Why Has Trading Volume Increased?

by

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Share turnover has increased dramatically over the past several years. We explore possible causes. Higher turnover is associated with more frequent smaller orders, which have progressively formed a larger fraction of trading volume over time. However, institutions seem also to be contributing because share turnover has increased the most for stocks with the greatest level of institutional holdings. Changes in tick size can explain some but not all of the turnover increase. The increase in turnover does not appear to have been accompanied by greater production of private information. Some of the volume increase appears to be driven by enhanced sensitivity of turnover to past returns, perhaps revealing a more widespread use of quantitative trading strategies.

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Share turnover has increased dramatically over the past several years. We explore possible causes. Higher turnover is associated with more frequent smaller orders, which have progressively formed a larger fraction of trading volume over time. However, institutions seem also to be contributing because share turnover has increased the most for stocks with the greatest level of institutional holdings. Changes in tick size can explain some but not all of the turnover increase. The increase in turnover does not appear to have been accompanied by greater production of private information. Some of the volume increase appears to be driven by enhanced sensitivity of turnover to past returns, perhaps revealing a more widespread use of quantitative trading strategies.

Introduction

The literature on financial markets has traditionally focused on explaining asset prices, while trading activity has attracted only peripheral attention. Empirical investigations of well-known asset pricing models such as the CAPM have centered only on the determinants of expected returns. Yet trading activity is an inalienable feature of financial markets and, thus, warrants 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 $17.5 billion dollars that the investing public paid in 2003.

In addition to the generally high levels of volume, trading activity has increased rather dramatically over the past several years. For instance, the value-weighted average monthly share turnover (on the NYSE) increased from about 5% to about 12% from 1993 to 2005. This paper focuses on possible causes of this strong recent trend in trading activity. Although explaining an unusual trend 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 cost of equity

capital.[1] Thus, an increased level of trading activity should be associated with a decreased cost of capital, *ceteris paribus*.

While there is a large literature on trading volume, few previous studies have examined the underlying causes of trends in trading activity. 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 (1993b) demonstrate a U-shaped intraday volume pattern and also find that trading volume is lower on Mondays. Gallant, Rossi, and Tauchen (1992) investigate the relation between price and volume using a semi-nonparametric method. In their time-series analysis, they find that daily trading volume is positively related to the magnitude of daily price changes and that high volume follows large price changes.

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 the cross-section. Lo and Wang (2000) regress median turnover for NYSE/AMEX stocks on a set

[1]See Brennan, Chordia and Subrahmanyam (1998) and Chordia, Subrahmanyam, and Anshuman (2001).

of contemporaneous variables aggregated over five-year intervals. Chordia, Huh, and Subrahmanyam (2007) analyze cross-sectional predictors of trading activity.

There also is an extensive theoretical literature on volume. First, trading could arise naturally from the portfolio rebalancing needs of investors in response to changes in asset valuations. Apart from this motive, there are two schools of thought that develop theories for trading activity. In the first, which is founded on the rational expectations paradigm, 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.[2] Investors try to infer information from trading activity and market prices. Noise trading usually hinders this inference.

The second school of thought, trading as 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.[3] In Harris and Raviv (1993) and Kandel and Pearson (1995), investors share the same public information but interpret it differently, a scenario which results in trading activity.

[2] See Grossman and Stiglitz (1976, 1980), Hellwig (1980), Kyle (1985), Admati and Pfleiderer (1988), Grundy and McNichols (1989), Foster and Viswanathan (1990, 1993), Kim and Verrecchia (1991a, 1991b), and Wang (1994).

[3] Examples of this literature include Harrison and Kreps (1978), Varian (1985, 1989), Harris and Raviv (1993), and Kandel and Pearson (1995).

Our paper examines recent data from various perspectives to understand sources of changes in trading activity. We begin by asking whether the large or small trades have contributed to more volume changes. Subsequently, we examine turnover changes across different groups of stocks sorted by institutional holdings, and then look at the role of exogenous decreases in the minimum tick size. We also study whether increased volume has been accompanied by greater production of private information, and whether turnover has become more sensitive to return predictors that are increasingly employed in quantitative trading strategies used by hedge funds.

