Short Interest, Institutional Ownership, and Stock Returns

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Abstract

Stocks are short sale constrained when there is a strong demand to sell short and a limited supply of shares to borrow. Using data on both short interest, a proxy for demand, and institutional ownership, a proxy for supply, we find that constrained stocks underperform during 1988-2002 by a significant 215 basis points per month on an EW basis, although by only an insignificant 39 basis points per month on a VW basis. For the overwhelming majority of stocks, short interest and institutional ownership levels make short selling constraints unlikely.

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1. Introduction

Shares sold short, as a percentage of shares outstanding, have more than doubled in the last twenty years. In dollar terms, the increase is more than twenty-fold. While our understanding of short sales has not increased nearly as much, it is now widely accepted that if short selling is costly and there are heterogeneous investor beliefs, a stock can be overvalued and generate low subsequent returns. This hypothesis originates with Miller (1977), and its cross-sectional predictions have motivated many recent empirical studies.

There are now three distinct empirical literatures on short selling. The oldest contends that high short interest ratios (shares sold short/shares outstanding) forecast low future returns. This literature is best summarized by Asquith and Meulbroek (1995) and Desai, Ramesh, Thiagarajan, and Balachandran (2002), who find negative and significant abnormal returns for stocks with high short interest on, respectively, the New York (NYSE) and American (Amex) stock exchanges for 1976-1993 and Nasdaq for 1988-1994.

The second literature investigates the actual cost of short selling by looking at the rebate rate on borrowed stock. Both D'Avolio (2002) and Geczy, Musto, and Reed (2002) find that low or negative rebate rates precede negative abnormal returns. These papers only examine a short time period (less than two years), however, and the rebate rates they use are proprietary and thus not publicly available.

The third and most recent empirical short sale literature assumes that short sales depend on stock ownership by mutual funds and institutions. This literature either assumes that the number of institutions owning a stock is a proxy for heterogeneous expectations, or that most lendable shares are from institutional owners. Either way, stocks with low institutional ownership are more likely to be short sale constrained. This in turn implies that they are more likely to be overvalued and have low subsequent returns. Chen, Hong, and Stein (2002) and Nagel (2004) use this logic to explain lower returns for those stocks held by either low numbers of mutual funds, or in lower amounts by mutual funds, respectively.

Each of these literatures examines an instrument relevant to short sale constraints. Constraints exist when short sellers wish to sell short but are either unable to borrow shares or can only do so by receiving a low rebate rate on the proceeds from their short sales. In this paper, we combine the first and third literatures to identify short sale constraints. We posit that short interest ratios are a proxy for short sale demand and institutional ownership is a proxy for lendable supply. Next, we assume that short sale constraints are most binding when there is strong demand and limited supply.

Using data on short interest ratios for NYSE-Amex stocks from 1980-2002, and for Nasdaq stocks from June 1988-2002, portfolios of stocks with high short interest generally underperform the market, as measured by the intercepts from four-factor time series regression models. When these high short interest portfolios are then ranked by institutional ownership, we find a monotonic relationship between returns and institutional ownership using equally weighted (EW) portfolios: the lower the institutional ownership, the more negative the portfolio's abnormal returns. When using value weighted (VW) portfolios of stocks with high short interest, however, we do not find statistically reliable underperformance or a monotonic relation between institutional ownership and subsequent returns.

We define short sale constrained stocks as those in the highest percentile of short interest ratios that are also ranked in the lowest third of stocks by institutional ownership. Portfolios of these short sale constrained stocks underperform by 215 basis points per month during 1988-2002 on an EW basis. Stocks with high short interest but with high institutional ownership do not underperform as much. On a VW basis, the underperformance of short sale constrained stocks is a statistically insignificant 39 basis points per month.

This paper also extends Asquith and Meulbroek's and Desai *et al*'s previous time series of short sales for both NYSE-Amex and Nasdaq stocks until 2002. We find that while short interest ratios rose above the levels reported by those papers as of 1993 and 1994, respectively, and both NYSE-Amex and Nasdaq short interest ratios reached new maximums in 2002, the general uptrend was interrupted during the bull market of the late 1990s. The longer time series data continues to show that short interest ratios are skewed, however, with only a few stocks having high ratios. We also find, consistent with other studies, that the higher the short interest ratio, the lower is the subsequent performance.

When we examine short interest ratios and stock returns along with other criteria, however, we find more ambiguous patterns than the previous literature suggests. While high short interest stocks significantly underperform for EW portfolios, they do not for VW portfolios. This difference is not because highly shorted stocks are predominately micro-cap stocks. Highly shorted stocks are disproportionately small stocks, with both micro-cap stocks and large-cap stocks underrepresented, and they have a larger median equity value than for non-highly shorted stocks. There are also differences between NYSE-Amex and Nasdaq stocks. The abnormal returns on NYSE-Amex stocks with high short interest are more negative and more well-behaved across portfolios than for Nasdaq stocks.

Desai *et al* (2002) report, over the period July 1988-1994 for Nasdaq stocks, abnormal returns of –76 bp/month for stocks with high short interest ratios in the prior month and –84 bp/month for stocks with high short interest at any time during the prior 12 months, implying that frequent portfolio rebalancing is not required to capture the abnormal returns. We find that when their sample period is extended, the negative abnormal performance of stocks with high short interest is less persistent than Desai *et al* report. In the eight years following their sample period, high short interest ratio portfolios that remove stocks as soon as the short interest ratio drops below a fixed threshold have more negative abnormal returns than those that keep a firm in the portfolio for some additional inclusion period, e.g. 12 months. Thus, to implement a strategy that is restricted to stocks with a high short interest ratio, portfolio turnover must be extensive, and this would result in an implementation shortfall relative to returns that are estimated ignoring transaction costs.

Moreover, we document that individual stocks have high short interest for a variety of reasons. Some stocks have high short interest because some investors feel they are overvalued (valuation shorts). Other stocks have high short interest because some investors feel that a convertible bond issued by the company is undervalued (arbitrage shorts). When we categorize stocks in our high short interest portfolios on the basis of whether they may be subject to convertible bond arbitrage, we find that the arbitrage short sellers do not profit as much as value-based short sellers.

Finally, while we find that stocks that are short sale constrained have reliably negative abnormal returns, these stocks comprise a small percentage of all stocks and market capitalization. In a typical year, there are 5,500 domestic operating companies trading on the

NYSE, Amex, and Nasdaq National Market System. For these stocks, we find that institutional ownership is greater than short sales for 95% of stocks, suggesting that short sale constraints are not common. We classify only about 21 stocks per month as short sale constrained. For the other 5,479 stocks, short interest ratios have only a modest ability to predict abnormal returns. This finding severely restricts the importance of short sale constraints in explaining why anomalous patterns in stock returns are not arbitraged away.

The remainder of this paper is organized as follows. Section 2 reviews related literature, while Section 3 describes the data. Section 4 outlines the research design. Section 5 presents the main empirical results, while Section 6 considers arbitrage versus valuation-based short selling. Section 7 outlines some implications of our results and concludes.

2. Related literature

Short sales restrictions were originally passed to prevent downward pressure on stock prices (Jones and Lamont (2002)) and short sellers remain reviled today by firm managers (Lamont (2002)). Rubinstein (2004) surveys the theoretical literature on short sales and the connection between short sales and stock returns. This literature primarily relies on the institutional restrictions governing short sales and on heterogeneous beliefs among investors. With heterogeneous beliefs and no short sale constraints, pessimistic investors who sell short counterbalance optimistic investors who buy long and they jointly set equilibrium stock prices and, as a consequence, subsequent returns. With short sale constraints, pessimistic investors are unable to short the stock to the extent they desire, and the equilibrium price will reflect a positive bias and the subsequent returns will be low. For any given amount of short sale constraint, the more heterogeneous the expectations, the greater the price and return bias. Likewise, given the amount of divergence in expectations, the greater the constraint on short sales, the greater the price and return bias.

The modern empirical literature linking the level of short sales with subsequent stock returns begins with Asquith and Meulbroek (1995) and Desai *et al* (2002). Contemporaneous research on levels of short interest and stock returns includes Boehme, Danielson, and Sorescu (2004) and Gopalan (2003). Boehme *et al* examine the relation between short interest and abnormal returns in the period January 1988 through July 1999 for NYSE-listed stocks and January 1993 through July 1999 for Nasdaq-listed stocks. They use market capitalization as a

proxy for the difficulty of shorting and the standard deviation of residuals as a proxy for divergence of investor opinion. They report that the underperformance of stocks with a high short interest ratio is concentrated among smaller stocks with a higher residual standard deviation. Gopalan uses dispersion of analyst forecasts as a proxy for heterogeneous beliefs, and finds that high short interest stocks have lower returns the greater is the dispersion of analyst forecasts for a sample of NYSE and Nasdaq stocks from 1992-2000.

There are also two recent papers that look at daily short sales and subsequent returns on the Australian and Nasdaq stock markets. The first, by Aitken, Frino, McCorry, and Swan (1998), examines daily short sales on the Australian Stock Market for the two years 1994-1996. The second, by Angel, Christophe, and Ferri (2003), uses proprietary Nasdaq data over a three-month period from September 13th through December 12th 2000. Both papers show that high daily short sales are followed quickly by negative abnormal returns. Finally, in their event study of the announcement effects of monthly short interest, Senchek and Starks (1992) find that changes in short sales are followed by negative abnormal returns. Taken together with the previous papers on monthly short interest, this literature provides consistent evidence that high short interest is followed by lower stock returns.

A recent strand of the short sale literature uses the interest rate that institutional short sellers receive on the proceeds of the sale. (Retail borrowers typically receive no interest on their proceeds.) This interest rate is called the *rebate rate*. If the amount of shares available to borrow exceeds the number of shares that short sellers desire to sell short, then the rebate rate is approximately equal to the Fed funds overnight rate. If the demand for shorting a stock exceeds the amount available to borrow at the Fed funds rate, the rebate rate falls. In short sellers' jargon, these stocks are "on special." If the demand is sufficiently high and the supply sufficiently low, the rebate rate received by the short seller may actually become negative.

Currently, rebate rates are not publicly available and empirical research has generally been limited to proprietary databases over short time periods. Jones and Lamont (2002) examine a small database of rebate rates on stocks that they collect from the *Wall Street Journal* during the period 1926-1933. During this period, there was a public "stock loan" market with public loan rates. Jones and Lamont find that the 167 stocks that are newly listed in this market subsequently underperform. Geczy *et al* (2002), using a database from a single lender for the period November 1998 through October 1999, report that the higher costs of borrowing stocks

that are on special do not eliminate the abnormal returns from the short selling strategies they examine. They also conclude that short sales constraints are unable to explain anomalous patterns in stock returns.

D'Avolio (2002), also using a database from a single lender for the period April 2000 through September 2001, reports that only nine percent of the stocks in his sample are "on special" on a typical day. The other 91 percent have a rebate rate approximately equal to the Fed funds overnight rate. He also finds that stocks that are on special have higher short interest ratios.[1] Finally, Ofek, Richardson, and Whitelaw (2004), using a proprietary database of rebate rates from July 1999 to December 2001, document that stocks that are on special are more likely to violate put-call parity. Consistent with D'Avolio, they find that 10.8% of their sample stocks have rebate rates more than 1% below the Fed funds rate. Furthermore, Ofek *et al* report that stocks with abnormally low rebate rates have lower subsequent returns.

Most recently a new literature uses institutional ownership to proxy for short sale constraints. It has also criticized research that uses short interest to measure short sale constraints. This is most clearly stated by Chen, Hong, and Stein (2002), who write that "there need be no clear cut relationship between short interest and subsequent returns." They posit that short sales constraints are strongly linked to the availability of shares to borrow, and argue that when the number of institutions owning a stock increases or decreases, short sales constraints are either relaxed or tightened, respectively. They present evidence that during 1979-1998 the change in the number of mutual funds holding a stock is positively related to subsequent stock returns. Chen *et al* point out that this may not be due to short sale constraints, but may be due to mutual funds choosing stocks that perform better.

Nagel (2004) modifies this proxy by considering the percentage of shares owned by institutions instead of the number of institutions owning shares. During his sample period 1980-2003, he reports that a number of cross-sectional patterns, including the book-to-market effect, are much stronger when residual institutional ownership is low than when it is moderate or high.

