Why Has Trading Volume Increased?

by

Tarun Chordia, Richard Roll, and Avanidhar Subrahmanyam

December 2, 2008

Abstract

Share turnover has increased dramatically over the past few years. We explore patterns in the microstructure of trading activity underlying this increase and analyze possible causes and consequences of this up-trend. Higher turnover is associated with more frequent smaller orders, which have progressively formed a larger fraction of trading volume over time. Turnover and serial dependence in large orders has increased the most for stocks with the greatest level of institutional holdings. The evidence thus points to an increase in institutional trading as the key contributor to the turnover trend. Tick size decreases and increases in the volatility of equity fund flows appear to have played roles in this increase. Variance ratio tests suggest that greater trading has increased information production, particularly in stocks with greater institutional representation. The sensitivity of turnover to past returns has increased in recent years, revealing a more widespread use of quantitative trading strategies.

Contacts

	Chordia	Roll	Subrahmanyam
Voice:	1-404-727-1620	1-310-825-6118	1-310-825-5355
Fax:	1-404-727-5238	1-310-206-8404	1-310-206-5455
E-mail:	Tarun_Chordia@bus.emory.edu	Rroll@anderson.ucla.edu	asubrahm@anderson.ucla.edu
Address:	Goizueta Business School Emory University Atlanta, GA 30322	Anderson School UCLA Los Angeles, CA 90095-1481	Anderson School UCLA Los Angeles, CA 90095-1481

We thank Viral Acharya, Ashwini Agarwal, Imad Al Akhdar, Yakov Amihud, Antonio Bernardo, Menachem Brenner, Sabrina Buti, Bruce Carlin, Bhagwan Chowdhry, Mathijs van Dijk, Ingolf Dittman, David Goldreich, Joel Hasbrouck, Byoung-Hyoun Hwang, Russell Jame, Hao Jiang, Wei Jiang, Kose John, Marcin Kacperczyk. Mark Kamstra, Andrew Karolyi, Elena Kotlyar, Tom McCurdy, Andreas Park, Lasse Pedersen, Marti Subrahmanyam, Kevin Tang, Qing Tong, Jonathan Weaver, Kent Womack, Xing Zhou, and seminar participants at New York University, University of Toronto, McGill University, Rutgers University, UCLA and the First Erasmus Liquidity Conference in Rotterdam, Netherlands, for valuable comments.

Why Has Trading Volume Increased?

Abstract

Share turnover has increased dramatically over the past few years. We explore patterns in the microstructure of trading activity underlying this increase and analyze possible causes and consequences of this up-trend. Higher turnover is associated with more frequent smaller orders, which have progressively formed a larger fraction of trading volume over time. Turnover and serial dependence in large orders has increased the most for stocks with the greatest level of institutional holdings. The evidence thus points to an increase in institutional trading as the key contributor to the turnover trend. Tick size decreases and increases in the volatility of equity fund flows appear to have played roles in this increase. Variance ratio tests suggest that greater trading has increased information production, particularly in stocks with greater institutional representation. The sensitivity of turnover to past returns has increased in recent years, revealing a more widespread use of quantitative trading strategies.

I. Introduction

The literature on financial markets has traditionally focused on explaining asset prices, while trading activity has attracted only peripheral attention. Indeed, Rubinstein (1975), Hakannsson, Kunkel and Ohlson (1982), and Milgrom and Stokey (1982) suggest that there will be no trading in a market consisting of rational agents with identical priors. Empirical investigations of well-known asset pricing models such as the CAPM have also centered only on the determinants of expected returns. Yet trading activity is an inalienable feature of financial markets and, thus, warrants a separate examination. Indeed, trading volumes are large in financial markets. For example, the NYSE website indicates that the annual share turnover rate in 2003 on the NYSE was about 99%, amounting to a total volume of about 350 billion shares. Assuming a per share value of $20 and a 50 basis point round-trip cost of transacting, this amounts to a transaction cost of several billion dollars that the investing public paid in 2003. In his AFA presidential address French (2008) suggests that the cost of price discovery via trading was about $99 billion in 2006.[1]

Trading activity in equities is not only at high levels, but also has increased rather dramatically over the past few years. For instance, straightforward computations show that value-weighted average monthly share turnover (on the NYSE) increased from about 5% to about 10% from 1993 to 2005, and the average daily dollar volume and number of transactions per stock increased about seven-fold and ten-fold, respectively, during that same period. The aim of this paper is to search for possible causes and consequences of this strong upswing. Although examining an unusual pattern in trading is a worthwhile pursuit in itself, our study attains further significance because recent research has found that trading activity is related to the cross-section of expected returns and hence to the

[1] French (2008) includes trading commissions as well as the fees charged by mutual funds and hedge funds in his cost measure, and documents that U.S. investors spent an average of 0.67% of the aggregate value of the market each year over the period 1980-2006 in searching for superior returns.

cost of equity capital.[2] Thus, an increased level of trading activity should be associated with a decreased cost of capital, *ceteris paribus*.

There is an extensive body of theoretical research on trading volume. First, as suggested by models of dynamic asset allocation such as Merton (1971), it is intuitive that trading could arise naturally from the portfolio rebalancing needs of investors in response to changes in expected returns. Thus, Lo and Wang (2000) examine the implications of portfolio theory for the cross-sectional behavior of trading volume. Apart from this portfolio-rebalancing motive, there are two schools of thought that develop theories for trading activity. In the first, trading is precipitated by both non-informational reasons and by the profit-seeking motives of privately informed investors. Such models generally examine trading among privately informed traders, uninformed traders, and liquidity or noise traders.[3] Investors try to infer information from trading activity and market prices. Noise trading usually hinders this inference. As per the second school of thought, trading is induced by differences of opinion. This line of research often de-emphasizes the role of information gleaned from market prices, and does not include noise traders. In Harris and Raviv (1993) and Kandel and Pearson (1995),[4] investors share the same public information but interpret it differently, a scenario which results in trading activity. Testing this line of thinking, Chordia, Huh, and Subrahmanyam (2007) study the cross-section of trading activity and show that the dispersion of analyst opinion is positively related to trading volume. They also show that volume is strongly related to past returns in the cross-section.

There also have been previous time-series studies of volume, which have largely focused on the contemporaneous links between volume and other variables such as return

[2]See Datar, Naik, and Radcliffe (1998), Brennan, Chordia and Subrahmanyam (1998) and Chordia, Subrahmanyam, and Anshuman (2001).

[3] See Grossman and Stiglitz (1980), Hellwig (1980), Kyle (1985), Admati and Pfleiderer (1988), Grundy and McNichols (1989), Foster and Viswanathan (1990), Kim and Verrecchia (1991a, 1991b), and Wang (1994).

[4] See also Harrison and Kreps (1978) and Varian (1985, 1989).

volatility or short-term patterns in volume. For example, a number of other empirical studies have documented a positive correlation between volume and absolute price changes (see Karpoff, 1987, Schwert, 1989, and Gallant, Rossi, and Tauchen, 1992). Amihud and Mendelson (1987, 1991) find that volume is higher at the market's open. Foster and Viswanathan (1993) demonstrate a U-shaped intraday volume pattern and also find that trading volume is lower on Mondays. In other work, Lakonishok and Maberly (1990) observe that volume from individuals is larger but institutional volume is smaller on Mondays. Ziebart (1990) documents a positive relation between volume and the absolute change in the mean forecast of analysts. Campbell, Grossman, and Wang (1993) and Llorente, Michaely, Saar, and Wang (2002) analyze the dynamic relation between volume and returns.

In contrast to earlier literature, in this paper we focus on recent *trends* in trading activity. In doing so, we acknowledge at the outset that costs of trading have declined, likely contributing to this trend. For example, French (2008) and Chakravarty, Panchapagesan, and Wood (2005) argue that institutional commissions have declined over time, and it is well known (e.g., Chordia, Roll, and Subrahmanyam, 2001) that bid-ask spreads also have decreased substantially over time. Further, the advent of technology has made it easier for institutions to execute automated algorithmic trading (Hendershott, Jones, and Menkveld, 2008) and online brokerage accounts have made trading easier for retail investors. However, recognizing that trading frictions have decreased still leaves several unanswered research questions related to the turnover trend. Thus, while trading cost reductions likely have caused hidden trading needs to manifest themselves, there remains the issue of which agents' needs have most contributed to the turnover increase. One possibility is that intensified retail investing due to ease of on-line trading, lower trading costs, and the accompanying "illusion of control" (Barber and Odean, 2002) is principally responsible for the increase in turnover. Another possibility is that institutional trading due to reduced commissions and spreads accounts primarily to the turnover trend. It also is an open question whether other known determinants of

trading such as dispersion of opinion and implied volatility have increased, and have thus contributed to the increase in turnover. Finally, a related question is that of the consequences of the turnover trend. For instance, if the turnover trend is due to uninformed investing, then the market may have become less efficient at incorporating information; but more informed investing by institutions may well have led to greater information production and a more efficient market.

Motivated by the above observations, in this paper, we address the following specific questions: (i) What microstructure patterns have accompanied the sharp increase in turnover? Is the increase due to changes in transaction frequency, or trade size, or both? (ii) What can the data tell us about whether institutions or individuals are primarily responsible for the turnover trend? (iii) Is it possible to discern why trading by certain trader classes has increased? (iv) What have been the consequences of the shift in trading activity? For example, has production of private information increased? Have there been changes in the cross-section of expected turnover, possibly due to the actions of hedge funds that exploit cross-sectional return predictability documented by academic researchers?

We examine the preceding issues in several stages. First, we establish some basic facts about turnover. In particular, we show that volume has increased substantially for both index and non-index stocks, suggesting that indexation alone is not responsible for increase in trading activity.[5] We also document that the turnover increase has principally resulted from smaller orders and greater frequency of transactions. We then ask whether institutions or individuals are primarily responsible for the increase in turnover. We find that stocks with more institutional holdings experienced the greatest increases in turnover, indicating a prominent causative role for institutions. In addition, changes in the breadth of ownership (as measured by the number of shareholders) are not associated

[5] French (2008) shows that the fraction of US domestic equity invested passively has increased steadily for all four groups of institutions (defined benefit plans, defined contribution plans, non-profits and public funds) examined. For instance, non-profits start with 2.8% of their assets being passively managed in 1986 to 28.7% in 2006.

with changes in turnover in the cross-section. Under the supposition that changes in ownership breadth primarily reflect changes in dispersed retail ownership (as opposed to concentrated institutional ownership), this further points to the role of institutions in causing turnover trends. Finally, daily serial correlations in large trade order flows have increased the most for stocks with the largest levels of institutional holdings. Since large orders are more likely to be used by institutions, this once again suggests that it is the institutional trading that has led to the recent increases in trading volumes.

The natural question that arises next is why do institutions appear to be trading more frequently in recent years. While secular decreases in trading costs due to technological advances and tick size drops are well known and have undoubtedly influenced trading activity,[6] have other known determinants changed in a manner consistent with increases in institutional trading? We consider this question by looking at the roles of shifts in analyst forecast dispersion, equity fund flows, and option-implied volatility. A key finding that emerges is that fund flows have become more volatile in recent years. This change can be attributed to an increase in individuals' frequency of asset allocation owing to technological innovations such as online access, which, in turn stimulates trading activity by their agent institutions. The evidence indicates that the role of the other turnover determinants in causing turnover shifts is likely limited. Overall, the results suggest that the significant increase in institutional turnover has primarily been stimulated by shifts in fund flow volatility and by decreases in trading costs.

Finally, we turn to the effects of increased trading by institutions on their own account. One possibility is that institutions are able to trade more effectively on private information in recent years and contribute to increased market efficiency. A second possibility is that they are able to exploit findings on cross-sectional return predictability more effectively. Evidence supports both of these conjectures. First, our analysis of

[6] As Chakravarty, Panchagesan and Wood (2005) point out, the decline in trading commissions can be attributed to the growth of alternative, automated trading systems as well as online brokerage firms which allow institutions a greater choice of execution venues and consequently, greater competition between providers of trading services.

open/close and close/open variance ratios (along the lines of French and Roll, 1986) indicates that increased turnover has indeed been accompanied by greater production of private information. Second, the increased information production is most pronounced for stocks with the highest levels of institutional holdings. Third, point estimates of daily serial correlations have generally decreased in recent years, suggesting an enhancement of market efficiency. Fourth, turnover has become more sensitive in recent years to return predictors that are increasingly employed in quantitative trading strategies used by hedge funds,[7] pointing to the prominent role of these institutions in causing turnover patterns.

