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Trading activity and expected stock returns☆

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Abstract

Given the evidence that the level of liquidity affects asset returns, a reasonable hypothesis is that the second moment of liquidity should be positively related to asset returns, provided agents care about the risk associated with fluctuations in liquidity. Motivated by this observation, we analyze the relation between expected equity returns and the level as well as the volatility of trading activity, a proxy for liquidity. We document a result contrary to our initial hypothesis, namely, a negative and surprisingly strong cross-sectional relationship between stock returns and the variability of dollar trading volume and share turnover, after controlling for size, book-to-market ratio, momentum, and the level of dollar volume or share turnover. This effect survives a number of robustness checks, and is statistically and economically significant. Our analysis demonstrates the importance of trading activity-related variables in the cross-section of expected stock returns. © 2001 Elsevier Science S.A. All rights reserved.

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1. Introduction

The notion that measures of liquidity can influence asset returns (Amihud and Mendelson, 1986) is by now well accepted. Extending this notion, Brennan et al. (1998) demonstrate a negative relation between average returns and dollar trading volume, with the latter being used as a proxy for liquidity. In this paper, we document a negative and surprisingly strong relation between average returns and both the level as well as the variability of trading activity, after controlling for the well-known size, book-to-market ratio, and momentum effects, as well as the price level and dividend yield. This negative relation is statistically and economically significant.

Our analysis of the effect of volatility of trading activity on expected returns is motivated by a very plausible reason for the variability of liquidity to be priced, namely, that agents are risk averse and dislike variability in liquidity, so that stocks with greater variability should command higher expected returns.[1] We find that the data does not support this hypothesis. There is reliable evidence that stocks with high variability in trading activity command lower expected returns.

We find that our negative relationship between average returns and the coefficients of variation of both dollar trading volume and share turnover persists after a number of robustness checks. These checks include different definitions of variability in liquidity, performing separate regressions for NYSE, Amex, and Nasdaq stocks, accounting for the Pontiff and Schall (1998) predictor variables, and testing whether our effect serves as a proxy for non-linearities in the relation between the level of liquidity and asset returns.

Obviously, the criticism of "data-mining" on our part can never be fully addressed, but indications that data-dredging is not our intention can be obtained by considering the following. Given that the first moment of liquidity has been shown to be priced, it is natural to investigate whether investors price the risk associated with fluctuations in liquidity. Analysis of the effect of liquidity variations on expected returns is the basic motivation for our work. In other words, we did not pick our variable after running several regressions and choosing the significant one to report. Furthermore, we are not aware of any prior work that has studied the impact of variability in trading activity on expected returns, suggesting that our results are not driven by data-snooping (see Lo and MacKinlay, 1990).

In our empirical investigation, we use the Brennan, Chordia, and Subrahmanyam (1998) (BCS) methodology to relate expected returns to the volatility of liquidity. Since we do not have data on bid–ask spreads for a length of time

[1] This argument is suggested by Chordia et al. (2000) and Hasbrouck and Seppi (1998), who document correlated movements in liquidity.

sufficient to run asset pricing tests, we proxy for liquidity by two measures of trading activity: dollar trading volume and share turnover. These proxies have been used by BCS and Datar et al. (1998). The turnover rate is related to the representative investor's holding period, and is related to liquidity in Amihud and Mendelson (1986) and Chalmers and Kadlec (1998). Dollar trading volume is related to how quickly a dealer expects to turn around her position and is positively related to liquidity in Stoll (1978). Also, Brennan and Subrahmanyam (1995) find that trading volume is an important determinant of the measure of liquidity. Chordia et al. (2000) document a strong cross-sectional relationship between dollar trading volume and various measures of the bid–ask spread and market depth. We use both dollar volume and turnover as proxies of liquidity.

We are mindful of Berk's (1995) observation that any price-related variable will be related to returns under improper risk-adjustment. However, two aspects lead us to believe that this phenomenon is not what drives our results. First, we control for the price level in the regressions, and second, our results also hold for the variability of share turnover, which is a dimensionless variable that does not involve the price level.

In other related work, Lee and Swaminathan (1998) discuss the relation between price momentum and turnover, but do not discuss the relation between returns and the second moment of turnover. They argue that turnover may be a less than perfect proxy for liquidity because the relation between turnover and expected returns depends on how stocks have performed in the past. We control for past performance in our tests, and also perform tests separately for dollar volume and turnover. Datar et al. (1998) empirically analyze the relationship between share turnover and liquidity. In contrast, our study aims to explore whether variability in trading activity has an effect on expected returns after accounting for other, previously identified effects.

Though we cannot rule out alternative explanations for our findings, such as an omitted risk factor, such explanations are certainly not obvious. One potential explanation could be the clientele effect hypothesis of Merton (1987), who argues that stocks with greater investor following should command lower expected return. It is possible that the volatility of trading activity proxies for the heterogeneity of the clientele holding the stock. In this case, a high volatility could imply a shift towards a more heterogeneous group of people who want to hold the stock. Such a shift would lower the required rate of return, which is consistent with our result. However, when we use the number of analysts following a company as a proxy for investor interest, we find that the effect of the volatility of trading activity on expected returns is essentially unchanged. The role of this and other proxies will become clearer as more data with enough time-series and cross-sectional analyst coverage becomes available. Our results establish that variables related to trading activity play an important role in the cross-section of expected returns over and above well-studied effects such as size, book-to-market ratio, and momentum.

This paper is organized as follows. Section 2 presents the empirical methodology. Section 3 describes the data, and Section 4 documents the regression results. Section 5 presents robustness checks and explores alternative explanations for the basic result, while Section 6 concludes.

2. Empirical methodology

We use the Fama and French (1993) factors in our risk-adjustment procedure.[2] Assume that returns are generated by an L-factor approximate factor model:

$$\tilde{R}_{jt} = \mathrm{E}(\tilde{R}_{jt}) + \sum_{k=1}^{L} \beta_{jk}\tilde{f}_{kt} + \tilde{e}_{jt}, \tag{1}$$

where R_{jt} is the return on security j at time t, and f_{kt} is the return on the kth factor at time t. We begin by estimating each year, from 1966 to 1995, the factor loadings, β_{jk}, for all securities that had at least 24 return observations over the prior 60 months. Since the Fama and French factors begin in July 1963, the factor loadings in the first month of the regression period (January 1966) were estimated from 30 observations per factor, the next month, 31, and so on till the 60 month level was reached, from which point the observation interval was kept constant at 60 months. In order to allow for thin trading, we used the Dimson (1979) procedure with one lag to adjust the estimated factor loadings.

The exact or equilibrium version of the APT in which the market portfolio is well diversified with respect to the factors can be written as

$$\mathrm{E}(\tilde{R}_{jt}) - R_{Ft} = \sum_{k=1}^{L} \lambda_{kt}\beta_{jk}, \tag{2}$$

where R_{Ft} is the return on the riskless asset and λ_{kt} is the risk premium for factor k.

The estimated risk-adjusted return on each of the securities, $\tilde{R}^*_{jt}$, for each month t of the following year was then calculated as

$$\tilde{R}^*_{jt} \equiv \tilde{R}_{jt} - R_{Ft} - \sum_{k=1}^{L} \hat{\beta}_{jk}\tilde{F}_{kt}, \tag{3}$$

where $\tilde{F}_{kt} \equiv \lambda_{kt} + \tilde{f}_{kt}$, is the sum of the factor realization and its risk premium. Our risk adjustment procedure imposes the assumptions that the zero-beta

[2] We are grateful to Eugene Fama and Kenneth French for providing these factors to us.

return equals the risk-free rate, and that the APT factor premium is equal to the excess return on the factor. The risk-adjusted returns from Eq. (3) constitute the raw material for the estimates that we present below of the equation:

$$\tilde{R}^*_{jt} = c_0 + \sum_{m=1}^{M} c_m Z_{mjt} + \tilde{e}'_{jt}, \tag{4}$$

where Z_{mjt} is the value of security characteristic m for security j in month t.

As in Brennan et al. (1996, 1998), we present two estimates of the coefficients, c_m, in Eq. (4). The first is the standard Fama-Macbeth (1973) estimator, and the second is the constant term from the OLS regression of the month-by-month Fama-Macbeth estimates on the factor portfolio returns, which is referred to as the purged estimator. We first calculate an estimate of the vector of characteristics rewards $\hat{c}_t$ each month from a simple OLS regression:

$$\hat{c}_t = (Z'_t Z_t)^{-1} Z'_t R^*_t,$$

where Z_t is the vector of firm characteristics in month t and R^*_t is the vector of risk-adjusted returns. The standard Fama-Macbeth (1973) estimators are the time-series averages of these coefficients, $\hat{c}_t$. Note that although the factor loadings are estimated with error, this error affects only the dependent variable, R^*_t. While the factor loadings will be correlated with the security characteristics, Z_t, there is no a priori reason to believe that the errors in the estimated loadings will be correlated with the security characteristics. This implies that the estimated coefficient vector $\hat{c}_t$ is unbiased.

