The Information Content of Trading Volume and Short Sales*

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Abstract

This paper examines the link between stock prices and trading volume for the Hong Kong stock market. The results suggest that the informational content of volume is strongest in trades initiated by short sellers. Based on the analysis of a proprietary database from Dataexplorers, shifts in the demand curve for the Hong Kong securities lending market provide the most information about future prices, although shifts in supply are also found to be important. This information however, is short lived. In general, this paper finds strong evidence that short interest is a major channel for the transmission of information about prices.

JEL Classification: G12

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1. Introduction

A substantial literature has evolved that clearly identifies trading volume as an important agent in the price discovery process. For example, theoretical models such as Campbell, Grossman and Wang (1993), Blume, Easley and O'Hara (1994) He and Wang (1995), Chordia and Swaminathan (2000) and Suominen (2001) show how trading volume can signal the information content of returns. Empirical research has also emphasised the significance of volume in understanding asset price dynamics (see Karpoff, 1988, and Gallant, Rossi, and Tauchen, 1993, and Brunnermeier, 1997 for a survey).

The possibility that both price and volume may reveal information to the market is an interesting prospect and the purpose of this study is to provide further insights into this issue. The past literature has considered the role of aggregate trading volume in price discovery. Yet, trading volume may originate from any of a number of agents, each of whom has a different information set. For example, some trades are initiated by noise traders who follow (and exacerbate) market trends. Other trades may be based on the need for liquidity, the desire to rebalance a portfolio and other such reasons. Finally, and most importantly in the current context, some trades are purely informational based. It is the trading activity of this latter group that reveals information to the market and the literature suggests that short sellers may possess superior information relative to other traders (see Angel, Christophe and Ferri, 2003, Boehmer, Jones and Zhang, 2008, Cohen, Diether and Malloy, 2007, and Francis, Venkatachalam and Zhang, 2005, inter alia) and that short sales signify bad news (see Senchack and Starks, 1993, Choie and Hwang, 1994, Asquith and Meulbroek, 1996, Aitken, Frino, McCorry and Swan, 1998, Desai, Ramesh, Thiagarajan and Balachandran, 2002, Angel, Christophe and Ferri, 2003, Cohen, Diether and Malloy, 2007, and Diether, Lee and Werner, 2006).

It is an interesting empirical issue to consider the extent to which the different types of trading volume reveal information to the market. The available evidence suggests that short sales may have greater informational content compared to other forms

of trading volume. To this end, this study will investigate the relationship between trading volume and price dynamics for a wide range of Hong Kong equities. Further, total trading is decomposed into short and long volume to allow an individual assessment of the information content of each. The results of this paper suggest that, while past returns have significant predictive power, past trading volume does not. When volume is decomposed into short selling and all other transactions however, the former is highly significant and an increase in short sales leads to lower excess returns in the following period. Thus, this evidence clearly finds support in favour of short volume as an important source of information that is monitored by the market.

To investigate this result further, we draw on a unique database that captures detailed information on the state of the securities lending market. This data is provided by Data Explorers and captures information on both the demand and the supply side of the market.[1] This data is used to identify shifts in the supply and demand for shorting and it is the latter that is found to be more important in predicting future returns. The use of securities lending market data is a fairly new innovation in the literature and only a handful of papers have had access to this type of data, including D'Avolio (2002), Diether, Lee and Werner (2005), Cohen, Diether and Malloy (2007) and Saffi and Sigurdsson (2007).

In particular, Cohen et al (2007) employ proprietary data on loan prices and quantities to identify shifts in the demand and supply curves for borrowing stock. Cohen et al. (2007) argue that the existence of an active market to borrow and lend stock can have an impact on the equilibrium price of the stock. However, the opaque nature of the market for borrowing stock ensures that identifying any link between this market and the stock price is a difficult task. Despite this, Cohen et al (2007) find that shorting demand is an important determinant of stock prices. Furthermore, they argue that as their results are stronger in markets with less private information flow, the evidence is consistent with the

[1] Data Explorers data has also been used by Saffi and Sigurdsson (2007), who undertook a multicountry study and concluded that short sales constraints lower the pricing efficiency of a market.

view that the market for borrowing and lending stock acts as a conduit for the revelation of private information.

The remainder of the paper proceeds as follows. Section 2 provides a summary of the securities lending market data that form the basis of this study. Section 3 discusses the empirical design employed in this study and presents a baseline model of returns. This section then proceeds to augment the model to include information on the short side of the market. The final section presents some concluding comments.

2. Hong Kong Stock and Securities Lending Market Data

Information on the Hong Kong securities lending market is provided by Data Explorers Ltd., a commercial data provider.[2] Data Explorers collects information from a significant number of the largest custodians in the industry and, by their own estimates, capture approximately 80% of the market for lending equity at the end of the sample period. This data is sampled at a weekly frequency over the period September 14, 2005 to June 27, 2007. From the Data Explorers database, information is sampled on the total value of lendable assets (LA, a measure of the value of the securities that their custodians currently have available for lending), the percentage utilisation (UTL, the fraction of total lendable assets that is currently on loan), the securities lending fee (SLFEE, the weighted average loan fee expressed in basis points), and loan tenure (SLTEN, average number of days outstanding).

-Figure 1 about here-

Data Explorers securities lending data is available for 815 stocks listed on the Hong Kong stock exchange. The focus of this study is on a subset of 95 stocks, which have continuous securities lending activity across the entire 94 week sample period.[3] To

[2] See www.dataexplorers.co.uk

[3] The Hong Kong stock exchange code for these 95 stocks is 1, 2, 3, 4, 6, 8, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 23, 35, 41, 44, 48, 54, 66, 69, 83, 100, 101, 123, 129, 142, 144, 148, 165, 173, 178, 179, 183, 203, 242, 267, 270, 291, 293, 302, 303, 308, 315, 316, 321, 330, 341, 363, 388, 392, 420, 440, 480, 493, 494,

provide some understanding of this data, Figure 1 presents time series plots of the cross sectional medians of the Utilisation, Fee, Tenure and Short Volume variables for the entire sample. For the sample as a whole, the average and mean utilisation are 18.30% and 10.97%, respectively. However, there are times when all the stock available is on loan and also periods where none of the stock available is on loan. Panel (a) of figure 1 displays the time series evolution of median utilisation and the first half of the sample is characterised by increasing utilisation which peaks in the middle of 2006. Utilisation then declines in the second half of the sample and finishes at approximately the sample median of 11% of lendable assets.

