

## **The Price Impact of Institutional Trading**

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## **The Price Impact of Institutional Trading**

### **Abstract**

Recent studies document a strong positive relation between quarterly and annual changes in institutional ownership and returns measured over the same period. The source of this positive correlation could arise from institutional investors' intra-period positive feedback trading, institutions forecasting intra-period price changes, or from price pressure caused by institutional trades. Price pressure can in turn arise for inventory/liquidity reasons, or because market participants infer information from institutional trades. Our results suggest that the price impact of institutional trading is primarily responsible for the documented positive covariance between quarterly changes in institutional ownership and quarterly returns. Moreover, our analyses suggest this price pressure results from information revealed through institutional trading.

## **The Price Impact of Institutional Trading**

Recent studies document a strong positive cross-sectional relation between changes in institutional ownership and returns over the same period. Nofsinger and Sias (1999), for example, find the decile of New York Stock Exchange (NYSE) stocks that experience the largest annual increase in aggregate institutional ownership outperforms (by over 28 percent per year) the decile that experiences the largest decrease. Wermers (1999) finds a similar relation on a quarterly basis for a subset of institutional investors – mutual funds. Extant studies, however, have been unable to infer the source of the positive correlation between changes in institutional ownership and returns measured over the same period. That is, the positive relation is consistent with three hypotheses: (1) because of price pressure, trading by institutional investors contemporaneously affects stock prices; (2) institutional investors tend to be short-term momentum investors (i.e., intra-period institutional positive feedback trading); and (3) institutions have information that allows them to time their trades (i.e., changes in institutional ownership are positively correlated with subsequent intra-period returns).

At least initially, the price pressure hypothesis seems quite intuitive. If institutions as a group are adding to their holdings of a certain stock, we expect their buying activity to push up the price of the stock. However, when considering price pressure effects, it is important to recognize that the demand for shares from one group of investors must be offset by the supply of shares from another group of investors. Hence, if we believe that, on average, buying by large institutions causes prices to increase, we are implicitly assuming that selling by individuals and smaller institutions does not have a countervailing effect. There are two reasons, however, to suspect that institutional trading may in fact impact security prices. The first possibility is that trades initiated by institutions require price concessions because they push individuals and other liquidity providers away from their preferred inventory or portfolio positions (the “liquidity hypothesis”). This explanation is consistent with models developed by Grossman and Miller (1988) and Stoll (1978) as well as empirical studies that examine price changes around liquidity

events.<sup>1</sup> The second possibility is that information revealed through trading is primarily responsible for price changes (French and Roll, 1986; Barclay, Litzenberger, and Warner, 1990) and that due to economies of scale, institutional investors are better informed than other traders (the “informed trading hypothesis”). This possibility is also consistent with the microstructure models developed by Copeland and Galai (1983), Glosten and Milgrom (1985), Kyle (1985), Foster and Viswanathan (1996), and Back, Cao, and Willard (2000). In addition, there is some empirical support for the informed trading explanation. Bartov, Radhakrishnan, and Krinsky (2000), for example, find lower post-earnings drift for stocks with higher levels of institutional ownership. Similarly, Szewczyk, Tsetsekos, and Varma (1992) and Alangar, Bathala and Rao (1999) find that firms with high levels of institutional ownership have smaller price reactions following announcements of equity offerings or dividend changes, respectively. Dennis and Weston (2000) find transaction data measures of informed trading (e.g., the adverse selection component of the spread) are positively related to the level of institutional ownership. Using a small sample of firms with trader-identified transaction data, Nofsinger and Sias (1999) and Chakravarty (2000) find that daily changes in security prices are correlated with daily changes in institutional ownership over a three-month period.

The informed trading hypothesis is also related to the explanation that the positive relation between changes in institutional ownership and returns could arise because institutional investors successfully forecast intra-period returns. That is, if institutional investors are better informed, then the stocks they purchase should outperform those they sell. Recent studies reveal that measures of institutional demand are positively correlated with subsequent returns (e.g., Grinblatt and Titman, 1989, 1993; Daniel, Grinblatt, Titman, and Wermers, 1997; Wermers, 1999; Nofsinger and Sias, 1999; Chen,

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<sup>1</sup> For example, a number of studies find evidence of a downward-sloping demand curve for shares when a company is added or deleted from the S&P 500 Index (e.g., Shleifer, 1986; Harris and Gurel, 1986) or when a firm is spun off (Brown and Brooke, 1993). Similarly, Hodrick (1999) finds evidence of demand elasticity for stock repurchases. On a broader level, Zheng (1999) and Massa and Goetzmann (1999) find supply-demand effects for market sectors and index funds.

Hong, and Stein, 2001) suggesting that at least some of the correlation could be explained by institutional investors' ability to forecast returns.

The third possibility is that the positive relation between changes in institutional ownership and returns arises from intra-period institutional positive feedback trading. If the price impact of institutional investors' buying (selling) is offset by the price impact of non-institutional investors' selling (buying), changes in institutional ownership will still be correlated with same period returns if institutional investors (non-institutional investors) follow short-term positive (negative) feedback trading strategies. This explanation is consistent with theoretical models that suggest smart investors may rationally engage in positive feedback trading strategies (e.g., DeLong, Shleifer, Summers, and Waldmann, 1990; Cutler, Poterba, and Summers, 1990; Hong and Stein, 1999). Moreover, recent empirical work suggests institutional investors tend to purchase (sell) stocks that performed well (poorly) in the recent past (e.g., Grinblatt, Titman, and Wermers, 1995; Wermers, 1999, 2000; Nofsinger and Sias, 1999; Cai, Kaul, and Zheng, 2000). In addition, Odean (1998) reports that individual investors are more likely to sell past winners than losers (i.e., negative feedback trade).

If we had daily data on institutional holdings, it would be straightforward to distinguish among these hypotheses. In particular, we could easily measure the extent to which returns lead changes in holdings and vice versa. However, because comprehensive institutional ownership data is only available on a quarterly basis, we must employ a methodology that allows us to indirectly estimate covariances between changes in institutional ownership and returns over shorter intervals. Specifically, we exploit the additive property of covariances to infer minimum bounds for the extent to which the relation between changes in institutional ownership and returns is contemporaneous, leading, or lagging.

Our covariance estimates suggest that most of the covariance between institutional ownership changes and returns over the same quarter arises contemporaneously, i.e., as a result of price pressure. For example, our point estimate suggests that about 80 percent of the quarterly covariance between changes in institutional ownership and returns arises from price movements that occur *the same month* as the change in institutional ownership (and about 74 percent occurs in the same week and about 86 percent

in the same day). We also examine this relation across different types of institutional investors: Bank trust departments, insurance companies, investment companies, independent investment advisers, and other types of institutions.<sup>2</sup> We find that evidence of price pressure holds for each of the different types of institutions.

We conduct two tests to determine whether the price pressure results are more consistent with the information or liquidity hypotheses. First, we examine the relation between changes in institutional ownership and subsequent returns. If the price pressure induced by institutional trading results from informed trading, then price changes associated with changes in institutional ownership should be permanent. Alternatively, if temporary liquidity constraints are responsible for the price pressure, then the price changes should be temporary. We find that the price changes are permanent. That is, returns subsequent to institutional buys (sells) tend to be positive (negative), which supports the information models of price pressure rather than the liquidity/inventory models.

We further distinguish between the information and liquidity hypotheses by comparing the strength of the relation between contemporaneous stock returns and changes in two different measures of institutional ownership – the number of institutions holding the stock and the fraction of shares they hold. If price pressure results from liquidity constraints, we expect returns to be more strongly related to changes in the fraction of shares held by institutional investors than to changes in the number of institutions holding the stock, because share volume would be more important than the number of traders. In contrast, recent models of market micro-structure (e.g., Back, Cao, and Willard, 2000), suggest that the price-impact of informed trading will increase with the number of informed traders. Thus, under the informed trading hypothesis, we expect that returns will be more strongly related to changes in the

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<sup>2</sup> The positive relation between changes in institutional ownership and contemporaneous returns has been previously documented for institutional investors in aggregate (Nofsinger and Sias, 1999) and for one subset of institutional investors, mutual funds (Wermers, 1999). Previous research has not disaggregated the institutions into each of the institutional types to examine the relation. However, as has been pointed out, (e.g., Del Guercio, 1996), institutions differ in a number of characteristics such as their incentives, regulations, and clienteles. Because of these differences, their investment motivations and effects may differ as well, which implies that the relation could vary systematically by type of institution.

number of institutions holding the stock than changes in the fraction of shares held by institutional investors. We find returns are significantly related to both measures of institutional ownership change, but that the relation is much stronger for changes in the number of institutions owning a stock than changes in the fraction of shares that they hold. Consistent with our first test, this result supports the hypothesis that the price impact of institutional trading results from informed trading rather than liquidity constraints.

The balance of the paper is organized as follows: In the next section we discuss the data and examine the relations between quarterly changes in institutional ownership and quarterly returns. In Section 2 we partition the covariance between quarterly changes in institutional ownership and quarterly returns into monthly covariances. Empirical estimates of monthly covariances are also reported in Section 2. In Section 3 we extend the empirical analysis partitioning the quarterly covariance into weekly and daily covariances. In Section 4 we examine the source of the price pressure. Section 5 provides robustness tests. Our conclusions are presented in the final section.

## **1. Quarterly Changes in Institutional Ownership and Quarterly Returns**

We compute daily, weekly, monthly, and quarterly returns for all New York Stock Exchange (NYSE) securities with data from the Center for Research in Security Prices (CRSP) tapes. Each firm's institutional holdings (from CDA Spectrum) are derived from 13(f) filings for each quarter from December 1979 through December 1996, a total of 69 quarters.<sup>3</sup> CDA Spectrum classifies each institution as one of five "types" according to Standard and Poor's definition of the institution's primary line of business: bank trust departments, insurance companies, investment companies, independent

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<sup>3</sup> The 1975 revision to the Securities Exchange Acts requires institutional investment managers with \$100 million or more in exchange-traded or NASDAQ-quoted equity securities under management to file 13(f) reports within 45 days of the end of each calendar quarter. Institutions are required to report all equity positions greater than either 10,000 shares or \$200,000 in market value. These institutions constitute the majority of institutional holdings. For example, in 1990, the total market value of the equity holdings of institutions filing 13(f) reports (and thus included in the CDA Spectrum database) accounts for 89 percent of the Conference Board estimate of total institutional investor equity holdings. The omitted institutions include hedge funds, specialist firms, some public pension funds and small money managers.

investment advisors, and others (which encompasses foundations, university endowments, ESOPs, internally managed pension funds, and individuals who invest others' money who are not otherwise categorized.)<sup>4</sup>

The growing importance of institutional investors is depicted in Figures 1 and 2. Specifically, for each quarter from December 1979 through December 1996, we report in Figure 1 the number of institutional investors filing 13(f) reports by the total number of institutions and by institutional type. Similarly, in Figure 2 we report the average fraction of shares held by institutional investors in aggregate and by type. On average, across all 69 quarters, there are 928 institutional investors who together hold approximately 34 percent of each firm's shares. This average reflects growth in the number of institutions from under 600 in 1979 to over 1,400 in 1996. It also reflects growth in the average fractional holdings, from under 25 percent in 1979 to over 40 percent in 1996. The figures indicate changes over time in the dominance of different types of institutions. Bank trust departments and independent investment advisors account for most of the institutional holdings in the early part of our sample. However, over the sample period investment companies become more important and banks relatively less important.