[1] D'Avolio's Figure 1 shows that both the highest and the lowest short interest stocks have a higher percentage of stocks that are on special. However, his result for low short interest stocks is likely due to his inclusion of ADRs and recent initial public offerings (IPOs), whose short interest ratios are probably misleading because the float available to borrow shares from is much smaller than the shares outstanding. D'Avolio's Table 4 lists 35 negative rebate rate stocks, of which 21 are either foreign firms or recent IPOs. When we compute the short interest ratios for these 35 stocks, we find the stocks with the seven lowest short interest ratios consist of four ADRs or foreign listings and three recent IPOs.

Furthermore, he reports that the patterns are mainly driven by low returns on overvalued stocks, rather than high returns on undervalued stocks. Nagel also finds that when he combines his period with Chen, Hong, and Stein's period, there is no longer any reliable pattern for 1980-2003 between the number of mutual funds holding a stock and subsequent returns.

D'Avolio (2002) directly tests whether institutional ownership affects the amount of short selling. His data is from one lender and covers the five quarters beginning with the second quarter of 2000. He finds that the percentage of institutional ownership explains an average of 55% of the cross-sectional variation in that lender's supply of loanable shares scaled by shares outstanding. This R^2 probably overstates this relation for a random sample of stocks however, since D'Avolio's data comes from a large stock lender that is a depository for mutual funds that mainly invest in large cap stocks. In fact, D'Avolio finds that 19% of the stocks shorted during his sample period are not available for loan from his stock lender.

Other empirical work focuses on why stocks are shorted. For example, Dechow, Hutton, Meulbroek, and Sloan (2001) document that short sellers position themselves in stocks with low ratios of fundamentals (such as earnings and book values) to market values and cover their positions as ratios mean-revert. In addition, Christophe, Ferri, and Angel (2004) examine short sales around earnings announcements and find that short interest increases before negative earning surprises.

3. Descriptive Statistics

We use a sample of NYSE and Amex stocks from 1980-2002 and Nasdaq National Market System (NMS) stocks from July 1988-December 2002 and collect both short sales and institutional ownership data. The exchanges collect the level of short interest in individual stocks for the NYSE, Amex, and Nasdaq from member firms as of the fifteenth calendar day of every month (if it is a business day) and the institutional ownership level is collected quarterly as of the last day of every quarter. (Even though the Nasdaq market is not an exchange, for convenience we will refer to all three markets as exchanges.) The Appendix presents a detailed description of the data.

Figure 1 plots the time series of monthly short interest data and quarterly institutional ownership data (relative to shares outstanding) for NYSE and Amex stocks over the period January 1980-December 2002. Figure 2 plots the short interest and institutional ownership ratios

for Nasdaq stocks over the period June 1988-December 2002. Four ratios are reported in the figures: the median, the 90th and 99th percentiles of short interest, and the median of institutional ownership.[2]

Three characteristics of the short interest distributions stand out. First, the typical firm in our sample has very little short interest. Even at its peak in 2002, the median firm in Figure 1 on the NYSE-Amex and in Figure 2 on Nasdaq had only one percent of its outstanding shares shorted. While most stocks have little or no short interest, a very small number have substantial short interest. An NYSE-Amex firm in the 99th percentile had at least 23% of its outstanding shares shorted in December 2002, and the corresponding firm on Nasdaq had 24% shorted. Second, short interest increased dramatically from 1980 for NYSE-Amex stocks, and from 1988 for Nasdaq stocks. This is true for all three short interest measures presented in Figures 1 and 2. Third, the rise in short interest is not continuous. The secular increase in short interest ratios is subject to interruptions following positive market returns. For example, there is a decline in the late 1990s.[3]

The institutional ownership measures in Figures 1 and 2 show that there is a dramatic rise in institutional ownership over our time period 1980-2002. In addition, the institutional ownership medians are many times larger than the short interest medians. This means that for most stocks, if institutional ownership is a proxy for loan supply, finding shares to borrow in order to sell short will not be difficult. To illustrate the types of stocks with high short interest,

[2] All short interest numbers in this paper are reported as percentages of total shares outstanding. While we measure short interest relative to shares outstanding, a more traditional measure, reported in the *Wall Street Journal* each month, is short interest relative to daily trading volume, known as the days to cover ratio or days short. Which measure is more appropriate partly depends on the question being addressed. If one views short interest as indicative of future buying pressure as short sellers cover their positions, the days to cover ratio is arguably the best measure. But if one views short interest as reflecting the information of informed investors, then the short interest to shares outstanding ratio is arguably the best measure. In any event, these two measures are positively correlated.

[3] This point is also made by Lamont and Stein (2004) who compare monthly Nasdaq short interest ratios and the prior 12-month market return for the period 1995-2002. They report a sample correlation between these variables of –0.54. We ran the same correlations for our longer period and for NYSE-Amex as well as Nasdaq stocks. In unreported results, we find a dramatically lower correlation of –0.16 between the Nasdaq short interest ratio and 12-month returns over the July 1988-2002 period, and a correlation of –0.13 between the NYSE-Amex short interest ratio and 12-month returns over the 1980-2002 period. Because the upward trend in mean short interest ratios (see Figures 1 and 2) suggests that the series is nonstationary, it is not surprising to find that, the longer the sample period, the closer the correlation between the *level* of short interest and prior market returns is to zero. Since short interest should change quickly when arbitrageurs perceive misvaluations to have changed, we feel a better measure to examine a "limits to arbitrage" argument is to calculate the correlation between the *change* in the percentage of the market sold short and the lagged market return. The correlation between the one month prior market return and the subsequent change in short interest is –0.17.

Table 1 lists the names of the 54 stocks within the 99th percentile portfolio in December 2002, along with several characteristics of each firm. 51 of the 54 stocks have a market capitalization of between $140 million and $1.5 billion. Thus, most are small cap stocks, but not micro-cap. Almost all of these stocks were in the Russell 2000 index representing the stocks with market caps ranking them 1,001 to 3,000 among the roughly 5,000 domestic operating companies on the NYSE, Amex, and Nasdaq NMS at the end of 2002. Furthermore, the industry representation is fairly broad—this portfolio of stocks does not subject the holder to excessive concentration in one industry. The combined market cap of these 54 stocks was approximately $35 billion, only a little more than 10% of the market cap of General Electric or Microsoft.

Table 1 also lists the prior 12-month buy-and-hold return for the 54 stocks with high short interest, their market-to-book ratios, and the percent owned by institutions. Inspection of the list shows that most of the stocks have had negative returns in the prior year, although a few have had big run-ups. As measured by market-to-book ratios, there is a combination of growth and value stocks, with Nasdaq stocks tending to be growth stocks and NYSE-Amex stocks tending to be value stocks. The institutional ownership of these stocks is also quite high for most of the sample and in some instances exceeds 100%. Because shares that are shorted are owned by more than one party (the original lender plus the purchaser on the other side of the short sale), institutional ownership can exceed 100%. If a share sold short is re-borrowed and sold again, short interest ratios can also exceed 100%. For only three of the 54 stocks is the institutional ownership less than the short interest.[4]

Table 2 compares median size, market-to-book ratios, and institutional ownership of highly shorted stocks to the medians for other stocks. The median market cap of highly shorted stocks in Panel A is noticeably higher than the median for other stocks, reflecting the paucity of micro-cap stocks in our portfolios. This is consistent with Table 1, which lists the 99th percentile sample of stocks for December 2002 and their characteristics. Panel B shows that the median highly shorted firm is a growth firm, as measured by its market-to-book ratio, consistent with Dechow *et al* (2001). Panel C shows that median institutional ownership is higher for highly

[4] As we discuss in the Appendix, CRSP sometimes underreports the number of shares outstanding, resulting in calculations of short interest and institutional ownership ratios that are higher than the true ratios. We investigated each of the 54 stocks in Table 1 using data from SEC filings, and in one case had to correct the number of shares outstanding. The one case we had to modify was UAL Corporation, which underwent a bankruptcy and restructuring. CRSP's shares outstanding reflected the actual change in shares outstanding two months late.

shorted stocks than for non-shorted stocks. This is consistent with Nagel (2004), who finds that short interest is highly correlated with institutional ownership.

4. Research design

To empirically investigate whether stocks with short sale constraints underperform relative to the market, we first study the relation between short interest and subsequent returns. We form portfolios of highly shorted stocks and calculate returns on these portfolios. We later sort these portfolios by the level of institutional ownership and calculate these returns. Our reasoning is that the strongest relation between short interest and abnormal returns should exist for stocks that have large short positions combined with low institutional ownership. These are the stocks that are most likely to be short sale constrained.

We assume that short interest is a proxy for short sale demand and that institutional ownership is a proxy for the supply of shares available to be shorted. This first assumption is consistent with the literature that finds high short interest precedes abnormal returns (see Asquith and Meulbroek (1995) and Desai *et al* (2002)). The second assumption is consistent with the literature that assumes high institutional ownership prevents short sale constraints, i.e. stocks with high institutional ownership are readily available to borrow and hence the stocks do not become overpriced (see Chen, Hong, and Stein (2002) and Nagel (2004)). The amount of institutional ownership is our proxy for the length of the horizontal segment of the supply curve, for which the rebate rate is equal to the Fed funds rate. Beyond this, the supply curve is positively sloped with the vertical axis measuring the net interest rate received by the lender of shares.

As shown in Figures 1 and 2, the median percentage of shares sold short is far less than the median percentage of shares held by institutional owners. We also find, in unreported results, that over the entire time period 1980-2002, only 5.0% of our sample stocks in an average month have short interest greater than institutional ownership. Thus, for most stocks, the positively sloped segment of the supply curve is always to the right of the demand curve. Consistent with this being the norm, D'Avolio (2002) reports that 91 percent of the shorted stocks in his sample have a rebate rate approximately equal to the Fed funds rate. For some stocks, however, the demand for shorting the stock exceeds the amount available to borrow at the Fed funds rate. The cost of borrowing rises, the stock is "on special" i.e. the rebate rate received by the short seller

falls, and the measured short interest underestimates the unconstrained demand for shorting. In this case, short interest measures the intersection of supply and demand on the positively sloped segment of the supply curve. Since the amount of borrowable supply limits the measured amount of short interest, the short interest ratios are not necessarily negatively correlated with subsequent returns, validating the criticism leveled by Chen *et al* (2002).

Using institutional ownership by itself to proxy for short constraints, however, is subject to the same criticism. It is possible for a stock with high institutional ownership to be more constrained than one with low institutional ownership if the demand to short the first stock is high enough. Only by considering demand and supply together can it be determined if a stock is short sale constrained. Only stocks with binding short sale constraints should have negative subsequent abnormal returns.[5]

We use two approaches to select samples of stocks with large short interest positions and by implication high short demand. The first approach identifies stocks based on their short interest relative to other stocks. Specifically, each month all stocks are ranked according to short interest divided by shares outstanding. The stocks in the top percentile of short interest comprise the 99th percentile sample, and similarly, the stocks in the top five percent comprise the 95th percentile sample. Because the overall level of short interest increased substantially during the 1980-2002 time period, stocks entering the high percentile samples during the early part of the time period are likely to have smaller short interest positions than stocks entering the sample during the later part of the time period. The second approach to selecting stocks with large short interest positions imposes absolute cutoff criteria. Following Asquith and Meulbroek (1995) and Desai *et al* (2002), we construct three different absolute short interest samples. These samples have short interest greater than or equal to 2.5%, 5%, or 10% of shares outstanding.

Since short interest information is collected in the middle and released near the end of a calendar month, we form monthly short interest portfolios on the basis of whether a stock's short interest ratio was high during prior months. We name portfolios as [1,T], where the [1,T]

[5] Our proxies for supply and demand are not perfect and may not capture all instances of stocks that are short sale constrained. For example, if there exists no supply of shares to borrow, a stock may have zero short sales yet still be constrained. In addition, there may be available shares of stock to borrow from sources other than institutional owners (e.g. retail brokerage accounts). In fact, D'Avolio finds that 19 percent of the stocks sold short during his sample period are not available in his database, which examines one large lender. These additional stocks are being borrowed from somewhere, possibly other institutions or possibly non-institutional sources. The ideal way to measure short sale constraints would be to have actual demand, supply, and price.

portfolio is composed of stocks that qualified for inclusion during at least one month in the prior T months. The [1,1] portfolio is composed of firms whose short interest ratio in the prior calendar month qualifies them for inclusion. Most of our reported results are for the [1,1] inclusion period. The [1,12] inclusion period is discussed in Section 5.6 of the text and is representative of a longer inclusion period.

