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Abstract

Essay 1: Is Underreaction Related to Behavioral Biases?

Studies show that stock prices underreact to news over a period of up to 12 months. The source of underreaction, however, remains controversial. We present empirical evidence that suggests such underreaction may be related to institutional investors’ behavioral biases. Using a sample of trading data on 13F institutional investors from the second quarter of 1978 to the first quarter of 2001, we find that institutional investors who held the stock longer sold the shares later and those who held the stock shorter sold the shares earlier. Such a positive length relation (PLR) is significant in the sample period during which stocks experienced negative returns for four consecutive quarters, but with less or no significance in the six quarters before and after the sample period. There is evidence that the PLR is significantly related to two behavioral biases -- conservatism and representativeness.

Essay 2: The Relation between the Asset Liquidity and the Trading Liquidity: An Empirical Investigation

Using a sample of public firms from 1994 to 1998, we examine the relation between the firms’ asset liquidity and their stocks’ trading liquidity. The results show that the higher the firms’ asset liquidity, the lower their stocks’ trading liquidity. This relation does not hold for banks. Bank stocks have lower trading liquidity than other firms’ stocks do. The results are consistent with market microstructure theory and support the paradox of asset liquidity suggested by recent theory. The results may suggest that firms with severe asset substitution and entrenching investment problems may have a different trading behavior of their stocks than those of others.
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Finance is fun!
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Essay 1: Is Underreaction Related to Behavioral Biases?

I. Introduction

According to well-perceived empirical evidence, stock prices underreact to news over a period of up to 12 months.¹ The source of underreaction, however, remains controversial. The sample-specific result of chance (Fama 1998) is one explanation. Johnson (2002) develops a single-firm model with a standard pricing kernel to show that underreaction can potentially be generated without investor irrationality, heterogeneous information, and market frictions. Michaely, Womack, and Thaler (1995) find stock prices underreact to dividend initiations and omissions news. Boehme and Sorescu (2002), however, find such underreaction only for equally weighted portfolios and only for the period after 1964. Furthermore, they also find post-event reductions in the risk factor loadings of underlying stocks, suggesting that underreaction due to dividend initiations and omissions may be generated by chance.²

A second source of underreaction is investors’ irrationality or behavioral biases. Jegadeesh and Titman (2001) show that their 1993 findings continued in the 1990s, suggesting that underreaction is not sample-specific. Barberis, Shleifer, and Vishny (1998), Daniel, Hirshleifer, and Subrahmanyam (1998), and Hong and Stein (1999) develop models to explain that underreaction can be caused by behavioral biases. In Barberis et al.’s model, investors believe that a firm’s earnings are either in a mean-reversal regime or a momentum regime in which earnings are trending. If, in fact, earnings are a random walk process, investors’ misjudgments lead to underreaction in stock prices when they believe the first regime holds, and

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² “There is, however, another interpretation that is fully consistent with rationality: chance.”
³ “… we favor the rational explanation on grounds that the price drift is not robust across time periods and methodologies” (Page 898).
to overreaction in stock prices when they believe the second regime holds. The model is supported by Bloomfield and Hales (2001). In their experiments, participants overreacted to changes that were preceded by many continuations and underreacted to changes that were preceded by many reversals.

Underreaction in Barberis et al.’s model is consistent with psychological evidence of conservatism. Conservatism is defined as the slow updating one’s beliefs relative to rational Bayesian rules in the face of new evidence (Edwards, 1968). If investors have conservatism, they update their beliefs more slowly than they should. This may cause stock prices to underreact to new information. Edwards suggests that conservatism is related to the complexity of the problem, or the costs of investigation. That is, conservatism is less likely to be observed when people solve simple tasks. In addition, subjects are seldom or less conservative at the first trial of the experiment, but later on become more conservative.

There are potentially two implications of these findings for investment, which have not been previously investigated. That is, conservatism is likely to be more dramatic (1) if the stock is hard to price due to the complexity of the firm and/or high investigation costs and (2) if the investor has been exposed to, studied, or held the stock for a long period of time. This implication is due to the fact that people develop more conservatism in the experiments that they have previously been exposed. This leads to the following two hypotheses:

1. If investors display this behavioral bias, we should find a positive correlation between underreaction and higher investigation costs.

2. Underreaction should be positively correlated with the length of time investors have held a position in a stock.
Hirshleifer (2001, P. 1577) points out: “It is often not obvious how to translate preexisting evidence from psychological experiments into assumptions about investors in real financial settings. Routine experimental testing of the assumptions and conclusions of asset-pricing theories is needed to guide modeling.” We are doing just that in this study. We test the first hypothesis by using the proxies for the investigation costs or the complexity, such as R&D expenses to total sales. We test the second hypothesis by studying whether the length of time that institutional investors have held the stock would affect their trading behavior. The results of our study support both hypotheses and suggest that a portion of stock price underreaction is due to investor conservatism. Using a sample of trading data on 13F institutional investors from the second quarter of 1978 to the first quarter of 2001, we find evidence of conservatism on the part of institutional investors. This conservatism manifests itself in a positive relation between the holding period of a stock and the time to divestment in reaction to a prolonged drop in the stock price. We label this correlation a Positive Length Relation (PLR). The PLR is statistically significant in the sample period, but with less or no significance in the six quarters before and after the sample period. The PLR is also significantly related to the firms with higher costs of investigation, which supports the first hypothesis mentioned above.

Barberis et al.’s model is also consistent with psychological evidence of the representativeness heuristic (Kahneman and Tversky, 1982). Representativeness heuristic is defined as a judgment process in which people tend to focus on the aspect of evidence that is representative of some typical information but neglect the laws of probability. Thus, people may overreact to new information. Griffin and Tversky (1992) show that both representativeness and conservatism can be explained by the hypothesis that people overemphasize the strength of the evidence and overlook its weight. Strength is defined by the salience or extremity and weight is
defined by the reliability. For example, in the dividend initiation, resumption, and omission events, the strength of such events can be proxied by the ratio of the annualized dividend amount to the last trading price prior to the announcement date. Annualized dividend-to-sales and annualized dividend-to-assets can also be used as the proxy for strength. Using dividend-to-price ratio as a proxy for strength is consistent with the definitions in Griffin and Tversky (1992). In their experiments with human subjects, strength is defined by sample proportion. The higher the sample proportion is, the higher the strength is. Likewise, the higher the dividend-to-price ratio is, the greater the strength of dividend events is.

The use of dividend-to-price ratio as strength is also consistent with the signaling theory of dividend payout. It states that dividend payout is a signal of future earnings or firm quality. As Michaely, Womack, and Thaler (1995) put it: "if dividend changes have information content, then presumably the information transmitted is related to the size of the change in the dividend. Initiating or omitting a 5 percent dividend should be more informative than initiating or omitting a dividend paying a 1 percent yield" (Page 592). Thus, the dividend-to-price ratio represents the strength of dividend events.

Weight refers to the credibility of dividend events or the precision of the signals received by the investors when initiations, resumptions, and omission occur. The announcements made by large firms are generally more credible than those made by small firms. Therefore, the firm size can be used as a proxy for weight.

In Griffin and Tversky’s (1992) letter of recommendation example, the weight refers to the credibility of the writer (or how knowledgeable is the writer) and the strength refers to the warmth of the letter. They argue that people tend to put too much emphasis on the strength of the evidence and tend to neglect the weight of the evidence. It is the combination of the strength and
the weight that makes people update their beliefs in a way that is different from a Bayesian. Consider the following situations:

a. *When strength is high and weight is low.* Because people put too much emphasis on the strength, they think the strength is higher than the reality. And because they neglect the weight, although the weight is low, they think the weight is higher than the reality. The result is that people update their beliefs more than a Bayesian would do. Overconfidence (representativeness) occurs.

b. *When strength is low and weight is high.* Because people put too much emphasis on the strength, they think the strength is even lower than the reality. And because they neglect the weight, although the weight is high, they think the weight is lower than the reality. The result is that people update their beliefs less than a Bayesian would do. Underconfidence (conservatism) occurs.

c. *In all other cases about strength and weight.* People still put too much emphasis on the strength and still neglect the weight but no bias occurs. When facing new information, peoples’ judgments would be close to what the Bayesian rule would predict.

Our work is related to a study by Cohen, Gompers and Vuolteenaho (2001). They estimate a vector autoregression to investigate the impact of cash-flow news (or lack of it) on return and trading between individuals and institutions and find that institutions buy shares from individuals in the presence of favorable cash-flow news, but sell shares to individuals in the absence of good cash-flow news when price goes up. This finding is not strong, however, among small stocks. Our work is also related to Coval and Shumway’s (2000) study regarding testing the behavioral biases. They examine the trading behavior of market makers in the Treasury bond futures contracts at the Chicago Board of Trade and find strong evidence of loss-aversion.
Traders who experience morning losses are about 30 percent more likely to assume afternoon risk than traders with morning gains. They also find that the afternoon prices are affected by the behavior.

To be brief, we use an approach similar to what was suggested by Hirshleifer (2001) and applied by Coval and Shumway. Hirshleifer suggests that one uses datasets in which one can identify the trades of traders with behavioral biases versus rational arbitrageurs. Coval and Shumway separate traders into two groups; one group suffered morning loss, and the other did not. In this study, we classify institutional investors into different categories according to how long they have held the stock.

The remainder of the paper is organized as follows: Section II describes the data; Section III presents research methods; the results are presented in Section IV; and Section V concludes.

II. Data Selection

A. Institutional Ownership Data

Under section 13F of the Securities and Exchange Act of 1934, institutional investors are required to report their holdings to the SEC. The reporting requirements apply to any institutional investment manager with over $100 million market value of securities under his or her discretionary management. The Form 13F report is filed quarterly. It must include any common stock positions over 10,000 shares or $200,000.

In this study, we use quarterly SEC 13F institutional filings historical data available on ShareWorld from Thomson Financial. The data in the sample cover the time period from the second quarter of 1978 to the first quarter of 2001 (a total of 88 quarters). Quarterly information
on the data include owners, share price, shares outstanding, shares held, market value, total equity, and industry. Since not all institutional owners are covered in the dataset, the institutions under this study are simply called 13F institutions.

We study institutions’ trading behavior to identify the source of underreaction primarily because trades by institutions influence stock prices (or vice versa) much more than the trades by individuals. Although trades by individual investors accounted for more than 30% of NYSE’s trading volume in 1999, up from less than 15% in 1989 (Pulliam, 1999), individual investors’ trades could be greatly influenced by institutional trades. Individual investors frequently refer to the large size trades as evidence to make their arguments in stock message boards on the Internet. Institutional ownership information is widely available to individual investors free of charge. Evidence shows that as institutional ownership of equities has risen sharply over the past two decades, institutional investors’ trading behavior has increasingly affected stock prices. For example, Barclay and Warner (1993) show that medium size trades disproportionately impact prices. Chakravarty (2001) confirms their finding and shows that the source of such impact is the trades initiated by institutions. Nofsinger and Sias (1999) show that institutional trades can offer clues about the equity returns. Badrinath, Kale and Noe (1995) report that past returns on stocks with the highest level of institutional ownership will be positively correlated with the contemporaneous returns on stocks with lower levels of institutional ownership, even after controlling for firm size. The most intriguing finding in institutional trading that motivates our study is the strong evidence presented by Cai, Kaul, and Zheng (2000) that stocks with heavy institutional buying (selling) experience positive (negative) momentum over the previous 12 months. Also, Chan (2001) finds that underreaction is mainly driven by small stocks with fewer number of individual investors. Building on their results, we try to determine why some
institutions would like to sell shares heavily after stocks experienced negative momentum. Our study may shed light on to what extent institutions are involved in the underreaction by studying institutional investors’ trading behavior.

B. Securities Prices Data

We first obtain all the securities from January 1, 1980 through December 31, 1999 in the Center for Research on Security Prices (CRSP) 2000 database with their permanent numbers and the latest available monthly prices. The securities that had existed for less than 25 months are dropped out of this sample, which leaves 12,448 securities to start with. Next, the average quarterly prices are calculated by averaging the monthly prices, if there are at least two valid monthly prices for the securities. We use the average monthly prices instead of the quarter ending prices to smooth the sudden change in prices at the end of quarters caused by fund managers window-dressing or random fluctuations in prices that may not reflect the earnings growth of the firms as perceived by investors. The average quarterly market capitalization is calculated accordingly. The sample quarterly file consists of those available average prices and market capitalization.

Starting from the first quarter of 1981, we select the securities that experienced a drop in average quarterly prices for the four consecutive quarters. This four-quarter period is the sample period. Selecting four consecutive quarters of negative returns serves several purposes in studying institutional investors’ behavioral biases. First, literature shows that stock prices underreact to news over a period of up to 12 months. Second, the evidence suggests that after stocks experienced negative momentum over a period of 12 months, institutional investors sold

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3 Certain stocks have beginning-date or ending-date within the range the daily CRSP data cover (1962-2000). For example, a stock started trading on December 6, 1972. The fourth quarter of 1972 only has one price available.
the stocks heavily. So it is convenient for us to investigate why some institutions sold their shares earlier while others sold at the end of the four-quarter sample period. Third, there is important new information investors need to update, at least in the first two quarters. Selling in the early quarters is beneficial given the definition of sample period. If there are behavioral biases, it is easier to detect them than in other periods when selling is not necessarily beneficial. Fourth, because the critical information is more consistent and stronger in the sample period, the effects of different behavioral biases, such as conservatism and representativeness, may not cancel each other out in the sample period as easily as in other periods. Fifth, the sample period is long enough to study any impact on the prices caused by the possible biases.

We also choose to study institutions’ trades in stocks with significant negative returns. The first reason is that underreaction occurs when some investors take actions (selling, in this case) early and some other investors (or may be the same investors) continue to take the same actions at a later stage. In the case of buying, however, it is difficult to know why investors who bought stocks later did not buy earlier. It could simply be that they did not notice the stocks earlier, since there are literally thousands of stocks that investors can choose from at any time. So we focus on why some institutional investors sell earlier while others sell later. A second reason that we study negative return underreaction is that underreaction is strongest for bad news (Chan 2001). A third reason is that investors may be loss-averse. Their utility function may be risk-averse when they have gains and risk seeking when they have loss (Kahneman and Tversky, 1979). If so, investors may be reluctant to sell loser stocks. Prior empirical evidence suggests that certain investors are reluctant to sell loser stocks. Odean (1998) studies transaction data of clients of a large discount brokerage and finds strong evidence of overconfidence and disposition biases.
Because of those considerations, we choose our sample period to be the one during which stocks experienced negative returns for four consecutive quarters.

