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Trading Volume and Stock Investments

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Previous studies suggest that trading-volume measures may proxy for a number of factors, including liquidity, momentum, and information. For relatively illiquid (typically smaller) stocks, investors may demand a liquidity premium, which can result in a negative relationship between trading volume (as a proxy for liquidity) and stock returns. For relatively liquid (typically larger) stocks—the focus of this article—momentum and information effects may dominate and result in a positive relationship between trading volume and stock returns. Portfolios of S&P 500 Index and large-capitalization stocks sorted on higher trading volume and turnover tend to have higher subsequent returns (holding periods of 1–12 months) than those with lower trading volume.

The existing literature suggests that trading-volume measures may proxy for a number of factors, including liquidity, momentum, and information. Many investors care about such trading-volume measures. For example, investors commonly track "activity" as measured by trading volume and many technical analysts use measures related to trading volume to predict whether a stock will rise or fall in the short term or the midterm (e.g., the *Wall Street Journal* reports such measures as "most active stocks," "key day reversals," and "moving average crossovers," which are all based on number of shares traded).

Liquidity, Momentum, and Information

At the broadest level, liquidity refers to the ability to trade a large number of securities rapidly at low cost and with little impact on market prices. Thus, we can consider four dimensions of liquidity: trading cost, trading quantity or volume, price impact, and trading speed.[1] Most studies have focused on one particular dimension of liquidity. Amihud and Mendelson (1986) examined bid–ask spreads related to trading costs. According to their model, if a security is less liquid and thus more costly to trade, it should provide a higher gross return as compensation. Datar, Naik, and Radcliffe (1998) studied the trading quantity (the turnover rate as measured by the number of shares traded over a given period as a percentage of the number of shares outstanding). Their results support the predictions of the Amihud and Mendelson model.[2] Chordia, Subrahmanyam, and Anshuman (2001) proxied liquidity with trading volume and turnover as measured at the company level. They found that stocks with more volatile liquidity had lower expected returns.

DeLong, Shleifer, Summers, and Waldmann (1990) developed a model showing a positive correlation of stock returns at shorter horizons when "positive feedback traders" respond to past price increases by entering the market and thus create higher trading volume. In an important empirical paper, Lee and Swaminathan (2000) investigated how the interaction between trading volume and past price momentum can predict cross-sectional returns.[3] Using a sample of all NYSE and Amex stocks, they showed that although companies with high past turnover earn higher returns prior to their portfolio formation period, such stocks also exhibit characteristics of growth stocks and tend to have lower future returns. They also found that past trading volume predicts both the magnitude and the persistence of price momentum.

Measures of trading volume may capture more than a stock's liquidity and momentum; they may also contain information. Daniel, Hirshleifer, and Subrahmanyam (1998) presented a model indicating that investors may become overconfident when receiving confirming public information (e.g., resulting in an increase in trading volume) and cause prices to overreact in the short term. Using a

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sample of all NYSE and Amex stocks, Chordia and Swaminathan (2000) examined turnover and focused on cross-autocorrelations among size-sorted portfolios. They showed that the returns on high-volume portfolios adjust faster to marketwide information than the returns on low-volume portfolios. Gervais, Kaniel, and Mingelgrin (2001) examined the impact of short-term changes in trading volume. They found that stocks with unusually high (low) trading volume over the past day or week tend to experience a price increase (decrease) over the subsequent 20 trading days. They argued that this phenomenon is consistent with the notion that trading-activity shocks affect a stock's visibility and, in turn, subsequent demand. In a recent study, Hou, Peng, and Xiong (2006) focused on a similar notion that they termed "attention." They found support for their hypotheses that low-volume stocks tend to underreact to earnings news and that high-volume stocks tend to display overreaction-driven price momentum. Li and Wu (2006) used an econometric framework to decompose the information content of trading volume. They established that trading volume proxies for both market liquidity and information intensity.

Although our focus was on the individual stock, numerous researchers have focused on marketwide liquidity-related measures, particularly in the context of incorporating liquidity into asset pricing models. Chordia, Roll, and Subrahmanyam (2000) documented a commonality in liquidity among stocks, even after accounting for such well-known company-level liquidity determinants as trading volume, volatility, and price. Pastor and Stambaugh (2003) focused on the price impact dimension of liquidity. They created a measure ("liquidity betas") that essentially tries to associate lower liquidity with stronger volume-related return reversals.[4] They found that stocks with higher liquidity betas (i.e., higher sensitivity to aggregate liquidity shocks) offer higher expected returns. Such evidence—as well as O'Hara's (2003) argument that liquidity and the risks associated with price discovery need to be incorporated into asset pricing models—motivated Liu (2006) to develop a new measure of liquidity as a priced risk factor.[5] Liu's measure attempts to capture many dimensions of liquidity, including trading speed, trading quantity, and trading cost. The measure incorporates the number of zero daily volumes in the past months, as well as a turnover measure.[6] Liu's portfolio of the least liquid decile stocks outperformed the most liquid decile portfolio. In a recent study, Li, Mooradian, and Zhang (2007) created an illiquidity metric based on a time series of aggregate commission rates for NYSE trading, which is highly correlated with bid–ask spreads.

To summarize, the existing literature indicates that the concept of trading volume as it relates to liquidity, momentum, and information is complex. Pastor and Stambaugh (2003) referred to liquidity as a "broad and elusive concept." Thus, many interpretations are available to explain various trading-volume measures. For example, one common conjecture in liquidity studies is that trading-volume measures may act as a proxy for risk (i.e., if a stock's recent trading volume is low, an investor may require an expected return premium for holding a stock that does not trade very frequently). This argument is quite feasible, particularly for small stocks. An alternative conjecture, however, particularly for relatively large stocks that are traded frequently, is that trading-volume measures may reflect momentum trading and information (i.e., if a stock's recent trading volume is high, such volume may reflect new information coming to the market and, in turn, cause an investor to expect a higher return). Thus, although a portfolio manager may instinctively feel constrained by, say, having to avoid less frequently traded stocks in one's portfolio, more heavily traded stocks may actually perform better *ex post* if the increased trading is reflective of "good news." Performance and trading-volume differences may also be related to one's investment style. Building on the studies of Lee and Swaminathan (2000), Chordia and Swaminathan (2000), and others, we examined the empirical relationship between trading volume (and turnover) and stock performance, particularly among different investment styles. We differentiated our study from others by examining two measures of volume: shares and turnover (many studies have considered only one measure). To avoid some of the concerns related to liquidity and nonsynchronous trading in other studies (e.g., Chordia and Swaminathan), we focused on two "universes" of generally liquid stocks: the stocks that compose the S&P 500 Index and a broader sample of the top 1,000 stocks as measured by market capitalization (the "Largest 1,000"). We chose these universes because they were large and liquid and allowed us to test our hypotheses. We examined a recent sample period because some studies (e.g., Ben-Rephael, Kadan, and Wohl 2008) have suggested that the relationship between trading-related measures and returns may change over time.

We began our study by defining two simple measures related to trading volume: average daily trading volume as measured on a three-month basis and turnover as measured by the annualized trading volume as a percentage of shares outstanding. We first compared these measures averaged among each of five quintile portfolios in our

samples (i.e., 100 stocks for the S&P 500 universe and 200 stocks for the Largest 1,000) and sorted on three commonly used metrics/investment styles: the price-to-book ratio (i.e., price per share divided by the book value of equity), which captures the value-versus-growth styles; the market capitalization of equity, which captures small-versus-large stock styles; and price-momentum winners versus losers (measured by returns over the previous six months). We discovered monotonic relationships among the price-to-book ratio and market-capitalization variables and a U-shaped relationship with the momentum variable, which suggests some complex interactions among various investment styles and trading volume.

Next, we focused on the potential profitability of long–short portfolios sorted on the basis of trading volume and turnover. We formed portfolio deciles on the basis of the trading-volume measures and compared returns over the subsequent 1-month, 3-month, 6-month, and 12-month periods. Contrary to much of the existing literature, for our sample of larger stocks, we found generally monotonic patterns, with the less (more) traded stocks—that is, on the basis of trading volume and turnover—having lower (higher) returns. For the trading-volume measure, we found that when we regressed excess (of T-bill) returns on market excess returns (i.e., the traditional capital asset pricing model [CAPM]), the alpha was significant for the most heavily traded portfolio. These results were even stronger when we used the three-factor Fama–French (1992, 1993) model (with the factors market risk premium [RmRf], small-minus-big market-capitalization portfolios [SMB], and value-minus-growth or high book/price minus low book/price portfolios [HML]) and the four-factor Fama–French model (with a winner-minus-loser price-momentum factor [UMD] added[7]). The alpha was also positive and significant for the highest-turnover portfolio.