If the errors in the estimated factor loadings are correlated with the security characteristics, the monthly estimates of the coefficients will be correlated with the factor realizations and the Fama-Macbeth estimators will be biased by an amount that depends upon the mean factor realizations. Therefore, as a robustness check, the purged estimator is obtained for each of the characteristics as the constant term from the regression of the monthly coefficient estimates on the time series of the Fama-French factor realizations. This estimator, which was first developed by Black et al. (1972), purges the monthly estimates of the factor-dependent component. The standard errors of the estimators are taken from the time series of monthly estimates in the case of the Fama-Macbeth estimator, and from the standard error of the constant from the OLS regression in the case of the purged estimator.

In Tables 4 and 5 we present both the standard Fama-Macbeth estimates (which we denote the raw estimates) and the intercept from the OLS regression of the monthly coefficient estimates on the factor portfolio returns (which are denoted the purged estimates). In the subsequent tables we present only the intercept from the OLS regressions of the monthly estimates on the factor portfolios (purged estimates). The Fama-Macbeth estimates are essentially the same as the purged estimates, and are omitted for the sake of brevity.

3. Data

The basic data consist of monthly returns and other characteristics for a sample of the common stock of NYSE and AMEX-listed companies for the period January 1966 to December 1995.[3] Ideally, we would like to use direct measures of liquidity to calculate the variability in liquidity. Unfortunately, this data is not available at monthly intervals, which precludes a reliable calculation of standard deviation. Based on the work of Stoll (1978), we use measures of trading activity to serve as proxies for liquidity. These activity measures are dollar trading volume and turnover.[4]

To be included in the sample for a given month, a stock had to satisfy the following criteria. First, its return in the current month, t, and in 24 of the previous 60 months had to be available from CRSP, and sufficient data had to be available to calculate the size, price, and dividend yield as of month $t-2$, and dollar volume and turnover over the previous 36 months. Second, sufficient data had to be available on the COMPUSTAT tapes to calculate the book to market ratio as of December of the previous year. This screening process yielded an average of 1,787 stocks per month.

For each stock the following variables were calculated each month as follows:

SIZE – the natural logarithm of the market value of the equity of the firm as of the end of the second to last month.

BM – the natural logarithm of the ratio of the book value of equity plus deferred taxes to the market value of equity, using the end of the previous year market and book values. As in Fama and French (1992), the value of BM for July of year t to June of year $t+1$ was computed using accounting data at the end of year $t-1$, and book-to-market ratio values greater than the 0.995 fractile or less than the 0.005 fractile were set equal to the 0.995 and 0.005 fractile values, respectively.

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[3] The observation period began in January 1966 because the Fama and French factors are available only from July 1963 onwards, and we required enough lag time to allow loadings to be estimated reliably from past factor realizations. Further, we restrict much of our study to NYSE-AMEX stocks because trading volume for Nasdaq stocks is not available prior to November 1982. We report the results of our regressions for the Nasdaq sample of stocks in Table 8.

[4] We have checked the correlations between the coefficient of variation of dollar trading volume and various measures of the bid–ask spread and depth as follows. Using transactions data (about 30 million transactions) for 1169 NYSE stocks in 1992 we calculated the quoted spread, relative quoted spread, market depth, effective spread and the relative effective spread for each transaction (see Chordia et al. (2000) for a discussion of the sample). These transaction observations were averaged within each day to obtain a sample of 254 trading days for each stock. The coefficients of variation of the liquidity measures and the dollar trading volume were calculated for each month in 1992. The time series means of the monthly cross-sectional correlations between the various volatility measures of liquidity and the volatility of dollar trading volume varied from 0.36 to 0.46 and their standard deviations ranged from 0.04 through 0.06. Given that the correlations are calculated for standard deviations of daily averages, we consider their magnitude to be quite encouraging.

DVOL – the natural logarithm of the dollar volume of trading in the security in the second to last month.

STDVOL – the natural logarithm of the standard deviation of dollar volume calculated over the past 36 months beginning in the second to last month.

CVVOL – the natural logarithm of the coefficient of variation of dollar volume calculated over the past 36 months beginning in the second to last month.

TURN – the natural logarithm of the share turnover measured by the number of shares traded divided by the number of shares outstanding in the second to last month.

STDTURN – the natural logarithm of the standard deviation of turnover calculated over the past 36 months beginning in the second to last month.

CVTURN – the natural logarithm of the coefficient of variation of turnover calculated over the past 36 months beginning in the second to last month.

PRICE – the natural logarithm of the reciprocal of the share price as reported at the end of the second to last month.

YLD – the dividend yield as measured by the sum of all dividends paid over the previous 12 months, divided by the share price at the end of the second to last month.

RET2–3 – the cumulative return over the two months ending at the beginning of the previous month.

RET4–6 – the cumulative return over the three months ending three months previously.

RET7–12 – the cumulative return over the 6 months ending 6 months previously.

The lagged return variables serve as proxies for momentum effects, as documented by Jegadeesh and Titman (1993). These proxies were constructed to exclude the return during the immediate prior month in order to avoid any spurious association between the prior month return and the current month return caused by thin trading or bid–ask spread effects. In addition, all variables involving the price level were also lagged by one month in order to preclude the possibility that a linear combination of the lagged return variables, the book-to-market variable (which is related to the price level in the previous year), and the reciprocal of the price level could provide a noisy estimate of the return in the previous month, thus leading to biases because of bid–ask effects and thin trading.[5]

Table 1 reports the time-series averages of the cross-sectional means, medians, and standard deviations of the raw (i.e., unlogged) security characteristics. The variables display considerable skewness. Therefore, in our empirical analysis we

[5] See Jegadeesh (1990). It is easy to show that thin trading will cause risk-adjusted returns to exhibit first order negative serial correlation.

Table 1
Summary statistics

The summary statistics represent the time-series averages of the cross-sectional statistics for a monthly average of 1,787 NYSE and AMEX stocks over 360 months from Jan. 1966 through Dec. 1995. Each stock had to satisfy the following criteria: (1) Its return in the current month, t, and in 24 of the previous 60 months be available from CRSP, and sufficient data be available to calculate the size, price, dollar volume, and dividend yield as of the month $t-2$; (2) Sufficient data be available on the Compustat tapes to calculate the book-to-market ratio as of December of the previous year; and (3) Dollar trading volume be available in at least the most recent 12 of the past 36 months. The row titled Book-to-market ratio provides summary statistics for this variable after book-to-market ratio values greater than the 0.995 fractile or less than the 0.005 fractile are set to equal the 0.995 and 0.005 fractile values, respectively. The standard deviation and coefficient of variation of dollar trading volume and share turnover are calculated using data for the past three years (36 months), starting in month $t-2$.

	Mean	Median	Standard deviation
Firm size ($ billion)	0.66	0.12	0.34
Book-to-market ratio	1.35	0.90	0.62
Dollar trading volume ($million per month)	26.90	3.94	23.62
Standard deviation of dollar trading volume ($ million)	12.61	3.05	11.14
Coefficient of variation of dollar volume	0.78	0.70	0.04
Turnover*100	3.93	2.59	1.36
Standard deviation of turnover*100	2.53	1.68	0.90
Coefficient of variation of turnover	0.65	0.59	0.02
Share Price ($)	22.91	18.46	10.55
Dividend Yield (%)	3.19	2.47	0.69

employ logarithmic transforms of all these variables except the momentum variables and dividend yield (which may be zero). Further, for all of the regressions reported below, the transformed firm characteristic variables for a given month were expressed as deviations from their cross-sectional means for that month; this implies that the average security will have values of each non-risk characteristic that are equal to zero, so that under both the null and the alternative hypotheses its expected return will be determined solely by its risk characteristics. Table 2 reports the averages of the month by month cross-sectional correlations of some of the transformed variables that we use in our analysis. Not surprisingly the largest correlations are between SIZE and DVOL, TURN and DVOL, CVVOL and DVOL, TURN and STDVOL, TURN and STDTURN, CVTURN and SIZE, STDTURN and STDVOL, and CVTURN AND CVVOL. The other correlations are smaller than 0.40 in absolute value.

