	34%	100%
Panel B: Value of Trades (000s)					
Short Trades		8,277,393	11,969,896	5,546	20,252,835
Buy Trades		53,472,739	164,961,023	42,350,406	260,784,168
Sell Trades		42,717,894	153,739,052	44,074,386	240,531,333
Short Trades as % of Short + Sell Trades		16%	7%	0%	8%
% of Total Short Trades		41%	59%	0%	100%
% of Total Sell Trades		18%	64%	18%	100%
Panel C: Trade Sizes and Value					
Trade Size Short Trades	Mean	2,460	473	2,243	787
	Median	62	69	181	68
Trade Size Other Trades	Mean	4,424	2,445	2,390	2,614
	Median	144	85	106	96
Trade Value Short Trades	Mean	8,712	2,365	6,548	3,368
	Median	299	517	840	498
Trade Value Other Trades	Mean	14,414	8,662	4,172	7,690
	Median	581	581	328	505

These results are based on transaction data from the New Zealand Exchange and quote data from Refinitiv Datascope for all New Zealand stocks for the January 2012 to August 2021 period. The "Other" category includes transactions from retail investors, broker employees, and market makers.

Table 2: Returns Following Short Selling

	5-Minute		30-Minute		60-Minute	
Constant	-0.030***	-0.003	-0.044***	-0.018**	-0.046***	-0.024***
	(-41.705)	(-0.449)	(-27.385)	(-1.978)	(-18.922)	(-2.613)
Broker	-0.003	0.004	-0.012	0.015	-0.025	0.009
	(-0.674)	(0.821)	(-0.893)	(1.511)	(-1.366)	(0.786)
Trade Size		-0.002***		-0.002**		-0.001
		(-3.978)		(-2.049)		(-0.844)
Spread		-0.058***		-0.029		-0.039
		(-3.538)		(-0.957)		(-1.427)
Pre ASX Open		-0.01		-0.087***		-0.115***
		(-1.266)		(-3.310)		(-3.466)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Day fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R2	0.031	0.034	0.078	0.080	0.077	0.079
Observations	5,974,378	5,974,378	5,940,933	5,940,933	5,900,762	5,900,762

These results are based on transaction data from the New Zealand Exchange and quote data from Refinitiv Datascope for all New Zealand stocks for the January 2012 to August 2021 period. Returns are based on quote midpoints at trade time *t* and *h* minutes (*h* = 5, 30, 60) after a trade. *Broker* is a dummy variable that equals one if the return is following a short sale by a broker and zero otherwise. *Trade Size* is the natural logarithm of short trade value. *Spread* is the short trade's effective spread. *Pre ASX Open* is a dummy variable that equals one if a short sale occurs in the period prior to the open of the Australian Stock Exchange (ASX) and zero otherwise. Standard errors are adjusted for clustering by firm and day. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 3: Short Selling and News

	t-2	*t*-1	*t* = 0	*t*+1	*t*+2
Panel A: Positive News					
			Broker Short Selling		
POS_News	-0.117	-0.220***	1.047***	0.337***	0.076
	(-1.566)	(-2.675)	(5.809)	(3.245)	(0.776)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Day fixed effects	Yes	Yes	Yes	Yes	Yes
Adjusted R2	0.094	0.095	0.096	0.095	0.095
Observations	313,345	313,619	313,893	313,893	313,893
			Institutional Short Selling		
POS_News	-0.019	-0.005	-0.189***	0.000	0.010
	(-0.476)	(-0.136)	(-2.875)	(-0.000)	(0.237)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Day fixed effects	Yes	Yes	Yes	Yes	Yes
Adjusted R2	0.115	0.115	0.115	0.115	0.115
Observations	313,345	313,619	313,893	313,893	313,893
Panel B: Negative News					
			Broker Short Selling		
NEG_News	0.001	0.269***	-0.407**	-0.163	0.024
	(0.009)	(3.188)	(-2.409)	(-1.368)	(0.256)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Day fixed effects	Yes	Yes	Yes	Yes	Yes
Adjusted R2	0.094	0.095	0.095	0.095	0.095
Observations	313,345	313,619	313,893	313,893	313,893
			Institutional Short Selling		
NEG_News	0.196***	0.193***	0.419***	0.219***	0.195***
	(4.736)	(4.467)	(5.468)	(4.522)	(4.173)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Day fixed effects	Yes	Yes	Yes	Yes	Yes
Adjusted R2	0.115	0.115	0.115	0.115	0.115
Observations	313,345	313,619	313,893	313,893	313,893

