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Private Information, Short Sales, and Long-Run Performance

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Abstract

The relationship of information flow and market price formation are central to the basic tenets of financial economics. Whereas information is usually treated as being either public or private (monopolistic), most empirical studies focus on the price effects of public announcements. More recent research has centered more on the role of private information, such as insider trading, in efficient pricing and whether such trading increases investor welfare. Typically, "insider trading" refers to an officer that trades in his/her company's shares. Insider trading, however, also refers to anyone who generates private, albeit costly, information concerning a stock's fundamental value. Normally, such insider activity is more difficult to ascertain. One way in which negative information is revealed is through short-selling activity, especially the monthly short-interest positions reported by the national stock exchanges.

Diamond and Verrecchia (1987) provide a theoretical paradigm that predicts a negative price adjustment upon announcement of a company's monthly short interest, if the short interest displays an unusual increase and is correlated with

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negative information that is not yet public. Empirical studies of the short-run, negative price effect predicted by Diamond and Verrecchia find mixed results. One explanation is that the time period studied is too short for the market to absorb the informational content of these announcements. One reason is that these announcements are an ambiguous signal that requires more individuals and time to collect and act on the same information before full revelation occurs or before the implicit information becomes publicly known. This "long delayed reaction" also serves as a motivation for related research on the wealth effect of mergers, share repurchases, and initial equity offerings in which long-run performance differs from the initial, short-run reaction to such announcements or offerings.

This research also studies long-run performance by examining the cumulative returns to stocks experiencing a significant increase in month-over-month short interest. Over a three-year period, the evidence indicates that firms with unusually large increases in short interest significantly underperform stocks of similar size that do not experience an unusual increase in short interest. When the sample is divided into size-based portfolios, this underperformance stems from a "small firm effect." The smallest stocks' total returns over three years is half the returns experienced by a control portfolio of stocks comparable in size. Moreover, on a size- and beta-adjusted basis, smaller stocks underperform by 30 percent. In addition, the post-announcement underperformance of small stocks with unusual short-interest increases is negatively related to a pre-announcement positive excess return performance. On the other hand, small stocks' short-run price reaction to their short-interest announcement is similar in magnitude to that experienced by larger sized firms. This implies that negative private information is apparently not fully revealed upon announcement. Compared to prior studies of the small firm effect, our sample of smallest stocks are also uniquely distinguished

by above-average price-earnings ratios. In contrast, in a comparison of larger stocks with to those without a significant increase in short interest, no difference is found in their relative performance. This implies that larger stocks' short-interest announcements contain little useful information. An apparent reason is that short interest in these stocks is more likely to be a noisy signal that is contaminated by short selling for other than informational reasons, e.g., hedging and arbitrage activities. Nevertheless, these results imply that, for smaller stocks, short-interest announcements provide significant private information about future performance, and that policies designed to reduce short-sale restrictions should lead to more efficient pricing.

Information flow, market price formation, and their relationship are central to the efficient markets hypothesis as well as other tenets of financial economics. Information is usually treated as being either public or private (monopolistic), but most empirical studies focus on the price effects of publicly-announced information. More recent research has centered on the role of private information in efficient pricing, i.e., whether insider trading introduces noise into prices or leads to an incorporation of private information, and whether such trading decreases or increases investor welfare.[1] "Insider trading" can refer to the buying or selling of a company's shares by (1) its officers or directors or (2) outside investors or informed traders that generate costly, private information concerning a stock's fundamental value. The first type of insider trading requires timely public disclosure through the Securities and Exchange Commission; the second type of insider trading is more difficult to ascertain and more challenging to investigate empirically. One way in which private information is publicly revealed, however,

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1) Opponents of insider trading argue that insider trading fosters abusive managerial practices, decteases market liquidity and, in general, is unfair to the uninformed investor. Proponents argue that insider trading prometes quick price discovery, which reduces the incentive and cost for many individuals to collect the same information. See Meulbroek (1992) and Seyhun (1986).

is through short-selling activity contained in the monthly announcement of short interest by national stock exchanges.

Similar to company insider selling, the reason an information trader sells short is not apparent. That is, many motives for short selling, such as in hedging and arbitrage activities, do not involve fundamental considerations. Nevertheless, to the extent that a short sale does reflect private information, this information should be unambiguously negative. However, negative information may be imperfectly revealed through short selling. Most investors face short-sale restrictions, including no use of sales proceeds, legal prohibitions, and margin requirements. Because of such restrictions, some researchers argue that negative news concerning a company tends to be underweighted in its stock price, especially if there are widely divergent investor beliefs about its expected return and risk, e.g., see Miller (1977). Moreover, the more investors' desired portfolio decisions are affected by these restrictions, the greater is the degree of overvaluation. Nonetheless, sophisticated information traders do sell short and, thus, knowing the level of or change in short interest should provide valuable information to uninformed investors. In fact, there is anecdotal evidence that a security's short interest is a factor considered by traders in forming their own price expectations.

Diamond and Verrecchia (1987) provide a theoretical paradigm that predicts a negative price adjustment upon announcement of a company's monthly short interest, if the reported short interest displays an unusual increase and is correlated with negative information regarding a particular company that is not yet public. Two empirical studies investigate the short-run, negative price effect predicted by Diamond and Verrecchia. Senchack and Starks (1993) find that stocks with unusual, unexpected increases in short interest experience significant, yet small, negative returns surrounding the announcement date. On the other

hand, Vu and Caster (1987) find the immediate stock price reaction to an unusual increase in short interest is not significant.