[Insert Figures 1 and 2 about here]

To be included in the sample for a given quarter, a firm must be listed on the New York Stock Exchange (NYSE), have institutional ownership data at the beginning and end of the quarter, and have CRSP return data for the quarter.<sup>5</sup> The sample size ranges from 1,456 firms in the fourth quarter of 1986 to 2,585 firms in the fourth quarter of 1996 for a total of 118,485 firm-quarters of data. The quarterly change in the number of institutional investors is computed for each firm as the difference between the

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<sup>4</sup> The classifications are inexact in that institutions file 13(f) reports in the aggregate and some institutions would qualify as more than one type. For example, investment companies that also act as independent investment advisors are classified as investment companies if more than 50 percent of their assets are in investment companies and as independent investment advisors otherwise.

<sup>5</sup> We limit the sample to NYSE stocks to minimize the effects of non-trading on our covariance estimates.

number of institutional shareholders at the beginning and end of the quarter.<sup>6</sup> We similarly compute the quarterly change in the fraction of shares held by institutional investors as the difference between the fraction of shares held by institutional investors at the beginning and end of the quarter, where institutional fractional ownership for each firm-quarter is computed as the total number of that firm's shares held by institutional investors divided by that firm's shares outstanding.

We begin our analysis using changes in the number of institutional investors as our measure of institutional ownership change. Recent theoretical work suggests that changes in the number of institutional investors may better capture the intensity of informed trading. For example, Chen, Hong and Stein (2001) use breadth of ownership (measured as the proportion of mutual funds holding a stock) as a predictor of future stock returns. Further, Foster and Viswanathan (1996) and Back, Cao, and Willard (2000) demonstrate that information is revealed more quickly when there are more informed traders. These arguments are consistent with empirical evidence that price changes are more strongly related to number of trades than share volume (e.g., Jones, Kaul, and Lipson, 1994; Jiang and Kryzanowski, 1997). In Section 4 we compare the two measures of changes in institutional ownership directly.

We first compute, on a quarterly basis, the cross-sectional correlations and covariances between the change in the number of institutional investors and returns measured over the contemporaneous quarter, the previous quarter, and the following quarter. Table 1 reports the time-series average of these cross-sectional correlations in Panel A and covariances in Panel B for total institutional ownership and for each institutional type. The *t*-statistics (in parentheses) are computed from the time-series standard errors of these statistics.<sup>7</sup> We report both correlations and covariances because the two statistics provide different perspectives on the relation between returns and institutional ownership changes. Cross-sectional correlations provide a more intuitive metric for the degree to which quarterly changes in

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<sup>6</sup> Because 13(f) reporting is aggregated across different units within an institution, the number of institutions reflects the number of unrelated institutions holding the stock.

<sup>7</sup> Covariances reported throughout the study are based on returns in percent (e.g., a 10 percent return recorded as 0.10) and changes in the number of institutional investors recorded as the number (e.g., an increase of five institutional investors recorded as 5.0). Although covariances depend on the scale used, the *t*-statistics are not affected by scaling.

institutional ownership are associated with stock returns. On the other hand, because we can exploit their additive property, cross-sectional covariances allow us to infer short-term relations (e.g., monthly) between institutional ownership changes and returns. Further, these covariances can be approximately interpreted as a constant times the return earned on zero cost portfolios that have long positions in stocks that experience larger than average increases in institutional ownership and short positions in stocks that experience smaller than average increases in institutional ownership.<sup>8</sup>

[Insert Table 1 about here]

Consistent with recent studies (Wermers, 1999; Nofsinger and Sias, 1999), the results of Table 1 show a strong relation between quarterly changes in institutional ownership and returns measured over the same period – the time-series average of the quarterly contemporaneous correlation is 26.8 percent. Moreover, changes in institutional ownership are positively correlated with returns measured over the quarter prior to the change in ownership revealing that, as a group, institutional investors are positive feedback traders. In addition, consistent with recent studies that focus on the performance of assets held by mutual funds and other institutional investors (e.g., Daniel, Grinblatt, Titman, and Wermers, 1997;

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<sup>8</sup> Each cross-sectional covariance estimate can be interpreted exactly as a constant times the returns earned on a zero cost portfolio long in the stocks that experience an increase in institutional ownership and short in the stocks that experience a decrease in institutional ownership. Because the constant varies over time (the constant is a function of the number of firms used in the cross-sectional estimate and changes in institutional ownership), the time-series average of the covariances is not the same as a constant times the time-series average of long-short portfolio return. To see this, note that for  $n$  firms,  $n-1$  times the cross-sectional covariance between changes in institutional ownership and returns is given by the sum over the  $n$  firms of the product  $(\Delta_i - \text{ave}(\Delta))(r_i - \text{ave}(r))$ , where  $\Delta_i$  is the change in institutional ownership for firm  $i$ . Define  $(\Delta_i - \text{ave}(\Delta))$  as the weight in firm  $i$  and note that the sum of the weights is zero, i.e., the sum of the weights over the  $n$  firms is given by the sum of the changes less  $n$  times the average change. Note also that because the average return is a constant and the weights sum to zero, the sum of the product of the weights and the average return is zero. Although the weights sum to zero, the weights in the long (short) portfolio do not sum to 1 (-1). If there were only two stocks, for example, and the first stock experienced an increase of four institutional investors and the second experienced a decrease of four institutional investors, the weights in the long portfolio would sum to 4 and the weights in the short portfolio would sum to -4. To generate the return on the long-short portfolio we need to rescale the weights such that the long (short) portfolio weights sum to 1 (-1) by dividing the weight for each security by the sum of the positive weights (a constant). Multiplying the covariance by the ratio of  $(n-1)$  to the sum of the positive weights yields the return on the zero cost portfolio long in the stocks that experience larger than average increases in institutional ownership and short in the stocks that experience smaller than average increases in institutional ownership. Thus, for the quarter following the change in ownership, a constant times each covariance yields a performance measure similar to the measure reported in Grinblatt and Titman (1993). Note, however, that the Grinblatt and Titman methodology takes a long position in a mutual fund's current portfolio and a short position in its previous portfolio (which likely overlap). Our covariances are analogous to taking a long position in stocks that experience an increase in institutional ownership and a short position in the stocks that experience a decrease in institutional ownership (non-overlapping securities).

Wermers, 1999, 2000; Nofsinger and Sias, 1999), changes in institutional ownership are positively correlated with returns measured over the quarter following the change in ownership.

Since the covariances summed over the five investor types equals the covariance for all institutions, we expect that if they have roughly similar investment strategies, then each institutional type's share of the aggregate covariance should approximately equal the relative proportions of the different institutions. Over the 1979-1996 sample period, independent investment advisers and bank trust departments were the largest institutions in the equity markets and they have the largest share of the covariances.<sup>9</sup>

Across all institutional categories, there is a strong correlation and covariance between the change in institutional ownership and returns measured over the contemporaneous quarter as well as the previous quarter. Only mutual funds and independent advisers, however, exhibit statistically significant relations between changes in ownership and returns the following quarter. This result is consistent with the notion that the managers at some of these institutions have superior information.<sup>10</sup>

In summary, Table 1 provides evidence consistent with the hypothesis that the strong correlation between quarterly returns and contemporaneous changes in institutional ownership is primarily due to either the price impact of institutional trading or institutional positive feedback trading. The correlation between changes in institutional holdings and returns the prior quarter indicates that institutions tend to buy winners and sell losers, suggesting that at least over some intervals, institutions engage in positive feedback trading. The weaker positive correlation between portfolio changes and future returns is

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<sup>9</sup> At the beginning of each quarter we compute the cross-sectional average number of institutional investors holding each NYSE stock. On average, there are 83.04 institutional investors holding each stock (i.e., the time-series average of the 69 cross-sectional averages is 83.04). On average, banks account for 39.48 percent of institutional investors, insurance companies account for 8.81 percent of institutional investors, mutual funds account for 6.27 percent of institutional investors, independent investment advisers account for 36.12 percent of institutional investors, and other institutional investors account for the remaining 9.32 percent.

<sup>10</sup> As Daniel, Grinblatt, Titman, and Wermers (1997) note, positive correlation between changes in institutional ownership and subsequent returns might arise from stock return momentum if institutional investors tilt their portfolios toward stocks with recent strong performance. Consistent with this hypothesis, the results in the first column of Table 1 reveal that mutual funds and independent advisers exhibit the strongest correlation with prior quarter returns. It is also possible that changes in institutional ownership are positively correlated with future returns because the stocks institutional investors buy are, in some sense, temporarily riskier.

consistent with the hypothesis that some institutions have superior information or exploit return momentum.