The remainder of this paper is organized as follows. Section II describes the data. Section III presents some preliminary evidence documenting the increase in trading activity. Section IV analyzes causes for increases in turnover and establishes that the increase in turnover is likely due to increased institutional trading. Section V analyzes consequences of greater institutional trading, while Section VI concludes.

II. The Data

The sample period 1993 to 2005 was chosen because the Trade and Quote (TAQ) data are available from the New York Stock Exchange (NYSE) beginning in 1993. The sample consists of NYSE-listed stocks only. This avoids aggregating volume across exchanges with different trading protocols.

Stocks are included or excluded during a calendar year depending on the following criteria:

- To be included, a stock had to be present at the beginning and at the end of the year in both the CRSP and the intraday databases.

[7] Fung and Hsieh (2000, 2002) discuss the hedge fund strategies based on empirical return predictors.

- If a firm changed exchanges from Nasdaq to NYSE during a year (no firms switched from the NYSE to the Nasdaq during the sample period), it was excluded from the sample for that year.
- Because their trading characteristics might differ from ordinary equities, assets in the following categories were also expunged: certificates, ADRs, shares of beneficial interest, units, companies incorporated outside the U.S., Americus Trust components, closed-end funds, preferred stocks and REITs.
- To avoid the influence of unduly high-priced stocks, if the price at any month-end during the year was greater than $999, the stock was deleted from the sample for the year.

Given that a stock is included in the sample, its transaction data are filtered and the trades are signed as in Chordia, Roll and Subrahmanyam (2001), who, in turn, use the Lee and Ready (1991) trade-signing algorithm. Note that due to the filtering, a number of trades (especially for large stocks with a large number of trades), are excluded because of out of sequence recording of trades or because the trades are recorded before the open or after the close. Also, some trades cannot be signed as buy or sell trades and are excluded from the sample. Due to the exclusion of trades, the turnover obtained using transactions data from TAQ is understated as compared to turnover obtained from CRSP. All aggregates are value-weighted using market capitalization at the end of the previous calendar year. Two subperiods are selected to give an indication of changing conditions. They span seven and six complete calendar years, respectively; Subperiod 1 includes 1993 to 1999 and Subperiod 2 covers 2000-2005. We also obtain data on determinants of turnover from various sources, which are described in a later section.

III. Preliminary Evidence

Figure 1 presents the value-weighted monthly turnover for NYSE stocks from 1993 through 2005 inclusive. We first compute the monthly turnover for each stock using

trading volume and the number of shares outstanding from CRSP. Then we calculate the value-weighted turnover each month, using market capitalization as of the end of the previous month.[8] To examine the possible role of indexation, Figure 1 has separate plots for S&P500 and non-S&P500 NYSE stocks.[9] This is also a coarse categorization for large and small cap stocks, since stocks included in the S&P500 are generally those of the larger firms. As can be seen, turnover has gone up for both groups of stocks. The increase is quite large, from below 6% (per month) at the beginning of the period to 10-12% towards the end. Table 1 presents summary statistics associated with turnover for the two subperiods. There is no evidence that turnover of index (large cap) stocks increased more than that for non-index (smaller cap) stocks — an unreported test shows that the average difference in turnover between non-index and index stocks throughout the period is positive and marginally significant.

The increase in turnover could result from an increase in trading frequency or in the average trade size, or possibly both. To shed some light on this issue, Panel A of Figure 2 plots the daily average dollar trade size per transaction. The daily dollar trade size for each stock is computed as a ratio of the dollars traded each day to the total number of daily transactions. The mean dollar trade size per transaction has declined precipitously over the past few years, from about $100,000 to about $30,000. Thus, trades are now being conducted in ever-smaller units during recent years. A regression with a linear trend term confirms the drop in trade size, since the coefficient of the trend is significant with a t-statistic of –51.

The average number of transactions per day is plotted in Panel B of Figure 2. This quantity has increased dramatically through the sample period. Again, a linear trend regression confirms the statistical significance of this increase. Table 2 provides summary statistics on the average trade size and number of transactions by subperiod. It

[8] Unless otherwise stated, all averages in the paper are value-weighted in this manner.
[9] The S&P 500 index is by far the most common benchmark for index funds (see, for example, Fabozzi and Molay, 2000).

indicates that the average trade size decreased by about 60%, whereas the average number of transactions increased four-fold across the two subperiods. Consequently, the increase in total dollar turnover is entirely driven by an increase in trading frequency, which has more than offset the decline in average trade size.

As an additional piece of evidence regarding the source of the increase in dollar turnover, Figure 3 documents the proportion of dollar volume in trades of less than or more than $10,000.[10] For each stock each day, we use the transactions data to simply add up the dollar trading volume that is less than and greater than $10,000. We then calculate the (value-weighted) average of this quantity. There is a clear pattern: the proportion of volume due to smaller (larger) orders has been steadily growing (falling). Again, trend regressions confirm this finding, in that the coefficients of the trend are strongly positive (negative) and significant for the proportion of volume due to small (large) orders. Further, Table 3 provides magnitudes across the two subperiods and indicates that the proportion of small trades almost doubled in the second period relative to the first.

The next section considers the preceding findings in more depth by addressing the relative importance of retail and institutional investors in turnover trends. We also consider whether known determinants of turnover have shifted recently in a manner consistent with the increase in turnover.

IV. Potential Causes of Recent Trends in Trading Activity Patterns

The analysis thus far indicates that the increase in turnover is due to ever-smaller trades conducted ever more frequently. There are several possible reasons for this (which are not mutually exclusive). First, liquidity, as measured, for example, by effective spreads, may have shown a greater decline for smaller orders relative to larger ones due to exogenous shifts in ease of trading for small orders (e.g., by way of the NYSE Direct

[10] Lee (1992) uses a cutoff of $10,000 to separate large and small traders.

system).[11] Second, direct retail investing, consisting predominantly of smaller trades, may have increased due to the advent of online trading technologies (Barber and Odean, 2002). Third, institutions may have resorted to splitting orders to take advantage of lower trading costs in the presence of reduced depths as documented in Chakravarty, Panchapagesan and Wood (2005) as well as Jones and Lipson (2001). Fourth, other potential determinants of trading activity such as dispersion of analyst opinions and mutual fund flows may have contributed to the turnover increase. We now empirically explore the impacts of these potential reasons for the turnover increase.

A. The Role of Liquidity

Do turnover trends mirror a pattern in liquidity? In Figure 4, Panel A, we document the average effective spreads for large orders (>$10,000) and small orders (≤$10,000) over time.[12] Spreads have been decreasing for both large and small orders. Indeed, Panel A of Table 4 indicates that the average effective spread is about seven cents lower in 2000-2005 than in 1993-1999 for each type of order, and an unreported test indicates that the difference is statistically significant at the 1% level in both cases. This indicates a secular increase in liquidity for reasons unrelated to the mix of orders. Panel B of Figure 4 as well as Table 4 documents depths at the inside quote for the two subperiods. Consistent with Chordia, Roll, and Subrahmanyam (2001), inside depths have decreased in the second subperiod. The decrease in depths can be attributed to decreases in the minimum tick size, which has reduced the willingness of market makers to display large quote sizes at the inside price quotes.[13] However, tick size shifts are associated with dramatically reduced bid-ask spreads (Chordia, Roll, and Subrahmanyam, 2001).

[11] The NYSE Direct system is a procedure introduced in 2000 for automated execution of small orders (less than 1,099 shares). See, for example, Huang (2002).

[12] The effective spreads are calculated by taking twice the absolute difference between the transaction price and the mid-point of the prevailing bid-ask quote for each matched transaction. These are then averaged during the trading day; then value-weighted to obtain an aggregate.

[13] This does not necessarily mean that overall depth has decreased, because depth outside the minimum quotes may well have increased. The data on overall depth are available only in the limit order book.

However, there is a problem of endogeneity, in that it is not clear whether the decrease in spreads has led to an increase in trading volumes or whether the increase in trading volumes has led to a decrease in spreads. To resolve this endogeneity problem, we exploit the exogenous natural experiment where the tick size was reduced by the NYSE from an eighth to a sixteenth on June 24, 1997 and from a sixteenth to decimals on January 29, 2001. We run cross-sectional regressions of changes in average turnover between one month prior and one month after the change in the tick size as a function of the change in the average relative quoted spread (quoted spread divided by the quote midpoint)[14] and the change in daily volatility across the same period. The inclusion of the volatility shift as a control variable is suggested by the evidence in Karpoff (1987) and Chordia, Huh, and Subrahmanyam (2007), that volatility is an important driver of volume.

Results from the regression appear in Table 5. The table shows that the coefficient on spreads is negative and significant around both tick size decreases even after accounting for the effect of volatility. This indicates that the exogenous decrease in the tick size is related to the increase in turnover. [15] In addition to secular spread declines, we note that trading commissions also have declined steadily over the years. French (2008) documents the dramatic decreases in trading commissions relative to trading volume from over 60 basis points in 1993 to 11 basis points in 2006. Overall, therefore, the results thus far accord with the notion that a decline in the cost of a product (trading activity) leads to an increase in its consumption.

[14] We have also checked that the results are essentially unchanged when the relative effective spread is used.

[15] It is possible that there may be an endogeneity bias in our specification, since volatility may be jointly determined with volume. Two observations are noteworthy in this regard. First, the strength of significance for the spread coefficients makes it unlikely that this bias would materially affect our conclusions. Second, the spread coefficients are largely unchanged when volatility is excluded from the equation.

B. Retail vs. Institutional Trading

One possible causative influence on the turnover trend is that retail investors are participating to a greater extent because of enhanced access to online trading (Barber and Odean, 2000) and lower trading costs due to technological improvements and decreases in tick size. It should be noted here that direct holdings of individuals in the market have declined over time. French (2008) shows that the direct holdings have declined from about 47% in 1980 to about 22% in 2006. However, even though direct holdings by individual investors have declined, the ease of trading thanks to technological advances and lower costs of trading could have led to increased trading by individual investors. Another possibility is that institutions are able to trade more frequently and more cheaply.

To provide some perspective on the preceding possibilities, we sort all stocks into five groups by the institutional holdings, measured by the percentage of shares held by institutions in the immediately preceding quarter. The average turnover for these groups is plotted in Figure 5. Group 5 has the highest institutional holdings and Group 1 the lowest. As shown in the figure, turnover has increased the most for stocks that are held most by institutions, and there is a monotonic relation in the turnover trends across the groups. This suggests that retail investing alone probably does not account for the increased turnover. Indeed, the data used for Panel A of Table 6 indicate that the average difference in turnover across lowest and highest institutional holdings groups is about 3.6% over the period 1993-1999 and approximately 6.0% over the period 2000-2005. An unreported test indicates that the difference in these numbers is statistically significant with a p-value less than 1%.[16]

Further evidence on the role of institutions in the turnover increase appears in Panels B and C of Table 6, which provide turnover due to large and small orders separately for the two subperiods across the institutional holdings quintiles. It can be

[16] The difference in turnover between highest and lowest institutional ownership groups regressed on a trend line has a t-statistic of 15.8 and an adjusted R-square of 62%.

seen that for the group with the largest institutional holdings, small order turnover has increased by about 400% across the two sub-periods, whereas the corresponding increase is only about 120% for the lowest holdings group. The corresponding numbers for large order turnover are 30% and 20%, respectively.

In additional analysis, we consider the average ratios of turnover across the extreme institutional holdings quintiles. For small orders, we find that the ratios of turnover in the largest quintile to that in the smallest one are respectively 0.71 and 1.60 for the first and second subperiods. The corresponding numbers for large order turnover are 2.36 and 2.56. An unreported test shows that the ratio is statistically greater (at the 5% level) in the second subperiod for both small and large orders, pointing to more institutional trading in recent years. Moreover, the average difference in the ratio (for large orders relative to small orders) is 1.65 in the first period but 0.96 in the second, and the first number is statistically greater than the second at the 1% level. This suggests that the proclivity of institutions to submit small orders relative to large ones has increased in recent years. [17]

It is possible that institutional holdings are proxying for firm size, thus contaminating our inferences. To address this, we independently sort firms into institutional holdings and market capitalization-based quintiles and document total turnover, and turnover for large and small orders in Table 7. The general pattern is preserved even within size quintiles. Specifically, turnover generally is higher for the firms with greater institutional holdings, holding constant the size quintile. The difference in total turnover across quintiles with the largest and smallest holdings is statistically greater (at the 1% level) in the second sub-period within every size quintile.

[17] An additional factor influencing order size is the phenomenon of "tape shredding" (the practice wherein brokers artificially split orders to maximize commission revenue) that is documented by Caglio and Mayhew (2008). The extent of such activity throughout our sample period is hard to precisely discern. Our result that the increase small order turnover occurs more strongly in the largest holdings quintile indicates that such shredding, if it happens, occurs mainly in the stocks where institutions are active, possibly because such activity can be masked better in these stocks. This is not inconsistent with the view that the increased turnover in recent years is driven mainly by institutional trading.