One explanation for these mixed results is that a short-interest announcement is an ambiguous signal. As mentioned earlier, increased short selling may be due in part to arbitrage activities. On the other hand, even if short selling is done for informational reasons, short-sale restrictions may impede a complete price adjustment to the information. Therefore, the announcement periods studied by researchers may be too short. Additional time may be required for more individuals to overcome any short-sale restrictions or to produce and act on the same information before full revelation occurs or before the implicit information becomes publicly available. The latter explanation, or what may be called a "long delayed reaction," serves as the primary motivation for recent research on the long-run wealth effect of initial and seasoned equity offerings, mergers, and share repurchases. In this research, contrary results are found when long-run performance is compared to earlier studies' short-run price reaction to such offerings or announcements.

Several short-interest studies have studied the long-run, predictive content of the level of short interest for future price performance. Hurtado-Sanchez (1978) concludes that an investor cannot profit from knowledge of short interest, i.e., short interest is unrelated to current and next month's excess returns. On the other hand, McDonald and Baron (1973) find that the higher a stock's short interest is, the more negative its average monthly holding period return is over the next 12 months. Finally, the evidence in Figlewski (1981) and Figlewski and Webb (1993) indicates that stock with a high level of short interest substantially underperform stocks with low short interest and tend to generate negative excess returns over the year following the month in which short interest is measured.

Our research studies long-run performance by examining the cumulative

returns to stocks experiencing a significant increase in month-to-month short interest. Over a three-year period, the evidence indicates that firms with unusually large increases in short interest significantly underperform by over five percent after adjusting for size and risk using stocks without a significant increase in short interest. When the sample is divided into size-based portfolios, this underperformance is found to be due to small stocks' performance. The smallest stocks' holding period returns over three years is half the average return experienced by a control portfolio of stocks comparable in size. Moreover, on a size- and risk-adjusted basis, smaller stocks underperform by 30 percentage points. Surprisingly, the short-run price reaction to these smaller stocks' short-interest announcement is similar in magnitude to that experienced by larger sized firms, which suggests a long delayed reaction to the information implied in the short-interest announcement. In contrast, when larger stocks with a significant increase in short interest are compared to comparable stocks without an unusual increase in short interest, no difference is found in their relative performances. This implies that larger stocks' short-interest announcements contain little useful information regarding future performance. One apparent reason is that short interest in these stocks is a noisy signal that is confounded by short selling for other than informational reasons. These results imply that, for smaller stocks, short-interest announcements provide significant private information about their future performance.

In addition, the post-announcement underperformance of the smallest stocks with significant short-interest increases is negatively related to a pre-announcement, positive excess return performance, which is consistent with a mean reversion or overreaction in returns, e.g., see DeBondt and Thaler (1987). However, the magnitude of post-announcement underperformance cannot be fully explained by a mean reversion. Finally, in contrast to prior to studies of the

small firm effect, our sample of smallest stocks are distinguished by relatively high price-to-earnings ratios. This finding suggests that the relatively poor investment performance of high price-to-earnings ratio stocks found, for instance, in Basu (1983), Reinganum (1981), and Senchack and Martin (1987) may be due in part to another type of "small firm effect."

I. Research Design

A. Data

On or after the twentieth of each month, securities with a significant short-interest position are reported in national financial newspapers.[2] This information includes all New York Stock Exchange (NYSE) and American Stock Exchange (ASE) securities and includes each security's latest and prior months' short interest as well as the average daily trading volume (in shares) for the latest month. Our initial sample is drawn from all NYSE and ASE companies whose short-interest figures are published in The Wall Street Journal, January 1980 through December 1986. Additional requirements are (1) short interest in a particular month must have at least doubled from the prior month's short interest and not reflect arbitrage activities, (2) return data are available either from CRSP daily or monthly return file, (3) the firm is not a financial services or utility company, (4) a security is not a warrant or preferred stock, and (5) firm size data are available. A sample of 2,214 securities (from 1,330 firms) satisfied these requirements. The key consideration in the sample selection is how to determine

2) The definition of "significant" used by The Wall Street Journal changes over the test period. Prior to September 1983, a significant short position is defined as either a short position of 5,000 shares or a change of 2,000 shares since the last monthly report. Beginning in September 1983, the listing criteria were changed to 40,000 and 20,000 shares, respectively, and finally increased to 100,000 and 50,000 shares in November 1986. These new listing rriveria reflected the increased trading volume over the sample period.

an unusually large increase in short interest. Requirement (1) is used because typically less than one percent of all NYSE and ASE securities' short interest doubles in any particular month. Senchack and Starks (1993) also use a similar criterion.

Table I presents descriptive statistics of this sample. Panel A indicates that the sample is distributed nearly evenly over the calendar years, except for the 1980-81 period. Moreover and not reported here, the sample is distributed evenly across calendar months. Panel B gives the number of sample firms assigned to our firm size deciles and quintiles. This assignment is based on a ranking of all firms in the CRSP monthly return file by firm size, which is then used to determine the firm-size decile cutoffs for each year. Each firm in our sample is then assigned to that decile which contains its market value of equity at the end of the previous calendar year.

