Short Selling, Idiosyncratic Risk, and Stock Returns in the UK

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Abstract

This paper examines the relationship between short selling and stock returns in the U.K. Specifically, we examine whether idiosyncratic risk, a potential deterrent to arbitrage activity, has a direct impact on short sellers' trading behavior. We find that stocks with low short interest levels experience significant positive abnormal returns on both an equal- and value-weighted basis. Contrary to U.S. evidence, we document that highly shorted stocks exhibit positive and statistically significant abnormal returns. This effect is especially pronounced among smaller-sized and less liquid stocks. Our results also show that there is a negative relation between short interest and abnormal returns among stocks with high idiosyncratic risk. Consistent with Shleifer and Vishny (1997), who argue that idiosyncratic risk deters arbitrage leading to persistent mispricing, our evidence indicates that short selling activity is mostly concentrated in stocks with low idiosyncratic risk because it is less costly to arbitrage fundamental risk (more substitute stocks).

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1. Introduction

Following Miller (1977) who theorized that stock prices are overvalued in the presence of short sale constrains and heterogeneous investor beliefs, many researchers have attempted to uncover the effects of short sales on asset prices. For instance, Asquith and Meulbroek (1995) find negative and significant abnormal returns for highly short sale constrained New York stock exchange (NYSE) stocks for the 1976 to 1993 period. Desai et al. (2002) find similar evidence for Nasdaq stocks for the 1988 to1994 period. D'Avolio (2002), using less than two years of proprietary data, focuses on the effects of rebate on borrowed stocks and discovers that low or negative rebate rates precede negative abnormal returns. Getzy, Musto and Reed (2002), using a database from a single lender for the period from November 1998 to October 1999, find a similar relationship between rebate rates and abnormal returns, but show that short sales restrictions have a mixed impact on the profitability of standard arbitrage strategies. Jones and Lamont (2002), using early 20th Century U.S data, show that stocks that are expensive to short are overvalued. Ofek and Richardon (2003), show that short sale constraints, in the form of option lock-ups, have dramatic and persistent negative effects on subsequent stock returns, supporting the view that stock prices do not fully incorporate information under short sale constraints.

Diamond and Verechia (1987) have explored the effects of short sale constraints on the speed of price-adjustment to private information. Their model predicts that short sales constraints impair the dissemination of positive and negative information differently. That is, information in the presence of short sale constraints has an asymmetric impact on asset prices. In the spirit of this model, recent theoretical work by Abrew and Brunnermeier

(2002) and Scheinkman and Xiong (2003) shows that short sale constraints can lead to bubbles and excessive volatility. In a different line of research, He and Modest (1995), Hansen and Jaganathan (1997), Jouini and Kallal (2001), and Duffie et al. (2002), address the effect of market frictions and the magnitude of mispricing.

Although the impact of short selling has been widely analyzed in the U.S. market the evidence is mixed. For instance, while previous research suggests that there is a negative relationship between short selling and future firm performance,[1] more recent studies, Asquith et al. (2005) and Cohen et al. (2006), point out that this relation is weak and driven mostly by few, small firms.

Moreover, the U.S. evidence, due to regulatory and market differences, may not be indicative outside the U.S. market setting.[2] Studying the effect of short selling on stock returns outside of the U.S. avoids the criticism that observed regularities may be a function of data mining. This paper fills this gap in the literature through the examination of a unique U.K. daily short selling dataset. In the U.K. short selling, is regulated by the Financial Services Authority (FSA), whose laws governing short selling are comparatively less stringent than those in the U.S.

In the U.S., regulatory restrictions on short sales are responsible for making shorting more costly and difficult than going long[3]. For example, the U.S. imposes settlement rules that aid the settlement and delivery of securities. This means that short sellers must locate and borrow the stock they are selling prior to effecting short sales. In

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[1] For example see Asquith and Meulbroek (1995), Desai et al. (2002), and Christophe et al. (2004)

[2] There are a few studies that analyze the impact of short sales regulations on stock return distributions using international data. For example, see Aitken et al. (1998), Biais et al. (1999), and Poitras (2002).

[3] For more information on U.S. short sale rules see http://www.sec.gov.

addition, short sale can only be executed if it passes the "uptick" rule or "price bid" rule depending where the asset is traded. These rules are generally relaxed for market-making and a variety of hedging, risk management, or arbitrage trades since strict adherence to these rules would make it difficult to carry out trades where timely execution is important, leading to reduced liquidity or increased risk. The SEC also prohibits shorting, and/or covering of shorts, on securities during periods where this activity may greatly elevate risk, such as around secondary offerings.[4]

Unlike the Security Exchange Commission (SEC) and National Association of Securities Dealers (NASD), which have established specific rules for shorting U.S. securities,[5] the FSA has not imposed short sale specific restrictions or controls in the UK. Rather, short sellers are bound to general market and regulatory arrangements.[6] Unlike in U.S., there is no uptick rule in U.K. This suggests that, when short sale constraints are binding, ceteris paribus, the speed of adjustment of prices to private information should be faster in U.K. than U.S. Similar to the U.S., however, short sellers of U.K. securities must eventually locate and borrow the stocks they are selling. CREST, the source of our short data, handles the settlement of all securities trading on the London Stock Exchange (LSE). Availability of this unique and previously untested daily UK loan data allows us to examine the relationship between short interest and stock returns. To the best of our knowledge, there has been no published research that explores the link between short

[4] See the Report on Transparency of Short Selling by the Technical Committee of the International Organization of Securities Commissions (IOSCO).
[5] For more information on U.S. short sale rules see http://www.sec.gov.
[6] See FSA Discussion Paper 17 on Short Selling (October 2002) for more information.

selling, measured by short interest relative to shares available for borrowing on a market-wide basis, and stock returns in the U.K.

The second objective of this study is motivated by the findings of previous studies showing that high short interest ratios are associated with low abnormal returns. To the extent that these abnormal returns, documented in these studies, represent mispricing the question that emerges from this evidence is why they prevail for long horizons? To put it differently, if short selling, the activity of sophisticated investors, devotes considerable resources to identify overvalued stocks, why overvaluation is not corrected? We address this issue by investigating the role of idiosyncratic risk, the most important arbitrage (holding) cost according to Pontiff (1996). Specifically, we examine whether idiosyncratic risk deters short selling activity. Sholes (1972) argues that in the absence of close stock substitutes arbitrage becomes ineffective.

Our findings suggest that market participants investing in equities in the U.K. or similar markets would benefit from understanding important differences in short sale practices and regulation between U.S. and U.K. markets. Furthermore, due to the lack of uptick and bid-ask rules, the "locate and borrow" constraint is arguably the most important short sale constraint in the U.K.

To test the "locate and borrow" constraint in the U.S., previous research has focused on using institutional ownership as a proxy for shares available to borrow. Chen, Hong, and Stein (2002) and Nagel (2005) argue that stocks with low institutional ownership are more likely to be short sale constrained. D'Avolio (2002), the only paper which uses loan data to test whether institutional ownership affects the ability to locate and borrow shares, examines data is from one lender, a depository for mutual funds that mainly invest in large cap stocks, and covers the five quarters beginning with the second quarter of 2000. He finds that institutional ownership explains, on average, 55% of the cross-sectional variation in that lender's supply of loanable shares.

Like D'Avolio, we examine shares available for shorting. Our paper adds to this literature, by examining a longer time period of just over three years, and relying on loan data that spans the entire market rather than just a single lender. Using this market availability measure, as opposed to using an institutional ownership proxy or a partial availability measure, we can accurately test the "locate and borrow" constraint directly.

Our evidence shows that while stocks with low levels of short interest experience significant positive abnormal returns on both an equal- and value-weighted basis, equally weighted portfolios composed of highly shorted stocks exhibit positive, but statistically insignificant abnormal performance. These results are inconsistent with prior U.S. evidence, which demonstrates that heavily shorted stocks tend to have a negative performance. Consistent with Asquith et al. (2005), we find that value weighted portfolios of highly shorted stocks do not significantly underperform the market, as measured by the intercepts from three-factor time series regressions. While all intercepts of the value weighted portfolios are positive and insignificant, at conventional levels, their magnitude decreases with short selling increases. We argue that positive abnormal performance may be caused by short squeezes, a liquidity demand from short sellers covering their positions. This explanation seems to be plausible especially in light of our finding that smaller and less liquid securities with high short interest are more likely to experience large positive abnormal returns in the short-term.

We also find that idiosyncratic risk, a deterrent to arbitrage, is correlated with mispricing. Our results show that there is a negative relation between short interest and abnormal returns among stocks with high idiosyncratic risk. Consistent with Shleifer and Vishny (1997), who argue that idiosyncratic risk deters arbitrage leading to persistent mispricing, our evidence suggests that short selling activity is mostly concentrated in stocks with low idiosyncratic risk because it is less costly to arbitrage fundamental risk (more substitute stocks).

The remainder of the paper is organized as follows. In the next section, we provide some background and present an overview of the relevant literature. We describe our data and sample selection procedure in Section 3, and report our empirical results in Section 4. Section 5 contains a brief summary and concluding remarks.

2. Background and Motivation

Because of risks associated with short selling, many institutional and retail investors choose not to short stocks. At the same time assets managed by hedge funds, many of which regularly sell short, have grown rapidly in recent years, increasing the amount of short selling globally. Despite recent increases in both short interest data availability and academic research on all aspects of short selling, there is still disagreement among regulators, academics, and investors on the effect of short selling on financial markets.

On the one hand, proponents of short selling consider it an essential feature of an efficient securities market. On the other hand, critics of short selling are convinced that short selling activity, directly or indirectly, can destabilize the market. For example, Miller (1977), Jarrow (1980), and Chen et al. (2002) all argue that when investors disagree on valuations and short selling is difficult or expensive, stocks can become overvalued. Short sale constraints lead to mispricing by preventing negative information from being impounded into stock prices. More recent empirical evidence by Jones and Lamont (2002) and Bris et al. (2006), however, supports the theory that short sellers help maintain fair prices and efficient markets.

Due to the risks and costs associated with short selling, many have argued that the level of short selling is a good informed sentiment indicator. Indeed, U.S. studies by Diamond and Verrechia (1987), Fabozzi and Modigliani (1992), Asquith and Meulbroek (1995), Aitken et al. (1998), Dechow et al. (2001), and Desai et al. (2002) all conclude that short sellers possess an ability to identify overpriced securities. Asquith et al. (2005), using a more recent and comprehensive sample, confirm previous findings and demonstrate that while equal-weighted portfolios of highly shorted stocks underperform, value-weighted portfolios do not. This suggests that the level of short selling would be more informative, as a negative sentiment indicator, for a strategy that trades smaller capitalization securities.

In some cases it may be that a high level of short interest represents future demand that will eventually lead to higher prices when short sellers cover their positions through both voluntary means and short squeezes. This view has considerable support amongst practitioners. Hanna (1976) finds that it is possible to earn positive returns by trading on the assumption that large increases in short interest are bullish and large declines are bearish. Hurtado-Sanchez (1978), McDonald and Baron (1973), and Woolridge and Dickinson (1994) support this perspective and find that stock returns are positively related to the level of short interest.

To understand the relationship between short interest and stock returns, it is important to differentiate cases when short interest indicates poor prospects from cases when it may reflect high future demand, and thus a potential short squeeze, from short sellers who need to cover their positions. Indeed, recent evidence suggests that liquidity risk associated with uncovered short positions is important. Duarte et al. (2006), show that liquidity events in short selling, such as short squeezes, margin calls, and stock specialness, impose substantial costs on short sellers. Specifically, they examine the cost of hedging short positions in the options market and find that these costs exceed abnormal profits of uncovered short positions. Boehme et al. (2006), document that high turnover and short interest stocks experience negative abnormal returns, suggesting that liquidity events constrain short selling. Using U.K. data, we examine whether liquidity events, such as short squeezes, affect short selling activity. Specifically, we ask a question whether heavily shorted firms that experienced large trading volume in the recent past are more vulnerable to short squeezes.

Several studies relate arbitrage costs, measured by a security's idiosyncratic risk, to mispricing and to other anomalies such as index inclusion, merger arbitrage, book-to-market, and season equity offerings underperformance.[7] Unlike literature that examines the role of arbitrage costs indirectly through anomalies, we study how arbitrage costs influence short sellers' trading behavior directly.