Stocks often remain highly shorted for several consecutive months. Table 3 reports the length of time that stocks remain in a high short interest [1,1] portfolio once they have entered it. Table 3 shows that some stocks have high short interest for only one or a few months, but others have high short interest for years. For example, about one third of the stocks that enter a [1,1] portfolio in a given month are there for only one month, but about half are in for three consecutive months or more. Approximately 11-19% of the stocks, depending on the portfolio, remain in the high short interest [1,1] portfolios for more than one year after entering. This means that the portfolio for inclusion period [1,1] includes stocks that are highly shorted for the first time, as well as stocks that have been highly shorted for many previous months. The last column in Table 3 shows that the median number of consecutive months a firm is highly shorted is 2-3 months. Finally, Table 3 shows that once a stock is highly shorted, approximately 70% remain highly shorted for more than one month.

Monthly portfolio returns are calculated from the monthly CRSP tapes, where all returns are from holding long positions. Thus, a negative return is good for short sellers since the stocks sold short decreased in price. This return does not incorporate the possibly higher costs of short selling. That is, it does not include the costs to borrow, i.e. the difference between the rebate rate and the market interest rate, the risk of demand loans, and transaction costs associated with heavy portfolio turnover.

Portfolio abnormal returns are estimated from the four-factor regression model:

$$r_{pt} - r_{ft} = a + \beta_m (r_{mt} - r_{ft}) + \beta_s \, SMB_t + \beta_h \, HML_t + \beta_o \, MOM_t + \varepsilon_{pt}$$

where $r_{pt} - r_{ft}$ is the portfolio return minus the risk-free rate on a portfolio in time period t, $r_{mt} - r_{ft}$ is the realization of the market risk premium in period t, SMB_t is the return on a portfolio of Small stocks Minus the return on a portfolio of Big stocks in period t, HML_t is the return on a portfolio of High book-to-market (value) Minus a portfolio of Low book-to-market (growth) stocks in period t, and MOM_t is the return on a portfolio of prior winners minus the return on a

portfolio of prior losers (Fama and French (1993) and Carhart (1997)). The return interval over which winners and losers are measured is the 11 months before month t-1 (i.e., for March 2002, winners and losers are based on returns from March 2001 through January 2002). The monthly factor return realizations are provided by Kenneth French. The intercept is our measure of monthly abnormal performance.

We calculate four-factor time-series regression model abnormal returns on five different high short interest portfolios: 2.5%, 5%, 10%, 95 percentile, and 99th percentile. We also calculate returns for five different inclusion periods: [1,1], [1,3], [1,6], [1,12], and [1,24], although we do not report results for the [1,3], [1,6], and [1,24] portfolios. While Table 4 reports [1,1] returns for all five portfolios, to save space, in most tables we only report returns from the 2.5% and 99th percentile [1,1] portfolios. Table 7 reports both the [1,1] and the [1,12] inclusion period. The [1,12] portfolio's abnormal performance per month is typically smaller than the [1,1], [1,3] and [1,6], but larger than the [1,24] inclusion periods.

Since we assume that the supply of shares available to short is correlated with institutional ownership, we next examine institutional ownership. In each month after selecting our portfolio of highly shorted stocks, we then divide this portfolio into thirds by institutional ownership. Our prediction is that highly shorted stocks in the lowest third of institutional ownership are the most constrained and will have the lowest subsequent returns. Stocks with high short interest that fall into the highest third of institutional ownership should be less constrained and should have normal or less negative subsequent returns. Since institutional ownership is only reported quarterly, we use the institutional ownership data from the beginning of the quarter for all the months in the quarter.[6]

5. Empirical Results

5.1. Abnormal portfolio returns for high short interest stocks over inclusion period [1,1]

In Panels A and B of Table 4, we report the results of four-factor regressions for five portfolios composed of all NYSE-Amex and Nasdaq stocks with high short interest over the July

[6]Using the quarterly institutional ownership data over three months may introduce a bias towards finding no abnormal returns if institutional ownership rises or falls substantially over the quarter. Fortunately, institutional ownership tends to remain fairly constant from quarter to quarter. Although not reported in any table, we find that for 80% of stocks the percentage of shares held by institutional owners changes by less than plus or minus 3% from one quarter to the next. The mean percentage change from quarter to quarter is 0.36%, reflecting the growth in institutional ownership over time that is documented in Figures 1 and 2.

1988-2002 time period. This is the 174 month period that includes both NYSE-Amex and Nasdaq stocks. The portfolio inclusion period is [1,1]. The five portfolios we use have short interest ratios during the prior month of 2.5-4.9%, 5.0-9.9%, greater than 10.0%, or short interest ratios that place them in the 95-98.9th or 99th percentile of all stocks. Unlike Asquith and Meulbroek (1995) and Desai *et al* (2002), in Table 2 and Panels A and B of Table 4 we use truncated portfolios for the 2.5%, 5.0%, and 95th percentile portfolios. That is, we truncate the 2.5% portfolio before 5.0%, the 5.0% portfolio before 10.0%, and the 95th percentile portfolio before the 99th percentile. The portfolios for ≥ 10% and ≥ 99th percentile are untruncated portfolios. In Panel A, we report equally weighted results, and in Panel B, we report value weighted results.

Using truncated portfolios ensures that no firm appears in more than one portfolio. Without using truncated portfolios, if higher short interest stocks have more negative returns, portfolios with a short interest ratio greater than or equal to 2.5%, for example, will have a more negative return than the portfolio with short interest between 2.5% and 4.9%. In Panels C and D of Table 4 and later tables, when we present only two portfolios, we use the untruncated portfolio ≥ 2.5% to capture all stocks with short interest of at least 2.5%.

Inspection of the EW results in Panel A shows that all five portfolios have negative intercepts ranging from –28 basis points to –125 basis points per month. The more heavily shorted are the stocks in a portfolio, the more negative is the performance. On an annualized basis, this is -3% to -15% per year. The negative abnormal returns are statistically significant at the 5% level (two-tailed test) for three of the portfolios: 5.0-9.9%, greater than or equal to 10%, and the 99th percentile. The largest intercept of -125 basis points per month is from the 99th percentile portfolio, with a t-statistic –4.42.

In contrast to the statistically significant negative abnormal returns for the EW portfolios reported in Panel A, the VW results in Panel B show no reliable underperformance. Indeed, several of the VW portfolios have positive intercepts. As in Panel A, the more extreme portfolios (10% and 99th percentile) have lower intercepts than the less extreme portfolios (2.5-4.9% and 95-98.9th percentile). The difference between the EW and VW results suggests that larger stocks with high short interest do not reliably underperform.

Examination of the factor loadings (the slope coefficients) in Panels A and B of Table 4 reveals that stocks with high short interest tend to have relatively high systematic risk, tend to

positively covary with small stocks, tend to be tilted towards growth stocks when value weighted portfolios are used, and tend to have negative momentum. The high loading on SMB is accounted for by the rarity of very large capitalization stocks in the high short interest portfolio. As we pointed out in the discussion of the 54 stocks listed in our Table 1, both large-cap stocks and micro-cap stocks are underrepresented, with small stocks overrepresented.

In Panels C and D of Table 4, we examine whether the EW and VW performance of stocks with high short interest differs between NYSE-Amex stocks and Nasdaq stocks during the July 1988-December 2002 period. Two representative untruncated sample portfolios are presented: ≥ 2.5% and the 99th percentile. In constructing the NYSE-Amex portfolios and Nasdaq portfolios using the 99th percentiles, we use population-specific short interest ratio cutoffs, whereas when we report combined NYSE-Amex-Nasdaq results, the same absolute cutoff is used for all stocks in a given month.

In Panel C, the EW portfolio intercepts of NYSE-Amex stocks are slightly more negative than that of Nasdaq stocks. The value weighted intercepts in Panel D exhibit positive intercepts for the ≥ 2.5% portfolios. In further contrast with the EW results in Panels A and C, none of the VW portfolio intercepts in Panels B and D have a t-statistic of –2.0 or less, although the intercepts for the 99th percentile portfolio for NYSE-Amex and Nasdaq stocks in Panel D are significant at the 10% level, reflecting underperformance of 11% and 9% per year, respectively.

While in all of the regressions in Panels C and D the systematic risk is high and the momentum factor loadings are negative, some of the factor loadings differ substantially between the NYSE-Amex and Nasdaq regressions. Specifically, the EW Nasdaq portfolios are more sensitive to small stock movements, and the NYSE-Amex portfolios move with value stocks, whereas the Nasdaq portfolios move with growth stocks. The reliably positive coefficients on HML for NYSE-Amex stocks are somewhat surprising, given that our Table 2 and Dechow *et al* (2001) report that NYSE-Amex stocks with high short interest tend to be growth stocks.[7]

[7] The difference in conclusions about whether highly shorted NYSE-Amex stocks tend to be growth stocks (the conclusion based on the medians) or value stocks (the conclusion based on the slope coefficients) has to do with differences in the weighting schemes. The Fama-French HML factor is constructed by giving equal weights to the returns on a value weighted portfolio of small value stocks and a value weighted portfolio of large value stocks, and then subtracting the returns on two growth stock portfolios that are weighted in a similar manner. The effect of this (which is done to minimize the correlation of the HML factor with the size factor) is to overweight the influence of small growth stocks on Nasdaq. Consequently, since NYSE-Amex stocks are tilted towards value relative to Nasdaq stocks, even growth stocks on the NYSE-Amex appear to have a value tilt with respect to the HML factor.

Having investigated the relation between stock returns and short interest, our proxy for demand, we next examine the relation between short interest and institutional ownership, our proxy for supply.

5.2 Institutional ownership and short sales

D'Avolio (2002) reports that the number of shares available to borrow is highly correlated with institutional ownership. Although we do not have data on the supply of shares to borrow, we do have the actual shares shorted and we regress this against institutional ownership. While institutional ownership is significantly related to the short interest ratio, both the slope coefficient and our adjusted R^2 of 8.5% are much lower than D'Avolio finds using the supply of borrowable shares rather than the shares actually shorted. These differences in results between loan supply and loan usage suggest that while short sales are dependent on institutional ownership, the highest institutional ownership stocks are not necessarily those shorted the most. Another way to state this is that short sellers first decide what stocks to short and then try to find shares to borrow.

We also do a direct comparison of short interest versus institutional ownership on a firm by firm basis. Over the entire time period 1980-2002, only 5.0% of our sample stocks in an average month have short interest greater than institutional ownership. The highest percentage of stocks having short interest greater than institutional ownership is during the third quarter of 1998 when it is 7.9%. These percentages are slightly less than the 9% of stocks that D'Avolio finds have higher short interest than loan supply. Since short interest is sometimes greater than institutional ownership, it shows that there is a supply of shares available to short outside of institutional lenders, most likely from retail brokerages.

5.3 Abnormal returns for highly shorted stocks partitioned by levels of institutional ownership

Since we hypothesize that short sale constraints should be a function of both short sale demand as proxied by short interest and short sale supply as proxied by institutional ownership, Table 5 sorts our high short interest portfolios by institutional ownership. We report EW and VW four-factor model intercepts for the $\geq 2.5\%$ and 99^{th} percentile portfolios sorted into thirds by

levels of institutional ownership.[8] We examine two periods, 1980-2002 and July 1988-2002 in Table 5, although the results from 1980-June 1988 are only available for NYSE-Amex stocks.

Panel A reports monthly abnormal returns from the EW portfolios for all stocks (NYSE-Amex-Nasdaq) for both time periods. Panel B reports the two VW portfolio returns for the same stocks and subperiods. In each panel, we partition the two short interest (SI) portfolios into thirds by institutional ownership (IO). The row labeled lowest IO is for the one-third of stocks with the lowest percentage owned by institutions and is our proxy for the lowest shortable supply. The last row of each panel gives the combined short interest results without being partitioned by institutional ownership. These abnormal returns for the 99th percentile portfolios are identical to those reported in Panels A and B of Table 4. For the ≥ 2.5% portfolios, the numbers differ from Table 4 because the 2.5-4.9% truncated portfolio result is reported in that table. The remaining two panels of Table 5 categorize stocks by market. Panel C reports EW results for the combined portfolio and lowest IO third portfolio for NYSE-Amex vs. Nasdaq stocks over our two time periods. Panel D reports VW returns for the same portfolios.