Finally, we investigated the return difference between the high- and low-trading-volume portfolios, formed "trading-volume factors" in the spirit of the SMB and HML factors, and examined their properties and correlations with other known factors. We found that the trading-volume factors were often significant and "priced" above the well-known factors, which suggests the possibility of a marketwide risk factor.

Data, Hypotheses, and Methodology

We back tested simulations of historical data of the S&P 500 and the Largest 1,000 stock prices and measures of trading volume and turnover from January 1991 to December 2007. We obtained monthly data from Ford Equity Research. Our period of study was restricted by the availability of the average daily trading-volume measure, which first became available in January 1991.[8]

We found that both recent trading volume and turnover were related to various long–short investment strategies. Specifically, the trading-volume measures were systematically related to portfolios sorted by various metrics, including price-to-book ratio (PB), market capitalization (MKT), and price momentum (MOM) over the past six months.

We discovered potentially profitable trading-volume investment strategies. We formed portfolios within each decile of the S&P 500 and the Largest 1,000 stocks on both a value-weighted and an equal-weighted basis. We examined the return of each decile-sorted portfolio. We then investigated a strategy of going long in the highest-trading-volume (and highest-turnover) portfolio and going short in the lowest-trading-volume portfolio. Finally, we measured the returns of the various decile-sorted portfolios and the long–short portfolio on a risk-adjusted basis. For our regression analysis, we relied on the well-known CAPM, as well as the Fama–French factors. Our regression equation is

$$r_{it} - rf_t = \alpha_i + \sum_{j=1}^{J} \beta_{ij} \times F_{jt} + e_{it}, \quad i = 1,\ldots,N, t = 1,\ldots,T, \tag{1}$$

where

r_{it} = the return on portfolio i in period t (the portfolio is a group of equal-weighted or value-weighted stocks divided into deciles and sorted on trading volume or turnover)

rf_t = the risk-free return in period t

F_{jt} = the value of factor j (i.e., one of the J factors) in period t—the factors are either the market risk premium from the CAPM or the Fama–French factors RmRf, SMB, HML, and UMD

β_{ij} = the sensitivity of portfolio i to factor j

α_i = the intercept term

e_{it} = the error term

The Fama–French factors are available from Kenneth French's website.[9]

Finally, we found some evidence that trading-volume factors may be priced in a regression model containing other well-known risk factors (i.e., the Fama–French four-factor model). For the dependent variables, we considered three pure market-neutral strategies, in the spirit of Fama–French. Each strategy involved simultaneously going long/short in a portfolio of the top/bottom quintile of the

S&P 500 or the Largest 1,000 stocks on the basis of the following criteria: PB, MKT, and MOM.[10] We regressed the long–short returns of these various style-related portfolios on the Fama–French four factors, as well as a trading-volume measure:

$$r_{L,t} - R_{S,t} = \alpha + \beta_1 RmRf_t + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 UMD_t + \beta_5 TV_t + e_t, \quad (2)$$

where *RmRf*, *SMB*, *HML*, and *UMD* are as previously described and *TV* is the monthly return difference for either the most frequently traded or the highest-turnover portfolio less the least frequently traded or the lowest-turnover portfolio (described in more detail later). We tested whether β_5 was significantly different from zero (i.e., whether the trading-volume measure was "priced" in addition to the other factors).

Trading-Volume Measures and Investment-Style Portfolios

We began our study by examining the general properties of our sample stocks, the S&P 500 and the Largest 1,000. As **Table 1** shows, the average price-to-earnings ratio (PE) and price-to-book ratio (PB) are slightly lower for the S&P 500 stocks than for the Largest 1,000 stocks, and the return on equity (ROE) is slightly higher. The average returns over various investment horizons (e.g., from 1 month to 12 months) are of a similar order of magnitude for the two groups, as is the average share price of just over $30. Average earnings per share five-year average growth (EPS5yrg) is much lower for the S&P 500 stocks than for the Largest 1,000 stocks. Not surprisingly, market capitalization of equity (Mktcap) is much larger for the S&P 500 stocks, but in both samples, the average size is more than $10 billion. As expected, average daily trading volume, as measured on a rolling three-month basis (Dvol3mo), is quite high: 2.96 million shares for the S&P 500 stocks versus 2.06 million for the Largest 1,000 stocks. Finally, turnover, as measured by the annualized trading volume as a percentage of shares outstanding (Turno), is 1.50 times for the S&P 500 stocks, similar to the 1.51 times for the Largest 1,000 stocks.

Table 2 reports on Dvol3mo and Turno. We compared these trading-volume measures averaged among 100 of the S&P 500 stocks (200 of the Largest 1,000 stocks) in each of five quintile portfolios (1 is the lowest quintile and 5 is the highest quintile), sorted on three commonly used metrics: PB (i.e., price per share divided by the book value of equity per share), MKT, and MOM (measured by returns over the previous six months).

For Dvol3mo, we found a monotonic relationship across the PB metric for both the S&P 500 and the Largest 1,000 stocks. The average daily volume for the S&P 500 stocks in the lowest (highest) quintile is 1.93 (5.21) million shares. For the Largest 1,000 stocks, the pattern is similar, with volume ranging

Table 1. Summary Statistics, 1991–2007

	S&P 500 Stocks		Largest 1,000 Stocks	
	Mean	Median	Mean	Median
PE	20.45	20.47	26.13	24.45
PB	5.06	4.93	5.47	5.16
ROE (%)	19.24	19.23	18.12	18.03
Ret1mo (%)	1.07	1.37	1.04	1.45
Ret3mo (%)	3.14	3.50	3.08	3.43
Ret6mo (%)	6.20	7.45	6.12	6.97
Ret12mo (%)	12.60	13.28	12.46	13.58
EPS5yrg (%)	5.69	4.99	7.77	7.04
Mktcap ($ millions)	16,289.30	17,931.58	11,896.28	12,413.55
Shs (millions)	536.46	563.51	407.84	405.93
Price ($)	31.52	32.24	32.70	32.11
Dvol3mo (hundreds of shares)	29,641.57	28,791.97	20,559.73	20,597.47
Turno	1.50	1.33	1.51	1.58

Note: Variables are price-to-earnings ratio (PE), price-to-book ratio (PB), return on equity (ROE), 1-month return (Ret1mo), 3-month return (Ret3mo), 6-month return (Ret6mo), 12-month return (Ret12mo), earnings per share five-year average growth (EPS5yrg), market capitalization of equity (Mktcap), common shares outstanding (Shs), average share price (Price), average daily trading volume measured on a rolling 3-month basis (Dvol3mo), and turnover as measured by the annualized trading volume as a percentage of shares outstanding (Turno).

Source: Based on monthly data from Ford Equity Research.

Table 2. Trading Volume and Turnover, 1991–2007

	S&P 500 Stocks		Largest 1,000 Stocks	
	Trading Volume (Dvol3mo)	Turnover (Turno)	Trading Volume (Dvol3mo)	Turnover (Turno)
PB1	19,304	1.487	12,892	1.106
PB2	19,672	1.398	12,888	1.168
PB3	23,388	1.406	16,467	1.331
PB4	33,683	1.495	23,817	1.653
PB5	52,162	1.694	36,734	2.315
MKT1	10,079	1.826	7,230	1.728
MKT2	14,032	1.673	10,079	1.749
MKT3	20,038	1.508	14,889	1.695
MKT4	28,346	1.380	21,635	1.462
MKT5	75,713	1.093	48,964	0.939
MOM1	35,213	1.973	26,092	1.870
MOM2	24,787	1.273	16,907	1.168
MOM3	23,427	1.170	15,671	1.105
MOM4	24,353	1.237	16,754	1.241
MOM5	40,427	1.828	27,374	2.190

Notes: See note to Table 1. Data are for five quintiles, from lowest (1) to highest (5), sorted by price-to-book ratio (PB), market capitalization (MKT), and momentum as measured by the previous six-month return (MOM). Trading volume is measured in hundreds of shares.