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 Section V concludes.

II. The Data

The sample period 1993 to 2005 was chosen because TAQ data are available beginning in 1993 and currently ending at the end of 2005. Only NYSE-listed stocks are used to avoid 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, and in the S&P 500 at the beginning of the year.
- To keep the sample size manageable and also because signing trades for Nasdaq stocks is problematic (see, e.g., Christie and Schultz, 1999), only NYSE stocks are included in aggregated order imbalances.
- 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 included or excluded according to the following criteria:

- A trade is excluded if it is out of sequence, recorded before the open or after the closing time, or has special settlement conditions (because it might then be subject to distinct liquidity considerations).

- Quotes established before the opening of the market or after the close are excluded.
- Negative bid-ask spreads are discarded.
- Only BBO (best bid or offer)-eligible primary market (NYSE) quotes are retained (Chordia, Roll, and Subrahmanyam, 2001, provide a justification for using only NYSE quotes).
- Following Lee and Ready (1991), any quote less than five seconds prior to the trade is ignored and the first one at least five seconds prior to the trade is retained.

All aggregates are value weighed 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.

III. Preliminary Evidence

Figure 1 presents the trend in value-weighted monthly turnover for NYSE stocks from 1993 through 2005 inclusive. To examine the possible role of indexation, Figure 1 has separate plots for S&P500 and non-S&P500 NYSE stocks. This is also a rough categorization for large and small cap stocks since stocks included in the S&P500 are generally the largest 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 dramatic increase in dollar 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 average dollar trade size per transaction. It 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 number of transactions per day is plotted in Panel B of Figure 2. It 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 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. There is a clear pattern: the proportion of volume due to smaller orders has been steadily growing and vice versa. 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.

IV. Further Analysis of the Turnover Increase

A. The Role of Liquidity

To examine whether trends in turnover are induced by some exogenous shift in liquidity, Figure 4 documents the average effective spreads for large orders (>$10,000) and small orders (≤$10,000) over time. Spreads have been decreasing for both large and small orders. Indeed, 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.

While Figure 4 indicates that turnover trends are not due to general exogenous trends in liquidity, there remains a question of whether specific regulatory changes have impacted turnover. We now examine the role of shifts in tick sizes, which were associated with dramatically reduced bid-ask spreads (Chordia, Roll, and Subrahmanyam, 2001). We wonder if companies with greater relative increases in tick size experienced greater increases in turnover. We thus run cross-sectional regressions of changes in turnover between six months prior and six months after the change in the tick size as a function of the change in the relative quoted spread (quoted spread divided by the quote midpoint) and the change in the return across the same period. Inclusion of return as a control variable is suggested by evidence in Chordia, Huh, and Subrahmanyam (2007) that returns are a primary driver of volume.

Results from the regression appear in Table 5. The table shows that the intercept remains positive and significant around the sixteenth even after accounting for the effect of the control variables. In addition, there is no evidence that stocks with higher decreases in the relative spread experienced decreased turnover around decimalization. This indicates that the decrease in tick size alone does not account for the increase in turnover.

B. Retail vs. Institutional Trading

Another 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). A further possibility is that institutions are able to trade more frequently and more cheaply. To provide some perspective on these possibilities, we sort all stocks into five groups by their average level of institutional holdings throughout the sample period. The average turnover for these groups is plotted in Figure 5. Group 5 has the highest institutional ownership 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, Panel A of Table 6 indicates that the average difference in turnover across lowest and highest institutional holdings groups is 4.9% over the period 1993-1999 and 10.4% over the period 2000-2005, and an unreported test indicates that the difference in these numbers is statistically significant with a p-value less than 1%.[4]

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 holding quintiles. It can be seen that for the group with the largest institutional holdings, small order turnover has increased by about

[4] The difference in turnover between highest and lowest institutional ownership groups regressed on a trend line has a t-statistic of 17.6 and an adjusted r-square of 67%.

600%, whereas the corresponding increase is only 31% for the lowest institutional holdings group. The corresponding numbers for large order turnover are 62% and 13%, respectively.