The loan fee is the measure of the price of short selling used throughout this paper. This loan fee is calculated as the interest rate on cash deposits net of the rebate rate (the interest rate the short seller receives on the securities offered as collateral). The loan fee generally lies in the range of 22 to 99 basis points, but exhibits a substantial degree of variation over the sample period. The cost of short selling is an average of 86.68 basis points (bp) per week. This cost figure however, is highly skewed and the median fee is only 31.25 bp per week. For some stocks, the fee is very low at certain times (the minimum is 0.12bp), while for others it is extremely high (8,700 bp). Panel (b) of figure 1 displays a time series plot of the median fee, which highlights this variation.

Panel (c) of figure 1 displays the time series evolution of the cross sectional median tenure. The median loan tenure is over 110 days at the start of the sample, declines by approximately 30 days by June 2006 and then increases to approximately 130 days by the end of the sample period. While the average length of a loan is 128 days, some stocks have a loan life that goes on for years. The longest tenure in the sample is 1,352 days. Finally, panel (d) of figure 1 displays median short volume across the sample measured in millions of shares. This figure shows a general increase in short selling across the sample period.

-Figure 2 about here-

506, 511, 522, 551, 583, 604, 635, 659, 669, 682, 683, 688, 709, 716, 737, 762, 809, 836, 883, 906, 917, 941, 966, 1038, 1070, 1093, 1109, 1114, 1199, 1200, 1212, 2319, 2332, 2356, 2388, 2878.

To explore this apparent increase in short selling, figure 2 displays the median of relative short sales, that is short volume scaled by total volume. The cross sectional median of short selling as a proportion of total volume increased from 2% to 7% in the first half of the sample. In the latter half of the sample the cross sectional median declines to a level of approximately 4%, but displays a high degree of variation. To summarise, panel (d) of figure 1 and figure 2 suggest that short selling represents an increasingly important component of total volume in the Hong Kong market for equity.

- Table 1 about here-

The sample of 95 stocks listed on the Hong Kong stock exchange may be used to assess the informational content of short sales. To this end, a matched weekly database of price and volume information is sampled from Datastream. The returns for each stock are calculated as the log price relative and a summary of these returns data as well as trading volume is also included in Table 1. Across all stocks in the database, the mean weekly return is positive (0.46%), although the data is highly positively skewed. There are some large price changes observed in the sample: the maximum observed fall in price is 50.19% for Hutchinson Telecom in the first week of June, 2007. The largest weekly gain in price is 47.21% for China Foods Ltd. in the third week of 2007. Most stocks however, generally experienced price changes in the order of between 2.80% and -2.00%. An average of 39 million shares is traded per stock in a weekly period. Not all of this volume however, is initiated by traders taking long positions. Some of it is associated with short selling activity. The Hong Kong stock exchange provides daily short sales volume information for each stock.[4] The total short sales each week is sampled for all 95 stocks and a summary of this information is included in the final column of Table 1. The average weekly short sales volume is 2.09m shares, which is around 5% of total traded volume across the sample period.

[4] Henry and McKenzie (2007) provide a discussion of the institutional arrangements for short selling in Hong Kong.

3. The Information Content of Trading Volume

Following Diether, Lee and Werner (2005) *inter alia*, a pooled regression approach is taken to estimating the informational content of trading volume. As such, a generic model of the determinants of stock returns may be specified as:

$$er_{it} = \alpha_0 + \sum_{j=1}^{n} \alpha_j X_j + \sum_{k=1}^{11} \beta_k D_k + \varepsilon_t \quad (1)$$

where er_{it} is the excess return of stock i on day t, X is a vector of j independent variables that may influence the change in price of a stock, D are monthly dummy variables, α and β are parameters to be estimated and ε_t are the errors which are assumed ~N(0,1). All standard errors are adjusted for heteroscedasticity and autocorrelation. To control for the effects of size (see Banz, 1981) and book-to-market (see Fama and French, 1992), excess returns are calculated as $er_{it} = r_{it} - r_{Pt}$, where r_i is the actual stock return and r_P is the return to a portfolio. The portfolio return is estimated by grouping all stocks into quintiles according to their market value and book to market ratio. An overall portfolio return is estimated as the average return across all stocks in each size and book to market ratio combination.

-Table 2 about here-

To begin the analysis, a series of baseline regressions is undertaken in which adjusted returns are the dependent variable. In the first instance, the independent variable vector is specified solely to include lagged trading volume and the results are presented in the first column of Table 2. The results suggest that past trading volume is insignificant and exerts no influence on the current periods return. To test the veracity of this finding, the equation may be augmented to capture any autocorrelation in the data by initially including a one period lagged return, which is negative and highly significant. This is consistent with short-term contrarianism in equity returns, and is well documented in the literature, see Antoniou, Galariotis and Spyrou (2006), *inter alia*. The lagged volume term however, remains insignificant at the 5% level. To capture momentum effects, price movements over the previous month and year are included in the model. Where a four

period lagged (one month) term is included, it is significant and the R^2 value increases from 0.0041 to 0.2269. Adding a 52 period lagged (one year) return term, the previously tested variables retain their sign and significance levels and the new term is also significant. To summarise, momentum is found to be an important determinant of stock returns over the longer term, which is consistent with the evidence of Conrad and Kaul (1988), and Swinkels (2004), *inter alia*. However, there is no evidence that trading volume contains information about future returns.

The level of institutional ownership has been linked to returns in the previous literature (see *inter alia* Daniel, Grinblatt, Titman, and Wermers, 1997, Wermers, 1999, Gompers and Metrick, 2001). To test this proposition, the level of institutional ownership for each of the 95 stocks is sourced from the Thompson One Banker database as at the end of the sample period. Each stock is then sorted into terciles and a series of dummy variables created to indicate whether a stock is in the highest institutional ownership tercile, the mid institutional ownership tercile or the lowest tercile. The top (OI1) and mid-institutional ownership (OI2) tercile dummy variables are included in the baseline regression equation and the results are presented in column 5 in Table 2. Neither of the included terms is found to be significantly different from zero and so, the level of institutional ownership is excluded from the remaining baseline regressions. These results contrast to the previous literature as Asquith, Pathak and Ritter (2005) found that US stocks with high levels of short selling and low levels of institutional ownership tend to underperform by up to 215 basis points. Cohen et al (2007) found that institutional ownership has a positive but statistically insignificant effect on return**.**

To the extent that risk and return are related, the volatility of a stocks price may exert a significant influence on the current period's returns. The choice of volatility proxy however, is not obvious and although a number of choices exist, in this paper trading range is specified. Where the contemporaneous stock volatility (σ) is included, the results in column 6 of Table 2 reveal that all of the previous terms retain their sign and significance and the volatility variable is positive and significant. When an additional lagged volatility term ($\sigma(-1)$) is included the results, presented in the

penultimate column of Table 2, reveal that it is significant and the adjusted R^2 value of 0.2372 is the highest of any model tested so far.