We select securities with at least a $500 million average quarterly market capitalization, as defined above, at the beginning of the sample period. There are 1352 such securities and 3050 observations. This ensures enough presence of institutional investors and enough amount of funds invested in the securities selected, which serves the purpose of the study. As the results in Griffin and Tversky (1992) suggest, conservatism and representativeness are really the two sides of one coin. Underreaction can be all alleviated in the presence of representativeness. Thus, we study the effects of both conservatism and representativeness.

Four-quarter returns range from –3.95% to –99.80%. Only the securities with the returns less than –40% are included in the sample. We choose –40% as a cut-off return to ensure the seriousness of stock price reaction to the new information during the period. This ensures that information updates about these companies are extremely important to the investors. We do not use market or company size adjusted returns as screening criteria because, first, 40% or more loss in paper or otherwise is a big loss no matter what the market was doing. Second, if the markets also suffered the huge loss, investors needed to update the information about the securities they were holding too. Third, although hedging strategies could be used, most 13F institutions are not allowed to or do not short securities and use derivatives. Fourth, since we can use excess returns to compare the performance of securities in the sample, this raw return-screening criterion can give us a wider range of comparisons.

We also exclude ADRs, other Depository Receipts, closed-end funds, REITs, and companies incorporated outside the U.S. This CRSP sample consists of 689 securities and 1204 observations with the returns from –40.36% to –98.28%. The next step is to match the data with
those in ShareWorld. Using the cusip number from CRSP, we search each security one by one on the web-based ShareWorld database. ShareWorld gives multiple cusip numbers and multiple ticker symbols with multiple time periods. We obtain 655 securities that match cusip, ticker, and time periods in both the ShareWorld and CRSP databases.

Among the 655 securities, some had negative returns from quarter to quarter for five or six consecutive quarters. We treat these as one observation. Some had negative returns for four consecutive quarters over two separate periods. If these two separate periods are at least three quarters apart, we treat those as two observations. This method yields 718 observations in the sample. Since 20 observations do not have data in the corresponding quarters in ShareWorld, the final sample has 640 stocks and 698 observations.

C. Firm Characteristics Data

To study conservatism and representativeness, we select some firm characteristics that have salient features or can be used to proxy for costs of investigation. We obtain those firm characteristics data from Standard & Poor’s Compustat (North America) database with Research Insight (April, 1999 version) interface. The data are matched by cusip numbers with both active and inactive securities sets from Compustat. Since there is a lag before some firm characteristics values become available to the public, we select the data at least a year prior to the year the current quarter starts. For firm characteristics with high strength (salient features), first we use the average sales growth over the past three years (GrSALE, as defined in Computat), and second we use the market-to-book ratio (MK/BK). Following the proxies used in the previous empirical studies, we define MK/BK as the ratio of the total assets plus the market value of
equity minus the book value of equity to the book value of total assets. We use book value of total assets as total assets, and this is also used in all the other firm characteristics.

For firm characteristics that proxy for costs of investigation, we chose the R&D expenses as the percentage of sales (RDSALE), the ratio of intangible assets to total assets (INT), and the ratio of property, plant, and equipment to total assets (PPE). In the Compustat database the R&D expenses are not available for banks, utilities, life insurance and property and casualty companies, so we delete the firms with Industry Sector Code (SIC) (obtained from CRSP data) having the first two digits of 49, 60, 61, 62, 63, 64, and 67. Intangible assets and PPE data are not available for some firms either. Thus, in the analysis involved with those proxies, the number of observations is reduced to a maximum set of available data.

Firms with little tangible assets or more intangible assets are more likely to be subject to informational asymmetry. The same can be said about firms with high R&D to expenses or sales ratios. There is, however, a difference between investigating firms with high intangible assets and with high R&D expenses regarding the costs or the complexity. Difficult as it is, it is still not impossible to value intangible assets, such as patents, trademarks, and customer lists, on cross-sectional comparison basis or historical basis. R&D projects, however, have a greater uncertainty than intangible assets. They are the things happening before the existence of corresponding intangible assets. So R&D expenses could be a better proxy for costs or complexity.

In Harris and Raviv’s (1990) model, firms with lower investigation costs will have more debt. So we also include the ratio of long-term debt to total assets (DEBT) as the costs proxy. These firm characteristics variables are then averaged over the two years prior to the year the current quarter starts. Averaging can reduce problems of dramatic changes in value in any given
year. Finally, some variables are calculated for each stock for the current quarter and for each 13F institution within each stock. The definitions of those variables can be found in Appendix A.

III. Research Methods

This section presents research methods to answer five questions. First, is there any PLR? In other words, did 13F institutional investors who held the stock longer sell the shares later, or did investors who held the stock shorter sell the shares earlier, or both? Second, is the PLR, if there is any, unique to the sample period during which stocks experienced negative returns for four consecutive quarters? Third, what factors might affect the selling decisions of different groups of institutional investors. Fourth, what kind of behavioral biases might contribute to that and the PLR? Finally, how are the stock prices affected by different groups of investors?

A. Testing Positive Length Relation

We classify institutional investors into different categories according to how long they have held the stock. We use LENH variable to quantify this. LENH is defined as the number of quarters the institution has held the stock within the prior five quarters disregarding the past holding history before the –6 quarter. We use LENS to measure how long investors took to sell their shares. LENS is defined as the number of quarters from the beginning of sample period it took for the institution to sell all its shares in the stock. If the institution did not sell all its shares within the next five quarters, LENS is set to six.

The first thing to investigate is whether the institutions with different LENH sold the stock differently during the sample period. If there is conservatism, i.e. investors slowly update
their beliefs, then there could be reluctance of selling for all investors, leading to increased LENS. However, as our second hypothesis states, those having held the stock longer may exhibit more severe bias than those who just recently bought the stock because their prior positive beliefs about the stock are stronger. They will sell later resulting in longer LENS than those of other investors. So we first run the following regression for each stock:

$$\log (\text{LENS}) = \alpha_0 + \alpha_1 \text{LENH} + \alpha_2 \text{CSHRS} + \alpha_3 \text{CHNG} + \varepsilon$$

(1)

where CSHRS is the ratio of the number of shares held by an institution to the average number of shares held by all 13F institutions in the stock. CHNG is the geometric average rate of change in the number of shares from the prior LENH-th quarter to this quarter. We expect on average $\alpha_1, \alpha_2,$ and $\alpha_3$ to be significant and positive if there is such bias. Investors with a greater CSHRS own a larger proportion of shares, and may have stronger and a more positive belief about the stock, everything else the same. Investors with higher CHNG purchased their shares in a faster and more dramatic manner. This may lead to a higher LENS because those investors may also have strong positive belief about the stock.

If higher LENH leads to higher LENS and higher LENS is caused mainly by higher LENH, one wants to know whether this Positive Length Relation (PLR) is unique to the sample period or if it is universal across other periods. Because investors who have longer holdings may have longer investment horizons, their holdings are therefore less likely to be subject to short-term setbacks of their stocks’ performance. If this is the case, then it also leads to PLR in equation (1). It also means that the relation in the sample period would also exist in other periods when there is no such consistent negative information for investors to update, and the relation in the sample period may not be stronger than in other periods. On the other hand, if there are
behavioral biases, and the effects of those biases do not cancel out each other, then the PLR is either unique to the sample period or stronger in the sample period.

To test which theory is correct, we run the same regression (1) in 12 other quarters, i.e., six quarters before the first quarter of the sample period and six quarters after that. The results of regression (1) can be affected by investment horizons of different investors. Index fund investors may simply prefer to hold the stock in order to track the performance of the index. But such influence would likely be mild in our sample. U.S. index funds increase to about $317 billion in 2001 from $5 billion in 1990.\(^4\) The market capitalization of stocks in S&P 500 index in mid-1998 was about $8,900 billion (Goetzmann and Massa, 1999). Our sample covers the period from 1980 to 1999, during most of which index funds were not very popular. Furthermore, stocks that do not perform well would eventually be dropped from the index. WorldCom Inc., for example, was dropped from the S&P 500 index in mid-2002.

B. Testing Evidence of Behavioral Biases

The significance of the PLR, however, could be caused by three different reasons. First, more investors who held the stock longer (high LENH) sold later (high LENS). Second, more investors who held the stock shorter (low LENH) sold earlier (low LENS). Third, more investors who held the stock longer (high LENH) sold later (high LENS) and at the same time more investors who held the stock shorter (low LENH) sold earlier (low LENS). Only high LENH with high LENS is consistent with conservatism. By the same token, each proxy could influence the behavior of different investors differently, but still has the same effects on the significance of the PLR. Since investors as a whole could be subject to more than one behavioral bias,

conservatism and representativeness, at the same time, examining the PLR alone makes it difficult for one to distinguish which bias causes the PLR.

To avoid this problem, we examine the effects of each proxy on the selling decisions of a different group of investors. Specifically, we test what could possibly cause certain investors to be more likely to sell all their holdings within certain quarters. We run the regressions as the following:

\[
S_{xHy} = \alpha_0 + \alpha_1 \text{SPRET} + \alpha_2 \text{SP3yr} + \alpha_3 \text{N13F} + \alpha_4 h6n + \alpha_5 h1n + \alpha_6 h2n
+ \alpha_7 \text{GrSALE} + \alpha_8 \text{MK/BK} + \alpha_9 \text{RDSALE} + \alpha_{10} S1H6
+ \alpha_{11} S2H6 + \alpha_{12} S4H6 + \alpha_{13} S6H6 + \varepsilon
\]  

(2)

where \(x = 1, 2, 4, 6; y = 1, 2, 5; \)

\[
S_{xHy} = \alpha_0 + \alpha_1 \text{SPRET} + \alpha_2 \text{SP3yr} + \alpha_3 \text{N13F} + \alpha_4 h6n + \alpha_5 h1n + \alpha_6 h2n
+ \alpha_7 \text{GrSALE} + \alpha_8 \text{MK/BK} + \alpha_9 \text{RDSALE} + \alpha_{10} S1H1
+ \alpha_{11} S2H1 + \alpha_{12} S4H1 + \alpha_{13} S6H1 + \varepsilon
\]

(3)

where \(x = 1, 2, 4, 6; y = 6; \)

The definitions of the variables used in Equations (2) and (3) are listed below as well as in Appendix A:

\text{GrSALE} has a high correlation with \(h6n\) (correlation coefficient is -0.347). To avoid the multicollinearity problem, which may mislead the results of regression analysis, we partition \text{GrSALE} into two parts. One is endogenous and attributable to \(h6n\) in the regression; the other is exogenous and is orthogonal to \(h6n\). We regress \text{GrSALE} on \(h6n\), and use the residuals from the regression as an instrumental variable for \text{GrSALE}. Since the two instrumental variables are orthogonal to each other, the multicollinearity problem disappears in the regression.
Similarly, h6n has a high correlation with h1n and h2n (correlation coefficients are -0.630 and -0.611, respectively) and N13F also has a high correlation with h1n, h2n, and h6n. We regress h6n on h1n and h2n, and use the residuals from the regression as an instrumental variable for h6n. We regress N13F on h1n, h2n, and h6n, and use the residuals from the regression as an instrumental variable for N13F.

The existence of the PLR does not necessarily mean that there exist conservatism or representativeness biases among the institutional investors. There could be some other unknown biases that cause the PLR. To show that investors may have a conservatism bias, we search for four kinds of evidence. First, the evidence that there is new information and investors need to update their beliefs; second, the evidence that new information has high weight but low strength (information is not salient) to them; third, the evidence that during the information updating process, investors under weigh the low strength information and respond slowly to that; fourth, the evidence that the complexity of the information process, or the costs of investigation increases the likelihood of conservatism.

The sample period during which there is important information need to be updated by investors is the first kind of evidence. The information during the sample period must be negative because the average stock prices went down throughout the whole period. The information therefore contradicts institutional investors’ prior beliefs, since investors bought the shares expecting the price to go up. To the investors, the new information has low strength because it does not confirm their beliefs. Psychological studies show that people are confirmatory; they are more likely to seek evidence that confirms their beliefs. To them, this kind of information has high strength. So any information that does not confirm their beliefs has low strength. This is the second kind of evidence of conservatism. The third kind of evidence is
the slow response to this negative information, which is to delay selling their shares. Could the existence of the PLR be the evidence that investors with longer holding history slowly sold all their shares? And therefore did these investors have conservatism bias? Not necessarily. Because the PLR, although it is unique to the sample period, could be caused by simply faster selling of shares by investors with shorter holding history, not necessarily the ones with longer holding history selling late.

To distinguish which scenario or scenarios cause the PLR, we test what could possibly cause certain investors to be more likely to sell all their holdings within certain quarters. In the regression tests of equations (2) and (3), \( S_{xH_y} = \frac{P_{xy}}{Q_{xy}} \). \( P_{xy} \) is the ratio of the number of institutions that have held the stock for \( y \) quarters and sold all their holdings in quarter \( x \) to the total number of institutions that have held the stock for \( y \) quarter(s). \( Q_{xy} \) is the ratio of the number of institutions that sold all their holdings in quarter \( x \) to the total number of 13F institutions. For all \( x > 5 \) and \( y > 5 \), \( x \) and \( y \) are set to 6. A \( S_{1H6} \) greater than 1 means a higher proportion of investors held the stocks for six quarters or more sold all their holdings within one quarter relative to the average proportion of 13F institutions who sold all their holdings within one quarter.