The correlation between excess returns and STDVOL is higher in absolute terms than that between excess returns and DVOL. Similarly, the correlation between excess returns and STDTURN is higher in absolute terms than that

Table 2
Correlation matrix of transformed firm characteristics

This table presents time series averages of monthly cross-sectional correlations between transformed firm characteristics used in pricing regressions. The variables relate to a monthly average of 1,787 NYSE and AMEX stocks over 360 months from Jan 1966 through Dec 1995. RET denotes the excess monthly return, or the raw return less the risk-free rate. SIZE represents logarithm of the market capitalization of firms in billions of dollars. BM is the logarithm of the ratio of book value of equity plus deferred taxes to market capitalization, with the exception that book-to-market ratio values greater than the 0.995 fractile or less than the 0.005 fractile are set to equal the 0.995 and 0.005 fractile values, respectively. DVOL is the logarithm of the dollar trading volume, and STDVOL and CVVOL are the logarithms of the standard deviation and the coefficient of variation of dollar trading volume calculated over the past 36 months. TURN is the logarithm of the share turnover, and STDTURN and CVTURN are the logarithms of the standard deviation and coefficient of variation of share turnover calculated over the past 36 months. PRICE is the logarithm of the share price reciprocal. YLD is the dividend yield. RET2–3 is the cumulative return over the two months ending at the beginning of the previous month. RET4–6 and RET7–12 are defined similarly.

	RET	SIZE	BM	DVOL	STDVOL	CVVOL	TURN	STDTURN	CVTURN	RET 2–3	RET 4–6	RET 7–12
RET	1.000											
SIZE	– 0.005	1.000										
BM	0.024	– 0.293	1.000									
DVOL	– 0.011	0.885	– 0.297	1.000								
STDVOL	– 0.021	0.810	– 0.291	0.908	1.000							
CVVOL	– 0.002	– 0.565	0.147	– 0.446	– 0.243	1.000						
TURN	– 0.012	0.093	– 0.099	0.532	0.475	0.055	1.000					
STDTURN	– 0.018	– 0.227	– 0.014	0.121	0.475	0.484	0.689	1.000				
CVTURN	0.001	– 0.556	0.173	– 0.480	– 0.298	0.896	– 0.037	0.455	1.000			
RET2–3	0.014	0.057	0.031	0.119	0.008	0.054	0.142	0.013	0.037	1.000		
RET4–6	0.020	0.087	0.035	0.102	0.027	0.077	0.092	0.029	0.048	0.008	1.000	
RET7–12	0.033	0.087	– 0.026	0.129	0.060	0.096	0.112	0.058	0.053	0.050	0.061	1.000

between excess returns and TURN. In univariate terms, this suggests that an increase in STDVOL or STDTURN should be associated with a decrease in excess returns. Note that since the coefficient of variation is scaled by the mean, its univariate correlations should be interpreted cautiously because part of these correlations would pick up the correlation of the level of dollar volume and turnover with the other variables. This possibility is not an issue in our regressions, which include both the level of dollar volume (turnover) and the coefficient of variation of dollar volume (turnover), and thus capture the marginal effects of the level and the variability of trading activity in a multivariate context.

As a precursor to our regressions, based on the values at the end of the preceding month, in each month we stratify our sample into five size-based quintiles and then, in turn, within each size-based quintile, into five quintiles based on the coefficient of variation in dollar volume (CVVOL) and five quintiles based on the coefficient of variation in turnover (CVTURN). In Table 3, we report time-series means of the median portfolio returns of each of the 25 portfolios based on the CVVOL substratification and the same for those based on the CVTURN classification. The table indicates a monotonic decline in returns within each size quintile as one moves from low CVVOL stocks to high CVVOL stocks for four of five size quintiles. Three of five size quintiles show a similar pattern for the CVTURN portfolios. Even in cases where the monotonic pattern is violated (size quintile 5 for the CVVOL case and size quintiles 4 and 5 for the CVTURN case), the average of the returns in the top half of the table are higher than those in the bottom half. This table suggests a negative relationship between expected returns and measures of variability in liquidity. We test this relationship more formally in the next section.

4. Results

To begin our analysis we present the results of Fama-Macbeth regressions of excess (risk-*un*adjusted) returns on the characteristics SIZE, BM, DVOL, PRICE, YLD, and the momentum variables, in Table 4. The results of Table 4 document strong book-to-market, momentum, and dollar volume effects; these results are not surprising in light of Fama and French (1996) and Brennan, Chordia, and Subrahmanyam (1998). Risk-adjustment does not change these basic conclusions. We proxy for liquidity, inverse of the market impact costs and/or bid–ask spreads, by the monthly dollar trading volume. The significantly negative relationship between dollar trading volume and expected returns is thus consistent with Amihud and Mendelson (1986) and Brennan and Subrahmanyam (1996).

In the next set of regressions, we add measures of variability in liquidity. We choose to use a dimensionless quantity, the coefficient of variation in dollar

Table 3
Portfolio returns for SIZE-CVVOL and SIZE-CVTURN portfolios

This table presents time series averages of the monthly median excess returns and the monthly median risk-adjusted returns. Fama-French factors are used to calculate the risk-adjusted returns. SIZE represents the market capitalization, CVVOL is the coefficient of variation of dollar trading volume, and CVTURN is the coefficient of variation of turnover calculated each month using 3 years of lagged monthly data. First five size quintile portfolios are formed based on NYSE size breaks. Then each size quintile is further sorted into five CVVOL or CVTURN portfolios. Panel A presents results for dollar trading volume and Panel B presents results for turnover. The sample and the variables are defined in Tables 1 and 2. All numbers are in percentages.

	SIZE QUINTILES				
Median returns	Smallest	2	3	4	Largest
Panel A: Dollar trading volume quintiles					
Lowest					
Excess returns	− 0.101	0.150	0.374	0.333	0.328
Risk-adjusted returns	− 0.656	− 0.308	− 0.136	− 0.059	0.038
2					
Excess returns	− 0.400	0.216	0.351	0.296	0.039
Risk-adjusted returns	− 0.940	− 0.421	− 0.227	− 0.109	0.037
3					
Excess returns	− 0.511	0.115	0.322	0.289	0.177
Risk-adjusted returns	− 1.118	− 0.488	− 0.261	− 0.186	− 0.228
4					
Excess returns	− 0.589	0.029	0.275	0.264	0.260
Risk-adjusted returns	− 1.207	− 0.623	− 0.282	− 0.242	− 0.108
Highest					
Excess returns	− 0.885	− 0.406	0.098	0.358	0.082
Risk-adjusted returns	− 1.647	− 0.970	− 0.503	− 0.394	− 0.344
Panel B: Turnover quintiles					
Lowest					
Excess returns	− 0.179	0.167	0.443	0.314	0.330
Risk-adjusted returns	− 0.736	− 0.335	− 0.094	− 0.114	0.105
2					
Excess returns	− 0.432	0.270	0.367	0.331	0.266
Risk-adjusted returns	− 0.937	− 0.393	− 0.288	− 0.169	− 0.119
3					
Excess returns	− 0.491	0.075	0.333	0.400	0.306
Risk-adjusted returns	− 1.135	− 0.493	− 0.181	− 0.118	− 0.086
4					
Excess returns	− 0.615	− 0.004	0.111	0.214	0.167
Risk-adjusted returns	− 1.239	− 0.605	− 0.413	− 0.272	− 0.225
Highest					
Excess returns	− 0.786	− 0.240	0.113	0.201	0.191
Risk-adjusted returns	− 1.416	− 0.913	− 0.492	− 0.412	− 0.303

Table 4
Fama-Macbeth regression estimates using individual security data (Fama and Macbeth, 1973)

This table presents two sets of results, one for dollar trading volume and one for turnover. In each panel, the dependent variable in the first column is simply the excess return, while in the second and third columns it is the risk-adjusted return using the Fama-French factors (Dimson betas with one lag are used). The independent variables are the firm characteristics, measured as the deviation from the cross-sectional mean in each period. The estimates in the column labeled "Raw" are the standard Fama-MacBeth coefficient, while the coefficients labeled "Purged" are obtained as the intercept term on regressing the time-series of regression coefficients on the factors. The sample and the variables are defined in Tables 1 and 2. All coefficients are multiplied by 100. T-statistics are in parentheses.