As another piece of evidence, the average ratios of turnover across the largest and smallest institutional holdings quintiles for small orders are 0.58 and 3.19 for the first and second subperiods. The corresponding numbers for large order turnover are 2.72 and 4.19. An unreported test shows that the ratio is statistically greater (at the 1% level) in the second subperiod for both small and large orders, pointing to more institutional trading in recent years. In addition, the average difference in the ratio (for large orders relative to small orders) is 2.14 in the first period but 1.00 in the second, and the first number is statistically greater than the second at the 1% level. This indicates that the proclivity of institutions to submit small orders relative to large ones has increased in recent years.

Overall, the sharp increase in small order turnover for the largest institutional holdings group, coupled with the increase in the incidence of small orders (Table 3) suggests that increased trading in small orders by institutions in recent years has influenced the trend in total turnover.

C. Causes and Consequences of Greater Institutional Trading

If institutions are trading more, perhaps they now find it easier to exploit private information because decreased spreads have increased returns from information-based trading (Admati and Pfleiderer, 1988). To shed some light on this possibility, we examine open/close to close/open variance ratios. French and Roll (1986) indicate that these ratios indicate the degree of private information produced by the trading process. A graph of these 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 Table 7 reports, the variance ratios in the former and latter periods are 7.19, and 10.50, respectively, and this difference is statistically significant at the 5% level. Thus, there is some evidence that increased turnover has been accompanied by increased exploitation of private information.

In the early 1990s academics (e.g., Fama and French, 1992, Jegadeesh and Titman, 1993) came up with reliable predictors of returns in the cross-section that did not appear to be related to risk. Fung and Hsieh (2000) suggest that these effects form the backbone of trading strategies used by many hedge funds, which have exploded in numbers in recent years. A possible explanation for the increased turnover is that institutions as a group,

particularly hedge funds, have employed rapid trading strategies more vigorously (as a result of prior academic research.)

To investigate this hedge fund factor, we now examine whether turnover has become more sensitive to typical quantitative strategy triggers. We therefore cross-sectionally regress turnover on two variables. The first variable is the absolute value of the one-month lagged return. This variable approximates changes in book/market or short-term momentum at short horizons. The second explanatory variable is intended to capture changes in long-term momentum and 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.

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 8 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 1% level for the one-month lagged return, but only at the 10% level for the longer-term return.

The preceding evidence indicates that at least part of the increased turnover may be due to the increased reliance on book/market and momentum-based strategies. However, the evidence is only suggestive. As an additional piece of evidence that aggregate turnover is

influenced by cross-sectional sensitivities of turnover to lagged returns, we run a vector autoregression of turnover and the two cross-sectional return coefficients whose behavior is depicted in Figure 9. The idea is that increased turnover can imply incrased shifts in book/market or momentum due to the activity of unsophisticated investors. This can, in turn, increase the sensitivity of turnover to lagged returns as institutions seek to address perceived deviations of prices from fair values. However, increased sensitivity of turnover to lagged returns might mean increased arbitrage activity to exploit mispricing, which may imply increased aggregate turnover both contemporaneously and in the fiuture if arbitrage capital flows into the market gradually, as opposed to all at once.

We perform our analysis separately for S&P 500 and non-S&P 500 stocks to see if institutional arbitrage activity to correct mispricing is more prevalent in the relatively larger stocks that comprise the index. We also linearly detrend all variables before their usage in the VAR in an attempt to remove non-stationarities. The VAR uses four lags as indicated by the Akaike Information Criterion. Correlations between the VAR innovations and Granger causality tests appear in Table 9.

It can be seen that for S&P 500 stocks, there is bivariate Granger causality between turnover and the lagged return coefficient. In addition, turnover Granger-causes the longer-term momentum coefficients. Furthermore, all correlations between the VAR innovations are positive, though only the one between turnover and the lagged return is significant. For non-index stocks, while the correlations are all positive (and two are

significant) there is no evidence of Granger causality between the coefficients and turnover, which is consistent with the notion that the activity of institutions prefer larger stocks to conduct arbitrage activities.

Overall, this balance of this evidence tends to support our conjecture that trends in turnover may have been influenced by trends in arbitrage activity as evidenced by the sensitivity of turnover to past returns.