Table 5 allows us to investigate whether using institutional ownership increases the explanatory power over using short interest alone. To test this, we look for several patterns. The first is to see whether the abnormal returns vary by level of institutional ownership. That is, whether the portfolios that are the most institutional ownership constrained, i.e. the lowest IO third, have the most negative abnormal returns, and if the least institutional ownership constrained, the highest IO third, the least negative. We also wish to see if the combination of high short interest and low institutional ownership, i.e. our most constrained portfolios, produces the most negative results. Finally, we wish to see if the addition of institutional ownership data allows us to see patterns not detected using the short interest data alone. Inspection of Table 5 shows that for EW portfolios, the returns are generally monotonic with respect to institutional ownership, and the portfolio with 99th percentile short interest and lowest institutional ownership third usually has the most negative abnormal return. The results are more mixed for VW portfolios. In addition, Table 5 provides insights on EW and VW portfolios and exchanges not provided in Table 4.

[8] We do not use truncated portfolios in Table 5. Since we are not comparing several portfolios chosen with the same criteria, there is no reason to worry about overlapping samples. Moreover, the number of stocks in the remaining portfolios after dividing the portfolios into thirds on the basis of institutional ownership is larger with the untruncated portfolio.

In Panel A, partitioning the high short interest portfolios into thirds by level of institutional ownership shows that the abnormal returns are monotonic by amount of institutional ownership. That is, the third with the lowest IO has lower abnormal returns than the middle third, which has lower abnormal returns than the highest third. The most constrained portfolio, the one with the highest demand and the least supply (i.e. the 99th percentile portfolio with the lowest third of institutional ownership), has the most negative abnormal returns for both the sample starting in 1980 and the sample starting in 1988. For the July 1988-2002 period, this portfolio has abnormal returns of –215 basis points/month, or more than –25% per year.

In Panel B, which presents the VW returns over the same sample, there is no consistent pattern. Examining the columns, the abnormal returns are monotonically related to institutional ownership for only the ≥ 2.5% portfolio, and the abnormal return during 1980-2002 for the most constrained portfolio is insignificantly positive.

Panels C and D divide our sample stocks by market. In Panel C, we report EW results by market (NYSE-Amex vs. Nasdaq) for the lowest IO third of stocks and for the entire sample of stocks for our two high short interest portfolios. In Panel D, we report the VW results for these same portfolios. In Panels C and D there are no Nasdaq results over the period 1980-2002. In Panel C, the abnormal returns are more negative for the constrained portfolios for both exchanges, but the abnormal returns of the NYSE-Amex portfolios are always more negative than the Nasdaq's. The difference is small for the 99th percentile portfolios but large for the ≥ 2.5% portfolios. All four NYSE portfolios are significant, as are the two Nasdaq portfolios. In addition, for either market or time period, the most constrained portfolio (99th percentile of short interest and lowest third of IO) is the most negative with monthly abnormal returns ranging from –177 to –263 basis points per month.

Panel D reports the VW portfolio results by exchange. Here, the patterns are similar to our EW results but not as statistically significant. For both periods and both exchanges the abnormal returns are more negative for the lowest IO third VW portfolios. The most constrained portfolios are also the most negative for both exchanges, although only the NYSE-Amex most constrained portfolio from July 1988-2002 is statistically significant.

In Table 5, our VW portfolios of highly constrained stocks have intercepts of –39 basis points per month for the combined NYSE-Amex-Nasdaq sample, but –315 bp/month for the NYSE-Amex sample and -112 bp/month for the Nasdaq sample. The more extreme results for

the two different exchanges may be due to the effect of different factor loadings. As seen in Table 4, NYSE-Amex shorts tend to be value stocks and Nasdaq shorts tend to be growth stocks. It should also be noted that dividing the 99th percentile portfolio into institutional ownership thirds, and then splitting the sample by exchange, makes the portfolios quite small: NYSE-Amex portfolio average only about seven stocks per month and Nasdaq portfolios about 14 stocks per month. Since the sample cutoffs we use are exchange-specific, it is possible that the firms in our NYSE-Amex sample and Nasdaq sample are not exactly the same as the firms in the combined NYSE-Amex-Nasdaq sample. A few different firms per month combined with our small sample sizes may also be a reason for the differences in our intercepts.

In summary, the panels in Table 5 show that for high short interest EW portfolios, the lower the institutional ownership, the more negative the abnormal returns. High short interest, low IO EW portfolio abnormal returns are also significant regardless of exchange. Taken together, these results support the view that short sale constrained stocks are overvalued where short sale constrained is defined as having both high demand, in the form of short interest, and low supply, in the form of low IO. The VW results are not reliably negative.

5.4 Abnormal returns for calendar sub-periods

Comparing the NYSE-Amex results over the two periods reported in Table 5 shows the portfolio returns for the period July 1988-2002 are more negative than that of 1980-2002. This raises the possibility that abnormal returns may be time period specific. In this section, we examine this issue in more detail and compare our results to those in Desai *et al* (2002).

Table 6 breaks the time period July 1988-2002, where we have results for all markets, into two subperiods, July 1988-1994 and 1995-2002. The first subperiod is the subperiod that Desai *et al* (2002) analyze. The subsequent subperiod covers the tremendous stock price increases of the late 1990s and their subsequent decline. Since in the last section, we show that the results differ between markets, we continue to divide our sample into NYSE-Amex stocks vs. Nasdaq stocks as well. This also allows us to directly compare our results to Desai *et al*, who only examine Nasdaq stocks. We continue to report abnormal returns for two portfolios, stocks with short interest $\geq$ 2.5% and the 99th percentile, for both the combined sample of stocks and stocks with the lowest IO third.

Panel A of Table 6 shows that the EW abnormal returns are negative and significant in the subperiod July 1988-1994. All four of the reported NYSE-Amex portfolios, and all four of

the reported Nasdaq portfolios, have statistically significant negative abnormal returns. The most constrained portfolios have negative abnormal returns of -271 basis points (t=-2.62) for NYSE-Amex stocks and -313 basis points (t=-3.25) for Nasdaq stocks during this subperiod. In the subperiod 1995-2002, the EW results for NYSE-Amex stocks are similar to those for July 1988-1994, particularly for the most constrained portfolio. The EW Nasdaq portfolios have abnormal returns that are less negative or even insignificantly positive in the latter subperiod. The most constrained EW Nasdaq portfolio in 1995-2002 has abnormal returns of -220 basis points (t=-2.31) which is less extreme than in the early time period. The differences between the two subperiods for our VW constrained portfolios are also larger for Nasdaq stocks than NYSE-Amex stocks.[9]

To summarize, Table 6 shows that constrained short interest portfolios of Nasdaq stocks have more negative abnormal returns in July 1988-1994, the period Desai *et al* (2002) examine, than during 1995-2002. There is no clear difference between subperiods for our NYSE-Amex stocks.

5.5 Robustness

To examine the robustness of our results, we calculate abnormal returns using several alternatives to the four-factor regression model. All of our qualitative results hold, and in order to save space we do not report these results in a table.

First, instead of using a four-factor model, we compute Fama-French (1993) three-factor model regression intercepts. Since all of our high short interest portfolios load negatively on momentum, we expect that omitting the momentum factor will make all of our intercepts more negative and this is what happens. For example, using the three-factor model for the most constrained portfolio of NYSE-Amex-Nasdaq stocks during 1988-2002, the intercept increases from –215 bp/month to –281 bp/month.

[9] When comparing our July 1988-1994 EW $\geq$ 2.5% combined portfolio of Nasdaq stocks in Table 6 to Desai *et al*'s EW ≥2.5% portfolio, our four-factor model intercept of –103 basis is more negative than the underperformance of the –76 basis points that they report. Our stronger results may be due to our extensive data cleaning which would reduce sample selection mistakes. In addition, our empirical results consistently have larger standard errors than in Desai *et al* (2002), even when we use untruncated portfolios and methodology that is identical to their Table 2 methodology. Our t-statistic of -3.37 implies a monthly standard error of 31 basis points, whereas their t-statistic implies a monthly standard error of 23 basis points. Finally, on pp. 2275 and 2277 in their paper, they report the point estimates and t-statistics from additional robustness checks, with implied standard errors of an implausibly low 3-6 basis points per month.

Second, we calculate both raw and benchmark-adjusted monthly average returns. We use two benchmarks, the CRSP value-weighted market portfolio and size and book-to-market portfolios. The second benchmark uses a 5x5 sort on market capitalization (using NYSE firms for the size cutoffs) and book-to-market. For the most constrained NYSE-Amex-Nasdaq portfolio during 1988-2002, the average raw return is –183 bp/month, the average market-adjusted return is –274 bp/month, and the average size and book-to-market adjusted return is –238 bp/month. When using all three of these measures, the monotonic pattern with regards to institutional ownership that we report in Panel A of Table 5 continues to hold.

Next, since most of the abnormal returns in Tables 4, 5, and 6 are negative, there are two potential biases that we consider. The first, as is well-documented, arises because extreme small growth firms have negative intercepts in three-factor and four-factor model regressions. For example, using size and book-to-market quintiles, Fama and French (1993, Table 9a) report a negative intercept of 34 basis points per month for the extreme small growth firm portfolio. Since many of our Nasdaq high short interest firms are in the small growth category, this misspecification may bias our results towards negative intercepts. This bias cannot explain the magnitude of our results, however, given that our EW portfolio of the most constrained NYSE-Amex-Nasdaq stocks generates a four-factor model intercept of –215 basis points per month over the 1988-2002 period.

The second potential bias, as first pointed out by Chopra, Lakonishok, and Ritter (1992), arises since the empirical relation between average realized returns and beta is much flatter than the CAPM or multi-factor models assume. Thus, portfolios with betas greater than 1.0 will tend to have negative measured intercepts. For example, if the market risk premium is 6 percent per year (50 basis points per month) and the empirical slope of the relation between beta and excess returns is zero, the extent of the bias will be $(\beta - 1)\cdot(0 - 50)$ per month. Since in our four-factor regression models, beta estimates are as high as 1.4, this would make the bias -20 basis points per month. While this bias would result in more negative intercepts in our regressions, it is too small to explain our results. It also does not explain our differential results for low and high institutional ownership portfolios. Although we do not report the slope coefficients (factor loadings) to save space, the betas of the different portfolios are economically indistinguishable from each other. Thus, if this bias exists for our sample, it does not explain the magnitude of our

results or affect our conclusion that EW portfolios with high short interest and low institutional ownership have the most extreme subsequent underperformance.

5.6. Persistence of abnormal returns

Thus far, we have only reported returns on [1,1] portfolios, where stocks are removed from a portfolio at the end of the month in which their short interest ratio no longer qualifies them for inclusion. In Table 7, we report abnormal returns on the ≥2.5% and the 99th percentile [1,1] and [1,12] portfolios. These returns are reported for the combined portfolios and for the part of the portfolios with the lowest IO third. A [1,12] portfolio is one where stocks stay in a portfolio as long as they have qualified for inclusion during at least one of the prior 12 months. For example, if within 10 months after falling below the inclusion threshold, a stock's short interest ratio rises to qualify it for inclusion again, its time in the portfolio is extended. The purpose of using this longer portfolio inclusion period is to examine the persistence of abnormal performance. Unless there is an early delisting, all stocks in the portfolio are retained in the portfolio for at least one year, as contrasted with the one-month minimum in Tables 4, 5, and 6.

Desai *et al* find that for Nasdaq stocks during the subperiod July 1988-1994, the abnormal returns for [1,12] portfolios are as negative as for [1,1] portfolios. This suggests that frequent rebalancing of portfolios is not needed to capture the negative abnormal returns on stocks with high short interest. In Panel A of Table 7, we confirm that for the 1988-1994 subperiod, the [1,12] abnormal return is still negative and significant. This holds for NYSE-Amex stocks as well. When we examine the patterns for the 1995-2002 subperiod, however, the pattern of persistence in abnormal returns disappears for Nasdaq stocks and for the combined NYSE-Amex-Nasdaq stock portfolios. These results suggest that negative abnormal returns revert towards zero after a firm's short interest ratio drops. This suggests that frequent portfolio rebalancing is required to capture the negative abnormal returns on highly shorted firms.