Of the 95 stocks in our sample, 27 stocks have actively traded options. Typically, stocks that have exchange traded options tend to the largest and most well known. Options increase the ability of traders to engage in speculative trading and are used by many hedge funds. Investors with negative sentiments about the future performance of a stock may sell that stock short, and/or buy put options, and/or sell call options in the stock. This may mean that the returns for stocks with options are statistically different to those stocks that do not have options. The eighth column of Table 2 presents the results of a regression equation that includes all previously significant variables and also includes an options trading dummy (O_Dum). The estimated coefficient is significant and positive, indicating that options traded stocks have generally higher returns.

To summarise the baseline regression results in Table 2 thus far, current periods returns, adjusted for size and book to market effects, are found to be a function of past returns, current and lagged volatility and the presence of options trading. It is interesting to note that in each of these regression equations, past trading volume is insignificant.[5]

Trading volume is composed of transactions initiated by short sellers taking or closing out short positions in the market and transactions opening and closing long positions. Brent, Morse and Stice (1990) argue that short selling may be motivated by speculation, arbitrage and taxation issues. Brent et al (1990), Cohen et al (2007) and Henry and McKenzie (2007) *inter alia*, present evidence that short sellers are more likely to trade on superior information. To that extent, new short positions may reveal information about the future performance of a firm. By way of contrast, all other transaction types are motivated by a different information set. Once the short seller has exploited their informational advantage, they will close out their position. Thus, the decision to close a short position does not necessarily reveal any new information.

[5] Unreported results confirm that the insignificance of trading volume is robust to the length of lag in volume.

Similarly, the opening or closing of a long position are motivated by a different set of information compared to that which motivates a short sale. These observations motivate our first and second hypotheses about the information content of short selling

H1: New short sales contain information about future returns

H2: The information content about future stock returns in newly initiated short positions differs from that contained in all other transactions.

Daily information on newly initiated short positions is published by the HKSE with a 24 hour lag. Using these data, it is therefore possible to decompose daily volumes into newly initiated short positions and all other transactions.

The ninth column in Table 2 presents the results of a regression designed to test H1 and H2. In this regression total volume is replaced with its components, newly initiated short positions and all other transactions. The results reveal that short volume produces a negative and highly significant coefficient. The negative coefficient suggests that higher short sales in the previous period are associated with lower excess returns in the current period. This result is consistent with short selling possessing predictive power over share prices and suggests that short sales are informationally based. This result therefore, provides empirical support for H1.

The model presented in the final column of table 2 also suggests that the trading volume associated with all other transactions types is not a significant determinant of future equity returns. It appears that the information content of short volume may be lost in the process of aggregation, obscuring any potential relationship and resulting in insignificant estimated coefficients such as those reported for models 1-8 in Table 2. A Wald test of coefficient equality between short volume and all other transactions is rejected at the 5% level of significance (p-value = 0.0271). This rejection of the null of coefficient equality implies that the information content about future stock returns in newly initiated short positions differs from that contained in all other transactions,

providing support for H2. Furthermore, given the insignificance of all other transactions as a predictor of future stock returns, it appears that newly initiated short positions convey important information about future returns. There is no evidence that the remaining components of volume are similarly informative.

For a trader to initiate a short position on the HKSE they must have established the right to vest the stock. This is a costly process with involves negotiating a contract to borrow the security, the provision of collateral, and the payment of a fee to compensate the lender of the stock. A trader will only open a short position when the expected return to the position exceeds the cost of establishing the position. Equilibrium in the market for borrowing stock will determine the costs of establishing the right to vest in the stock and hence the ability to open a short position. As a consequence, conditions in the market for borrowing are likely to play a significant role in determining the observed level of shoring on the HKSE. We explore this in greater detail in the next section of the paper

4. The Information Content of Shifts in the Demand and Supply of Short Selling

While trading volume is not found to be informative on its own right, when long and short sales volume are distinguished, it is the latter that is found to be an important source of information to the market. In this section, we consider whether information about changes in conditions in the market for borrowing stock may provide superior information about the future returns that short volume alone. Cohen, Dieter and Malloy (2007, p 2062) argue that "(d)ifferentiating supply and demand is crucial for determining the channel through which … stock prices respond to activity in the shorting market." To this end, the procedure of Cohen et al (2007) is followed, in which shifts in the supply and demand for short sales are identified using actual market outcomes.

A simple supply and demand based model of a free market shows that where price falls and quantity rises, an outward shift in supply must have occurred. This need not suggest that an increase in supply is the only change that took place in the market, but for

prices to fall and quantities rise, we can say that an at least an increase in supply must have occurred. In the context of short selling, when the securities lending fee decreases (price) and the utilisation (quantity) increases, an outward shift in supply must have occurred (referred to as SOUT). This does not suggest however, that the rest of the market has not changed, ie. the possibility of a shift in the demand curve is not precluded. Given the observed change in price and quantity however, at least a outward shift in supply has occurred. Similarly, if the securities lending fee increases and utilisation falls, an inward shift in the supply curve is known to have happened (SIN). The demand side of the market may also be characterised using the same approach such that if price and quantity increase an outward shift of the demand curve is known to have taken place (DOUT). Finally, if price and quantity decrease an inward shift of the demand curve must have occurred (DIN). Cohen, Diether and Malloy (2006) identify these shifts in the market for borrowing stock using data drawn from a single large institutional lender. As such, they are unable to control for any substitution effects across lenders as opposed to an industry wide shift in supply or demand. As the data in this study is a drawn from a cross section of custodians, the same problem does not apply here.

Four hypotheses are proposed with respect to each of the four different shift regimes. The first two hypothesis relate to the supply side of the market and may be stated as:

H3: Supply shifting out (SOUT) predicts negative future returns

H4: Supply shifting in (SIN) is a significant predictor of future returns, although the sign is unclear.

The rationale behind the third hypothesis stems from the relationship between the supply of shorting and the cost of short selling. Where the supply curve shifts out and the price of shorting falls, the lower cost represents a loosening of short sales constraints. This makes it possible for investors who may previously have been excluded from trading by the transaction costs to enter the market. This should contribute to a more efficient

price discovery process and prices should converge more rapidly to their fundamental values meaning that any upward bias is mitigated.