It is also easily verified that in 14 out 15 cases (five each for total, small order, and large order turnover), the ratio of average turnover in the second sub-period to that in the first is greater for the quintile representing the largest level of institutional holdings than for that with the lowest holdings. It also is readily discerned that the difference in these ratios across small and large holding quintiles is particularly pronounced for the large order turnover. Specifically, the difference in the average turnover ratio across the two institutional holding quintiles is over two in almost every size group for the large order turnover, but the mean difference across the size quintiles for small order turnover is only 0.03. In fact, over the period 1993-1999 the small order turnover decreases with institutional holdings. Overall, this again supports the notion that the increase in turnover is driven more by institutions rather than retail investors.[18]

In unreported analysis, we also have experimented with a cutoff of 10,000 shares (as opposed to the dollar cutoff of $10,000) to separate large and small trades, and the results are qualitatively unaltered. However, we note that there is a caveat to the above analysis. While we infer an increase in trading by institutions, it should be noted that we do this using data on institutional holdings; indeed, direct data on U.S. institutional trading is not available over the extended sample period of our study. Also, we are not claiming that trading by retail investors has decreased over time. What we are claiming is that trading by institutions or rather trading in stocks with higher institutional holdings has increased by more. Therefore, we present additional pieces of evidence to support the link between turnover increases and increased institutional trading.

[18] An indirect way to distinguish the roles of retail versus institutional traders is to look at turnover patterns in low- and high-priced stocks. It may be argued that low-priced stocks are unlikely to be held by institutions as they tend to have high relative spreads, and are thinly traded. We therefore stratify all sample stocks into two groups: group 1 consists of those stocks whose monthly average closing price was less than $10 throughout the sample period, and group 2 consists of the complementary set. Across the two subperiods, average monthly turnover for the first group increased from 6.8% to 9.7%, whereas that for the second group increased from 7.2% to 12.4%. It can be seen that the relative increase in turnover is much larger for the second group of stocks, and we have verified that the increase in the turnover difference between the two groups is statistically significant. This further bolsters the role of institutions in causing the turnover trend.

First, as another indicator to distinguish retail from institutional trading, we examine changes in the number of shareholders over time.[19] Changes in the number of shareholders may be attributed to changes in the breadth of ownership and may be linked to changes in the number of retail investors holding, and thus trading, stocks. We obtain the number of shareholders from Compustat and calculate the value-weighted number of shareholders each year. This quantity shows a modest increase during the sample period; thus, the average annual numbers of shareholders are 181,896 and 210,772 in the 1993-1999 and 2000-2005 periods, respectively.

Further light on the number of shareholders is shed by the following exercise. For each stock listed in both the former and latter subperiods, we calculate the change in its average turnover across the periods and the change in the number of shareholders. The change in average turnover is then regressed on the change in shareholders. The coefficient in this regression is insignificant with a t-value of –0.29, indicating that trends in the shareholder base have not had a significant impact on turnover. This suggests that increased trading by existing shareholders, rather than changes in breadth of ownership is the stronger determinant of turnover.

Next, we consider serial correlation in order imbalances as a way to distinguish trends in retail and institutional trading. First order serial correlations in order imbalances are strongly positive (Chordia, Roll, and Subrahmanyam, 2002). Lee et al. (2005) attribute these serial correlations to both reputational herding (Scharfstein and Stein, 1990) as well as order splitting (Kyle, 1985) by investors. An overall increase in the serial correlation of order imbalance in more recent years would be consistent with the increase in turnover and would signify either increased herding or increased frequency of split orders. While a change in the serial correlation of small orders can be attributed to retail investors as well as institutional investors, an increase in the serial

[19] It would be desirable to have direct data on retail trading. However, these data are not available for our sample period, because the standard discount brokerage dataset used, for example, by Odean (1998) and Barber and Odean (2000) does not extend beyond the year 2000.

correlation of large orders is more likely to be driven by institutional trades. Motivated by these arguments, we present, in Table 8, the daily share order imbalance serial correlations for the two subperiods,[20] and across the five institutional holdings quintiles (the correlations are first calculated stock by stock, then averaged across stocks). We find that the overall serial correlation increased in the second subperiod for the full sample as well as for every holdings quintile. In addition, we find that the serial correlations for small orders decreased moderately but that for large orders increased substantially in the second subperiod. Further, the point estimate of the increase is greatest for the largest holdings quintile.[21] That the change in serial correlation in large orders (which are more likely to be due to institutions) mimics the change in the overall imbalance autocorrelation again supports the notion that increased trading by institutions drives the overall trend in turnover.[22]

Overall, the evidence suggests that increased trading by institutions in recent years, due to increased liquidity and decreased trading commissions, has influenced the trend in total turnover.[23] In addition to secular decreases in trading costs, other determinants of turnover could also have played a role in this turnover increase. We next explore the role of these other determinants in the turnover trend.

[20] The order imbalance is calculated as the daily estimated buy volume minus estimated sell volume, scaled by total volume. As stated in Section II, we use the Lee and Ready (1991) algorithm to sign trades.

[21] Of all the changes in serial correlations in the second subperiod relative to the first, only the increases listed in the second columns of Panels A and C (i.e., those for the overall sample, representing the combined and large order imbalance) are significant at the 10% level. All other changes are insignificant.

[22] Earlier we have argued that institutions have increasingly been reducing transaction sizes in recent years, possibly due to order splitting. However, at least some agents would continue to use large orders, especially if they possess perishable private information. Such agents are more likely to be institutions.

[23] We also considered the correlation between the change in institutional holdings and turover. To this, we first calculated the absolute value of the proportional change in percentage change in institutional holdings for each stock and each quarter within our sample (institutional holdings from the Thomson database are only available for the quarterly horizon). We then calculated the time-series average of the cross-sectional correlation between turnover and the absolute change holdings separately for the 1993-1999 and 2000-2005 subperiods. The average correlation is positive and increased from 0.168 to 0.188 in the second subperiod, suggesting increased representation of institutional trading in the latter period's turnover. Note, however, that the change in holdings from quarter to quarter may have a very noisy relation to quarterly turnover, especially if any institutions turn around their positions relatively quickly.

C. The Role of Dispersion of Opinion, Expected Volatility, and Fund Flows

Previous literature has pointed to three important determinants of trading activity, namely, divergence in analysts' forecasts, return volatility, and fund flows into equity funds.[24] Have they changed in recent years in a manner consistent with the dramatic increases in aggregate turnover? To address this issue, we consider three empirical constructs: (a) the monthly forecast dispersion, defined as the standard deviation of earnings per share (EPS) forecasts from multiple (two or more) analysts,[25] (b) the value-weighted average dispersion index for the aggregate market, where the weights are based on market capitalization as of the end of the previous year; (c) the VIX, a measure of the implied volatility[26] of the S&P 500 index published by the Chicago Board Options Exchange, (available from the Option Metrics database.)

The average values of the dispersion index and VIX across the two subperiods are presented in Panels A and B of Table 9. The proportional differences in means for these two potential determinants of turnover are small relative to the corresponding turnover statistics documented in Table 1. Statistically, an unreported test indicates that the difference in dispersion is not significant, whereas that in VIX is statistically significant (t=2.19). However, the changes in either variable do not appear large enough to justify the dramatic increase in turnover in recent years.[27] It can thus be asserted that the increase in turnover is likely not due to increased dispersion of analyst opinion or greater implied volatility of the stock market.

---

[24] See Edelen and Warner (2001) and Chordia, Huh, and Subrahmanyam (2007) for discussions on the importance of these determinants in the cross-section of turnover.

[25] Obtained from the I/B/E/S database disseminated by the firm Thomson Financial. Stocks without multiple forecasts are not included in the sample.

[26] We use implied option volatility because the speculative activity that sparks turnover would likely respond to expected volatility, rather than realized volatility.

[27] Support for this assertion is provided in Chordia, Huh, and Subrahmanyam (2007), which indicates that the cross-sectional slopes of trading activity with respect to the variables in Table 9 are far less than unity (see their Table 3). The dramatic increases in turnover documented in Table 1 are far greater than the percentage changes in the variables in Table 9, indicating that changes in the Table 9 variables are not likely to account for the turnover increase.

While the previous section suggests that institutions and not individual investors may be the driving force influencing turnover, individual investor behavior may have changed over time in a way that may have influenced institutional turnover. Thus, for example, the technology to switch between asset classes has improved substantially in that it now just takes a few clicks of the mouse to switch into a new mix of assets (Brunnermeier and Nagel, 2006). Based on either valid or invalid indicators, individuals likely may be prone to changing asset mixes more frequently in recent years. This implies that the volatility of fund flows into equity markets may have increased in recent years, which may, in turn, have influenced turnover.

To shed some light this conjecture, we obtain aggregate weekly flows to equity mutual funds from 1993 to 2005 from AMG Data Services. We present summary statistics for these flows across the two subperiods in Panel C of Table 9. Mean fund flows actually decreased in the later subperiod and the change is marginally significant. The decrease in the mean level may be due to the aftermath of the tech stock bubble. However, the volatility of fund flows did increase, as conjectured. The magnitude of the increase across the two subperiods is a substantial 38%, and an F-test indicates that the change is statistically significant at the 5% level.[28] This is consistent with the notion that the frequency of asset allocation has increased in recent years. Though the percentage increase in fund flow volatility is by far the largest amongst all of the determinants of trading activity in Table 9, it still is difficult to link this change conclusively to the increase in turnover, we calculate the correlations between detrended absolute changes in fund flows and, in turn, detrended S&P500 and non-S&P500 turnover. These correlations are 0.107 and 0.133, respectively. Though the correlations are modest, they do suggest a link between increased volatility of fund flows and increased turnover. Since the link between fund flows and turnover is provided by institutions trading on

[28] To address the issue that potential non-stationarities could influence the volatility estimates, we also tested for equality of variances of the linearly detrended data for mutual fund flows. The volatility estimates and conclusions of statistical tests are virtually unchanged using the transformed fund flow data.

behalf of their clients, this finding is consistent with the notion that institutional trading plays a key role in the turnover increase.

V. Consequences of Greater Institutional Trading

The previous section pointed to evidence suggesting that institutional trading, as opposed to retail investing, appears to be more responsible for the dramatic increase in turnover in recent year. This section examines considers the potential influence of such an increase in trading on price formation and the cross-section of expected turnover.

A. Production of Private Information

As the previous section indicates, institutions may be trading more frequently on their own account due to exogenous factors such as lower tick sizes (viz. Table 4), decreased commissions (French, 2008), and improvements in trading technology (Chakravarty, Panchapagesan, and Wood, 2005). Such trading may enable them to exploit private information more effectively because decreased trading costs may increase returns from information-based trading (Admati and Pfleiderer, 1988). On the other hand, if institutions are only passing along individual investors' asset allocational decisions to the financial markets then one would not expect much change in the flow of private information to the market. Open/close versus close/open variance ratios can shed some light on these competing hypotheses.

French and Roll (1986) relate these ratios to the amount of information incorporated into prices. They show that (per hour) open-close return variances are greater than (per hour) close-open ones and offer three potential explanations for this finding: (i) incorporation of private information during trading hours, (ii) mispricing caused by investor misreaction or market frictions and microstructure noise induced by bid-ask bounce, and (iii) greater incorporation of public information into prices during

trading hours. They reject (iii) because the variance ratios are not significantly different on business days when the stock market is closed. They conclude that the other two components help explain the higher ratio during market trading hours, with (i) being the dominant factor.[29]

A graph of the variance ratios for each sample month, together with a plot of the six-month moving average, appears in Figure 6. There is no dramatic or vivid trend in the variance ratios. However, a statistical test reveals a significant difference in the average ratios across the 1993-1999 and 2000-2005 periods. As Panel A of Table 10 reports, the variance ratios in the former and latter periods are 9.58, and 13.09, respectively. Thus, the average variance ratio increased by about 37% in the second subperiod, and it is easy to verify that this change is statistically significant at the 5% level. Thus, there is evidence that increased turnover, possibly due to lower trading commissions, has been accompanied by increased trading on private information.