Lintner (1965), Merton (1987), Malkiel and Xu (2002), and Spiegel and Wang (2006) predict and show that there is a positive relation between idiosyncratic risk and future stock returns. Ang et al. (2006), however, provide evidence of a negative relationship between idiosyncratic risk and future stock returns. In the context of this study, we argue that idiosyncratic risk is a cost that deters arbitrage causing the short interest anomaly. That is, unlike previous studies by D'Avolio (2002) and Nagel (2005) that suggest short selling costs are mostly related to institutional holding, rather than short interest,[8] we argue that idiosyncratic risk is likely to be a very important cost to short sellers. Exploring how idiosyncratic risk influences short sellers' trading activity can help us understand whether mispricing occurs as a result of lack of short selling due to idiosyncratic risk. Therefore, we are interested in discovering if short sellers are unwilling to establish short positions because of the high idiosyncratic risk of holding these positions. Our work builds on previous studies (Lamont (2002), Lamont (2004), and Ofek and Richardon (2003)), which argue that is unlikely that short sale costs, such as high lending fees, were the main reason for the price run-up during the DotCom bubble in the 1990s. Ofek and Richardon (2003), argue that while short sale costs were an important

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[7] Pontiff (1996) examined mispricing,Wurgler and Zhuravskaya (2002) examined index inclusion, Savasoglu (2002) examined merger arbitrage, Ali et al. (2003) examined book-to-market, and Pontiff and Schill (2004) examined season equity offerings underperformance.

[8] Chen et al. (2002) argue against using short interest as a proxy for either short sale costs or shorting demand. Jones and Lamont (2002) also point out that short interest represents the intersection of supply and demand for sorting a stock.

factor they conjecture that the relative volatility spread between internet and non-internet stocks needs to be part of a more complete explanation of internet stock price rise and fall.

In addition, a number of studies document that firm characteristics, such as size and book-to-market, affect cross-sectional returns and represent systematic risks. In our analysis we control for firm characteristics using three factor Fama-French regression. Banz (1981), Goodman and Peavy (1986), and Boehme et al. (2006) present evidence that underperformance of the stocks with high short interest ratios is concentrated among smaller firms. Rosenberg et al. (1985), Bhandari (1988), Fama and French (1992, 1996), Capaul, Rowley and Sharpe (1993), Chan and Chui (1996), and Jensen et al. (1997) find that stocks with higher book-to-market ratios exhibit higher returns.

In sum, the effect of short sale constraints on stock prices is ultimately an empirical issue that requires the use of an appropriate measure of shorting demand or shorting costs while controlling for the supply of shares to borrow. Moreover, since previous studies show that high short interest ratios are associated with negative abnormal returns, exceeding 1% per month, that last for long horizons, it begs the question why short sellers do not immediately arbitrage overvaluation away. In this study we also address this important question by analyzing the role of idiosyncratic risk as a potential deterrent to arbitrage activity.

3. Empirical Framework

A. Data Sources, Sample Construction and Variable Definitions

CRESTCo Limited operates the real-time securities settlement system for Irish, UK, Jersey, Isle of Man, Guernsey, and international securities. CREST started publishing data on daily stock lending for FTSE 350 securities as a proxy for short interest in September 2003, as a result of an FSA regulation to increase transparency in short selling. Although monthly average security information is publicly available free of charge, the daily information is only available through a subscription. In our analysis, we use a sample of daily FTSE 350 stock lending data from September 2003 through September 2006.

In comparison to previously outlined U.S. work, historically only U.S. monthly short interest data has been available.[9] A measure of available shares for shorting has been analyzed in a few papers which use sample data from single lenders over short time periods.[10] Although the SEC has recently made short sales flow data available, as compared to short interest level, studies analyzing this data only encompass a short time period.[11] None of these studies currently have both daily market level data and daily availability levels. Instead, they have used institutional ownership as a proxy for availability levels.

We obtain two stock loan variables from the CREST dataset: (1) *Shares on Loan*, which is a proxy for short interest, at a point in time, and (2) *Shares in CREST*, which is a proxy for the availability of lendable securities. Although the *Shares on Loan* measure is a good proxy for short interest, a stock loan can perform a number of other functions. For example, in addition to providing shares for short selling, stock loans are also used to

[9] For example, see Asquith and Meulbroek (1995), Aitken et al. (1998), Dechow et al. (2001), Desai et al. (2002), Asquith et al. (2005).
[10] For example, see D'Avolio (2002), Getzy et al. (2002), and Cohen et al. (2005).
[11] For example, see Diether et al. (2006).

insure settlement, facilitate equity repos, or take part in arbitrage activity.[12] To measure the degree of shorting we employ four short interest ratios: (1) SI_Avail is short interest (*Shares on Loan*) divided by *Shares in CREST*; (2) SI_Float is short interest (*Shares on Loan*) divided by float; (3) SI_Shrs is short interest (*Shares on Loan*) divided by shares outstanding; and (4) SI_Vol is short interest (*Shares on Loan*) divided by volume. We restrict our analysis to the first three measures because SI_Vol, has the lowest correlation with SI_Avail, SI_Float and SI_Shrs.[13]

Data on stock returns, market capitalization (MktCap) in GBP millions, shares outstanding, float, and book-to-market (BM) ratios are from WorldScope and FTSE. Float is defined as the number of freely traded shares, and is calculated as shares outstanding minus closely held shares. We use weekly one-month LIBOR rates from the Bank of England as our measure of the risk-free rate. Cumulative abnormal returns are computed relative to FTSE 350 returns and are denoted by XM_CAR where X indicated the number of months from the date of the short interest information. For example, the forward one-month cumulative abnormal return is expressed as 1M_CAR.

B. Descriptive Statistics

Figure 1 plots the time series of daily short interest over the three share measures (SI_Avail, SI_Float, and SI_Shrs) from September 2003 through September 2006. In agreement with results of Asquith et al. (2005), we observe that the typical firm in the U.K. sample has very little short interest. Although the bulk of securities have low levels of

[12] See the CRESTCo website, http://www.crestco.co.uk, for more information.
[13] The Pearson and Spearman correlations between SI_Avail, SI_Float, and SI_Shrs are above 70% and 90%, respectively. In contrast, the Pearson and Spearman correlations between these three measures and SI_Vol do no rise above 1% and 50%, respectively.

short interest over float (Figure 1B), the mean and median are around 3% and 2%, respectively, the 95th percentile, or the top 5% of the sample ranked by short interest over float, had an average SI_Float of around 11% in the mid-2006. We find similar results for short interest to shares, SI_Shrs (Figure 1C). The levels of short interest to available shares, SI_Avail, (Figure 1A) appear to have similar end of period statistics, although slightly higher, but more persistent through time. Also consistent with the U.S. results, the U.K. short interest levels have increased slightly throughout our time period, possibly due to increases in assets managed by hedge funds or evolving trading strategies

It is interesting to note that the trends of short interest and the market seem to move in opposite directions. This is most pronounced when examining the 95th percentile. Specifically, we notice that increases in aggregate short interest, graphically, seem to be associated with decreases in market prices. This result supports the notion, set forth by Shleifer and Vishney (1997), that the actions of informed traders do not dampen overreaction caused by other investors. In the U.S, Lamont and Stein (2004) find a highly negative correlation between short interest ratios and NASDAQ market returns, which implies that short sellers do not move the market towards a more accurate valuation. Asquith et al. (2005), replicating this research over a longer time period for both the NYSE-AMEX and NASDAQ samples, also report negative, although smaller in magnitude, correlations between short interest and market returns.

[Insert Figure 1]

4. Empirical Results

A. Univariate Analysis

Table 1 reports mean and median characteristics of firms across different percentiles of daily short interest. Panel A ranks firms by SS_Avail while Panels B and C rank firms by SS_Float and SS_Shrs, respectively. Panel D reports mean and median statistics for the entire sample. The most interesting pattern that emerges from the short interest statistics indicates that the majority of U.K. firms exhibit low short interest. We find average SI_Avail of 3.7%, SI_Float of 3.3% and SI_Shares of 3.3%. This is in-line with the recent U.S. results of Asquith et al. (2005) who find that the average short interest ratios for the NYSE-AMEX and NASDAQ samples are around 1.5% and 2.5% in the later part of 2002. Highly shorted firms (in the 95th percentile), however, have an average (median) SI_Avail of 11.1% (11.1%), SI_Float of 11.7% (10.8%) and SI_Shrs of 11.8 (10.8%).

The mean and median firm size (MktCap) decreases as the SI_Avail, SI_Float and SI_Shares ratios increase, suggesting that firms with high levels of short interest tend to be smaller in size. For example, Panel A (SI_Avail), shows that firms in the 5th percentile have a mean (median) market value of £713.8 (£725.5), while firms in the 95th percentile portfolio have a mean (median) market value of £463.9 (£426.3).

Our results suggest that the heavily shorted firms also tend to exhibit higher BM ratios than less shorted firms. For example, Panel A (SI_Avail) reports, that the firms in the 5th percentile portfolio have a mean (median) BM ratio of 0.91 (0.47). Firms in the 95th percentile have a mean (median) market BM ratio of 3.55 (1.68). This implies that, on average, during our sample period investors tended to short value stocks more heavily than growth stocks. Another interesting feature that transpires from Table 1 is that the one-month (1M_CAR), two months (2M_CAR) and three-months (3M_CAR) subsequent abnormal returns, with the exception of the firms in the 100th percentile portfolio, are mostly positive. Similar results are reported in Panels B (SI_Float) and C (SI_Shrs).

[Insert Table 1]

Figure 2 plots abnormal returns at different levels of percentiles and mean short interest. The mean short interest ratios at varying CAR percentiles, shown in Figure 2, indicate a slightly U-shaped relationship between forward abnormal returns and the short sale ratios. This relationship, as shown in Panel A, is much more pronounced when stocks are equally weighted. Value-weighted portfolios, reported in Panel B, do not seem to follow the same pattern.

[Insert Figure 2]

Figure 3 presents equal-weighted and value-weighted mean 1M_CAR, 2M_CAR and 3M_CAR for portfolios shorted by SI_Avail (Figure 3A) and SI_Float (Figure 3B) percentiles. We generally observe that as short interest, measured by SI_Avail and SI_Float, increases, forward abnormal returns decrease. A similar relation between abnormal returns and short interest is observed for the SI_Shrs ratio, not reported here for the sake of brevity. That is, the commonly employed zero investment strategy of longing low SI_Avail, SI_Float or SI_Shrs stocks and shorting high SI_Avail, SI_Float or SI_Shrs stocks, are likely to yield positive portfolio spreads. Surprisingly, however, we do not find that heavily shorted firms underperform the market either for equal-weighted or value-weighted portfolios. There are at least two reasons why extremely heavily shorted firms could experience positive abnormal performance. First, investors may overreact to bad news and short stocks more than suggested by their fundamentals. This behavior would result in short-term mispricing that would be subsequently corrected by the market. Second, the observed reversal pattern could be explained by the higher incidence of short squeezes associated with larger levels of short interest.

[Insert Figure 3]

B. Multivariate Analysis

Based on the results reported above, we can see that the relationship between short interest and forward abnormal returns is negative but non-monotonic. In fact, at extremely high levels of short interest the relationship becomes positive. In this section we explore this relationship further using a time-series regression framework. First, we examine the abnormal returns of portfolios created based on differential levels of shorting. For this purpose, we form equal- and value-weighted portfolios for different levels of SI_Avail or SI_Float and compare their risk-adjusted returns (alphas). Since stocks are sold short, one would expect heavily shorted stocks to be associated with negative alphas. This would indicate that the price of stocks declined with short selling reflecting short sellers' gain.[14] Portfolio abnormal returns are computed using the Fama-French three factor regression model. Second, we investigate whether the risk associated with short selling is priced by introducing an additional short interest risk factor to the Fama-French three-factor framework.

The portfolio abnormal returns are estimated from the Fama-French three-factor model:

$$R_{pi(t)} - R_{f(t)} = \alpha + \beta_1(R_{m(t)} - R_{f(t)}) + \beta_2 SMB_{(t)} + \beta_3 HML_{(t)} + \varepsilon_{pi(t)}$$

[14] This return does not account for short selling transactions costs such as the cost to borrow (rebate rate).