Where the supply curve shifts in, a similar logic suggests that short sellers may be excluded from the market due to increased costs of borrowing stock and/or limited availability of agents willing to lend stocks. In the event that this contributes to an upward price bias, a positive relationship is predicted. Chen, Hong and Stein (2002) however, argue that a tightening of short sales constraints may lead to lower returns as the overpricing is corrected for. Support for a negative relationship may also be garnered by considering the underlying cause of the shifts in supply. Recall the securities made available to custodians for lending typically come from large fund mangers. These fund managers may reduce the amount of stock they make available for loan where they hold an increasingly negative view of a stock. Thus, the desire to reduce their holding of that stock, results in a reduced supply of equity for vesting and the news that motivated this change in their portfolio holdings results in a negative excess return in the following period that outweighs any change in the price bias. Thus, it is not clear whether a decrease in the breadth of ownership will predict higher or lower returns and we may look to the data to resolve this contradiction. As such, an inward shift of the supply curve should exert a significant influence on future returns, although the sign in unclear depending on the dynamics of the price bias process and the underlying cause of the shift in supply.

A second set of hypothesis that relate to the demand side of the market may also be defined as:

H5: Demand shifting out (DOUT) predicts negative future returns

H6: Demand shifting in (DIN) predicts negative future returns, albeit lower than where demand shifts out.

The demand shift hypothesis present a more compelling case for predicting price changes. In the event that both price and quantity have increased, investors are shorting increasing amount of stock despite an increase in the loan fee, the price of short selling. This clearly signals an expectation of adverse private information coming to the market that will produce price declines sufficient to cover the increased cost of shorting.[6] Moreover, as suggested by Diamond and Verrechia (1987), an increase in the demand for shorting is likely to signal the arrival of large quantities of negative private information, particularly because few hedgers or liquidity based traders are likely to be active in the face of the increasing cost of shorting.

Alternatively, where both the loan fee and quantity of shorting falls, fewer investors are willing to take short positions despite a lower cost of short selling. This may not necessarily signal an increase in positive sentiment for the stock however, as this would be correctly expressed through heightened demand for long positions.[7] A fall in demand, may be more appropriately interpreted as a signal that fewer investors expect bad news for a company. In that sense, an inward shift in demand may be interpreted as a less compelling signal of negative future returns compared to an equivalent outward shift of demand. Another reason why D_Out may be a far stronger signal of future returns than D_In is that for 68 of the 95 stocks in the sample, there are no traded options. This effectively means that the only way to express negative sentiment in a stock is via short selling.

The final baseline regression model reported in column 9 of Table 2, which controls for past returns, volatility and the presence of options, provides a framework for our examination of the information content of movements in the supply and demand schedules for short selling. The only change to this model is that the lagged long and short volume variables are replaced with the four dummy variables DIN, DOUT, SIN and

[6] Cohen et al (2007) also discuss the possibility that nondiversifyable risk may be increasing in quantity, in which case higher expected returns must follow to compensate for the increase risk. If this is the case, the same price prediction holds.

[7] In this respect we disagree with Cohen et al (2007) who argue that an inward shift of demand is a (weak) predictor of positive future returns as investors are willing to engage in less shorting despite the cost of shorting having fallen. Their test equations find that this variable is insignificant.

SOUT. DOUT will take the value one in week t if an there was an increase in the loan fee and the quantity of new short positions opened in the preceding week. The remaining dummy variables are constructed in a similar fashion.

The regression results estimated using these securities market demand and supply dummy variables are presented in column 1 of Table 3 and the signs and magnitudes of the control variables are similar to those reported in table 2 and so we omit further discussion of these variables. The outward demand shift dummy variable (D_Out) is negative and significant, suggesting that in a week where an outward shift of the demand for short sales occurs, stock prices fall by 0.47% in the following week. This is consistent with the results of Cohen, Diether and Malloy (2007), who found that an outward shift in shorting demand is associated with a 2.98% negative excess return in the following month. Unlike Cohen et al (2007) however, we find that other observable shifts in the short sales market are also informationally useful. For example, an inward shift in demand (D_In) also produces a negative and significant coefficient. This contrasts with the Cohen et al (2007) study in which this variable was insignificant. The estimated coefficient for D-In however, is smaller than the D_Out coefficient and a Wald test confirms this difference to be statistically significant. These results are consistent with hypothesis 5 and 6 insomuch as inward shifts in demand mean that fewer investors hold negative views for a stock and that outward shifts in demand are a more compelling signal of future returns.

-Table 3 about here-

The results for the supply shift dummy variables reveal that an outward shift in supply is insignificant, which is consistent with the results of Cohen, Diether and Malloy (2007). The results differ however, to the extent that the inward shift of the supply curve dummy variable is negative and significant. These results do not support the cost of trading/price bias argument, which suggested an inward shift of supply would increase the cost of short selling and so exacerbate the positive price bias caused by information asymmetry. Rather, the negative coefficient supports the Chen, Hong and Stein (2002)

contention of a price bias correction or fund managers reducing the amount of stock they make available for loan based on the expectation of bad news.

Thus, the estimation results presented in column 1 of Table 3 suggest that DIN, DOUT and SIN are all statistically significant determinants of current period returns movement in the demand curve for borrowing stock. It is interesting to note that the adjusted coefficient of determination for this dummy variable augmented model is less than that of the model which had the actual long and short volume variables specified. Thus, it appears that there is a loss of information resulting from the use of dummy variables, which marginally decreases the explanatory power of the model. We return to consider this point more fully in the next section.

To provide further insights into the impact of shifts in the supply and demand of the securities lending market of stock returns, it is possible to augmenting this dummy variable model to include variables that capture information on the quality of signal. To this end, the "specialness" of a loan is captured by a dummy variable that takes on a value of unity when the loan fee is greater than 3%. A variable capturing changes in the loan fee is also considered. Recall risk may be proxied using information on the average length of a loan or changes in the average length of a loan. Finally, a variable capturing the level of utilisation and changes in the level of utilisation is may also be included in the model. Consistent with the previous hierarchical regression based approach, each of these variables is considered in turn and their impact on the overall explanatory power of the model assessed.

The results of this procedure are presented in columns 2 through 7 of table 3. In terms of the supply and demand shift dummy variables, each retains their sign and significance. Thus, the focus of the remaining discussion shall be on each additional variable as it is introduced into the model. To begin with, column 2 presents the estimation results where a dummy variable has been included that takes on a value of unity where large fees (>3%) occur. The prior literature has found that the cost of short selling is a significant predictor of future returns and the evidence here is consistent with

this notion as the estimated variable is significant at the 10% level. In addition to this large fee variable, the change in last periods fee is also included in the model (column 3) and the estimated coefficient is negative and significant. Thus, an increase in the fee last period is associated with a lower excess return in the current period. This result is consistent with the notion that the quality of signal improves as the cost of short selling increases, as a trader will only act on higher quality information the more expensive the trading costs become. The remaining models retain both of these variables and lagged utilisation (tenure) and change in utilisation (tenure) are each considered in turn an none are found to be significant.