We have earlier argued that the evidence supports the notion that the increase in trading activity in recent years is driven primarily by institutions. If this is the case, and variance ratios capture production of private information by institutions, then we would expect a greater shift in the variance ratios in stocks more widely held by institutions. We thus examine variance ratio shifts for stocks divided into groups by institutional holdings. Results appear in Panel B of Table 10. It can be seen from the table that the increase in the variance ratios is most pronounced for stocks with the highest levels of institutional holdings. Indeed, the percentage changes in the variance ratios in the second subperiod relative to the first are –5.9%, 7.8%, 45.7%, 83.7%, and 61.1% for the smallest to the largest holdings groups, respectively, and only the latter three increases are statistically significant at the 5% level. Thus, the increase in variance ratios is most evident in stocks with the highest levels of institutional holdings. The evidence therefore

[29] More recently, Chordia, Roll, and Subrahmanyam (2008) argue that these variance ratios reveal the degree of private information produced by the trading process.

supports the dual notions that institutions are trading more actively and trading on private information more effectively in recent years.[30]

While French and Roll (1986) show that much of the variance due to the trading process arises from private information, it is still possible that increased uninformed noise trading may be driving the increased variance ratios during trading hours relative to non-trading ones. As French and Roll (1986) argue, such noise trading should be associated with inefficiencies such as serial dependence in stock returns. To investigate this issue, we computed the value-weighted average daily first order return serial correlations for the entire sample of NYSE stocks and for the five institutional holdings group in the both the first and second subperiods. To mitigate the problem of bid-ask bounce, these serial correlations are obtained from mid-quote returns, using the last bid-ask quote of a trading day that can be matched to a transaction.[31] Though we desist from reporting all of the correlations for brevity, we find that for the overall sample, the serial correlation fell from 1.88% to 0.34% in the second subperiod relative to the first. The average serial correlation was 3.78% for the largest holding quintile in the first subperiod., which, interestingly was the highest absolute correlation amongst all of the holdings quintiles. This correlation fell to 0.51% in the second subperiod, forming the biggest drop in absolute serial correlations across all of the holdings quintiles. Whilst the decrease in serial correlations is not large (their values in the first subperiod are low to begin with), the point estimates suggest that the increased trading in recent years has been accompanied by an increase in market efficiency.

[30] The reader may wonder how the increased variance ratios in recent years, implying increased private information production are consistent with the increased liquidity documented, for example, in Jones (2002), Brennan, Chordia, Subrahmanyam, and Tong (2008) or in our Table 4, given that adverse selection due to informed trading reduces liquidity (Kyle, 1985). However, equilibrium liquidity may also be influenced by greater uninformed trades due to indexation or greater frequency of asset allocation by individual investors (as discussed in the previous section). Further, greater information production that is due to exogenous decreases in trading costs is likely associated with an increase in the number of informed traders, and this phenomenon may further increase equilibrium liquidity due to enhanced competition between the informed (Admati and Pfleiderer, 1988).

[31] We set the matching quote to be the first quote at least five seconds prior to a trade for the period from 1993 to 1998. Due to a generally accepted decline in reporting errors in recent times (see, for example, Madhavan et al., 2002), after 1998, the matching quote is simply the first quote prior to the trades.

B. The Impact of Hedge Funds: Changes in the Cross-Section of Expected Turnover

Another potential reason for increased institutional trading activity has to do with the proliferation of hedge funds,[32] possibly stimulated by the exogenous decreases in trading costs described in the previous subsection. Academic research may also have stimulated hedge fund growth. Specifically, in the early 1990s academics (e.g., Fama and French, 1992, Jegadeesh and Titman, 1993) uncovered reliable predictors of returns in the cross-section that did not appear to be related to risk.[33] Fung and Hsieh (2000, 2002) suggest that these effects form the backbone of trading strategies used by many hedge funds. Thus, a possible explanation for the increased turnover is that institutions as a group, possibly hedge funds, have employed rapid trading strategies more vigorously, as a result of prior academic research as well as secular declines in trading costs.

This hedge fund explanation would be bolstered if turnover has become more sensitive to typical quantitative strategy triggers. Motivated by this observation, we cross-sectionally regress turnover for all NYSE-listed stocks on two explanatory variables. The first is the absolute value of the one-month lagged return, which approximates changes in book/market or short-term momentum. The second explanatory variable, intended to capture changes in long-term momentum, is the absolute value of the compounded return from month t-2 to month t-6, where t is the month in which turnover is measured.

As pointed out by Griffin, Nardari, and Stulz (2007), past returns are the key determinants of trading activity, indicating that our regression is likely to be reasonably well specified. Nonetheless, to avoid omitted variable problems, we include the

[32] Federal Reserve estimates indicate that the total dollar value of assets under hedge fund management have increased from about $250 billion in mid-1998 to more than $1 trillion in recent years. For example, see http://www.federalreserve.gov/newsevents/testimony/warsh20070711a.htm and associated references therein.

[33] See, however, Conrad and Kaul (1998) and Jegadeesh and Titman (2002) for a debate on whether the profitability of these strategies is driven by rational time-variation in expected returns.

following control variables in our regression, which are lagged to avoid a look-ahead bias: market capitalization as of the end of the previous month, dispersion in analyst forecasts, and firm age. Size is an obvious candidate for explaining share turnover. Further, Chordia, Huh, and Subrahmanyam (2007) argue that analyst forecast dispersion and firm age may be cross-sectional determinants of trading activity. The notion is that these variables represent uncertainty about a firm's future cash flows, which, in turn, contributes to speculative activity.[34] The dispersion variable is similar to the one used in Diether, Malloy, and Scherbina (2003), and represents the standard deviation of earnings per share (EPS) forecasts from multiple (two or more) analysts, scaled by the stock price as of the end of the previous month.[35] This variable is annually averaged and the previous year's observation is used in the regression. Age is defined as the number of days since the date of first listing on CRSP, calculated as of the end of the previous year. The coefficients of these three control variables are suppressed for brevity.[36]

Figure 7 plots the cross-sectional regression coefficients of monthly turnover on the two absolute return variables. The figure shows that turnover has become more sensitive to the one-month lagged return in recent years. Table 11 provides summary statistics for the coefficients across the two subperiods. The mean coefficients for both return variables are greater in 2000-2005 than in 1993-1999, and the difference is statistically significant at the 5% level for both return variables. While the median coefficients in the second subperiod are lower than the means, a Wilcoxon rank sum test rejects the equality of the medians across the subperiods for both return coefficients, with p-values less than 0.05.[37]

---

[34] Note that while Table 9 does not show any increase in aggregate dispersion, there is still a need to control for it in a cross-sectional regression to draw reliable inferences about the behavior of the return coefficients over our sample period.

[35] We are grateful to Anna Scherbina for providing us the data on analyst forecast dispersion.

[36] The coefficients and Newey and West (1987, 1994) corrected t-statistics for these variables indicate that turnover is positively related to analyst dispersion but not (within our sample of NYSE firms) to firm age or market capitalization The qualitative features of our results are unaltered if the control variables are excluded, though the magnitudes of the return coefficients are higher without these variables.

[37] In unreported analyses we also analyze the behavior of the return coefficients by institutional holdings quintiles. We find that the coefficient of the lagged one-month absolute return increases by 117% and

As a robustness check, we also perform panel regressions that use the random effects method of Fuller and Battese (1974), which allows for firm-specific shocks for each time-period, an overall firm-specific shock across time, and an overall time-specific shock across firms. The dependent variable is turnover, and the explanatory variables are the same as those in Table 11. Also, the return variables are interacted with an indicator variable that is unity in the 2000 to 2005 period, and zero otherwise. The procedure requires a balanced panel, so the sample uses the 369 NYSE-listed firms that were present in every month of our sample period and had data available on all of the explanatory variables.

Coefficients of the four variables (the untransformed ones and their interactions with the 2000-2005 dummy) appear in Table 12. As can be seen, turnover is strongly and positively related to the past one-month return variable. Consistent with the Table 11 coefficients, the interacted variables are both positive and significant. Interestingly, the significance of the two-to-six month return variable is entirely due to the post-1999 period. The results confirm that turnover has indeed become more sensitive to past absolute returns in the later years of the sample. Thus, the results are consistent with the view that trends in turnover have been associated with increased activity to arbitrage return anomalies recently documented by academics. Coupled with evidence that return anomalies have weakened in recent years (Henker, Martens, and Hunh, 2006) and are mainly confined to stocks where institutions are not well-represented (Nagel, 2005,

---

123% across the smallest and largest quintiles in the second subperiod relative to the first. However, only the second increase is statistically significant because the coefficient exhibits larger dispersion for the low holdings quintile. The behavior of the median coefficients is more stark, in that while the median increases by only 23% for the smallest holdings quintile, it increases by 127% for largest one, and only the latter is significant as per a Wilcoxon test. With regard to the lagged absolute two-to-six month return coefficient, its mean and median actually decrease slightly (but statistically insignificantly) for the smallest holdings quintile, and increase by 82% and 54%, respectively, for the largest holdings quintile; these increases are statistically significant. These results support the notion that the increase in the sensitivity of turnover to past returns is more pronounced in the larger institutional holdings groups.

Phalippou, 2008),[38] this indicates that the activities of institutions that have led to increased market efficiency within the cross-section of expected stock returns.

C. Summary Remarks

The analysis in this section indicates that increased institutional trading has led to increases in information-based trading and heightened sensitivity of turnover to past returns. It is worth mentioning that one important technological factor leading to this increase in trading could be the increasing prevalence of algorithmic trading by hedge funds and other institutions.[39] Algorithmic trading refers to the use of computer algorithms to manage the trading process. The dramatic improvements in information technology have allowed algorithms to determine the optimal order submission strategy (typically, by dividing up a large order into smaller trades in order to manage market impact). Algorithms dynamically monitor liquidity across different trading venues and choose optimal price and quantity pairs along with order submission strategies (limit versus market orders) to most efficiently execute orders.

Our key results on turnover patterns, namely, the decline in order sizes but the increase in number of orders, the increased trading activity in stocks with higher institutional holdings, and the heightened sensitivity of turnover to past returns, all point to the notion that algorithms have allowed institutions to trade more cheaply and more

[38] While our paper is not focused on the cross-section of expected stock returns, we performed cross-sectional regressions for NYSE/AMEX stocks using returns adjusted for the Fama and French (1993) factors as the dependent variable, and lagged values of the momentum variables represented by the compounded two-to-three month return, the four-to-six month return, and the seventh-through-ninth month return, as well as the lagged one-month return, the book/market ratio, market capitalization, and share turnover as explanatory variables (the Brennan, Chordia, and Subrahmanyam, 1998 methodology was used). In these regressions the book/market was not significant, confirming Loughran's (1997) result that the value/growth anomaly is mainly confined to the smaller Nasdaq stocks. Consistent with Henker, Martens, and Hunh (2006), we found that the three momentum variables were significant at the 5% level for the 1993-1999 period, but the significance of all of these variables disappeared in the 2000-2005 period. This accords with the notion that the increased turnover has been accompanied by greater market efficiency.

[39] Algorithmic trading was non-existent in the early 1990s but is expected to represent about half of the trading volume by 2010. See "Ahead of the tape –Algorithmic Trading," Economist, March 10, 2007.

frequently. The evidence suggests that this increase in institutional trading has led to increased information production (measured by open-close/close-open variance ratios) and improved market efficiency (indicated by decreased serial correlations and diminished predictability of future returns from past returns within in the cross-section).

VI. Conclusions

Share turnover has increased dramatically over the past several years. We explore the anatomy of this significant up-trend in aggregate trading activity. The increase is associated with more frequent smaller orders, which have progressively formed a larger fraction of trading volume over time. The evidence points to the notion that institutions, rather than retail investors, have played the dominant role in the volume trend, because share turnover has increased the most for stocks with the greatest level of institutional holdings. Thus, institutions appear to breaking up orders into ever-smaller increments before trading.

Determinants of trading activity such as aggregate dispersion in analysts' forecasts and implied volatility show no dramatic shifts in a manner consistent with the increase in turnover. However, the increase in the volatility of equity fund flows suggests that that part of the turnover increase is due to improvements in technology that allow for more frequent asset allocations by retail investors, that, in turn, lead to more trading by institutions acting as investing agents for investors. The cross-sectional behavior of turnover around the exogenous decline in tick sizes provides support to the idea that the increased turnover is related to a decline in trading costs.

Variance ratio tests indicate that the increase in turnover is associated with greater production of private information, particularly in stocks with greater levels of institutional holdings. Point estimates of daily return serial correlations have decreased in recent years. This suggests that institutions are trading more on private information in

recent years due to lower trading costs, and that this behavior has enhanced market efficiency. The cross-section of turnover has also changed, in that turnover has become more sensitive to past returns in recent years. This indicates that at least part of the rather dramatic recent rise in turnover might be attributed to quantitatively-oriented institutions such as hedge funds, which employ such variables in their trading strategies

References

Anderson, T., 1996, Return volatility and trading volume: An information flow interpretation, *Journal of Finance* 51, 169-204.