V. Conclusions

Share turnover has increased dramatically over the past several years. We explore possible reasons for this increase. We find that the increase is associated with more frequent of smaller orders, which have progressively formed a larger fraction of trading volume over time. However, and paradoxically, institutions seem to be contributing towards the increase in volume because share turnover has increased the most for stocks with the greatest level of institutional holdings. This suggests that institutions are breaking up orders into smaller increments before trading.

Reductions in tick size and in spreads can explain some of the turnover increase, but they cannot explain the entire phenomena because they have been roughly similar across large and small stocks and across firms with high and low institutional ownership.

The increase in turnover appears to have been accompanied by greater production of private information.

Turnover has become more sensitive to past returns in recent years. This suggests 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

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Table 1: Turnover averages, 1993-2005

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

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

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, before and after the end of 1999

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

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

Dependent variable: average change in turnover; Δ: average change; QSPR: quoted spread

Panel A: Sixteenth shift

Variable	Coefficient	t-statistic
Intercept	0.258	4.04
ΔQSPR	-0.0195	-1.38
ΔReturn	0.0689	7.38

Panel B: Decimal Shift

Variable	Coefficient	t-statistic
Intercept	-0.586	-7.07
ΔQSPR	-0.0047	-0.37
ΔReturn	0.0092	1.63

Table 6: Average turnover across stocks stratified into quintiles by institutional holdings

Panel A: Total turnover

	Institutional Holdings Group				
	Smallest	2	3	4	Largest
1993-1999	0.0403	0.0448	0.0560	0.0706	0.0897
2000-2005	0.0644	0.0726	0.0991	0.1289	0.1688

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

	Institutional Holdings Group				
	Smallest	2	3	4	Largest
1993-1999	0.3556	0.2133	0.1804	0.1967	0.2011
2000-2005	0.4645	0.4330	0.6519	1.0286	1.4453

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

	Institutional Holdings Group				
	Smallest	2	3	4	Largest
1993-1999	3.4550	4.4605	5.5351	7.0884	8.7951
2000-2005	3.9182	5.8409	7.7321	10.6154	14.2571

Table 7: Per hour open/close and close/open variance ratios, 1993-2005

	1993-1999	2000-2005
Mean	7.191	10.501
Median	6.397	8.804
Std. Dev.	4.798	6.730

Table 8: Coefficients of past absolute return and past absolute two to six month return in regression of monthly turnover on these variables

Panel A: Book/market coefficient

	1993-1999	2000-2005
Mean	14.12	19.85
Median	13.95	20.40
Std. Dev.	5.57	9.92

Panel B: Momentum coefficient

	1993-1999	2000-2005
Mean	6.78	7.73
Median	6.33	7.69
Std. Dev.	2.73	3.61

Table 9: Vector autoregressions which pair detrended turnover with detrended coefficients of past absolute one-month return (LARET) and past absolute two to six month return (LARET26) in cross-sectional regressions of monthly turnover on these variables (* denotes significance at the 5% level)

Panel A: S&P 500 turnover

Correlations in VAR innovations		
	Turnover	LARET
LARET	0.258*	
LARET26	0.114	0.028

Granger Causality test p-values (for the null that row variable does not cause column variable)			
	Turnover	LARET	LARET26
Turnover	-	0.021	0.527
LARET	0.048	-	<0.01
LARET26	0.527	0.073	-

Panel B: Non-S&P 500 turnover

Correlations in VAR innovations		
	Turnover	LARET
LARET	0.268*	
LARET26	0.233*	0.062

Granger Causality test p-values (for the null that row variable does not cause column variable)			
	Turnover	LARET	LARET26
Turnover	-	0.922	0.115
LARET	0.934	-	<0.01
LARET26	0.125	0.039	-