To show that investors have representativeness bias, we search three kinds of evidence. First, the evidence that there is new information and investors need to update their beliefs; second, the evidence that new information has low weight but high strength (information is salient) to them; third, the evidence that during the information updating process, investors overweigh the high strength information and overreact to that. The sample period gives the first kind of evidence. To investors, if the new information is confirming their beliefs, their suspicions, and their doubts, then the information is salient and has high strength, opposite to the low
strength case. Thus, the second kind of evidence is when investors in firms with low market-to-book ratios and low sales growths receive negative information. If they sell too quickly, then there is the third kind of evidence of representativeness, which is the overreaction.

IV. Results

A. Data Description

Summary statistics for aggregated 13F institutions activities in three quarters are presented in Table 1. Since the sample period lasts four quarters, for Panel B, the first quarter LENS is uniquely identified from one to five, one quarter more than the last quarter of sample period. We do not distinguish any LENS longer than five, they are all set to six. So is LENH. For Panel A, the quarter before the first quarter, to cover the last quarter of the sample period, we need to identify LENS uniquely from one to six. So any LENS longer than six is set to seven. Thus, for Panel C. LENS can be uniquely identified from 1 to four. LENH also changes accordingly. Therefore, the means of LENS and LENH naturally decrease from quarter –1 to quarter 2. As expected, the mean of LENT, the total number of quarters since the stock had its 13F first institutions, increases by roughly one quarter from Panel A to C.

The average number of 13F institutions increased slightly from 153.458 to 154.972 from the beginning of quarter –1 to quarter 1, but dropped to 150.012 at the beginning of quarter 2, reflecting the fact that quarter 1 is the first quarter of four consecutive drops in stock prices. This is consistent with previous studies that show institutional trading activities are highly correlated with the stock performance.

Table 2 presents the 13F institutions composition statistics regarding the percentage of institutions that have certain quarters of LENS and LENH for quarters
The percentage of institutions that sold all their shares within one quarter increased from 13.773 to 19.655 in quarter 1, and to 23.747 in quarter 2. Again, this is consistent with previous studies. The percentage of institutions that sold all their shares within three quarters and four quarters dropped from quarter -1 to quarter 1 and continued to drop in quarter 2. The percentage of institutions that did not sell all their shares within four quarters dropped from 49.047 in quarter -1 to 44.619 in quarter 1 and to 45.614 in quarter 2. This shows that more institutions were selling within four quarters once the stock prices drop, but causality is not known in this study. Cai, Kaul, and Zheng (2000) find that returns cause institutional trading, especially purchases, rather than vice versa, suggesting that changes in stock prices affect institutional trading behavior. Nofsinger and Sias’s (1999) finding, on the other hand, suggests that institutional trades can offer clues about the returns.

The percentage of institutions that just bought their shares in the previous quarter, however, is steady from quarter 1 to quarter 2. Since the number of institutions dropped during the same period, the number of institutions that bought shares during the first quarter of the sample period actually increased. The percentage dropped from 14.678 in quarter –1 to 13.177 in quarter 1.

Table 3 presents the percentage of institutions that sold all their shares in different quarters grouped by how long they have held the stock. The percentage of institutions that sold all their shares within one quarter increased for all holding groups. The percentage of institutions that sold all their shares within two or more quarters decreased for most holding groups. It is difficult to see from the table which group experienced increases and decreases larger than others. Evidence presented in the later part of this section will reveal some of that.
Average correlation coefficients between variables for 13F institutions activities in the three quarters are shown in Table 4. The correlation coefficient between LENH and LENS is highest in the quarter 1 (0.252). This suggests that the PLR could be period specific. The correlation coefficient between LENH and CV is also high, but decreased from .380 to .347 and to .306 as the quarter progressed. This suggests that, first, institutions that held the stock longer tended to buy and sell their shares more than institutions with a shorter holding history. Second, as stock prices declined, either institutions that changed their holdings more frequently and held the stock longer tended to sell first, or institutions that changed their holdings less frequently and held the stock shorter tended to sell later, or both. Further tests are needed to confirm the conclusions. Whether those institutions that trade more frequently were momentum traders or they were less subject to conservatism bias also remains to be tested.

**B. Evidence of the Positive Length Relation**

To answer the question of whether higher LENH is correlated to higher LENS, we run regressions of equation (1) for each one of 698 stock observations for quarter 1 and quarter 2, and 697 stock observations for quarter –1. The average coefficients and t-statistics of those regressions are presented in Table 5. It shows that there is Positive Length Relation. For all three quarters, the coefficient of LENH is positive and statistically significant. For quarter 1, the average t-statistics is the highest (2.601). The average coefficients of CSHRS and CHNG are all positive but not significant.

To answer the second question, whether the PLR is unique to the sample period during which stocks experienced four consecutive quarters of negative returns, we run the same regression for an additional 12 quarters, from six quarters before quarter 1 to six quarters after
that. The definitions of LENH and LENS in all the 12 quarters are the same as in quarter 1, that is, for any LENH and LENS greater than five, LENH and LENS are set to six.

The average t-statistics on the coefficient of LENH are presented in Table 6. The PLR is significant in quarters 1, 2, 6, 7, -1, -2, and –3, with that in quarter 1 the highest. Since LENS in quarter –2, -1, and quarter 2 still covers part of the sample period, it is not surprising to see that the average t-statistics could be closer to the t-statistics of quarter 1 than other quarters, and could be significant too. Since there are 698 observations and 640 stocks in the sample, 58 observations are from the same stocks in those 640 stocks. The 58 observations are at least three quarters apart from the 640 observations, but could be covered in the regressions of quarter 6 and 7. That could cause the average t-statistics to increase as high as 2.045 and 2.110 in quarters 6 and 7. But why do the average t-statistics from the regressions in quarter –5 and –6 not increase? It could be that there are some factors other than the sample period factor. They contribute to the significance of the PLR.

The evidence in Tables 6 suggests that the PLR is unique to the sample period during which there is important information need to be updated by investors. The information updating process appears to be different among institutional investors with different stock holding history, specifically, the length of the holding period.

C. Evidence of Behavioral Biases

The results of regressions (2) and (3) are presented in Table 7 through Table 10. In Table 10 column 3, for example, the R&D expenses-to-sales ratio is negatively and statistically significantly related to the S1H6. This suggests that institutional investors that held the stocks for six quarters or more in firms that have higher R&D expenses-to-sales ratios are less likely to sell all their holdings within one quarter relative to the whole 13F institutional investors population.
Also in Table 10, the last column shows that the R&D expenses-to-sales ratio is positively and statistically significantly related to the S6H6. This suggests that institutional investors that held the stocks for six quarters or more in firms that have higher R&D expenses-to-sales ratios are more likely to sell all their holdings within no less than five quarters.

These two results are the third kind evidence of conservatism. This is because institutional investors that held the stocks for six quarters or more in the stocks of high R&D expenses-to-sales ratio firm would delay their selling. This could lead to the PLR. They are also the fourth kind evidence of conservatism. This is because the products of the firms with high R&D expenses-to-sales ratio are more complicated, and it is relatively difficult to judge the potential of such products to generate future cash flows, the investigation costs are high. Therefore, the higher the costs are, the severer the conservatism would be.

The statistically significant results from Table 7 to Table 10 are summarized in Table 11. The first column shows the independent variables in equations (2) and (3). They are grouped into saliency and costs proxies presented in two panels. The second column shows the dependent variables SfHf, SfHm, SmHf, and SmHm, where f = 1 and 2, m = 4, 5, and 6. The third column shows the sign of coefficient of the proxies in the regressions indicating the positive and negative relations between one of the variables in the first (Proxies) column and one of the variables in the second (Relations) column. The names of the relations are labeled in the fourth column. The fifth column identifies the type of behavioral biases whenever one of the relations on the same row is significant. If so, the last (Evidence) column indicates, “Yes”.

For Panel B, if the R&D expenses-to-sales ratio is negatively and statistically significantly related to the SfHf or SfHm, then relations R2 or R4 exist. Recall f = 1 and 2, R2 and R4 suggest that the higher the R&D ratio, the higher the costs of investigation, the less likely
that 13F investors sold their shares in the first and second quarters. Thus, the existence of R2 or R4 indicates the evidence of conservatism. For example, the R&D expenses-to-sales ratio is negatively and statistically significantly related to the S2H1 as shown in Table 7, thus, R2 exists. Therefore the last column shows “Yes” for conservatism. The R&D expenses-to-sales ratio is also negatively and statistically significantly related to S1H6 as shown in Table 10, thus, R4 exists. The last column also shows “Yes” for conservatism. On the other hand, if the R&D expenses-to-sales ratio is positively and statistically significantly related to the SfHf or SfHm, then relations R1 or R3 exist, which means that the higher the costs of investigation, the more likely that 13F investors sold their shares in the first and second quarters. This is not consistent with conservatism. We do not find the significant R1 or R3 relations.

Similarly, if the R&D expenses-to-sales ratio is negatively and statistically significantly related to the SmHf or SmHm, then relations R6 or R8 exist. Recall m = 4, 5, and 6, therefore, R6 and R8 suggest that the higher the R&D ratio, the higher the costs of investigation, the less likely that 13F investors sold their shares in the fourth quarter or longer. Thus, the existence of R6 or R8 does not indicate the evidence of conservatism. On the other hand, if the R&D expenses-to-sales ratio is positively and statistically significantly related to the SmHf or SmHm, then relations R5 or R7 exist, which means that the higher the costs of investigation, the more likely that 13F investors sold their shares in fourth quarter or longer. This is consistent with conservatism. For example, the R&D expenses-to-sales ratio is positively and statistically significantly related to the S6H6 as shown in Table 10, thus, R7 exists. Therefore the last column shows “Yes” for conservatism.

The significance of R2 and R4 relations in Panel A of Table 11 represents the situation when investors in firms with low market-to-book ratios and low sales growths are likely to sell
all their shares in quarter 1 or 2 disregarding how long they held the stock. The significance of R5 and R7 relations shows that they are less likely to hold their share into quarter 6 and beyond. Thus, if there is any significant relation in R2, R4, R5, and R7, then there could be representativeness bias because market-to-book and sales growths are saliency proxies. For example, the market-to-book ratio is positively and statistically significantly related to the S6H1 as shown in Table 7, thus, R5 exists. Therefore the last column shows “Yes” for representativeness. GrSale is positively and statistically significantly related to the S4H6 as shown in Table 10, thus, R7 exists. Therefore the last column shows “Yes” for representativeness. The results suggest that there is evidence of representativeness, but this is weaker than the evidence of conservatism because the t-statistics are smaller than those for conservatism.

IV. Conclusions

The results of this study show that there is a Positive Length Relation. In other words, 13F institutional investors who held the stock longer sold the shares later, while those who held the stock shorter sold the shares earlier. The PLR is significant in the sample period during which stocks experienced negative returns for four consecutive quarters, but with less or no significance in the six quarters before and after the sample period. There is evidence that the PLR is significantly related to behavioral biases among institutional investors. Two behavioral biases, conservatism and representativeness are identified. The results also show that investors that held the stocks for 6 quarters or more are more likely to be subject to conservatism, and that investors that just bought their shares one or two quarters ago, are less likely to be subject to conservatism.
Based on the results of this study and the proxies used in the analysis, additional proxies can be tested to see their usefulness. For instance, institutional investors’ own characteristics can be used as proxies, such as the objective of the investors, compositions of their portfolios, their portfolios’ past performance, and their entry and exit prices of the stocks they trade if the high frequency data are available. Knowing the entry and exit prices is crucial in testing the loss aversion hypothesis among institutional investors.

There are also several possibilities that could further help us understand the behavioral biases and their effects on the prices. One possibility is to measure how long the institutions sold not all, but 50%, or 80% of their holdings. This could be a more accurate way to see the behavioral biases among large shareholders or in a large cap stock, since those shareholders or some shareholders of large cap stock may never sell all of their holdings. The second possibility is to group the institutional investors in a different way. Instead of classifying institutional investors according to how long they held the stock, we can also classify them according to how frequently they traded the stock in the past. The correlation coefficient between LENH and CV averaged over 698 stock observations presented in Table 4 is high, but decreased from .380 to .347 and to .306 as the stock price declines. It suggests that either institutions that change their holdings more frequently and hold the stock longer tend to sell first, or that institutions that change their holdings less frequently and hold the stock shorter tend to sell later, or both. Further studies can be done to see whether those institutions that trade more frequently are momentum traders or if they are less subject to conservatism bias, and whether those institutions that trade less frequently are more likely to have behavioral biases. If so, do those biases affect prices?

Institutional investors can also be classified into mutual funds, investment advisors, and insurance firms, and the behavioral biases among them can be studied. Cai, Kaul, and Zheng
investigate five subgroups of institutional investors and find that mutual funds and investment advisors mainly drive the aggregate return and trading patterns. They also discover some distinct patterns in the trading activities of different types of institutions and the returns of stocks they trade.
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Shane, Philip B. and Peter Brous, 2001, Investor and (value line) analyst underreaction to information about future earnings: the corrective role of non-earnings-surprise information, Working Paper, NBER.

Appendix A

I. For each stock, variables are calculated for the current quarter as follows:

SPRET -- the return of S&P 500 index over the quarter prior to the current one;

SP3yr -- the return of S&P 500 index over three years prior to the current quarter;

N13F -- the number of 13F institutional investors;

hXn -- the percentage of institutions that held the stock for X quarter(s) at the beginning of the sample period.

GrSALE -- the average sales growth over the three years prior to the 1st quarter;

RDSALE -- the R&D expenses as the percentage of sales;

SxHy -- Pxy/Qxy. Pxy is the ratio of the number of institutions that have held the stock for “y” quarters and sold all their holdings in quarter “x” to the total number of institutions that have held the stock for “y” quarter(s). Qxy is the ratio of the number of institutions that sold all their holdings in quarter “x” to the total number of 13F institutions. For all x > 5 and y > 5, x and y are set to 6. Higher SxHy means more investors held the stocks for “y” quarters sold all their holdings in “x” quarters relative to the whole population.

Let Nxy be the number of institutions that have held the stock for “y” quarters and sold all their holdings in quarter “x”. Let Nay be the total number of institutions that have held the stock for “y” quarters. Let Nxa be the total number of institutions that sold all their holdings in quarter “x”. Then Pxy = Nxy/Nay, Qxy = Nxa/N13F, and SxHy = Pxy/Qxy = Nxy/Nay*(Nxa/N13F) = Nxy*N13F/(Nay*Nxa).