Admati, A., and P. Pfleiderer, 1988, A theory of intraday patterns: Volume and price variability, *Review of Financial Studies* 1, 3-40.

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

Amihud, Y., and H. Mendelson, 1986, Liquidity and stock returns, *Financial Analysts Journal* 42, 43-48.

Amihud, Y., and H. Mendelson, 1987, Trading mechanisms and stock returns: An empirical investigation, *Journal of Finance* 42, 533-553.

Amihud, Y., and H. Mendelson, 1991, Volatility, efficiency, and trading: Evidence from the Japanese stock market, *Journal of Finance* 46, 1765-1789.

Atkins, A., and E. Dyl, 1997, Market structure and reported trading volume: Nasdaq versus the NYSE, *Journal of Financial Research* 20, 291-304.

Baker, M., and J. Stein, 2004, Market liquidity as a sentiment indicator, *Journal of Financial Markets* 7, 271-299.

Ball, C., and T. Chordia, 2001, True spreads and equilibrium prices, *Journal of Finance* 56, 1801-1835.

Barber, B., and T. Odean, 2000, Trading is hazardous to your health: The common stock investment performance of individual investors, *Journal of Finance* 55, 773-806.

Barber, B., and T. Odean, 2002, Online investors: Do the slow die first?, Review of Financial Studies 15, 455-487.

Barberis, N., A. Shleifer, and R. Vishny, 1998, A model of investor sentiment, *Journal of Financial Economics* 49 307-343.

Barry, C., and S. Brown, 1985, Differential information and security market equilibrium, *Journal of Financial and Quantitative Analysis* 20, 407-422.

Bartlett, M., 1950, Periodogram analysis and continuous spectra, *Biometrika* 37, 1-16.

Benston, G., and R. Hagerman, 1974, Determinants of bid-asked spreads in the over-the-counter market, *Journal of Financial Economics* 1, 353-364.

Bessembinder, H., K. Chan, and P. Seguin, 1996. An empirical examination of information, differences of opinion, and trading activity, *Journal of Financial Economics* 40, 105-134.

Brennan, M., and T. Chordia, 1993, Brokerage commission schedules, *Journal of Finance* 48, 1379-1403.

Brennan, M., T. Chordia, and A. Subrahmanyam, 1998, Alternative factor specifications, security characteristics, and the cross-section of expected stock returns, *Journal of Financial Economics* 49, 345-373.

Brennan, M., T. Chordia, A. Subrahmanyam, and Q. Tong, 2008, Sell-side illiquidity and the cross-section of expected stock returns, working paper, University of California at Los Angeles.

Brennan, M., and P. Hughes, 1991, Stock prices and the supply of information, *Journal of Finance* 46, 1665-1691.

Brennan, M., and A. Subrahmanyam, 1995, Investment analysis and price formation in securities markets, *Journal of Financial Economics* 38, 361-381.

Brennan, M., and Y. Xia, 2001, Assessing asset pricing anomalies, *Review of Financial Studies* 14, 905-942.

Brunnermeier, M., and S. Nagel, 2006, Do wealth fluctuations generate time-varying risk aversion? Micro-evidence on individuals' asset allocation, working paper, Princeton University.

Caglio, Cecilia and Stewart Mayhew, 2008, Equity trading and the allocation of market revenue data, working paper, U.S. Securities and Exchange Commission.

Campbell, J., S. Grossman, and J. Wang, 1993, Trading volume and serial correlation in stock returns, *Quarterly Journal of Economics* 108, 905-939.

Chae, J., 2002, Trading volume, information asymmetry, and timing information, working paper, Massachusetts Institute of Technology.

Chakravarty, S., and J. McConnell, 1999, Does insider trading really move stock prices?, *Journal of Financial and Quantitative Analysis* 34,191-209.

Chakravarty, S., V. Panchapagesan, and R. Wood, 2005, Did decimalization hurt institutional investors?, *Journal of Financial Markets* 8, 400-420.

Chordia, T., S. Huh, and A. Subrahmanyam, 2007, The cross-section of expected trading activity, *Review of Financial Studies* 20, 709-740.

Chordia, T., R. Roll, and A. Subrahmanyam, 2001, Market liquidity and trading activity, *Journal of Finance* 56, 2, 501-530.

Chordia, T., R. Roll, and A. Subrahmanyam, 2002, Order imbalance, liquidity, and market returns, *Journal of Financial Economics* 65, 111-130.

Chordia, T., R. Roll, and A. Subrahmanyam, 2008, Liquidity and market efficiency, *Journal of Financial Economics* 87, 249-268.

Chordia, T., and A. Subrahmanyam, 2004, Order imbalance and individual stock returns: Theory and evidence, *Journal of Financial Economics* 72, 485-518.

Chordia, T., A. Subrahmanyam, and V. Anshuman, 2001, Trading activity and expected stock returns, *Journal of Financial Economics* 59, 3-32.

Coles, J., and U. Loewenstein, 1988, Equilibrium pricing and portfolio composition in the presence of uncertain parameters, *Journal of Financial Economics* 22, 279-303.

Coles, J., U. Loewenstein, and J. Suay, 1995, On equilibrium pricing under parameter uncertainty, *Journal of Financial and Quantitative Analysis* 30, 347-376.

Conrad, J., A. Hameed, and C. Niden, 1994, Volume and autocovariances in short-horizon individual security returns, *Journal of Finance* 49, 1305-1329.

Conrad, J., and G. Kaul, 1998, An anatomy of trading strategies, *Review of Financial Studies* 11, 489-519.

Cornell, B., and E. Sirri, 1992, The reaction of investors and stock prices to insider trading, *Journal of Finance* 47, 1031-1059.

Daniel, K., D. Hirshleifer, and A. Subrahmanyam, 1998, Investor psychology and security market under- and overreactions, *Journal of Finance* 53, 1839-1885.

Daniel, K., D. Hirshleifer, and A. Subrahmanyam, 2001, Overconfidence, arbitrage, and equilibrium asset pricing, *Journal of Finance* 56, 921-965.

Datar, V., N. Naik, and R. Radcliffe, 1998, Liquidity and asset returns: An alternative test, *Journal of Financial Markets* 1, 203-219.

De Long, B., A. Shleifer, L. Summers, and R. Waldmann, 1990, Positive feedback investment strategies and destabilizing rational speculation, *Journal of Finance* 45, 379-386.

Diamond, D., and R. Verrecchia, 1991, Disclosure, liquidity and the cost of capital, *Journal of Finance* 46, 1325-1359.

Diether, K., C. Malloy, and A. Scherbina, 2003, Differences of opinion and the cross-section of stock returns, *Journal of Finance* 57, 2113-2141.

Dupont, D., 2002, Extracting information from trading volume, working paper, EURANDOM, Eindhoven, Netherlands.

Easley, D., M. O'Hara, and J. Paperman, 1998, Financial analysts and information-based trade, *Journal of Financial Markets* 1, 175-201.

Edelen, R., and J. Warner, 2001, Aggregate price effects of institutional trading: a study of mutual fund flow and market returns, *Journal of Financial Economics* 59, 195-220.

Evans, M., 2002, FX trading and exchange rate dynamics, *Journal of Finance* 57, 2405-2447.

Evans, M., and R. Lyons, 2002, Order flow and exchange rate dynamics, *Journal of Political Economy* 110, 170-190.

Fabozzi, F., and R. Molay, 2000, *Perspectives on Equity Indexing*, John Wiley & Sons, New York.

Falkenstein, E. G., 1996, Preferences for stock characteristics as revealed by mutual fund holdings, *Journal of Finance* 51, 111-135.

Fama, E., and K. French, 1992, The cross-section of expected stock returns, *Journal of Finance* 47, 427-465.

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

Fama, E., and K. French, 1997, Industry costs of equity, *Journal of Financial Economics* 43, 153-193.

Fama E., and K. French, 2001, Disappearing dividends: Changing firm characteristics or lower propensity to pay? *Journal of Financial Economics* 60, 3-43.

Fama, E., and J. MacBeth, 1973, Risk, return, and equilibrium: Empirical tests, *Journal of Political Economy* 14, 22-34.

French, K., 2008, The cost of active investing, forthcoming, *Journal of Finance*.

French, K. and R. Roll, 1986, Stock return variances: The arrival of information and the reaction of traders *Journal of Financial Economics* 17, 5-26.

Foster, F., and S. Viswanathan, 1990, A theory of interday variations in volume, variance and trading costs in securities markets, *Review of Financial Studies* 3, 593-624.

Foster, D., and S. Viswanathan, 1993, Variations in trading volume, return volatility, and trading costs: Evidence on recent price formation models, *Journal of Finance* 40, 187-211.

Fuller, W., 1996, *Introduction to Statistical Time Series* (2nd edition), John Wiley and Sons, New York, NY.

Fuller, W., and G. Battese, 1974, Estimation of linear models with crossed-error structure, *Journal of Econometrics* 2, 67-78.

Fung, W., and D. Hsieh, 2000, Empirical characteristics of dynamic trading strategies: The case of hedge funds, *Review of Financial Studies* 10, 275-302.

Fung, W., and D. Hsieh, 2002, Asset-based style factors for hedge funds, *Financial Analysts Journal* 58, 16-27.

Gallant, R., P. Rossi, and G. Tauchen, 1992, Stock prices and volume, *Review of Financial Studies* 5, 199-242.

Goetzmann, W., and A. Kumar, 2002, Equity portfolio diversification, working paper, Yale University.

Graham, J., and C. Harvey, 1996, Market timing ability and volatility implied in investment newsletters' asset allocation recommendations, *Journal of Financial Economics* 42, 397-421.

Griffin, J., F. Nardari, and R. Stulz, 2007, Do investors trade more when stocks have performed well? Evidence from 46 countries, *Review of Financial Studies* 20, 905-951.

Grinblatt, M., and M. Keloharju, 2001, What makes investors trade?, *Journal of Finance* 56, 2, 589-616.

Grinblatt, M., and B. Han, 2002, The disposition effect and momentum, working paper, University of California at Los Angeles.

Grossman, S., and J. Stiglitz, 1980, On the impossibility of informationally efficient markets, *American Economic Review* 70, 393-408.

Grundy, B., and M. McNichols, 1989, Trade and revelation of information through prices and direct disclosure, *Review of Financial Studies* 2, 495-526.

Hakannsson, N., J. Kunkel and J. Ohlson, 1982, Sufficient and necessary conditions for information to have social value in pure exchange, *Journal of Finance* 37, 1169-1181.

Harris, M., and A. Raviv, 1993, Differences of opinion make a horse race, *Review of Financial Studies* 6, 473-506.

Harrison, J., and D. Kreps, 1978, Speculative investor behavior in a stock market with heterogeneous expectations, *Quarterly Journal of Economics* 93, 323–336.

He, H., and J. Wang, 1995, Differential information and dynamic behavior of stock trading volume, *Review of Financial Studies* 8, 919-972.

Hellwig, M., 1980, On the aggregation of information in competitive markets, *Journal of Economic Theory* 22, 477-498.

Hendershott, T., C. Jones, and A. Menkveld, 2008, Does algorithmic trading improve liquidity?, working paper, Columbia University.

Henker, T., M. Martens, and R. Huynh, 2006, The fading returns of momentum strategies, working paper, Erasmus University, Rotterdam, Netherlands.

Hiemstra, C., and J. Jones, 1994, Testing for linear and nonlinear Granger causality in the stock price-volume relation, *Journal of Finance* 49, 1639-1664.

Hirshleifer, D., A. Subrahmanyam, and S. Titman, 1994, Security analysis and trading patterns when some investors receive information before others, *Journal of Finance* 49, 1665-1698.

Holden, C., and A. Subrahmanyam, 1992, Long-lived private information and imperfect competition, *Journal of Finance* 47, 247-270.

Hong, H., and J. Stein, 1999, A unified theory of underreaction, momentum trading, and overreaction in assets markets, *Journal of Finance* 54, 2143-2184.

Huang, R., 2002, The quality of ECN and Nasdaq market maker quotes, *Journal of Finance* 57, 1285-1319.

James, C., and R. Edmister, 1983, The relation between common stock returns, trading activity, and market value, *Journal of Finance* 38, 1075-1086.

Jegadeesh, N., and S. Titman, 1993, Returns to buying winners and selling losers: Implications for stock market efficiency, *Journal of Finance* 48,65-92.

Jegadeesh, N., and S. Titman, 2002, Cross-sectional and time-series determinants of momentum returns, *Review of Financial Studies* 15, 143-157.

Jennings, W., K. Schnatterly, and P. Seguin, 2002, Institutional ownership, information and liquidity, *Advances in Financial Economics* 7, 41-72.