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

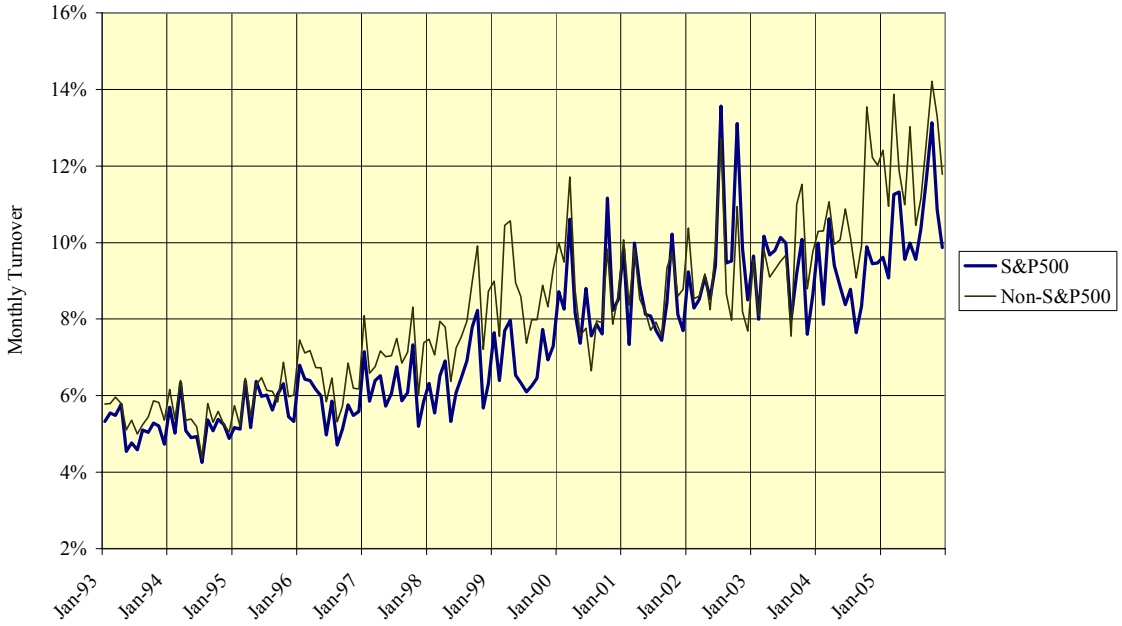

Figure 2-A. Average Dollar Trade Size, 1993-2005

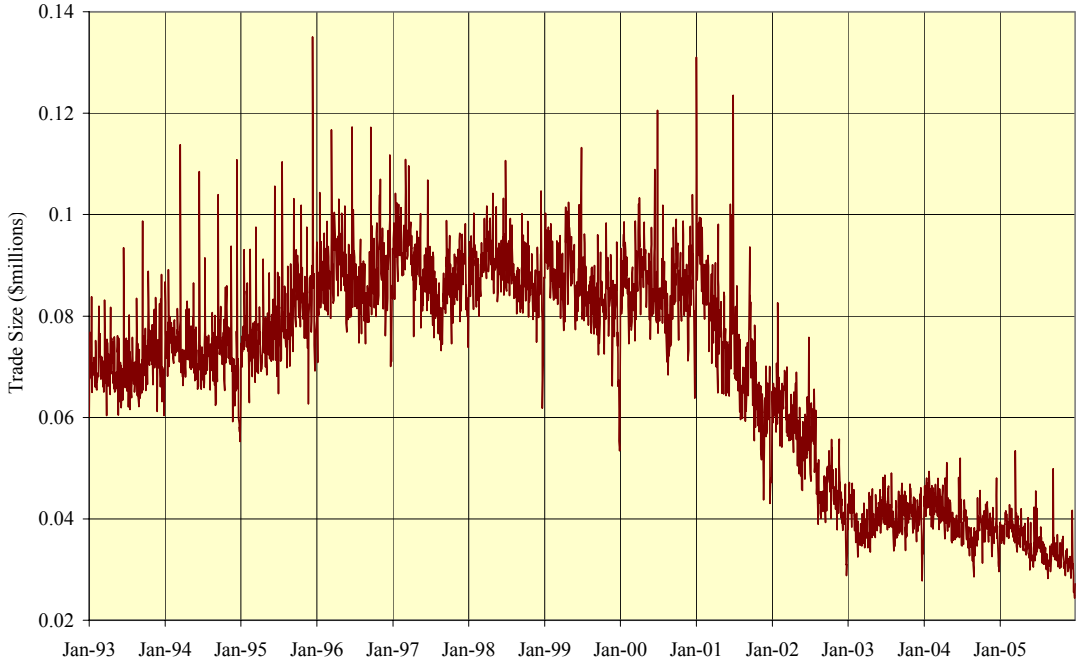

Figure 2-B. Average Number of Daily Transacations per Stock, 1993-2005