B. Methodology

We initially measure long-run abnormal return behavior by using the Dimson and March (1986) methodology that is subsequently adopted by Agrawal, Jaffe, and Mandelker (1992) and Lakonishok and Vermaelen (1990). This approach yields individual stocks' excess returns that are adjusted simultaneously for firm size and the beta risk of a portfolio of comparable stocks. The adjustment for size and risk involves creating a set of control portfolios. The market value of equity of all firms on the NYSE and ASE are computed at the end of each calendar year. These stocks are sorted each year according to their market values and divided into deciles. Each decile portfolio then serves as a control portfolio, with each decile's range of market values serving to classify our stock sample by size. The betas of each short-interest announcing stock and its comparable control portfolio are estimated by regressing each stock's and portfolio's returns against a

value-weighted market index using 36 monthly observations subsequent to the announcement month. The abnormal return of firm i in month t is thus measured as

$$AR_{it} = R_{it} - R_{ct} - (\beta_i - \beta_c)(R_{mt} - R_{ft}) \quad (1)$$

where

R_{it} = the total return on security i over month t,

R_{ct} = the equally-weighted average return during month t on a control portfolio of all firms in the same size decile as firm i based on their market value of equity at the end of the prior calendar year,

β_i = the beta of security i, estimated from monthly data over the period month +1 to month +36, where zero is the month containing the short-interest announcement,

β_c = the beta of the control group, estimated over months +1 to +36,

R_{mt} = the return on the CRSP value-weighted index,[3]

R_{ft} = the risk-free rate in month t, as measured by the yield on a one-month Treasury bill.

The average abnormal return (AAR) for all stocks in month t is

$$AAR_t = (1/N)\sum_i AR_{it},$$

3) Almost identical results are obtained using the equally-weighted index, so these results are not reported here.

where N is the number of securities in the sample with a return in month t. The cumulative average abnormal return (CAAR) from month t1 to month t2 is

$$CAAR(t_1, t_2) = \sum AAR_t, \text{ where } t = t_1 \text{ to } t_2.^{4)}$$

II. Empirical Results

A. Long-Run Performance: Overall Sample Results

Table II contains the long-run performance of the entire stock sample by year for up to three years after the initial short-interest announcement. From equation (1), one-year average abnormal returns for each of the three-year periods are negative, with the largest one-year return of -2.61 percent occurring in the first year of the post-announcement period. The first- and third-year holding periods' average abnormal returns (AAR) are -2.61 and -1.90 percent, respectively, and statistically different from zero. The cumulative average abnormal return (CAAR) for the entire three-year period is -5.47 percent, and all three yearly CAARs are negative and statistically significant. The percentages of negative abnormal returns are about 53 percent for each of the three years and also

4) We also use a second approach adopted by Agrawal, Jaffe, and Mandelker (1992) that combines the Return Across Time and Securities (RATS) methodology of Ibboston (1975) with an adjustment for firm size. In this approach, heta is assumed to be identical for all announcing firms, byt month-to-month shifts in betas are allowed. For each month t relative to the announcement month, the following cross-sectional regression is estimated:

$$R_{1t} - R_{ct} = \alpha_t + \beta_t(R_{mt} - R_{ft}) + \varepsilon_{it}$$

where the constant, α_t, measures the average abnormal return across all firms in event month t, and all other variables are defined as above earlier. Because qualitatively similar results are obtained in this study when this second approach is used, only the first approach's results are reported.

statistically different from zero.[5]

B. Long-Run Performance: By Firm Size

Short-interest data are notoriously noisy because short selling occurs for other than information reasons. That is, many hedging and arbitrage strategies involve selling short for other than firm-specific, fundamental information considerations. Nevertheless, short-interest announcements may represent a more significant information event for less widely-followed stocks. Therefore, we hypothesize that the less widely followed a stock is, as measured by firm size, number of analysts, number of institutional investors owning it, etc., the more likely an unusual short-interest report conveys relatively more negative news and leads to greater negative performance. Therefore, the sample is next divided into quintiles based on their market value of equity as of the previous calendar year-end.

Panel A in Table III reports the average and cumulative abnormal returns by size quintile, with Quintile 1 containing the set of smallest stocks. First, the results in Table II appear to be driven by the smallest stocks' relative performance. That is, Quintile 1's performance declines over the post-announcement period, with the AAR per year ranging from -8.89 to -11.75 percent and the three-year CAAR being -30.03 percent. On the other hand, only the first-year AAR for mid-sized firms (Quintile 3) have a significant negative return. Interestingly, the largest stock quintile (Quintile 5) experiences positive abnormal returns.[6]

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5) In addition, the analysis was extended to the fourth and fifth years in the post-announcement period. The AARs for the fourth and fifth years are equal to -1.23% and -0.92 jpercent but are not statistically different from zero at the 5 percent level, while the four-and five-year CAARs are -6.70 and -7.62 percent and they are significantly different from zero.

6) If the stock sample is also divided into deciles, the results reported above are further strengthened at the extreme firm-size deciles, with the smallest decile stocks realizing a three-year CAAR of -43.8 percent, while the largest decile stocks realizing an three-year CAAR of 7.7 percent.