Jones, C., G. Kaul, and M. Lipson, 1994, Transactions, volume, and volatility, *Review of Financial Studies* 7, 631-651.

Kandel, E., and N. Pearson, 1995, Differential interpretation of public signals and trade in speculative markets, *Journal of Political Economy* 103, 831-872.

Karpoff, J., 1987, The relation between price changes and trading volume: A survey, *Journal of Financial and Quantitative Analysis* 22, 109-126.

Kim, O., and R. Verrecchia, 1991a, Trading volume and price reactions to public announcements, *Journal of Accounting Research* 29, 302-321.

Kim, O., and R. Verrecchia, 1991b, Market reactions to anticipated announcements, *Journal of Financial Economics* 30, 273-309.

Kim, O., and R. Verrecchia, 1994, Market liquidity and volume around earnings announcements, *Journal of Accounting and Economics* 17, 41-67.

Klein, R., and V. Bawa, 1977, The effect of limited information and estimation risk on optimal portfolio diversification, *Journal of Financial Economics* 5, 89-111.

Kmenta, J., 1986, *Elements of Econometrics* (2nd Edition), MacMillan, New York.

Krishnaiah, P., P. Hagis (Jr.), and L. Steinberg, 1963, A note on the bivariate chi distribution, *SIAM Review* 5, 140-144.

Kyle, A., 1985, Continuous auctions and insider trading, *Econometrica* 53, 1315-1335.

Lamoureux, C., and W. Lastrapes, 1990, Heteroskedasticity in stock return data: Volume vs. GARCH effects, *Journal of Finance* 45, 487-498.

Lamoureux, C., and W. Lastrapes, 1994, Endogenous trading volume and momentum in stock-return volatility, *Journal of Business and Economic Statistics* 12, 253-260.

LeBaron, B., 1992, Persistence of the Dow Jones Index on rising volume, working paper, University of Wisconsin at Madison.

Lee, C., 1992, Earning news and small traders: an intraday analysis, *Journal of Accounting and Economics* 15, 265-302.

Lee, C., and M. Ready, 1991, Inferring trade direction from intraday data, *Journal of Finance* 46, 733-747.

Lee, Y., Y. Liu, R. Roll, and A. Subrahmanyam, 2002, Order imbalances and market efficiency: Evidence from the Taiwan Stock Exchange, *Journal of Financial and Quantitative Analysis* 39, 327-341.

Llorente, G., R. Michaely, G. Saar, and J. Wang, 2002, Dynamic volume-return relation of individual stocks, *Review of Financial Studies* 15, 1005-1047.

Lo, A., and J. Wang, 2000, Trading volume: definitions, data analysis, and implications of portfolio theory, *Review of Financial Studies* 13, 257-300.

Lo, A., and J. Wang, 2001, Trading volume: Implications of an intertemporal capital asset-pricing model, working paper, Massachusetts Institute of Technology.

Loughran, T., 1997, Book-to-market across, firm size, exchange, and seasonality: Is there an effect?, *Journal of Financial and Quantitative Analysis* 32, 249-268.

Madhavan, A., K. Ming, V. Straser, and Y. Wang, 2002, How effective are effective spreads? An evaluation of trade side classification algorithms, working paper, ITG, Inc.

Meulbroek, L., An empirical analysis of illegal insider trading, 1992, *Journal of Finance* 47, 1661-1699.

Merton, R., 1971, Optimal consumption and portfolio rules in a continuous-time model, *Journal of Economic Theory* 3, 373-413.

Milgrom, P., and N. Stokey, 1982, Information, trade, and common knowledge, *Journal of Economic Theory* 26, 17-27.

Nagel, S., 2004, Trading rules and trading volume, working paper, Harvard University.

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

Newey, W., and K. West, 1987, A simple positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix, *Econometrica* 55, 703-708.

Newey, W., and K. West, 1994, Automatic lag selection in covariance matrix estimation, *Review of Economic Studies* 61, 631-653.

Nofsinger, J., and R. Sias, 1999, Herding and feedback trading by institutional and individual investors, Journal of Finance 54, 2263-2295.

Odean, T., 1998, Are investors reluctant to realize their losses?, *Journal of Finance* 53, 1775-1798.

Pastor, L., and R. Stambaugh, 2003, Liquidity risk and expected stock returns, *Journal of Political Economy* 113, 642-685.

Phalippou, L., 2008, Where is the value premium?, *Financial Analysts Journal* 64, 41-48.

Rubinstein, M., 1975, Security market efficiency in an Arrow-Debreu economy, *American Economic Review* 65, 812-824.

Scharfstein, D., and J. Stein, 1990, Herd behavior and investment, *American Economic Review* 80, 465-479.

Schwartz, R., and J. Shapiro, 1992, The challenge of institutionalization for the equity market, in Anthony Saunders Ed.: *Recent Developments in Finance* (New York University Salomon Center, NY).

Schwert, W., 1989, Why does stock market volatility change over time?, *Journal of Finance* 44, 1115-1155.

Shalen, C., 1993, Volume, volatility and the dispersion of beliefs, *Review of Financial Studies* 6, 405-434.

SHAZAM, 1993, *User's Reference Manual Version 7.0,* McGraw Hill, New York.

Siegel, J., and P. Bernstein, 2002, *Stocks for the Long Run : The Definitive Guide to Financial Market Returns and Long-Term Investment Strategies*, McGraw-Hill, New York, NY.

Strobl, G., 2003, Information asymmetry, price momentum, and the disposition effect, working paper, University of Pennsylvania.

Tkac, P., 1999, A trading volume benchmark: theory and evidence, *Journal of Financial and Quantitative Analysis* 34, 89-115.

Varian, H., 1985, Divergence of opinion in complete markets, *Journal of Finance* 40, 309-317.

Varian, H., 1989, Differences of opinion in complete markets, in Courteney C. Stone (ed), *Financial Risk: Theory, Evidence and Implications*, Proceedings of the Eleventh Annual Economic Policy Conference of the Federal Reserve Bank of St. Louis, Kluwer Publishers, Boston, MA, 3-37.

Veronesi, P., 1999, Stock market overreaction to bad news in good times: A rational expectations equilibrium model, *Review of Financial Studies* 12, 975-1007.

Wang, J., 1994, A model of competitive stock trading volume, *Journal of Political Economy* 102, 127-168.

Womack, K., 1996, Do brokerage analysts' recommendations have investment value? *Journal of Finance* 51, 137-167.

Wooldridge, J. M., 2002, *Econometric Analysis of Cross Section and Panel Data*, The MIT Press, Cambridge.

Xia, Y., 2001, Learning about predictability: The effects of parameter uncertainty on dynamic asset allocation, *Journal of Finance* 56, 205-246.

Ziebart, D., 1990, The association between consensus of beliefs and trading activity surrounding earnings announcements, *Accounting Review* 65, 477-488.

Table 1: Turnover averages, 1993-2005

This table presents the value-weighted NYSE average turnover (using market capitalizations as of the end of the previous year for weighting) in two subperiods from 1993 to 2005.

Panel A: 1993-1999

	S&P500	Non-S&P500
Mean	0.059	0.068
Median	0.059	0.065
Std. Dev.	0.009	0.013

Panel B: 2000-2005

	S&P500	Non-S&P500
Mean	0.093	0.099
Median	0.092	0.098
Std. Dev.	0.013	0.017

Table 2: Dollar trade size and number of transactions, before and after the end of 1999

This table presents the value-weighted average dollar trade size and number of transactions on the NYSE (using market capitalizations as of the end of the previous year for weighting) in two subperiods from 1993 to 2005.

Panel A: Dollar trade size ($millions)

	1993-1999	2000-2005
Mean	0.0824	0.0549
Median	0.0833	0.0448
Std. Dev.	0.0100	0.0207

Panel B: Number of transactions

	1993-1999	2000-2005
Mean	879.38	3530.50
Median	644.90	3393.32
Std. Dev.	559.94	930.20

Table 3: Small and large trades as a proportion of total dollar volume, before and after the end of 1999

This table presents the proportions of volume comprising large and small trades on the NYSE in two subperiods from 1993 to 2005.

Panel A: Proportion of dollar volume in trades less than $10,000

	1993-1999	2000-2005
Mean	0.0454	0.0824
Median	0.0436	0.0825
Std. Dev.	0.0099	0.0323

Panel B: Proportion of dollar volume in trades more than $10,000

	1993-1999	2000-2005
Mean	0.9546	0.9176
Median	0.9564	0.9175
Std. Dev.	0.0099	0.0323

Table 4: Effective Spreads for Small (≤$10,000) and Large (>$10,000) Trades, and Depth, before and after the end of 1999

This table presents the value-weighted average effective spreads for small (Panel A) and large (Panel B) trades and value-weighted mean depth (Panel C) on the NYSE (using market capitalizations as of the end of the previous year for weighting) in two subperiods covering 1993 to 2005.

Panel A: Small Trades

	1993-1999	2000-2005
Mean	0.0999	0.0311
Median	0.1110	0.0229
Std. Dev.	0.0207	0.0185

Panel B: Large Trades

	1993-1999	2000-2005
Mean	0.1099	0.0381
Median	0.1176	0.0280
Std. Dev.	0.0156	0.0239

Panel C: Depth (Shares)

	1993-1999	2000-2005
Mean	10607	3917
Median	11634	2938
Std. Dev.	3622	2328

Table 5: Cross-sectional Regressions around 16th and decimal shifts, for six months before and after the shift in tick size

In these regressions, the dependent variable is the average change in turnover across the two subperiods; and the explanatory variables are the average change in the proportional quoted spread (ΔRQSPR) and in the volatility (standard deviation) of returns.

Panel A: Sixteenth shift

Variable	Coefficient	t-statistic
ΔRQSPR	-0.06524	-5.96
ΔVolatility	0.09254	19.88

Panel B: Decimal Shift

Variable	Coefficient	t-statistic
ΔRQSPR	-0.04164	-4.80
Δ Volatility	0.06004	15.79

Table 6: Average turnover in percent per month across stocks stratified into quintiles by institutional holdings

All stocks are divided into five groups by the level of institutional holdings in the immediately preceding quarter. Then, value-weighted average total turnover, small order turnover and large order turnover are presented for these quintiles (using market capitalizations as of the beginning of the relevant year for weighting).

Panel A: Total turnover

	Institutional Holdings Group				
	Smallest	2	3	4	Largest
1993-1999	3.408	4.652	5.422	6.225	7.012
2000-2005	4.645	6.844	8.174	9.272	10.673

Panel B: Turnover due to small (≤$10,000) orders

	Institutional Holdings Group				
	Smallest	2	3	4	Largest
1993-1999	0.571	0.562	0.523	0.471	0.403
2000-2005	1.261	1.655	1.826	1.915	2.013

Panel C: Turnover due to large (>$10,000) orders

	Institutional Holdings Group				
	Smallest	2	3	4	Largest
1993-1999	2.842	4.108	4.995	5.843	6.698
2000-2005	3.399	5.232	6.401	7.420	8.695

Table 7: Average turnover in percent per month across stocks stratified into quintiles by institutional holdings and firm size

Stocks are divided into 25 groups by the level of institutional holdings in the immediately preceding quarter and average market capitalization as of the beginning of the relevant year. Then, value-weighted average total turnover, small order turnover and large order turnover are presented for these quintiles (using market capitalizations as of the beginning of the relevant year for weighting).