## 2. Partitioning Quarterly Covariance into Monthly Covariances

As mentioned in the introduction, part of the contemporaneous correlation measured at quarterly intervals could be due to positive feedback trading within the quarter or due to institutions buying (selling) stocks prior to favorable (unfavorable) intra-quarter returns. In this section, we decompose the quarterly covariances into components to gauge how much of the covariance arises from contemporaneous relations within the quarter. The key to this decomposition is that although we have data on institutional ownership changes only on a quarterly basis, we can make use of the fact that we have returns at shorter intervals. If institutional trading causes price pressure, then there should be a systematic covariance between changes in institutional ownership and contemporaneous returns. Similarly, if institutions engage in positive feedback trading, then there should be a systematic covariance between changes in institutional ownership and lag returns. Finally, if the institutions are consistently successful in forecasting returns, there should be a systematic covariance between changes in institutional ownership and lead returns.<sup>11</sup>

### 2.1 The covariance between quarterly institutional ownership changes and monthly returns

Define the continuous return over month  $t$  as  $r_t$  and the continuous return from the beginning of month  $A$  through the end of month  $B$  as  $r_{A,B}$ .<sup>12</sup> Similarly, define the change in institutional ownership in month  $t$  as  $D_t$  and the change in the number of institutional investors from the beginning of month  $A$  to the end of month  $B$  as  $D_{A,B}$ . For the quarter ending in month  $t=2$  then, the continuous return can be written as the sum of the three monthly returns:

$$r_{0,2} = r_0 + r_1 + r_2, \tag{1}$$

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<sup>11</sup> A detailed derivation of the decomposition methodology is provided in the Appendix.

and the change in institutional ownership, given by  $\mathbf{D}_{0,2}$ , can be written as the sum of the changes for each month:

$$\mathbf{D}_{0,2} = \mathbf{D}_0 + \mathbf{D}_1 + \mathbf{D}_2. \quad (2)$$

Thus, the covariance between quarterly changes in ownership and returns over the same quarter can be represented by:

$$\text{cov}(\mathbf{D}_{0,2}, r_{0,2}) = \text{cov}(\mathbf{D}_0 + \mathbf{D}_1 + \mathbf{D}_2, r_0 + r_1 + r_2). \quad (3)$$

Because covariances are linear in the arguments, we can decompose the covariance between changes in institutional ownership and returns in the same quarter into its parts:

$$\begin{aligned} \text{cov}(\mathbf{D}_{0,2}, r_{0,2}) = & \text{cov}(\mathbf{D}_0, r_0) + \text{cov}(\mathbf{D}_1, r_0) + \text{cov}(\mathbf{D}_2, r_0) + \\ & \text{cov}(\mathbf{D}_0, r_1) + \text{cov}(\mathbf{D}_1, r_1) + \text{cov}(\mathbf{D}_2, r_1) + \\ & \text{cov}(\mathbf{D}_0, r_2) + \text{cov}(\mathbf{D}_1, r_2) + \text{cov}(\mathbf{D}_2, r_2). \end{aligned} \quad (4)$$

The first, fifth, and last terms (i.e.,  $\text{cov}(\mathbf{D}_0, r_0)$ ,  $\text{cov}(\mathbf{D}_1, r_1)$ , and  $\text{cov}(\mathbf{D}_2, r_2)$ ) on the right-hand side of equation (4) are the monthly contemporaneous covariances, i.e., the covariances between changes in ownership in a given month and returns in that month. The second and sixth terms (i.e.,  $\text{cov}(\mathbf{D}_1, r_0)$  and  $\text{cov}(\mathbf{D}_2, r_1)$ ) are the lag one-month feedback trading terms, i.e., the covariance between changes in ownership in a given month and returns over the previous month. Similarly, the third term,  $\text{cov}(\mathbf{D}_2, r_0)$ , measures institutional feedback trading at a two month lag. Analogously, the fourth, seventh, and eighth terms (i.e.,  $\text{cov}(\mathbf{D}_0, r_1)$ ,  $\text{cov}(\mathbf{D}_0, r_2)$ , and  $\text{cov}(\mathbf{D}_1, r_2)$ ) represent the covariance between monthly changes in institutional ownership and returns measured over the first or second subsequent month within the quarter.

Ideally, we would measure each term in equation (4) to estimate the relations between monthly changes in institutional ownership and returns measured over the previous, same, and following months. Unfortunately, because institutional investors are only mandated to report holdings quarterly, direct

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<sup>12</sup> We use continuous returns to maintain a linear relation between shorter- and longer-term returns, e.g., continuous quarterly returns are the sum of the continuous monthly returns.

estimation is not possible. Our methodology, however, exploits the fact that we can directly estimate each “row” of equation (4). Panel A in Table 2 reports these decompositions. The covariance between the quarterly change in institutional ownership and returns over the first month in the quarter ( $cov(\mathbf{D}_{0,2}, r_0)$ ), for example, consists of a contemporaneous *monthly* covariance ( $C$ ), a lag one-month covariance ( $L1$ ), and a lag two-month covariance ( $L2$ ). The decomposition can also be employed for the covariance between institutional ownership changes and the previous months’ returns as shown in Panel B of Table 2. Again, the right-hand side columns show the representations for the covariances between institutional ownership changes and returns over previous months: Contemporaneous ( $C$ ), lag by month  $t$  ( $Lt$ ) and lead (forward) by month  $t$  ( $Ft$ ).

[Insert Table 2 about here]

We employ the additive properties of the observable covariances in the second column of Table 2 to obtain an indirect estimate of the unobservable covariances in the last column of Table 2. In particular, the expected value of the covariance between the quarterly ownership changes and the return over the first month of the quarter (“Covariance 0” in Table 2) less the covariance between the quarterly ownership changes and the return over the month preceding the quarter (“Covariance -1” in Table 2) is the contemporaneous covariance less the lag three-month covariance,

$$\begin{aligned}
 E[cov(\mathbf{D}_{0,2}, r_0) - cov(\mathbf{D}_{0,2}, r_{-1})] &= cov(C) + cov(L1) + cov(L2) - cov(L1) - cov(L2) - cov(L3) \\
 &= cov(C) - cov(L3)
 \end{aligned} \tag{5}$$

Assuming  $E(cov(L3)) \geq 0$  (i.e., on average, monthly changes in institutional ownership are not negatively correlated with returns three months prior), then equation (5) provides a minimum estimate of the covariance between monthly changes in institutional ownership and returns the same month.

In addition, assuming that covariances between returns and changes in ownership decrease, on average, as returns get further away from the change in ownership (e.g.,  $cov(L6) < cov(L3)$ ), we may improve this estimate by adding the covariance between the return for month  $t=-3$  and the quarterly change in institutional ownership and subtracting the covariance between the return for month  $t=-4$  and

the quarterly change in institutional ownership. The expected value of equation (5) plus the difference between the covariances between the quarterly change in ownership and the monthly return three months prior to the quarter (“Covariance -3” in Table 2) and the monthly return four months prior to the quarter (“Covariance -4” in Table 2) yields:

$$E[\text{cov}(\mathbf{D}_{0,2}, r_0) - \text{cov}(\mathbf{D}_{0,2}, r_{-1}) + \text{cov}(\mathbf{D}_{0,2}, r_{-3}) - \text{cov}(\mathbf{D}_{0,2}, r_{-4})] = \text{cov}(C) - \text{cov}(L6) \quad (6)$$

As shown in Panel C of Table 2, each of the terms on the left-hand side of equation (6) are observable and consequently can be used in the estimation of the covariance between monthly changes in institutional ownership and contemporaneous monthly returns. By the same process, we can generate a second estimate of the covariance between monthly changes in institutional ownership and returns in the same month by taking the difference between the covariance for the last month in the quarter and the covariance for the first month following the quarter plus an adjustment term to move the “remainder” further from the quarter. Specifically, as shown in Panels D and E of Table 2, the second estimate of the monthly contemporaneous covariance is given by:

$$E[\text{cov}(\mathbf{D}_{0,2}, r_2) - \text{cov}(\mathbf{D}_{0,2}, r_3) + \text{cov}(\mathbf{D}_{0,2}, r_5) - \text{cov}(\mathbf{D}_{0,2}, r_6)] = \text{cov}(C) - \text{cov}(F6) \quad (7)$$

Equations (6) and (7) provide minimum estimates of the contemporaneous covariances between changes in monthly holdings and returns the same month less a lead or lag covariance. If  $\text{cov}(L6)$  and  $\text{cov}(F6)$  have expected values of zero, the equations yield unbiased estimates of the covariance between the monthly change in institutional ownership and returns the same month. To the extent that these “remainder” covariances (i.e.,  $\text{cov}(L6)$  and  $\text{cov}(F6)$ ) average greater than zero, we will underestimate the covariance between the monthly changes in institutional ownership and returns the same month. Alternatively, if the “remainder” covariances are, on average, negative, then equations (6) and (7) will overestimate the covariance between monthly changes in institutional ownership and contemporaneous monthly returns.

To check the validity of the assumption that the remainder covariances are close to zero, we estimate cross-sectional covariances between *monthly* returns and *quarterly* changes in institutional

holdings with lags going back six months and leads going forward six months. The time-series averages of these cross-sectional covariances are reported in Table 3. As shown in equation (4), the sum of the appropriate monthly covariances reported in Table 3 are identical to the quarterly covariances reported in the first row of Panel B in Table 1.

[Insert Table 3 about here]

Although we cannot directly estimate the “remainder” covariances (i.e.,  $cov(L6)$  or  $cov(F6)$ ), Table 3 provides the average sum given by  $[cov(L6) + cov(L7) + cov(L8)]$  as the covariance between the quarterly change in institutional ownership and monthly returns six months prior to beginning of the quarter (i.e.,  $cov(\mathbf{D}_{0,2}, r_{.6})$ ). Similarly, although we cannot directly estimate  $cov(F6)$ , Table 3 provides the average sum given by  $[cov(F6) + cov(F7) + cov(F8)]$  as the covariance between the quarterly change in institutional ownership and returns six months following the end of the quarter (i.e.,  $cov(\mathbf{D}_{0,2}, r_8)$ ).<sup>13</sup>

Because the covariances between quarterly changes in institutional ownership and monthly returns six months prior and six months following tend to be positive, the estimates given in equations (6) and (7) yield conservative (i.e., biased low) estimates of the covariance between monthly changes in institutional ownership and returns the same month. Hence we interpret our estimates as representing “minimum” covariances.<sup>14</sup>

In developing our estimates, we assumed that, on average, covariances decline as the period between the quarterly change in institutional ownership and monthly return increases. The results in Table 3 support this assumption, revealing a large drop in the monthly covariance terms when the contemporaneous covariance term is dropped. For example, moving from the first month in the quarter

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<sup>13</sup> Note that because the quarter spans months  $t=0, 1,$  and  $2,$  six months following the end of the quarter is month  $t=8.$

<sup>14</sup> Similarly, by taking the difference between the covariances for quarterly changes in institutional ownership and different lag returns, we can generate two estimates of each lead- and lag-covariance. For example, the lag one-month covariance can be estimated as the difference between the covariance of quarterly changes in institutional ownership and returns in the month prior to the quarter (i.e.,  $cov(\mathbf{D}_{0,2}, r_{.1})$ ) and the covariance between quarterly changes in institutional ownership and returns two months prior to the quarter (i.e.,  $cov(\mathbf{D}_{0,2}, r_{.2})$ ) less a second difference to push the “remainder” closer to zero. To conserve space we do not report these estimates. Consistent with our results showing contemporaneous covariances account for most of the quarterly covariance, we find that monthly, weekly, and daily lag and lead covariances account for relatively little of the quarterly covariance.

(which contains one contemporaneous monthly covariance) to the month prior to the quarter (which does not), the covariance falls by 52 percent. Similarly, moving from the third month in the quarter to the month following the quarter, the covariance falls by 88 percent. Overall, lead covariances tend to be small (relative to lag covariances), positive, and have little systematic pattern in the six months following the change in institutional ownership. Alternatively, lag covariances tend to be larger, positive, and systematically decline as the interval between the change in institutional ownership and return increases. Thus, on average, the “remainder” covariance in equation (6) (i.e.,  $cov(L6)$ ) will be smaller than the “remainder” covariance in equation (5) (i.e.,  $cov(L3)$ ).