4.1 Large Shifts in the Market for Short Selling

Cohen et al (2007) argue that the study of large movements in the market may provide the most information on the link between short selling and future returns. To test this possibility, the previous analysis may be refined by focussing only on transactions that produce a large shift in the market. To this end, the base regression specification may be augmented to allow for interactions between the four short selling market shift indicators and three additional variables. The first is ΔFee^{+}_{big}, which is a dummy variable that takes a value of unity if the change in the loan fee in the previous week is in the top decile. The second is ΔFee^{-}_{big}, which is a dummy variable that takes a value of unity if the change in the loan fee in the previous week is in the bottom decile. The third is $\Delta Util^{+}_{big}$, which is a dummy variable that takes a value of unity if the change in the utilisation in the previous week is in the top decile. Each of these three terms may be used to allow an examination of large shifts in the demand and supply for short selling. To aid in the understanding of these results, the first column of table 4 summarises the results of the baseline regression equation presented in full in column 1 of table 3. The sign and significance of each of these variables is generally unaltered from the base case, and so the discussion shall focus solely on interpreting these additional terms. Increases in the supply or demand of short selling that are associated with large changes in fees (column 2) are insignificant. So too are changes in the market that are associated with large changes in utilisation. These results are in keeping with those of Cohen, Diether

and Malloy (2007). Consistent with these results, we find that where large increases (decreases) in fees are coupled with large increases in quantity, ie. $\Delta Fee^{+}_{big} * \Delta Util^{+}_{big}$ ($\Delta Fee^{-}_{big} * \Delta Util^{+}_{big}$), the estimated coefficients are also insignificant (column 4). By way of contrast, Cohen et al (2007) found large outward shifts in demand to be negative and significant. Thus, these results suggest that focussing the analysis on large shifts does not provide any additional insights into the basic relationship provided by the base model that considers all shifts in the demand and supply of short selling. These results contrast to those of Desai, Ramesh, Thiagarajan and Balachandran (2002), who find a positive relationship between the level of short interest and the magnitude of abnormal returns.

From column 2 of table 3, the cost of shorting, captured by the loan fee, is found to have significant explanatory power for returns (reproduced in summary form in column 5 of table 4). The main advantage of distinguishing between the different sources of changes in the market for short selling rests on the notion that outward shifts in demand are more informative. If this is the case, then greater information on this relationship may be garnered by allowing each of the market shift variables to interact with the large loan fee dummy variable. Column 6 of table 4 presents the results of this equation and the loan fee dummy variable retains its sign and significance. Of the four multiplicative dummy terms, only the D_In * Fee>3% coefficient is significant at the 10% level. Thus, these results do not support those of Cohen, Diether and Malloy (2007), who found the D_Out * Fee>3% coefficient to be significant, which they argue adds further support to their argument that D_Out provides the most informative market signal.

4.2 Indirect Costs and the Risks of Short Selling

Cohen, Diether and Malloy (2007) investigate the extent to which shifts in the short selling market can be used to trade profitably, and find evidence to suggest that the returns exceed the direct costs of trading. To investigate whether the risks of trading would account for these potential profits Cohen et al (2007) consider recall and arbitrage risk. D'Avolio (2002) observes that recall risk, while rare, is more likely to occur on days when trading volume is extremely high. Thus, while it is not possible to directly test

for the effect of recall risk, it is possible to include a dummy variable that takes a value of unity if the traded volume for a stock is above the 80th percentile. Column 1 of table 5 summarises the baseline market shift model from table 3. Column 2 presents a regression equation where this model is augmented with the high volume dummy variable ($Volume_{high}$) as well as a multiplicative dummy variable that interacts high volume with D_Out (theoretically, the most informative market shift parameter). The $Volume_{high}$ term is positive and significant and the interactive term is insignificant (Cohen et al, 2007, finds that both of these terms are insignificant). Thus, to the extent that high volume proxies for recall risk, no evidence can be found of the significance of this indirect trading cost.

Cohen et al (2007) also attempt to establish whether arbitrage risk can account for the profits of trading on information furnished by the shorting market. They argue if arbitrage risk is relevant, then the signal provided by D_Out should be greatest for larger stocks. They dismiss this based on the observation that the information signal of D_Out is actually greatest for small stocks. In this context, small stocks are defined as those stocks that fall in the bottom 20% of the sample when ranked by market capitalisation. To test whether this same result holds for the Hong Kong sample of data, a dummy variable is created that takes a value of unity if lagged market capitalisation falls in the bottom quintile of all stocks in the sample and is denoted as ME_{small}. Column 3 of table 5 presents the estimation results where the base model is augmented to include ME_{small} and an interactive variable ME_{small} * D_Out. Consistent with Cohen et al (2007), the ME_{small} variable on its own is insignificant. In contrast to Cohen et al (2007) however, the ME_{small} * D_Out variable in this model is insignificant. Thus, the Hong Kong market does not provide supportive evidence of outward shifts in the demand for short selling being more informative for small stocks

Cohen et al (2007) provide further evidence on this issue by drawing on Wurgler and Zhuravskaya (2002). They argue that stock level arbitrage risk can be proxied in the following way. Defining IRisk as the standard deviation of the residuals from a regression equation of the following form, $r_{it} = \alpha_i + \beta_{1i} r_{Mt} + \beta_{2i} r_{Mt-1} + \varepsilon_{it}$, where r_{it} is the

return to stock i on day t and r_{Mt} is the return to the Hang Seng. This model is estimated using one years historical data. The dummy variable $IRisk_{high}$ may be created, which takes a value of unity if IRisk falls in the top 20% of all stocks in the regression. The results of Cohen et al (2007) find that $IRisk_{high}$ is insignificant in both its own right as well as where it interacts with D_Out. This procedure applied to the Hong Kong data produces the regression results presented in column 4 of table 5, and these results concur as both estimated coefficients are found to be insignificant. Thus, consistent with the results of Cohen et al (2007), we do not find any evidence of indirect costs to shorting in the form of recall risk or arbitrage risk, although the results for Hong Kong do not find any difference between the smallest stocks and the other stocks in the sample.

4.3 The Time Horizon and the Market for Short Selling

The results of this study, clearly provide support for the notion that the short selling market provides important information for predicting stock returns. It is an interesting question to consider the time horizon over which this information may be exploited. The estimation results discussed in Section 4.0 – 4.2 all focus on weekly data. It is worthwhile considering other sampling intervals to establish whether the superior information furnished by the securities lending market can be used to predict stock returns at less frequently sampled intervals. To this end, the final regression equation specification tested in table 3 (column 7) is specified as the starting point for the analysis. The only minor modification is the inclusion of two dummy variables that take a value of unity if a stock is in the top or bottom decile of performing stocks for a given week (denoted D_Winner and D_Loser respectively). These additional variables are included to account for any overreaction to news (see Kahneman and Tversky, 1979). In the first instance, this equation is estimated using weekly data and the results are presented in column 1 of table 6. All of the estimated coefficients are consistent with the previous version of the model insomuch as the control equation variables retain their sign and significance. The demand shift dummy variables are both significant as is the inward shift supply curve dummy variable. The outward shift supply dummy variable remains insignificant. Similarly, the quality of signal variables are also consistent with earlier

results. Of the overreaction terms, only past poorly performing stocks are found to exhibit any evidence of overreaction. The positive and significant coefficient for D_Loser suggests, that stocks that underperformed in the past week, will generate relatively higher returns in the current week. The adjusted coefficient of determination for this equation is 0.2350, which is only marginally higher than the R^2 value for the same equation excluding the overreaction terms presented in the final column of table 3.