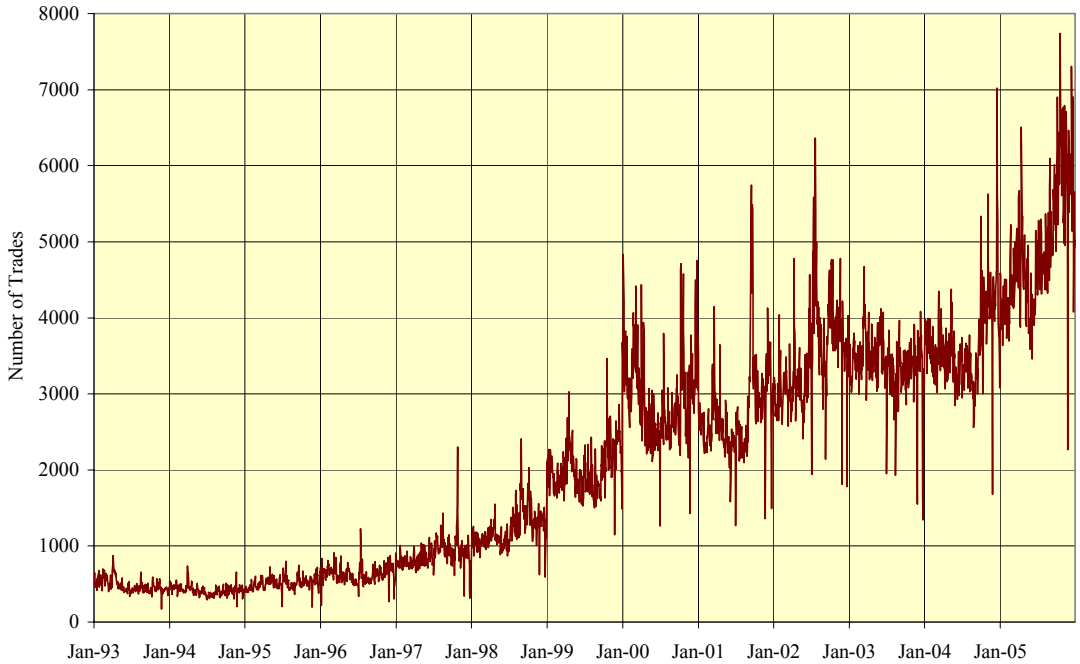

Figure 3-A. Percentage of Trades less than $10,000, 1993-2005

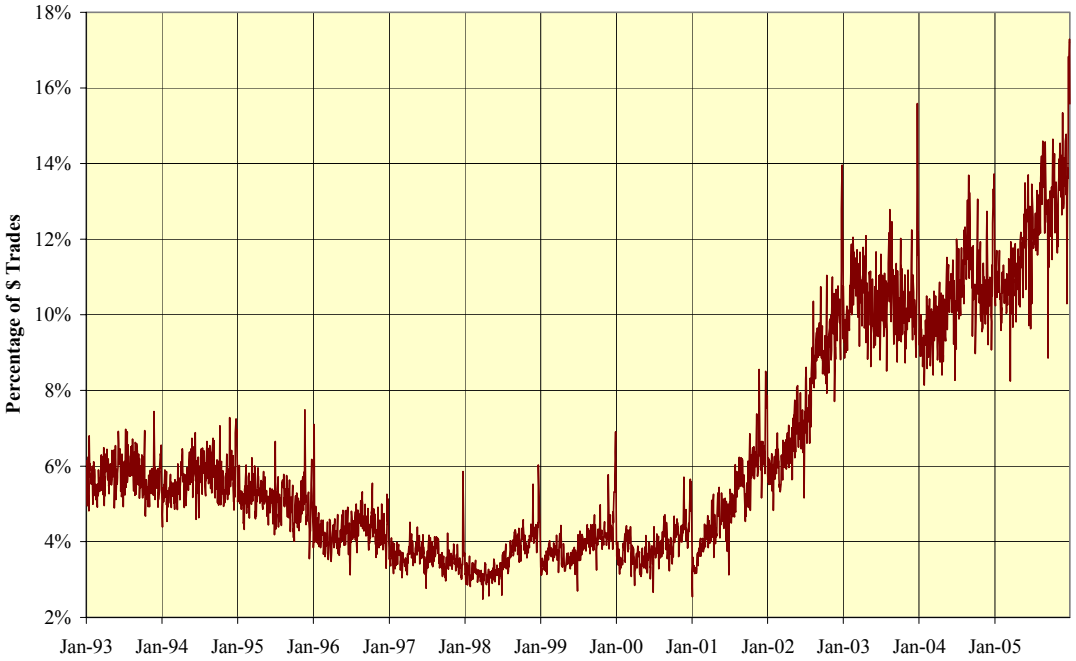

Figure 3-B. Percentage of Trades greater than $10,000, 1993-2005