	Panel A: Dollar trading volume			Panel B: Turnover		
		Returns adjusted using Fama-French factors			Returns adjusted using Fama-French factors	
	Excess returns	Raw	Purged	Excess returns	Raw	Purged
Intercept	0.718	− 0.002	− 0.022	0.718	0.002	− 0.022
	(2.35)	(0.05)	(− 0.46)	(2.35)	(0.05)	(− 0.46)
SIZE	0.125	0.149	0.136	− 0.058	− 0.070	− 0.094
	(2.06)	(3.61)	(3.29)	(− 1.80)	(− 2.65)	(− 3.57)
BM	0.222	0.099	0.093	0.222	0.099	0.093
	(4.49)	(2.39)	(2.26)	(4.49)	(2.39)	(2.26)
PRICE	0.088	− 0.048	− 0.139	0.088	− 0.048	− 0.139
	(0.81)	(− 0.50)	(− 1.47)	(0.81)	(− 0.50)	(− 1.47)
DVOL	− 0.183	− 0.219	− 0.231	—	—	—
	(− 3.63)	(− 5.84)	(− 6.07)			
TURN	—	—	—	− 0.183	− 0.219	− 0.231
				(− 3.63)	(− 5.84)	(− 6.07)
YLD	− 1.31	− 0.591	− 0.941	− 1.31	− 0.592	− 0.941
	(− 0.85)	(− 0.56)	(− 0.87)	(− 0.85)	(− 0.56)	(− 0.87)
RET2–3	0.904	1.20	1.43	0.904	1.20	1.43
	(2.95)	(3.89)	(4.61)	(2.95)	(3.89)	(4.61)
RET4–6	0.811	1.09	1.30	0.812	1.09	1.30
	(3.08)	(3.87)	(4.71)	(3.08)	(3.87)	(4.71)
RET7–12	1.06	0.792	1.12	1.06	0.793	1.12
	(6.70)	(3.73)	(5.70)	(6.70)	(3.73)	(5.70)

volume, as a measure of variability, because the standard deviation is highly correlated with the level of dollar volume and could contaminate the results.[6] The results after adding the variability of trading volume are presented in Table 5.

The book-to-market, liquidity, and momentum effects persist after including these variables; their coefficients and their significance remains essentially unchanged. The coefficient on CVVOL in the excess return regression is -0.333 and is strongly significant with a t-statistic of -5.10. In fact, the coefficients of CVVOL are statistically more significant than those on DVOL. There is little change in the basic result upon adjustment with the Fama-French factors; there is also little difference between the raw and purged estimates as we should expect if the factor loading errors are uncorrelated with the non-risk characteristics. For robustness, we repeated the analysis using the coefficient of variation in volume calculated over the past 12 months, as opposed to the past 36 months; this enabled us to make the variability measure more current, but with fewer observations. The coefficients on CVVOL continued to be negative and significant. Further, recall that we calculate the coefficient of variation measures each month as the standard deviation of DVOL over the past 36 months divided by the mean over the past 36 months. In order to address the issue that the mean DVOL over the past 36 months could be picking up some level effect, we defined CVVOL by dividing the standard deviation by the value of DVOL at time $t-2$. The results using this definition were not materially different from those provided here.

In Panel B of Table 5, we repeat the analysis using turnover instead of dollar volume as a measure of trading activity. Note that, unlike Panel A, the coefficient on SIZE in Panel B is highly significant and negative (the size anomaly). This result is not surprising given that the correlation in Table 2 between SIZE and DVOL is 0.89 while that between SIZE and TURN is less than 0.1. The variable related to the level of trading activity (TURN) is negative and strongly significant throughout. In addition, the variable measuring variability of trading activity is also strongly significant. Thus, overall, there is reliable evidence that average returns are negatively related to both the level and the variability of turnover.[7]

It is worth noting here that turnover is not a market price-related variable, which assuages concerns that our results are due to Berk (1995)-type problems, wherein returns are definitionally related to any variable which involves market

[6] The coefficients on standard deviation of volume (STDVOL) were similar to those on CVVOL. However, when STDVOL was used instead of CVVOL, the coefficients on DVOL were no longer significant.

[7] We ran separate regressions for the non-January months, and found that there was no evidence of seasonality in the relation between expected returns and the variability of trading activity.

Table 5
Fama-Macbeth regression estimates: includes coefficients of variation of DVOL and TURN as explanatory variables (Fama and Macbeth, 1973)

The table presents two sets of results, one for dollar trading volume and the one for turnover. In each panel, the dependent variable in the first column is simply the excess return, while in the second and third columns it is the risk-adjusted return using the Fama-French factors (Dimson betas with one lag are used). The independent variables are the firm characteristics, measured as the deviation from the cross-sectional mean in each period. The estimates in the column labeled "Raw" are the standard Fama-MacBeth coefficients, while the coefficients labeled "Purged" are obtained as the intercept term on regressing the time-series of regression coefficients on the factors. The sample and the variables are defined in Tables 1 and 2. All coefficients are multiplied by 100. T-statistics are in parentheses.

	Panel A: Dollar trading volume			Panel B: Turnover		
		Returns adjusted using Fama-French factors			Returns adjusted using Fama-French factors	
	Excess returns	Raw	Purged	Excess returns	Raw	Purged
Intercept	0.719	0.003	− 0.021	0.718	0.002	− 0.022
	(2.36)	(0.07)	(− 0.44)	(2.36)	(0.05)	(− 0.45)
SIZE	0.081	0.088	0.080	0.102	− 0.121	− 0.141
	(1.42)	(2.20)	(1.99)	(3.18)	(− 4.44)	(− 5.13)
BM	0.222	0.101	0.096	0.226	0.106	− 0.100
	(4.50)	(2.45)	(2.34)	(4.57)	(2.54)	(− 2.42)
PRICE	0.102	− 0.030	− 0.122	0.089	− 0.045	− 0.136
	(0.94)	(− 0.32)	(− 1.29)	(0.81)	(− 0.48)	(− 1.45)
DVOL	− 0.177	− 0.208	− 0.220	—	—	—
	(− 3.56)	(− 5.60)	(− 5.87)			
TURN	—	—	—	− 0.188	− 0.223	− 0.234
				(− 3.74)	(− 5.99)	(− 6.17)
YLD	− 1.80	− 1.38	− 1.70	− 1.68	− 1.08	− 1.40
	(− 1.20)	(− 1.31)	(− 1.59)	(− 1.10)	(− 1.01)	(− 1.29)
RET2–3	0.958	1.27	1.50	0.944	1.26	1.48
	(3.11)	(4.10)	(4.81)	(3.08)	(4.07)	(4.79)
RET4–6	0.894	1.20	1.41	0.866	1.16	1.36
	(3.39)	(4.27)	(5.09)	(3.29)	(4.13)	(4.95)
RET7–12	1.12	0.892	1.21	1.10	0.854	1.18
	(7.13)	(4.17)	(6.11)	(7.00)	(4.02)	(5.96)
CVVOL	− 0.333	− 0.453	− 0.424	—	—	—
	(− 5.10)	(− 6.57)	(− 6.05)			
CVTURN	—	—	—	− 0.367	− 0.453	− 0.407
				(− 6.03)	(− 6.69)	(− 5.96)

price under improper risk adjustment. In any case, we have controlled for price in our monthly cross-sectional regressions.

5. Robustness checks and potential explanations

Table 5 documents the basic results of this paper. We now present robustness checks and discuss potential explantions for our results. For brevity, henceforth we present only the results for the excess return regressions and the purged values of the coefficients after risk-adjustment, as displayed in the first and third columns of Table 5. Results for the raw coefficients, which correspond to the second column of Table 5, were qualitatively similar to the purged coefficients we report.

5.1. Conditional volatilities

We first use different measures of variability of DVOL and TURN. By fitting a GARCH(1, 1) model to the ratio of DVOL and TURN to their time series means we obtain conditional volatilities, which are then used in the cross-sectional regressions. The following GARCH(1, 1) model is used.

$$y_t = \alpha_0 + \alpha_1 t + \varepsilon_t,$$

$$\varepsilon_t = h_t e_t,$$

$$h_t^2 = \beta_0 + \beta_1 \varepsilon_{t-1}^2 + \beta_2 h_{t-1}^2. \tag{5}$$

where e_t is IN(0, 1) and y_t is the ratio of DVOL and TURN to their time-series means. We divide by the means to remove any level effects. Since DVOL and TURN have likely been increasing over time, we allow for a time trend as well.

Table 6 reports the result of regressions using the conditional volatilities, h_t. The coefficients on the level of liquidity, DVOL and TURN, and on their conditional volatilities, HDVOL and HTURN, continue to be negative and significant in all cases.