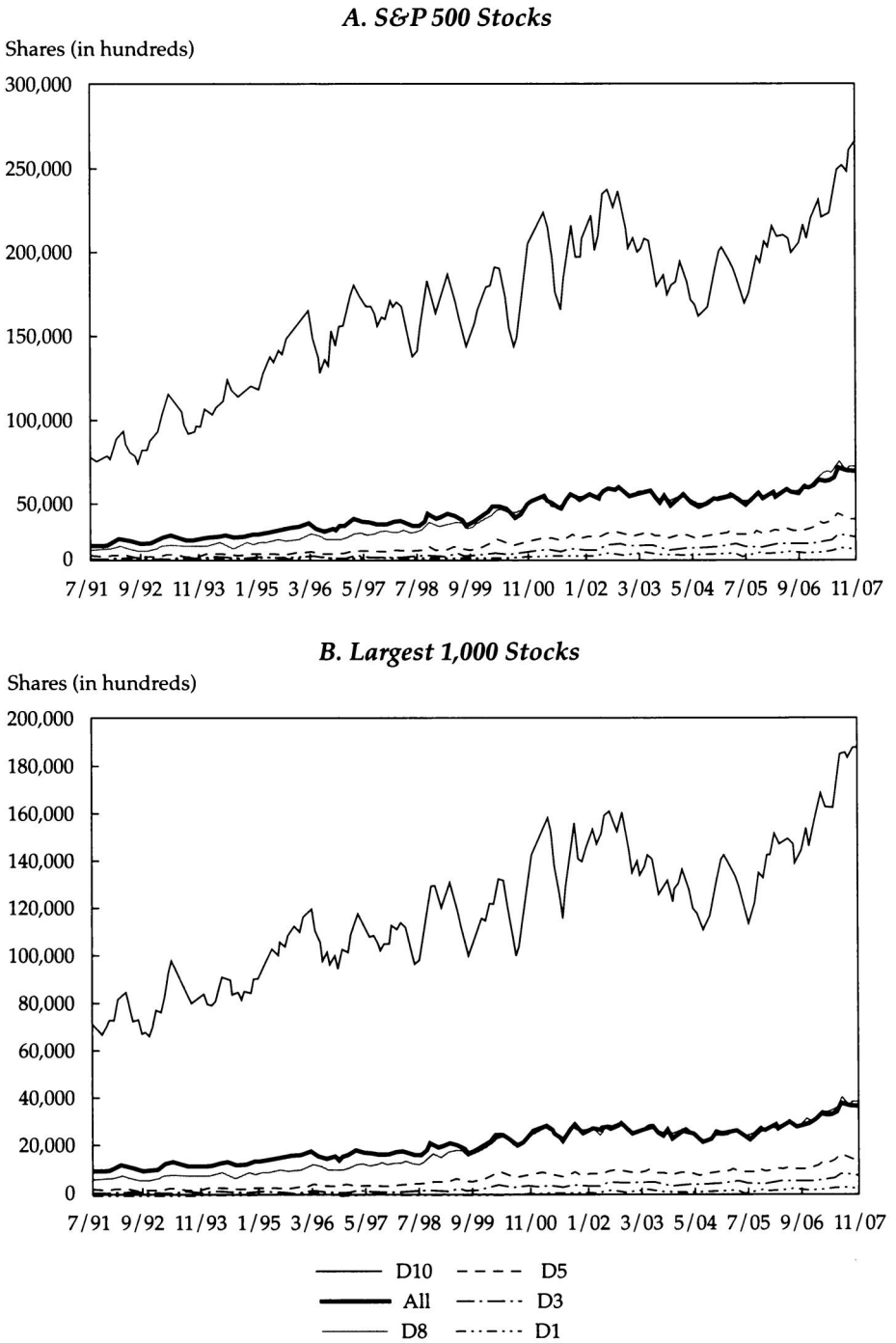
from 1.29 million to 3.67 million. The monotonic relationship is similar for the MKT, and the range is much larger, with an average daily volume for the S&P 500 stocks in the lowest (highest) quintile of 1.01 (7.57) million shares and for the Largest 1,000 stocks in the lowest (highest) quintile of 0.72 (4.89) million shares. We did not, however, find a monotonic relationship among quintiles for the MOM variable but, rather, a U-shape, with both the highest and the lowest quintiles experiencing more trading volume than any of the other three portfolios. These findings suggest that trading volume is higher for growth stocks than for value stocks, higher for large stocks than for small stocks, and higher for stocks that have tended to do either quite well or poorly in the past year than for "mediocre" stocks. This last possibility, in particular, suggests that trading volume may contain information that is more reflective than a simple liquidity measure. For example, investors may be selling the most recent top performers and buying the worst performers.

For Turno, the relationship for the PB-sorted portfolios is generally monotonic for the S&P 500 stocks (with the exception of the lowest-PB portfolio) and is also monotonic for the Largest 1,000 sample, in which the highest quintile has the highest turnover. The relationship is generally monotonic but reversed across the MKT variable for both samples, with the lowest-quintile (highest-quintile) S&P 500 stocks experiencing an average turnover of 1.83 (1.09) times and the lowest-quintile (highest-quintile) Largest 1,000 stocks experiencing an average turnover of 1.73 (0.94) times. Finally, for the MOM variable, the U-shaped pattern remains, with the highest and lowest quintiles having substantially greater turnover than any of the other three quintiles. Thus, the trading-volume and turnover results are consistent for both price-to-book and momentum styles. For market-cap sorting, a monotonic relationship exists for both styles but in a reverse direction (i.e., relatively smaller stocks have less trading volume but higher turnover). These preliminary results suggest that portfolio managers should be aware of the type of investment style before examining the relationship between trading-volume measures and returns.

Trading-Volume Profitability

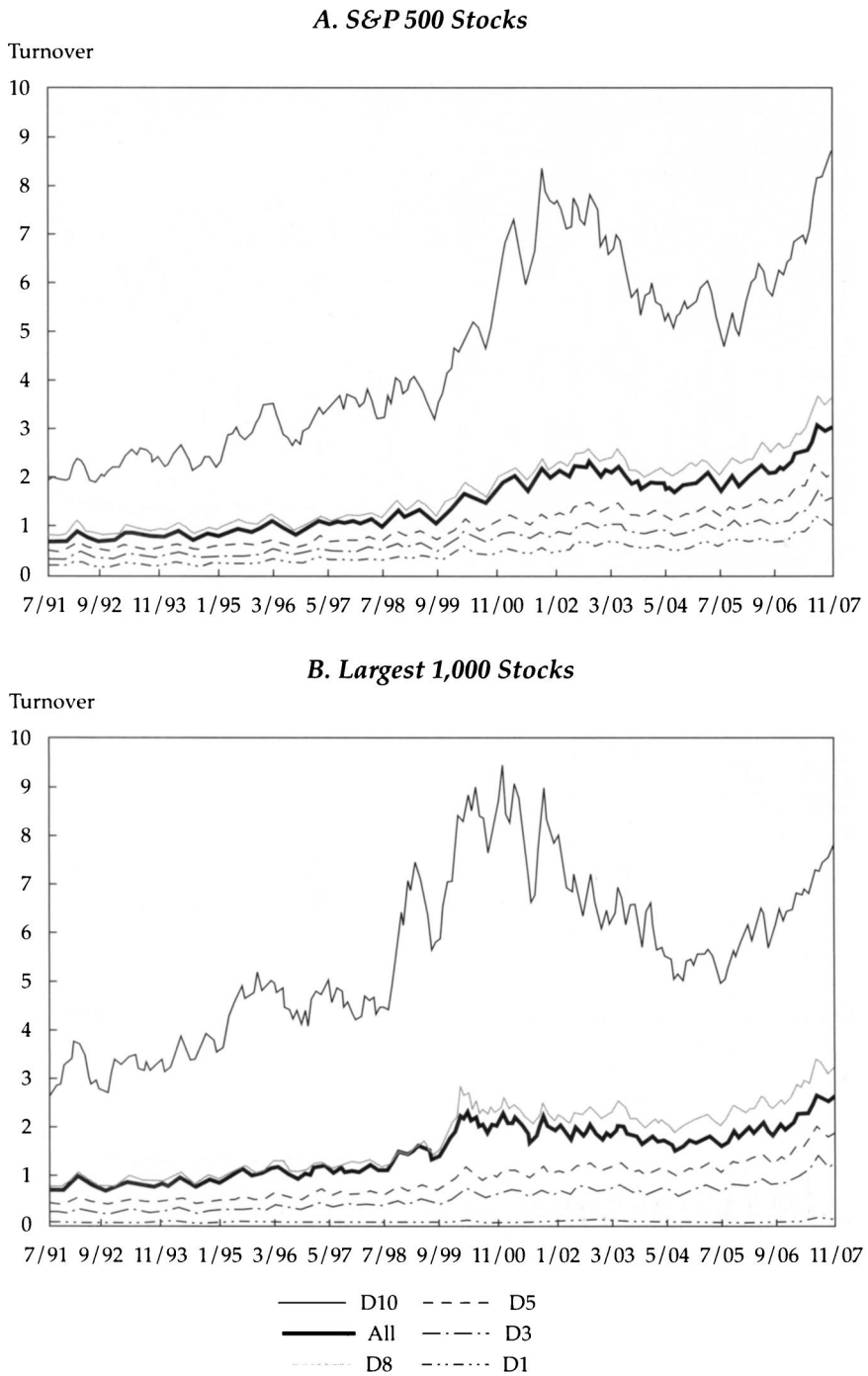
To investigate potentially profitable investment strategies, we formed portfolio deciles based on the two trading-volume measures, with D1 (D10) being the lowest (highest) measure. **Figure 1** depicts the pattern of trading volume for selected deciles, and **Figure 2** shows the pattern of turnover. One can clearly see the much larger trading volume and turnover for the most liquid decile in both samples. **Table 3** reports returns for the subsequent 1-month, 3-month, 6-month, and 12-month holding periods for both value-weighted and equal-weighted portfolios. We divided the overall sample into two arbitrarily chosen subsamples that roughly correspond