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

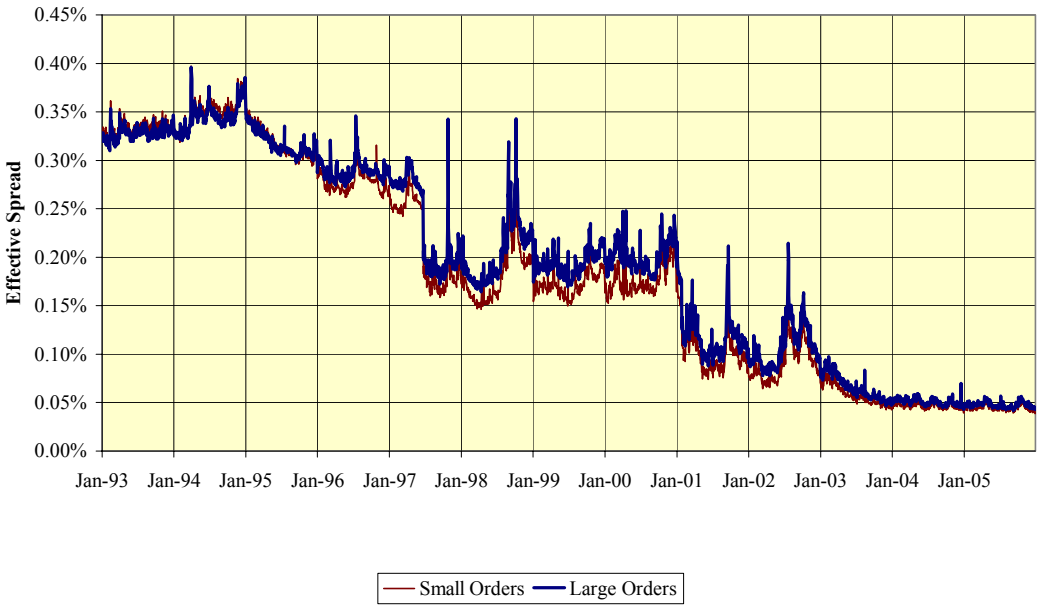

Figure 5. Value-weighted average turnover, 1993-2005, by lowest to highest institutional ownership holding groups