## 2.2 Decomposing monthly covariances by investor type

Our data partitions institutional investors into five groups: Bank trust departments, insurance companies, mutual funds, independent investment advisors, and others. Therefore, the total change in the number of institutions holding a stock over any period is simply the sum of the changes in each of the five categories. As before, denote the total change in institutional ownership from the beginning of month  $A$  to the end of month  $B$  as  $D_{A,B}$ . Similarly denote the change in the number of bank trust departments, insurance companies, mutual funds, independent investment advisors, and others over the same period as  $DB_{A,B}$ ,  $DI_{A,B}$ ,  $DM_{A,B}$ ,  $DD_{A,B}$ , and  $DO_{A,B}$ , respectively. Then the covariance between the total change in institutional ownership ( $D_{A,B}$ ) and returns over period  $t$  is given by:

$$cov(D_{A,B}, r_t) = cov(DB_{A,B}, r_t) + cov(DI_{A,B}, r_t) + cov(DM_{A,B}, r_t) + cov(DD_{A,B}, r_t) + cov(DO_{A,B}, r_t) \quad (8)$$

Because the quarterly change in total institutional ownership is simply the sum of the quarterly changes in ownership by investor type, each term in any covariance equation can be partitioned by investor type. The estimates of the contemporaneous monthly relation between changes in ownership by bank trust departments and returns analogous to equations (6) and (7), for example, are given by:

$$E[cov(DB_{0,2}, r_0) - cov(DB_{0,2}, r_{-1}) + cov(DB_{0,2}, r_{-3}) - cov(DB_{0,2}, r_{-4})] = cov(C_{banks}) - cov(L6_{banks}) \quad (9)$$

$$E[cov(DB_{0,2}, r_2) - cov(DB_{0,2}, r_3) + cov(DB_{0,2}, r_5) - cov(DB_{0,2}, r_6)] = cov(C_{banks}) - cov(F6_{banks}) \quad (10)$$

Equations (9) and (10) yield our estimates of the minimum value for the contemporaneous covariance between monthly returns and monthly changes in bank trust department ownership. Moreover, because changes in total institutional ownership are the sum of changes in ownership by investor type, the estimated monthly covariance between returns and changes in total institutional ownership are simply the sum of the estimated monthly covariances over each investor type.

### 2.3 Empirical results

We begin by estimating, each quarter, the cross-sectional covariance between continuous quarterly returns and quarterly changes in the number of institutional investors. The first row in Table 4 reports the time-series average (and associated  $t$ -statistic) of this covariance across the 68 quarters.<sup>15</sup> The other columns in the first row report this quarterly covariance partitioned by investor type (see equation (8)). Note that the covariances reported in the first row of Table 4 are the same as those reported in the middle column of Panel B in Table 1.

[Insert Table 4 about here]

Each quarter, we estimate the covariance between the change in ownership over the quarter (i.e.,  $D_{0,2}$ ) and monthly returns for month  $t=-4$  through month  $t=6$  and then use equations (6) and (7) to generate two quarterly estimates of the monthly contemporaneous covariance. The 69 quarters of data yield a total of 136 estimates, the averages of which are reported in Table 4. Note also that the point estimates reported in Table 4 (for total changes in institutional ownership) can be inferred from the covariance estimates given in Table 3.<sup>16</sup>

As shown in equation (4), the quarterly covariance (reported in the first row of Table 4) consists of three contemporaneous monthly covariances, two lag one-month covariances, one lag two-month covariance, two lead one-month covariances, and one lead two-month covariance. Our goal is to

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<sup>15</sup> Standard errors used to calculate the  $t$ -statistics reported in Table 4 are calculated from time-series variation in the estimated covariances.

determine how much of this quarterly covariance is accounted for by the monthly contemporaneous covariance. Because the quarterly covariance contains three monthly contemporaneous covariances, we estimate the contribution of the monthly contemporaneous covariance to the quarterly covariance as three times the estimated monthly contemporaneous covariance (i.e., equations (6) and (7) times three).<sup>17</sup> We denote this estimate, the average of the 136 time-series observations, as the partitioned monthly contemporaneous covariance and report it in the first row of the “Total” column in Table 4. The “Fraction” column then reports the estimated fraction of the quarterly covariance accounted for by the contemporaneous monthly covariance, i.e., the number in the “Total” column divided by the number in the first row of that column. As the table shows, the estimated monthly contemporaneous covariance accounts for, on average, a minimum of 80 percent of the covariance between quarterly changes in institutional ownership and quarterly returns.

The next two rows of Table 4 report the estimates from equations (6) (i.e., the estimate from the beginning of the quarter) and (7) (i.e., the estimate from the end of the quarter), separately. Consistent with the earlier results suggesting lag covariances are greater than lead covariances, the end-of-quarter estimate is larger than the beginning-of-quarter estimate.<sup>18</sup> Both estimates, however are statistically significant at the 1 percent level.

The other columns in Table 4 report partitioned monthly contemporaneous covariances separated by investor type. Similar to the results for institutional investors in aggregate, the contemporaneous relation is by far the dominant source of the quarterly covariance for each type of institutional investor. The partitioned monthly contemporaneous covariance differs significantly (at the 1 percent level or better) from zero for each of the five investor types. The estimated minimum fraction of the quarterly

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<sup>16</sup> For example, plugging the estimates reported in Table 3 into equations (6) and (7) yield two (average) estimates of the contemporaneous monthly covariance. The average of these two estimates times three (as discussed in the next paragraph) yields the “contemporaneous” point estimate reported in Table 4.

<sup>17</sup> Multiplying these estimates by a constant does not affect the *t*-statistics.

<sup>18</sup> That is, the estimate from the beginning of the month is the monthly contemporaneous covariance less a lag six-month monthly covariance (equation (6)) and the estimate from the end of the month is the monthly contemporaneous covariance less a lead six-month monthly covariance (equation (7)).

covariance accounted for by the contemporaneous covariance ranges from 70 percent for the “other” category of institutional investor to 90 percent for bank trust departments.

In sum, the results suggest that a minimum of 80 percent of the covariance between quarterly changes in ownership and returns the same quarter arises from the covariance between monthly changes in institutional ownership and returns that month. Moreover, these relations hold for each type of institutional investor.

### **3. Weekly and Daily Covariances**

The results presented in the previous section suggest that most of the covariance between quarterly changes in ownership and quarterly returns arises from the covariance between changes in ownership and returns in the same month. To examine intra-month effects of institutional trading, we extend our analysis to weekly and daily partitioning.

Finer partitioning allows us to better isolate the relative importance of the price impact of institutional trading versus very short-term (i.e., less than one month) feedback trading or price forecasting. The cost, however, is that we are always limited to two estimates each quarter regardless of the interval because the partitioning methodology generates two covariance estimates each quarter from the differences in the covariances between quarterly changes in institutional ownership and adjacent returns. In the case of weekly data, for example, we generate two estimates of the weekly contemporaneous covariance each quarter. Because there are 12 weekly contemporaneous covariances each quarter, we estimate the total contribution of the weekly contemporaneous covariances to the quarterly covariance (i.e., the “partitioned covariance”) as 12 times the average weekly contemporaneous covariance estimate. The greater extrapolation, however, will likely result in a noisier estimate.

### 3.1 Decomposing quarterly covariances by week

The number of trading days in any quarter over our sample period ranges from 61 to 64 days. We define the first “weekly” return of the quarter as the first five trading days of the quarter.<sup>19</sup> We similarly define 11 other weekly returns for a total of 12 weekly returns each quarter. Depending on the number of days in the quarter, one to four of the “middle weeks” get an extra trading day.<sup>20</sup> We then estimate the contemporaneous weekly covariances, each quarter, using formulas analogous to equations (6) and (7) (see appendix for specific formulas).

Panel B in Table 4 reports that the estimated weekly contemporaneous covariance accounts for, on average, 74 percent of the covariance between quarterly changes in institutional ownership and returns. Moreover, the average contemporaneous covariance differs from zero at the 1 percent level. When examining the covariances further partitioned by each investor type, the contemporaneous covariance differs significantly from zero (at the 1 percent level or better) for each investor type except “others.” The weekly contemporaneous covariance accounts for 39 percent (for others) to 99 percent (for banks) of the corresponding quarterly covariance given in the first row.

The next two rows in Panel B report the estimate from the beginning of the quarter (analogous to equation (6)) and the estimate from the end of the quarter (analogous to equation (7)) separately. Again, because lag covariances are greater than lead covariances, the end-of-quarter estimate (which suggests the contemporaneous weekly covariance accounts for 82 percent of the quarterly covariance) is likely the better estimate (i.e., the “remainder” is smaller). Both estimates, however, are statistically significant at the 1 percent level.

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<sup>19</sup> Because we can only observe institutional ownership at the beginning and end of each quarter, we define “weeks” as five to six consecutive trading days within the quarter.

<sup>20</sup> Specifically, in the case of 61 trading days, weeks 1-6 and 8-12 get five trading days, and week 7 gets the extra trading day. In the case of 62 trading days, weeks 7 and 8 get the extra days. In the case of 63 trading days, weeks 6, 7, and 8 get the extra trading days. In the case of 64 trading days, weeks 6-9 get the extra trading days.

### **3.2 Decomposing quarterly covariances by day**

Because the number of trading days in any quarter ranges from 61 to 64 days, the exact formula used to estimate each partitioned covariance depends on the number of days in the quarter (see Appendix). Panel C in Table 4 reports the estimated daily contemporaneous covariance accounts for, on average, 86 percent of the covariance between quarterly changes in institutional ownership and returns the same quarter. The daily contemporaneous covariance estimates differ significantly from zero at the 1 percent level for institutions in aggregate as well as, banks, mutual funds, and independent investment advisors.

The last two rows in Panel C report the beginning-of-quarter estimate and end-of-quarter estimate separately. As in Panels A and B, the end-of-quarter estimate is greater than the beginning-of-quarter estimate again suggesting lag covariances are greater than lead covariances. In fact, the end-of-quarter estimate suggests that the daily contemporaneous covariance accounts for all of the quarterly covariance.<sup>21</sup>

### **4. Source of Price Pressure**

The evidence from the previous sections suggests the large majority of the relation between changes in institutional ownership and returns is a result of price pressure. There are two explanations for this price pressure: Either large institutions have better information that is revealed when they trade or institutions face a liquidity cost when they trade. We next consider which of these possibilities is more likely. If the price pressure induced by institutional trading results from informed trading, then price changes associated with changes in institutional ownership should be permanent. Alternatively, if temporary liquidity constraints are responsible for the price pressure, then the price changes should be temporary.