These results are based on transaction data from the New Zealand Exchange and quote data from Refinitiv Datascope for all New Zealand stocks for the January 2012 to August 2021 period. Company news is obtained from the NZX Company Research database. We assign each news item as *POS_News* (*NEG_News*) if the stock return on the day of the announcement is positive (negative). The analysis involves regressing the daily number of short to total trades on day $t + k$ ($k \in [-2, 2]$) on positive or negative news dummy (defined at day t). We control for the one- and two-day lagged returns relative to the day of short activity. Standard errors are clustered by firm and day. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 4: Short Selling and Market Conditions

	Broker		Wholesale	
OIB_t	0.376***	0.460***	-0.495***	-0.733***
	(5.801)	(5.786)	(-5.747)	(-5.680)
$OIB_{[t\text{-}5,t\text{-}1]}$	-0.100	-0.022	-0.821***	-1.084***
	(-0.519)	(-0.099)	(-5.684)	(-5.503)
$Spread_t$		-0.022		-0.012
		(-1.581)		(-1.214)
Std Dev_t		2.410*		1.713***
		(1.764)		(3.090)
Std $Dev_{[t\text{-}5,t\text{-}1]}$		8.148**		5.193***
		(2.592)		(2.860)
$Turnover_{[t\text{-}5,t\text{-}1]}$		0.000		-0.000*
		(1.518)		(-1.870)
Firm fixed effects	Yes	Yes	Yes	Yes
Day fixed effects	Yes	Yes	Yes	Yes
Adjusted R2	0.095	0.084	0.118	0.116
Observations	314,581	216,292	314,581	216,292

These results are based on transaction data from the New Zealand Exchange and quote data from Refinitiv Datascope for all New Zealand stocks for the January 2012 to August 2021 period. The analysis involves regressing the daily number of short to total trades on order imbalance and the control variables of spread, standard deviation, and volume. OIB_t is order imbalance, calculated as the difference between buyer-initiated and seller-initiated trades divided by the total trades for a stock on day *t*; and $OIB_{[t\text{-}5,t\text{-}1]}$ is the average of order imbalance over the previous five days. $Spread_t$ is the daily average of value-weighted effective spread, $Std\ Dev_t$ is the daily standard deviation for a stock, which is measured as the difference between maximum and minimum prices divided by the maximum price on day *t.* $Std\ Dev_{[t\text{-}5,\ t\text{-}1]}$ is the average standard deviation over the previous five days. $Turnover_{[t\text{-}5,t\text{-}1]}$ is the average turnover over the previous five days where turnover is daily traded volume divided by total shares outstanding. Standard errors are clustered by firm and day. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 5: Price Efficiency Following Short Selling

	5-Minute			30-Minute			60-Minute		
OIB	0.019***	0.030***	0.029***	0.033***	0.038***	0.036***	0.043***	0.041***	0.041***
	(14.299)	(11.617)	(11.565)	(12.484)	(9.347)	(9.596)	(10.287)	(6.567)	(6.752)
OIB*Short							0.000		
							(-0.000)		
OIB*BmW_ShortTrade		-0.015***			-0.011**			-0.004	
		(-6.224)			(-2.570)			(-0.419)	
OIB*BmW_ShortValue			-0.015***			-0.012***			-0.007
			(-6.283)			(-2.950)			(-0.926)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Day fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R2	0.006	0.009	0.009	0.018	0.014	0.015	0.031	0.025	0.026
Observations	1,901,386	387,509	408,957	625,695	164,199	182,763	376,429	115,224	130,312