-m quarter – the m-th quarter prior to the current quarter.
II. **For each 13F institutional investor within each stock, the variables are calculated as follows:**

LENH -- the number of quarters the institution has held the stock within the prior five quarters disregarding the past holding history before the –6 quarter. If the institution has held the stock for more than five quarters, LENH is set to six. For instance, if the institution bought the stock in –9 quarter, sold all its shares in –6 quarter, and bought again in –5 quarter, then LENH is 5. If it did not sell all its shares in –6 quarter, then LENH is 6.

LENS -- the number of quarters from the beginning of sample period it took for the institution to sell all its shares in the stock. If the institution did not sell all its shares within the next five quarters, LENS is set to six.

LENT -- the total number of quarters since the stock had its first 13F institutions.

SHRS -- the number of shares held by the institution.

CSHRS -- the ratio of the number of shares held by the institution relative to the average number of shares held by all 13F institutions in the stock.

CV -- the coefficient of variance of the number of shares the institution held within the prior LENH quarters.

CHNG -- the geometric average rate of change in the number of shares from the prior LENH-th quarter to the quarter.
**Tables**

Table 1  
Summary statistics for 13F institutions activities

This table presents summary statistics for three quarters of institutional investors activities. LENH is the number of quarters the institution has held the stock. If the institution has held the stock for more than six (five, four) quarters, LENH is equal to seven for Panel A (six for Panel B, five for Panel C). LENS is the number of quarters it took for the institution to sell all its shares in the stock. If the institution did not sell all its shares within the next six (five, four) quarters, LENS is equal to seven for Panel A (six for Panel B, five for Panel C). LENT is the total number of quarters since the stock had its first 13F institution. SHRS is the number of shares held by the institution. CSHRS is 100 times the ratio of SHRS to the average number of shares held by all 13F institutions in the stock. N13F is the number of 13F institutions. CV is the coefficient of variance of the number of shares the institution held within the prior LENH quarters. CHNG is the geometric percentage rate of increase of the number of shares from the prior LENH-th quarter to the quarter. There are 698 stock observations in each panel. There are 76,997, 79,837, and 76,798 13F institutions in Panel A, B, and C.

<table>
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<tr>
<th></th>
<th>Minimum</th>
<th>1st Quart</th>
<th>Mean</th>
<th>Median</th>
<th>3rd Quart</th>
<th>Maximum</th>
<th>Std. dev.</th>
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<tr>
<td><strong>Panel A: One quarter before the first of four consecutive negative-return quarters</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>1</td>
<td>2</td>
<td>4.450</td>
<td>4</td>
<td>7</td>
<td>7</td>
<td>2.313</td>
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<td>6</td>
<td>7</td>
<td>7</td>
<td>2.308</td>
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<tr>
<td>LENT</td>
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<td>37.747</td>
<td>39</td>
<td>53</td>
<td>81</td>
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<tr>
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<td>100</td>
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<td>89.680</td>
<td>7364.597</td>
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<td>251.320</td>
<td>48</td>
<td>190.750</td>
<td>48,745.25</td>
<td>804.63</td>
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<td>431</td>
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<td>43.309</td>
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<td>0</td>
<td>11</td>
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<td>15,873</td>
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</table>

| **Panel B: The first of four consecutive negative-return quarters** |         |           |        |        |           |         |           |
| LENS          | 1       | 2         | 3.798  | 4      | 6         | 6       | 2.035     |
| LENH          | 1       | 3         | 4.411  | 6      | 6         | 6       | 1.920     |
| LENT          | 2       | 17        | 38.467 | 40     | 54        | 82      | 22.680    |
| CSHRS         | 0.001   | 6.578     | 100    | 23.065 | 89.657    | 7542.950| 236.467   |
| SHRS          | 0       | 13.15     | 247.790| 47     | 188.900   | 30,683.99| 767.040   |
| N13F          | 6       | 91        | 154.972| 131    | 204       | 424     | 85.282    |
| CV            | 0       | 2.531     | 34.474 | 19.947 | 51.415    | 244.776 | 40.998    |
| CHNG          | -50     | -2.8      | 105.8  | 0      | 10.6      | 985,007.8| 5,724.1   |

| **Panel C: The second of four consecutive negative-return quarters** |         |           |        |        |           |         |           |
| LENS          | 1       | 2         | 3.370  | 4      | 5         | 5       | 1.690     |
| LENH          | 1       | 3         | 3.904  | 5      | 5         | 5       | 1.506     |
| LENT          | 3       | 18        | 39.348 | 41     | 55        | 83      | 22.704    |
| CSHRS         | 0.001   | 6.727     | 100    | 22.752 | 88.203    | 6,920.47| 236.234   |
| SHRS          | 0       | 14        | 255.32 | 48.200 | 189.700   | 38,759.97| 798.83    |
| N13F          | 9       | 87        | 150.012| 125    | 198       | 415     | 82.843    |
| CV            | 0       | 1.950     | 31.643 | 17.709 | 47.344    | 223.511 | 38.320    |
| CHNG          | -50     | -3        | 108    | 0      | 11        | 1,059,967| 5,194     |
Table 2
Composition statistics about the number of quarters of held and sold.

This table presents 13F institutions composition statistics for three quarters. LENH is the number of quarters the institution has held the stock within the prior five quarters. If the institution has held the stock for more than six (five, four) quarters, LENH is equal to seven for Panel A (six for Panel B, five for Panel C). LENS is the number of quarters it took for the institution to sell all its shares in the stock. If the institution did not sell all its shares within the next six (five, four) quarters, LENS is equal to seven for Panel A (six for Panel B, five for Panel C). Each column for the row “LENS” represents the percentage of 13F institutions that sold all their shares in the corresponding quarter. Each column for the row “LENH” represents the percentage of 13F institutions that have held the stock in the corresponding quarter. There are 698 stock observations in each panel. There are 76,997, 79,837, and 76,798 13F institutions in Panel A, B, and C.

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<th>Quarter</th>
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<th>4</th>
<th>5</th>
<th>6</th>
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<tr>
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<td>7.156</td>
<td>11.799</td>
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<tr>
<td>Panel B: The first of four consecutive negative-return quarters</td>
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<td></td>
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<tr>
<td>LENH</td>
<td>13.177</td>
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<td>7.949</td>
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<td>7.760</td>
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<td>Panel C: The second of four consecutive negative-return quarters</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>
Table 3
Percentage of institutions that sold all their shares in different quarters

This table presents the percentage of institutions that sold all their shares in different quarters grouped by how long they have held the stock. Three panels represent the statistics for three quarters. LENH is the number of quarters the institution has held the stock. If the institution has held the stock for more than six (five, four) quarters, LENH is equal to seven for Panel A (six for Panel B, five for Panel C). LENS is the number of quarters it took for the institution to sell all its shares in the stock. If the institution did not sell all its shares within the next six (five, four) quarters, LENS is equal to seven for Panel A (six for Panel B, five for Panel C). Each column represents the percentage of 13F institutions that held the stock for “LENH=” quarters sold all their shares in the corresponding quarter. There are 698 stock observations in each panel. There are 76,997, 79,837, and 76,798 13F institutions in Panel A, B, and C.

<table>
<thead>
<tr>
<th>Quarter</th>
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<th>4</th>
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<td>20.368</td>
<td>15.670</td>
<td>9.441</td>
<td>5.778</td>
<td>3.663</td>
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</tr>
<tr>
<td>LENH=3</td>
<td>15.475</td>
<td>17.548</td>
<td>16.618</td>
<td>10.108</td>
<td>7.364</td>
<td>5.473</td>
<td>27.413</td>
</tr>
<tr>
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<td>15.263</td>
<td>13.757</td>
<td>15.045</td>
<td>9.927</td>
<td>7.568</td>
<td>5.953</td>
<td>32.486</td>
</tr>
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<td>LENH=6</td>
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<td>11.040</td>
<td>10.820</td>
<td>8.310</td>
<td>6.835</td>
<td>4.931</td>
<td>47.122</td>
</tr>
<tr>
<td>LENH=7</td>
<td>8.563</td>
<td>10.495</td>
<td>13.449</td>
<td>8.319</td>
<td>7.024</td>
<td>5.099</td>
<td>47.052</td>
</tr>
</tbody>
</table>

Panel B: The first of four consecutive negative-return quarters

| LENH=3  | 24.441 | 20.643 | 12.433 | 8.856 | 5.373 | 28.254 |
| LENH=5  | 19.984 | 18.483 | 11.299 | 8.475 | 5.504 | 36.255 |

Panel C: The second of four consecutive negative-return quarters

| LENH=1  | 35.580 | 16.812 | 10.323 | 6.953 | 30.331 |
| LENH=3  | 29.465 | 17.568 | 10.374 | 6.677 | 35.917 |
| LENH=4  | 27.986 | 16.317 | 11.879 | 7.005 | 36.814 |
| LENH=5  | 18.130 | 11.628 | 9.245 | 6.713 | 54.284 |
Table 4
Average correlations between variables for 13F institutions activities

This table shows correlation coefficients averaged over 698 stock observations for three periods. LENH is the number of quarters the institution has held the stock. If the institution has held the stock for more than six (five, four) quarters, LENH is equal to seven for Panel A (six for Panel B, five for Panel C). LENS is the number of quarters it took for the institution to sell all its shares in the stock. If LENS is greater than six (five, four) quarters, LENS is equal to seven for Panel A (six for Panel B, five for Panel C). LENT is the total number of quarters since the stock had its first 13F institution. SHRS is the number of shares held by the institution. CSHRS is 100 times the ratio of SHRS to the average number of shares held by all 13F institutions in the stock. CV is the coefficient of variance of the number of shares the institution held over the prior LENH quarters. CHNG is the geometric percentage rate of increase of the number of shares from the prior LENH-th quarter to the quarter. Standard deviations are in parentheses.

<table>
<thead>
<tr>
<th></th>
<th>LENS</th>
<th>LENH</th>
<th>CSHRS</th>
<th>CV</th>
<th>CHNG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel A: One quarter before the first of four consecutive negative-return quarters</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>LENS</td>
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<td>0.233</td>
<td>0.136</td>
<td>0.007</td>
<td>0.073</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.146)</td>
<td>(0.113)</td>
<td>(0.134)</td>
<td>(0.114)</td>
</tr>
<tr>
<td>LENH</td>
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<td>0.380</td>
<td>0.061</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.117)</td>
<td>(0.160)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CSHRS</td>
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<td></td>
<td>0.141</td>
<td></td>
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<td></td>
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<td>(0.125)</td>
<td>(0.177)</td>
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<tr>
<td>CV</td>
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<td>0.344</td>
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<td></td>
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<td>(0.174)</td>
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</tr>
<tr>
<td>CHNG</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Panel B: The first of four consecutive negative-return quarters</td>
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<td></td>
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<td></td>
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</tr>
<tr>
<td>LENS</td>
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<td>0.011</td>
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<td></td>
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<td>(0.147)</td>
<td>(0.109)</td>
<td>(0.133)</td>
<td>(0.115)</td>
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<tr>
<td>LENH</td>
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<td>0.153</td>
<td>0.347</td>
<td>0.045</td>
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<tr>
<td></td>
<td></td>
<td>(0.111)</td>
<td>(0.146)</td>
<td>(0.117)</td>
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<td>CSHRS</td>
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<td>(0.164)</td>
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<td>CHNG</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Panel C: The second of four consecutive negative-return quarters</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>LENS</td>
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<td>0.007</td>
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<td></td>
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<td>(0.148)</td>
<td>(0.108)</td>
<td>(0.127)</td>
<td>(0.118)</td>
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<tr>
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<td>(0.145)</td>
<td>(0.109)</td>
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<td>CSHRS</td>
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<td></td>
</tr>
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<td></td>
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</table>
Table 5
Average regression estimates using individual stock data for the sample period

This table presents three sets of regression results corresponding to institutions’ selling decisions at three different quarters. The results for the quarter before the sample period are shown in Panel A, those for the 1st and 2nd quarter are in Panel B and C. The sample period is a four-quarter time frame during which stocks had negative returns in each quarter. Quarterly returns are calculated using monthly prices averaged within the quarter. The dependent variable in each panel is the natural log of the number of quarters an institution sold all its shares in the stock (LENS). If LENS is greater than six (five, four), LENS is set to seven for Panel A (six for Panel B, five for Panel C). The independent variables are listed in the first column. LENH is the number of quarters the institution has held the stock. If the institution has held the stock for more than six (five, four) quarters, LENH is equal to seven for Panel A (six for Panel B, five for Panel C). CSHRS is 100 times the ratio of the number of shares held by the institution to the average number of shares held by all 13F institutions in the stock. CHNG is the geometric percentage rate of increase of the number of shares from the prior LENH-th quarter to the quarter. CSHRS and CHNG are divided by 1000. The numbers presented are the estimates averaged over 697 regressions for Panel A and 698 for both Panel B and C. Standard deviations are in parentheses.