Figure 1. Average Daily Trading Volume Measured on a Rolling Three-Month Basis



Note: Data are sorted into various deciles, with D1 (D10) having the lowest (highest) average trading volume.

Figure 2. Turnover as Measured by the Annualized Trading Volume as a Percentage of Shares Outstanding



Note: See note to Figure 1.

Table 3. Performance of Portfolios Sorted by Trading Volume and Turnover, 1991–2007

	Trading Volume (Dvol3mo)						Turnover (Turno)					
	Value Weighted			Equal Weighted			Value Weighted			Equal Weighted		
	Overall	Sub1	Sub2	Overall	Sub1	Sub2	Overall	Sub1	Sub2	Overall	Sub1	Sub2
A. S&P 500 stocks												
1-month holding period (annualized return)												
D1	8.0%	7.0%	9.4%	9.3%	8.3%	10.7%	10.5%	16.9%	2.4%	10.9%	13.4%	7.6%
D3	9.0	10.8	6.6	11.4	13.2	9.0	11.6	16.5	5.3	13.6	16.4	10.0
D5	10.4	14.4	5.1	12.8	16.1	8.4	11.1	16.4	4.2	14.5	18.0	10.0
D8	9.4	13.7	3.7	14.9	21.4	6.6	14.4	23.5	3.0	13.8	16.9	9.7
D10	14.0	25.4	0.1	18.6	32.2	2.2	18.5	30.8	3.4	16.4	26.7	3.6
D10–D1	5.6%	18.4%	–9.3%	8.6%	23.9%	–8.5%	7.2%	13.9%	1.0%	5.0%	13.3%	–3.9%
t-Test *p*-value	0.077	0.002	0.036	0.051	0.001	0.157	0.156	0.098	0.466	0.242	0.091	0.376
3-month holding period (annualized return)												
D1	7.9%	7.2%	8.9%	9.4%	8.4%	10.8%	10.5%	16.5%	2.8%	10.9%	13.8%	7.0%
D3	9.8	12.0	6.9	11.7	13.8	8.9	11.6	16.2	5.5	13.8	16.9	9.6
D5	9.8	12.3	6.4	12.1	14.3	9.2	10.5	15.3	4.1	13.9	17.5	9.1
D8	9.6	12.7	5.4	14.3	19.2	8.0	11.6	16.5	5.1	12.1	15.4	7.8
D10	13.5	22.8	1.8	18.2	29.3	4.2	17.5	27.1	5.3	15.5	22.6	6.4
D10–D1	5.3%	15.6%	–7.1%	8.2%	20.9%	–6.6%	6.5%	10.7%	2.5%	4.2%	8.7%	–0.7%
t-Test *p*-value	0.016	0.000	0.003	0.003	0.000	0.058	0.047	0.034	0.336	0.137	0.052	0.461
6-month holding period (annualized return)												
D1	7.7%	7.2%	8.3%	9.1%	8.4%	10.0%	10.5%	16.3%	2.7%	10.5%	13.5%	6.3%
D3	9.5	11.5	6.9	10.9	12.7	8.4	11.0	15.5	4.9	12.7	15.4	9.2
D5	9.7	11.9	6.8	11.4	13.0	9.3	11.2	16.1	4.7	14.3	18.1	9.2
D8	9.6	12.7	5.4	13.9	18.2	8.3	9.0	13.1	3.6	11.1	13.7	7.6
D10	13.5	22.4	2.0	18.5	29.2	4.7	17.7	27.1	5.4	15.5	22.9	5.8
D10–D1	5.6%	15.1%	–6.3%	9.1%	20.8%	–5.3%	6.8%	10.7%	2.7%	4.8%	9.4%	–0.5%
t-Test *p*-value	0.003	0.000	0.001	0.000	0.000	0.034	0.006	0.005	0.235	0.041	0.009	0.452
12-month holding period (annualized return)												
D1	7.6%	7.6%	7.7%	8.8%	8.3%	9.5%	10.3%	15.7%	3.1%	10.1%	12.7%	6.5%
D3	8.9	9.9	7.4	9.9	10.8	8.5	11.4	14.8	6.8	12.7	14.8	9.8
D5	9.4	10.9	7.4	11.2	12.1	9.9	11.2	14.5	6.6	13.3	16.1	9.6
D8	10.0	12.8	6.3	13.8	17.1	9.4	9.6	12.2	6.0	11.7	13.0	10.0
D10	14.5	21.9	4.4	19.8	28.1	8.6	19.0	26.1	9.3	16.0	20.6	9.8
D10–D1	6.8%	14.3%	–3.3%	11.0%	19.8%	–0.9%	8.7%	10.5%	6.2%	5.9%	7.9%	3.3%
t-Test *p*-value	0.000	0.000	0.005	0.000	0.000	0.322	0.000	0.000	0.006	0.002	0.004	0.119

(continued)

Table 3. Performance of Portfolios Sorted by Trading Volume and Turnover, 1991–2007 (continued)