6. Arbitrage vs. valuation shorts

A stock can have a high short interest ratio for several reasons. Thus far we have assumed that stocks have high short interest because some investors considered them to be overvalued. We refer to these as valuation shorts. But many short positions are established as part of an arbitrage strategy, with convertible bond arbitrage and takeover arbitrage among the most common motivations. In a typical convertible bond arbitrage, an investor views the conversion

option on the convertible to be underpriced, and buys the convertible while simultaneously shorting the stock. The position is unwound when the convertible price rises so that the conversion option is no longer underpriced, a process that might take many months. In a typical takeover arbitrage, the investor shorts the acquiring firm and goes long in the takeover target if the takeover is a stock-for-stock exchange. In cash-for-stock takeovers, risk arbitrageurs typically just take an unhedged long position in the target. Because few takeovers drag on for long periods, takeover arbitrage frequently involves positions held for at most a few months before being unwound.

Of course, a firm might have a high short interest ratio because there is both valuation shorting and arbitrage shorting taking place simultaneously. Unfortunately, we cannot identify these situations precisely. To simplify things, we categorize stocks that either have a convertible bond outstanding or are making an acquisition as arbitrage shorts. As a crude measure we take all stocks with convertible bonds from Compustat balance sheet information and classify them as arbitrage shorts while the convertible bond remains outstanding. Panel A of Table 8 shows that stocks with convertible bonds outstanding are much more likely to have high short interest ratios than random stocks. During July 1988-2002, 9.6% of all stocks in an average month had a convertible bond outstanding. In the $\geq 2.5\%$ portfolio, however, 19.3% of stocks had a convertible bond outstanding, and in the 99^{th} percentile portfolio, 25.7% of stocks had a convertible bond outstanding. Thus, stocks with convertible bonds are roughly two or three times as likely to be in high short interest portfolios as random stocks. This finding supports our assumption that this crude measure may identify arbitrage shorting.

Categorizing our sample as either arbitrage or valuation shorts and estimating the EW four-factor regression model over the period 1988-2002 yields the results in Panel B of Table 8.[10] For both $\geq 2.5\%$ and 99^{th} percentile portfolios, the abnormal returns on arbitrage shorts are less negative and less statistically significant than on valuation shorts. Thus, Table 8 suggests that the negative abnormal returns on our high short interest portfolios are driven more by valuation shorts than by arbitrage shorts.

[10] We also investigated arbitrage portfolios involving merger arbitrage from a proprietary database. The results, which we are not allowed to report here, are qualitatively similar to those for our convertibles.

7. Conclusion and implications

With the exception of papers using data on rebate rates, the existing literature has tended to examine the relation between stock returns and short selling by either using proxies for demand, or for supply. This paper uses both short interest ratios (a proxy for demand) and institutional ownership ratios (a proxy for supply) to investigate whether short sales constraints affect stock returns. We find that short-sale constrained stocks, defined by high short interest and low institutional ownership, have significantly lower abnormal stock returns than unconstrained stocks. Over the period 1988-2002 constrained stocks, those in the 99th percentile of short interest ratios and the lowest third of institutional ownership, underperform relative to a four-factor model specification by a statistically significant 215 basis points per month on an EW basis and by an insignificant 39 basis points per month on a VW basis. For EW portfolios, abnormal returns are more negative the higher the short interest ratio, and, within high short interest portfolios, abnormal returns are more negative the lower is the institutional ownership.

Looking at a longer time period than previous empirical work, this paper confirms several patterns found in the short sale literature and discovers several others. Short interest rises over the time period 1980-2002, although short interest dips following periods of high market returns. In all time periods only a small portion of stocks have high short interest ratios.

In addition, we show that the performance of high short interest NYSE-Amex stocks is generally more consistent and negative than for their Nasdaq counterparts over the period July 1988-2002. More importantly, small cap stocks make up a large portion of the stocks that are highly shorted and EW portfolios underperform more consistently than VW portfolios. We also find that the underperformance of high short interest stocks is fairly brief. Thus, to realize the negative abnormal returns on these stocks, frequent portfolio rebalancing is required.

This paper also posits that there are at least two distinct types of short selling: valuation and arbitrage. We investigate one type of arbitrage short in this paper, convertible arbitrage, using the existence of an outstanding convertible bond by the firm as our proxy. Even though our proxy is crude, we find that convertible bond arbitrage appears to be a major reason for high short interest. Dividing the sample by type of short selling shows that arbitrage shorts do not underperform as much.

Whether short sellers in fact can profit from short selling depends on implementation costs, including some unique to short selling. First, short sellers must locate the stock to borrow,

although we find an ample supply for most stocks. Second, even after locating the stock, short sellers face the risk that their positions may be terminated at a less than optimal time. More importantly, as other studies show (D'Avolio (2002), Geczy, Musto, and Reed (2002), and Jones and Lamont (2002)), many of the high short interest stocks with the most negative abnormal returns are on special, which increases the cost of shorting. Thus, active trading strategies are likely to be subject to an implementation shortfall relative to the returns that we report. Regardless of whether short selling is profitable, the finding that short sale constrained stocks underperform the market has other important investment implications. An investor should avoid long positions in stocks that are short sale constrained. The number of stocks in any month that must be avoided or sold is small, however. The 99th percentile short sale constrained portfolio and the $\geq$ 2.5% constrained portfolio contain only about 20 and 60 stocks per month, respectively. Therefore, following the advice to stay away from highly shorted stocks requires investors to avoid only about one percent of all stocks in each month, although diligence is required to track the changing composition of these stocks.

Our findings also have implications for the common assertion that hedge funds add value because of their ability to take short positions in overvalued equities, whereas most mutual funds are restricted to long-only positions. Our results indicate that the only class of stocks reliably producing negative abnormal returns is small cap stocks with extremely high short interest ratios. At the end of 2002, stocks in the 99th percentile of short interest ratios had an aggregate market capitalization of only $35 billion. If only one third of these stocks are short sale constrained, and the average short interest ratio for these stocks is 40%, only $5 billion in short positions is available. Given that the hedge fund industry is estimated to have had about $600 billion under management (albeit not all in domestic equities) in 2002, our findings suggest that the average hedge fund is unlikely to be creating significant value from short selling stocks.

If short sale constraints are binding, they are a significant factor in limiting arbitrage. However, our proxies show that short sales constraints are not widespread. Institutional ownership is greater than short interest for 95.0% of our stocks in an average month and in addition there exists a supply of stocks from retail investors to borrow. While the rebate rate is probably the best measure of scarcity—and thus short sale constraints—it is unfortunately not publicly available. By using publicly available proxies for both the supply and demand for

shorting stocks, we are able to identify stocks that are likely to be constrained. These portfolios, at least on an equally weighted basis, reliably underperform.

Appendix: Sample Construction

We use a sample of NYSE and Amex stocks from 1980-2002 and Nasdaq National Market System (NMS) stocks from July 1988-December 2002 and collect both short sales and institutional ownership data. The level of short interest in individual stocks for the NYSE, Amex, and Nasdaq is collected monthly from member firms on the fifteenth calendar day of every month (if it is a business day). This information represents short positions established in transactions that occurred three or five business days prior (member firms only report after the trade is settled, and the settlement period changed from five to three days in June 1995). The exchanges then release this data to the news services. Press release dates vary from month to month since exchanges have no required release date. The data is sometimes published as early as the 19th, and sometimes as late as the first of the next month. Nasdaq has traditionally released the information a few days later than the NYSE and Amex. The short interest positions for some, but not all, listed firms are then reported to investors in the *Wall Street Journal*, *Barron's*, and the *New York Times.*[11] In recent years, they are also listed on Bloomberg.

The markets and the financial press report both the current and past month short interest together. The short interest data are frequently revised the following month. These revisions occur primarily because a member firm is tardy in reporting, and its short interest is not included in the initial amount reported. Most revisions are quite small and where the revised numbers are provided, we use the revised numbers.

The short interest data in this paper are from five sources. The first two sources are the NYSE and Amex, which began selling their monthly short interest data to the public in January 1991. The third source is Nasdaq, which began supplying data in electronic form on a monthly basis in June 1988, although February and July 1990 are missing. The last two sources are owned by Standard and Poor's and are roughly equivalent. Interactive Data Corporation, a subsidiary of Standard and Poor's, publishes a *Quarterly History Tape*, which provides short interest data for each firm. This is the primary source for our NYSE and Amex data prior to 1991. Standard and

[11] Newspapers limit their coverage of short interest positions to stocks with the largest number of shares sold short or stocks with large changes in short interest. The cut-off criteria change over time. For example, the August 2000 *Wall Street Journal* reports short sales for NYSE and Amex stocks with positions greater than 850,000 shares or whose short positions changed by more than 525,000 shares since the last month. The Nasdaq numbers for August 2000 are 575,000 and 350,000 respectively. In August 1995, the short sale cut-offs for NYSE-Amex stocks are 300,000 and 50,000. In general, the increases in reporting requirements reflect stock splits and the general increase in short sales.

Poor's *Daily Stock Price Record*, published quarterly, lists the prior 12 months of short interest data for each firm on the NYSE and Amex. This source was used repeatedly to check revisions in monthly short interest. All the sources we use are more comprehensive in their coverage of short interest positions than the financial press.

The difference between the Standard and Poor's data and the exchange data is that the exchanges report a value for short interest for every firm, even if the firm has low or no short interest. For instance, in December 1990, the Standard and Poor's sources report short interest data for 1,335 NYSE and Amex stocks. In January 1991, the NYSE and Amex provide December 1990 data for 1,854 stocks, of which 1,766 stocks have non-zero entries. The Standard and Poor's sources therefore omit 431 stocks that the exchange data reveals has an average short interest of 3,825 shares, equivalent to 0.07% of shares outstanding. For stocks with no reported short interest in a given month, we assume the short interest is zero for that month. This paper uses the Standard and Poor's sources for the 1980-1990 data for the NYSE and Amex. Post-1990 come directly from the exchanges. For all months for which we have Nasdaq data, Nasdaq is the source.

Numerous cross-checks were performed to ensure short sale data accuracy. Since the quarterly *Daily Stock Price Records* each contain 12 months of data and the monthly exchange data each contains two months, we compared overlapping months to search for data problems. We also identified outliers based on deviations from moving averages and compared the observations to data published in *Barron's* and listed in Bloomberg. Since *Barron's* lists two months of data in each of its reports, we compared each data point to two separate issues of *Barron's*. In total, we manually checked approximately 50,000 data points.[12]

To assist in comparing short positions across time and stocks, we adjust short interest in two ways. First, the exchange reported short sales are not always adjusted for stock splits or stock dividends that occur the same month, so we matched all stocks with the CRSP tapes and corrected for these events. Adjusting for stock splits is cumbersome because the effective date of the stock split during a month may be before or after the short interest numbers are reported. Second, as mentioned, we divide each firm's short interest by the number of shares outstanding. The two sources we use for shares outstanding are CRSP and Compustat. However, these data

[12] We do not believe that we have completely corrected this database; indeed it is our belief that it would be impossible to do so. We do believe that we have eliminated the obvious errors in the data. Often the errors appear straightforward, e.g. transposed digits, short sales incorrectly credited to another similarly named firm, etc.

sources sometimes differ in the number of shares outstanding they report. When the shares outstanding differ, CRSP tends to lag actual shares outstanding when checked against S.E.C. filings. Compustat often sums shares across all classes of common stock. We use shares outstanding from CRSP if both sources are available because their errors are less severe in calculating short interest. Since our errors from CRSP are typically too few shares outstanding, we may overstate short interest and institutional ownership ratios. Any such errors may weaken our results, since they will place stocks that are not highly shorted into our high short interest portfolios, and/or they will identify some stocks as having high institutional ownership when they do not.

The institutional ownership data are taken from the S.E.C. Form 13-F filings. Our source for this data is Thomson Financial's CDA/Spectrum Institutional (13-F) Holdings database. Money managers with at least $100 million in assets are required to file this form with the SEC 45 days after the end of any quarter. These filings do not represent all institutions as they exclude hedge funds for our time period 1980-2002. In addition, about five percent of funds submit their Form 13-Fs late. If so, Spectrum skips that fund's next filing date and all stock ownership for that institution is recorded as zero. We filled these missing data points by assuming the stock ownership for that institution during the missing quarter is the minimum of the quarter before and after. We chose the minimum of the two data points instead of the average because we did not know the date of any buy or sell transaction and wished to be conservative. In addition, while stock splits are handled correctly if filings are done on time, stock splits are mishandled when filings are late and we had to adjust the number of shares owned. See Gompers and Metrick (2001) for a more detailed description of this database.