To test the robustness of these results to the time horizon, this regression equation is reestimated using data sampled at a two, three and four weekly horizon. The estimated results are presented in columns 2, 3 and 4 of table 6 respectively and the following observations are relevant. For the control variables, they all typically retain their sign, however their estimated level of significance generally declines as the sampling interval lengthens. The same can be said for the short selling market demand and supply shift dummy variables. In particular, the D_In variable quickly loses its significance as the sampling interval is lengthened to two weeks or more. The t-statistic for the D_Out variable falls below the critical value once the sampling interval is 3 weeks. On the supply side, only the S_In variable is consistently significant across all four sampling intervals, while consistent with previous regression equations, the S_Out variable is never significant. Of the quality of signal variables, the change in tenure is not significant for any sampling frequency other than weekly. The Fee>3% dummy variable is weakly significant across all equations tested, while the lagged change in fee (ΔFee(-1)) is the only variable in the equations to retain its sign and significance level. The most telling metric of the impact of using less frequently sampled data is the adjusted R^2 value. The overall explanatory power of the equations falls by over 50% when the frequency of the data falls from weekly to bi-weekly. When data sampled every three weeks is used, the coefficient of determination falls again from 0.115 to 0.083, ie. by over a quarter. Comparing the weekly test equation to the monthly results, and the explanatory power of the regression equation falls by over 70%. Thus, the data clearly indicates that the information content of the short selling market is typically very short lived. Once the data is more than one week old, it is most likely stale. These results form an interesting contrast to Cohen et al (2007), who based their research findings on monthly data and

report that their estimation results were unchanged where weekly data was used. It is an interesting research question to consider whether the quality of signal is enhanced using higher frequency data, and this is an ongoing area of investigation for the authors.

5. Conclusion

The academic literature has clearly established that trading volume is an important informational agent in the price discovery process. Using data sourced from the Hong Kong stock market, this study suggests that not all volume is created equal insomuch as it is short sales trading volume that provides the channel for the transmission of sensitive information about prices. To investigate this result further, this study utilises weekly Dataexplorers data to create variables that capture demand and supply shift information for the securities lending market in Hong Kong. This information suggests that it is shifts in the demand curve that provide the most information about future prices, although inward shifts in the supply also have a role to play. These results provide an interesting contrast to those of Cohen, Diether and Malloy (2007), who found that it was only outward shifts in demand that were relevant. Robustness testing of this result finds that it is not sensitive to large movements in the market.

The analysis of this study also tends to suggest that the information provided by short selling tends to be fairly short lived. The main results of this study are derived assuming a weekly horizon. When the estimation period over which the returns data is estimated increases however, the explanatory power of the regression equations quickly diminishes such that information on changes in the demand for securities lending ceases to exhibit any explanatory power for return horizons or three weeks or longer.

While interesting insights into the nature of the relationship between short selling and price determination can be garnered by considering the individual supply and demand curves for the securities lending market, a comparison of the regression results of this study suggest that it is short sales volume that has the most significant role to play in informing the market.

In general, we find strong evidence that short interest is a major channel for the transmission of information about prices.

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Table 1
Securities Lending Data summary

	Utilisation (%)	Fee (bp)	Tenure (Days)	Returns (%)	Volume (m)	Short Volume (m)
Average	18.30	86.68	128.82	0.46	39.05	2.09
Median	10.97	31.25	111.00	0.26	18.14	0.54
Stdev	19.15	144.61	108.05	4.88	79.12	5.41
Skew	1.48	24.85	5.46	18.55	0.01	0.00
25^{th} Percentile	4.35	22.73	72.00	-2.00	7.26	0.06
75^{th} Percentile	25.90	99.03	159.00	2.80	39.61	2.00
Max	100.00	8,700.00	1,352.00	47.21	3,202.66	225.04
Min	0.00	0.12	0.00	-50.19	0.00	0.00

Table 2
Baseline Regressions

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
vo(-1)	0.0757*	0.1000*	-0.0757*	-0.0878*	-0.0996*	-0.0115*	-0.00637	-0.0809	
	(1.58)	(1.80)	(1.28)	(1.40)	(1.42)	(1.40)	(1.17)	(1.44)	
ss(-1)									-0.0002
									(2.26)
lv(-1)									-0.0022*
									(0.35)
r(-1)		-0.0527	-0.2628	-0.263	-0.263	-0.2651	-0.265	-0.265	-0.2645
		(5.18)	(-26.76)	(26.73)	(26.73)	(24.44)	(27.51)	(27.53)	(27.52)
r(-4)			0.2375	0.2318	0.2318	0.2298	0.2303	0.2305	0.2301
			(47.38)	(43.78)	(43.78)	(41.77)	(41.91)	(42.01)	(42.13)
r(-52)				0.0049	0.0048	0.0039	0.0048	0.0047	0.0049
				(7.10)	(6.84)	(5.59)	(6.35)	(6.14)	(6.13)
IO1					0.0004				
					(0.77)				
IO2					0.0003				
					(0.62)				
σ						0.1482	0.1884	0.1945	0.1937
						(3.81)	(4.36)	(4.39)	(4.37)
σ(-1)							-0.1707	-0.1639	-0.1645
							(5.78)	(5.52)	(5.51)
O_Dum								0.0014	0.0017
								(2.96)	(3.53)
R^2	0.0003	0.0041	0.2269	0.2276	0.2276	0.2319	0.2372	0.2374	0.2377
Adj. R^2									0.2361

Note: Absolute values of t-statistics in parentheses. Standard errors take into account clustering by calendar week. * figures are x 10^4