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<sup>21</sup> In unreported results, we also generate estimates from equations analogous to equation (5). These estimates tend to be slightly smaller than the estimates generated from equations analogous to equation (6). This is expected because the results in Table 3 suggest the “remainder” covariances from equation (5) are greater than the “remainder” covariances in equation (6). Nonetheless, even these coarser estimates suggest that most of the covariance between quarterly changes in institutional ownership and quarterly returns arises from the covariance between daily changes in institutional ownership and returns the same day. For example, our point estimate using equations analogous to equation (5) reveals that the contemporaneous daily covariance accounts for a minimum of

Tables I and III shows that returns subsequent to institutional buys (sells) tend to be positive (negative), implying a permanent change, which supports the information models of price pressure rather than the liquidity/inventory models.

We can employ a second test to differentiate the two hypotheses by comparing the strength of the relation between contemporaneous stock returns and changes in two different measures of institutional ownership – the number of institutions holding the stock and the fraction of shares they hold. If price pressure results from liquidity constraints, we expect returns to be more strongly related to changes in the fraction of shares held by institutional investors than to changes in the number of institutions holding the stock, because share volume should better capture liquidity constraints. Alternatively, as noted in the introduction, the informed trading hypothesis suggests returns should be more strongly related to changes in the number of institutional investors than changes in the fraction of shares held by institutional investors.

For each quarter, we compute the cross-sectional correlations between the two institutional ownership change variables and quarterly returns measured over three different periods: the same quarter, the previous quarter, and the following quarter. The time-series averages of the quarterly cross-sectional correlations (and associated  $t$ -statistics) are reported in Table 5, where the change in number of institutions is used for the correlations reported in the first row and the change in their fractional holdings is used for the correlations reported in the second row.<sup>22</sup> We also calculate the difference, each quarter, between the correlation based on changes in the number of institutional investors and the correlation based on changes in the fraction of shares held by institutional investors and then estimate a paired  $t$ -test of the hypothesis that the mean correlations are equal. The last row in Table 5 reports the mean differences between the correlations and the associated  $t$ -statistics.

[Insert Table 5 about here]

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73 percent of the quarterly covariance (compared to an estimate of 86 percent based on equations analogous to equation (6)).

<sup>22</sup> The  $t$ -statistics are computed from time-series standard errors.

A comparison of the correlations calculated with the number of institutions holding shares to those calculated with the fraction of shares held by institutions supports the informed trading explanation over the liquidity explanation. Specifically, as shown in Table 5, the correlations using the change in the number of institutions as the measure of institutional ownership are substantially larger than the correlations using the change in the fraction of shares held by institutions as the measure of ownership. In fact, the mean correlation between changes in the number of institutional investors and returns measured over the same quarter is 133 percent greater than the mean correlation between changes in the fraction of shares held by institutional investors and returns measured over the same quarter. We also document a 61 percent larger average correlation for lag quarterly returns and a 59 percent larger average correlation for subsequent quarterly returns. Moreover, these differences are statistically significant at the 1 percent level for both prior quarter and contemporaneous quarter returns.

As a final test of the relative strength of the relations between contemporaneous returns and the two measures of changes in institutional holdings, we estimate cross-sectional regressions of contemporaneous quarterly returns on changes in the number of institutional investors and changes in the fraction of shares held by institutional investors. To allow direct comparison of the estimated coefficients, we standardized (i.e., rescale to zero mean, unit variance) both the dependent and independent variables.<sup>23</sup> The average coefficients from the 68 cross-sectional regressions and associated  $t$ -statistics (in parentheses, computed from time-series standard errors) are:

$$r_{qtr} = 0.0419(\mathbf{D}_{qtr} \% \text{ shares held by institutions}) \quad + 0.2581(\mathbf{D}_{qtr} \text{ number of institutions})$$

(5.13) (31.10)

According to the  $t$ -statistics, both coefficients differ significantly from zero at the 1 percent level. In addition, the average  $R^2$  is 8.28 percent. The standardized coefficients reveal that a one standard deviation increase in the fraction of shares held by institutional investors is associated with a 0.0419 standard deviation larger quarterly return while a one standard deviation increase in the number of

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<sup>23</sup> Because standardization is simply a linear rescaling of the original variables, the  $R^2$  is not affected. In addition, because all (rescaled) variables are mean zero, the intercept is zero.

institutional investors is associated with a 0.2581 standard deviation larger quarterly return. Although the average coefficients for both differ significantly from zero, the average coefficient associated with the change in the number of institutions is over six times the average coefficient associated with the change in the fraction of shares held by institutions. Moreover, a paired  $t$ -test of the hypothesis that the coefficients are equal is rejected at the 1 percent level ( $t$ -statistic=19.70). In sum, consistent with the informed trading hypothesis, the results show that returns are much more strongly related to changes in the number of institutional investors than to changes in the fraction of shares held by institutional investors.

## 5. Robustness Tests

### 5.1 Potential bias due to window-dressing

Our analysis to this point assumes the covariance between changes in institutional holdings and lead or lag returns is independent of the calendar date. For example, equation (6) assumes that the expected value of the covariance between changes in ownership the last month in the quarter and returns in the first month in the quarter ( $cov(\mathbf{D}_2, r_0)$ ) equals the expected value of the covariance between changes in ownership the second month in the quarter and returns one month prior to the quarter ( $cov(\mathbf{D}_1, r_{-1})$ ). In other words, we are assuming that the covariance between portfolio changes in December and returns in October is equal, on average, to the covariance between portfolio changes in November and returns in September.

One might expect this assumption to be violated if institutional investors have a tendency to “window-dress” at the end of each quarter.<sup>24</sup> If so, changes in ownership at the end of the quarter could be more strongly related to returns of a given lag than changes in ownership in the middle of the quarter are related to returns of the same lag.

We address the issue of potential bias due to window-dressing in several ways. First, it is important to note that there is little evidence of systematic institutional window-dressing. Lakonishok,

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<sup>24</sup> Window-dressing refers to institutional investors selling losers and/or buying winners to present “respectable” portfolios to sponsors.

Shleifer, Thaler, and Vishny (1991), for example, report that although some pension funds appear to sell poorly-performing stocks at the end of the quarter, other pension funds buy poorly-performing stocks at the end of the quarter. Window-dressing will only be an issue if institutional investors, as a group, window-dress. If some institutional investors' window-dressing sells are offset by other institutional investors' purchases, there will be no net change in institutional ownership and our results will not be affected.<sup>25</sup>

Second, the limited evidence supporting the window-dressing hypothesis that does exist suggests it only occurs at the turn-of-the-year (see, for example, Lakonishok, Shleifer, Thaler, and Vishny, 1991). Therefore, we repeat the analyses in Tables 4 excluding estimates garnered from both the first and last quarters of the year. Our results remain similar to those that include all quarters. For example, the monthly contemporaneous covariance accounts for 79 percent of the quarterly covariance when excluding the first and fourth quarters and 80 percent of the quarterly covariance when including all quarters.<sup>26</sup>

Third, this potential bias is likely to be less important as we move to a finer partitioning of the data. If institutional investors only window-dress in the last week in the quarter, the potential bias remains. To the extent that institutional investors begin to window-dress in the second week prior to the end of the quarter, the potential bias is diminished. A similar argument holds for the daily analysis. If institutional window-dressing is done any time prior to the last day of the quarter, the potential bias is diminished.<sup>27</sup>

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<sup>25</sup> Similarly, Griffiths and White (1993) and Chen and Singal (2001) find little evidence of institutional window-dressing.

<sup>26</sup> Similarly, excluding the first and fourth quarters, we estimate the weekly (daily) contemporaneous covariance accounts for 70 percent (59 percent) of the quarterly covariance.

<sup>27</sup> For example, in our analysis of 12 weekly returns each quarter, our first estimate of the weekly contemporaneous covariance is given by the difference between the covariance of the quarterly change in institutional ownership and returns the first week of the quarter and the covariance of the quarterly change in institutional ownership and returns in the week prior to the quarter. The covariance of returns the first week in the quarter consists of one weekly contemporaneous covariance plus one each of a lag one- to lag 11-week covariance. The covariance based on returns the week prior to the quarter consists of one each of a lag one- to lag-12 week covariance. The difference, therefore, is the weekly contemporaneous covariance less the lag 12-week covariance if the lag 1- to lag 11-week covariance have the same expected values for returns the first week in the quarter and returns the week prior to the quarter. For example, the lag 11-week covariance based on the return the first week in the quarter is the covariance between returns the first week in the quarter and the change in institutional ownership the last week in the quarter. The lag 11-week covariance based on the return the week prior to the quarter is the covariance between returns the

Fourth, although window-dressing has the potential to bias the beginning-of-quarter estimate (e.g., Equation (6)), it should not bias the end-of-quarter estimate (e.g., Equation (7)). Specifically, the end-of-quarter estimates only consider contemporaneous and future returns. We assume, for example, that the covariance between portfolio changes in October and returns in December is equal, on average, to the covariance between portfolio changes in November and returns in January. The results reported in Table 3, however, reveal that end-of-quarter estimates tend to be larger than beginning-of-quarter estimates.<sup>28</sup>

In sum, although institutional window-dressing has the potential to bias our estimates, any bias is likely to be quite small, our results remain intact when we exclude the turn-of-the-year period, and this potential bias is likely to be less important as our partitioning moves to a finer interval (e.g., less important for weekly estimates than monthly estimates). Most important, although window-dressing has the potential to bias the beginning-of-quarter estimate, window-dressing cannot bias the end-of-quarter estimate. Given the end-of-quarter estimates tend to be larger than the beginning-of-quarter estimates, any potential bias induced by window-dressing does not appear to be severe.

## 5.2 Stationarity of covariances

If the contemporaneous correlation is due to either information revealed by institutional trades or liquidity effects, we expect that as the proportion of institutional traders grows there would be a contemporaneous increase in the covariance. In addition, we expect the market to become more efficient with more

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week prior to the quarter and the change in institutional ownership the second to last week in the quarter. If institutional investors only window-dress the last week of the quarter the potential bias remains. To the extent that institutional investors begin to window-dress in the second week prior to the end of the quarter, the potential bias is diminished.

<sup>28</sup> As noted previously, because changes in institutional ownership are more strongly related to lag returns than future returns, it is not surprising that end-of-quarter estimates are greater than beginning-of-quarter estimates. Thus, although window-dressing may impact an upward bias on the beginning-of-quarter estimates, the downward bias induced by subtracting the covariance of changes in institutional ownership and lag returns appears to be much greater. End-of-quarter estimates (that tend to be greater than beginning-of-quarter estimates) are immune from the window-dressing bias and have a smaller downward bias than beginning-of-quarter estimates as the covariance between changes in institutional ownership and future returns is smaller than the covariance between changes in institutional ownership and lag returns.

institutional trades, so that covariances with the following quarter returns should be lower. To test these hypotheses, we divide our sample into two periods. The first period runs from the first quarter of 1980 through the second quarter of 1988. The second period runs from the third quarter of 1988 through the fourth quarter of 1996. Within each of the two periods, we examine the decile of stocks with the largest increase in the number of institutional investors versus the decile of stocks with the largest decrease in the number of institutional investors. The results (not shown) suggest that institutional trades affect prices more in the later half of the sample than in the earlier half. However, we find no evidence of increased efficiency – the returns in the following quarter do not change much over time.