Diamond and Verrecchia (1987) suggest that any negative information conveyed by a short-interest announcement is more likely to be observed initially through lower-cost option trading activity rather than in the underlying stock price. Moreover, Senchack and Starks (1993) report no significant stock price reaction surrounding an unusual increase in short-interest announcement for optioned stocks, whereas nonoptioned stocks do experience a significant negative reaction, on average. Therefore, we next divide the entire sample into those stocks with tradable options (376 announcements) and those without tradable options (1,838). For nonoptioned stocks, the three-year CAARs are very similar to those reported for the full sample, while optioned stocks' average CAAR is not different from zero in any of the individual years or for the overall three-year period. These results thus indicate that the evidence in Table II is largely due to nonoptioned stocks, which comprise 83 percent of the sample. However, listed options tend to be written on stocks of larger sized firms than nonoptioned stocks (79 percent of the optioned stocks belong to Quintiles 4-5). Therefore, if firm size and the magnitude of short-interest changes are controlled, no significant difference in post-announcement performance is observed between optioned and nonoptioned stocks.[7]

In Panel B of Table III, the average and median percentage short interest and short-interest ratios are reported for each quintile. The percentage short interest is defined to be the current month's short interest as a percentage of total

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7) For the formal test, we run the following regressions three times for each of one-, two-, and three-years post-announcement abnormal returns:

$$CAR_{post} = \alpha_0 + \alpha_1 LNMV + \alpha_2 LNSHORT + \alpha_3 OPTION,$$

where CAR_{post} is the cumulative abnormal returns measured over the post-announcement period; LNMV is the logarithm of market value of equity at the end of previous calendar year; LNSHORT is the logarithm of the ratio of the number of shares sold short to the number of shares sold short to the mumber of shares outstanding; OPTION is an index variable indicating the existence of trdable options. As edpected, As expected, the coefficients for LNNV are positive andsignificant whereas those of LNSHORT are significantly negatice.

number of shares outstanding. Similarly, the short-interest ratio is the current month's short interest divided by the current months' average daily trading volume in shares. A *monotonic* increase in the percentage short interest is exhibited as one moves from larger to smaller stocks. In fact, percentage short interest is nearly three times as great for smaller firms compared to larger firms, and this difference is significant at any reasonable significance level (t=7.76). Part of this difference arises simply from the criteria for short interest to be reported. That is, a minimum number of shares must be held short before they are considered to be "significant" and by definition, this minimum will be a larger percentage for a smaller firm's shares outstanding (see footnote 2). (This cautionary note also applies to the short-interest ratio results cited below.) Nonetheless, short interest is typically a very small percentage of total shares outstanding for all firms, regardless of size.

The mean short-interest ratio is also considerably larger for smaller versus larger stocks. That is, smaller firms tend to be sold short heavily relative to larger firms, with the difference between Quintile 1 and Quintile 5 firms' short-interest ratio being quite significant (t=3.84). Tempering the interpretation of these results, however, is that during our sample period, the average short-interest ratio for NYSE firms with reported short interest ranged from 1.7 (August 1982) to almost 3.0 (August 1987), which coincidentally were associated with a bottom (top) of a bear (bull) market, respectively.[8] Moreover, the market's short-interest ratio increased steadily throughout our sample period, regardless of the overall direction (conditions) of the general market.

To better understand the observed price behavior in Table III, abnormal returns for the one-year and six-month pre-announcement periods are calculated for each

8) The average short-interest ratio is defined as the total short sales outstanding for a month on the NYSE divided by average daily volume for the Exchange. Again, the statistic only applies to those NYSE firms having a "significant short-interest position."

quintile, with both periods ending one month prior to the announcement date. Senchack and Starks (1993) and Vu and Caster (1987) find a significant increase in stock prices immediately preceding a short-interest announcement. Senchack and Starks (1993), for instance, report that highly significant, positive cumulative average prediction errors occurs on days -15 through -10. Panel C in Table III also reveals a tendency for small stock prices to increase relative to its control portfolio prior to the short-interest announcement. For the smallest stocks, the six-month average, pre-announcement abnormal return is nearly 10 percent. Moreover, the average abnormal returns are monotonically decreasing in firm size over months -6 to -1.

Figure 1 depicts an alternative analysis of the stocks' behavior over an extended period that ranges from two years prior to three years after a significant increase in short interest. The two larger stock portfolios (Quintiles 4 and 5) tend to experience a slight positive drift in their abnormal returns until two to three months before announcement, while Quintiles 2 and 3 stock returns appear to be driftless over the same period. All four quintile portfolios, however, experience a sharp increase in returns in the two months prior to announcement. Following the announcement, all four quintile stocks are essentially driftless.

On the other hand, the smaller Quintile 1 stocks' performance is very distinct from the other stocks. The smaller stocks' performance deteriorates steadily until five months prior to announcement and then experiences a similar but more exaggerated runup compared to other stocks. After announcement, the smaller stocks' performance then reverts back to its prior pre-announcement behavior for the remainder of the period. These results demonstrate that, for these stocks, a sharp price runup occurs over a relatively longer period prior to an announcement, but that this runup is an exaggerated, yet temporary, blip in an otherwise steadily deteriorating relative underperformance. Miller (1977) argues that because of

short-selling restrictions, negative news about a security tends to be underweighted, causing overvaluation. Thus, our evidence implies that increased short selling may reflect attempts by informed investors to correct a serious overreaction or overly optimistic expectations by investors. Below, the relation between positive abnormal returns in the pre-announcement period and long-run performance in the post-announcement period will be more formally tested in a cross-sectional analysis.