5.2. Macroeconomic predictor variables

We use the Fama and French factors for risk adjustment. These factors have come to be the canonical risk-adjustment standard in the literature, and Fama and French (1993, 1996) have presented convincing evidence that the factors capture a large part of the cross-sectional variation in expected returns. However, since CVVOL and CVTURN are calculated using lagged volume data, it is possible that these variables capture some predictable component in stock

Table 6
Fama-Macbeth regression estimates: conditional DVOL and TURN volatilities (Fama and Macbeth, 1973)

In this table, HVOL (HTURN) are the conditional volatilities calculated for each stock by fitting a GARCH(1,1) model to the ratio of DVOL and TURN to their respective time-series means. The table presents two sets of results, one for dollar trading volume and one for turnover. In each panel, the dependent variable in the first column is simply the excess return, while in the second column it is the risk- adjusted returns using the Fama-French factors (Dimson betas with one lag are used). In the first column in each panel the coefficient estimates are time-series averages of cross-sectional OLS regressions. The estimates in the second column in each panel are obtained as the intercept term by regressing the time-series of the monthly cross-sectional regression coefficients on the factors. The independent variables are the firm characteristics, measured as the deviation from the cross-sectional mean in each period. The sample and the variables are defined in Tables 1 and 2. All coefficients are multiplied by 100. T-statistics are in parentheses.

	Panel A: Dollar trading volume		Panel B: Turnover	
	Excess returns	Risk-adjusted returns	Excess returns	Risk-adjusted returns
Intercept	0.713	−0.027	0.712	−0.028
	(2.34)	(−0.57)	(2.33)	(−0.59)
SIZE	0.034	0.046	−0.073	−0.110
	(0.55)	(1.12)	(−2.24)	(−4.09)
BM	0.201	0.072	0.223	0.095
	(4.08)	(1.77)	(4.57)	(2.30)
PRICE	0.095	−0.128	0.103	−0.120
	(0.87)	(−1.36)	(0.95)	(−1.28)
DVOL	−0.116	−0.164	—	—
	(−2.27)	(−4.38)		
TURN	—	—	−0.159	−0.203
			(−3.08)	(−5.39)
YLD	−1.12	−0.777	−1.26	−0.912
	(−0.73)	(−0.72)	(−0.82)	(−0.84)
RET2–3	1.16	1.69	1.02	1.56
	(3.76)	(5.44)	(3.33)	(5.03)
RET4–6	1.02	1.51	0.881	1.37
	(3.84)	(5.34)	(3.34)	(4.96)
RET7–12	1.21	1.27	1.09	1.16
	(7.56)	(6.38)	(6.95)	(5.86)
HVOL	−0.205	−0.198	—	—
	(−11.24)	(−8.99)		
HTURN	—	—	−0.099	−0.102
			(−3.49)	(−3.17)

returns unrelated to the Fama-French factors. In order to mitigate concerns that our results on CVVOL and CVTURN may be driven by omitted systematic variables that help predict returns, we adjust returns for the business cycle variables that Pontiff and Schall (1998) have shown to have predictive power for stock returns.[8] The predictor variables are available only until 1994. Therefore the regressions using the Pontiff and Schall (1998) variables are run monthly from January 1966 through December 1994, whereas all other regressions in this section are run for the period January 1966–December 1995.

Individual stock returns were first regressed on the one month lagged values of the predictor variables, term spread, default spread, 3-month T-bill yield and dividend yield. The residuals from this regression were then used in the cross-sectional regressions. The results using the adjusted returns are presented in Table 7. The coefficients corresponding to dollar volume and its coefficient of variation, as well as turnover and its coefficient of variation, continue to be negatively and significantly related to returns after adjusting for the macroeconomic factors known to have predictive power for stock returns.

5.3. Nasdaq stocks

Our analysis up to this point has been restricted to NYSE and AMEX stocks only. In order to eliminate the possibility that our results are being driven by the design of the trading process, we now present results for Nasdaq stocks. Nasdaq volume can be considered to be overstated relative to NYSE-AMEX volume due to the inclusion of inter-dealer trading on Nasdaq. Trading volume is not available for Nasdaq stocks on CRSP prior to November 1982. Further, we needed at least 12 months of data to construct our measures of variability in liquidity. Hence the regressions are performed and reported for the period 1984–1995. The results presented in Table 8, indicate that while the momentum effect is somewhat weaker for Nasdaq stocks in our sample period, both the level and the variability of liquidity continue to be negative and significant. Thus, our original results, obtained using NYSE and AMEX stocks, are not driven by market structure or trading protocols. Also, more importantly, our results are robust to the differences in measuring of trading volumes on NYSE-AMEX versus the Nasdaq exchange.

5.4. Non-linearities

It is possible that the second moment of trading activity serves as a proxy for non-linearities in the relation between liquidity and returns, or size and returns. To address this we include quadratic terms for SIZE, DVOL and TURN in the

[8] Data on these variables were kindly provided to us by Jeffrey Pontiff.

Table 7
Fama-Macbeth regression estimates: returns adjusted for business cycle variables (Fama and Macbeth, 1973)

In this table, stock returns are first adjusted for business cycle variables used in Pontiff and Schall (1998). Raw stock returns are first regressed on the business cycle variables and the residuals from this regression (RES) are used in further analysis. The table presents two sets of results, one for dollar trading volume and one for turnover. In each panel, the dependent variable in the first column is the excess return (RES less the risk free rate), while in the second column it is the excess returns, risk-adjusted using the Fama-French factors (Dimson betas with one lag are used). In the first column in each panel the coefficient estimates are time-series averages of cross-sectional OLS regressions. The estimates in the second column in each panel are obtained as the intercept term by regressing the time-series of the monthly cross-sectional regression coefficients on the factors. The independent variables are the firm characteristics, measured as the deviation from the cross-sectional mean in each period. The variables are defined in Tables 1 and 2. The sample is the same as in Tables 1 and 2 except that the sample period extends upto December 1994. All coefficients are multiplied by 100. T-statistics are in parentheses.

	Panel A: Dollar trading volume		Panel B: Turnover	
	Excess returns	Risk-adjusted returns	Excess returns	Risk-adjusted returns
Intercept	− 0.570	− 0.617	− 0.571	− 0.619
	(− 1.99)	(− 2.01)	(− 1.99)	(− 2.01)
SIZE	0.133	0.153	− 0.046	− 0.029
	(2.57)	(2.65)	(− 1.46)	(− 0.81)
BM	0.276	0.276	0.281	0.282
	(5.78)	(4.93)	(5.88)	(5.02)
PRICE	0.262	0.204	0.243	0.186
	(2.42)	(1.83)	(2.23)	(1.65)
DVOL	− 0.181	− 0.185	—	—
	(− 3.89)	(− 3.67)		
TURN	—	—	− 0.199	− 0.204
			(− 4.22)	(− 3.97)
YLD	− 0.810	0.241	− 0.542	0.608
	(− 0.57)	(0.15)	(− 0.37)	(0.37)
RET2–3	− 0.328	− 0.193	− 0.351	− 0.211
	(− 1.08)	(− 0.52)	(− 1.17)	(− 0.57)
RET4–6	− 0.369	− 0.118	− 0.418	− 0.175
	(− 1.53)	(− 0.39)	(− 1.73)	(− 0.58)
RET7–12	0.194	0.076	0.147	0.026
	(1.30)	(0.36)	(0.98)	(0.12)
CVVOL	− 0.488	− 0.533	—	—
	(− 7.72)	(− 6.69)		
CVTURN	—	—	− 0.461	− 0.508
			(− 7.68)	(− 7.43)

Table 8
Fama-Macbeth regression estimates: NASDAQ stocks (Fama and Macbeth, 1973)

This table presents two sets of results, one for dollar trading volume and one for turnover. In each panel, the dependent variable in the first column is simply the excess return, while in the second column it is the risk-adjusted returns using the Fama-French factors (Dimson betas with one lag are used). In the first column in each panel the coefficient estimates are time-series averages of cross-sectional OLS regressions. The estimates in the second column in each panel are obtained as the intercept term by regressing the time-series of the monthly cross-sectional regression coefficients on the factors. The independent variables are the firm characteristics, measured as the deviation from the cross-sectional mean in each period. The variables are defined in Tables 1 and 2. The sample consists of all NASDAQ stocks from 1984 through 1995, selected as per the criteria of Table 1. All coefficients are multiplied by 100. T-statistics are in parentheses.