	Trading Volume (Dvol3mo)						Turnover (Turno)					
	Value Weighted			Equal Weighted			Value Weighted			Equal Weighted		
	Overall	Sub1	Sub2	Overall	Sub1	Sub2	Overall	Sub1	Sub2	Overall	Sub1	Sub2
B. Largest 1,000 stocks												
1-month holding period (annualized return)												
D1	11.1%	9.8%	12.8%	10.0%	8.8%	11.7%	10.9%	12.7%	8.6%	13.1%	13.4%	12.7%
D3	10.6	12.7	7.8	10.5	11.7	8.8	11.3	16.1	5.2	12.5	14.8	9.4
D5	10.1	13.9	5.0	11.8	14.7	7.9	12.8	17.4	6.8	15.7	18.7	11.7
D8	9.8	13.8	4.6	13.9	19.5	6.6	11.7	20.0	1.3	11.7	16.8	5.1
D10	14.2	24.6	1.3	22.1	38.9	2.4	17.0	30.9	0.2	14.2	27.5	–1.8
D10–D1	2.8%	14.8%	–11.5%	11.1%	30.0%	–9.3%	5.5%	18.3%	–8.3%	0.9%	14.1%	–14.6%
t-Test *p*-value	0.207	0.004	0.009	0.014	0.000	0.124	0.225	0.062	0.214	0.446	0.112	0.073
3-month holding period (annualized return)												
D1	11.0%	9.2%	13.5%	10.3%	8.9%	12.1%	10.8%	11.9%	9.4%	13.0%	12.9%	13.1%
D3	10.5	12.2	8.2	10.6	11.5	9.4	11.1	14.7	6.4	12.9	14.7	10.5
D5	10.0	12.9	6.2	11.4	13.4	8.8	11.3	15.8	5.5	14.1	16.9	10.4
D8	9.7	12.4	6.1	13.3	17.0	8.5	10.8	16.5	3.5	10.7	14.0	6.4
D10	13.7	22.4	2.6	21.4	35.0	4.5	16.3	26.0	4.1	14.2	23.1	2.9
D10–D1	2.4%	13.1%	–11.0%	10.3%	26.1%	–7.6%	5.1%	14.1%	–5.3%	1.1%	10.2%	–10.2%
t-Test *p*-value	0.115	0.000	0.000	0.000	0.000	0.033	0.116	0.025	0.150	0.396	0.078	0.019
6-month holding period (annualized return)												
D1	10.9%	9.0%	13.6%	10.2%	8.9%	12.1%	10.9%	11.7%	9.9%	13.0%	12.9%	13.2%
D3	9.2	10.6	7.3	10.1	11.0	8.9	10.4	13.9	5.7	12.0	13.8	9.6
D5	9.9	12.0	7.0	11.2	12.6	9.2	11.3	15.5	5.7	13.5	16.1	10.0
D8	10.3	13.0	6.6	13.3	16.8	8.7	9.8	14.7	3.3	10.3	12.4	7.4
D10	13.6	22.0	2.8	21.6	34.5	5.1	16.6	25.2	5.5	14.4	22.5	3.8
D10–D1	2.6%	13.0%	–10.9%	10.8%	25.6%	–7.0%	5.4%	13.5%	–4.4%	1.2%	9.6%	–9.4%
t-Test *p*-value	0.054	0.000	0.000	0.000	0.000	0.002	0.032	0.003	0.067	0.340	0.031	0.001
12-month holding period (annualized return)												
D1	11.1%	8.4%	14.7%	10.0%	7.9%	12.9%	11.4%	11.3%	11.5%	13.1%	12.1%	14.5%
D3	9.2	9.7	8.5	9.2	9.3	9.2	10.7	13.8	6.5	11.8	13.2	10.0
D5	9.1	9.9	8.0	10.0	10.5	9.3	11.3	14.4	7.1	12.9	14.8	10.2
D8	10.2	12.4	7.3	13.6	15.9	10.5	9.8	12.3	6.4	10.8	11.1	10.2
D10	14.2	21.1	4.7	22.8	32.9	9.0	17.5	23.5	9.3	16.1	22.4	7.5
D10–D1	3.1%	12.7%	–10.0%	12.8%	25.0%	–3.9%	6.1%	12.3%	–2.2%	2.9%	10.3%	–7.0%
t-Test *p*-value	0.011	0.000	0.000	0.000	0.000	0.004	0.001	0.000	0.119	0.097	0.002	0.000

Notes: See note to Table 1. Sub1 = 1991–2000 and Sub2 = 2001–2007. Portfolios are formed into deciles (D1 is the lowest, and D10, the highest). The *p*-value of the *t*-test of significance of the D10–D1 return difference is also indicated.

to bull (July 1991–December 2000) and bear (January 2001–December 2007) markets. During the bull market period, the S&P 500 price (total return) index shows an average annual compound return of 14.1 percent (16.6 percent) versus the bear market return of only 1.5 percent (3.3 percent).

For both trading-volume measures, we found somewhat surprising results relative to much of the existing literature. For Dvol3mo, we found generally monotonic patterns, with the less (more) liquid stocks having lower (higher) returns. For example, the average annualized value-weighted (equal-weighted) returns for the one-month holding period are 8.0 percent (9.3 percent) for the least heavily traded S&P 500 stocks and 14.0 percent (18.6 percent) for the most heavily traded S&P 500 stocks. The average annualized value-weighted (equal-weighted) returns for the one-month holding period are 11.1 percent (10.0 percent) for the least heavily traded Largest 1,000 stocks and 14.2 percent (22.1 percent) for the most heavily traded Largest 1,000 stocks. This pattern of the most heavily traded stocks experiencing higher returns is consistent for different holding periods. For example, the average annualized value-weighted (equal-weighted) returns for the 12-month holding period range from 7.6 percent (8.8 percent) to 14.5 percent (19.8 percent) for the S&P 500 stocks. For the Largest 1,000 stocks, the average annualized value-weighted (equal-weighted) returns for the 12-month holding period range from 11.1 percent (10.0 percent) to 14.2 percent (22.8 percent). For the various holding periods for both samples, the D10−D1 return differences range from 2.4 percent to 6.8 percent for the value-weighted portfolios and from 8.2 percent to 12.8 percent for the equal-weighted portfolios; in almost every case, the return difference is statistically significant. Thus, we found that investing on the basis of recent trading volume is potentially profitable. In contrast to most other studies in the literature, our sample universe was the highly liquid S&P 500 stocks and the relatively liquid Largest 1,000 stocks, a factor that may have contributed to our findings.

For the other trading-volume measure (Turno), we found a similar pattern. Among the various holding periods for both samples, the D10−D1 return differences for the value-weighted (equal-weighted) portfolios range from 6.5 percent to 8.7 percent (4.2 percent to 5.9 percent) for the S&P 500 sample and from 5.1 percent to 6.1 percent (0.9 percent to 2.9 percent) for the Largest 1,000 sample. For most of the 6-month and 12-month samples, the differences are statistically significant. Consistent with our conjecture, for our sample of large (market capitalization of equity) stocks, trading volume and turnover appear to reflect momentum and information effects rather than simply indicating a liquidity premium. Thus, we found a positive relationship between the trading-volume measures and subsequent returns.

After comparing the bull market (1991–2000) and bear market (2001–2007) subperiods in Table 3, we found much stronger effects during the bull market. In most cases, the pattern is reversed during the bear market. For example, for the trading-volume measure (Dvol3mo) for the 12-month holding period, the D10−D1 return difference for the value-weighted S&P 500 sample is 14.3 percent during the bull market and −3.3 percent during the bear market. The corresponding results for the Largest 1,000 stocks are 12.7 percent and −10.0 percent. For the turnover measure (Turno), we found a similar pattern for the value-weighted Largest 1,000 sample, with a bull market difference of 12.3 percent versus a bear market difference of −2.2 percent. For the S&P 500 stocks, the bull market difference of 10.5 percent is higher than the difference for the overall period but the bear market difference of 6.2 percent is still positive and significant. In general, however, results are affected by the type of market (i.e., bull or bear).

We also investigated the *risk-adjusted* return performance of the various trading-volume-sorted portfolios. We attempted to find any significant superior (or inferior) performance by regressing monthly portfolio returns, in excess of T-bill returns, on market excess returns (the RmRf variable measured by Fama–French)—that is, in the context of the CAPM, whereby the intercept return in this regression form is interpreted as the traditional Jensen's alpha. We also measured alpha after controlling for both the three- and the four-factor Fama–French models: RmRf, SMB, HML, and UMD. The results are presented in **Table 4**.

Panel A1 presents the results for the S&P 500 stocks sorted by the trading-volume variable (Dvol3mo) and based on value-weighted returns. Overall, we found that the Jensen's alpha (CAPM) is not significant; under the three-factor Fama–French model, the alpha for most portfolios is negative but the alpha for portfolio D10 (most heavily traded) is 0.39 percent (or 4.8 percent on an annualized basis) and significant. A regression on D10−D1 returns reveals that the alpha is 0.87 percent, or 10.9 percent on an annualized basis. Results are similar for the four-factor model regression, with a D10−D1 alpha of 0.86 percent, or 10.8 percent on an annualized basis. Results are also similar for the Largest 1,000 stocks (Panel B1). The only positive and significant alphas are in the D10 portfolio. For the CAPM, the D10 alpha is 0.10 percent

Table 4. CAPM and Fama–French Three- and Four-Factor Risk-Adjusted Portfolio Performance, 1991–2007
(*t*-statistics in parentheses)