C. Long-Run Performance: Alternative Approaches

C.1. Book-to-Market Approach

In addition to firm size, Fama and French (1992) find a significant cross-sectional relation between book-to-market ratios and average stock returns. This finding motivates an alternative benchmark to control for any possible book-to-market effect. Each of ten firm size deciles is further grouped by book-to-market ratio into quintiles, with Quintile 1 containing 20 percent of all stocks with the lowest book-to-market ratios for a given firm size decile. Then abnormal returns are computed each month relative to this size- and book-to-market-adjusted benchmark. The results obtained with this alternative benchmark are qualitatively similar to the results in Tables II and III and, therefore, are not reported here.

C.2. Buy-and-Hold Approach

Because Conrad and Kaul (1993) have documented a potential upward or downward bias induced by cumulating short-run abnormal returns over long periods, we next compute three-year holding period returns to measure return from a buy-and-hold strategy. A stock is assumed to be purchased at the end of the announcement month and held for 36 months or until it is delisted. In

addition to three-year returns, we also determine one- and two-year returns for each quintile and then compare these results to the comparable size-based control portfolio returns.

From Table IV, the average first-year return for the smallest stocks following their short-interest announcement is 12.33 percent, which is almost one-half the control portfolio's 22.79 percent return, or a difference of 10.46 percentage points. This same difference for two-year and three-year returns steadily increases from 18.42 to 29.13 percentage points. The differential in all three-year comparisons are statistically significant from zero. The yearly total returns for the remaining quintile and control portfolios are remarkably similar and, except for Quintile 3 stocks, the difference between the short-interest and control stock samples are not significant. Moreover, the smallest quintile stocks also are distinguished by a fewer number of individual stocks with positive raw returns compared to the other short-interest stocks, i.e., a little less than one-half have negative raw returns. Note also that for the control portfolio stocks, the average returns do not indicate the presence of a small firm effect, with the return performance of the five control portfolios being very similar in magnitude.

D. Short-Run Price Reaction to Short-Interest Announcements

Our earlier results show that the long-run underperformance in stocks reporting unusual increases in short interest is primarily due to the relatively inferior performance of small stocks. To determine whether such stocks also experience any initial price reaction at the time their short-interest positions are released, we replicate the Senchack and Starks' (1993) approach with our quintile sample. First, from the bottom of Table V, a nearly identical effect is found for all stocks: A five-day (over days -3 to +1) CAAR of -0.33 percent (t= -2.35). Second, when the sample is divided into size-based quintiles, the largest stocks' five-day

CAAR is positive, whereas the other four quintiles' CAARs are negative. Only Quintiles 3 and 4, however, are weakly significant and different from zero. Finally, the smallest stocks' short-run announcement effect is not significantly different from zero or from Quintiles 2-4's price reaction. This is a somewhat surprising result, given the small stocks' significant underperformance over the three-year post-announcement period and seems to imply that, at the time of announcement, the negative private information is not apparent or revealed.

Taking Tables III-V together, then, the market apparently does not respond quickly to a short-interest announcement because the market is not able to identify whether the short interest is related to negative information or to hedging and arbitrage activity. Consequently, a longer time is required for the market to produce or discover the content of the informed traders' private information.

E. Relationship of Long-Run Performance to the Near-Term Announcement Effect and Pre-Announcement Returns

Panel A of Table VI presents a cross-sectional analysis of individual stocks' near-term announcement effect (CARit over days -3 to +1) and their long-run performance as well as their abnormal returns over six months prior to announcement (CARit over months -6 to -1). While the short-run announcement effect and long-run post-announcement performance are not related, the pre-announcement abnormal price runup is significantly related to the long-run, post-announcement underperformance, most significantly in the case of two-year CARs.

Given that long-run performance and the pre-announcement price runup were separately found to be unusually significant for smaller stocks, an additional analysis is performed in order to verify whether there is a relationship between smaller stocks' long-run performance and the pre-announcement price runup that

is distinct from the other quintile stocks. To do this, the following regression is performed:

$$CAR_{post} = \alpha_0 + \alpha_1 DUMMY_1 + \alpha_2 CAR(6,-1)DUMMY1 + \alpha_3 CAR(-6,-1)DUMMY2,$$

where DUMMY1 has the value 1 if the firm does not belong to Quintile 1 and zero otherwise; DUMMY2 has the value 1 if the firm does belong to Quintile 1 and zero otherwise; CAR(-6,-1) is the cumulative abnormal returns measured over months -6 to -1. Accordingly, α_0 and α_3 are the intercept and slope parameters respectively for Quintile 1 stocks. For other quintile stocks, the sum of coefficients α_0 and α_1 is the intercept term and α_2 is the slope parameter. As might be expected, the coefficients for any price runup associated with stocks in Quintiles 2-5 are insignificant, whereas those for Quintile 1 are significant. Therefore, stocks that realize positive abnormal returns prior to their short-interest announcement tend to underperform in the long-run post-announcement period.[9]

9) Table III reports that for the smallest stocks, the six-month pre-announcement abnormal return is almost 10 percent. Given the presence of long-run mean reversion documented by DeBondt and Tahaler (1987), we make a control portfolio for Quintile 1 stocks to make sure that smallest stocks' post-announcement abnormal underperformance is not a manifestation of this mean reversion. For each firm in our Quintile 1 sample, we compute six-month (ending one month prior to the announcement date) pre-announcement holding period return and then get an control firm whose corresponding (matched by the year and month) six-month holding period return is closest, among firms that belong to two smallest deciles using all firms included in NYSE, to that of our sample firm. Since the average three-year holding period return of these control firms with similar magnitude of pre-announcement price runup is 52%, the significant underperformance of our smallest stocks cannot be fully explained by mean reversion.