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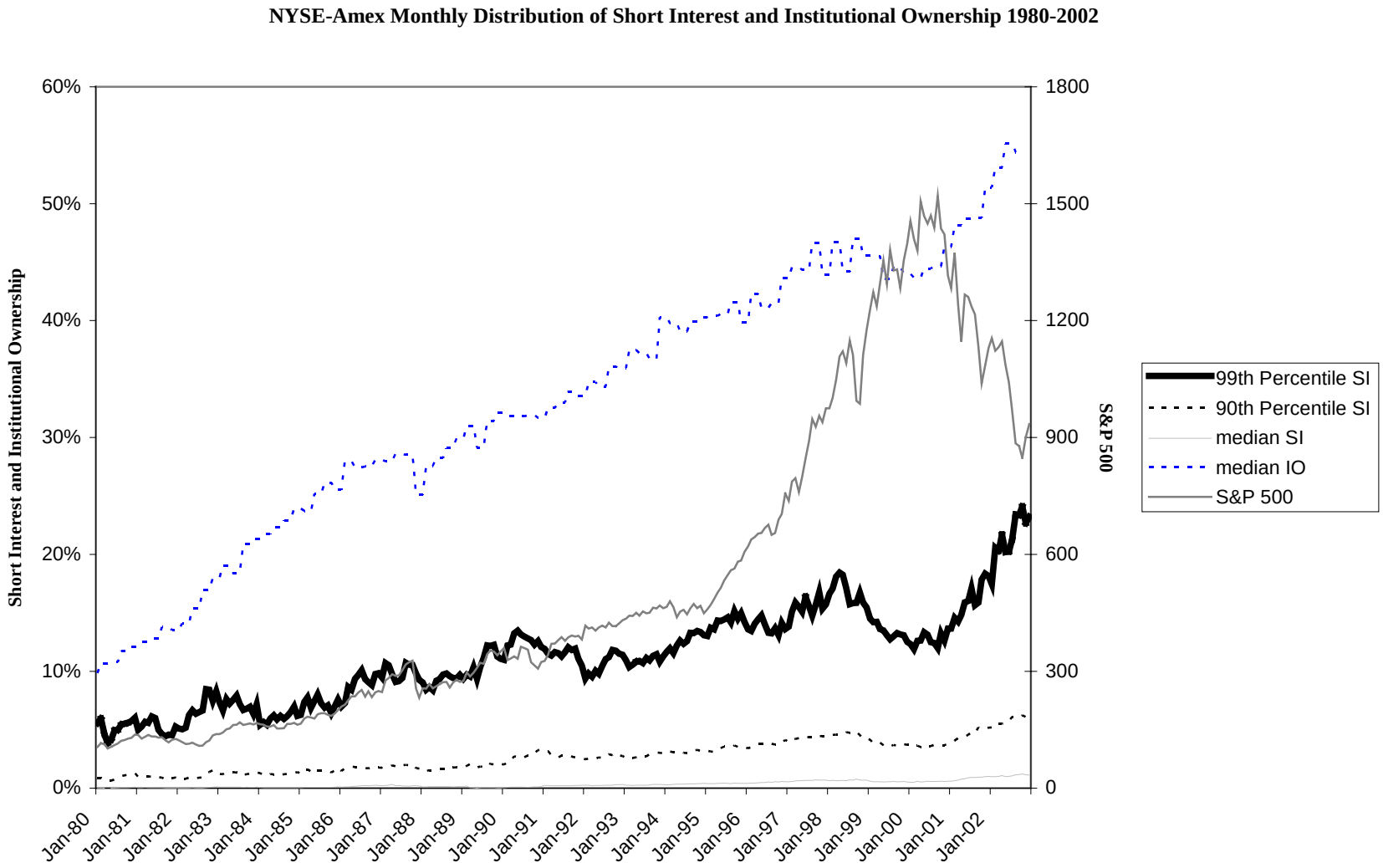

Figure 1—The median, 90th and 99th percentiles of short interest ratios (scale on left axis) for NYSE-Amex stocks, the median institutional ownership (left axis), and the level of the S&P 500 (right axis) at the end of the month, for January 1980 to December 2002. Short interest ratios are defined as short interest divided by shares outstanding. If no short interest is reported for a stock in a given month, the ratio is assumed to be zero. Institutional ownership is defined as shares held by institutions divided by shares outstanding and is calculated quarterly.

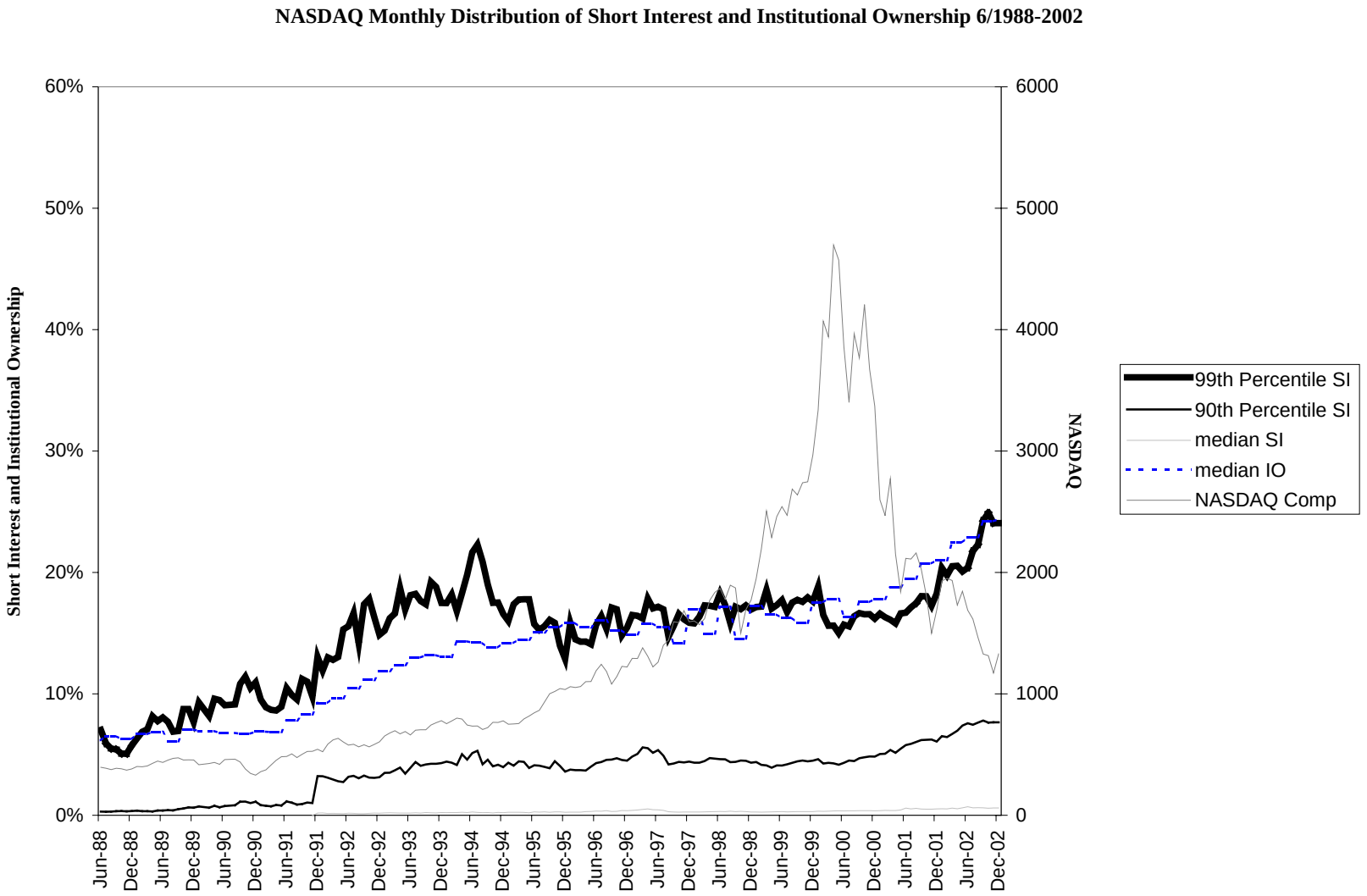

Figure 2—The median, 90th and 99th percentiles of short interest ratios (scale on left axis) for Nasdaq NMS stocks, the median institutional ownership (left axis), and the level of the Nasdaq Composite (right axis) at the end of the month, for June 1988 to December 2002. Short interest ratios are defined as short interest divided by shares outstanding. If no short interest is reported for a stock in a given month, the ratio is assumed to be zero. The jump in short interest ratios in January 1992 is due to an increase in the number of firms for which Nasdaq reported positive short interest. Institutional ownership is defined as shares held by institutions divided by shares outstanding and is calculated quarterly.

Table 1
54 Firms in the 99th Percentile Portfolio in December 2002

Short interest ratio is shares short in November 2002 divided by shares outstanding. Institutional ownership is the sum of shares held by institutions from 13F filings in December 2002 divided by shares outstanding. Market cap is as of June 30, 2002. Book value of equity is for the end of the fiscal year ending during calendar 2002, or (for three companies that have not filed 2002 annual reports as of August 2003) the latest quarterly report during 2002. The 12-month prior return is for the 12 months ending in November 2002. When a return is missing for any of the prior 12 months, the firm's return is set to the return on the value weighted market index. The 99th percentile short interest ratio cutoff is determined from a pooled sample of NYSE-Amex and Nasdaq firms.

Company Name	Short Interest	Institutional Ownership	Market Cap ($mm)	Market to Book	Prior 12 Month Return	Industry
NYSE-Amex						
CVD Equipment Corp	99.3%	0.00%	$653	1.10	-42.37%	Semiconductor processor
Prepaid Legal Services	54.7%	74.06%	$401	11.46	50.00%	Legal services
UAL (United Airlines)	39.2%	10.66%	$638	-0.18	-85.48%	Airline
Federal Agricultural Mortgage	33.5%	88.01%	$269	-0.17	-30.86%	Consumer finance
Fleetwood Enterprises	33.3%	122.50%	$304	2.74	-34.34%	Recreational vehicle producer
Jo Ann Stores	32.7%	72.88%	$293	1.01	258.38%	Retail fabric stores
Metris	32.1%	94.31%	$517	0.82	-79.00%	Credit card issuer
BMC Industries MN	30.2%	40.75%	$260	0.44	-34.74%	Electronics
SWS Group	29.2%	51.37%	$338	1.33	-10.80%	Finance
Fleming Companies	28.9%	102.24%	$976	1.45	-70.85%	Supermarket supplier
Northwestern Corp.	28.7%	49.92%	$464	-1.02	-56.64%	Electricity and gas distribution
Nautilus Group	28.5%	42.36%	$1,077	5.32	-43.37%	Exercise equipment
Sunrise Assisted Living	28.1%	79.65%	$602	1.29	1.93%	Retirement housing
Action Performance	27.9%	95.81%	$562	2.45	-32.88%	Motorsports merchandise
Administaff	26.6%	73.45%	$280	2.41	-76.70%	Temporary staffing
Univision Communications	26.2%	97.84%	$5,025	3.23	-9.74%	Spanish-language TV
American Italian Pasta	25.7%	114.65%	$916	3.08	-2.16%	Pasta producer and marketer
Chico Fas	24.4%	88.60%	$1,490	6.21	112.68%	Women's clothing retailer
Salton	23.3%	61.94%	$157	0.64	-19.63%	Small appliance retailer
Duane Reade	23.3%	116.09%	$812	2.46	-42.37%	Drug store chain
Footstar	23.2%	108.72%	$492	1.74	-76.55%	Shoe retailer
Nasdaq						
Biosite	48.3%	114.72%	$415	3.85	72.74%	Diagnostic product developer
Cognizant Tech Solutions	46.1%	135.29%	$452	2.73	123.02%	IT outsourcing
Polymedica	45.0%	102.90%	$310	1.58	24.96%	Medical products retailer
Eresearch Technology	43.1%	73.49%	$176	4.34	120.05%	Cardiac clinical research
Cabot Microelectronics	39.6%	107.15%	$1,045	4.89	-12.99%	Polishing compound producer
Neoware Systems	37.7%	81.43%	$146	4.01	676.54%	Thin client appliances/software
FPIC Insurance Group	37.6%	67.07%	$141	0.85	-53.65%	Liability insurance provider
American Capital Strategies	33.0%	58.96%	$1,058	1.54	-17.53%	Buyout fund
Sirius Satellite Radio	31.6%	35.11%	$289	9.54	-87.78%	Satellite radio
Expedia	31.1%	105.69%	$1,337	2.75	131.13%	Internet travel agency
New Century Financial	31.0%	75.36%	$864	2.24	67.51%	Subprime mortgages
Silicon Laboratories	29.5%	77.68%	$1,366	8.77	13.70%	Integrated circuit designer
THQ	29.3%	108.79%	$1,177	2.88	-53.21%	Video games for PCs
J2 Global Comm	28.9%	69.64%	$178	3.14	460.99%	Communications services
Zix Corp.	28.7%	10.94%	$97	10.12	-42.52%	E-mail management/ protection
AAIPharma	28.0%	86.84%	$411	4.13	-16.54%	Drug marketing
XM Satellite Radio Holdings	27.4%	38.75%	$661	1.12	-78.26%	Satellite radio
Hot Topic Inc.	26.6%	108.38%	$848	5.27	27.67%	Clothing retailer for teenagers
Invision Technologies	25.8%	64.18%	$403	1.70	15.03%	Airline security systems
Shuffle Master	25.8%	89.02%	$330	6.56	7.78%	Gambling industry supplier
Cell Therapeutics	25.3%	67.70%	$181	4.17	-64.91%	Biotech (cancer)
Kroll Inc	25.3%	94.15%	$656	1.44	30.03%	Risk consulting and security
SCP Pool Corp.	25.3%	99.78%	$751	5.29	22.08%	Swimming pool wholesaler
Photon Dynamics	25.0%	104.66%	$514	2.27	-9.92%	Flat panel display developer
Conceptus	24.7%	98.74%	$350	4.95	-26.92%	Surgical birth control
Astropower	24.1%	51.28%	$427	2.75	-64.25%	Solar cell manufacturer
Multimedia Games	23.8%	88.63%	$280	4.27	4.50%	Gambling industry supplier
Webex Communications	23.7%	77.92%	$645	7.32	-39.40%	Internet conferencing services
Take Two Interactive	23.1%	107.02%	$800	2.25	114.71%	Video games for PCs
Scios Inc.	22.6%	98.05%	$1,427	216.32	19.77%	Biotech (heart disease)
Trimeris Inc.	22.5%	86.40%	$833	6.40	32.96%	Biotech (anti-virus)
Drexler Technology Corp.	21.5%	54.95%	$223	6.05	-1.57%	Optical data storage
Microstrategy	21.1%	66.43%	$24	-0.69	-46.98%	Business software