	CAPM			Fama–French Three Factor					Fama–French Four Factor					
	Alpha	RmRf	R^2	Alpha	RmRf	SMB	HML	R^2	Alpha	RmRf	SMB	HML	UMD	R^2
A1. S&P 500 stocks—trading-volume sorted (Dvol3mo), value weighted														
Overall (%)	0.01	0.94		0.01	0.02	–0.21	0.99		0.04	–0.03	0.02	–0.20	0.98	
(*t*-stat.)	(0.17)	(58.95)	0.95	(0.27)	(1.85)	(–22.28)	(110.78)	0.99	(1.26)	(–4.60)	(1.49)	(–22.52)	(113.11)	0.99
D1 (%)	–0.07	0.67		–0.48	0.59	0.02	0.91		–0.39	–0.09	0.57	0.04	0.89	
(*t*-stat.)	(–0.38)	(14.41)	0.51	(–3.20)	(10.99)	(0.56)	(22.18)	0.72	(–2.58)	(–2.80)	(10.86)	(0.96)	(21.55)	0.73
D3 (%)	–0.01	0.69		–0.41	0.60	–0.13	0.97		–0.34	–0.06	0.58	–0.12	0.95	
(*t*-stat.)	(–0.03)	(15.01)	0.53	(–3.30)	(13.43)	(–3.66)	(28.30)	0.81	(–2.72)	(–2.54)	(13.31)	(–3.31)	(27.61)	0.82
D5 (%)	0.05	0.76		–0.18	0.35	–0.06	0.92		–0.12	–0.06	0.34	–0.04	0.90	
(*t*-stat.)	(0.38)	(21.39)	0.70	(–1.46)	(7.81)	(–1.55)	(26.81)	0.79	(–0.96)	(–2.24)	(7.64)	(–1.23)	(26.09)	0.80
D8 (%)	–0.05	0.80		–0.25	0.31	–0.19	0.97		–0.23	–0.02	0.31	–0.19	0.96	
(*t*-stat.)	(–0.34)	(23.12)	0.73	(–2.38)	(8.26)	(–6.25)	(33.39)	0.86	(–2.11)	(–0.99)	(8.13)	(–6.05)	(32.52)	0.86
D10 (%)	0.07	1.21		0.39	–0.45	–0.29	1.07		0.47	–0.07	–0.46	–0.27	1.05	
(*t*-stat.)	(0.45)	(33.26)	0.85	(3.31)	(–10.54)	(–8.26)	(32.85)	0.91	(3.95)	(–3.06)	(–11.01)	(–7.91)	(32.26)	0.91
D10–D1 (%)	0.14	0.54		0.87	–1.03	–0.31	0.16		0.86	0.01	–1.03	–0.31	0.16	
(*t*-stat.)	(0.48)	(7.65)	0.23	(4.14)	(–13.77)	(–5.06)	(2.73)	0.61	(3.98)	(0.27)	(–13.65)	(–5.03)	(2.72)	0.61
A2. S&P 500 stocks—turnover sorted (Turno), value weighted														
Overall (%)	0.01	0.94		0.01	0.02	–0.21	0.99		0.04	–0.03	0.02	–0.20	0.98	
(*t*-stat.)	(0.17)	(58.95)	0.95	(0.27)	(1.85)	(–22.28)	(110.78)	0.99	(1.26)	(–4.60)	(1.49)	(–22.52)	(113.11)	0.99
D1 (%)	0.14	0.64		0.08	0.13	–0.44	0.77		0.05	0.03	0.13	–0.45	0.78	
(*t*-stat.)	(0.83)	(14.98)	0.53	(0.69)	(2.94)	(–12.54)	(23.23)	0.79	(0.40)	(1.33)	(3.06)	(–12.63)	(23.07)	0.79
D3 (%)	0.15	0.76		–0.05	0.32	–0.30	0.95		–0.03	–0.02	0.32	–0.30	0.94	
(*t*-stat.)	(0.94)	(19.16)	0.65	(–0.48)	(8.31)	(–9.50)	(31.89)	0.85	(–0.27)	(–0.90)	(8.18)	(–9.27)	(31.05)	0.86
D5 (%)	0.01	0.93		–0.13	0.21	–0.08	1.04		–0.02	–0.11	0.19	–0.05	1.01	
(*t*-stat.)	(0.04)	(26.07)	0.78	(–0.96)	(4.20)	(–1.87)	(26.97)	0.81	(–0.16)	(–3.83)	(3.96)	(–1.38)	(26.57)	0.82
D8 (%)	0.01	1.34		0.13	–0.17	0.00	1.27		0.29	–0.15	–0.20	0.03	1.23	
(*t*-stat.)	(0.07)	(27.94)	0.80	(0.67)	(–2.44)	(–0.04)	(23.20)	0.81	(1.46)	(–3.66)	(–2.86)	(0.48)	(22.71)	0.82
D10 (%)	–0.01	1.87		0.46	–0.69	0.17	1.55		0.61	–0.15	–0.72	0.20	1.51	
(*t*-stat.)	(–0.02)	(21.81)	0.71	(1.46)	(–6.14)	(1.85)	(17.85)	0.78	(1.93)	(–2.28)	(–6.40)	(2.17)	(17.22)	0.78
D10–D1 (%)	–0.15	1.23		0.38	–0.82	0.61	0.78		0.57	–0.18	–0.85	0.65	0.73	
(*t*-stat.)	(–0.32)	(10.78)	0.37	(0.98)	(–5.94)	(5.43)	(7.36)	0.60	(1.46)	(–2.28)	(–6.20)	(5.75)	(6.83)	0.61

(continued)

Table 4. CAPM and Fama–French Three- and Four-Factor Risk-Adjusted Portfolio Performance, 1991–2007
(*t*-statistics in parentheses) (continued)

	CAPM			Fama–French Three Factor					Fama–French Four Factor					
	Alpha	RmRf	R^2	Alpha	RmRf	SMB	HML	R^2	Alpha	RmRf	SMB	HML	UMD	R^2
A3. S&P 500 Stocks—D10–D1 trading-volume sorted (Dvol3mo), value weighted (VW), and equal weighted (EW) for various periods, including 1991–2007 (overall)														
VW (%)	0.85	0.52		1.69	–1.17	–0.34	–0.03		1.59	0.09	–1.14	–0.36	–0.03	
Sub1	(2.04)	(5.04)	0.18	(5.61)	(–10.71)	(–4.07)	(–0.34)	0.61	(5.17)	(1.40)	(–10.28)	(–4.23)	(–0.38)	0.62
VW (%)	–0.81	0.51		–0.09	–0.85	–0.37	0.34		–0.05	–0.10	–0.80	–0.35	0.28	
Sub2	(–2.39)	(6.06)	0.31	(–0.37)	(–9.12)	(–4.14)	(5.19)	0.69	(–0.22)	(–1.58)	(–8.28)	(–4.01)	(3.75)	0.70
EW (%)	0.18	0.85		0.95	–1.10	–0.12	0.41		1.08	–0.12	–1.12	–0.09	0.37	
Overall	(0.53)	(9.87)	0.33	(3.42)	(–11.05)	(–1.46)	(5.30)	0.60	(3.83)	(–2.12)	(–11.30)	(–1.15)	(4.82)	0.61
EW (%)	1.05	0.69		1.97	–1.25	–0.21	0.07		1.91	0.05	–1.24	–0.22	0.07	
Sub1	(2.23)	(5.92)	0.24	(5.90)	(–10.36)	(–2.25)	(0.75)	0.65	(5.57)	(0.76)	(–9.99)	(–2.33)	(0.72)	0.65
EW (%)	–0.81	1.01		–0.05	–1.09	0.00	0.69		0.04	–0.26	–0.97	0.03	0.54	
Sub2	(–1.64)	(8.23)	0.45	(–0.11)	(–6.75)	(0.00)	(6.05)	0.65	(0.11)	(–2.44)	(–5.87)	(0.23)	(4.19)	0.68
A4. S&P 500 Stocks—D10–D1 turnover sorted (Turno), value weighted (VW), and equal weighted (EW) for various periods, including 1991–2007 (overall)														
VW (%)	0.06	0.96		0.90	–1.01	0.45	0.36		0.94	–0.04	–1.02	0.46	0.36	
Sub1	(0.10)	(5.88)	0.24	(1.75)	(–5.43)	(3.18)	(2.40)	0.58	(1.79)	(–0.37)	(–5.38)	(3.19)	(2.40)	0.58
VW (%)	–0.14	1.59		0.20	–0.92	0.83	1.15		0.23	–0.08	–0.88	0.84	1.11	
Sub2	(–0.24)	(10.62)	0.58	(0.38)	(–4.51)	(4.26)	(8.02)	0.72	(0.43)	(–0.58)	(–4.10)	(4.28)	(6.63)	0.72
EW (%)	–0.36	1.29		0.12	–0.75	0.77	0.83		0.53	–0.40	–0.82	0.85	0.73	
Overall	(–0.78)	(11.35)	0.40	(0.32)	(–5.87)	(7.29)	(8.40)	0.66	(1.57)	(–5.73)	(–6.85)	(8.60)	(7.74)	0.71
EW (%)	0.05	0.95		0.81	–0.86	0.68	0.39		1.01	–0.18	–0.92	0.71	0.40	
Sub1	(0.09)	(6.21)	0.26	(1.96)	(–5.74)	(5.89)	(3.24)	0.70	(2.41)	(–2.07)	(–6.12)	(6.19)	(3.34)	0.71
EW (%)	–0.55	1.72		–0.20	–0.97	0.89	1.25		–0.01	–0.53	–0.72	0.96	0.94	
Sub2	(–0.86)	(10.76)	0.59	(–0.35)	(–4.45)	(4.30)	(8.17)	0.72	(–0.03)	(–3.86)	(–3.41)	(5.01)	(5.75)	0.76
B1. Largest 1,000 stocks—trading-volume sorted (Dvol3mo), value weighted														
Overall (%)	0.02	0.96		0.02	0.00	–0.11	0.98		0.02	0.01	0.00	–0.11	0.98	
(*t*-stat.)	(0.39)	(93.15)	0.98	(0.71)	(–0.02)	(–11.23)	(109.31)	0.99	(0.51)	(0.84)	(0.06)	(–11.22)	(107.19)	0.99
D1 (%)	0.11	0.75		–0.02	0.18	0.05	0.82		–0.06	0.04	0.19	0.04	0.83	
(*t*-stat.)	(0.54)	(14.18)	0.51	(–0.07)	(2.35)	(0.73)	(13.54)	0.52	(–0.26)	(0.88)	(2.42)	(0.60)	(13.44)	0.52
D3 (%)	0.05	0.79		–0.19	0.34	0.12	0.91		–0.21	0.02	0.34	0.12	0.92	
(*t*-stat.)	(0.37)	(22.25)	0.72	(–1.41)	(7.09)	(3.13)	(24.80)	0.77	(–1.51)	(0.61)	(7.10)	(3.01)	(24.38)	0.78
D5 (%)	0.02	0.78		–0.21	0.33	0.04	0.91		–0.26	0.05	0.34	0.03	0.93	
(*t*-stat.)	(0.16)	(25.47)	0.77	(–1.94)	(8.49)	(1.30)	(30.39)	0.83	(–2.40)	(2.26)	(8.76)	(0.98)	(30.54)	0.84