The three zero investment portfolios that proxy as risk factors are: the market risk premium (MRP) computed as $R_{m(t)}$, where the market is defined as the FTSE 350, minus $R_{f(t)}$, where $R_{m(t)}$ is a long return of the market portfolio and $R_{f(t)}$ is the risk-free rate; the size factor (SMB), is the return on a portfolio of small MktCap stocks minus the return on a portfolio of large MktCap stocks; and the book-to-market factor (HML), is the return on a portfolio of high BM stocks minus the return on a portfolio of low BM stocks. $R_{i(t)}$ is the one-month total return for a given security. The factor loadings (β_1, β_2, and β_3) are the slopes in the time-series regression, while α is the intercept of the regression line and ε is the error term. The intercept is our measure of abnormal returns.

We form portfolios based on MktCap and BM, using the approach outlined by Fama and French (1993, 1996). On the last trading day of each year we sort the portfolios independently on the basis of MktCap and BM. Hence, we end up with six portfolios, SL, SM, SH, BL, BM and BH. To compute SMB we subtract the average returns of the three big MktCap portfolios from the average returns of the three small MktCap portfolios. Likewise, HML is calculated as the average returns on the two high BM portfolios minus the average returns on the two low BM portfolios.

In Table 2 we report the regression results for both equal- and value-weighted portfolios formed based on cross-sectional ranking of their constituents by short interest based on SI_Avail. We estimate three factor models on equal-weighted portfolios in Panel A and on value-weighted portfolios in Panel B. These portfolios are formed weekly using middle-of-week SI_Avail quintiles.

The results in Table 2 show that abnormal returns generally decrease with increases in short interest levels. Consistent with our previous results, this relationship is not monotonic. Equal-weighted results in Panel A show that portfolios of stocks with low short interest, such as Portfolios 1 and 2, exhibit positive and statistically significant weekly abnormal returns. The abnormal return of the lowest SI_Avail portfolio (Portfolio 1) earns 0.16% weekly abnormal profit. This result suggests that an investor can earn 16 basis points per week from investing in an equally-weighted portfolio of low SI_Avail stocks. In contrast, more heavily shorted stocks, such as Portfolios 4 and 5, realize positive but statistically insignificant abnormal returns. The abnormal return of the highest SI_Avail portfolio (Portfolio 5) is positive 0.03% and is statistically insignificant. Overall, equal-weighted regression results suggest that portfolios formed from stocks with low SI_Avail outperform the portfolios containing stocks with high levels SI_Avail.

Consistent with the results in Panels A, value-weighted low SI_Avail portfolios, reported in Panel B, tend to outperform high SI_Avail portfolios. The magnitude of abnormal returns for low short interest value-weighted portfolio (Portfolio 1) is comparable to that for equally-weighted portfolio and is statistically significant at 5% level. The intercept is 0.15, implying that abnormal profit of 15 basis points per week can be earned from investing in a value-weighted portfolio of low SI_Avail stocks. The highest SI_Avail portfolio (Portfolio 5) exhibits a positive and statistically insignificant abnormal return.

We also performed a similar analysis using SI_Float instead of SI_Avail.[15] The portfolios are ranked based on cross-sectional ranking of their constituents by short interest based on SI_Float. Even in portfolios based on SI_Float, a noisier measure of lendable supply, we still find positive and statistically significant abnormal returns for stocks with low short interest (portfolio 1). The high SI_Float (portfolio 5) portfolio, consistent with the equally-weighted results, exhibits a positive and statistically insignificant abnormal return.

Turning to the factor loadings (slope coefficients) of highly shorted stocks the results indicate that they have relatively high systematic (MRP) risk. In addition, we observe that they load positively on SMB and tend to have a negative covariation with high book-to-market stocks (i.e., tilt towards growth stocks) especially in value-weighted portfolios.

The positive and significant intercepts for the low-shorted stocks (portfolio 1) suggest that short sellers are unable to correct mispricing. On the other hand, short sellers, though they do not realize significant gains from the heavily sorted stocks (portfolio 5), succeed to remove mispricing. A possible explanation for the different impact of short selling on stock prices is that short sellers' positions are imperfectly hedged in the case of low shorted stocks (i.e., the variance of these stocks' return is unhendgable) while they do not appear to be prohibited from hedging their positions for the highly shorted stocks (portfolio 5). That is, idiosyncratic risk, which makes arbitrage costly, may deter short sellers from correcting mispricing in the low shorted stock portfolio. We address this issue later in the paper.

[15] These results are available upon request.

Overall regression results show that both equal- and value-weighted portfolios composed of low short interest stocks earn positive abnormal returns. The magnitude of the abnormal returns is slightly larger for equal-weighted portfolios. Contrary to U.S. evidence, we also find that highly shorted stocks do not underperform the market. Our results suggest that short selling in the U.K. does not appear to be profitable (negative alphas).

[Insert Table 2]

C. Short Selling and Idiosyncratic Risk

As mentioned above, a plausible explanation of why stocks with low short interest are overvalued relative to stocks with high short interest stems from the fact that stocks with low short interest tend to have higher idiosyncratic risk. In the case of stocks that have low short interest, this high idiosyncratic risk would cause a short position to be imperfectly hedged (i.e., the variance of these stocks' return is unhedgeable). For this reason short sellers would avoid establishing positions in high idiosyncratic risk stocks, leading to low short interest and overvaluation. If our explanation is valid, we should find that stocks with high short interest exhibit lower idiosyncratic risk. For this group of stocks short sellers would not appear to be prohibited from hedging their positions and, therefore, any mispricing would be quickly eliminated. However, if there is a systematic relation between idiosyncratic risk and returns, then, both low and high short interest stocks should exhibit the same sensitivity to idiosyncratic risk.

If idiosyncratic risk is responsible for overvaluation of stocks with low short interest, we should find greater overvaluation (alphas) in portfolios with higher idiosyncratic risk. To test this prediction, we construct equally- and value-weighted portfolios based on SI_Avail and idiosyncratic risk. First, we sort stocks by SI_Avail and assign them into five quintile portfolios. Next, within each SI_Avail portfolio, we sort stocks based on idiosyncratic risk, which Ang et al. (2006) used as a proxy for idiosyncratic risk. Idiosyncratic risk (IR) is computed as the standard deviation of the residual from the three factor Fama-French model. The regressions are run daily with a rolling estimation window of 100 days. Although this analysis yields fifteen portfolios, for the sake of brevity, we only report results for six portfolios: three IR portfolios for top SI_Avail quintile and three for the bottom SI_Avail quintile.

In Table 3, Panel A we report alphas and loadings from Fama-French regressions for the equal-weighted portfolios. As predicted, the abnormal returns of the portfolios formed from low SI_Avail (bottom SI_Avail quintile) and high IR (top IR tercile) stocks exceed abnormal profits earned by stocks with low SI_Avail and lower levels of IR (bottom and mid IR terciles). In fact, the alpha of the portfolios containing stocks with the lowest SI_Avail and highest IR (Portfolio [1,3]) is positive 0.27% and is statistically significant at 1% level. The remaining two low SI_Avail portfolios, portfolios [1,1] and [1,2], exhibit positive but statistically insignificant alphas. This result suggests that idiosyncratic risk is responsible for overvaluation of stocks with low short interest. Examining the alpha of the high SI_Avail portfolio, it follows that regardless of IR stocks with high SI_Avail exhibit statistically insignificant alphas. While alphas for portfolio [5,1] and portfolio [5,2] are positive, the alpha for portfolio [5,3] is negative, implying that heavily shorted stocks with high idiosyncratic risk tend to underperform.

Table 3, Panel B presents estimates from Fama-French regressions for the value-weighted portfolios. The results, while weaker, are consistent with equal-weighted results in Panel A. The alpha associated with the portfolio from stocks with low short interest and high idiosyncratic risk, portfolio [1,3], is highest but is only statistically significant at the 10% level.

[Insert Table 3]

Next, we test the prediction of the idiosyncratic risk hypothesis using cross-sectional regression approach. We construct two portfolios: high SI and low SI. High SI portfolio is composed of top 20% of stocks ranked based on SI_Avail. Low SI portfolio includes bottom 20% of securities based on SI_Avail. For each portfolio, we run daily a cross-sectional regression of one-day forward return on IR. In our regression, we control for other transactions costs such as: size, liquidity, institutional ownership, book-to-market, and momentum. SIZE is a natural logarithm of market capitalization; ILLIQ is a five-day Amihud's illiquidity measure[16]; IO is a proxy for institutional ownership, which is computed as a natural logarithm of *Shares in CREST*; BM is a book-to-market; and MOM is a past one-month return of a security.

Table 4 presents Fama-MacBeth estimates for low SI and high SI portfolios. In the regressions we standardize all explanatory variables through demeaning and division by their standard deviations. As predicted, for stocks with low SI_Avail the coefficient of the IR variable is positive and statistically significant at 1% level. This implies that idiosyncratic risk is a significant determinant of cross-sectional returns for low SI_Avail stocks. To the extent that idiosyncratic risk is only a measure of arbitrage costs, then, this result suggests that low short interest stocks earn higher returns because of higher arbitrage costs. This is consistent with Pontiff (1996, 2006) who argues that idiosyncratic risk is the largest cost faced by arbitragers. Among the control variables only MOM is statistically significant. Consistent with previous short-term momentum studies, MOM, has a strong negative relation with future returns.

For heavily shorted stocks, however, the coefficient of IR is still positive, but not statistically significant. This result suggests that when it is less costly to short sellers to hedge idiosyncratic risk, arbitrage becomes effective and mispricing is corrected. Collectively, these results are consistent with the prediction of the arbitrage risk hypothesis, suggesting that short sellers' positions are imperfectly hedged in low-shorted stocks because the variance of these stocks' return is unhedgeable. That is, short sellers avoid establishing positions in high idiosyncratic risk stocks, leading to low short interest and mispricing. As for the control variables, SIZE, MOM, and BM are statistically significant at 1% level. SIZE and BM load positively, suggesting that short sellers tend to short more heavily stocks with larger capitalization and higher book-to-market ratios. Consistent with results for low SI_Avail stocks, MOM is negatively related with future returns. Regression results using weekly data are comparable and are available upon request.

Finally, one can argue that the idiosyncratic risk measure is a proxy for differences of opinion and, hence, our results are consistent with the Miller's (1977) prediction. The positive coefficient of the idiosyncratic risk variable, in the regression for the highly unshortable (Low SI_Avail) sample of stocks, does not support Miller's hypothesis.

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[16] See Amihud (2002).

[Insert Table 4]

D. Effect of Size/Short Squeezes

The last issue we address is whether positive abnormal performance of heavily shorted firms can be attributed to short squeezes. We argue that short squeezes are more likely to occur among actively traded heavily shorted stocks, characterized by high turnover (volume scaled by shares outstanding) and high short interest. Indeed, while high trading volume may indicate increased demand for the security, high short interest relative to availability indicates limited supply. Both factors coupled together would cause temporary mispricing, resulting in positive abnormal performance at very short horizons. However, since this mispricing is only caused by temporary imbalance, it should revert at longer horizons. We define a short horizon as up to one month and a longer horizon as more than one month. Our prediction is that stocks with high SI_Avail and high turnover are likely to experience positive abnormal performance over one month horizon followed by negative performance at longer horizons. Negative performance would be manifestation of informed short interest.

Figure 4 presents average 1, 2, and 3-month cumulative abnormal returns of independently sorted combinations of the top and bottom 5% SI_Avail and volume, scaled by shares outstanding. Consistent with regression results, for stocks with low short interest, excess returns are positive. Returns are generally higher for low short interest stocks that experienced high turnover over recent past (Low SI_Avail and High Volume). Since high turnover is usually associated with greater demand, it is possible that higher turnover stocks with high SI_Avail would be more mispriced because short seller constraint would be even more binding. On the contrary, high SI_Avail stocks that are not actively traded (High SI_Avail and Low Volume) experience strong negative performance. This suggests that short interest for this group of stocks reflects fundamental information. As predicted, we find that the performance of high short interest stocks with high turnover is positive at one-month horizon and negative at longer horizons. This finding is consistent with the prevalence of short squeezes among this group of stocks.

[Insert Figure 4]

5. Conclusion

We set out to explore the relationship between short selling and stock returns for U.K. stocks. In agreement with previous studies, we find that stocks with low short interest based on three short interest measures have significant positive abnormal returns and outperform more heavily shorted stocks. In addition, we find that portfolios made up of heavily shorted stocks exhibit slightly positive abnormal returns on an equal-weighted basis. Contrary to U.S. evidence, which suggests that stocks with high short interest significantly underperform, abnormal performance of these portfolios disappears on a value-weighted basis, suggesting that smaller, less liquid stocks are responsible for outperformance of high short interest stocks.