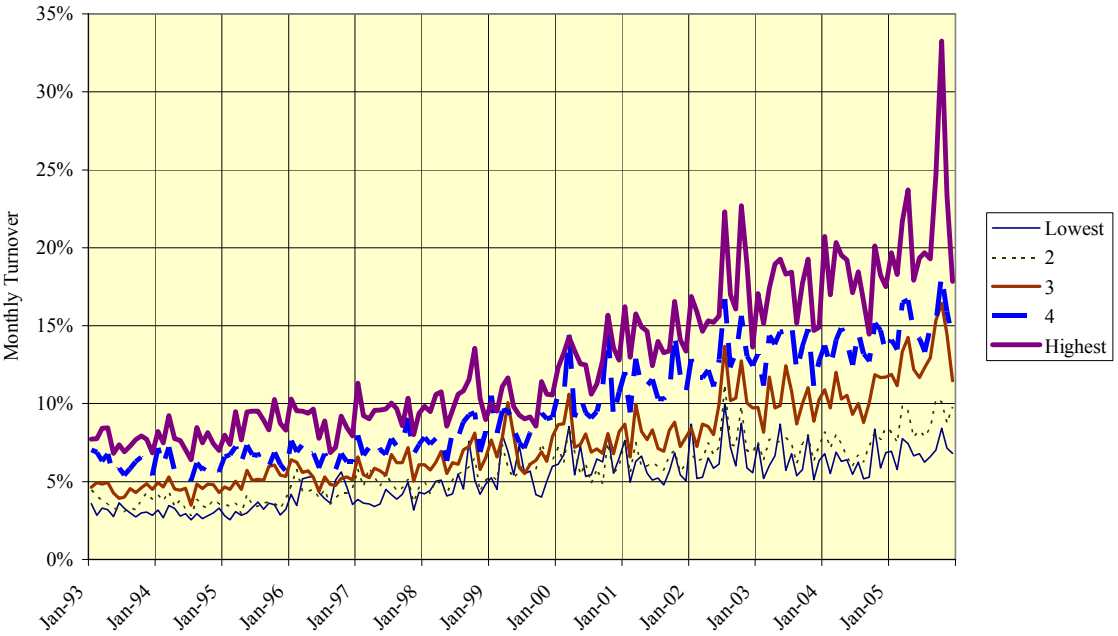

Figure 6. Variance Ratio per Hour, Open to Close/Close to Open
1993-2005, Within Calendar Months

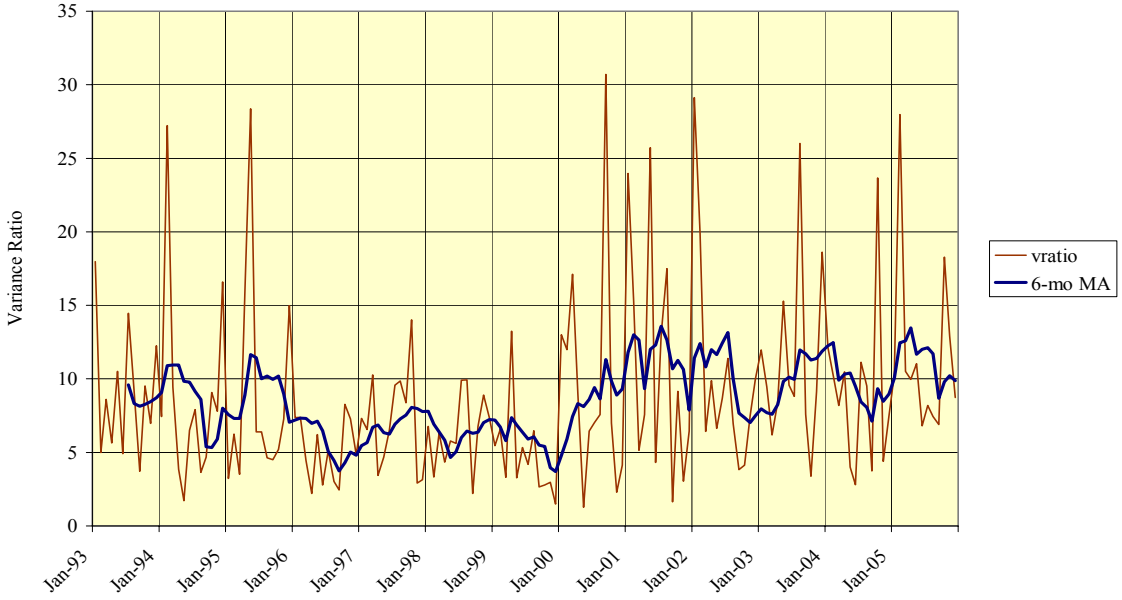

Figure 7. Coefficients from Regressing Turnover Cross-Sectionally on Lagged One-Month Absolute Return [aret(t-1)] and Lagged Two- to Six-Month Absolute Returns [aret(t-2,t-6)]