These results are based on transaction data from the New Zealand Exchange and quote data from Refinitiv Datascope for all New Zealand stocks for the January 2012 to August 2021 period. The dependent variable is midpoint returns in an *h*-minute interval (*h* = 5, 30, or 60). *OIB* is order imbalance, calculated as the difference between buyer-initiated and seller-initiated trades divided by the total trades for a stock within an interval. *Short* is a dummy variable that equals one of there is short selling in interval *h*-1 and zero otherwise, and *BmW_Short* is a variable that equal to one when the net or broker minus institutional short selling in interval *h*-1 is positive and zero otherwise. We test two alternative specifications. The first is based on difference in the number of shares traded, *BmW_ShortTrade*, while the second is based on the difference in the value of shares traded, *BmW_ShortValue*. Standard errors are clustered by firm and day. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 6: Liquidity Following Short Selling

	5-Minute			30-Minute			60-Minute		
ShortTrade	0.000			-0.002			0.001		
	(0.208)			(-0.924)			(0.229)		
BmW_ShortTrade		-0.008***			-0.009***			-0.015***	
		(-3.549)			(-3.454)			(-4.080)	
BmW_ShortValue			-0.008***			-0.008***			-0.013***
			(-3.540)			(-3.229)			(-4.058)
Lag Liquidity	0.647***	0.655***	0.655***	0.567***	0.561***	0.561***	0.503***	0.521***	0.491***
	(30.669)	(18.350)	(18.874)	(13.265)	(6.678)	(6.810)	(11.735)	(7.437)	(6.606)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Day fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R2	0.670	0.750	0.748	0.695	0.766	0.762	0.674	0.723	0.714
Observations	1,155,079	196,343	211,155	563,310	140,147	158,257	356,791	98,773	114,388

These results are based on transaction data from the New Zealand Exchange and quote data from Refinitiv Datascope for all New Zealand stocks for the January 2012 to August 2021 period. The dependent variable is the average quoted spread on each stock in an *h*-minute interval (*h* = 5, 30, or 60). *Short* is a dummy variable that equals one of there is short selling in interval *h*-1 and zero otherwise, and *BmW_Short* is a variable that equal to one when the net or broker minus institutional short selling in interval *h*-1 is positive and zero otherwise. We test two alternative specifications. The first is based on difference in the number of shares traded, *BmW_ShortTrade*, while the second is based on the difference in the value of shares traded, *BmW_ShortValue.* Standard errors are clustered by firm and day. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 7: Volatility Following Short Selling

	5-Minute			30-Minute			60-Minute		
ShortTrade	-0.000***			-0.000***			-0.001***		
	(-8.717)			(-3.557)			(-3.252)		
BmW_ShortTrade		-0.000***			-0.001***			-0.001***	
		(-9.522)			(-7.135)			(-5.430)	
BmW_ShortValue			-0.000***			-0.001***			-0.001***
			(-10.767)			(-6.844)			(-5.960)
Lag Volatility	0.072***	0.034**	0.051**	0.244***	0.299***	0.292***	0.350***	0.405***	0.377***
	(7.035)	(2.275)	(2.573)	(5.340)	(4.442)	(4.515)	(5.382)	(5.952)	(5.421)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Day fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R2	0.025	0.017	0.018	0.116	0.147	0.142	0.199	0.241	0.222
Observations	1,921,534	395,129	416,842	637,933	168,698	187,608	379,782	108,496	124,407