We also document that idiosyncratic risk, a deterrent to arbitrage, is correlated with mispricing. Our results indicate that there is a negative relation between short interest and abnormal returns among stocks with high idiosyncratic risk. Consistent with Shleifer and Vishny (1997), who argue that idiosyncratic risk deters arbitrage leading to persistent mispricing, our evidence suggests that short selling activity is mostly concentrated in stocks with low idiosyncratic risk because it is less costly to arbitrage fundamental risk.

We conduct multivariate tests to better understand how different costs limit short selling activity. Our results suggest that idiosyncratic risk, a cost borne both by short and long arbitrage positions, is a greater deterrent to short selling than are transactions and short sale costs. Our results are in line with the view that fewer arbitrage resources are directed to high idiosyncratic stocks and offer an explanation for the persistent mispricing among high idiosyncratic stocks. Our findings are consistent with both Pontiff (1996) and Slheifer and Vishny (1997) who conjecture that mispricing is mostly prevalent among high idiosyncratic risk stocks.

References

Abrew, D., and M. K. Brunnermeier, 2002, Synchronization risk and delayed arbitrage, *Journal of Financial Economics* 66, 341-360.

Aitken, M. J., Frino, A., McCorry, M. S., and P. L. Swan, 1998, Short sales are almost instantaneously bad news: Evidence from the Australian Stock Exchange, *Journal of Finance* 53, 2205-2223.

Ali, A, L-S. Hwang, and M. A. Trombley, 2003, Arbitrage risk and the book-to-market anomaly, *Journal of Financial Economics* 69, 355-373.

Amihud, Y., 2002, Illiquidity and stock returns, cross-section and time-series effects, *Journal of Financial Markets* 5, 31-56.

Ang, A, R. J. Hodrick, Y. Xing, and X. Zhang, 2006, The cross-section of volatility and expected returns, *Journal of Finance* 61, 259-299.

Asquith, P., and L. Meulbroek, 1995, An empirical investigation of short interest. Working paper. Harvard University.

Asquith, P., Pathak, P. A., and J. R. Ritter, 2005, Short interest, institutional ownership, and stock returns. *Journal of Financial Economics*, 78, 243-276.

Baker, M., and S. Savasoglu, 2002, Limited arbitrage in mergers and acquisitions, *Journal of Financial Economics* 64, 91-115.

Bhandari, L.C., 1988, Debt/equity ratios and expected common stock returns: empirical evidence, *Journal of Finance* 43, 507-28.

Banz, R.W., 1981, The relationship between return and market value of common stocks. *Journal of Financial Economics*, 9, 3-18.

Biais, B., C. Bisiere and Jean-Paul Decamps (1999) Short Sales Constraints, Liquidity and Price Discovery: an Empirical Analysis on the Paris Bourse, *European Financial Management*, 5, 1999, 395-409.

Boehme, R. D., Danielsen, B. R., and S. M. Sorescu, 2006, Short-sale constraints and overvaluation, *Journal of Financial and Quantitative Analysis* 41, 455-487.

Bris, A., Goetzmann, W., and Zhu, N., 2006, Efficiency and the bear: Short sales and markets around the world, *Journal of Finance forthcoming*.

Capaul, C., Rowley, L., and W.F. Sharpe, 1993, International value and growth stock returns, *Financial Analysts Journal* 49, 27-36.

Chan, A., and A. Chui, 1996, An empirical re-examination of the cross section of expected returns: UK evidence, *Journal of Business Finance and Accounting*, 23, 1435-52.

Chen, J., Hong, H., and J. C. Stein, 2002, Breadth of ownership and stock returns, *Journal of Financial Economics*, 66, 171-205.

Christophe, S., Ferri, M., and J. Angel, 2004, Short-selling prior to earnings announcements, *Journal of Finance* 59, 1845-1875.

Cohen, L., Diether K., and C. Malloy, 2006, Supply and demand shifts in the shorting market, *Journal of Finance forthcoming.*

D'Avolio, G., 2002, The market for borrowing stock, *Journal of Financial Economics*, 66, 271-306.

Dechow, P., Hutton, A., Meulbroek, L., and R. Sloan, 2001, Short-sellers, fundamental analysis, and stock returns, *Journal of Financial Economics*, 61, 77-106.

Desai, H., Ramesh, K., Thiagarajan, S. R., and B. V. Balachandran, 2002, An investigation of the informational role of short interest in the NASDAQ market, *Journal of Finance*, 57, 2263-2287.

Diamond, D., and R. Verrecchia, 1987, Constraints on short-selling and asset price adjustment to private information, *Journal of Financial Economics*, 18, 277-311.

Diether, K., Lee, K., and I. Werner, 2006, Can short-sellers predict returns? Daily evidence, Working paper. Ohio State University.

Duarte, J., Lou, X., and R. Sadka, 2006, Can liquidity events explain the low-short-interest puzzle? Implications from the options market, Working paper. Washington University

Duffie, D., Garleanu, N., and L. Pedersen, 2002, Securities lending, shorting, and pricing" *Journal of Financial Economics* 66, 307-339.

Fabozzi, F., and F. Modigliani, 1992, Capital Markets - Institutions and Instruments, Englewood Cliffs, NJ, Prentice Hall.

Fama, E. and K. French, 1992, The cross-section of expected stock returns, *Journal of Finance*, 47, 427-65.

Fama, E. and K. French, 1993, Common risk factors in the returns on stocks and bonds, *Journal of Financial Economics*, 33, 3-56.

Fama, E. and K. French, 1996, Size and book-to-market factors in earnings and returns, *Journal of Finance*, 50, 131-155.

Financial Services Authority, FSA Discussion Paper 17: Short Selling. October 2002.

Goodman, D., and J. III. Peavy, 1986, The low price effect: relationship with other stock market anomalies, *Review of Business and Economic Research*, 22, 18-37.

Hanna, M., 1976, A stock price predictive model based on changes in ratios of short interest to trading volume, *Journal of Financial and Quantitative Analysis*, 11, 857-72.

Hansen, L. P. and R. Jaganathan, 1997, Assessing Specification Errors in Stochastic Discount Factor Models, *Journal of Finance* 52(2), 557-90.

He, H. and D. M. Modest, 1995, Market Frictions and Consumption-Based Capital Asset Pricing, *Journal of Political Economy* 103, 94–117, 1995.

Hurtado-Sanchez, L., 1978, Short interest: Its influence as a stabilizer of stock returns, *Journal of Financial and Quantitative Analysis*, 13, 965-85.

International Organization of Securities Commissions, Report on Transparency of Short Selling. June 2003.

Jarrow, R., 1980, Heterogeneous expectations, restrictions on short sales, and equilibrium asset prices, *Journal of Finance*, 35, 1105-1113.

Jensen, G.R., Mercer, J.M., and R.R. Johnson, 1997, w evidence on size and price-to-book effects in stock returns, *Financial Analysts Journal*, 53, 34-42.

Jones, C. and O. Lamont, O., 2002, Short sale constraints and stock returns, *Journal of Financial Economics*, 66, 207-239.

Jouini, E. and H. Kallal, 2001, Efficient Trading Strategies in the Presence of Market Frictions, *Review of Financial Studies* 14(2), 343-69.

Lamont, O., 2004, Short sale constraints and overpricing, in *The Theory and Practice of Short Selling*, edited by F.J Fabozzi.

Lamont, Owen, and Jeremy C. Stein, 2004, Aggregate short interest and market valuations, *American Economic Review*, 94: 29-32.

Lintner, J., 1965, The aggregation of investor's diverse judgment and preferences in purely competitive security markets, *Journal of Financial and Quantitative Analysis,* 4, 347-400.

McDonald, J. and D. Baron, 1973, Risk and return on short positions in common stocks, *Journal of Finance*, 28, 97-107.

Malkiel, B., and Y. Xu , 2002, Idiosyncratic risk and security returns, Working paper. Princeton University.

Merton, R., 1987,A Simple Model of Capital Market Equilibrium with Incomplete Information, *Journal of Finance,* 42, 483-510.

Miller, E. M., 1977, Risk, uncertainty, and divergence of opinion, *Journal of Finance*, 32,1151-1168.

Nagel , S., 2005, Short sales, institutional investors and the cross-section of stock returns, *Journal Financial Economics* 78, 277-309.

Ofek, E. and M., Richardson, 2003, DotCom Mania: The Rise and the Fall of Internet Stocks, *Journal of Finance* 58, 1113-1138.

Poitras G., 2002, Short sales restrictions, dilution and the pricing of rights issues on the Singapore Stock Exchange, Pactic-Basin Finance Journal 10, 141-162.

Pontiff, J., 1996, Costly arbitrage: Evidence from closed-end funds, *Quarterly journal of Economics* 111, 1135-1151.

Pontiff, J., 2006, Costly arbitrage and the myth of idiosyncratic risk, *Journal of Accounting and Economics* 42, 35-52.

Pontiff, J., and M. J. Schill, 2004, Long-run seasoned equity offering returns: Data snooping, model misspecification, or mispricing? A costly approach, Working paper, Boston College.

Rosenberg, B., Reid, K., and R. Lanstein, 1985, Persuasive evidence of market inefficiency, *Journal of Portfolio Management*, 11, 9-16.

Scheinkman, J., and W. Xiong, 2003, Overconfidence and Speculative Bubbles, *Journal of Political Economy* 111, 1183-1219.

Shleifer, A., and R. Vishny, 1997,The Limits to Arbitrage, *Journal of Finance* 52, 35-55.

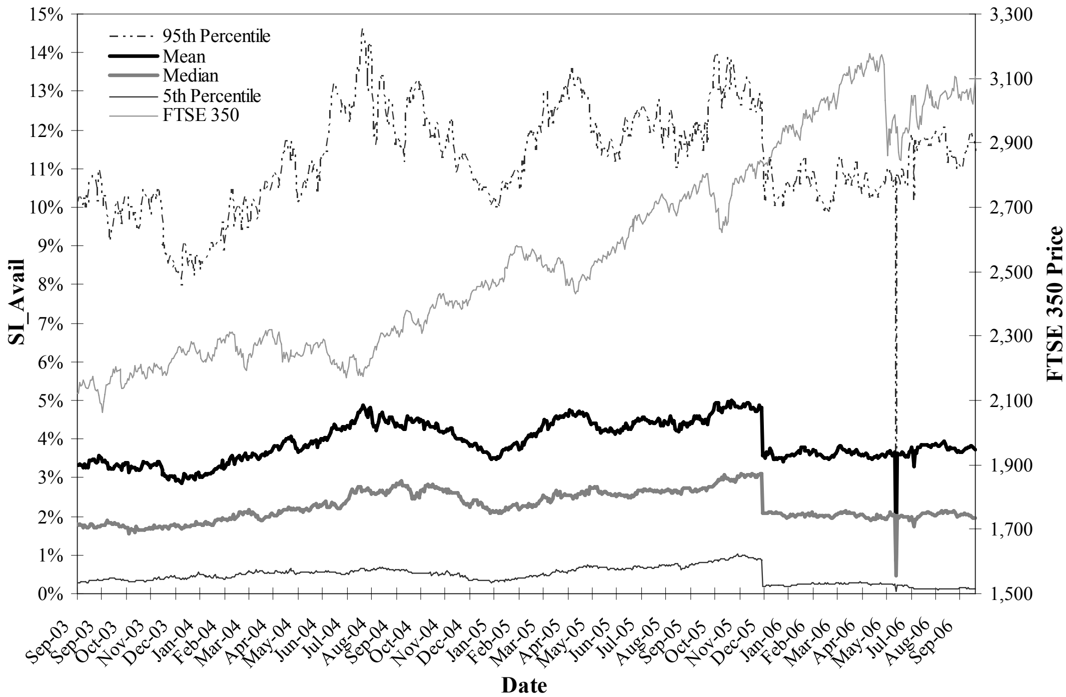
Spiegel. M., and X. Wang, 2006, Cross-sectional variation in stock returns: Liquidity and idiosyncratic risk, Working paper, Yale University.

Woolridge, J.R., and A. Dickinson, 1994, Short selling and common stock prices, *Financial Analysts Journal* 50, 20-28.