III. Summary and Concluding Comments

Diamond and Verrecchia's (1987) theoretical paradigm predicts a negative price adjustment to a firm's short-interest announcement if it reflects an unusual increase and is correlated with negative information not yet public. Empirical studies of this short-run, negative price effect find mixed results. One explanation is that the market needs more time to absorb or decipher these announcements' informational content because they are an ambiguous signal requiring more individuals to collect information before full revelation occurs or before the implicit information becomes publicly known. This "long delayed reaction" also motivates related research on mergers, share repurchases, and initial public offerings in which the long-run price effect or performance associated with such announcements or offerings differs significantly from any initial, short-run wealth effect.

This research also studies long-run performance by examining the cumulative raw and abnormal returns to stocks experiencing a significant month-over-month increase in short interest. Over a three-year period, the evidence indicates that firms with unusually large increases in short interest significantly underperform stocks of similar size and risk that do not have an unusual increase in short interest. If the sample is divided into size-based portfolios, this underperformance stems from a type of "small firm effect." The smallest stocks' total returns over three years is half the return experienced by a control portfolio of stocks comparable in size. Moreover, smaller stocks underperform by 30 percent on a size- and risk-adjusted basis. In addition, the long-run underperformance of smaller stocks with unusual short-interest increases is negatively related to a pre-announcement positive excess return performance.

That is, such stocks exhibit a significant price runup prior to their

short-interest announcement. On the other hand, the short-run price reaction in smaller stocks to their short-interest announcement is similar in magnitude to that experienced by larger sized firms. This implies that negative private information is apparently not fully revealed upon announcement. Finally, compared to prior studies of the small firm effect, our sample of smallest stocks are also uniquely distinguished by above-average price-earnings ratios.

In contrast, in a comparison of larger stocks with to those without a significant increase in short-interest, no difference is found in their relative performance. This implies that larger stocks' short-interest announcements contain little useful information. An apparent reason is because knowledge of the short interest in these stocks is more likely to be a noisy signal that is contaminated by short selling for other than informational reasons, e.g., hedging and arbitrage activities. Nevertheless, the overall results imply that, at least for smaller stocks, short-interest announcements provide significant private information about future performance and argue for policies designed to reduce short-sale restrictions in order to facilitate more efficient pricing.

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Table I

The Sample

The sample consists of 2,214 large short-interest announcements from January 1980 to December 1986 published in *The Wall Street Journal* with the following requirements: 1) short interest in a particular month must have at least doubled from the prior month's short interest; 2) return data are available either from *CRSP* daily or monthly return file; 3) the firm is not a financial services or utility company; 4) a security is not a warrant or preferred stock; and 5) firm size data are available. The deciles that are determined with all firms in the *CRSP* monthly return file are used to determine the firm size decile cutoffs. Each firm in our sample is then assigned to that decile that matches its market value of equity at the end of the previous year.

Panel A. By calendar year

Year	Number of stocks	% of total sample
1980	486	22.0%
1981	189	8.5%
1982	348	15.7%
1983	320	14.5%
1984	271	12.2%
1985	286	12.9%
1986	314	14.2%
Total	2,214	100%

Panel B. By firm size

Decile	1	2	3	4	5	6	7	8	9	10
# of obs.	172	193	185	212	253	241	247	272	259	180

Quintile	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
# of obs.	365	397	494	519	439

Table II

Long-run performance of firms reporting unusual increases in short interest after adjustments for firm size and beta risk

The abnormal return of firm i on month t is computed as:

$$AR_{it} = R_{it} - R_{ct} - (\beta_i - \beta_c)(R_{mt} - R_{ft}),$$

where R_{it} = the return on security i over month t; R_{ct} = the equally-weighted average return during month t on a size-based (control) portfolio of all firms in the same size deciles as firm i, based on the market value of equity at the end of the previous calendar year; β_i = the beta of security i, estimated using monthly data over the period from month +1 to month +36 relative to the announcement date; β_c = the beta of the control group, estimated over months +1 to +36; R_{mt} = the return on the *CRSP* value-weighted index; R_{ft} = the risk-free rate in month t, as measured by the one-month Treasury bill yield. The sample consists of 2,214 unusual short-interest announcements over 1980-1986. The t-statistics for *AAR* and *CAAR* are given in parentheses and are computed according to the crude dependence adjustment methods of Brown and Warner (1980). The Wilcoxon signed-rank test statistics are used to test the null hypothesis that the proportion of negative *CAR*s equals 0.50.

Months after announcement	*AAR*	*CAAR*	Percent of negative *CAR*s
1-12	-2.61%[a]	-2.61%[a]	53.9%[a]
	(-3.62)	(-3.62)	
13-24	-0.96%	-3.57%[a]	52.5%[a]
	(-1.34)	(-3.55)	
25-36	-1.90%[a]	-5.47%[a]	53.0%[a]
	(-2.63)	(-4.41)	

[a] significant at the 1% level.