Table 3
Short Selling Supply and Demand Shift Regressions

	[1]	[2]	[3]	[4]	[5]	[6]	[7]
r(-1)	-0.2667	-0.2667	-0.2672	-0.2672	-0.2672	-0.2672	-0.2676
	(27.46)	(27.44)	(26.78)	(26.78)	(26.78)	(27.07)	(27.11)
r(-4)	0.2304	0.2303	0.2296	0.2296	0.2295	0.2296	0.2296
	(41.62)	(41.81)	(41.37)	(41.35)	(41.32)	(41.83)	(41.86)
r(-52)	0.0051	0.0051	0.0052	0.0052	0.0052	0.0052	0.0052
	(5.98)	(5.90)	(5.99)	(5.69)	(5.98)	(6.26)	(6.28)
σ	0.1927	0.1921	0.1911	0.1912	0.1912	0.1911	0.1916
	(4.40)	(4.38)	(4.32)	(4.32)	(4.33)	(4.37)	(4.40)
σ(-1)	-0.1694	-0.1704	-0.1681	-0.168	-0.1680	-0.1682	-0.1677
	(5.74)	(5.76)	(5.68)	(5.66)	(5.68)	(5.65)	(5.64)
O_Dum	0.0016	0.0020	0.0021	0.0021	0.0021	0.0021	0.0021
	(3.82)	(4.01)	(4.24)	(4.21)	(4.24)	(4.24)	(4.22)
D_In	-0.0034	-0.0032	-0.0037	-0.0037	-0.0037	-0.0038	-0.0037
	(2.51)	(2.42)	(2.60)	(2.62)	(2.60)	(2.64)	(2.59)
D_Out	-0.0047	-0.0045	-0.0049	-0.0049	-0.0048	-0.0049	-0.0047
	(3.37)	(3.28)	(3.33)	(3.33)	(3.29)	(3.41)	(3.31)
S_In	-0.0047	-0.0046	-0.005	-0.0049	-0.0049	-0.0050	-0.0048
	(3.43)	(3.32)	(3.46)	(3.47)	(3.45)	(3.63)	(3.54)
S_Out	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0007
	(0.50)	(0.50)	(0.50)	(0.50)	(0.51)	(0.50)	(0.53)
Fee>3%		0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
		(1.81)	(1.80)	(1.64)	(1.80)	(1.71)	(1.78)
Δfee(-1)			-0.0052	-0.0052	-0.0053	-0.0052	-0.0051
			(7.94)	(7.91)	(7.68)	(8.26)	(7.83)
utl(-1)				-0.0002			
				(0.16)			
Δutl(-1)					-0.0085		
					(1.01)		
Tenure(-1)						0.0005*	
						(0.22)	
Δtenure(-1)							0.0001
							(1.69)
R^2	0.2374	0.2376	0.2368	0.2367	0.2368	0.2368	0.2370
Adj R^2	0.2356	0.2357	0.2348	0.2346	0.2347	0.2348	0.2349
	Wald Tests of Coefficient Restrictions						
W_1	16.4434	15.9078	15.9302	16.2768	15.9732	15.8259	16.4465
	[0.0009]	[0.0012]	[0.0012]	[0.0010]	[0.0011]	[0.0012]	[0.0009]
W_2	16.8271	16.1921	16.2545	16.5715	16.2335	16.1594	16.8994
	[0.0021]	[0.0028]	[0.0027]	[0.0023]	[0.0027]	[0.0028]	[0.0020]
W_3	1.2459	1.2988	1.1136	1.1170	0.9771	1.1133	0.9653
	[0.2643]	[0.0012]	[0.2913]	[0.2906]	[0.3229]	[0.2914]	[0.3258]
W_4	9.0768	8.6982	9.3928	9.6876	9.3631	9.4016	9.5262
	[0.0026]	[0.0032]	[0.0022]	[0.0019]	[0.0022]	[0.0022]	[0.0020]

Note: Absolute values of t-statistics in parentheses, Standard errors take into account clustering by calendar week. * figures are x 10^4

Table 4:
Short Selling and High Loan Fees

	[1]	[2]	[3]	[4]	[5]	[6]
D_In	-0.0034	-0.0035	-0.0035	-0.0033	-0.0032	-0.0012
	(2.51)	(2.56)	(2.56)	(2.45)	(2.42)	(0.76)
D_Out	-0.0047	-0.0053	-0.0049	-0.0046	-0.0045	-0.0036
	(3.37)	(3.71)	(3.59)	(3.42)	(3.28)	(-2.30)
S_In	-0.0047	-0.0048	-0.0047	-0.0047	-0.0046	-0.0031
	(3.43)	(3.58)	(3.59)	(3.56)	(-3.38)	(1.70)
S_Out	0.0006	0.0007	0.0006	0.0006	0.0006	0.0002
	(0.50)	(0.56)	(0.51)	(0.52)	(0.50)	(0.19)
$D\_OUT * \Delta Fee^{+}_{big}$		0.0027				
		(1.16)				
$S\_OUT * \Delta Fee^{-}_{big}$		-0.0002				
		(0.09)				
$D\_OUT * \Delta Utili^{+}_{big}$			0.0016			
			(0.58)			
$S\_OUT * \Delta Utili^{+}_{big}$			-0.0003			
			(0.11)			
$\Delta Fee^{+}_{big} * \Delta Utili^{+}_{big}$				-0.0017		
				(0.51)		
$\Delta Fee^{-}_{big} * \Delta Utili^{+}_{big}$				-0.0051		
				(1.63)		
Fee>3%					0.0010	0.0034
					(1.8090)	(1.99)
D_In * Fee>3%						-0.0045
						(1.93)
D_Out * Fee>3%						0.0007
						(0.26)
S_In * Fee>3%						0.0028
						(1.22)
S_Out * Fee>3%						0.0013
						(0.44)
R^2	0.2375	0.2376	0.2375	0.2377	0.2375	0.2378
Adj R^2	0.2357	0.2356	0.2355	0.2358	0.2357	0.2356

Note: Absolute values of t-statistics in parentheses. Standard errors take into account clustering by calendar week. Regressions include controls for r(-1), r(-4), r(-52),σ, σ(-1) and traded options.

Table 5:
Indirect Costs and Risks of Short Selling

	[1]	[2]	[3]	[4]
D_In	-0.0034	-0.0030	-0.0032	-0.0034
	(2.51)	(2.07)	(2.35)	(2.49)
D_Out	-0.0047	-0.0041	-0.0045	-0.0047
	(3.37)	(2.73)	(3.20)	(3.34)
S_In	-0.0047	-0.0045	-0.0046	-0.0047
	(3.43)	(-3.00)	(3.31)	(3.42)
S_Out	0.0006	0.0008	0.0006	0.0006
	(0.50)	(0.67)	(0.051)	(0.49)
$Volume_{high}$		0.013		
		(6.34)		
$Volume_{high}$*D_OUT		-0.0051		
		(1.37)		
ME_{small}			0.0009	
			(1.24)	
ME_{small}*D_OUT			-0.0019	
			(1.04)	
$Irisk_{high}$				-0.0002
				(0.21)
$Irisk_{high}$*D_OUT				-0.0002
				(0.07)
R^2	0.2375	0.2450	0.2376	0.2375
Adj R^2	0.2357	0.2430	0.2356	0.2355

Note: Absolute values of t-statistics in parentheses. Standard errors take into account clustering by calendar week. Regressions include controls for r(-1), r(-4), r(-52),σ, σ(-1) and traded options.