These results are based on transaction data from the New Zealand Exchange and quote data from Refinitiv Datascope for all New Zealand stocks for the January 2012 to August 2021 period. The dependent variable is volatility measured as the difference between max and min prices scaled by the max price in an *h*-minute interval (*h* = 5, 30, or 60). *Short* is a dummy variable that equals one of there is short selling in interval *h*-1 and zero otherwise, and *BmW_Short* is a variable that equal to one when the net or broker minus institutional short selling in interval *h*-1 is positive and zero otherwise. We test two alternative specifications. The first is based on difference in the number of shares traded, *BmW_ShortTrade*, while the second is based on the difference in the value of shares traded, *BmW_ShortValue*. Standard errors are clustered by firm and day. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Appendix 1: Retail, Employee, and Market Maker Descriptive Statistics

	Retail	Employee	Market Maker	Total
Panel A: Number of Trades				
Short Trades	335	499	13	6,012,798
Buy Trades	11,265,587	32,856	25,638	37,290,201
Sell Trades	10,484,288	46,272	34,367	31,277,403
Short Trades as % of Short + Sell Trades	0%	1%	0%	16%
% of Total Short Trades	0%	0%	0%	100%
% of Total Sell Trades	34%	0%	0%	100%
Panel B: Value of Trades (000s)				
Short Trades	2,325	3,102	119	20,252,835
Buy Trades	37,331,450	146,518	941,454	260,784,168
Sell Trades	43,013,293	187,068	874,025	240,531,333
Short Trades as % of Short + Sell Trades	0%	2%	0%	8%
% of Total Short Trades	0%	0%	0%	100%
% of Total Sell Trades	18%	0%	0%	100%

These results are based on transaction data from the New Zealand Exchange and quote data from Refinitiv Datascope for all New Zealand stocks for the January 2012 to August 2021 period. The last column shows the total number of trades or trade values across all participants, including brokers and wholesale investors.

Appendix 2: Short Sales by Time of the Day

Panel A: Number of Short Trades

	Short Trades				As % of (Short + Sell) Trades				As % of Total Short Trades		
Hour	Broker	Wholesale	Other	Short Total	Broker	Wholesale	Other	Short Total	Broker	Wholesale	Other
10-11	259,165	66,090	94	325,349	25.7%	6.0%	0.0%	6.0%	79.7%	20.3%	0.0%
11-12	111,529	160,167	122	271,818	26.7%	12.3%	0.0%	9.1%	41.0%	58.9%	0.0%
12-1	127,898	898,417	89	1,026,404	25.0%	26.0%	0.0%	19.4%	12.5%	87.5%	0.0%
1-2	109,346	854,601	145	964,092	23.4%	25.0%	0.0%	19.2%	11.3%	88.6%	0.0%
2-3	108,381	910,292	191	1,018,864	23.9%	24.0%	0.0%	18.9%	10.6%	89.3%	0.0%
3-4	107,023	998,366	135	1,105,524	22.5%	23.4%	0.0%	18.7%	9.7%	90.3%	0.0%
4-5	126,523	1,173,172	71	1,299,766	21.7%	21.4%	0.0%	18.0%	9.7%	90.3%	0.0%

Panel B: Value of Short Trades

	Short Value				As % of (Short + Sell) Value				As % of Total Short Value		
Hour	Broker	Wholesale	Other	Short Total	Broker	Wholesale	Other	Short Total	Broker	Wholesale	Other
10-11	932,561	168,216	581	1,101,357	18.3%	1.4%	0.0%	4.4%	84.7%	15.3%	0.1%
11-12	820,273	325,222	886	1,146,381	17.5%	2.5%	0.0%	4.9%	71.6%	28.4%	0.1%
12-1	1,208,623	2,067,320	583	3,276,527	15.8%	8.2%	0.0%	8.3%	36.9%	63.1%	0.0%
1-2	1,104,633	1,802,168	639	2,907,439	14.7%	7.5%	0.0%	7.9%	38.0%	62.0%	0.0%
2-3	1,148,379	1,888,126	805	3,037,311	15.6%	7.8%	0.0%	8.1%	37.8%	62.2%	0.0%
3-4	1,231,231	2,086,683	1,158	3,319,071	15.4%	8.1%	0.0%	8.3%	37.1%	62.9%	0.0%
4-5	1,820,608	3,611,392	895	5,432,895	17.1%	8.7%	0.0%	9.3%	33.5%	66.5%	0.0%