Table III

Long-run performance of firms reporting unusual increases in short interest by size quintiles after adjustments for firm size and beta risk

The abnormal return of firm i on month t is computed as:

$$AR_{it} = R_{it} - R_{ct} - (\beta_i - \beta_c)(R_{mt} - R_{ft}),$$

where R_{it} = the return on security i over month t; R_{ct} = the equally-weighted average return during month t on a size-based (control) portfolio of all firms in the same size deciles as firm i, based on the market value of equity at the end of the previous calendar year; β_i = the beta of security i, estimated using monthly data over the period from month +1 to month +36 relative to the announcement date; β_c = the beta of the control group, estimated over months +1 to +36; R_{mt} = the return on the *CRSP* value-weighted index; R_{ft} = the risk-free rate in month t, as measured by the one-month Treasury bill yield. The sample consists of 2,214 unusual short-interest announcements over 1980-1986. The t-statistics for *AAR* and *CAAR* are given in parentheses and are computed according to the crude dependence adjustment methods of Brown and Warner (1980). The % short interest is short interest of current month as the percentage of total number of shares outstanding. The short interest ratio is the ratio of short interest of current month to the average daily trading volume in shares. The price-earnings ratio is computed by dividing the stock price by earnings per share, all at the end of the previous calendar year.

Months after announcement	Quintile 1		Quintile 2		Quintile 3		Quintile 4		Quintile 5	
	AAR	*CAAR*	*AAR*	*CAAR*	*AAR*	*CAAR*	*AAR*	*CAAR*	*AAR*	*CAAR*
Panel A										
1-12	-9.39%[a]	-9.39%[a]	-0.59%	-0.59%	-3.85%[a]	-3.85%[a]	-0.87%	-0.87%	0.55%	0.55%
	(-3.21)	(-3.21)	(-0.24)	(-0.24)	(-2.58)	(-2.58)	(-0.92)	(-0.92)	(0.49)	(0.49)
13-24	-8.89[a]	-18.28[a]	0.37	-0.22	-1.45	-5.30[b]	0.77	-0.10	2.82[b]	3.37[b]
	(-3.04)	(-4.42)	(0.11)	(-0.10)	(-0.97)	(-2.54)	(0.81)	(-0.11)	(2.50)	(2.10)
25-36	-11.75[a]	-30.03[a]	-3.87	-4.09	-0.46	-5.76[b]	1.47	1.37	1.49	4.86[b]
	(-3.98)	(-5.86)	(-1.62)	(-0.93)	(-0.29)	(-2.31)	(1.53)	(0.75)	(1.32)	(2.48)
Panel B										
Average size (million $)	47		146		337		778		3086	
Average [median] % short interest	1.05%	[0.68%]	0.71%	[0.45%]	0.46%	[0.29%]	0.31%	[0.18%]	0.31%	[0.12%]
Average [median] short interest ratio	4.28	[2.15]	3.69	[2.06]	3.07	[1.54]	2.77	[1.08]	2.45	[0.98]
Average [median] price-earnings ratio	26.1	[12.3]	21.0	[11.2]	18.1	[10.1]	16.3	[9.5]	10.8	[8.5]
Number of observations	365		397		494		519		439	
Panel C										
Months over (-12, -1)	6.77%		3.35%		0.72%		3.90%		2.72%	
Months over (-6, -1)	9.41%		3.32%		2.38%		2.18%		0.17%	

[a] ([b], [c]) significant at the 1% (5%, 10%) level.
Note: quintile 1 (smallest) and quintile 5 (largest)

Table IV

Holding period returns for firms reporting unusual increases in short interest and size-based control portfolios by size quintiles

The holding period return of firm i is calculated as:

$$HPR_i = \Pi_t (1 + R_{it}),$$

where R_{it} is the return on security i over month t. The corresponding holding period returns of size-based control portfolios are computed over the same period. Because of early delistings, the actual average holding period is less than reported holding period.

	Announcing firms		Control portfolio		
	HPR (%)	%Positive	*HPR* (%)	Difference	*t*-stat
Quintile 1					
one-year	12.33	53	22.79	-10.46	-3.99
two-year	18.88	53	37.30	-18.42	-4.38
three-year	31.82	57	60.95	-29.13	-5.55
Quintile 2					
one-year	23.11	65	23.25	-0.14	-0.00
two-year	36.88	67	37.39	-0.51	-0.10
three-year	57.61	76	63.21	-5.60	-1.20
Quintile 3					
one-year	20.98	70	25.61	-4.63	-2.96
two-year	32.52	72	40.81	-8.29	-3.47
three-year	61.56	77	70.48	-8.92	-2.43
Quintile 4					
one-year	20.65	73	23.55	-2.90	-2.40
two-year	35.71	76	37.15	-1.44	-0.71
three-year	67.36	85	67.92	-0.56	-0.17
Quintile 5					
one-year	19.77	74	20.73	-0.96	-0.76
two-year	36.35	77	33.87	2.48	1.19
three-year	69.04	85	66.35	2.68	0.80

Table V
Short-run abnormal returns of firms reporting unusual increases in short interest by size quintiles

The abnormal return of portfolio i on day t is computed as:

$$R_{pt} = \alpha_p + \beta_p R_{mt} + \gamma_p D_t + e_{pt},$$

where R_{pt} are the daily returns on portfolio p (one portfolio for each of the 84 months in the sample period); R_{mt} are the daily returns on the *CRSP* value-weighted index; D_t is an index variable that takes a value of one if day t is a Monday and zero otherwise; α_p, β_p, and γ_p are the estimated model parameters; and e_{pt} is the prediction error components of R_{pt} on day t. The Dodd and Warner (1983) standardized prediction error method is applied to get the statistical significance. The t-statistics are in parentheses.