### **5.3 Measure of institutional ownership change**

Although specific results are not reported, we find qualitatively similar results when we repeat the analyses in Table 4 using changes in the fraction of shares held by institutional investors. For example, using changes in fractional ownership, we estimate that 83 percent of the quarterly covariance is apportioned to price movements that occur the same day as the change in institutional ownership. In general, however, standard errors based on changes in fractional ownership are larger than the standard errors based on changes in the number of institutional investors.

## **6. Conclusions**

There is a strong positive cross-sectional relation between quarterly changes in institutional ownership and returns measured over the same quarter. This relation has three possible sources: (1) intra-quarter feedback trading, (2) the price impact of institutional trading, and (3) changes in institutional ownership leading intra-quarter returns. Our decomposition results suggest that most of the contemporaneous covariance between quarterly changes in institutional holdings and returns arises because institutional buying and selling move prices.

There are two potential reasons changes in institutional ownership may affect returns. First, institutional trading may have temporary liquidity effects. Such a situation could result if institutional

investors generally initiate trades and other investors stand ready to buy when prices fall and sell when prices rise. We propose that if price changes associated with changes in institutional ownership are driven by temporary liquidity effects, then (1) returns associated with changes in institutional ownership should be temporary, and (2) the relation between returns and changes in institutional ownership should be stronger when institutional ownership is measured using the fraction of shares held by institutions rather than by the number of institutional investors holding the stock.

The second potential reason changes in institutional ownership move prices is that informed trading moves prices and institutional investors are more likely to be informed than other investors. If so, then (1) returns associated with changes in institutional ownership should be permanent, and (2) returns should be more strongly related to the number of institutions entering or leaving the stock than changes in the fraction of shares held by institutions.

Our results support the second reason. First, we find changes in institutional ownership are weakly, but positively, correlated with future returns. This result is consistent with other recent studies (e.g., Daniel, Grinblatt, Titman, and Wermers, 1997; Wermers, 1999, 2000; Nofsinger and Sias, 1999) and the informed trading hypothesis, but inconsistent with the temporary liquidity hypothesis. Further consistent with the informed trading explanation we document that contemporaneous returns are more strongly related to changes in the number of institutional shareholders than changes in the fraction of shares held by institutional investors. In sum, our results suggest that returns are correlated with changes in institutional ownership because institutional investors' informed trading impacts prices.

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Table 1

Average correlations and covariances between quarterly changes in institutional ownership and return over the prior, same, and following quarters

Investor	Prior quarter	Same quarter	Following quarter
<b>Panel A: Average cross-sectional correlation</b>			
<b>All institutions</b>	0.1302 (14.56)**	0.2678 (29.95)**	0.0216 (2.35)*
<b>Bank trusts</b>	0.0760 (9.16)**	0.1907 (20.54)**	0.0054 (0.66)
<b>Insurance companies</b>	0.0710 (11.71)**	0.1026 (16.92)**	0.0057 (1.19)
<b>Mutual funds</b>	0.0835 (15.93)**	0.1542 (21.34)**	0.0213 (3.34)**
<b>Independent advisors</b>	0.1110 (14.76)**	0.2413 (36.69)**	0.0229 (3.09)**
<b>Others</b>	0.0572 (8.97)**	0.0687 (11.54)**	0.0071 (1.28)
<b>Panel B: Average cross-sectional covariance</b>			
<b>All institutions</b>	0.1681 (11.79)**	0.3504 (21.78)**	0.0244 (1.85)
<b>Bank trusts</b>	0.0415 (7.79)**	0.1099 (17.14)**	0.0026 (0.48)
<b>Insurance companies</b>	0.0153 (11.26)**	0.0228 (14.50)**	0.0012 (1.13)
<b>Mutual funds</b>	0.0187 (11.36)**	0.0359 (14.23)**	0.0046 (3.12)**
<b>Independent advisors</b>	0.0804 (10.81)**	0.1674 (19.27)**	0.0149 (2.55)**
<b>Others</b>	0.0121 (7.48)**	0.0145 (10.19)**	0.0012 (0.88)

Each quarter between 1979:4 and 1996:4 (for a total of 68 quarters), we estimate the cross-sectional correlation and covariance between changes in the number of institutional investors holding each security and returns measured over the previous, same, and following quarters for all NYSE stocks with return and institutional ownership data available. The sample size ranges from 1,456 firms in 1986:4 to 2,585 firms in 1996:4. Panel A reports time-series mean correlation coefficients (and associated *t*-statistics). Panel B reports time-series mean covariances. The *t*-statistics reported in Panels A and B are based on standard errors computed from time-series variation in the 68 cross-sectional estimates of correlation and covariance, respectively. \*\* indicates statistical significance at the 1 percent level; \* at the 5 percent level.

**Table 2**

**Decomposition of covariance between quarterly changes in institutional ownership and quarterly returns**

**Panel A: Covariance of quarterly institutional ownership change with monthly returns within quarter**

		$cov(\mathbf{D}_0, r_0)$	Contemporaneous	$C$
Covariance 0	$cov(\mathbf{D}_{0,2}, r_0)$	$cov(\mathbf{D}_1, r_0)$	Lag 1-month	$L1$
		$cov(\mathbf{D}_2, r_0)$	Lag 2-months	$L2$
		$cov(\mathbf{D}_0, r_1)$	Lead 1-month	$F1$
Covariance 1	$cov(\mathbf{D}_{0,2}, r_1)$	$cov(\mathbf{D}_1, r_1)$	Contemporaneous	$C$
		$cov(\mathbf{D}_2, r_1)$	Lag 1-month	$L1$
		$cov(\mathbf{D}_0, r_2)$	Lead 2-months	$F2$
Covariance 2	$cov(\mathbf{D}_{0,2}, r_2)$	$cov(\mathbf{D}_1, r_2)$	Lead 1-month	$F1$
		$cov(\mathbf{D}_2, r_2)$	Contemporaneous	$C$

**Panel B: Covariance of quarterly institutional ownership change with returns in previous four months**

		$cov(\mathbf{D}_0, r_{-1})$	Lag 1-months	$L1$
Covariance -1	$cov(\mathbf{D}_{0,2}, r_{-1})$	$cov(\mathbf{D}_1, r_{-1})$	Lag 2-months	$L2$
		$cov(\mathbf{D}_2, r_{-1})$	Lag 3-months	$L3$
		$cov(\mathbf{D}_0, r_{-2})$	Lag 2-months	$L2$
Covariance -2	$cov(\mathbf{D}_{0,2}, r_{-2})$	$cov(\mathbf{D}_1, r_{-2})$	Lag 3-months	$L3$
		$cov(\mathbf{D}_2, r_{-2})$	Lag 4-months	$L4$
		$cov(\mathbf{D}_0, r_{-3})$	Lag 3-months	$L3$
Covariance -3	$cov(\mathbf{D}_{0,2}, r_{-3})$	$cov(\mathbf{D}_1, r_{-3})$	Lag 4-months	$L4$
		$cov(\mathbf{D}_2, r_{-3})$	Lag 5-months	$L5$
		$cov(\mathbf{D}_0, r_{-4})$	Lag 4-months	$L4$
Covariance -4	$cov(\mathbf{D}_{0,2}, r_{-4})$	$cov(\mathbf{D}_1, r_{-4})$	Lag 5-months	$L5$
		$cov(\mathbf{D}_2, r_{-4})$	Lag 6-months	$L6$

**Panel C: Beginning-of-quarter estimation of monthly contemporaneous covariance**

$$cov(\mathbf{D}_{0,2}, r_0) - cov(\mathbf{D}_{0,2}, r_{-1}) + cov(\mathbf{D}_{0,2}, r_{-3}) - cov(\mathbf{D}_{0,2}, r_{-4})$$

$$= \text{Covariance 0 less Covariance -1 plus Covariance -3 less Covariance -4}$$

$$= [C + L1 + L2] - [L1 + L2 + L3] + [L3 + L4 + L5] - [L4 + L5 + L6]$$

$$= C - L6$$

**Table 2 (continued)**

**Decomposition of covariance between quarterly changes in institutional ownership and quarterly returns**

**Panel D: Covariance of quarterly institutional ownership change with returns in following four months**

		$cov(\mathbf{D}_0, r_3)$	Lead 3-months	$F3$
Covariance 3	$cov(\mathbf{D}_{0,2}, r_3)$	$cov(\mathbf{D}_1, r_3)$	Lead 2-months	$F2$
		$cov(\mathbf{D}_2, r_3)$	Lead 1-months	$F1$
		$cov(\mathbf{D}_0, r_4)$	Lead 4-months	$F4$
Covariance 4	$cov(\mathbf{D}_{0,2}, r_4)$	$cov(\mathbf{D}_1, r_4)$	Lead 3-months	$F3$
		$cov(\mathbf{D}_2, r_4)$	Lead 2-months	$F2$
		$cov(\mathbf{D}_0, r_5)$	Lead 5-months	$F5$
Covariance 5	$cov(\mathbf{D}_{0,2}, r_5)$	$cov(\mathbf{D}_1, r_5)$	Lead 4-months	$F4$
		$cov(\mathbf{D}_2, r_5)$	Lead 3-months	$F3$
		$cov(\mathbf{D}_0, r_6)$	Lead 6-months	$F6$
Covariance 6	$cov(\mathbf{D}_{0,2}, r_6)$	$cov(\mathbf{D}_1, r_6)$	Lead 5-months	$F5$
		$cov(\mathbf{D}_2, r_6)$	Lead 4-months	$F4$

**Panel E: End-of-quarter estimation of monthly contemporaneous covariance**

$$cov(\mathbf{D}_{0,2}, r_2) - cov(\mathbf{D}_{0,2}, r_2) + cov(\mathbf{D}_{0,2}, r_5) - cov(\mathbf{D}_{0,2}, r_6)$$

$$= \text{Covariance 2 less Covariance 3 plus Covariance 4 less Covariance 6}$$

$$= [C + F1 + F2] - [F1 + F2 + F3] + [F3 + F4 + F5] - [F4 + F5 + F6]$$

$$= C - F6$$

This table shows the decomposition of the covariance between quarterly changes in institutional ownership and quarterly returns. Panel A shows the covariances of quarterly changes in institutional ownership with each of the monthly returns within the quarter, i.e., a tabular representation of equation (4). Panel B shows the covariances of quarterly changes in institutional ownership with each of the four monthly returns preceding the quarter. Panel C shows how the observable beginning-of-quarter covariances can be combined to achieve an estimate of the contemporaneous monthly covariance. Panel D shows the covariances of quarterly changes in institutional ownership with each of the four monthly returns following the quarter. Panel E shows how the observable end-of-quarter covariances can be combined to achieve an estimate of the contemporaneous monthly covariance.