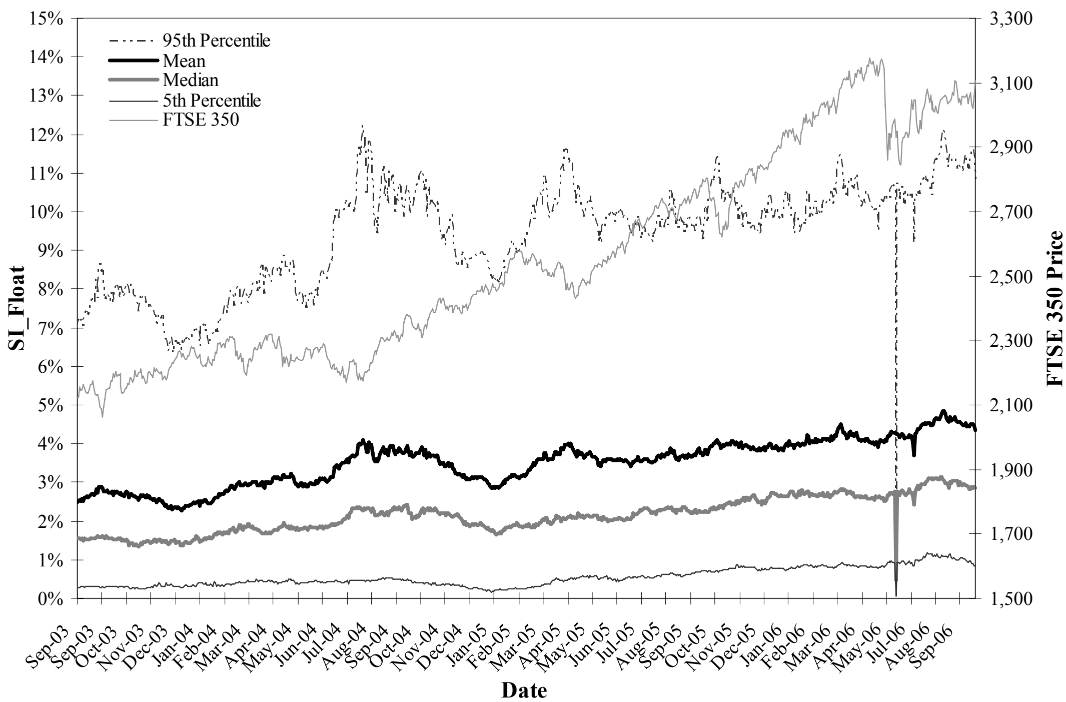
Wurgler, J., and E. Zhuravskaya, 2003, Does arbitrage flatten demand curves for stocks? *Journal of Business* 75, 583–608.

Figure 1: Distribution of Short Interest Ratios from September 2003 through September 2006

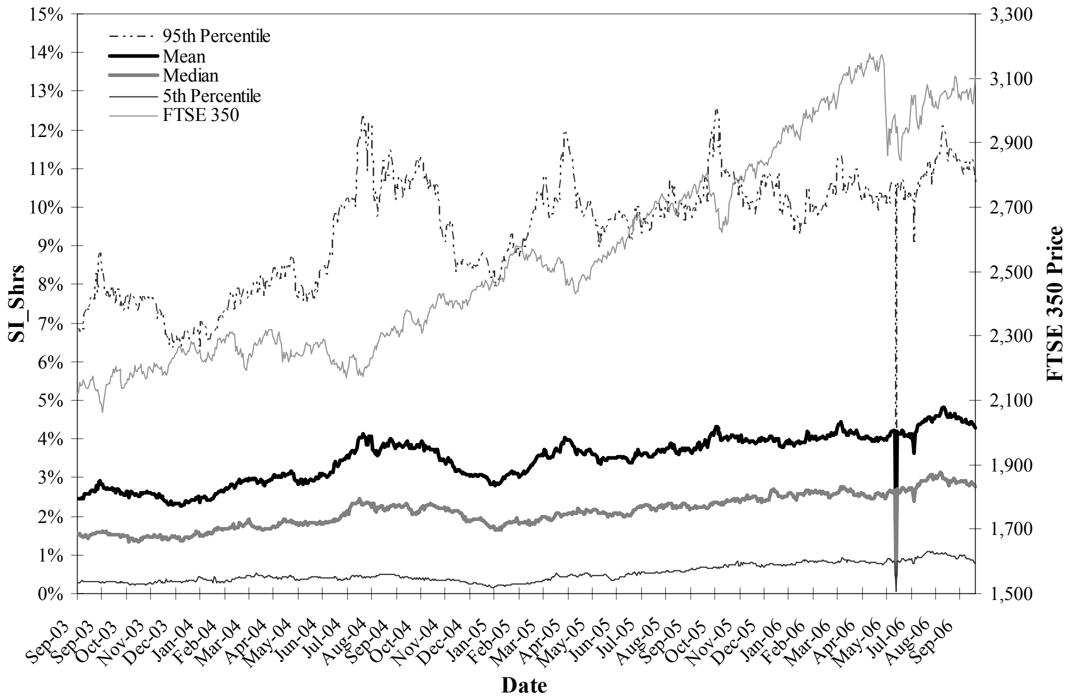
Panel A: Short Interest over Available Shares (SI_Avail)



Panel B: Short Interest over Float (SI_Float)



Panel C: Short Interest over Shares Outstanding (SI_Shrs)



Notes to Figure 1: The mean, median, and the 5th and 95th percentiles of short interest ratios for FTSE 350 stocks (left axis) and the level of the FTSE 350 price (right axis) for each trading day from September 2003 through September 2006. The short interest ratios are defined as follows: SI_Avail is short interest, *Shares on Loan* ‡, divided by *Shares in CREST*; SI_Float is short interest, *Shares on Loan* ‡, divided by float; and SI_Shrs is short interest, *Shares on Loan* ‡, divided by shares outstanding. Float represents the number of freely traded shares, and it is calculated as shares outstanding minus closely held shares. Data from CRESTCo Limited.

Table 1: Average of Daily Short Interest Ratio Portfolio Statistics

This table presents descriptive statistics by percentile of short interest ratio by day. The variables are defined as follows: SI_Avail is short interest, *Shares on Loan* ‡, divided by *Shares in CREST*‡; SI_Float is short interest, *Shares on Loan* ‡, divided by float; SI_Shrs is short interest, *Shares on Loan* ‡, divided by shares outstanding, SI_Vol is short interest, *Shares on Loan* ‡, divided by volume; MktCap is market capitalization in GBP millions; BM is book value per share divided by price; and CAR is the forward monthly cumulative abnormal return computed against the FTSE 350. ‡Data from CRESTCo Limited.

Panel A: Short Interest over Available Shares (SI_Avail)

SS_Avail Portfolios		SI_ Avail	SI_ Float	SI_ Shrs	SI_ Vol	MktCap	BM	Monthly CAR 1M	2M	3M
0	Mean	0.1%	0.2%	0.2%	5.11	£610.2	1.27	1.5%	3.1%	4.5%
Low	Median	0.1%	0.2%	0.2%	0.78	£667.9	0.45	0.5%	1.6%	3.6%
	Std Dev	0.1%	0.1%	0.1%	27.59	£344.8	8.74	5.0%	7.8%	10.0%
5	Mean	0.4%	0.5%	0.5%	11.62	£713.8	0.91	0.4%	1.0%	1.9%
	Median	0.4%	0.5%	0.5%	2.48	£725.5	0.47	0.2%	0.8%	1.3%
	Std Dev	0.2%	0.2%	0.2%	173.70	£388.1	4.41	5.7%	8.2%	10.4%
25	Mean	1.1%	1.0%	1.0%	10.91	£563.4	4.61	0.5%	1.5%	2.3%
	Median	1.0%	1.0%	1.0%	3.42	£479.7	0.59	0.2%	0.3%	1.1%
	Std Dev	0.3%	0.3%	0.3%	81.02	£342.8	13.96	6.6%	10.5%	13.1%
50	Mean	2.2%	1.9%	1.9%	15.38	£511.0	4.86	0.6%	0.7%	1.2%
	Median	2.1%	1.9%	1.9%	5.01	£426.8	0.93	0.3%	0.2%	0.4%
	Std Dev	0.3%	0.5%	0.5%	161.19	£329.2	14.20	5.7%	8.4%	10.1%
75	Mean	4.5%	3.9%	3.8%	15.83	£457.4	5.25	0.5%	0.6%	1.0%
	Median	4.4%	4.0%	3.9%	8.61	£375.3	1.15	-0.1%	-0.1%	0.0%
	Std Dev	0.6%	0.9%	1.0%	37.02	£327.4	16.30	8.3%	11.7%	12.6%
95	Mean	11.1%	9.3%	9.1%	24.96	£463.9	3.55	0.3%	0.1%	-0.6%
	Median	11.1%	9.6%	9.6%	14.75	£426.3	1.68	0.1%	0.0%	-0.1%
	Std Dev	1.2%	2.2%	2.5%	50.04	£280.5	7.50	7.8%	11.4%	13.8%
100	Mean	31.5%	14.2%	13.1%	41.55	£741.2	3.63	0.1%	-0.4%	-0.8%
High	Median	25.9%	11.9%	11.8%	25.87	£640.5	3.13	0.0%	-1.2%	-1.0%
	Std Dev	22.2%	6.6%	7.1%	77.19	£537.1	5.86	9.4%	13.3%	15.9%

Panel B: Short Interest over Float (SI_Float)

SS_Float Portfolios		SI_ Avail	SI_ Float	SI_ Shrs	SI_ Vol	MktCap	BM	Monthly CAR 1M	2M	3M
0	Mean	1.0%	0.2%	0.2%	9.82	£511.2	1.07	1.4%	2.9%	4.6%
Low	Median	0.5%	0.2%	0.2%	1.26	£425.5	0.44	0.9%	2.5%	4.4%
	Std Dev	1.5%	0.2%	0.2%	71.40	£316.1	4.88	6.4%	9.2%	11.6%
5	Mean	0.8%	0.6%	0.6%	16.45	£594.3	2.15	0.4%	0.9%	1.7%
	Median	0.7%	0.5%	0.5%	2.73	£508.3	0.54	0.2%	0.6%	0.8%
	Std Dev	0.7%	0.2%	0.3%	382.95	£368.3	7.65	6.7%	9.5%	11.3%
25	Mean	1.5%	1.2%	1.2%	9.38	£540.7	4.59	0.6%	1.5%	2.2%
	Median	1.4%	1.1%	1.1%	3.91	£455.8	0.61	0.5%	1.3%	1.6%
	Std Dev	0.6%	0.3%	0.3%	30.82	£330.9	13.89	6.5%	9.2%	11.2%
50	Mean	2.7%	2.2%	2.3%	13.56	£476.7	5.96	0.3%	0.4%	0.5%
	Median	2.5%	2.2%	2.2%	5.08	£381.6	0.99	0.1%	0.2%	0.2%
	Std Dev	1.0%	0.5%	2.0%	154.42	£326.1	17.96	6.1%	8.6%	10.3%
75	Mean	5.0%	4.4%	4.3%	24.64	£494.5	4.24	0.1%	-0.1%	0.0%
	Median	4.9%	4.5%	4.4%	8.38	£404.2	1.26	-0.1%	-0.3%	-0.2%
	Std Dev	1.4%	0.9%	1.1%	190.94	£327.5	12.92	6.2%	9.1%	10.8%
95	Mean	11.7%	9.5%	9.2%	25.53	£530.4	3.27	-0.3%	-0.3%	0.2%
	Median	10.8%	9.8%	9.7%	15.29	£452.4	1.68	-0.3%	0.1%	0.5%
	Std Dev	3.5%	1.3%	1.9%	46.61	£327.1	5.59	7.8%	11.5%	13.7%
100	Mean	20.2%	17.8%	17.2%	31.16	£462.7	3.15	0.8%	1.6%	2.7%
High	Median	19.4%	17.4%	16.7%	20.70	£416.9	1.87	0.4%	0.5%	0.6%
	Std Dev	5.4%	4.1%	4.2%	70.48	£306.8	6.23	8.2%	12.1%	15.4%