(continued)

Table 4. CAPM and Fama–French Three- and Four-Factor Risk-Adjusted Portfolio Performance, 1991–2007
(*t*-statistics in parentheses) (continued)

	CAPM			Fama–French Three Factor					Fama–French Four Factor					
	Alpha	RmRf	R^2	Alpha	RmRf	SMB	HML	R^2	Alpha	RmRf	SMB	HML	UMD	R^2
D8 (%)	–0.04	0.85		–0.19	0.21	0.00	0.94		–0.22	0.03	0.22	0.00	0.95	
(*t*-stat.)	(–0.41)	(34.43)	0.86	(–2.00)	(6.32)	(0.08)	(36.56)	0.89	(–2.29)	(1.54)	(6.46)	(–0.14)	(36.26)	0.89
D10 (%)	0.10	1.18		0.39	–0.40	–0.29	1.06		0.41	–0.02	–0.41	–0.28	1.05	
(*t*-stat.)	(0.81)	(39.98)	0.89	(4.65)	(–13.38)	(–11.62)	(45.50)	0.95	(4.80)	(–1.16)	(–13.44)	(–11.35)	(44.39)	0.95
D10–D1 (%)	–0.02	0.42		0.41	–0.59	–0.33	0.23		0.47	–0.06	–0.60	–0.32	0.22	
(*t*-stat.)	(–0.07)	(6.56)	0.18	(1.69)	(–6.83)	(–4.74)	(3.53)	0.35	(1.91)	(–1.21)	(–6.92)	(–4.53)	(3.22)	0.36
B2. Largest 1,000 stocks—turnover sorted (Turno), value weighted														
Overall (%)	0.02	0.96		0.02	0.00	–0.11	0.98		0.02	0.01	0.00	–0.11	0.98	
(*t*-stat.)	(0.39)	(93.15)	0.98	(0.71)	(–0.02)	(–11.23)	(109.31)	0.99	(0.51)	(0.84)	(0.06)	(–11.22)	(107.19)	0.99
D1 (%)	0.08	0.78		–0.02	0.15	–0.04	0.85		–0.06	0.04	0.15	–0.04	0.86	
(*t*-stat.)	(0.48)	(18.37)	0.63	(–0.10)	(2.35)	(–0.69)	(17.61)	0.65	(–0.32)	(1.05)	(2.44)	(–0.84)	(17.47)	0.65
D3 (%)	0.16	0.70		0.07	0.17	–0.33	0.83		0.04	0.03	0.18	–0.33	0.84	
(*t*-stat.)	(1.11)	(19.26)	0.65	(0.62)	(4.42)	(–10.36)	(27.99)	0.83	(0.33)	(1.30)	(4.53)	(–10.46)	(27.73)	0.83
D5 (%)	0.15	0.91		0.01	0.22	–0.16	1.04		0.07	–0.06	0.21	–0.15	1.02	
(*t*-stat.)	(1.17)	(29.28)	0.81	(0.06)	(5.79)	(–5.21)	(35.38)	0.88	(0.63)	(–2.64)	(5.59)	(–4.86)	(34.66)	0.88
D8 (%)	–0.19	1.34		–0.01	–0.27	0.09	1.21		0.11	–0.11	–0.29	0.12	1.18	
(*t*-stat.)	(–1.08)	(30.92)	0.83	(–0.03)	(–4.60)	(1.93)	(26.33)	0.86	(0.64)	(–3.15)	(–4.99)	(2.40)	(25.75)	0.87
D10 (%)	–0.22	2.06		0.52	–1.11	0.40	1.52		0.44	0.07	–1.10	0.38	1.54	
(*t*-stat.)	(–0.55)	(20.32)	0.68	(1.75)	(–10.46)	(4.56)	(18.51)	0.84	(1.45)	(1.19)	(–10.31)	(4.35)	(18.40)	0.84
D10–D1 (%)	–0.31	1.27		0.54	–1.26	0.43	0.67		0.50	0.04	–1.25	0.43	0.68	
(*t*-stat.)	(–0.64)	(10.75)	0.37	(1.48)	(–9.74)	(4.08)	(6.67)	0.67	(1.35)	(0.47)	(–9.63)	(3.97)	(6.62)	0.67
B3. Largest 1,000 stocks—D10–D1 trading-volume sorted (Dvol3mo), value weighted (VW), and equal weighted (EW) for various periods, including 1991–2007 (overall)														
VW (%)	0.68	0.42		0.99	–0.46	–0.25	0.22		1.01	–0.02	–0.47	–0.24	0.22	
Sub1	(1.83)	(4.52)	0.15	(2.70)	(–3.47)	(–2.41)	(2.02)	0.24	(2.67)	(–0.24)	(–3.43)	(–2.35)	(2.02)	0.24
VW (%)	–0.95	0.39		–0.29	–0.75	–0.39	0.25		–0.25	–0.10	–0.71	–0.37	0.19	
Sub2	(–2.88)	(4.68)	0.21	(–1.15)	(–7.80)	(–4.20)	(3.60)	0.60	(–1.02)	(–1.50)	(–7.02)	(–4.07)	(2.40)	0.61
EW (%)	0.31	0.96		0.93	–0.89	–0.06	0.60		1.15	–0.22	–0.93	–0.02	0.54	
Overall	(1.05)	(13.19)	0.47	(3.85)	(–10.34)	(–0.87)	(9.01)	0.67	(4.91)	(–4.50)	(–11.22)	(–0.26)	(8.35)	0.70
EW (%)	1.28	0.85		1.93	–0.87	–0.03	0.40		2.03	–0.09	–0.90	–0.02	0.40	
Sub1	(3.31)	(8.83)	0.41	(6.44)	(–7.94)	(–0.40)	(4.59)	0.67	(6.63)	(–1.44)	(–8.11)	(–0.21)	(4.65)	0.68
EW (%)	–0.88	1.06		–0.14	–1.03	–0.05	0.77		–0.01	–0.38	–0.85	0.00	0.54	
Sub2	(–2.07)	(10.03)	0.55	(–0.41)	(–7.89)	(–0.42)	(8.32)	0.75	(–0.03)	(–4.79)	(–7.01)	(–0.02)	(5.76)	0.80

(continued)

Table 4. CAPM and Fama–French Three- and Four-Factor Risk-Adjusted Portfolio Performance, 1991–2007
(*t*-statistics in parentheses) (continued)