<table>
<thead>
<tr>
<th></th>
<th>Panel A: The prior quarter</th>
<th>Panel B: 1st quarter</th>
<th>Panel C: 2nd quarter</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>T-statistics</td>
<td>Coefficient</td>
</tr>
<tr>
<td>Intercept</td>
<td>0.911</td>
<td>5.958</td>
<td>0.701</td>
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<tr>
<td></td>
<td>(0.261)</td>
<td>(2.437)</td>
<td>(0.286)</td>
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<tr>
<td>LENH</td>
<td>0.069</td>
<td>2.305</td>
<td>0.088</td>
</tr>
<tr>
<td></td>
<td>(0.050)</td>
<td>(1.695)</td>
<td>(0.056)</td>
</tr>
<tr>
<td>CSHRS</td>
<td>0.370</td>
<td>1.012</td>
<td>0.327</td>
</tr>
<tr>
<td></td>
<td>(0.714)</td>
<td>(0.936)</td>
<td>(0.763)</td>
</tr>
<tr>
<td>CHNG</td>
<td>0.627</td>
<td>0.451</td>
<td>0.613</td>
</tr>
<tr>
<td></td>
<td>(2.876)</td>
<td>(0.955)</td>
<td>(3.688)</td>
</tr>
<tr>
<td>Adj. R²</td>
<td>0.108</td>
<td>0.117</td>
<td>0.098</td>
</tr>
</tbody>
</table>
Table 6
Average T statistics for the sample period and beyond

This table presents average T statistics for the coefficient of variable LENH over the regressions in the quarters of the sample period and beyond. The sample period is a four-quarter time frame during which stocks had negative returns in each quarter. Quarterly returns are calculated using monthly prices averaged within the quarter. Quarter 1 is the 1st quarter in the period, quarter –1 is one quarter before to the 1st quarter in the sample period, and so forth. The dependent variable in the regressions is the natural log of the number of quarters an institution sold all its shares in the stock (LENS). For any LENS greater than five, LENS is set to six. The independent variables are LENH, CSHRS and CHNG. LENH is the number of quarters the institution has held the stock. If the institution has held the stock for more than five quarters, LENH is set to six. CSHRS is 100 times the ratio of the number of shares held by the institution to the average number of shares held by all 13F institutions in the stock. CHNG is the geometric percentage rate of increase of the number of shares from the prior LENH-th quarter to the quarter. CSHRS and CHNG are divided by 1000. The numbers in the “Mean” row are the T statistics for the coefficient of variable LENH averaged over certain number of regression estimates. The numbers of regressions performed for each quarter are presented in the “Number” row. Panel A presents the results for quarter 1 to 7, and Panel B for quarter –1 to –6.

Panel A:

<table>
<thead>
<tr>
<th>Quarter</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>2.601</td>
<td>2.093</td>
<td>1.892</td>
<td>1.695</td>
<td>1.882</td>
<td>2.045</td>
<td>2.110</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>1.801</td>
<td>1.609</td>
<td>1.504</td>
<td>1.502</td>
<td>1.510</td>
<td>1.594</td>
<td>1.707</td>
</tr>
<tr>
<td>Number</td>
<td>698</td>
<td>698</td>
<td>698</td>
<td>698</td>
<td>698</td>
<td>695</td>
<td>676</td>
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</tbody>
</table>

Panel B:

<table>
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<tr>
<th>Quarter</th>
<th>-1</th>
<th>-2</th>
<th>-3</th>
<th>-4</th>
<th>-5</th>
<th>-6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>2.304</td>
<td>2.118</td>
<td>2.054</td>
<td>1.807</td>
<td>1.612</td>
<td>1.457</td>
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<tr>
<td>Std. Dev.</td>
<td>1.694</td>
<td>1.672</td>
<td>1.612</td>
<td>1.668</td>
<td>1.542</td>
<td>1.560</td>
</tr>
<tr>
<td>Number</td>
<td>697</td>
<td>697</td>
<td>695</td>
<td>694</td>
<td>666</td>
<td>650</td>
</tr>
</tbody>
</table>
Table 7
Regression estimates: institutions that have held the stock for one quarter

This table presents four regressions estimates listed on Panel A to D for 13F institutions that have held the stock for one quarter. $S_xH_y = P_x/y / Q_x/y$. $P_x/y$ is the ratio of the number of institutions that have held the stock for “$y$” quarters sold all their holdings in quarter “$x$” to the total number of institutions that have held the stock for “$y$” quarter(s). $Q_x/y$ is the ratio of the number of institutions sold all their holdings in quarter “$x$” to $N_{13F}$. $N_{13F}$ is the total number of 13F institutions at the beginning of the quarter. For all $x > 5$ and $y > 5$, $x$ and $y$ are set to 6. The dependent variables are $S_{1H1}$, $S_{2H1}$, $S_{4H1}$, and $S_{6H1}$ for Panel A to D. The independent variables are listed in the first column. “$hXn$” is the percentage of institutions that held the stock for $X$ quarter(s) at the beginning of the sample period. SPRET is the return of S&P 500 index a quarter prior to the 1st quarter. SP3yr is the S&P 500’s return over three years prior to the 1st quarter. GrSALE is the average sales growth over the three years prior to the year the 1st quarter starts. MK/BK is the market-to-book ratio defined as the ratio of the book value of total assets plus the market value of equity minus the book value of equity to the book value of total assets. RDSALE is the R&D expenses as the percentage of sales. MK/BK and RDSALE are averaged over the two years prior to the year the 1st quarter starts. First, GrSALE is regressed on $h6n$, $h6n$ on $h1$, and $h2$, and $N_{13F}$ on $h1n$, $h2n$, and $h6n$. Then, the residuals from these regressions are used in the four regressions in the table. There are 517 observations in Panel A, B, D and 498 in Panel C.

<table>
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<tr>
<th></th>
<th>Panel A: S1H1</th>
<th></th>
<th>Panel B: S2H1</th>
<th></th>
<th>Panel C: S4H1</th>
<th></th>
<th>Panel D: S6H1</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>268.975</td>
<td>18.472</td>
<td>205.800</td>
<td>13.388</td>
<td>139.524</td>
<td>8.062</td>
<td>83.655</td>
<td>13.150</td>
</tr>
<tr>
<td>SPRET</td>
<td>1.982</td>
<td>2.015</td>
<td>-1.825</td>
<td>-1.686</td>
<td>-3.043</td>
<td>-2.307</td>
<td>-0.413</td>
<td>-1.044</td>
</tr>
<tr>
<td>SP3yr</td>
<td>0.190</td>
<td>1.337</td>
<td>0.310</td>
<td>1.991</td>
<td>0.288</td>
<td>1.506</td>
<td>-0.193</td>
<td>-3.382</td>
</tr>
<tr>
<td>N13F</td>
<td>0.057</td>
<td>0.882</td>
<td>-0.054</td>
<td>-0.756</td>
<td>-0.037</td>
<td>-0.421</td>
<td>0.025</td>
<td>0.958</td>
</tr>
<tr>
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<td>2.464</td>
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<td>-1.384</td>
</tr>
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<td>-0.796</td>
<td>-1.866</td>
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<td>-1.229</td>
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<td>3.879</td>
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<tr>
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<td>-0.646</td>
<td>-1.659</td>
<td>-0.649</td>
<td>-1.362</td>
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<td>-0.049</td>
<td>-0.408</td>
<td>-0.055</td>
<td>-2.612</td>
</tr>
<tr>
<td>MK/BK</td>
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<td>-0.702</td>
<td>-0.372</td>
<td>3.477</td>
<td>1.503</td>
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<td>2.087</td>
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<td>-4.316</td>
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<td>-0.270</td>
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<td>-64.963</td>
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<td>-6.839</td>
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<td>-6.450</td>
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<tr>
<td>Adj. $R^2$</td>
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Table 8  
Regression estimates: institutions that have held the stock for two quarters

This table presents four regression estimates listed on Panel A to D for 13F institutions that have held the stock for one quarter. $S_{xHy} = P_{xy}/Q_{xy}$. $P_{xy}$ is the ratio of the number of institutions that have held the stock for “$y$” quarters sold all their holdings in quarter “$x$” to the total number of institutions that have held the stock for “$y$” quarter(s). $Q_{xy}$ is the ratio of the number of institutions sold all their holdings in quarter “$x$” to $N_{13F}$. $N_{13F}$ is the total number of 13F institutions at the beginning of the quarter. For all $x > 5$ and $y > 5$, $x$ and $y$ are set to 6. The dependent variables are $S_{1H2}$, $S_{2H2}$, $S_{4H2}$, and $S_{6H2}$ for Panel A to D. The independent variables are listed in the first column. “hXn” is the percentage of institutions that held the stock for X quarter(s) at the beginning of the sample period. SPRET is the return of S&P 500 index a quarter prior to the 1st quarter. SP3yr is the S&P 500’s return over three years prior to the 1st quarter. GrSALE is the average sales growth over the three years prior to the year the 1st quarter starts. MK/BK is the market-to-book ratio defined as the ratio of the book value of total assets plus the market value of equity minus the book value of equity to the book value of total assets. RDSALE is the R&D expenses as the percentage of sales. MK/BK and RDSALE are averaged over the two years prior to the year the 1st quarter starts. First, GrSALE is regressed on $h6n$, $h6n$ on $h1$, and $h2$, and $N_{13F}$ on $h1n$, $h2n$, and $h6n$. Then, the residuals from these regressions are used in the four regressions in the table. There are 517 observations in Panel A, B, D and 498 in Panel C.

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<th>Panel A: S1H2</th>
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<th>Panel B: S2H2</th>
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<th>Panel C: S4H2</th>
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<th>Panel D: S6H2</th>
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</thead>
<tbody>
<tr>
<td>SPRET</td>
<td>1.904</td>
<td>1.759</td>
<td>-1.295</td>
<td>-1.057</td>
<td>1.163</td>
<td>0.759</td>
<td>-0.610</td>
<td>-1.019</td>
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<tr>
<td>SP3yr</td>
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<td>-1.074</td>
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<td>1.510</td>
<td>0.076</td>
<td>0.344</td>
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<td>-2.485</td>
</tr>
<tr>
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<td>0.016</td>
<td>0.197</td>
<td>0.070</td>
<td>0.694</td>
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</tr>
<tr>
<td>h6n</td>
<td>0.713</td>
<td>1.864</td>
<td>0.763</td>
<td>1.769</td>
<td>-0.556</td>
<td>-1.014</td>
<td>-0.312</td>
<td>-1.484</td>
</tr>
<tr>
<td>h1n</td>
<td>-2.417</td>
<td>-5.606</td>
<td>-0.206</td>
<td>-0.426</td>
<td>0.945</td>
<td>1.551</td>
<td>0.831</td>
<td>3.460</td>
</tr>
<tr>
<td>h2n</td>
<td>-1.006</td>
<td>-2.589</td>
<td>-0.995</td>
<td>-2.260</td>
<td>0.052</td>
<td>0.094</td>
<td>0.707</td>
<td>3.273</td>
</tr>
<tr>
<td>GrSALE</td>
<td>0.002</td>
<td>0.039</td>
<td>0.086</td>
<td>1.328</td>
<td>0.142</td>
<td>1.017</td>
<td>0.036</td>
<td>1.120</td>
</tr>
<tr>
<td>MK/BK</td>
<td>-0.056</td>
<td>-0.029</td>
<td>1.468</td>
<td>0.687</td>
<td>-4.134</td>
<td>-1.539</td>
<td>-0.764</td>
<td>-0.734</td>
</tr>
<tr>
<td>RDSALE</td>
<td>-0.667</td>
<td>-0.304</td>
<td>-0.802</td>
<td>-0.329</td>
<td>1.847</td>
<td>0.588</td>
<td>0.861</td>
<td>0.720</td>
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<tr>
<td>S2H6</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>S4H6</td>
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<td>S6H6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adj. $R^2$</td>
<td>0.116</td>
<td>0.049</td>
<td>0.068</td>
<td>0.165</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Table 9
Regression estimates: institutions that have held the stock for five quarters

This table presents four regression estimates listed on Panel A to D for 13F institutions that have held the stock for one quarter. $SxHy = \frac{Pxy}{Qxy}$. $Pxy$ is the ratio of the number of institutions that have held the stock for “y” quarters sold all their holdings in quarter “x” to the total number of institutions that have held the stock for “y” quarter(s). $Qxy$ is the ratio of the number of institutions sold all their holdings in quarter “x” to N13F. N13F is the total number of 13F institutions at the beginning of the quarter. For all $x > 5$ and $y > 5$, $x$ and $y$ are set to 6. The dependent variables are $S1H5$, $S2H5$, $S4H5$, and $S6H5$ for Panel A to D. The independent variables are listed in the first column. “hXn” is the percentage of institutions that held the stock for X quarter(s) at the beginning of the sample period. SPRET is the return of S&P 500 index a quarter prior to the 1st quarter. SP3yr is the S&P 500’s return over three years prior to the 1st quarter. GrSALE is the average sales growth over the three years prior to the year the 1st quarter starts. MK/BK is the market-to-book ratio defined as the ratio of the book value of total assets plus the market value of equity minus the book value of equity to the book value of total assets. RDSALE is the R&D expenses as the percentage of sales. MK/BK and RDSALE are averaged over the two years prior to the year the 1st quarter starts. First, GrSALE is regressed on $h6n$, $h6n$ on $h1$, and $h2$, and N13F on $h1n$, $h2n$, and $h6n$. Then, the residuals from these regressions are used in the four regressions in the table. There are 505 observations in Panel A, B, D and 487 in Panel C.