	Panel A: Dollar trading volume		Panel B: Turnover	
	Excess returns	Risk-adjusted returns	Excess returns	Risk-adjusted returns
Intercept	0.709	0.121	0.710	0.122
	(1.77)	(0.79)	(1.77)	(0.80)
SIZE	0.137	0.129	− 0.044	− 0.085
	(1.67)	(1.65)	(− 0.76)	(− 1.49)
BM	0.405	0.341	0.400	0.338
	(6.27)	(4.62)	(6.18)	(4.58)
PRICE	0.246	0.227	0.217	0.205
	(1.89)	(1.77)	(1.69)	(1.59)
DVOL	− 0.151	− 0.198	—	—
	(− 2.02)	(− 3.54)		
TURN	—	—	− 0.162	− 0.204
			(− 2.19)	(− 3.63)
YLD	1.775	1.037	1.825	1.092
	(1.24)	(0.78)	(1.26)	(0.82)
RET2–3	0.012	0.149	− 0.012	0.111
	(0.04)	(0.45)	(− 0.04)	(0.34)
RET4–6	0.350	0.462	0.331	0.436
	(1.67)	(1.72)	(1.61)	(1.64)
RET7–12	0.589	0.347	0.607	0.346
	(4.74)	(1.82)	(4.80)	(1.80)
CVVOL	− 0.341	− 0.355	—	—
	(− 3.46)	(− 3.48)		
CVTURN	—	—	− 0.491	− 0.403
			(− 4.13)	(− 2.89)

regressions of Table 5. The results are presented in Table 9. Interestingly, the relation between size and returns and between turnover and returns has a non-linear component to it, while there is no evidence of non-linearity in the relation between returns and volume. However, the coefficients of CVVOL and CVTURN remain negative and strongly significant. We have included the quadratic terms separately instead of all together as in Table 9 and the results were essentially unchanged. We also included non-linear terms for the book-to-market ratio and return momentum variables and found that the coefficients on CVVOL and CVTURN were essentially unchanged. These results are not reported for brevity.

5.5. Clientele hypotheses

As stocks move up or down, their clienteles may shift, for example, across institutions and individuals, or across individuals. A more heterogeneous clientele could lead to greater variability in trading activity. In other words, CVTURN and CVVOL could be serving as proxies for how the stock has performed in the recent past. While we have included past returns in our regressions, the clientele effect may be conditional on whether past returns are positive or negative.

In Table 10, we analyze whether there is an asymmetric relationship between past performance and the volatility of trading activity. Our goal is to examine whether a stock that has exhibited positive returns in the past is more likely to show a strong relation between returns and the volatility of trading activity than a stock that has been performing poorly. This could happen, for example, if clienteles shift more rapidly for well-performing (or poorly-performing) stocks and cause a greater variability in trading activity. This argument is suggested by Odean (1998) who presents evidence of a disposition effect, i.e., the tendency to sell winners too soon. We thus define the following variables: CVVOL+, which equals CVVOL if the compound return over the past six months is positive, and zero otherwise, and CVVOL− which equals CVVOL if the reverse is true Similar variables, CVTURN+ and CVTURN−, are defined for turnover. The regressions in Table 10 indicate that the effect of the volatility of trading activity on expected returns is symmetric; there is no major difference in the behavior of the coefficients on the variables CVVOL+ and CVVOL− as well as CVTURN+ and CVTURN−.[9]

[9] We also included variables that directly account for the sign of past return movements. We do this by splitting each of the variables RET2–3, RET4–6, and RET7–12 into two parts which account for the sign of the past values of these vari-ables; for example RET 2–3 is split into RET 2–3+ = max(RET2–3,0) and RET2–3− = min(RET2–3, 0); and similar split variables are defined for RET4–6 and RET7–12. CVVOL and CVTURN remained strongly significant even after splitting the return variables.

Table 9
Fama-Macbeth regression estimates: includes non-linear terms and coefficients of variation of DVOL and TURN as explanatory variables (Fama and Macbeth, 1973)

This table presents two sets of results, one for dollar trading volume and one for turnover. In each panel, the dependent variable in the first column is the excess return, while in the second column it is the risk-adjusted return using the Fama-French factors (Dimson betas with one lag are used). In the first column in each panel the coefficient estimates are time-series averages of cross-sectional OLS regressions. The estimates in the second column in each panel are obtained as the intercept term by regressing the time-series of the monthly cross-sectional regression coefficients on the factors. The independent variables are the firm characteristics, measured as the deviation from the cross-sectional mean in each period. The sample and the variables are defined in Tables 1 and 2. The variables SIZE2, DVOL2, and TURN2 are obtained by squaring the values of SIZE, DVOL, and TURN for each firm. All coefficients are multiplied by 100. T-statistics are in parentheses.

	Panel A: Dollar trading volume		Panel B: Turnover	
	Excess returns	Risk-adjusted returns	Excess returns	Risk-adjusted returns
Intercept	0.719	– 0.021	0.797	0.044
	(2.36)	(0.43)	(2.62)	(0.91)
SIZE	0.054	0.045	– 0.096	– 0.144
	(0.96)	(1.06)	(– 2.76)	(– 4.56)
SIZE2	0.027	0.026	0.020	0.027
	(2.89)	(2.60)	(2.41)	(2.94)
BM	0.212	0.081	0.217	0.084
	(4.32)	(1.95)	(4.41)	(2.02)
PRICE	0.061	– 0.171	0.065	– 0.173
	(0.59)	(– 1.94)	(0.62)	(– 1.96)
DVOL	– 0.166	– 0.204	—	—
	(– 3.38)	(– 5.50)		
DVOL2	– 0.008	– 0.000	—	—
	(– 1.20)	(– 0.06)		
TURN	—	—	– 0.228	– 0.261
			(– 4.34)	(– 6.43)
TURN2	—	—	– 0.077	– 0.060
			(– 6.44)	(– 4.96)
YLD	– 1.65	– 1.38	– 1.79	– 1.29
	(– 1.09)	(– 1.32)	(– 1.17)	(– 1.23)
RET2–3	1.02	1.55	1.10	1.61
	(3.33)	(4.96)	(3.59)	(5.14)
RET4–6	0.903	1.40	0.927	1.41
	(3.45)	(5.09)	(3.54)	(5.09)

Table 9 (*continued*)

	Panel A: Dollar trading volume		Panel B: Turnover	
	Excess returns	Risk-adjusted returns	Excess returns	Risk-adjusted returns
RET7–12	1.13 (7.26)	1.20 (6.03)	1.13 (7.21)	1.18 (5.93)
CVVOL	− 0.302 (− 4.66)	− 0.393 (− 5.61)	—	—
CVTURN	—	—	− 0.244 (− 3.97)	− 0.295 (− 4.28)

Table 10
Fama-Macbeth regression estimates: includes the interactions of CVVOL and CVTURN with past returns (Fama and Macbeth, 1973)

This table presents two sets of results, one for dollar trading volume and one for turnover. In each panel, the dependent variable in the first column is simply the excess return, while in the second column it is the risk-adjusted return using the Fama-French factors (Dimson betas with one lag are used). In the first column in each panel the coefficient estimates are time-series averages of cross-sectional OLS regressions. The estimates in the second column in each panel are obtained as the intercept term by regressing the time-series of the monthly cross-sectional regression coefficients on the factors. The independent variables are the firm characteristics, measured as the deviation from the cross-sectional mean in each period. The sample and the variables are defined in Tables 1 and 2. The variable CVVOL + is the value of CVVOL if the cumulative return over the past six months is positive and zero otherwise. The variable CVVOL − is the value of CVVOL if the return over the past six months is negative and zero otherwise. The variables CVTURN + and CVTURN − are defined similarly for CVTURN. All coefficients are multiplied by 100. *T*-statistics are in parentheses.