**Table 3**

**Average covariance between quarterly changes in number of institutional investors and contemporaneous, lead, and lag monthly returns**

Continuous return measured over: (representing covariances of lead/lag)	DInstitutions covariance ( <i>t</i> -statistic)	Total covariance over quarter
<b>6 months prior</b> ( $cov(D_{0,2},r_{.6})$ ) $cov(L6)+cov(L7)+cov(L8)$	0.0398 (7.47)**	
<b>5 months prior</b> ( $cov(D_{0,2},r_{.5})$ ) $cov(L5)+cov(L6)+cov(L7)$	0.0298 (5.97)**	
<b>4 months prior</b> ( $cov(D_{0,2},r_{.4})$ ) $cov(L4)+cov(L5)+cov(L6)$	0.0378 (8.06)**	
<b>3 months prior</b> ( $cov(D_{0,2},r_{.3})$ ) $cov(L3)+cov(L4)+cov(L5)$	0.0511 (8.28)**	.1681
<b>2 months prior</b> ( $cov(D_{0,2},r_{.2})$ ) $cov(L2)+cov(L3)+cov(L4)$	0.0445 (8.95)**	
<b>Prior month</b> ( $cov(D_{0,2},r_{.1})$ ) $cov(L1)+cov(L2)+cov(L3)$	0.0725 (10.73)**	
<b>First month in quarter</b> ( $cov(D_{0,2},r_0)$ ) $cov(C)+cov(L1)+cov(L2)$	0.1501 (15.58)**	.3504
<b>Second month in quarter</b> ( $cov(D_{0,2},r_1)$ ) $cov(F1)+cov(C)+cov(L1)$	0.1029 (15.29)**	
<b>Third month in quarter</b> ( $cov(D_{0,2},r_2)$ ) $cov(F1)+cov(F2)+cov(C)$	0.0974 (13.76)**	
<b>Month following</b> ( $cov(D_{0,2},r_3)$ ) $cov(F1)+cov(F2)+cov(F3)$	0.0113 (1.37)	.0244
<b>2<sup>nd</sup> month following</b> ( $cov(D_{0,2},r_4)$ ) $cov(F2)+cov(F3)+cov(F4)$	-0.0006 (-0.09)	
<b>3<sup>rd</sup> month following</b> ( $cov(D_{0,2},r_5)$ ) $cov(F3)+cov(F4)+cov(F5)$	0.0137 (2.41)*	
<b>4<sup>th</sup> month following</b> ( $cov(D_{0,2},r_6)$ ) $cov(F4)+cov(F5)+cov(F6)$	0.0032 (0.45)	
<b>5<sup>th</sup> month following</b> ( $cov(D_{0,2},r_7)$ ) $cov(F5)+cov(F6)+cov(F7)$	0.0107 (2.20)*	
<b>6<sup>th</sup> month following</b> ( $cov(D_{0,2},r_8)$ ) $cov(F6)+cov(F7)+cov(F8)$	0.0229 (4.71)**	

Each quarter between 1979:4 and 1996:4 (for a total of 68 quarters), we estimate the cross-sectional covariance between changes in the number of institutional investors and returns measured over each of the previous and following six months. The time-series mean covariance (and associated *t*-statistic) is reported for each month. The *t*-statistic is based on the standard error computed from time-series variation in the 68 covariance estimates. \*\* indicates statistical significance at the 1 percent level; \* at the 5 percent level.

**Table 4**  
**Monthly, weekly, and daily partitioning of covariance between quarterly changes in institutional ownership and returns**

Estimate from:	Fraction of quarterly	Total	Banks	Insurance companies	Mutual funds	Independent advisors	Others
		0.3504 (21.78)**	0.1099 (17.14)**	0.0228 (14.50)**	0.0359 (14.23)**	0.1674 (19.27)**	0.0145 (10.19)**
<b>Panel A: Minimum monthly contemporaneous covariance</b>							
<b>Average of beginning - and end-of-qtr estimates</b>	80.19%	0.2810 (10.99)**	0.0994 (10.67)**	0.0162 (6.19)**	0.0264 (8.87)**	0.1289 (9.91)**	0.0101 (3.32)**
<b>Beginning-of-quarter estimate</b>	77.63%	0.2720 (9.40)**	0.0939 (8.86)**	0.0138 (4.06)**	0.0273 (7.41)**	0.1306 (7.94)**	0.0064 (1.82)
<b>End-of-quarter estimate</b>	82.79%	0.2901 (6.85)**	0.1049 (6.82)**	0.0186 (4.67)**	0.0254 (5.42)**	0.1272 (6.28)**	0.0139 (2.79)**
<b>Panel B: Minimum weekly contemporaneous covariance</b>							
<b>Average of beginning - and end-of-qtr estimates</b>	73.69%	0.2582 (5.02)**	0.1086 (5.50)**	0.0151 (2.99)**	0.0312 (5.56)**	0.0976 (4.00)**	0.0057 (0.90)
<b>Beginning-of-quarter estimate</b>	65.10%	0.2281 (3.79)**	0.0835 (3.37)**	0.0053 (0.78)	0.0360 (5.96)**	0.1065 (3.69)**	-0.0032 (-0.37)
<b>End-of-quarter estimate</b>	82.31%	0.2884 (3.45)**	0.1337 (4.37)**	0.0249 (3.39)**	0.0265 (2.79)**	0.0887 (2.24)*	0.0146 (1.61)
<b>Panel C: Minimum daily contemporaneous covariance</b>							
<b>Average of beginning - and end-of-qtr estimates</b>	85.76%	0.3005 (3.40)**	0.1131 (3.24)**	0.0174 (1.57)	0.0405 (3.56)**	0.1210 (2.75)**	0.0085 (0.56)
<b>Beginning-of-quarter estimate</b>	65.04%	0.2279 (2.13)*	0.0368 (0.79)	0.0043 (0.29)	0.0470 (2.99)**	0.1610 (3.24)**	-0.0212 (-0.96)
<b>End-of-quarter estimate</b>	106.45%	0.3730 (2.65)**	0.1893 (3.75)**	0.0305 (1.87)	0.0339 (2.05)*	0.0810 (1.12)	0.0382 (1.87)

Each quarter we estimate the cross-sectional covariance between quarterly changes in the number of institutional investors (overall and by type) and returns measured over the same quarter. The first row reports the time-series average (and associated  $t$ -statistic) of these 68 cross-sectional quarterly covariances. Using equations (6) and (7) and the formulas given in the appendix, we then generate two estimates, each quarter, of the minimum covariance between monthly, weekly, and daily changes in institutional ownership and contemporaneous monthly, weekly, or daily returns. These covariance estimates are multiplied by the number of terms they contribute to the quarterly covariance to generate our estimate of each monthly (weekly or daily) covariance term's contribution to the quarterly covariance. The second row reports the time-series average of the 68 estimates garnered from differences in covariances at the beginning of the quarter (e.g., equation (6)). The third row reports the time-series average of the 68 estimates garnered from differences in covariances at the end of the quarter (e.g., equation (7)). The first row reports the average across all 136 estimates. Results for monthly, weekly, and daily partitioning are reported in Panels A, B, and C, respectively. The  $t$ -statistics are based on standard errors computed from time-series variation in the estimates. \*\* indicates statistical significance at the 1 percent level; \* at the 5 percent level.

**Table 5**

**Average correlations between quarterly changes in the number of institutions, quarterly changes in the fraction of shares held by institutions, and returns over the prior, same, and following quarters**

<b>Change in:</b>	<b>Prior quarter</b>	<b>Same quarter</b>	<b>Following quarter</b>
<b>Number of institutional investors</b>	0.1302 (14.56)**	0.2678 (29.95)**	0.0216 (2.35)*
<b>Fraction of shares held by institutional investors</b>	0.0808 (12.45)**	0.1151 (14.08)**	0.0136 (2.76)**
<b>Difference</b>	0.0494 (6.67)**	0.1527 (20.19)**	0.0080 (0.99)

Each quarter between 1979:4 and 1996:4 (for a total of 68 quarters), we estimate the cross-sectional correlation between quarterly changes in the number of institutional investors and quarterly returns measured over the previous, same, and following quarters for all NYSE stocks with return and institutional ownership data available. Similarly, we estimate the cross-sectional correlation between quarterly changes in the fraction of shares held by institutional investors and quarterly returns measured over the previous, same, and following quarters. The sample size ranges from 1,456 firms in 1986:4 to 2,585 firms in 1996:4. The time-series mean correlation coefficients (and associated *t*-statistic) are reported in the first two rows. The *t*-statistics in the first two rows are based on the standard error computed from time-series variation in the 68 correlation coefficients. The last row reports the mean difference between the correlations in the first two rows. The *t*-statistic reported in the last row is computed from a paired *t*-test estimated from the time-series of the 68 correlation coefficients. \*\* indicates statistical significance at the 1 percent level; \* at the 5 percent level.

**Appendix**  
**Estimated Covariance Terms**

Assume there are  $N$  sub-periods in the quarter and the quarter runs from sub-period 0 to  $N-1$  (e.g., with the monthly partitioning there are three months – months 0, 1, and 2). The covariance between the return for the last sub-period in the quarter (i.e., the return over period  $N-1$ ) and the change in the ownership over the quarter is given by:

$$\text{cov}(\mathbf{D}_{0,N-1}, r_{N-1}) = \text{cov}(\mathbf{D}_0, r_{N-1}) + \text{cov}(\mathbf{D}_1, r_{N-1}) + \dots + \text{cov}(\mathbf{D}_{N-2}, r_{N-1}) + \text{cov}(\mathbf{D}_{N-1}, r_{N-1}) \quad (\text{A1})$$

Following the notation in the paper, the expected value of the equation (A1) is:

$$E(\text{cov}(\mathbf{D}_{0,N-1}, r_{N-1})) = E(\text{cov}(F(N-1))) + E(\text{cov}(F(N-2))) + \dots + E(\text{cov}(F1)) + E(\text{cov}(C)) \quad (\text{A2})$$

The covariance between the return for the first sub-period beyond the quarter (i.e., the return over period  $N$ ) and the change in institutional ownership over the quarter is given by:

$$\text{cov}(\mathbf{D}_{0,N-1}, r_N) = \text{cov}(\mathbf{D}_0, r_N) + \text{cov}(\mathbf{D}_1, r_N) + \dots + \text{cov}(\mathbf{D}_{N-2}, r_N) + \text{cov}(\mathbf{D}_{N-1}, r_N) \quad (\text{A3})$$

The expected value of the equation (A3) is:

$$E(\text{cov}(\mathbf{D}_{0,N-1}, r_N)) = E(\text{cov}(F(N))) + E(\text{cov}(F(N-1))) + \dots + E(\text{cov}(F2)) + E(\text{cov}(F1)) \quad (\text{A4})$$