Table 2

Median Size, Market-to-Book, and Institutional Ownership of Highly Shorted Firms

Panel A reports the size (market capitalization) for firms in the respective short interest portfolios, and for firms whose short interest ratio is lower than required for inclusion. For firms with a missing size value in year t, the year t-1 size value is used. Size is calculated by taking the year end market price times the shares outstanding at year end. Panel B reports the median market-to-book ratio of equity for firms in the respective short interest portfolios, and for firms whose short interest ratio is lower than required for inclusion. For firms with a missing book value in year t, the year t-1 book value is used. Book values are from Compustat and are calculated at the end of the fiscal year. Nasdaq firms include only National Market System (NMS) listings. For Panels A and B, the firms in the portfolio are determined for each year: a firm is considered highly shorted if it is in the portfolio during any month of the year. Then, the median is calculated by taking the median of the pooled firm-year sample. Panel C reports the median shares held by institutions divided by shares outstanding for firms in the respective short interest portfolios and those not in the portfolios. The median is calculated as the median of the pooled firm-quarter institutional ownership percentage.

Panel A: Median size, ($ millions)

	All firms, 1980-2002		NYSE-Amex 1980-2002		Nasdaq July 1988-2002	
Portfolio	Highly Shorted	Others	Highly Shorted	Others	Highly Shorted	Others
2.5-4.9%	366	70	716	218	237	43
5.0-9.9%	343	77	488	230	265	44
≥ 10.0%	326	81	373	234	280	45
95-98.9th %ile	267	78	314	234	196	44
≥ 99th %ile	242	83	256	237	192	46

Panel B: Median Market-to-Book Ratios

	All firms, 1980-2002		NYSE-Amex 1980-2002		Nasdaq July 1988-2002	
Portfolio	Highly Shorted	Others	Highly Shorted	Others	Highly Shorted	Others
2.5-4.9%	2.43	1.52	1.79	1.39	3.14	1.69
5.0-9.9%	2.51	1.55	1.79	1.41	3.26	1.71
≥ 10.0%	2.61	1.57	1.65	1.42	3.46	1.72
95-98.9th %ile	2.13	1.56	1.58	1.42	2.96	1.70
≥ 99th %ile	2.30	1.57	1.60	1.42	3.19	1.73

Panel C: Median Institutional Ownership (as a Percentage of Shares Outstanding)

	All firms, 1980-2002		NYSE-Amex 1980-2002		Nasdaq July 1988-2002	
Portfolio	Highly Shorted	Others	Highly Shorted	Others	Highly Shorted	Others
2.5-4.9%	43.2%	19.2%	49.2%	30.7%	36.8%	12.8%
5.0-9.9%	45.4%	19.7%	50.0%	31.3%	41.4%	13.0%
≥ 10.0%	49.7%	20.0%	50.1%	31.6%	49.5%	13.3%
95-98.9th %ile	39.2%	19.7%	40.8%	31.5%	35.5%	13.0%
≥ 99th %ile	41.5%	20.2%	38.5%	31.8%	43.2%	13.5%

Table 3

Highly Shorted Firms Categorized by Persistence and Median Months in Portfolio

Table 3 reports the distribution of the length of time that a firm spends continuously in the high short interest [1,1] portfolios once it enters. For example, of firms that crossed the 2.5% short interest ratio threshold, 31.8% fall back below 2.5% in the following month. A firm that re-enters the 2.5% portfolio after falling out is treated as a new observation. If a firm is in a portfolio in 2002, the length of its observation can be truncated. For example, a firm which enters a portfolio in December 2002 will count for at most one month.

	Distribution of the length of time spent in a portfolio once entering				
Portfolio	1 month	2-3 months	4-12 months	13 or more months	median months
≥ 2.5%	31.8%	22.0%	26.9%	19.4%	3
≥ 5%	30.6%	22.8%	28.8%	17.8%	3
≥ 10%	32.8%	23.3%	29.5%	14.4%	3
≥ 95%ile	32.8%	23.4%	27.5%	16.3%	3
≥ 99%ile	35.1%	26.7%	26.9%	11.3%	2

Table 4

Four-factor Model Parameters for EW and VW Portfolios of NYSE-Amex-Nasdaq Stocks with High Short Interest, July 1988-December 2002

In the time series regressions using monthly percentage returns, the dependent variable is $r_{pt} - r_{ft}$, the excess return over the risk-free rate on either an equally weighted (EW) or value weighted (VW) portfolio in time period t, $r_{mt} - r_{ft}$ is the realization of the market risk premium in period t, SMB_t is the return on a portfolio of Small stocks Minus the return on a portfolio of Big stocks in period t, HML_t is the return on a portfolio of High book-to-market (value) Minus Low book-to-market (growth) stocks in period t, and MOM_t is the return on a portfolio of prior winners minus the return on a portfolio of prior losers. The monthly factor return realizations are provided by Kenneth French. For July 1988-December 2002, 174 monthly returns are used in the regressions. In Panels A and B, the 2.5-4.9% portfolio in month t is the portfolio composed of all Amex, NYSE, and Nasdaq National Market System stocks with a short interest ratio (short interest / shares outstanding) of at least greater than 2.5% (but less than 5.0% in Panels A and B) in month t-1. The portfolio is updated monthly. The 5.0-9.9%, 10%, 95-98.9th percentile, and 99th percentile portfolios are defined analogously. T-statistics are shown in parentheses. An intercept of –0.28 is –28 basis points per month.

$$r_{pt} - r_{ft} = \alpha + \beta_m (r_{mt} - r_{ft}) + \beta_s SMB_t + \beta_h HML_t + \beta_o MOM_t + \varepsilon_{pt}$$

Panel A: EW NYSE-Amex-Nasdaq Firms July 1988 - December 2002

Sample	Intercept	RMRF	SMB	HML	MOM	R^2adj
2.5-4.9%	-0.28	1.19	0.89	-0.07	-0.32	91%
	(-1.58)	(24.95)	(17.77)	(-1.14)	(-8.92)	
5.0-9.9%	-0.62	1.31	1.09	-0.01	-0.39	91%
	(-3.00)	(23.83)	(18.82)	(-0.10)	(-9.39)	
≥ 10.0%	-0.78	1.28	1.25	-0.24	-0.51	88%
	(-2.87)	(17.84)	(16.52)	(-2.50)	(-9.37)	
95-98.9th %ile	-0.36	1.29	1.00	-0.14	-0.44	91%
	(-1.74)	(23.11)	(18.86)	(-1.91)	(-10.48)	
≥ 99th %ile	-1.25	1.33	1.38	-0.08	-0.41	87%
	(-4.42)	(17.73)	(17.52)	(-0.84)	(-7.33)	

Table 4 (continued)

Panel B: VW NYSE-Amex-Nasdaq Firms, July 1988 - December 2002

Sample	Intercept	RMRF	SMB	HML	MOM	R^2adj
2.5-4.9%	0.31	1.18	0.29	-0.23	-0.22	88%
	(1.69)	(23.77)	(5.63)	(-3.60)	(-5.91)	
5.0-9.9%	-0.11	1.33	0.50	-0.31	-0.31	90%
	(-0.55)	(24.75)	(8.76)	(-4.43)	(-7.64)	
≥ 10.0%	-0.27	1.36	0.86	-0.45	-0.31	83%
	(-0.86)	(16.33)	(9.89)	(-4.14)	(-4.97)	
95-98.9th %ile	0.32	1.25	0.48	-0.47	-0.36	91%
	(1.63)	(23.89)	(8.77)	(-6.83)	(-9.18)	
≥ 99th %ile	-0.38	1.42	1.18	-0.30	-0.17	81%
	(-1.09)	(15.26)	(12.09)	(-2.44)	(-2.48)	

Panel C: EW July 1988-December 2002, by Exchange

Sample	Intercept	RMRF	SMB	HML	MOM	R^2adj
NYSE-Amex	-0.65	1.26	0.77	0.68	-0.28	87%
≥ 2.5%	(-3.62)	(26.23)	(15.18)	(10.68)	(-7.67)	
Nasdaq	-0.42	1.26	1.16	-0.50	-0.44	92%
≥ 2.5%	(-1.85)	(20.44)	(18.20)	(-6.31)	(-9.78)	
NYSE-Amex	-1.46	1.32	1.13	0.45	-0.47	69%
≥ 99th %ile	(-3.71)	(12.62)	(10.31)	(3.27)	(-5.98)	
Nasdaq	-1.27	1.30	1.35	-0.37	-0.43	82%
≥ 99th %ile	(-3.49)	(13.38)	(13.38)	(-2.90)	(-6.04)	

Panel D: VW July 1988-December 2002, by Exchange

Sample	Intercept	RMRF	SMB	HML	MOM	R^2adj
NYSE-Amex	0.11	1.18	0.25	0.26	-0.21	89%
≥ 2.5%	(0.81)	(30.07)	(6.06)	(4.98)	(-7.26)	
Nasdaq	0.07	1.38	0.70	-0.89	-0.27	90%
≥ 2.5%	(0.27)	(19.46)	(9.51)	(-9.65)	(-5.16)	
NYSE-Amex	-0.95	1.50	0.76	0.34	-0.28	56%
≥ 99th %ile	(-1.85)	(10.94)	(5.25)	(1.90)	(-2.68)	
Nasdaq	-0.73	1.44	1.17	-0.79	-0.05	79%
≥ 99th %ile	(-1.66)	(12.15)	(9.57)	(-5.13)	(-0.62)	

Table 5: Four-factor Model Intercepts for EW and VW Portfolios of NYSE-Amex-Nasdaq, NYSE-Amex, and Nasdaq Stocks with High Short Interest Partitioned by Institutional Ownership