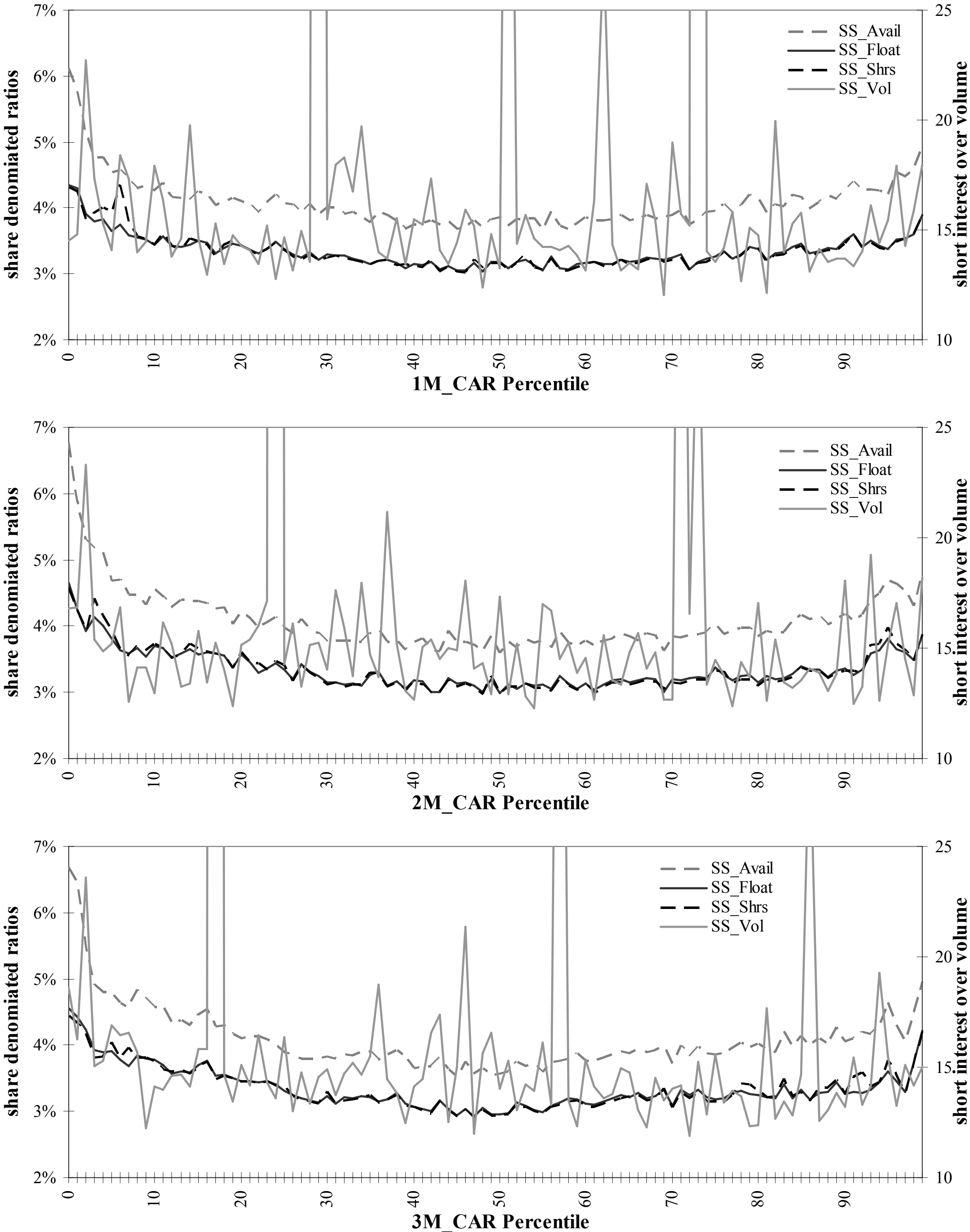
Panel C: Short Interest over Shares Outstanding (SI_Shrs)

SS_Shrs Portfolios		SI_ Avail	SI_ Float	SI_ Shrs	SI_ Vol	MktCap	BM	Monthly CAR 1M	2M	3M
0	Mean	1.0%	0.4%	0.2%	41.83	£401.1	4.47	1.2%	2.1%	3.1%
Low	Median	0.7%	0.3%	0.1%	2.33	£315.4	0.44	0.7%	1.6%	2.1%
	Std Dev	1.3%	0.4%	0.2%	406.87	£340.1	12.27	6.7%	9.3%	10.8%
5	Mean	0.9%	0.6%	0.5%	6.16	£599.7	2.10	0.6%	1.3%	1.9%
	Median	0.7%	0.5%	0.5%	2.50	£542.6	0.59	0.3%	0.4%	0.5%
	Std Dev	0.8%	0.4%	0.2%	33.76	£355.5	7.42	6.5%	9.6%	11.7%
25	Mean	1.5%	1.2%	1.2%	9.48	£532.2	5.23	0.5%	1.2%	2.1%
	Median	1.4%	1.1%	1.1%	3.95	£448.0	0.64	0.2%	0.8%	1.4%
	Std Dev	0.7%	0.4%	0.3%	43.01	£328.4	16.62	6.3%	8.9%	11.1%
50	Mean	2.7%	2.2%	2.2%	14.60	£460.9	5.79	0.3%	0.4%	0.7%
	Median	2.5%	2.2%	2.2%	5.38	£367.1	0.98	0.1%	0.1%	0.2%
	Std Dev	1.3%	0.7%	0.4%	157.06	£319.2	16.55	6.4%	8.9%	10.8%
75	Mean	5.1%	4.3%	4.3%	23.03	£472.3	3.76	0.2%	0.2%	0.4%
	Median	4.8%	4.5%	4.5%	8.13	£391.2	1.33	-0.1%	-0.3%	0.1%
	Std Dev	2.4%	1.0%	0.9%	187.21	£319.1	9.34	6.1%	8.5%	10.1%
95	Mean	11.8%	9.5%	9.5%	23.56	£531.2	2.63	-0.1%	-0.1%	0.6%
	Median	10.8%	9.8%	9.8%	14.91	£458.4	1.76	-0.1%	0.0%	0.9%
	Std Dev	4.1%	1.5%	1.4%	40.22	£330.9	3.84	7.7%	11.6%	14.0%
100	Mean	19.1%	17.2%	20.8%	32.33	£506.7	2.84	0.9%	1.6%	2.8%
High	Median	18.9%	17.1%	17.1%	19.82	£446.8	1.61	0.4%	0.2%	0.4%
	Std Dev	5.8%	5.1%	21.9%	96.49	£342.0	6.48	7.8%	11.7%	15.1%

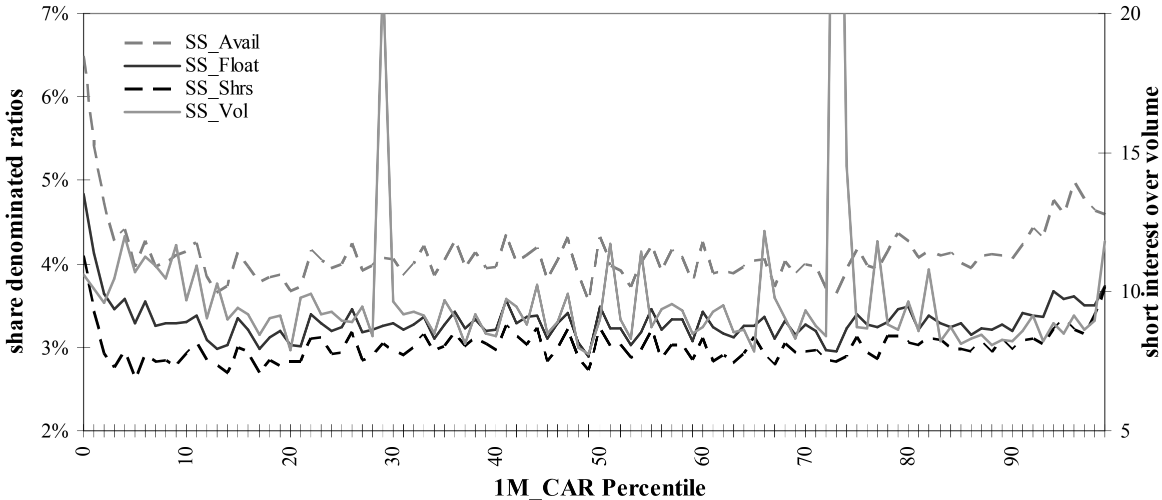
Panel D: Total Sample

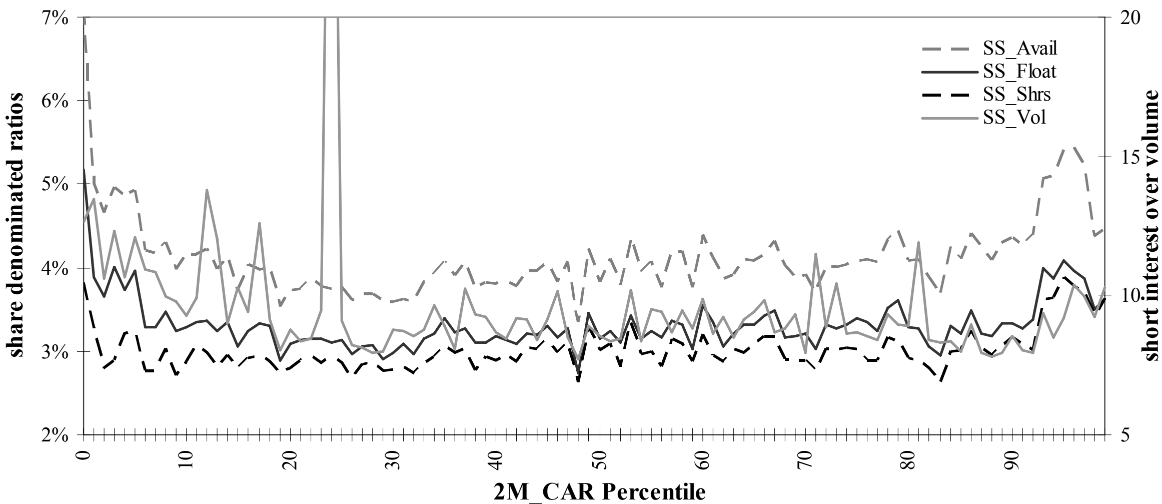
	SI_Avail	SI_Float	SI_Shrs	SI_Vol	MktCap	BM	Monthly CAR 1M	2M	3M
Mean	3.7%	3.3%	3.3%	20.62	£517.2	4.17	0.4%	0.8%	1.2%
Median	2.2%	2.2%	2.2%	6.28	£432.4	0.90	0.1%	0.4%	0.8%
Std Dev	4.8%	3.2%	3.9%	1735.58	£336.5	12.56	6.6%	9.3%	11.4%

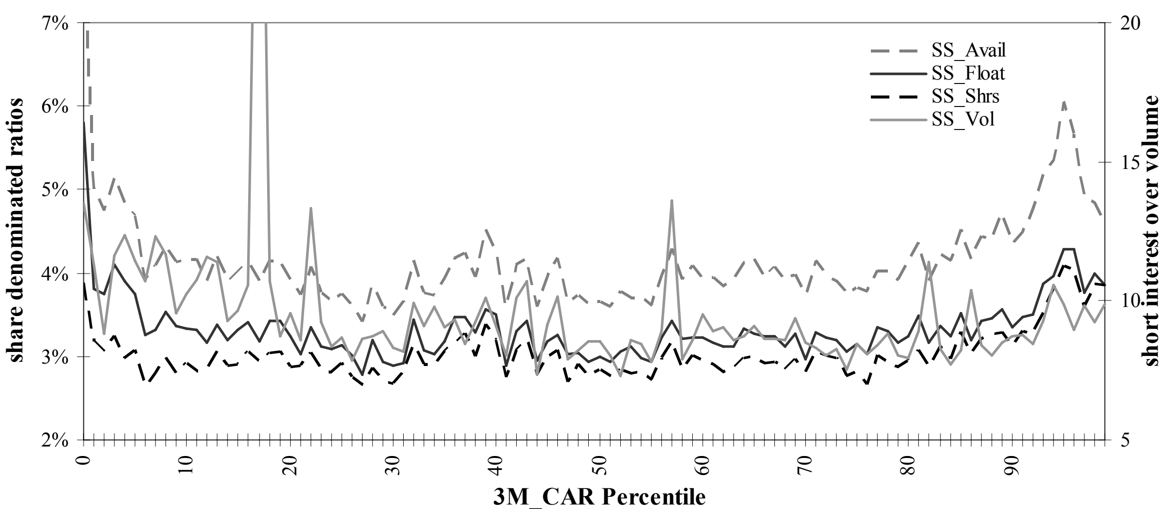
Figure 2: Short Interest Ratio Levels and Abnormal Return Percentiles
Panel A: Equal-weighted Portfolio