The covariance between the return for sub-period  $2N-1$  and the change in institutional ownership over the quarter is given by:

$$\text{cov}(\mathbf{D}_{0,N-1}, r_{2N-1}) = \text{cov}(\mathbf{D}_0, r_{2N-1}) + \text{cov}(\mathbf{D}_1, r_{2N-1}) + \dots + \text{cov}(\mathbf{D}_{N-2}, r_{2N-1}) + \text{cov}(\mathbf{D}_{N-1}, r_{2N-1}) \quad (\text{A5})$$

The expected value of the equation (A5) is:

$$E(\text{cov}(\mathbf{D}_{0,N-1}, r_{2N-1})) = E(\text{cov}(F(2N-1))) + E(\text{cov}(F(2N-2))) + \dots + E(\text{cov}(F(N+1))) + E(\text{cov}(FN)) \quad (\text{A6})$$

The covariance between the return for sub-period  $2N$  and the change in institutional ownership over the quarter is given by:

$$\text{cov}(\mathbf{D}_{0,N-1}, r_{2N}) = \text{cov}(\mathbf{D}_0, r_{2N}) + \text{cov}(\mathbf{D}_1, r_{2N}) + \dots + \text{cov}(\mathbf{D}_{N-2}, r_{2N}) + \text{cov}(\mathbf{D}_{N-1}, r_{2N}) \quad (\text{A7})$$

The expected value of the equation (A7) is:

$$E(\text{cov}(\mathbf{D}_{0,N-1}, r_{2N})) = E(\text{cov}(F(2N))) + E(\text{cov}(F(2N-1))) + \dots + E(\text{cov}(F(N+2))) + E(\text{cov}(F(N+1))) \quad (\text{A8})$$

Equation (A1) less (A3) plus (A5) less (A7) gives our first estimate of the contemporaneous covariance:

$$EstI(cov(C)) = cov(\mathbf{D}_{0,N-1}, r_{N-1}) - cov(\mathbf{D}_{0,N-1}, r_N) + cov(\mathbf{D}_{0,N-1}, r_{2N-1}) - cov(\mathbf{D}_{0,N-1}, r_{2N}) \quad (A9)$$

Thus, the expected value of our first estimate of the contemporaneous covariance is given by the expected value of equation (A9), or equivalently, equation (A2) less (A4) plus (A6) less (A8):

$$E(EstI(cov(C))) = E(cov(C)) - E(cov(F(2N))) \quad (A10)$$

Comparing covariances at the beginning of the quarter generates our second estimate of the contemporaneous covariance. Specifically, the covariance between the return for the first sub-period in the quarter (i.e., the return over period 0) and the change in the ownership over the quarter is given by:

$$cov(\mathbf{D}_{0,N-1}, r_0) = cov(\mathbf{D}_0, r_0) + cov(\mathbf{D}_1, r_0) + \dots + cov(\mathbf{D}_{N-2}, r_0) + cov(\mathbf{D}_{N-1}, r_0) \quad (A11)$$

The expected value of the equation (A11) is:

$$E(cov(\mathbf{D}_{0,N-1}, r_0)) = E(cov(C)) + E(cov(L1)) + \dots + E(cov(L(N-2))) + E(cov(L(N-1))) \quad (A12)$$

The covariance between the return in the sub-period just before the quarter (i.e., the return over period -1) and the change in institutional ownership over the quarter is given by:

$$cov(\mathbf{D}_{0,N-1}, r_{-1}) = cov(\mathbf{D}_0, r_{-1}) + cov(\mathbf{D}_1, r_{-1}) + \dots + cov(\mathbf{D}_{N-2}, r_{-1}) + cov(\mathbf{D}_{N-1}, r_{-1}) \quad (A13)$$

The expected value of the equation (A13) is:

$$E(cov(\mathbf{D}_{0,N-1}, r_{-1})) = E(cov(L1)) + E(cov(L2)) + \dots + E(cov(L(N-1))) + E(cov(LN)) \quad (A14)$$

The covariance between the return for sub-period -N and the change in institutional ownership over the quarter is given by:

$$cov(\mathbf{D}_{0,N-1}, r_{-N}) = cov(\mathbf{D}_0, r_{-N}) + cov(\mathbf{D}_1, r_{-N}) + \dots + cov(\mathbf{D}_{N-2}, r_{-N}) + cov(\mathbf{D}_{N-1}, r_{-N}) \quad (A15)$$

The expected value of the equation (A15) is:

$$E(cov(\mathbf{D}_{0,N-1}, r_{-N})) = E(cov(LN)) + E(cov(L(N+1))) + \dots + E(cov(L(2N-2))) + E(cov(L(2N-1))) \quad (A16)$$

The covariance between the return for sub-period -(N+1) and the change in institutional ownership over the quarter is given by:

$$cov(\mathbf{D}_{0,N-1}, r_{-(N+1)}) = cov(\mathbf{D}_0, r_{-(N+1)}) + cov(\mathbf{D}_1, r_{-(N+1)}) + \dots + cov(\mathbf{D}_{N-2}, r_{-(N+1)}) + cov(\mathbf{D}_{N-1}, r_{-(N+1)}) \quad (A17)$$

The expected value of the equation (A17) is:

$$E(cov(\mathbf{D}_{0,N-1}, r_{-(N+1)})) = E(cov(L(N+1))) + E(cov(L(N+2))) + \dots + E(cov(L(2N-1))) + E(cov(L(2N))) \quad (A18)$$

Equation (A11) less (A13) plus (A15) less (A17) gives our second estimate of the contemporaneous covariance:

$$Est2(cov(C)) = cov(\mathbf{D}_{0,N-1}, r_0) - cov(\mathbf{D}_{0,N-1}, r_{-1}) + cov(\mathbf{D}_{0,N-1}, r_{-N}) - cov(\mathbf{D}_{0,N-1}, r_{-(N+1)}) \quad (A19)$$

Thus, the expected value of our second estimate is given by the expected value of equation (A19), or equivalently, equation (A12) less (A14) plus (A16) less (A18):

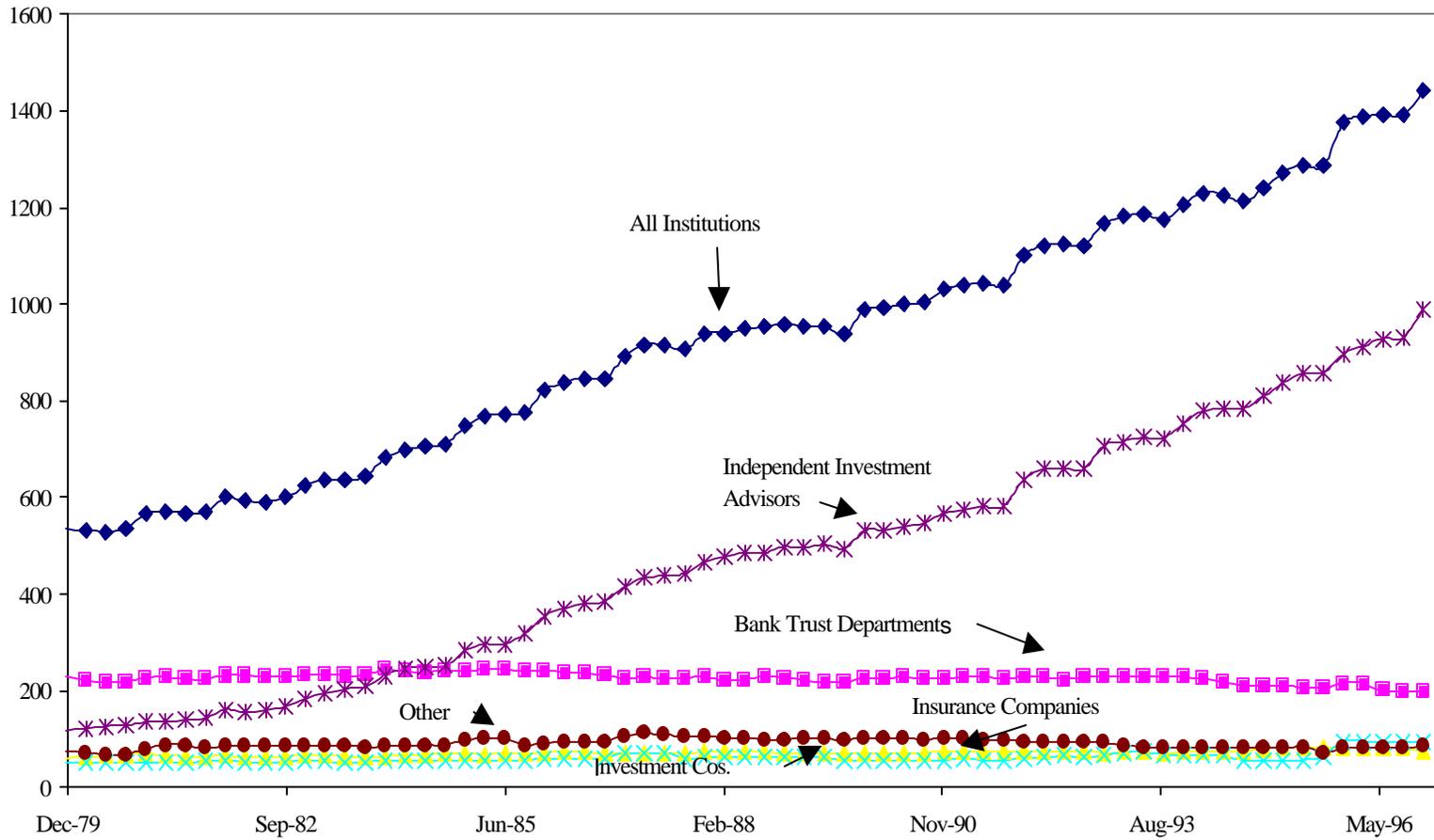
$$E(Est2(cov(C))) = E(cov(C)) - E(cov(L(2N))) \quad (A20)$$

Equations (A9) and (A19) serve as our general estimates of the contemporaneous covariance for each quarter. The partitioned coefficient for is then estimated as the estimated covariance times the number of covariances of that lag in the quarterly covariance. Specifically, there are  $N$  contemporaneous covariance terms each quarter. Thus the formula for the partitioned coefficient is:

$$Partitioned\ Contemporaneous\ Coefficient = (N)[Est(cov(X))] \quad (A21)$$

Figure 1: Number of institutional investors

This figure details the number of institutional investors reporting holdings in NYSE companies each quarter from December 1979 through December 1996.



**Figure 2: Fraction of shares held by institutions**

**This figure shows the fraction of shares of NYSE companies held by institutions reporting holdings each quarter from December 1979 through December 1996.**