	All	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
No. of portfolios	84	76	81	84	83	79
Relative to announcement date						
-5	-0.01	-0.24	-0.05	0.06	0.02	0.00
-4	-0.02	0.10	0.09	0.10	-0.23	-0.01
-3	-0.10	-0.31	-0.05	-0.21	-0.11	-0.09
-2	-0.07	-0.26	-0.02	-0.00	-0.08	0.03
-1	-0.09	0.30	-0.19	-0.18	-0.06	0.04
0	0.00	0.11	0.02	0.12	0.00	0.08
1	-0.07	-0.19	-0.25	-0.17	-0.04	0.05
2	-0.02	-0.33	0.06	0.01	0.13	-0.03
3	-0.08	-0.11	0.09	-0.22	-0.12	-0.10
4	-0.13	-0.22	0.10	-0.03	-0.15	-0.02
5	0.07	0.36	0.09	-0.18	0.14	0.19
CAAR over days (-3, +1)	-0.33 (-2.35)	-0.35 (-1.10)	-0.49 (-1.84)	-0.44 (-1.67)	-0.29 (-1.29)	0.11 (0.43)

Table VI
Cross-sectional regressions of the long-run performance of firms announcing unusual increases in short interest on abnormal price runup before the announcement or 5-day short-run announcement abnormal returns

The abnormal return of firm i on month t is computed as:

$$AR_{it} = R_{it} - R_{ct} - (\beta_i - \beta_c)(R_{mt} - R_{ft}),$$

where R_{it} = the return on security i over month t; R_{ct} = the equally-weighted average return during month t on a size-based (control) portfolio of all firms in the same size deciles as firm i, based on the market value of equity at the end of the previous calendar year; β_i = the beta of security i, estimated using monthly data over the period from month +1 to month +36 relative to the announcement date; β_c = the beta of the control group, estimated over months +1 to +36; R_{mt} = the return on the *CRSP* value-weighted index; R_{ft} = the risk-free rate in month t, as measured by the one-month Treasury bill yield.

Panel A:

This panel shows the coefficients from the following regression:

$$CAR_{post,\,i} = \alpha_0 + \alpha_1 CAR_i + e_i,$$

where $CAR_{post,\,i}$ is the cumulative abnormal returns of firm i measured over the post-announcement period and CAR_i is the cumulative abnormal returns of firm i measured over two different intervals; over days -3 to +1 relative to the announcement date and over months -6 to -1 relative to the announcement month. The t-values are in parentheses.

CAR measured over post-announcement months	short-run abnormal returns over days (-3, +1)		abnormal price runup over months (-6, -1)	
	α_0	α_1	α_0	α_1
(1, 12)	-0.03	-0.08	-0.03	-0.03
	(-4.65)	(-0.57)	(-4.56)	(-1.14)
(1, 24)	-0.06	0.13	-0.06	-0.15
	(-6.03)	(0.65)	(-5.56)	(-3.47)
(1, 36)	-0.10	0.32	-0.09	-0.15
	(-7.14)	(1.19)	(-6.87)	(-2.57)

Panel B

This panel shows the coefficients from the following regression:

$$CAR_{post,\,i} = \alpha_0 + \alpha_1 DUMMY1_i + \alpha_2 CAR(-6,-1)DUMMY1_i + \alpha_3 CAR(-6,-1)DUMMY2_i,$$

where $CAR_{post,\,i}$ is the cumulative abnormal returns of firm i measured over the post-announcement period; *CAR(-6,-1)* is the cumulative abnormal returns of firm i measured over months -6 to -1. An index variable *DUMMY1* takes the value of 1 if the firm i does not belong to quintile 1 and otherwise 0. An index variable *DUMMY2* takes the value of 1 if the firm i belongs to quintile 1 and otherwise 0. The t-values are in parentheses.

CAR measured over post-announcement months	α_0	α_1	α_2	α_3	Adj. R-sq.
(1, 12)	-0.09	0.07	0.01	-0.07	0.01
	(-5.34)	(3.88)	(0.36)	(-1.46)	
(1, 24)	-0.15	0.11	-0.02	-0.31	0.02
	(-5.58)	(3.79)	(-0.32)	(-4.28)	
(1, 36)	-0.27	0.20	-0.03	-0.21	0.02
	(-7.64)	(5.46)	(-0.48)	(-2.23)	

Figure 1

The pre- and post-announcement performance of firms announcing unusual increases in short interest by size quintiles

The abnormal return of firm i on month t is computed as:

$$AR_{it} = R_{it} - R_{ct} - (\beta_i - \beta_c)(R_{mt} - R_{ft}),$$

where R_{it} = the return on security i over month t; R_{ct} = the equally-weighted average return during month t on a size-based (control) portfolio of all firms in the same size deciles as firm i, based on the market value of equity at the end of the previous calendar year; β_i = the beta of security i, estimated using monthly data over the period from month +1 to month +36 relative to the announcement date; β_c = the beta of the control group, estimated over months +1 to +36; R_{mt} = the return on the *CRSP* value-weighted index; R_{ft} = the risk-free rate in month t, as measured by the one-month Treasury bill yield.