Panel B: Value-weighted Portfolio

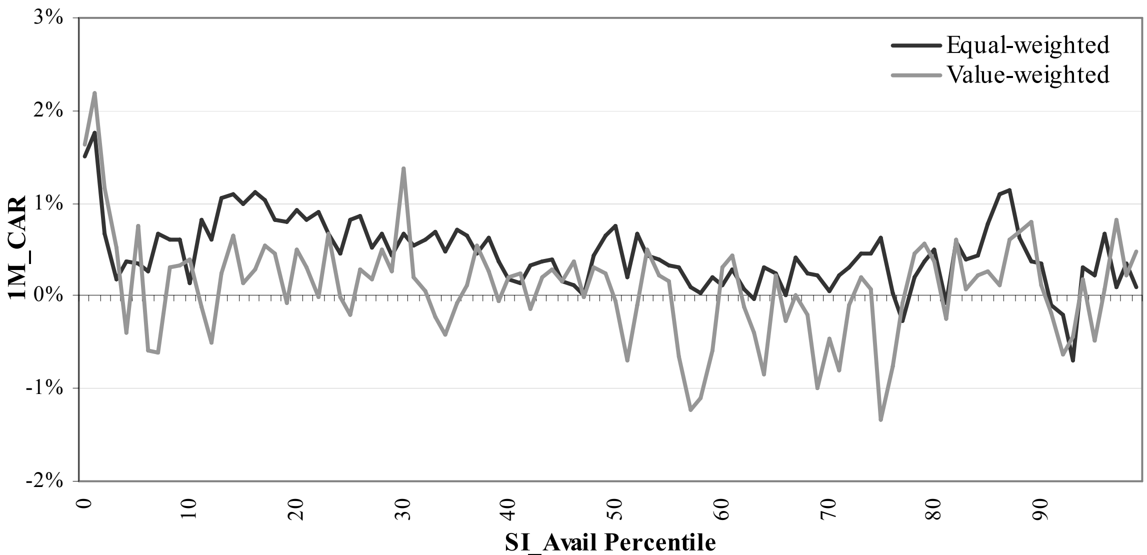




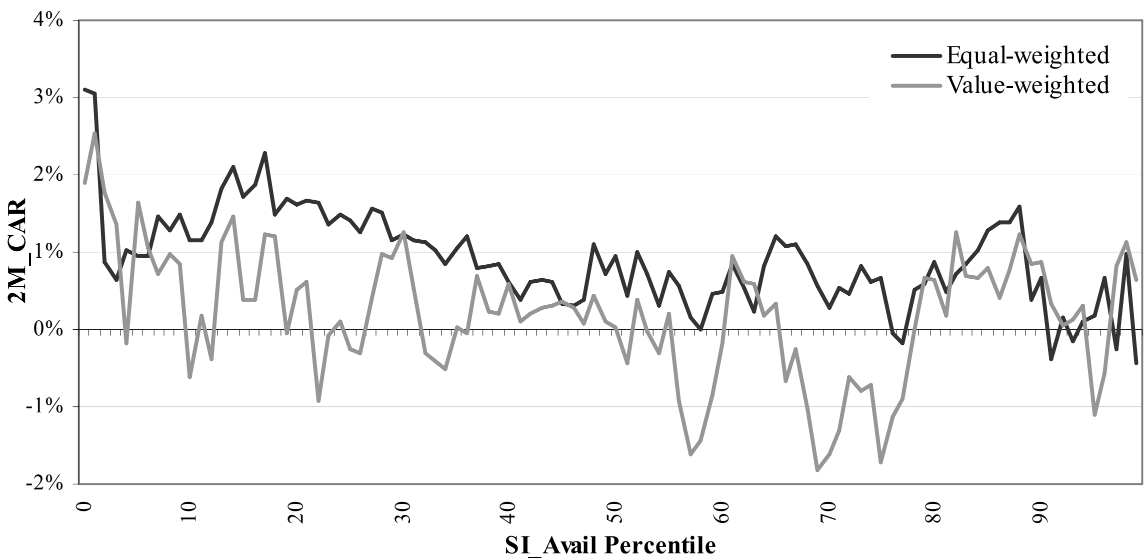


Notes to Figure 2: Equal-weighted (Panel A) and value-weighted (Panel B) mean of daily SS_Avail (left axis), SS_Float (left axis), and SS_Shrs (left axis) and SS_Vol (right axis) by 1-month forward return percentiles from September 2003 through December 2005. The variables are defined as follows: SI_Avail is short interest, *Shares on Loan* ‡, divided by *Shares in CREST*; SI_Float is short interest, *Shares on Loan* ‡, divided by float; SI_Shrs is short interest, *Shares on Loan* ‡, divided by shares outstanding; SI_Vol is short interest, *Shares on Loan* ‡, divided by volume; and 1M_CAR is the forward 1-month cumulative abnormal return computed against the FTSE 350. ‡Data from CRESTCo Limited.

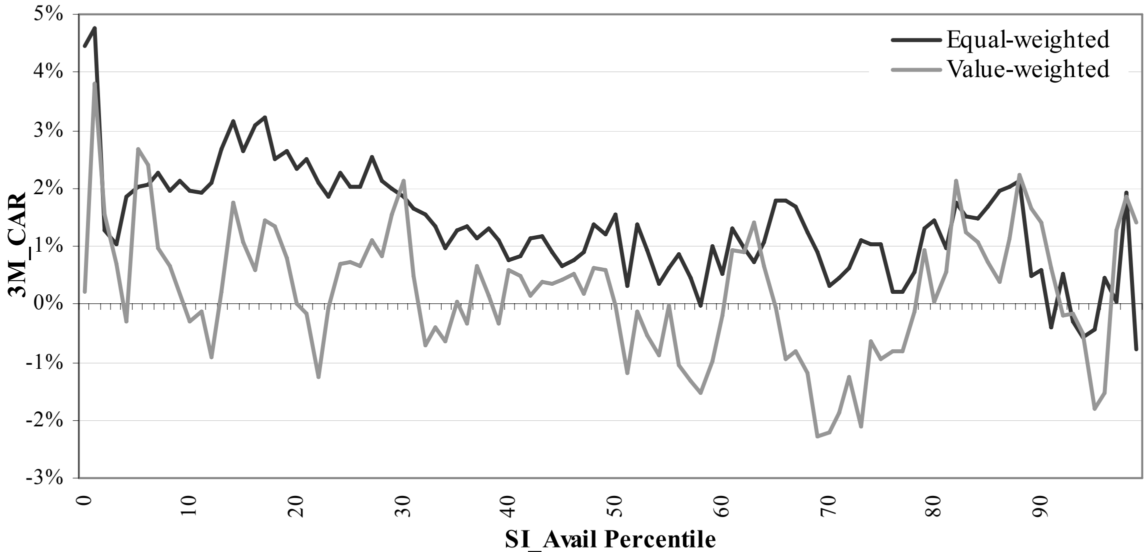
Figure 3A: Abnormal Returns and Short Interest over Available Shares (SI_Avail) Percentiles
Panel A: 1-month Cumulative Abnormal Return



Panel B: 2-month Cumulative Abnormal Return



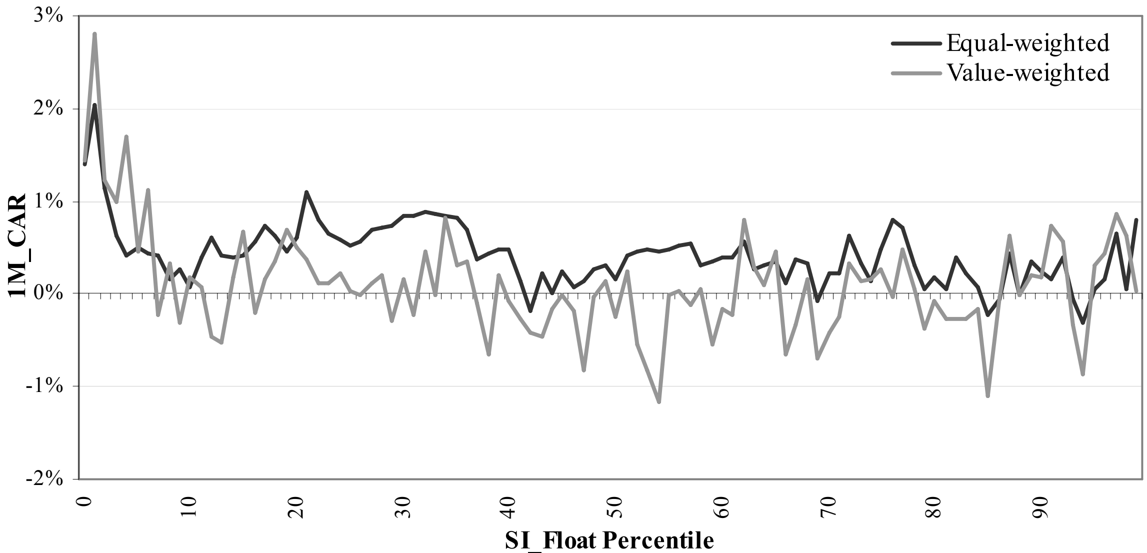
Panel C: 3-month Cumulative Abnormal Return



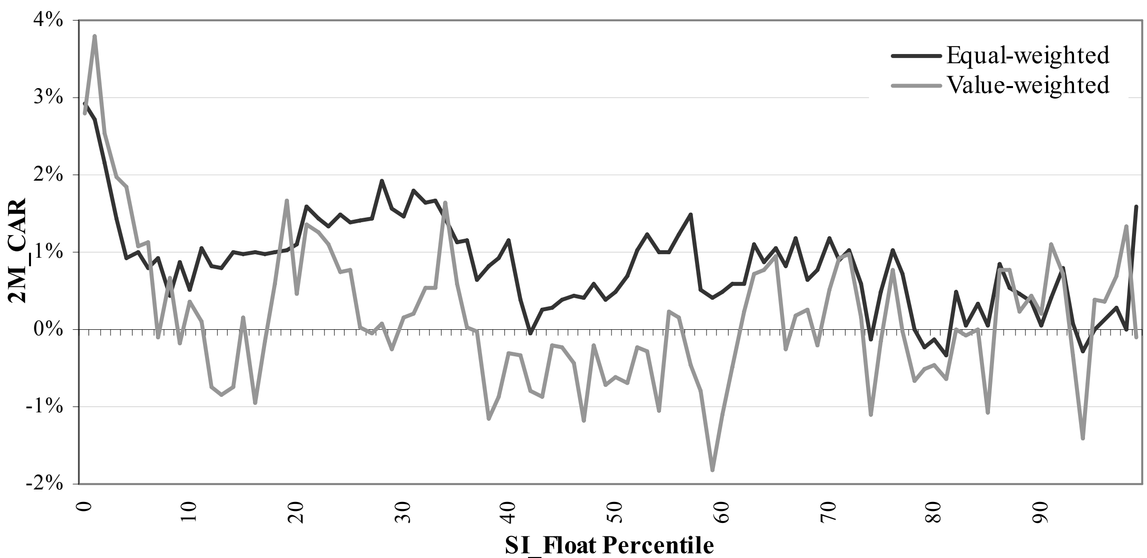
Notes to Figure 3A: This figure graphs the equal-weighted and value-weighted mean by 1M_CAR percentiles from September 2003 through December 2005. SI_Avail is short interest, *Shares on Loan* ‡, divided by *Shares in CREST*‡ and CAR is the forward cumulative abnormal return computed against the FTSE 350. ‡Data from CRESTCo Limited.