	Panel A: Dollar trading volume		Panel B: Turnover	
	Excess returns	Risk-adjusted returns	Excess returns	Risk-adjusted returns
Intercept	0.720 (2.36)	− 0.018 (− 0.39)	0.720 (2.36)	− 0.019 (− 0.39)
SIZE	0.081 (1.43)	0.078 (1.96)	− 0.103 (− 3.19)	− 0.142 (− 5.13)
BM	0.224 (4.53)	0.097 (2.37)	0.228 (4.61)	0.102 (2.47)
PRICE	0.098 (0.90)	− 0.124 (− 1.32)	0.086 (0.79)	− 0.138 (− 1.46)

Table 10 (*continued*)

	Panel A: Dollar trading volume		Panel B: Turnover	
	Excess returns	Risk-adjusted returns	Excess returns	Risk-adjusted returns
DVOL	− 0.179 (− 3.61)	− 0.221 (− 5.87)	—	—
TURN	—	—	− 0.190 (− 3.77)	− 0.235 (− 6.19)
YLD	− 1.79 (− 1.19)	− 1.66 (− 1.56)	− 1.64 (− 1.07)	− 1.33 (− 1.23)
RET2–3	0.946 (3.05)	1.50 (4.79)	0.939 (3.04)	1.48 (4.78)
RET4–6	0.867 (3.25)	1.39 (4.99)	0.846 (3.18)	1.35 (4.87)
RET7–12	1.12 (7.05)	1.21 (6.08)	1.10 (6.95)	1.17 (5.93)
CVVOL +	− 0.265 (− 3.06)	− 0.421 (− 4.62)	—	—
CVVOL −	− 0.404 (− 4.22)	− 0.487 (− 4.66)	—	—
CVTURN +	—	—	− 0.295 (− 3.58)	− 0.384 (− 4.22)
CVTURN −	—	—	− 0.418 (− 4.31)	− 0.450 (− 4.28)

A final issue is whether proxies for clientele effects can help explain the relation between the volatility of trading activity and expected returns. The relation between clienteles and expected returns is suggested by Merton (1987). To partially explore this possibility, we consider the role of the number of analysts following a stock in explaining expected returns. A high level of analyst following could be associated with a high level of institutional holdings, and thus a less heterogenous clientele. Alternatively, a high level of analyst following could be associated with a high level of investor interest and a more heterogenous clientele.[10] We thus use the number of analysts following a company in the

[10] Direct measures of institutional holdings are hard to obtain for a sufficiently large sample period and for a sufficiently extensive sample of stocks in order for reliable asset pricing results to be obtained.

Table 11
Fama-Macbeth regression estimates: includes the number of analysts (Fama and Macbeth, 1973)

This table presents two sets of results, one for dollar trading volume and one for turnover. In each panel, the dependent variable in the first column is simply the excess return, while in the second column it is the risk-adjusted return using the Fama-French factors (Dimson betas with one lag are used). In the first column in each panel the coefficient estimates are time-series averages of cross-sectional OLS regressions. The estimates in the second column in each panel are obtained as the intercept term by regressing the time-series of the monthly cross-sectional regression coefficients on the factors. The independent variables are the firm characteristics, measured as the deviation from the cross-sectional mean in each period. The sample and the variables are defined in Tables 1 and 2. The data covers the period February 1976 to December 1995. NANAL is defined as the logarithm of one plus the number of analysts reported by IBES as following the firm in the previous month. All coefficients are multiplied by 100. T-statistics are in parentheses.

	Panel A: Dollar trading volume		Panel B: Turnover	
	Excess returns	Risk-adjusted returns	Excess returns	Risk-adjusted returns
Intercept	0.861	− 0.070	0.861	− 0.070
	(2.60)	(− 1.17)	(2.60)	(− 1.17)
SIZE	0.021	0.036	− 0.133	− 0.168
	(0.30)	(0.72)	(− 3.53)	(− 5.26)
BM	0.191	0.097	0.197	0.102
	(3.20)	(2.00)	(3.29)	(2.10)
PRICE	− 0.033	− 0.257	− 0.045	− 0.273
	(− 0.28)	(− 2.27)	(− 0.38)	(− 2.42)
DVOL	− 0.153	− 0.203	—	—
	(− 2.79)	(− 5.39)		
TURN	—	—	− 0.166	− 0.219
			(− 2.99)	(− 5.77)
NANAL	0.068	0.046	0.071	0.050
	(2.10)	(1.24)	(2.18)	(1.36)
YLD	− 2.20	− 0.938	− 2.09	− 0.721
	(− 1.58)	(− 0.93)	(− 1.49)	(− 0.72)
RET2–3	0.682	1.15	0.658	1.13
	(2.07)	(3.57)	(1.99)	(3.50)
RET4–6	1.02	1.14	0.982	1.09
	(3.80)	(4.05)	(3.68)	(3.89)
RET7–12	1.19	0.977	1.16	0.934
	(7.19)	(5.57)	(6.96)	(5.34)
CVVOL	− 0.325	− 0.435	—	—
	(− 4.51)	(− 5.06)		
CVTURN	—	—	− 0.293	− 0.390
			(− 3.98)	(− 4.61)

previous month, as reported by Institutional Brokers' Estimate System (I/B/E/S), as an explanatory variable in our regressions. Our I/B/E/S data only spans the period 1977–1995, and therefore we restrict this part of the analysis to this period. The results are presented in Table 11. The table indicates that the coefficients of variation of volume and turnover remain strongly significant in the presence of the number of analysts. The number of analysts has, at best, a weakly positive effect on expected returns.

We also pursued the role of institutional holdings by obtaining data on the percentage of a company's stock held by institutions on an annual frequency. This data is only available for about 1200 stocks from 1980–1995. While a sample period of this length is probably insufficient to on which to base conclusions about asset pricing, we found the role of institutional holdings in explaining expected returns to be insignificant. Further, inclusion of institutional holdings did not reduce the significance of the variables corresponding to the volatility of trading activity. We also explored the role of index membership by including a dummy variable indicating membership in the S&P500 index for a sample from 1976 through 1989. Again, the S&P dummy was not significant and its inclusion did not materially affect the magnitude or the significance of CVVOL and CVTURN. The above results are not reported for brevity, but are available from the authors upon request.

Finally, in Table 12, we analyze how CVVOL and CVTURN vary across securities, and attempt to identify the cross-sectional determinants of CVVOL and CVTURN. In Panels A and B, we present characteristics of quintile portfolios of CVVOL and CVTURN. CVVOL varies from 0.31 to 0.89 across these quintiles, whereas CVTURN varies from 0.35 to 1.04. Interestingly, portfolios with large values of CVVOL tend to be smaller in size, and vice versa. In this regard, note that firm size is negatively related to returns in the classical size effect and that CVVOL is negatively related to returns. This observation, and the inverse relationship between size and CVVOL in Table 12, suggest that CVVOL is not picking up the size effect. It also is interesting to note that quintiles with high CVVOL tend to have low values of DVOL, but quintiles with high values of CVTURN tend to have high values for TURN. In spite of this feature of the data, the coefficients of CVTURN and CVVOL are both negative and strongly significant, suggesting that our results are picking up a generic negative relationship between the volatility of trading activity and returns, a result which is robust to how trading activity is measured.

Panel C shows that the cross-sectional relation between the number of analysts and the volatility measures, after controlling for size, trading volume, turnover, and bid–ask spread, is not significantly different from zero. Given the strong cross-sectional relation between CVVOL and SIZE and CVTURN and SIZE demonstrated in Table 12, the reader may wonder if the effect of CVVOL and CVTURN actually serves as a proxy for some type of size effect. However, the evidence does not support this possibility. First, in Table 3, we document a CVVOL and CVTURN effect within size quintiles. Further, we include non-linear terms for SIZE (Table 9), and find that inclusion of these does not materially alter the significance of CVVOL and CVTURN. Finally, CVVOL and CVTURN are generally more statistically significant than SIZE in the

Table 12
Retail investor shareholdings, number of analysts and volatility of volume and turnover

Panel A presents the time series averages of the median cross-sectional portfolio characteristics for quintile portfolios of the coefficient of variation of dollar volume, CVVOL, and the coefficient of variation of turnover, CVTURN. CVVOL and CVTURN are calculated each month using data over the previous three years. Size represents the market capitalization of stocks each month. DVOL is dollar trading volume and TURN is the share turnover each month. SPREAD is the average of the previous year's beginning and end of year relative spread. INDIVHOLD is the proportion of stock held by non-institutions. NANAL represents the number of analysts following the company in the previous month. Panel B presents the coefficient estimates that are the time series averages of monthly cross-sectional regressions of the natural logarithm of the coefficient of variations of dollar volume (CVVOL) and turnover (CVTURN) on various explanatory variables. In Panel B all variables except NANAL are logged. In Panel B, NANAL is the natural logarithm of one plus the number of analysts. The entire data spans 216 months from 1981 to 1998 for an average of approximately 1,720 NYSE stocks. The analyst data from IBES is available only upto 1995 for an average of 1,595 stocks per month. The t-statistics in parentheses are corrected for first order autocorrelation as follows. The first-order auto-correlations of the coefficients across adjacent months ranges between 0.55 to 0.98. Assuming that the coefficient's estimation error volatility, σ, is constant and that only first-order auto-correlation, ρ, is present, the standard error of the time series sample mean becomes $\sigma\{[1+2\rho/(1-\rho)]/T - 2\rho[(1-\rho^T)/(1-\rho)^2]/T^2\}^{1/2}$, where T is the sample size. When $\rho > 0$, this expression exceeds the usual estimator, $\sigma/T^{1/2}$, resulting in a smaller t-statistic, which is the one reported.