Panel A: Total turnover

Sub-Period: 1993-1999

	Smallest	2	3	4	Largest
Firm Size	Institutional Holdings Group				
Smallest	4.274	4.950	5.206	5.559	6.184
2	3.486	4.827	5.759	6.072	6.764
3	3.244	4.976	5.842	6.883	7.685
4	3.314	4.981	6.045	6.874	8.070
Largest	2.846	3.736	4.383	5.629	6.409

Sub-Period: 2000-2005

	Smallest	2	3	4	Largest
Firm Size	Institutional Holdings Group				
Smallest	4.686	6.125	7.499	7.781	9.194
2	4.550	6.870	7.512	8.816	10.282
3	5.026	7.676	9.142	10.165	11.654
4	4.879	7.657	9.598	10.759	12.124
Largest	4.085	5.891	7.118	8.838	10.113

Table 7 (Continued)

Panel B: Turnover due to small (≤$10,000) orders

Sub-Period: 1993-1999

	Smallest	2	3	4	Largest
Firm Size	Institutional Holdings Group				
Smallest	1.390	1.186	1.017	0.855	0.791
2	0.692	0.689	0.661	0.599	0.519
3	0.371	0.494	0.483	0.462	0.367
4	0.308	0.362	0.363	0.306	0.269
Largest	0.161	0.145	0.134	0.144	0.128

Sub-Period: 2000-2005

	Smallest	2	3	4	Largest
Firm Size	Institutional Holdings Group				
Smallest	2.054	2.533	2.828	2.745	3.053
2	1.640	2.287	2.364	2.612	2.768
3	1.382	1.875	2.096	2.222	2.277
4	0.947	1.264	1.425	1.454	1.382
Largest	0.283	0.319	0.415	0.540	0.585

Panel C: Turnover due to large (>$10,000) orders

Sub-Period: 1993-1999

	Smallest	2	3	4	Largest
Firm Size	Institutional Holdings Group				
Smallest	2.892	3.765	4.189	4.704	5.393
2	2.798	4.138	5.099	5.473	6.245
3	2.881	4.490	5.373	6.428	7.319
4	3.007	4.625	5.734	6.582	7.839
Largest	2.688	3.679	4.638	5.939	6.681

Sub-Period: 2000-2005

	Smallest	2	3	4	Largest
Firm Size	Institutional Holdings Group				
Smallest	2.640	3.593	4.672	5.036	6.141
2	2.914	4.598	5.148	6.204	7.520
3	3.661	5.818	7.095	7.944	9.386
4	3.939	6.407	8.236	9.345	10.787
Largest	3.842	5.741	6.855	8.572	9.642

Table 8: First order daily serial correlations in order imbalances for stocks stratified into quintiles by institutional holdings

All stocks are divided into five groups by the level of institutional holdings in the immediately preceding quarter. Then, cross-sectional averages of daily serial correlations in order imbalance are presented for these quintiles. (Order imbalance is calculated as the daily estimated buy volume minus estimated sell volume, scaled by total volume.)

Panel A: Total order imbalance

		Institutional Holdings Group				
	Overall	Smallest	2	3	4	Largest
1993-1999	0.103	0.108	0.103	0.103	0.101	0.097
2000-2005	0.161	0.152	0.158	0.162	0.166	0.165

Panel B: Order imbalance due to small (≤$10,000) orders

		Institutional Holdings Group				
	Overall	Smallest	2	3	4	Largest
1993-1999	0.256	0.194	0.245	0.284	0.291	0.252
2000-2005	0.232	0.211	0.241	0.249	0.231	0.224

Panel C: Order imbalance due to large (>$10,000) orders

		Institutional Holdings Group				
	Overall	Smallest	2	3	4	Largest
1993-1999	0.087	0.078	0.082	0.089	0.092	0.092
2000-2005	0.136	0.108	0.130	0.142	0.149	0.151

Table 9: Potential Determinants of Aggregate Turnover, 1993-2005

The panels below present various potential determinants of NYSE turnover across the sub-periods from 1988 to 2005. The panels respectively consider value-weighted monthly open/close and close/open variance ratios, value-weighted analyst forecast dispersion, the implied volatility of S&P 500 index, measured by the published VIX, and weekly aggregate money flows into equity funds. (Value-weights use market capitalizations as of the end of the previous year.)

Panel A: Dispersion in Analyst Forecasts

	1993-1999	2000-2005
Mean	0.0513	0.0573
Median	0.0453	0.0493
Std. Dev.	0.0261	0.0268

Panel B: Implied volatility (VIX)

	1993-1999	2000-2005
Mean	18.549	20.890
Median	17.090	19.505
Std. Dev.	6.668	6.549

Panel C: Weekly Equity Fund Flows (billions of dollars)

	1993-1999	2000-2005
Mean	1.917	1.117
Median	1.981	1.276
Std. Dev.	2.621	3.588

Table 10: Variance Ratios, 1993-2005

The panels below present averages of per hour open/close to close/open variance ratios for NYSE stocks across the sub-periods from 1993 to 2005. The ratios are computed monthly, then value-weighted using market capitalizations as of the end of the previous year for weighting. Panel A presents summary statistics on these ratios for the full sample. Panel B presents the statistics for five groups sorted by the level of institutional holdings in the immediately preceding quarter.

.

Panel A: Full sample

	1993-1999	2000-2005
Mean	9.579	13.085
Median	7.968	11.690
St. Dev.	6.099	7.490

Panel B: By institutional holdings quintile

	Small		2		3		4		Large	
	93-99	00-05	93-99	00-05	93-99	00-05	93-99	00-05	93-99	00-05
Mean	13.136	12.353	10.297	11.102	8.605	12.538	8.496	15.605	10.479	16.877
Median	10.845	11.107	8.272	10.162	7.502	11.474	6.733	13.268	8.846	14.854
St. Dev.	9.440	7.637	7.217	6.276	5.788	7.231	4.934	11.514	7.282	10.175

Table 11: Cross-Sectional Regressions for Turnover

This table presents coefficients of past absolute return (LARET) and past absolute two to six month return (LARET26) in the cross-sectional regression of monthly turnover of NYSE stocks on these variables. The sample period is 1993 to 2005.

Panel A: One-month return (LARET) coefficient

	1993-1999	2000-2005
Mean	4.136	8.113
Median	4.549	6.603
Std. Dev.	3.503	6.481

Panel B: Past two-to six-month return (LARET26) coefficient

	1993-1999	2000-2005
Mean	1.263	2.128
Median	1.218	1.446
Std. Dev.	1.083	2.112

Table 12: Panel Regressions for Turnover

This table presents coefficients of past absolute return (LARET) and past absolute two to six month return (LARET26) in a panel regression of monthly turnover on these variables (the Fuller and Battese, 1974, method is used for estimation). Firm age, analyst forecast dispersion, and market capitalization are used as control variables, but their coefficients are not reported for brevity. The approach accounts for two-way random and fixed effects. The sample period is 1993 to 2005 and the cross-section consists of the 369 NYSE-listed firms that were present in the sample every month. The variable Post1999 takes on the value one in the 2000-2005 period and zero otherwise.

Variable	Coefficient	t-statistic
LARET	0.0381	4.01
LARET*POST1999	0.2221	18.24
LARET26	-0.0038	-0.97
LARET26*POST1999	0.0842	16.64