These results are based on transaction data from the New Zealand Exchange and quote data from Refinitiv Datascope for all New Zealand stocks for the January 2012 to August 2021 period. The "Other" category includes transactions from retail investors, broker employees, and market makers.

Appendix 3: Short Sales by Stock Characteristics

	Broker			Wholesale		
	Short (1)	Sell (2)	(1) / [(1) + (2)]	Short (3)	Sell (4)	(3) / [(3) + (4)]
Panel A: Number of Trades						
Small	22,646	95,875	19.1%	44,331	406,753	9.8%
Large	597,410	1,772,094	25.2%	4,877,125	16,554,112	22.8%
Value	208,769	666,024	23.9%	1,377,655	5,016,771	21.5%
Growth	393,890	1,133,422	25.8%	3,461,158	11,682,163	22.9%
Low Volatility	656,494	2,200,808	23.0%	1,849,542	8,847,388	17.3%
High Volatility	293,650	762,814	27.8%	3,212,263	8,901,454	26.5%
Low Liquidity	43,247	180,380	19.3%	41,602	487,256	7.9%
High Liquidity	906,899	2,783,243	24.6%	5,020,203	17,261,597	22.5%
Panel B: Value of Trades						
Small	85,080	689,560	11.0%	44,541	2,992,885	1.5%
Large	7,202,921	34,881,645	17.1%	11,397,810	136,407,961	7.7%
Value	2,223,665	11,531,392	16.2%	3,149,184	45,680,949	6.4%
Growth	4,810,109	22,647,798	17.5%	8,121,270	89,875,824	8.3%
Low Volatility	5,688,417	32,221,223	15.0%	5,415,090	99,920,884	5.1%
High Volatility	2,588,964	10,496,668	19.8%	6,554,806	53,818,120	10.9%
Low Liquidity	113,265	839,148	11.9%	69,879	3,939,260	1.7%
High Liquidity	8,164,127	41,878,747	16.3%	11,900,017	149,799,793	7.4%

These results are based on transaction data from the New Zealand Exchange and quote data from Refinitiv Datascope for all New Zealand stocks for the January 2012 to August 2021 period. In each instance we form sub-samples based on firms that are above and below the median of each characteristic. *Small* and *Large* refer to low and high market capitalization stocks, respectively. *Value* and *Growth* refer to low and high book-to-market ratio stocks, respectively. *Low Volatility* and *High Volatility* refer to stocks with low and high return volatility, respectively. Finally, *Low Liquidity* and *High Liquidity* refer to stocks with low and high liquidity, respectively.

Appendix 4: Daily Short Selling Summary Statistics

	Broker	Wholesale	Other	Total
Panel A: Proportion of Daily Trades that are Shorts				
Minimum	0.0	0.0	0.0	0.0
Median	8.9	8.0	0.0	11.8
Mean	11.3	8.3	0.0	12.6
Maximum	48.3	48.6	1.2	48.2
Std Dev	8.6	5.4	0.0	7.0
Panel B: Proportion of Daily Traded Value that are Shorts				
Minimum	0.0	0.0	0.0	0.0
Median	7.5	2.3	0.0	6.6
Mean	8.7	3.0	0.0	7.5
Maximum	46.8	29.7	0.9	45.5
Std Dev	5.9	2.8	0.1	4.5

These results are based on transaction data from the New Zealand Exchange and quote data from Refinitiv Datascope for all New Zealand stocks for the January 2012 to August 2021 period. The "Other" category includes transactions from retail investors, broker employees, and market makers.