<table>
<thead>
<tr>
<th></th>
<th>Panel A: S1H5</th>
<th>Panel B: S2H5</th>
<th>Panel C: S4H5</th>
<th>Panel D: S6H5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>175.541</td>
<td>133.154</td>
<td>132.270</td>
<td>87.067</td>
</tr>
<tr>
<td></td>
<td>12.112</td>
<td>7.089</td>
<td>4.835</td>
<td>6.004</td>
</tr>
<tr>
<td>SPRET</td>
<td>-2.489</td>
<td>-0.752</td>
<td>-1.085</td>
<td>-1.406</td>
</tr>
<tr>
<td></td>
<td>-2.628</td>
<td>0.569</td>
<td>-0.519</td>
<td>1.174</td>
</tr>
<tr>
<td>SP3yr</td>
<td>-0.031</td>
<td>0.218</td>
<td>0.353</td>
<td>-0.793</td>
</tr>
<tr>
<td></td>
<td>-0.227</td>
<td>1.157</td>
<td>1.174</td>
<td>-1.036</td>
</tr>
<tr>
<td>N13F</td>
<td>0.096</td>
<td>0.148</td>
<td>0.070</td>
<td>-0.387</td>
</tr>
<tr>
<td></td>
<td>1.532</td>
<td>1.712</td>
<td>0.510</td>
<td>-0.519</td>
</tr>
<tr>
<td>h6n</td>
<td>1.013</td>
<td>0.950</td>
<td>-0.793</td>
<td>1.649</td>
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<td>2.945</td>
<td>1.997</td>
<td>-1.036</td>
<td>5.164</td>
</tr>
<tr>
<td>h1n</td>
<td>-1.414</td>
<td>-0.861</td>
<td>1.174</td>
<td>0.746</td>
</tr>
<tr>
<td></td>
<td>-3.572</td>
<td>-1.576</td>
<td>1.357</td>
<td>1.998</td>
</tr>
<tr>
<td>h2n</td>
<td>-1.406</td>
<td>-0.788</td>
<td>-0.387</td>
<td>1.649</td>
</tr>
<tr>
<td></td>
<td>-4.177</td>
<td>-1.674</td>
<td>-0.519</td>
<td>5.164</td>
</tr>
<tr>
<td>GrSALE</td>
<td>0.074</td>
<td>-0.069</td>
<td>-0.010</td>
<td>0.074</td>
</tr>
<tr>
<td></td>
<td>1.494</td>
<td>-0.994</td>
<td>-0.054</td>
<td>1.998</td>
</tr>
<tr>
<td>MK/BK</td>
<td>0.432</td>
<td>0.358</td>
<td>-6.081</td>
<td>1.548</td>
</tr>
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<td></td>
<td>0.258</td>
<td>0.155</td>
<td>-1.651</td>
<td>0.992</td>
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<tr>
<td>RDSALE</td>
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<td>-0.205</td>
<td>4.744</td>
<td>-0.623</td>
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<td></td>
<td>-0.205</td>
<td>1.183</td>
<td>1.113</td>
<td>-0.351</td>
</tr>
<tr>
<td>S1H6</td>
<td>-46.097</td>
<td>-3.208</td>
<td>-44.123</td>
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</tr>
<tr>
<td></td>
<td>-3.126</td>
<td>-3.208</td>
<td>-3.721</td>
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</tr>
<tr>
<td>S2H6</td>
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<td>-12.373</td>
<td>-12.373</td>
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</tr>
<tr>
<td>S4H6</td>
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<td>-0.40</td>
<td>-1.239</td>
<td></td>
</tr>
<tr>
<td>S6H6</td>
<td>0.124</td>
<td>0.056</td>
<td>0.097</td>
<td></td>
</tr>
<tr>
<td>Adj. $R^2$</td>
<td>0.124</td>
<td>0.056</td>
<td>0.040</td>
<td>0.097</td>
</tr>
</tbody>
</table>
Table 10
Regression estimates: institutions that have held the stock for more than five quarters

This table presents four regression estimates listed on Panel A to D for 13F institutions that have held the stock for one quarter. $S_{x/y} = P_{x/y} / Q_{x/y}$. $P_{x/y}$ is the ratio of the number of institutions that have held the stock for “$y$” quarters sold all their holdings in quarter “$x$” to the total number of institutions that have held the stock for “$y$” quarter(s). $Q_{x/y}$ is the ratio of the number of institutions sold all their holdings in quarter “$x$” to $N_{13F}$. $N_{13F}$ is the total number of 13F institutions at the beginning of the quarter. For all $x > 5$ and $y > 5$, $x$ and $y$ are set to 6. The dependent variables are $S_{1H6}$, $S_{2H6}$, $S_{4H6}$, and $S_{6H6}$ for Panel A to D. The independent variables are listed in the first column. “$h_{Xn}$” is the percentage of institutions that held the stock for $X$ quarter(s) at the beginning of the sample period. SPRET is the return of S&P 500 index a quarter prior to the 1st quarter. SP3yr is the S&P 500’s return over three years prior to the 1st quarter. GrSALE is the average sales growth over the three years prior to the year the 1st quarter starts. MK/BK is the market-to-book ratio defined as the ratio of the book value of total assets plus the market value of equity minus the book value of equity to the book value of total assets. RDSALE is the R&D expenses as the percentage of sales. MK/BK and RDSALE are averaged over the two years prior to the year the 1st quarter starts. Then, the residuals from these regressions are used in the four regressions in the table. There are 505 observations in Panel A, B, D and 487 in Panel C.

<table>
<thead>
<tr>
<th></th>
<th>Panel A: S1H6</th>
<th>Panel B: S2H6</th>
<th>Panel C: S4H6</th>
<th>Panel D: S6H6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>99.504</td>
<td>109.253</td>
<td>114.389</td>
<td>115.199</td>
</tr>
<tr>
<td>SPRET</td>
<td>0.269</td>
<td>0.540</td>
<td>-0.012</td>
<td>-1.048</td>
</tr>
<tr>
<td>SP3yr</td>
<td>-0.065</td>
<td>-0.020</td>
<td>-0.036</td>
<td>0.036</td>
</tr>
<tr>
<td>N13F</td>
<td>-0.006</td>
<td>-0.020</td>
<td>-0.036</td>
<td>-0.079</td>
</tr>
<tr>
<td>h6n</td>
<td>0.244</td>
<td>0.160</td>
<td>-0.365</td>
<td>0.543</td>
</tr>
<tr>
<td>h1n</td>
<td>-0.760</td>
<td>-0.445</td>
<td>-0.068</td>
<td>0.915</td>
</tr>
<tr>
<td>h2n</td>
<td>-0.047</td>
<td>-0.442</td>
<td>-0.079</td>
<td>0.543</td>
</tr>
<tr>
<td>GrSALE</td>
<td>0.037</td>
<td>-0.035</td>
<td>0.144</td>
<td>-0.107</td>
</tr>
<tr>
<td>MK/BK</td>
<td>1.465</td>
<td>0.859</td>
<td>-1.388</td>
<td>-0.239</td>
</tr>
<tr>
<td>RDSALE</td>
<td>-3.188</td>
<td>-1.482</td>
<td>1.832</td>
<td>2.287</td>
</tr>
<tr>
<td>S1H1</td>
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<td>-13.024</td>
<td>-14.034</td>
<td>-27.151</td>
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<td>-5.475</td>
<td>-6.450</td>
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<tr>
<td>S4H1</td>
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<td>-1.482</td>
<td>1.164</td>
<td>0.221</td>
</tr>
<tr>
<td>S6H1</td>
<td>-27.151</td>
<td>-1.388</td>
<td>2.287</td>
<td>0.221</td>
</tr>
<tr>
<td>Adj. $R^2$</td>
<td>0.145</td>
<td>0.112</td>
<td>0.078</td>
<td>0.221</td>
</tr>
</tbody>
</table>

505 observations in Panel A, B, D and 487 in Panel C.
Table 11
Evidence of behavioral biases

This table presents evidence that identifies conservatism and representativeness among institutional investors. The first column shows the independent variables in equations (2) and (3). They are grouped into saliency and costs proxies presented in two panels. The second column shows the dependent variables $S_fH_f$, $S_fH_m$, $S_mH_f$, and $S_mH_m$, where $f = 1$ and $2$, $m = 4$, 5, and 6. $S_{xHy} = P_{xy}/Q_{xy}$. $P_{xy}$ is the ratio of the number of institutions that have held the stock for “$y$” quarters sold all their holdings in quarter “$x$” to the total number of institutions that have held the stock for “$y$” quarter(s). $Q_{xy}$ is the ratio of the number of institutions sold all their holdings in quarter “$x$” to the total number of 13F institutions. For all $x > 5$ and $y > 5$, $x$ and $y$ are set to 6. Definitions of the variables in the 1st column are shown in Table 6. The third column shows the sign of coefficient of the proxies in the regressions indicating the positive and negative relations between one of the variables in the first (Proxies) column and one of the variables in the second (Relations) column. The names of the relations are labeled in the fourth (ID) column. The fifth column identifies the type of behavioral biases whenever one of the relations on the same row is significant. If so, the last (Evidence) column indicates, “Yes”.

<table>
<thead>
<tr>
<th>Proxies</th>
<th>Relations</th>
<th>Sign $\alpha_i$</th>
<th>ID</th>
<th>Biases</th>
<th>Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Panel A: Saliency Proxies</strong></td>
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<tr>
<td>GrSALE, MK/BK,</td>
<td>$S_fH_f$</td>
<td>+</td>
<td>R1</td>
<td>representativeness</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>-</td>
<td>R2</td>
<td>representativeness</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$S_fH_m$</td>
<td>+</td>
<td>R3</td>
<td>representativeness</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>-</td>
<td>R4</td>
<td>representativeness</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$S_mH_f$</td>
<td>+</td>
<td>R5</td>
<td>representativeness</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>-</td>
<td>R6</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$S_mH_m$</td>
<td>+</td>
<td>R7</td>
<td>representativeness</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-</td>
<td>R8</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Panel B: Investigation Costs Proxies</strong></td>
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</tr>
<tr>
<td>RDSALE, INT</td>
<td>$S_fH_f$</td>
<td>+</td>
<td>R1</td>
<td>Conservatism</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-</td>
<td>R2</td>
<td>Conservatism</td>
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</tr>
<tr>
<td></td>
<td>$S_fH_m$</td>
<td>+</td>
<td>R3</td>
<td>Conservatism</td>
<td></td>
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<tr>
<td></td>
<td></td>
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<td></td>
<td>$S_mH_f$</td>
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<td>R5</td>
<td>Conservatism</td>
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<tr>
<td></td>
<td></td>
<td>-</td>
<td>R6</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>$S_mH_m$</td>
<td>+</td>
<td>R7</td>
<td>Conservatism</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-</td>
<td>R8</td>
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</tbody>
</table>
Essay 2: The relation between the asset liquidity and the trading liquidity: An empirical investigation

I. Introduction

There are two kinds of liquidity in financial literature: liquidity of firms’ assets and liquidity of stocks’ trading. Each kind of liquidity has been widely explored both theoretically and empirically. Early works on the former area can be found in Jensen and Meckling (1976) and Myers (1977). Early works on the latter area can be found in Garman (1976), Ho (1981), Stoll (1978), and Cohen, Maier, Schwartz, and Whitcomb (1981). However, the interaction between the two has not been previously studied.

We attempt to investigate empirically the relation between the two kinds of liquidity in three major ways. First, we analyze empirical relations between the three measures of trading liquidity and several firm characteristics including the asset’ liquidity measures, which were previously uninvestigated. Second, we attempt to provide empirical results that may suggest directions for future theoretical and empirical research, which could bridge the gap between the two separate liquidity areas. Third, we use a larger number of firms than that in most previous trading liquidity studies.

The theoretical linkage between the two liquidities is not obvious at a first glance, the concept of information asymmetry, however, links the two liquidities. Less liquidity of firms’ assets lead to less asset transformation by the managers. Less asset transformation problems lead to less information asymmetry, which leads to high trading liquidity. Figure 1 shows the linkage
and the related literature. The first part of the Figure 1 shows the linkage between the asset liquidity and the information asymmetry.

**Figure 1. The linkage between asset liquidity and trading liquidity**
It is more difficult for the managers of firms with less liquid assets to transform their assets (Ourers and Rajan 1999), so the less severe the problems of assets substitution (Jensen and Meckling 1976) and entrenching investment (Hart 1995, Shleifer and Vishny 1989) for those firms. Thus, if the firms are not in the process of liquidation, in which case investors would prefer more liquid assets, less liquid assets of firms will lead to lower agency costs to the investors. Lower agency costs to shareholders means more dividends pay out and/or more capital gains. In either way, most shareholders have to buy stocks at markets, and in realizing capital gains shareholders have to sell their stocks in the markets. In other words, the benefit of lower agency costs must be realized through trading and then the benefits are passed on to the shareholders. High trading liquidity can certainly help shareholders materialize more of the benefits of their low agency costs. Less severe problems of assets substitution and entrenching investment along with low agency costs may also mean less information asymmetry between inside managers and outside investors.

The second part of the Figure 1 shows the linkage between the information asymmetry and trading liquidity. The market microstructure literature shows that the stocks trading liquidity is a function of three cost components corresponding to the risks the market-makers are facing: order processing, inventory holding, and adverse selection costs. Order processing costs are the market-maker's fixed costs such as clearing and settlement costs. The inventory holding cost is the market-maker's cost of holding inventories. The adverse selection cost is related to the information asymmetry because an uninformed market-maker will increase the spread to compensate for the risk of losing to informed traders (Kavajecz (1999), Brennan and Tamarowski (2000), Glosten and Harris (1988), Glosten and Harris, 1988). Less information asymmetry will lead to more uninformed traders trading the firms’ stocks. According to previous
theoretical and empirical studies (Glosten and Milgrom 1985, Lee et al. 1993, and Greene and Smart 1999), market makers narrow (or widen) their spread due to reduced (or increased) adverse selection risk. Their adverse selection risk is reduced when more uninformed traders are trading stocks with them. In additional to the well documented evidence of the positive relation between adverse selection cost and bid-ask spreads, Brockman and Chung (1999) and Heflin and Shaw (2001) present evidence of the inverse relation between adverse selection cost and depths.

The results of this study show that for all the firms in the sample, the more the illiquid assets, such as fixed assets in proportion to the book value of total assets, the higher the measures of trading liquidity of their stocks. The more the liquid assets, such as cash, short investment and inventory in proportion to the book value of total assets, the lower the measures of trading liquidity their stocks have. In other words, low asset liquidity is related to high trading liquidity. Since the liquidity of firms’ assets is a proxy for assets substitution problems, the results suggest that investors may enjoy trading high liquidity stocks if the firms have less potential assets substitution problems. However, in terms of the relation between another proxy for assets substitution problems, market-to-book ratio, and the measures of trading liquidity, the results are mixed. This may suggest that market-to-book ratio be less accurate than asset liquidity to indicate the assets substitution problems.

The results also show that for financial and banking firms in the trading sample period from February 1996 to May 1999, there is no consistent statistically significant relation between firms’ asset liquidity and their stocks’ trading liquidity. Although this could suggest that the liquidity of banks’ assets might not be manifested in their stocks’ trading as that of other firms is, we do not have evidence for that. So the results may suggest that an increase in banks asset liquidity does not necessarily lead to increased or decreased liquid of banks’ stocks. On the other
hand, loans are major illiquid assets in banks as well as in savings and loan companies. The fixed assets ratio is not an accurate proxy for those firms’ illiquid assets. The fact that the relations between fixed assets ratio and trading liquidity proxies are not significant makes sense for financial firms. The remainder of the paper is organized as follows. Section II reviews the assets and trading liquidity literature. Section III describes the data and empirical methods. The results are presented in Section IV. Section V discusses the implications of our findings and concludes.