In the time series regressions using monthly percentage returns, the dependent variable is $r_{pt} - r_{ft}$, the excess return over the risk-free rate on a portfolio in time period t, $r_{mt} - r_{ft}$ is the realization of the market risk premium in period t, SMB_t is the return on a portfolio of Small stocks Minus the return on a portfolio of Big stocks in period t, HML_t is the return on a portfolio of High book-to-market (value) Minus Low book-to-market (growth) stocks in period t, and MOM_t is the return on a portfolio of prior winners minus the return on a portfolio of prior losers. The 2.5% portfolio in month t is the untruncated portfolio composed of all stocks with a short interest ratio (short interest / shares outstanding) of at least 2.5% month t-1 and the 99th%ile is defined analogously. Intercepts are presented for the sample partitioned into thirds by institutional ownership (IO) while the last row of each panel presents combined results. The first panel presents results on an equally weighted (EW) basis, while Panel B presents results on a value weighted (VW) basis. T-statistics are shown in parenthesis. An intercept of -2.15 is 215 basis points per month.

$$r_{pt} - r_{ft} = \alpha + \beta_m (r_{mt} - r_{ft}) + \beta_s SMB_t + \beta_h HML_t + \beta_o MOM_t + \varepsilon_{pt}$$

Panel A: All Markets EW by Time Period (Only NYSE-Amex prior to July 1988)

	1980-2002		July 1988-2002	
Sample	EW ≥ 2.5%	EW 99th %ile	EW ≥ 2.5%	EW 99th %ile
Lowest IO Third	-0.59	-1.31	-0.81	-2.15
	(-1.87)	(-3.03)	(-1.92)	(-4.17)
Middle IO Third	-0.19	-0.40	-0.32	-0.88
	(-1.24)	(-1.14)	(-2.07)	(-1.87)
Highest IO Third	-0.13	-0.33	-0.31	-0.83
	(-0.80)	(-1.07)	(-1.84)	(-2.29)
Combined	-0.30	-0.66	-0.48	-1.25
	(-2.13)	(-2.76)	(-2.79)	(-4.42)

Panel B: All Markets VW by Time Period (Only NYSE-Amex prior to July 1988)

	1980-2002		July 1988-2002	
Sample	VW ≥ 2.5%	VW 99th %ile	VW ≥ 2.5%	VW 99th %ile
Lowest IO Third	-0.26	0.59	-0.58	-0.39
	(-0.75)	(0.80)	(-1.39)	(-0.46)
Middle IO Third	0.17	-0.38	0.04	-0.34
	(0.82)	(-0.70)	(0.17)	(-0.45)
Highest IO Third	0.38	-0.11	0.25	-0.46
	(2.37)	(-0.31)	(1.47)	(-1.01)
Combined	0.32	-0.05	0.16	-0.38
	(2.20)	(-0.16)	(1.02)	(-1.09)

Table 5 (continued):

Panel C: EW by Time Period and Exchange

	1980-2002		July 1988-2002	
Sample	EW ≥ 2.5%	EW 99th %ile	EW ≥ 2.5%	EW 99th %ile
NYSE Lowest	-1.00	-1.77	-1.21	-2.63
IO Third	(-3.70)	(-3.28)	(-3.37)	(-3.67)
NYSE	-0.53	-0.89	-0.65	-1.46
Combined	(-3.29)	(-2.98)	(-3.62)	(-3.71)
Nasdaq Lowest	-------	-------	-0.55	-2.55
IO Third			(-1.11)	(-3.75)
Nasdaq	-------	-------	-0.42	-1.27
Combined			(-1.84)	(-3.49)

Panel D: VW by Time Period and Exchange

	1980-2002		July 1988-2002	
Sample	VW ≥ 2.5%	VW 99th %ile	VW ≥ 2.5%	VW 99th %ile
NYSE Lowest	-0.27	-1.41	-0.35	-3.15
IO Third	(-0.84)	(-1.92)	(-1.04)	(-3.95)
NYSE	0.19	-0.52	0.12	-0.95
Combined	(1.29)	(-1.29)	(0.81)	(-1.85)
Nasdaq Lowest	-------	-------	-0.59	-1.12
IO Third			(-1.09)	(-1.08)
Nasdaq	-------	-------	0.07	-0.73
Combined			(0.27)	(-1.66)

Table 6

Four-factor Model Intercepts for EW and VW Portfolios of NYSE-Amex and Nasdaq Stocks with High Short Interest Partitioned by Calendar Subperiods

In the time series regressions using monthly percentage returns, the dependent variable is $r_{pt} - r_{ft}$, the excess return over the risk-free rate on a portfolio in time period t, $r_{mt} - r_{ft}$ is the realization of the market risk premium in period t, SMB_t is the return on a portfolio of Small stocks Minus the return on a portfolio of Big stocks in period t, HML_t is the return on a portfolio of High book-to-market (value) Minus Low book-to-market (growth) stocks in period t, and MOM_t is the return on a portfolio of prior winners minus the return on a portfolio of prior losers. The 2.5% portfolio in month t is the portfolio composed of all Nasdaq National Market System stocks with a short interest ratio (short interest / shares outstanding) of at least 2.5% in month t-1. The portfolio is updated monthly. The 99th-%ile portfolios are defined analogously. T-statistics are shown in parentheses. An intercept of -2.68 is -268 basis points per month.

$$r_{pt} - r_{ft} = \alpha + \beta_m (r_{mt} - r_{ft}) + \beta_s SMB_t + \beta_h HML_t + \beta_o MOM_t + \varepsilon_{pt}$$

Panel A: EW by Time Period and Exchange

	July 1988-1994		1995-2002	
	EW ≥ 2.5%	EW 99th %ile	EW ≥ 2.5%	EW 99th %ile
NYSE Lowest	-1.35	-2.71	-0.94	-2.68
IO Third	(-2.11)	(-2.62)	(-2.91)	(-2.70)
NYSE	-0.63	-1.62	-0.59	-1.36
Combined	(-2.48)	(-2.75)	(-3.14)	(-2.67)
Nasdaq Lowest	-1.38	-3.13	0.13	-2.20
IO Third	(-2.16)	(-3.25)	(0.19)	(-2.31)
Nasdaq	-1.03	-1.36	0.02	-1.24
Combined	(-3.37)	(-3.03)	(0.06)	(-2.28)

Panel B: VW by Time Period and Exchange

	July 1988-1994		1995-2002	
	VW ≥ 2.5%	VW 99th %ile	VW ≥ 2.5%	VW 99th %ile
NYSE Lowest	-1.39	-2.46	0.39	-3.83
IO Third	(-2.54)	(-2.19)	(1.11)	(-3.36)
NYSE	0.22	-1.45	0.05	-0.64
Combined	(1.16)	(-2.32)	(0.26)	(-0.90)
Nasdaq Lowest	-1.20	-1.80	-0.13	-0.38
IO Third	(-1.83)	(-1.57)	(-0.18)	(-0.24)
Nasdaq	-0.66	-1.59	0.62	-0.06
Combined	(-1.94)	(-3.20)	(1.78)	(-0.09)

Table 7

Four-factor Model Intercepts for EW and VW Portfolios of NYSE-Amex and Nasdaq Stocks with High Short Interest for Different Inclusion Periods

In the time series regressions using monthly percentage returns, the dependent variable is $r_{pt} - r_{ft}$, the excess return over the risk-free rate on a portfolio in time period t, $r_{mt} - r_{ft}$ is the realization of the market risk premium in period t, SMB_t is the return on a portfolio of Small stocks Minus the return on a portfolio of Big stocks in period t, HML_t is the return on a portfolio of High book-to-market (value) Minus Low book-to-market (growth) stocks in period t, and MOM_t is the return on a portfolio of prior winners minus the return on a portfolio of prior losers. The 2.5% portfolio in month t is the portfolio composed of all, NYSE-Amex, and Nasdaq National Market System stocks with a short interest ratio (short interest / shares outstanding) of at least 2.5% in month t-1. The portfolio is updated monthly. Panel A presents results for the time period July 1988-1994, while panel B presents results for the time period 1995-2002. T-statistics are shown in parentheses. An intercept of -1.44 is -144 basis points per month.

$$r_{pt} - r_{ft} = \alpha + \beta_m (r_{mt} - r_{ft}) + \beta_s SMB_t + \beta_h HML_t + \beta_o MOM_t + \varepsilon_{pt}$$

Panel A: EW July 1988-1994 by Exchange

		NYSE-Amex-Nasdaq		NYSE-Amex		Nasdaq	
		EW ≥ 2.5%	EW 99th %ile	EW ≥ 2.5%	EW 99th %ile	EW ≥ 2.5%	EW 99th %ile
Lowest IO Third	[1,1]	-1.44	-2.55	-1.35	-2.71	-1.38	-3.13
		(-2.58)	(-3.46)	(-2.11)	(-2.62)	(-2.16)	(-3.25)
	[1,12]	-1.14	-2.89	-0.99	-2.30	-1.17	-2.63
		(-2.67)	(-4.71)	(-2.18)	(-3.06)	(-2.23)	(-3.67)
Combined	[1,1]	-0.79	-1.36	-0.63	-1.62	-1.03	-1.36
		(-3.27)	(-3.54)	(-2.48)	(-2.75)	(-3.37)	(-3.03)
	[1,12]	-0.67	-1.12	-0.46	-1.06	-0.93	-1.01
		(-3.39)	(-3.59)	(-2.47)	(-2.77)	(-3.46)	(-3.02)

Panel B: EW 1995-2002 by Exchange

		NYSE-Amex-Nasdaq		NYSE-Amex		Nasdaq	
		EW ≥ 2.5%	EW 99th %ile	EW ≥ 2.5%	EW 99th %ile	EW ≥ 2.5%	EW 99th %ile
Lowest IO Third	[1,1]	-0.23	-1.88	-0.94	-2.68	0.13	-2.20
		(-0.43)	(-2.53)	(-2.91)	(-2.70)	(0.19)	(-2.31)
	[1,12]	0.26	-0.43	-0.41	-2.60	0.52	-0.15
		(0.50)	(-0.58)	(-1.55)	(-4.09)	(0.83)	(-0.20)
Combined	[1,1]	-0.23	-1.18	-0.59	-1.36	0.02	-1.24
		(-1.06)	(-2.92)	(-3.14)	(-2.67)	(0.06)	(-2.28)
	[1,12]	0.16	-0.48	-0.26	-1.43	0.43	-0.15
		(0.69)	(-1.16)	(-1.42)	(-3.98)	(1.32)	(-0.30)

Table 8

Four-factor Model Intercepts for EW Portfolios of Firms with High Short Interest, by Arbitrage Category, July 1988-December 2002

Arbitrage shorts are firms with high short interest that have a convertible bond outstanding. Valuation shorts are all other firms with high short interest. Intercepts and their t-statistics from time series regressions using monthly percentage returns of $r_{pt} - r_{ft}$, the excess return over the risk-free rate on a portfolio in time period t, regressed on $r_{mt} - r_{ft,}$ the realization of the market risk premium in period t, $SMB_{t,}$ the return on a portfolio of Small stocks Minus the return on a portfolio of Big stocks in period t, $HML_{t,}$ the return on a portfolio of High book-to-market (value) Minus Low book-to-market (growth) stocks in period t, and $MOM_{t,}$ the return on a portfolio of prior winners minus the return on a portfolio of prior losers, are reported. For July 1988-December 2002, 174 monthly returns are used. The 2.5% portfolio in month t is the portfolio composed of all NYSE-Amex-Nasdaq stocks in with a short interest ratio (short interest / shares outstanding) of at least 2.5% in month t-1. The portfolio is updated monthly. The 99th percentile portfolio in month t is composed of all stocks that are in the top one percent of short interest ratios in month t-1. Panel A reports the average percentage of firms that are in the convertible arbitrage category, while Panel B reports the intercept and t-statistic in parenthesis from:

$$r_{pt} - r_{ft} = \alpha + \beta_m (r_{mt} - r_{ft}) + \beta_s SMB_t + \beta_h HML_t + \beta_o MOM_t + \varepsilon_{pt}$$

Panel A: Percentage of Firms with Convertible Debt in Portfolios, July 1988-December 2002

All firms	≥ 2.5%	99th-%ile
9.60%	19.33%	25.70%

Panel B: EW NYSE-Amex-Nasdaq firms, July 1988-December 2002

≥ 2.5%		99th-%ile	
Valuation	Arbitrage	Valuation	Arbitrage
-0.53	-0.38	-1.38	-0.62
(-2.61)	(-2.28)	(-4.05)	(-1.76)