Medians	Smallest	2	3	4	Largest
Panel A: Summary statistics for CVVOL quintile portfolios					
CVVOL	0.31	0.41	0.51	0.63	0.89
SIZE ($ bill)	1.44	0.64	0.33	0.22	0.17
DVOL ($ mill)	61.88	27.79	14.01	9.39	6.85
TURN (%)	3.76	4.18	4.13	4.11	3.91
SPREAD ($\times$100)	0.78	0.96	1.18	1.32	1.46
INDIVHOLD (%)	0.66	0.67	0.63	0.68	0.77
NANAL	18.58	11.47	7.77	5.77	4.27
Panel B: Summary statistics for CVTURN quintile portfolios					
CVTURN	0.35	0.47	0.58	0.73	1.04
SIZE ($ bill)	1.07	0.64	0.38	0.24	0.17
DVOL ($ mill)	41.73	26.31	15.43	10.70	7.60
TURN (%)	3.48	4.00	4.13	4.31	4.50
SPREAD ($\times$100)	0.85	0.95	1.11	1.30	1.53
INDIVHOLD (%)	0.62	0.57	0.62	0.67	0.76
NANAL	17.77	11.38	8.16	6.00	4.14

Table 12 (*continued*)

	CVVOL	CVTURN	CVVOL	CVTURN
Panel C: Time-series averages of monthly cross-sectional regression coefficients				
Intercept	− 0.523	− 0.540	− 0.526	− 0.503
	(− 6.96)	(− 6.17)	(− 4.13)	(− 6.06)
SIZE	− 0.153	− 0.101	− 0.155	− 0.092
	(− 16.31)	(− 9.94)	(− 10.64)	(− 6.87)
DVOL	0.064		0.070	
	(6.85)		(4.98)	
TURN		0.021		0.024
		(2.54)		(2.36)
SPREAD	0.073	0.030	0.065	0.026
	(3.17)	(1.55)	(2.07)	(1.20)
INDIVHOLD	0.006	0.021	0.030	0.037
	(0.07)	(0.29)	(0.42)	(0.65)
NANAL			− 0.017	− 0.018
			(− 0.81)	(− 0.87)

regressions. Perhaps there are other, more precise measures of clientele effects that might perform better do in explaining the role of CVVOL and CVTURN in determining expected returns. As more data on variables that could serve as proxies for clientele effects, such as institutional holdings, becomes available, this avenue of research can be pursued further.

To sum up, there is strong and credible evidence that average returns are influenced by both the level and the variability in measures of trading activity, and this result survives a comprehensive set of robustness checks. With regard to economic significance, note that the coefficient estimates for CVVOL and CVTURN in Table 5 for the excess return regressions on the left-hand side are − 0.33 and − 0.37, respectively. Further, the means of the monthly standard deviation of these variables are 0.40 and 0.45, respectively. This implies that a one standard deviation decrease in the variability of dollar volume or turnover yields an average extra return of about 150 to 200 basis points per year.

6. Conclusion

A body of literature starting with Amihud and Mendelson (1986) has found that investors demand a premium for less liquid stocks, so that expected returns should be negatively related to the level of liquidity. In this paper, we document negative and significant cross-sectional relationship between average stock returns and the level as well as the second moment of measures of trading activity such as dollar volume and share turnover.

Since data on liquidity is not available at sufficient frequencies to allow a reliable calculation of standard deviation, in our empirical work we use measures of trading activity (dollar trading volume and turnover) as proxies for liquidity. Of course, there is always the possibility that these measures are actually picking up some unknown and as yet undiscovered risk factor, or some behavioral anomaly. However, we believe this concern is mitigated both by the fact that we adjust returns for risk using the Fama-French factors, and that we have also controlled for well-known return determinants such as size, book-to-market ratio, momentum, price, and dividend yield, in addition to the predictor variables used by Pontiff and Schall (1998). In light of Fama and French (1996), who argue that momentum perhaps is the only effect not explainable by the Fama and French factors, it is worth noting that the effect of the volatility of trading activity is statistically about as significant as the effect of short-term continuation in stock returns.

If the variability of trading activity serves as a proxy for heterogeneity in the set of investors holding the stock, then, according to Merton (1987), an increase in such heterogeneity would lower the required rate of return on the stock, which is consistent with our results. We consider a proxy for this type of clientele effect, the number of analysts following a stock, and find its role in explaining expected returns to be limited. An alternative possibility is that increased volatility of trading activity corresponds to the entry of institutions that enhances liquidity in a fashion that cannot be measured by the bid–ask spread. Doubtless, as more data on analyst following and other variables, such as changes in institutional holdings, become available, the role of these hypotheses will become clearer. Alternatively, higher volatility in trading volume could be associated with the entry and exit of traders, which in turn could be indicative of low trading costs or higher liquidity in terms of ability to accomodate large block trades. In the cross-section, securities with lower trading costs should have lower expected returns because traders have lower round-trip execution costs. Studies by Chan and Lakonishok (1995) and Keim and Madhavan (1995) document significant trading costs.

Overall, variables related to trading activity play an important role in the cross-section of expected returns over and above previously identified effects such as size, book-to-market ratio, and momentum. However, our findings do not lend themselves to an obvious explanation, so that further investigation of our results would appear to be a reasonable topic for future research.

References

Amihud, Y., Mendelson, H., 1986. Asset pricing and the bid–ask spread. Journal of Financial Economics 17, 223–249.

Berk, J., 1995. A critique of size related anomalies. Review of Financial Studies 8, 275–286.

Black, F., Jensen, M., Scholes, M., 1972. The capital asset pricing model: some empirical tests. In: Jensen, M. (Ed.), Studies in the Theory of Capital Markets. Praeger Publishers, New York.

Brennan, M., Chordia, T., Subrahmanyam, A., 1996. Cross-sectional determinants of expected returns. In: Lehmann, M. (Ed.), On Finance: In Honor of Fischer Black. Oxford University Press, forthcoming.

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

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

Brennan, M., Subrahmanyam, A., 1996. Market microstructure and asset pricing: On the compensation for illiquidity in stock returns. Journal of Financial Economics 41, 341–364.

Chalmers, J., Kadlec, G., 1998. An empirical examination of the amortized spread. Journal of Financial Economics 48, 159–188.

Chan, L., Lakonishok, J., 1995. The behaviour of stock prices around institutional trades. Journal of Finance 50, 1147–1174.

Chordia, T., Roll, R., Subrahmanyam, A., 2000. Commonality in liquidity. Journal of Financial Economics, forthcoming.

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

Dimson, E., 1979. Risk measurement when shares are subject to infrequent trading. Journal of Financial Economics 7, 197–226.

Fama, E., French, K., 1992. The cross section of expected stock returns. Journal of Finance 47, 427–466.

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

Fama, E., French, K., 1996. Multifactor explanations for asset pricing anomalies. Journal of Finance 51, 55–84.

Fama, E., Macbeth, J., 1973. Risk, return, and equilibrium: Empirical tests. Journal of Political Economy 71, 607–636.

Hasbrouck, J., Seppi, D., 1998. Common factors in prices, order flows and liquidity. Unpublished working paper. Stern School of Business, New York University.

Jegadeesh, N., 1990. Evidence of predictable behaviour of security returns. Journal of Finance 45, 881–898.

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

Keim, D., Madhavan, A., 1995. Anatomy of the trading process: Empirical evidence on the behaviour of institutional traders. Journal of Financial Economics 37, 371–398.

Lee, C., Swaminathan, B., 1998. Price momentum and trading volume. Unpublished working paper, Cornell University.

Lo, A., MacKinlay, C., 1990. Data-snooping biases in tests of financial asset pricing models. Review of Financial Studies 3, 431–468.

Merton, R., 1987. A simple model of capital market equilibrium with incomplete information. Journal of Finance 42, 483–510.

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

Pontiff, J., Schall, L., 1998. Book-to-market ratios as predictors of market returns. Journal of Financial Economics 98, 141–160.

Stoll, H., 1978. The supply of dealer services in securities markets. Journal of Finance 33, 1133–1151.