II. Assets and Trading Liquidity

Asset liquidity refers to the speed and easiness with which assets can be traded. Asset liquidity has two sides (Myers and Rajan 1999). On the one side, the illiquid assets can limit a firm’s ability to seek or retain outside financing. Facing the risk of default, lenders value illiquid assets than highly liquid assets (See Myers (1977), Diamond (1991), Diamond (1993a), Diamond (1993b), Hart and Moore (1994), Hart (1995), Diamond and Rajan (1998), and Myers and Rajan (1999)). Illiquid assets can become even more illiquid when a firm is facing financial problems under unfavorable economic conditions. It is very likely that other firms in its industry may not be doing well simply because of the bad market conditions. Thus, more firms need to sell similar assets, which leads to assets being traded at prices below their value in best use (Shleifer and Vishny 1992). Clearly, lenders prefer liquid assets in a borrowing firm.

On the other side of liquidity, however, highly liquid assets give managers greater flexibility to take or transform the assets for their own benefits (Hart 1995, Myers and Rajan 1999). The actions of asset transformation include assets substitution (Jensen and Meckling
1976), underinvestment (Myers 1977) and entrenching investment (Hart 1995, Shleifer and Vishny 1989). In the first case, managers substitute riskier assets for less risky ones, therefore shifting value from debt holders to equity holders. In the second case, managers avoid taking risky and positive net present value projects to entrench themselves. In the last case, managers substitute general-use assets for manager-specific ones, therefore the assets are less valuable to the outside lenders than to the managers of a firm after liquidation.

Myers and Rajan (1999) study the interactions of both sides of asset liquidity. Their model suggests that the liquidity of firms’ assets is pivotal to the potential conflict between the managers and the lenders over property rights. For a firm with overly liquid assets, it is to the firm’s advantage to undertake less liquid projects rather than to borrow funds directly from investors for those less liquid projects. Increased liquidity of the assets of an overly liquid firm would lead to its increased ability to finance less liquid projects. Myers and Rajan (1999) apply their model to financial intermediations, which hold illiquid loans and liquid assets at the same time. They argue that because banks have to hold liquid assets to meet the liquid demands of depositors (Diamond and Rajan 1998), banks have a natural advantage in undertaking less liquid projects. In lending to the projects, Diamond (1984) argues that banks have an advantage in reducing an additional layer of agency costs. Because the cost of monitoring would be higher if investors directly lend money to borrowers, banks can reduce the costs of monitoring. Banks know more about their borrowers than other banks who do not have lending business do (Fama 1985). Their superior information can verify the credit worthiness of the borrowers and reduce the monitoring costs by creating the reputation of borrowers (Sharpe 1990). Banks can serve as a buffer so that the liquidity demand of investors would not affect the borrowers (Diamond and Rajan 1998).
Like asset liquidity, trading liquidity can have two aspects: the speed of trading and the cost of such trading (or the value after the trading). Early works of Garman (1976), Amihud and Mendelson (1980), Kyle (1985), and Glosten and Milgrom (1985) model a market maker’s behavior. They show how a market maker can use the bid-ask spread to manage inventory risk and to reduce the adverse selection problem.

In those models, bid-ask spread is a measure of liquidity. In Amihud and Mendelson's (1980) model, supply and demand are determined by a price-dependent Poisson process. They show that bid-ask prices depend on the market maker's stock inventory position. An optimal pricing policy leads to the existence of a "preferred" inventory position. It is also shown that it is impossible to profit by trading against the monopolistic market maker. In Kyle's (1985) model, liquidity is measured by the order flow needed to move prices one unit. In this sense, bid-ask spread can be used as a proxy for liquidity. See also O'Hara (1997), which gives a detailed review on liquidity. In Glosten and Milgrom's (1985) model, the market maker is risk-neutral and earns zero expected profits. A bid-ask spread exists because the market maker has to trade with informed traders who have superior information, so she can use expected profits earned from trading with uninformed traders to offset expected losses resulting from trading with informed traders.

Empirical investigations support such theoretical predictions. Lee, Mucklow, and Ready (1993) find that bid-ask spreads widen and depths fall surrounding earnings announcements. Those effects are accompanied by higher volume and are more significant for announcements with larger subsequent price changes. Lee et al. (1993) argue that market makers widen spreads and reduce depths to reduce information asymmetry risk when they are trading with more informed traders during earnings announcements periods. The opposite events are the times
when there is more uninformed (noise) trading and less informed trading. Greene and Smart (1999) regard the publication of the Wall Street Journal Investment Dartboard column as such events. They find the statistically narrowing in bid-ask spreads in three of 26 half-hour trading intervals surrounding such publication events. The largest reduction in spreads occurs in the morning of those publication days. They also find a decrease in the adverse selection component of the bid-ask spread. Greene and Smart (1999) interpret such increase in liquidity due to the possible reason that market makers were trading with more noise traders so that their adverse selection risks were reduced. Those results are consistent with Glosten and Milgrom's (1985) model.

On the other aspect of trading liquidity, the model of Grossman et al. (1988) focuses on the price of immediacy. The price rises due to the supply and demand of trading immediately or trading later. Market makers supply the immediacy. They adjust their immediacy supply depending in part on their willingness to take risk. This adjustment determines the level of liquidity.

Based on those theoretical models, empirical studies such as Corwin (1999), Greene and Smart (1999), Hasbrouck and Sofianos (1993), Madhavan and Smidt (1993), and Madhavan et al. (1997) use a few common proxies, such as quoted bid-ask spread, depth, and percentage of price improved trades, to measure the trading liquidity of stocks. The next section describes these proxies.

### III. Data and Empirical Methods

There are two data sets used in this study. The final samples are the matched data between the two. One is Standard & Poor’s Compustat (North America) database with Research Insight
interface. The other is the Trade and Quote (TAQ) database. We first obtain 10,092 of all the active U.S. companies in 1998 from the first one.

Following the proxies used in the previous empirical studies (Detragrache 1994, Houston and James 1996, Johnson 1997, and Esty 1998), we use book value of total assets as total assets. We use ratio of property, plant, and equipment to total assets (fixed assets ratio) as one proxy for asset liquidity. We also use the ratio of intangible assets to total assets as another proxy for liquidity. The third proxy for liquidity we use in the study is the market-to-book ratio. Johnson (1997) suggests that firms with higher market-to-book ratios correspond to lower liquidation values of the firms’ assets. Following Johnson (1997) we define the market-to-book ratio as the ratio of the book value of total assets plus the market value of equity minus the book value of equity to the book value of total assets.

For the firm characteristics we also use cash-to-total assets ratio, short-term investments-to-total assets ratio, and inventory-to-total assets ratio. We define cash ratio as cash divided by cash equivalent, short-term investments ratio as short-term investments divided by cash equivalent. Cash equivalent is equal to cash plus short-term investments. The reason we use cash ratio and short-term investments ratio is that the market-to-book ratio has a high correlation with cash-to-total assets ratio and short-term investments-to-total assets ratio (correlation coefficient are 0.488 and 0.188 respectively with p-value = 0), but low correlation (correlation coefficient are 0.040 and -0.034 respectively with p-value = 0) with cash ratio and short-term investments ratio. To avoid the multicollinearity problem in the regression analysis, if there is market-to-book ratio in the regression, we use cash ratio and short-term investments ratio instead of cash-to-total assets ratio and short-term investments-to-total assets ratio.
To control the capital structure factor in our analysis, we use long-term debt-to-total assets ratio and short-term debt-to-total assets ratio in the regression. We also use investments and advances (equity method)-to-total assets ratio and investments and advances (other)-to-total assets ratio. “Investments and advances represents long-term investments and advances to unconsolidated subsidiaries and affiliates in which the parent company has significant control, as stated in the consolidated financial statements” Compustat (1999). Investments and advances (other) “represents long-term receivables and other investments, and advances including investments in unconsolidated companies in which there is no significant control” Compustat (1999).

We average all the above firm characteristics over the five-year period from 1994-1998 as in Johnson (1997). We retain the firms that have a valid value in each of the above variables. This gives us 7631 firms. We use the firms’ Cusip number in this sample to match the Cusip number of firms in the Trade and Quote (TAQ) database by New York Stock Exchange, Inc. TAQ database contains intraday transactions data (bid, ask quotes, trades and size of trades) for all securities listed on the New York Stock Exchange (NYSE), American Stock Exchange (AMEX), Nasdaq National Market System (NMS) and SmallCap issues. We select four sample periods (months): February 1996, March 1997, April 1998, and May 1999. All sample periods have 20 trading days, except April 1998, which has 21 trading days. We use three trading liquidity proxies, the definitions of which are from previous studies such as Lee et al. (1993) and Corwin (1999):

1. Percentage Quoted Spread (PQS) = 100* (Ask Price-Bid Price)/Midpoint
2. Percentage Effective Spread (PES) = 200 *|Trading Price- Midpoint/Midpoint
3. Percentage of Price-Improved Trades (PPIT) = 100*(number of trades that trading price < ask price and trading price > bid price)/total number of trades

where Trading Price is the price when the trades are executed. Midpoint is (Ask Price - Bid Price)/2. Since trades are usually reported with a lag (Lee and Ready 1991), we match Midpoint with Trading Price when the bid-ask quotes are at least 15 seconds prior to the trade (Corwin 1999).

We chose to use the percentage quoted spread and the percentage effective spread because midpoints in our sample vary. Using PQS and PES can eliminate the stock price effect (Harris 1994). Some studies suggest that using effective spread may be enough for the purpose of studying the transaction costs. Petersen and Fialkowski (1994) document the significant difference between the quoted spread and the effective spread. When the quoted spread widens, only 10% to 22% of the increase appear in the effective spread. The authors show that when trades are executed inside the quoted bid-asked spread, the quoted spread is no longer an accurate measure of transactions costs faced by investors. Some studies only use effective spread, not the quoted spread to measure transaction costs (Garfinkel and Nimalendran 1998). For the purpose of using them as proxies for liquidity, however, we include both PQS and PES in the study as theoretical models suggest (Garman (1976), Amihud and Mendelson (1980), Kyle (1985), and Glosten and Milgrom (1985)). Since PES is superior to PQS and PPIT and the results of using all three proxies are similar, we only present the results using PES.

For every one of the four sample periods, we eliminate the stocks that on any trading day have the average midpoint below $2.00. Usually those stocks are traded less frequently. We eliminate the trades that have zero or a negative bid price and ask price, the trades that ask price minus bid price is negative, the trades that the trading price is more than 20 % higher or lower
than the previous trade, the trades that quoted ask-bid spread is greater than $2.00, and the trades that the effective spread (trading price minus midpoint) is greater than $2.00.

We first average the percentage quoted spread and the percentage effective spread across those valid trades in each trading day. The percentage of price-improved trades is also first calculated in each trading day using those valid trades. The average PQS, PES, and PPIT are then calculated by averaging across all trading days during each sample period. Previous studies show that PQS, PES, and PPIT are related to other variables (Harris 1994, Corwin 1999), such as midpoint, market capitalization, trade size, number of trades, and the standard deviation of daily return. We include all of them except the standard deviation of daily return in the regression analysis. Instead of using the standard deviation of daily returns, we first calculate the standard deviation of intraday returns, and then use the average of it over the trading days in the sample period. This is because the standard deviation calculated over 20 observations may not be representative. We find statistically significant relations with the liquidity proxies. We define the Market Capitalization as average midpoint times the number of shares outstanding. We average the trade size of each trade for each trading day during the sample period, then average them across trading days in the sample period. The number of trades is averaged across all trading days during the sample period.

During each sample period the securities are matched with the 7631 firms selected from Compustat with their unique Cusip numbers. Since stock tickers are changing from time to time, matching the firms by stock tickers using the two data sets can cause mismatches. The number of matched securities for each period is 3404 for February 1996, 4766 for March 1997, 5475 for April 1998, and 5176 for May 1999. We use the three trading liquidity proxies PQS, PES, and PPIT as dependent variables in OLS regressions with the firm characteristics and market trading.
variables as independent variables. In order not to make the regression coefficients too small or too large, we first take log of Market Capitalization, take log of 1000 times market-to-book ratio and multiply by 0.1, and multiply Midpoint by 0.1, then multiply both dependent and independent variables by 1000.

There are four general forms of regression used in the study:

Dependent Variable = \( r_0 + r_1 \log \text{(Market Capitalization)} + r_2 \text{Fixed Assets Ratio} + r_3 \text{Intangible Assets Ratio} + r_4 \times 0.1 \log (1000 \times \text{Market-to-Book Ratio}) + r_5 \text{ Long-term debt-to-assets Ratio} + r_6 \times \text{Short-term debt-to-assets Ratio} + r_{10} \times \text{Cash Ratio} + r_{11} \times \text{ST Investment Ratio} + r_{12} \times \text{Investment Equity-to-assets Ratio} + r_{13} \times \text{Investment Other-to-assets Ratio} + r_{14} \times 0.1 \times \text{Quote Midpoint} + r_{15} \times \text{Trade Size} + r_{16} \times \text{Number of Trades} + r_{17} \times \text{Return Standard Deviation} \)  

(1)

Dependent Variable = \( r_0 + r_1 \log \text{(Market Capitalization)} + r_2 \text{Fixed Assets Ratio} + r_3 \text{Intangible Assets Ratio} + r_5 \times \text{Long-term debt-to-assets Ratio} + r_6 \times \text{Short-term debt-to-assets Ratio} + r_7 \times \text{Cash-to-Assets Ratio} + r_8 \times \text{ST Investment-to-Assets Ratio} + r_9 \times \text{Inventory-to-Assets Ratio} + r_{12} \times \text{Investment Equity-to-assets Ratio} + r_{13} \times \text{Investment Other-to-assets Ratio} + r_{14} \times 0.1 \times \text{Quote Midpoint} + r_{15} \times \text{Trade Size} + r_{16} \times \text{Number of Trades} + r_{17} \times \text{Return Standard Deviation} \)  

(2)
Investment Ratio + \( r_{12} \) * Investment Equity-to-assets Ratio + \( r_{13} \) * Investment Other-to-assets Ratio + \( r_{14} \) * 0.1 * Quote Midpoint + \( r_{15} \) * Trade Size + \( r_{16} \) * Number of Trades + \( r_{17} \) * Return Standard Deviation + \( r_{16} \) * D  \hspace{1cm} (3)

Dependent Variable = \( r_0 + r_1 \) * log (Market Capitalization) + \( r_2 \) * Fixed Assets Ratio + \( r_3 \) * Intangible Assets Ratio + \( r_5 \) * Long-term debt-to-assets Ratio + \( r_6 \) * Short-term debt-to-assets Ratio + \( r_7 \) * Cash-to-Assets Ratio + \( r_8 \) * ST Investment-to-Assets Ratio + \( r_9 \) * Inventory-to-Assets Ratio + \( r_{12} \) * Investment Equity-to-assets Ratio + \( r_{13} \) * Investment Other-to-assets Ratio + \( r_{14} \) * 0.1 * Quote Midpoint + \( r_{15} \) * Trade Size + \( r_{16} \) * Number of Trades + \( r_{17} \) * Return Standard Deviation + \( r_{16} \) * D  \hspace{1cm} (4)

where D is a dummy variable for banks. It is 1 if it is a bank including regional, major regional, and money center with Compustat Industry Sector Code 5025, 5030, and 5040, respectively, and zero for all the other firms. All the other independent variables are defined as above. The regressions include one observation per firm.