Figure 1. Average Turnover, 1993-2005,
S&P500 stocks and other stocks

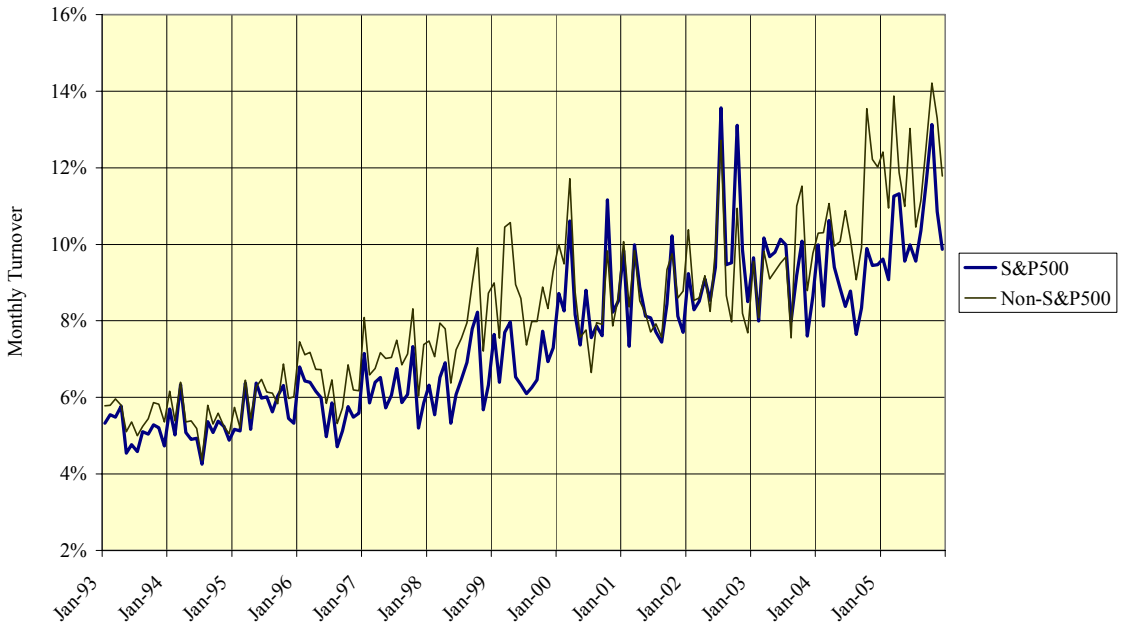

Figure 2-A. Average Dollar Trade Size, 1993-2005

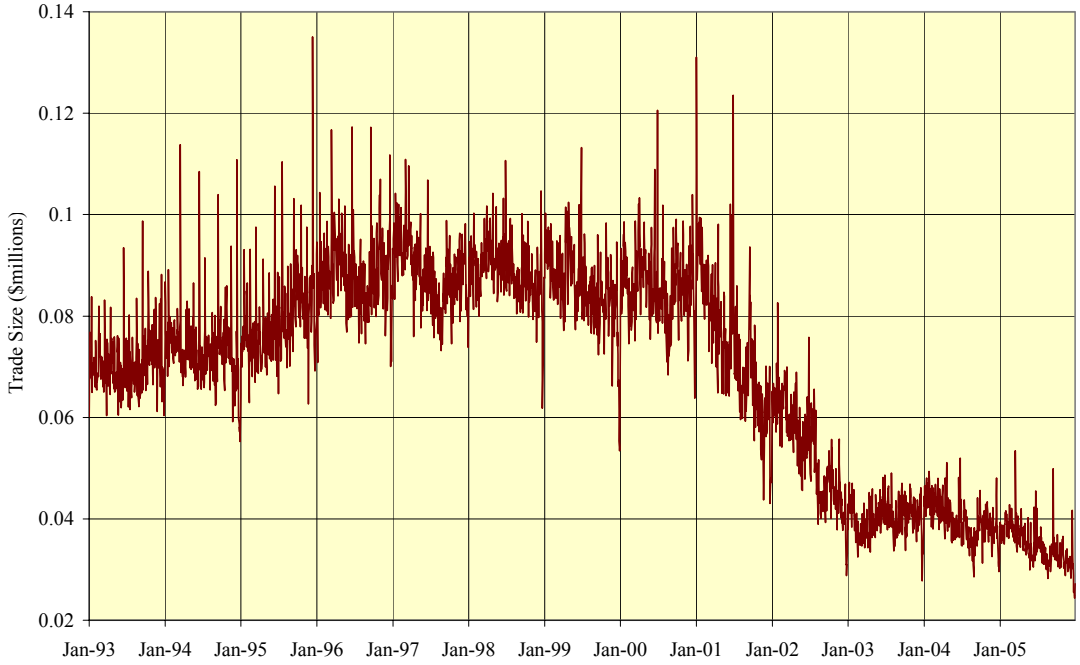

Figure 2-B. Average Number of Daily Transacations per Stock, 1993-2005

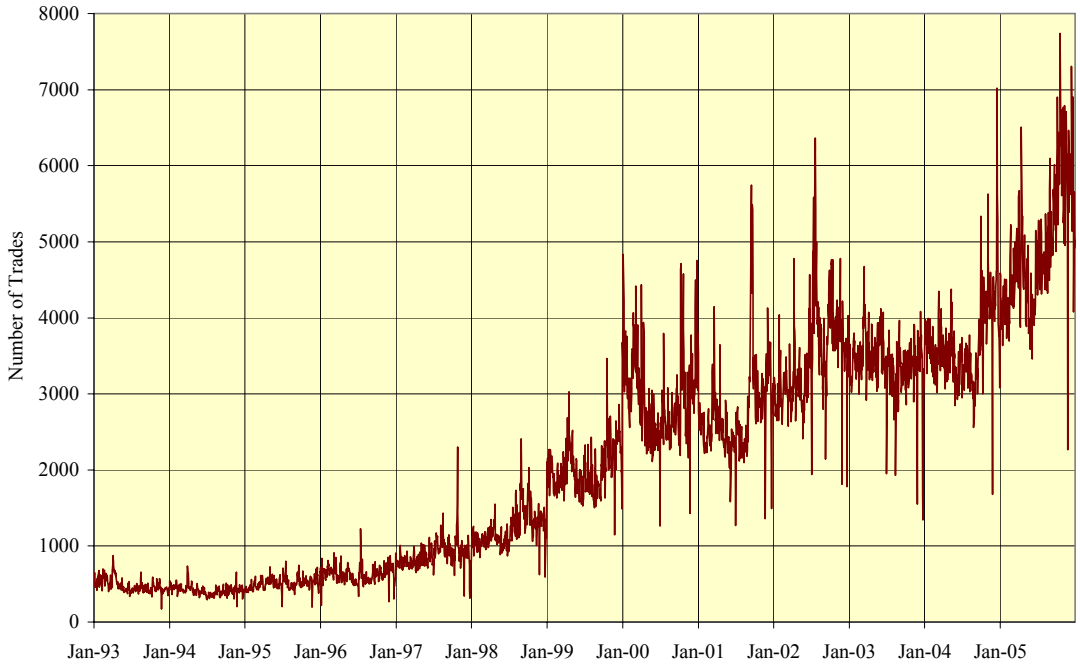

Figure 3-A. Percentage of Trades less than $10,000, 1993-2005

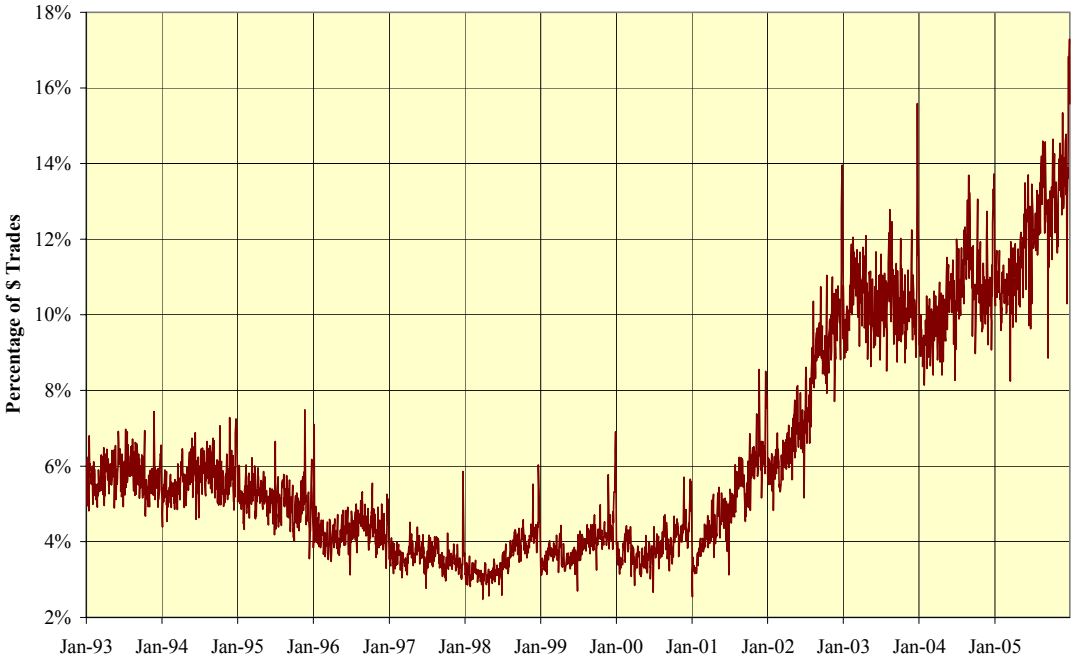

Figure 3-B. Percentage of Trades greater than $10,000, 1993-2005

Figure 4-A. Value-weighted proportional effective spreads, small orders (<$10,000) and large orders (>$10,000), 1993-2005

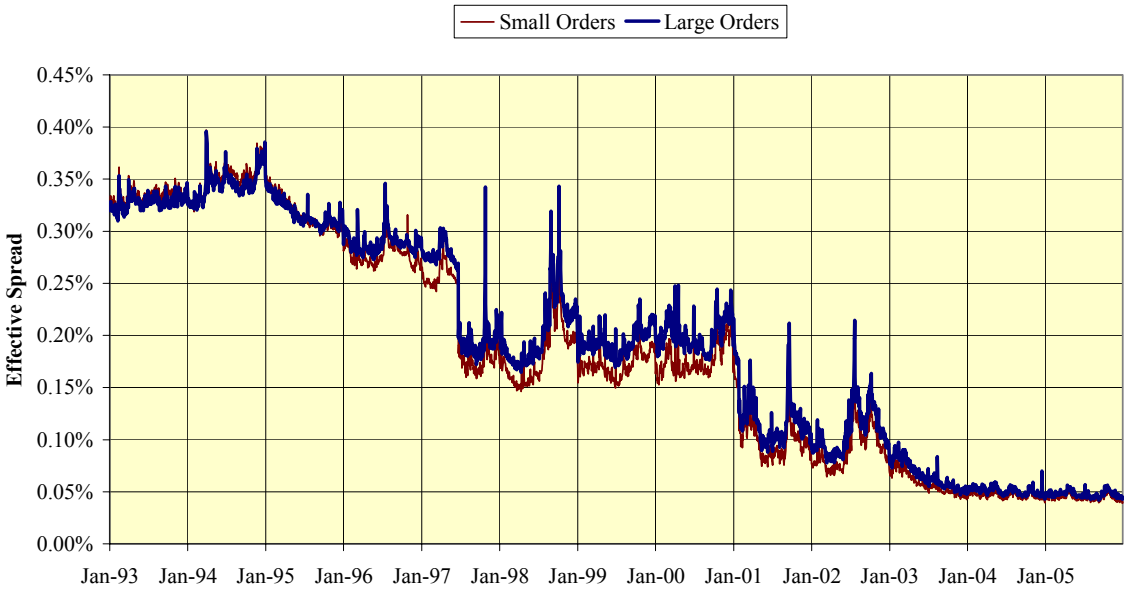

Figure 4-B. Depth, Value-Weighted, 1993-2005

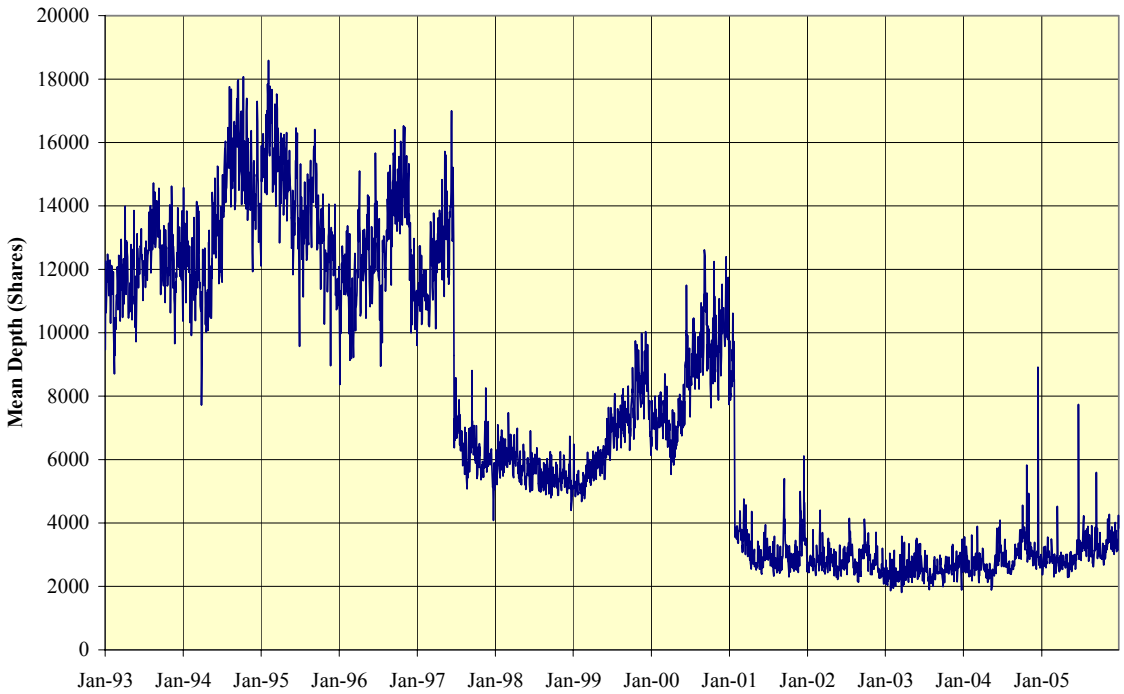

**Figure 5. Value-weighted average turnover, 1993-2005,
by lowest to highest institutional ownership holding groups**

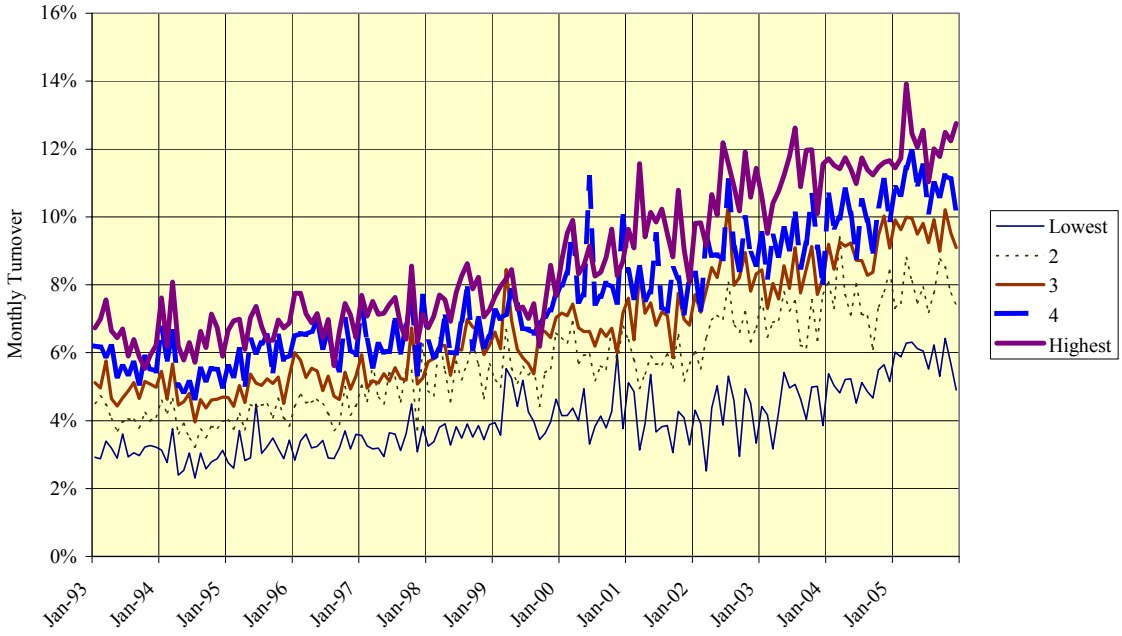

**Figure 6. Variance Ratio per Hour, Open to Close/Close to Open
1993-2005, Within Calendar Months**

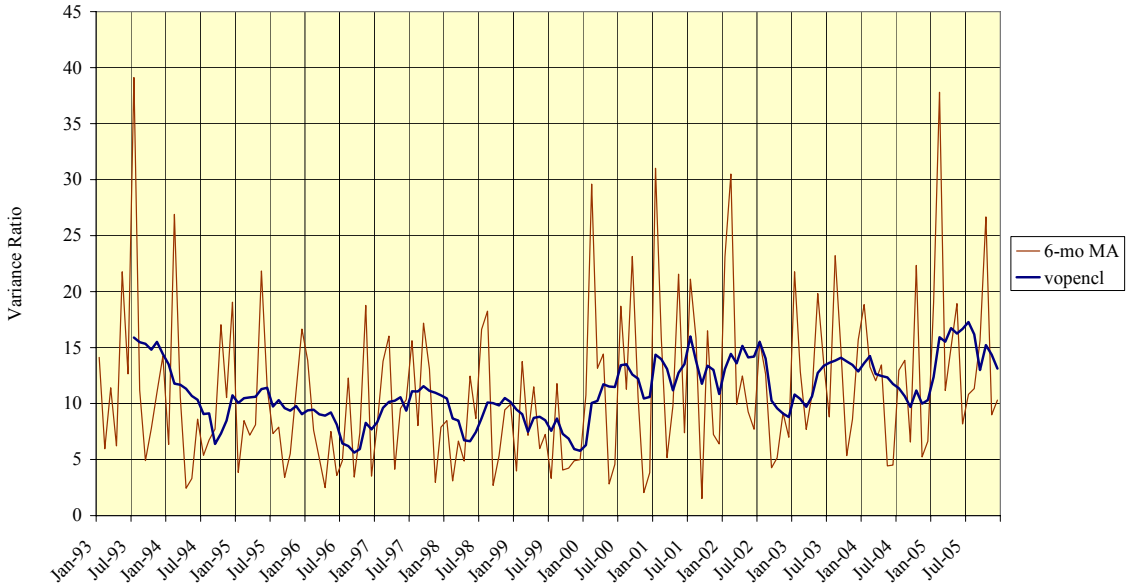

Figure 7. Turnover on absolute return-1
and absolute cumulative return -2 to -6, NYSE Listings Only