Table 6
Short Selling and Long Horizon Returns

Horizon	1 week	2 weeks	3 weeks	4 weeks
r(-1)	-0.2765	-0.2785	-0.2790	-0.2615
	(22.68)	(14.97)	(15.31)	(12.07)
r(-4)	0.2302	0.2030	0.1879	0.1747
	(41.66)	(26.73)	(17.96)	(14.54)
r(-52)	0.0052	0.0131	0.021	0.02906
	(5.85)	(6.51)	(6.51)	(6.62)
σ	0.1933	0.1473	0.1398	0.0171
	(4.37)	(3.60)	(2.68)	(2.77)
σ(-1)	-0.1613	-0.1522	-0.1080	-0.0115
	(5.44)	(3.62)	(2.27)	(2.06)
O_Dum	0.0019	0.0021	0.0028	0.0034
	(3.89)	(1.50)	(1.22)	(1.06)
D_In	-0.0036	-0.0025	-0.0039	-0.0022
	(2.53)	(0.96)	(1.07)	(0.50)
D_Out	-0.0046	-0.0068	-0.0061	-0.0069
	(3.18)	(2.64)	(1.70)	(1.57)
S_In	-0.0048	-0.0071	-0.0088	-0.0096
	(3.37)	(3.07)	(2.56)	(2.25)
S_Out	0.0007	0.0021	-0.0022	-0.0021
	(0.56)	(1.27)	(1.13)	(0.97)
D_WINNER(-1)	-0.0001	-0.8300*	-0.0028	-0.0248*
	(0.05)	(0.03)	(0.88)	(0.71)
D_LOOSER(-1)	0.0027	-0.0014	-0.0011	-0.0022
	(2.06)	(0.57)	(0.41)	(-0.71)
Fee>3%	0.0010	0.0024	0.0040	0.0055
	(1.82)	(1.80)	(1.74)	(1.72)
Δfee(-1)	-0.0052	-0.0127	-0.0086	-0.0108
	(7.63)	(11.65)	(7.48)	(9.24)
ΔTenure(-1)	0.0002	-0.0803*	-0.0103*	-0.0151*
	(1.66)	(0.43)	(0.04)	(0.59)
R^2	0.237293	0.117635	0.085817	0.072328
R^2	0.235017	0.115002	0.083089	0.069559

Note: Absolute values of t-statistics in parentheses, Standard errors take into account clustering by calendar week. * figures are x 10^4

Figure 1
Securities Lending Data

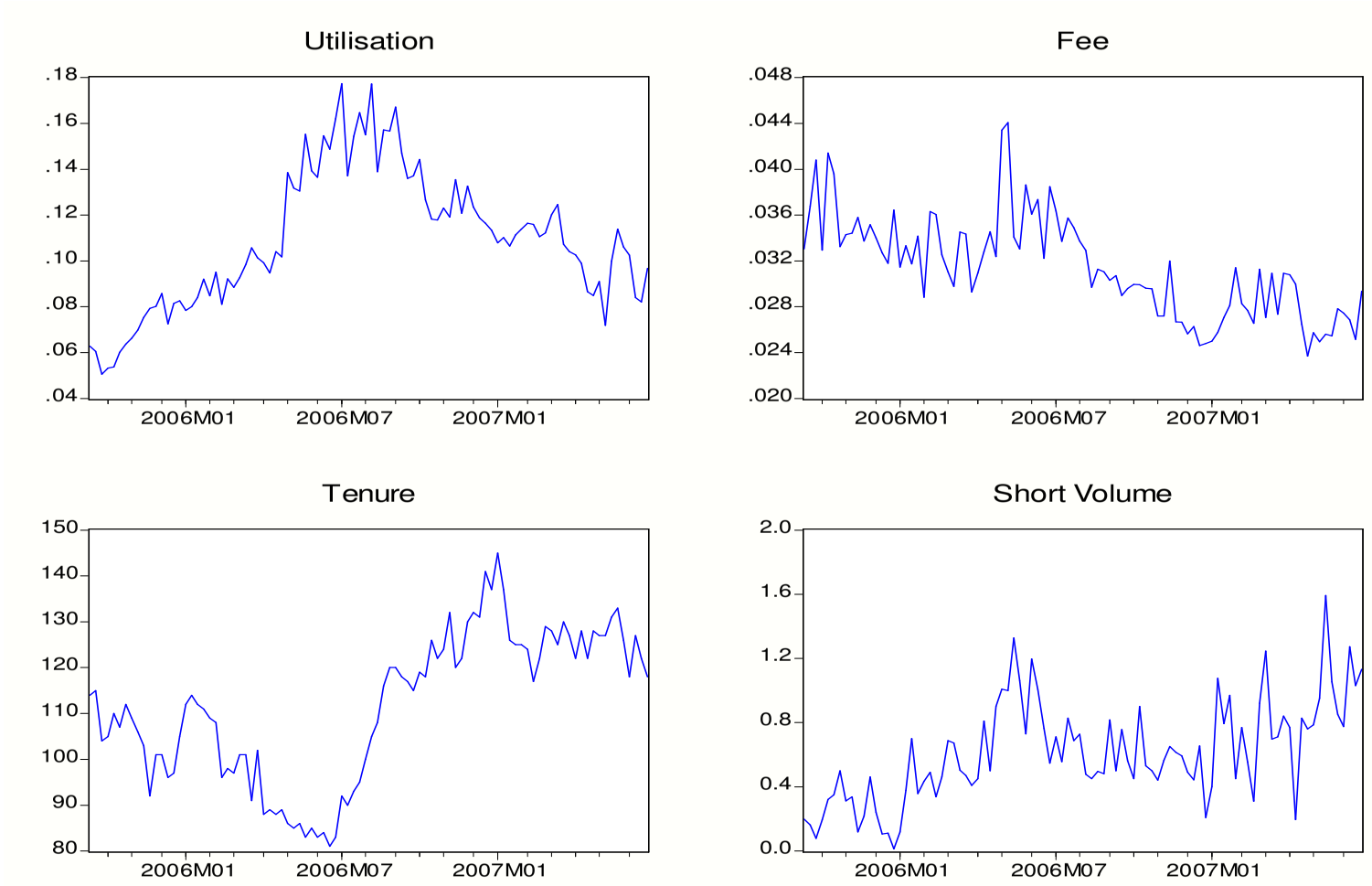

Figure 2
Median Relative Short Sales