The Market Capitalization and Fixed Assets Ratio have a high correlation with each other and with other independent variables in the regression. Previous studies (e.g., Johnson (1997)) suggest that they are related to each other, to debt ratio, and to investment opportunities. To avoid this multicollinearity problem, which may mislead the results of regression analysis, we use Johnson’s method. We partition the Market Capitalization and the Fixed Assets Ratio into two parts. One is endogenous and attributable to the other independent variables in the regression; the other is exogenous and is orthogonal to the other independent variables. For each sample period, we first regress the Market Capitalization on all the other independent variables except
the Cash Ratio and the Short-term Investment Ratio, and use the residuals from the regression as an instrumental variable for Market Capitalization. We then regress Fixed Assets Ratio on the other independent variables except Market Capitalization, Cash Ratio, and Short-term Investment Ratio, and use the residuals from the regression as an instrumental variable for Fixed Assets Ratio. Since the two instrumental variables are orthogonal to the other independent variables, except Cash Ratio and Short-term Investment Ratio, the above mentioned multicollinearity problem disappears in the regression.

To give more examples, in addition to running regressions for four sample periods from March 1996 to May 1999, we also run the same form of regressions with three different industry groups. These groups are savings and loan companies with the Compustat Industry Sector Code 5020, banks (including regional, major regional, and money centers) with codes 5025, 5030, and 5040, and financial firms (diversified) with the code 5110. The regressions are run with each industry group for the four sample periods.

IV. Results

The regression results with the percentage effective spread as a dependent variable for all the sample firms are shown in Table I. Across all the sample periods and consistent with previous studies, the PES is significantly and negatively related to number of trades, trade size (except in one regression in which the coefficient is close to zero), Market Capitalization, and quote midpoint, significantly and positively related to the return standard deviation.

The fixed assets ratio is used as a negative indicator of assets liquidity. Certainly, cash-to-assets ratio, short-term investments-to-assets ratio, and inventory-to-assets ratio are positive
indicators. PQS and PES are negative indicators of trading liquidity. PPIT is a positive indicator of trading liquidity. Significantly, both the PQS and the PES are negatively related to the fixed assets ratio and positively related to the inventory ratio, while the PPIT is positively related to the fixed assets ratio and negatively related to the cash-to-assets ratio and the short-term investments-to-assets ratio. These regression results suggest that firms with less liquid assets are related to their stocks’ higher trading liquidity.

Opposite to fixed assets ratio, intangible assets ratio can be a positive indicator of potential assets substitution problems (Detragrache 1994). Johnson (1997) uses market-to-book ratio as a positive indicator of potential assets substitution problems. Firms with high market-to-book ratio likely have great investment opportunities and high growth potentials. Like firms with a high intangible assets ratio, they could have more assets substitution problems.

Both the intangible assets ratio and the log of market-to-book ratio are significantly and negatively related to PQS and PES. Markets perceive firms with a high market-to-book ratio as having strong future growth and great investment opportunities. Those firms are often in those strong growth industries with great media and brokerage coverage or exposures. Such exposures lead to more, especially uninformed, investors to buy and trade their stocks. Therefore, their stocks’ trading liquidity tends to be high, as reflected in a low PQS and PES.

We suspect that firms with a high intangible assets ratio are also subject to such exposures. Since intangible assets include client lists, computer software patent costs, copyrights, franchises and franchise fees, etc. Therefore, the more value of intangible assets a firm has, the more clients, the more franchises, the more outsider exposures the firm will have. Thus, their stocks’ trading liquidity tends to be high with a low PQS and PES.
Another factor that could contribute to a low or a high PQS and PES, as in the relations between trading liquidity and fixed assets ratio, is that less assets substitution problems and less agency costs can lead to high trading liquidity. In the relations between trading liquidity and intangible assets ratio and market-to-book ratio, this factor may be offset by the degree of outside exposures of firms.

Other interesting results are that both PQS and PES are significantly and negatively related to long-term debt-to-assets ratio, and significantly and positively related to short-term debt-to-assets ratio. Diamond (1991) shows that the firms with high credit ratings prefer short-term debt and that the firms with somewhat lower ratings prefer long-term debt. Lower rated firms can issue only short-term debt-to-assets. Barnea, Haugen, and Senbet (1980) show that the agency cost resulting from informational asymmetry can be reduced by shortening the maturity of the debt. Short-term debt-to-assets can eliminate firms’ incentives to shift from low risk to high risk low value projects. Therefore, firms with potential severe assets substitution problems will use more short-term debt-to-assets proportionately.

Firms with higher credit ratings or less severe assets substitution problems would attract more uninformed investors to buy their stocks. Informed investors rather than uninformed investors would like to invest in the stocks of firms with lower credit ratings or more severe information asymmetry problems. So, the trading liquidity is high if the firms’ ratings are high and they have less severe assets substitution problems. Therefore, they use more long-term debt and less short-term debt.

Results of regression from (3) and (4) using banks dummy variable D are shown from Table II. Banks have a significantly lower PPIT than other firms for all the sample periods. In
general, banks have a higher PQS and PES than other firms, although for some sample periods the results are not significant.

We also use the following regression forms:

\[
\text{Dependent Variable} = r_0 + r_1 \cdot \log (\text{Market Capitalization}) + r_2 \cdot \text{Fixed Assets Ratio} + r_3 \cdot 0.1 \cdot \log (1000 \cdot \text{Market-to-Book Ratio}) + r_4 \cdot 0.1 \cdot \text{Quote Midpoint} + r_5 \cdot \text{Trade Size} + r_6 \cdot \text{Number of Trades} + r_7 \cdot \text{Return Standard Deviation} + r_8 \cdot D
\]

(5)

The results are the same.

The fact that there is no significant relation between long-term and short-term debt-to-assets and trading liquidity of bank stocks may be due to the fact that banks use short-term deposits, which in a sense is like other firms’ short-term debt-to-assets. It may also suggest that banks use debt in a different way than other firms.

Myers and Rajan (1999) suggest that the banks have to hold liquid assets to meet depositors’ demands for liquidity. If banks hold only liquid assets, their debt capacity would be limited by transformation risk. So they hold illiquid loans as assets. Diamond and Rajan (1998) show that the banks have to have a fragile capital structure in order to meet the liquidity needs of both depositors and borrowing firms. The theories in both studies suggest that debt use by banks and other firms are quite different. Those differences are reflected in our regression results.

V. Conclusions and Implications

This study provides empirical evidence of the relations between the firms’ assets liquidity and their stocks’ trading liquidity. As proxies for trading liquidity, both the percentage quoted spread and the percentage effective spread are negatively related to the fixed assets ratio and
positively related to the inventory ratio, while the percentage of price-improved trades is positively related to the fixed assets ratio and negatively related to the cash-to-assets ratio and the short-term investments-to-assets ratio. These regression results suggest that firms with less liquid assets are related to their stocks’ high trading liquidity.

The above results of asset liquidity are based on the use of the fixed assets ratio as a proxy for liquidity. However, in terms of the relation between another proxy for assets substitution problems, the market-to-book ratio, and the measures of trading liquidity, the results are mixed. This may suggest that the market-to-book ratio is less accurate than asset liquidity as an indicator of the assets substitution problem. Managers of high market-to-book firms need to sell their firms securities in order to transform their assets. Such selling is highly transparent. Managers of firms with high liquidity assets, however, can transform their assets with little or no such publicity. Therefore, firms with highly liquid assets can potentially have a greater degree of assets substitution problems than firms with a high market-to-book ratio.

The findings pose interesting questions: how are firms’ agency costs related to their stocks’ transaction costs? How can we see the asset transformation problems by stocks’ trading? Can markets efficiently incorporate firms’ asset transformation risk through their stocks’ trading behavior? Theoretical studies and more empirical research can be done in those directions.
Reference


Table I – Regressions of PES on Firm and Trading Characteristics

The sample includes all Computstat 1998 active securities matched with TAQ data using Cusip numbers for each of four months: February 1996, March 1997, April 1998, and May 1999. All securities have at least an average quote midpoint of $2.00. The dependent variable is the percentage effective spread. Fixed assets ratio is net property, plant, and equipment divided by the book value of total assets. The market-to-book ratio is the ratio of (the book value of total assets plus the market value of equity minus the book value of equity) to the book value of total assets. Long-term debt-to-assets ratio is long-term debt (Compustat items) divided by total assets, and all the other item-to-assets ratio represent an Compustat item divided by total assets. Cash ratio is cash divided by cash equivalent. ST investment ratio is Short-term investment divided by cash equivalent. All the above characteristics are averaged over 1994 to 1998. Quote midpoint, number of trades, and trade size are the average quote-midpoint, average number of trades, and average trades size in shares per day, respectively. They are then averaged over each sample period. Market capitalization equals midpoint times average shares outstanding (the unit is million) from 1994 to 1998. The return standard deviation is the average intraday return standard deviation for the sample period. ***, **, and * indicate significance of the coefficient at the one, five and ten percent levels, respectively.

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</table>
Table II – Regressions of S&L’s PES on Firm and Trading Characteristics

The sample includes Computstat 1998 active savings and loan firms matched with TAQ data using Cusip numbers for each of four months: February 1996, March 1997, April 1998, and May 1999. All securities have at least an average quote midpoint of $2.00. The dependent variable is the percentage effective spread. Fixed assets ratio is net property, plant, and equipment divided by the book value of total assets. The market-to-book ratio is the ratio of (the book value of total assets plus the market value of equity minus the book value of equity) to the book value of total assets. Long-term debt-to-assets ratio is long-term debt (Compustat items) divided by total assets, and all the other item-to-assets ratios represent an Compustat item divided by total assets. Cash ratio is cash divided by cash equivalent. ST investment ratio is Short-term investment divided by cash equivalent. All the above characteristics are averaged over 1994 to 1998. Quote midpoint, number of trades, and trade size are the average quote-midpoint, average number of trades, and average trades size in shares per day, respectively. They are then averaged over each sample period. Market capitalization equals midpoint times average shares outstanding (the unit is million) from 1994 to 1998. The return standard deviation is the average intraday return standard deviation for the sample period. ***, **, and * indicate significance of the coefficient at the one, five and ten percent levels, respectively.

<table>
<thead>
<tr>
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<th>9602</th>
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<tbody>
<tr>
<td>Intercept</td>
<td>-660.08*</td>
<td>3.90***</td>
<td>-476.71*</td>
<td>3.63***</td>
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<td>log of Market Capitalization</td>
<td>-0.0012***</td>
<td>-0.0013***</td>
<td>-0.0016***</td>
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<tr>
<td>Fixed Asset Ratio</td>
<td>-0.0077</td>
<td>-0.0045</td>
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<td>Intangible Asset Ratio</td>
<td>-0.0200</td>
<td>-0.0246</td>
<td>-0.0278*</td>
<td>-0.0269*</td>
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<tr>
<td>0.1<em>log(1000</em>Market-to-Book Ratio)</td>
<td>0.1700</td>
<td>0.1125*</td>
<td>-0.1124***</td>
<td>-0.0270</td>
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<tr>
<td>Long-term Debt-to-Assets Ratio</td>
<td>0.0007</td>
<td>0.0006</td>
<td>-0.0005</td>
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<td>Short-term Debt-to-Assets Ratio</td>
<td>-0.0001</td>
<td>-0.0009</td>
<td>-0.0014</td>
<td>-0.0017</td>
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<td>Cash-to-Assets Ratio</td>
<td>0.0055</td>
<td>0.0039</td>
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<td>ST Investment-to-Assets Ratio</td>
<td>0.0035</td>
<td>0.0028</td>
<td>-0.0002</td>
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<td>Inventory-to-Assets Ratio</td>
<td>0.0062*</td>
<td>0.0032</td>
<td>-0.0013</td>
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<td>Cash Ratio</td>
<td>0.5625</td>
<td>0.4130</td>
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<td>ST Investment Ratio</td>
<td>0.5624</td>
<td>0.4130</td>
<td>0.1467</td>
<td>0.0095</td>
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<td>Investment Equity-to-Assets Ratio</td>
<td>-0.0006</td>
<td>-0.0053</td>
<td>0.0170</td>
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<td>Investment Other-to-Assets Ratio</td>
<td>-0.0008</td>
<td>-0.0011</td>
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<td>-0.0002</td>
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<td>0.1*Quote Midpoint</td>
<td>-0.0005***</td>
<td>-0.0004***</td>
<td>-0.0005***</td>
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<td>Trade Size</td>
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<td>-0.0003***</td>
<td>-0.0001**</td>
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<td>Number of Trades</td>
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<td>-0.0101**</td>
<td>-0.0039**</td>
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<td>Return Standard Deviation</td>
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<td>0.0021</td>
<td>0.0056**</td>
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<td>Adjusted R Squared</td>
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<td>F-statistic</td>
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