Figure 3B: Abnormal Return and Short Interest over Float (SI_Float) Percentiles

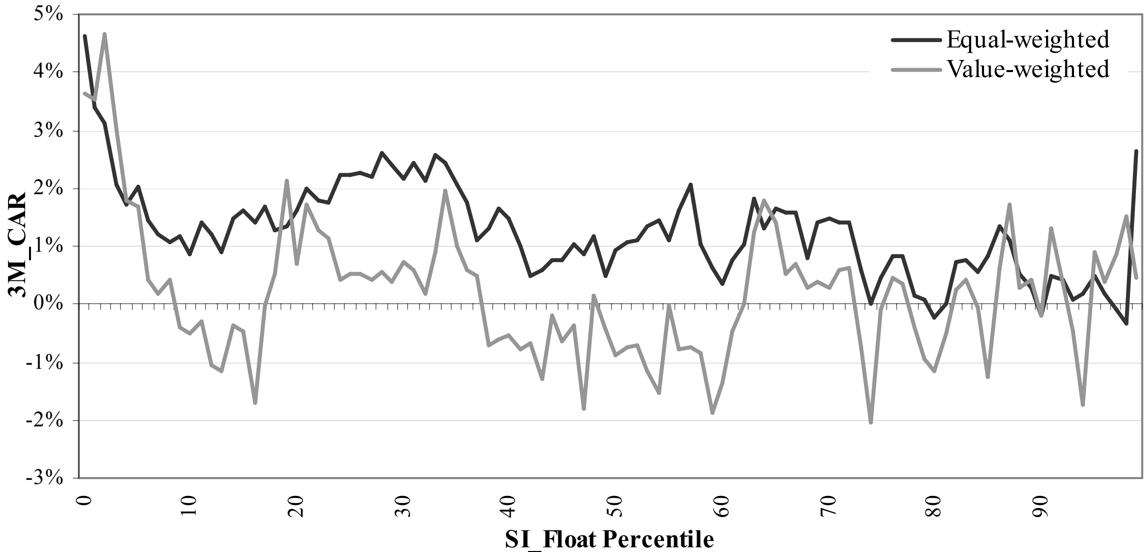
Panel A: 1-month Cumulative Abnormal Return



Panel B: 2-month Cumulative Abnormal Return



Panel C: 3-month Cumulative Abnormal Return



Notes to Figure 3B: This figure graphs the equal-weighted and value-weighted mean by 1M_CAR percentiles from September 2003 through December 2005. SI_Float is short interest, *Shares on Loan* ‡, divided by float and CAR is the forward cumulative abnormal return computed against the FTSE 350. ‡Data from CRESTCo Limited.

Table 2: Short Interest and Returns for UK Firms

This table reports time series regression coefficients for both equal- and value-weighted portfolios formed based on cross-sectional ranking of their constituents by short interest based on SI_Avail. We estimate three factor models on equal-weighted portfolios in Panel A and on value-weighted portfolios in Panel B. These portfolios are formed weekly using middle-of-week SI_Avail quintiles. The estimated model is: $R_{i(t)} - R_{f(t)} = \alpha + \beta_1(R_{m(t)} - R_{f(t)}) + \beta_2 SMB_{(t)} + \beta_3 HML_{(t)} + \varepsilon$, where $R_{i(t)}$ is return, α is constant, $R_{f(t)}$ is weekly one-month LIBOR, $R_{m(t)}$ is the market return (FTSE 350), $MPR_{(t)}$ is the market risk premium defined as $R_{m(t)} - R_{f(t)}$, $SMB_{(t)}$ is the size factor and $HML_{(t)}$ is the book-to-market factor. SMB and HML portfolios are formed last trading day of a calendar year and held for one year. Equally weighted (Panels A) and value-weighted (Panels B) portfolios are created by sorting middle-of-week SI_Avail (Panels A and B) is short interest, *Shares on Loan* ‡ divided by *Shares in CREST*‡, and assigned to quintile portfolios. The procedure is repeated every week. P-values are listed below the regression coefficients. * one-tailed probability < 0.10; ** one-tailed probability < 0.05; *** one-tailed probability < 0.01. ‡Data from CRESTCo Limited.

Panel A: Equal-weighted Portfolios

Portfolio	Intercept x 100		β_1 MRP		β_2 SMB		β_3 HML		Adj R^2	N
1	0.155	***	1.028	***	0.787	***	0.077		85.5	141
Low SI_Avail	0.004		<.0001		<.0001		0.296			
2	0.101	*	1.005	***	0.679	***	0.145	*	81.33	141
	0.097		<.0001		<.0001		0.084			
3	0.023		1.003	***	0.567	***	-0.015		81.73	141
	0.701		<.0001		<.0001		0.850			
4	0.058		0.983	***	0.277	**	-0.036	*	76.17	141
	0.403		<.0001		0.016		0.702			
5	0.033		1.052	***	0.362	***	-0.010		74.13	141
High SI_ Avail	0.668		<.0001		0.005		0.925			

Panel B: Value-weighted Portfolios

Portfolio	Intercept x 100		β_1 MRP		β_2 SMB	β_3 HML		Adj R^2	N
1	0.149	**	0.903	***	0.154	-0.045		70.98	141
Low SI_Avail	0.042		<.0001		0.199	0.649			
2	0.055		0.934	***	-0.004	0.341	***	78.44	141
	0.382		<.0001		0.968	0.000			
3	-0.099	*	1.032	***	0.122	-0.063		84.36	141
	0.080		<.0001		0.187	0.413			
4	-0.067		1.046	***	0.000	-0.081		83.40	141
	0.262		<.0001		0.997	0.323			
5	0.065		1.075	***	-0.075	0.022		80.83	141
High SI_ Avail	0.330		<.0001		0.494	0.813			

Table 3: Short Interest, Idiosyncratic Risk, and Returns for UK Firms

This table reports coefficients of ordinary least squares across portfolios formed based on SI_Avail and idiosyncratic risk (IR). The estimated model is: $R_{i(t)} - R_{f(t)} = \alpha + \beta_1(R_{m(t)} - R_{f(t)}) + \beta_2 SMB_{(t)} + \beta_3 HML_{(t)} + \varepsilon$, where $R_{i(t)}$ is return, α is constant, $R_{f(t)}$ is weekly one-month LIBOR, $R_{m(t)}$ is the market return (FTSE 350), $SMB_{(t)}$ is the size factor and $HML_{(t)}$ is the book-to-market factor. First, stocks are sorted by middle-of-week SI_Avail and assigned to quintile portfolios. Next within top and bottom SI_Avail quintil, stocks are sorted by IR and assigned into three portfolios. As a result, we obtain 6 portfolios with equal number of stocks. SI_Avail is short interest, *Shares on Loan* ‡, divided by *Shares in CREST*‡. IR is a standard deviation of the residual from the Fama-French regression using 90-day rolling history. Panel A presents results of the estimation for equal-weighted portfolios and Panel B presents results for the value-weighted ones. P-values are listed below the correlation numbers. * one-tailed probability < 0.10; ** one-tailed probability < 0.05; *** one-tailed probability < 0.01. ‡Data from CRESTCo Limited.

Panel A: Equal-weighted Portfolios

SI_Avail	IR	Intercept x100		Market		SMB		HML		Adj R^2	Sample size
1 (low)	1	0.060		1.071	***	0.439	***	0.243	***	87.88	141
	(low)	0.232		<.0001		<.0001		0.001			
	2	0.099		0.978	***	0.909	***	0.065		70.01	141
		0.228		<.0001		<.0001		0.564			
	3	0.266	***	1.027	***	1.037	***	0.032		71.57	141
	(high)	0.002		<.0001		<.0001		0.780			
5 (high)	1	0.101		0.802	***	0.022		0.189	**	70.46	141
	(low)	0.130		<.0001		0.838		0.039			
	2	0.068		1.110	***	0.206		-0.100		70.25	141
		0.454		<.0001		0.169		0.423			
	3	-0.107		1.282	***	0.817	***	-0.205		57.82	141
	(high)	0.439		<.0001		0.001		0.276			

Panel B: Value-weighted Portfolios

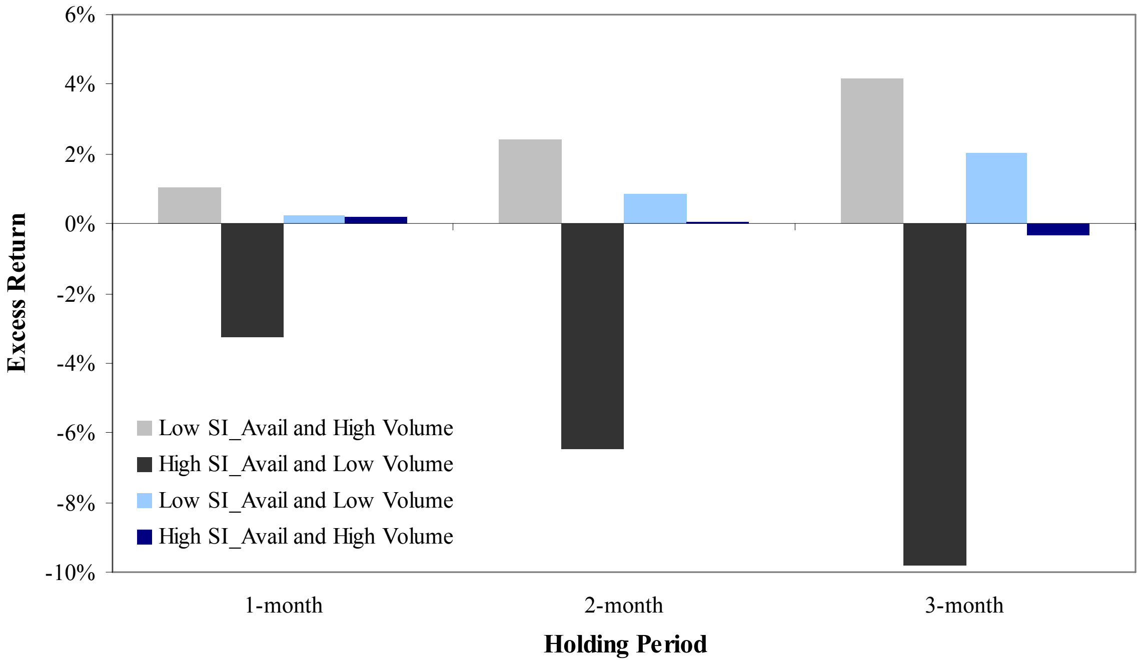
SI_Avail Portfolio	IR Portfolio	Intercept x100		Market		SMB		HML		Adj R^2	Sample size
1 (low)	1	0.156		0.880	***	0.050		0.075		52.75	141
	(low)	0.138		<.0001		0.771		0.603			
	2	0.200		0.943	***	0.266	***	-0.028		50.03	141
		0.089		<.0001		<.0001		0.860			
	3	0.225	*	1.199	***	1.002	***	-0.153		58.92	141
	(high)	0.078		<.0001		<.0001		0.380			
5 (high)	1	0.087	*	0.806	***	-0.273	*	0.189		65.87	141
	(low)	0.255		<.0001		0.031		0.113			
	2	0.031		1.287	***	-0.124		-0.065		69.41	141
		0.778		<.0001		0.490		0.664			
	3	0.030		1.450	***	0.640	**	-0.408		50.02	141
	(high)	0.855		<.0001		0.019		0.072			

Table 4: Fama-MacBeth Regressions

This table reports Fama-MacBeth estimates from the daily multivariate cross-sectional regressions. The regressions are estimated for two groups of stocks: low SI_Avail and high SI_Avail. Low SI_Avail portfolio contains bottom 20% of stocks based on SI_Avail and high SI_Avail contains top 20% of stocks based on SI_Avail. SI_Avail is a short interest, *Shares on Loan* ‡, divided by *Shares in CREST*‡. Dependent variable is a one-day forward return. Explanatory variables include IR, SIZE, ILLIQ, IO, BM, and MOM. IR is a standard deviation of the residual from the Fama-French regression using 90-day rolling history; SIZE is a natural logarithm of market cap; ILLIQ is a five-day Amihud's illiquidity measure; IO is a proxy for institutional ownership, which is computed as a natural logarithm of Shares in CREST; BM is a book-to-market; and MOM is a past one-month return of a security. T-statistiscs are listed below the mean estimates. ‡Data from CRESTCo Limited.

Portfolio	N	Fama-MacBeth Estimates					
		IR x 100	SIZE x 100	ILLIQ x 100	MOM x 100	IO x 100	BM x 100
1	684	0.059	0.014	-0.002	-0.051	-0.014	0.017
Low SI_Avail		*4.19*	*1.13*	*-0.09*	*-4.78*	*-1.08*	*1.60*
5	684	0.018	0.035	-0.033	-0.032	-0.017	0.024
High SI_Avail		*0.88*	*2.58*	*-0.36*	*-2.36*	*-1.33*	*2.36*

Figure 4: Abnormal Returns for Portfolios Based on Short Interest to Availability (SI_Avail) and Volume



Notes to Figure 4: This figure graphs equal-weighted excess return, CAR, for low SI_Avail and high Mktcap stocks and High SI_Avail and Low Mktcap stocks. The variables are defined as follows: SI_Avail is short interest, *Shares on Loan* [‡], divided by *Shares in CREST*[‡] ; Volume is normalized by shares outstanding; and CAR is the forward cumulative abnormal return computed against the FTSE 350. [‡]Data from CRESTCo Limited.