	CAPM			Fama–French Three Factor					Fama–French Four Factor					
	Alpha	RmRf	R^2	Alpha	RmRf	SMB	HML	R^2	Alpha	RmRf	SMB	HML	UMD	R^2
B4. Largest 1,000 stocks—D10–D1 turnover sorted (Turno), value weighted (VW), and equal weighted (EW) for various periods, including 1991–2007 (overall)														
VW (%)	0.19	1.17		1.21	–1.26	0.43	0.44		0.87	0.31	–1.15	0.38	0.43	
Sub1	(0.27)	(6.55)	0.28	(2.26)	(–6.48)	(2.88)	(2.83)	0.63	(1.64)	(2.80)	(–6.00)	(2.59)	(2.85)	0.66
VW (%)	–0.86	1.39		–0.03	–1.43	0.48	0.87		0.02	–0.15	–1.36	0.50	0.78	
Sub2	(–1.49)	(9.63)	0.53	(–0.07)	(–8.59)	(2.99)	(7.37)	0.77	(0.05)	(–1.32)	(–7.81)	(3.12)	(5.77)	0.77
EW (%)	–0.65	1.23		0.21	–1.30	0.61	0.57		0.23	–0.02	–1.30	0.61	0.56	
Overall	(–1.39)	(10.62)	0.37	(0.70)	(–12.17)	(6.96)	(6.94)	0.76	(0.76)	(–0.39)	(–12.12)	(6.93)	(6.71)	0.76
EW (%)	–0.10	1.18		0.94	–1.24	0.69	0.42		0.69	0.23	–1.16	0.65	0.41	
Sub1	(–0.15)	(6.78)	0.29	(2.33)	(–8.44)	(6.15)	(3.56)	0.79	(1.72)	(2.75)	(–7.99)	(5.93)	(3.59)	0.80
EW (%)	–1.33	1.26		–0.51	–1.41	0.46	0.75		–0.40	–0.34	–1.25	0.51	0.55	
Sub2	(–2.36)	(8.93)	0.49	(–1.22)	(–8.64)	(2.97)	(6.54)	0.75	(–0.99)	(–3.19)	(–7.71)	(3.43)	(4.40)	0.78

Notes: See notes to Tables 1 and 3. Monthly portfolio returns in excess of risk-free returns are regressed on market excess returns (i.e., RmRf in the context of the CAPM) and on the Fama–French factors: RmRf, SMB, HML, and UMD. The intercept term (α), slope (β), adjusted R^2, and *t*-statistics are presented for each portfolio.

(monthly) and not significant; but for the three-factor Fama–French model, the alpha is 0.39 percent (or 4.8 percent on an annualized basis) and significant. And for the four-factor Fama–French model, the alpha is 0.41 percent (or 5.0 percent annualized) and significant. Running a regression on the D10−D1 returns, we found an alpha of 0.41 percent, or 5.0 percent on an annualized basis, for the three-factor Fama–French model and an alpha of 0.47 percent (5.8 percent annualized) for the four-factor model. Thus, for this particular period and our sample universe of S&P 500 and Largest 1,000 stocks, a strategy of investing in the most liquid stocks, as measured by recent trading volume, appears to provide potentially superior performance, even after accounting for market risk, size, value growth, and price momentum.

Panel A2 (S&P 500 stocks) and panel B2 (Largest 1,000 stocks) present the results sorted by the turnover variable (Turno) and based on value-weighted returns. For the S&P 500 stocks, the alpha for the D10 portfolio and the four-factor model is 0.61 percent (7.6 percent annualized) and significant. For the Largest 1,000 stocks, the corresponding alpha is 0.44 percent (5.4 percent annualized) but is not significant, although it is marginally significant under the three-factor model.

Panel A3 (S&P 500 stocks) and panel B3 (Largest 1,000 stocks) present the results of robustness checks for equal-weighted and subperiod D10−D1 returns for the trading-volume variable (Dvol3mo). The overall equal-weighted return results are substantially the same. Consistent with the previous Table 4 panels, the bull market alphas are positive and significant, and the bear market alphas are generally negative but not significant.

Finally, panel A4 (S&P 500 stocks) and panel B4 (Largest 1,000 stocks) present the results of robustness checks for equal-weighted and subperiod D10−D1 returns for the turnover variable (Turno). Again, we see that the overall equal-weighted return results are substantially the same: The bull market alphas are positive and significant, and the bear market alphas are not significant.

Trading-Volume Factors

We further investigated what might be driving these results and, in particular, the incremental performance of the most heavily traded versus least heavily traded stocks (as measured by the trading-volume and turnover variables). We started by examining the return difference between the highest and lowest trading-volume and turnover portfolios (D10 and D1, respectively) and formed "trading-volume factors" based on the Dvol3mo and Turno variables (for each of the S&P 500 and Largest 1,000 samples), in the spirit of the SMB and HML factors. **Table 5** reports the portfolios' properties and their correlations with the four Fama–French factors. For the Dvol3mo variable, the average monthly mean (median) return difference is 0.69 percent (0.81 percent) for S&P 500 stocks and 0.89 percent (0.61 percent) for the Largest 1,000 stocks, which implies—for our sample and period—that more heavily traded stocks perform better than less heavily traded stocks. For the Turno variable, the average monthly mean (median) return difference is 0.39 percent (0.34 percent) for S&P 500 stocks and 0.08 percent (0.20 percent) for the Largest 1,000 stocks. Over our sample period, the trading-volume factor mean monthly returns are of a similar order of magnitude as the four Fama–French factors, which range from a low of 0.17 percent (SMB) to a high of 0.89 percent (UMD). The trading-volume factor standard deviations are greater than those for the Fama–French factors.

We then compared the correlations between these trading-volume factor monthly series and those of Fama–French. Our results suggest that the trading-volume measures are strongly positively related to the RmRf factor: When the market excess return is up (down), the most heavily traded stocks tend to be up (down) as well. The positive, but smaller, correlation with the SMB factor suggests a tendency for the more heavily traded stocks to do better when small stocks are performing better than large stocks. The strong negative correlation with the HML factor implies that more heavily traded stocks do better when growth stocks (i.e., low-book-to-market companies) are doing better than value stocks. Finally, the correlation with the UMD variable is low and consistent with the U-shaped pattern described earlier, with both "winner" and "loser" portfolios showing high trading volume and turnover.

Table 5 also reports the extent to which the trading-volume factor contains unique information as a "priced" factor based on the regressions in Equation 2. The dependent variables are the various long–short quintile portfolio returns discussed earlier: PB, MKT, and MOM. For the PB strategy, we go long value stocks (P1) and short growth stocks (P5). For the MKT strategy, we go long small stocks (P1) and short large stocks (P5). For the MOM strategy, we go long the winners (P5) and short the losers (P1) over the past six months. Table 5 shows the results from regressions of various portfolios on the four Fama–French factors and the trading-volume factors. To conserve space, we present only the β_5 coefficients for the trading-volume factors (i.e., based on sorting on either

Table 5. Trading-Volume Factor Measures, 1991–2007
(*t*-statistics in parentheses)

	Trading-Volume Factors				Fama–French Factors			
	S&P 500		Largest 1,000					
	Dvol3mo	Turno	Dvol3mo	Turno	RmRf	SMB	HML	UMD
Summary statistics								
Mean (%)	0.69	0.39	0.89	0.08	0.63	0.17	0.43	0.89
Median (%)	0.81	0.34	0.61	0.20	1.03	–0.08	0.31	0.81
Minimum (%)	–24.16	–28.39	–20.31	–31.85	–16.20	–16.58	–12.66	–25.05
Maximum (%)	20.22	34.31	19.99	39.60	10.30	21.87	13.71	18.40
Std. dev. (%)	5.90	8.20	5.63	8.14	3.98	3.66	3.39	4.72
Correlations								
RmRf	0.59	0.64	0.69	0.61				
SMB	0.26	0.56	0.28	0.57				
HML	–0.74	–0.67	–0.73	–0.81				
UMD	–0.10	–0.19	–0.20	0.03				

	S&P 500 Stocks					Largest 1,000 Stocks				
	1	2	3	4	5	1	2	3	4	5
Trading-volume (Dvol3mo) factor betas										
PB (%)	–0.04	–0.15*	–0.17*	–0.06*	0.01	0.01	–0.13*	–0.07***	–0.02	0.13*
	(–1.09)	(–5.66)	(–6.56)	(–2.69)	(0.64)	(0.17)	(–4.62)	(–1.78)	(–0.75)	(4.04)
MKT (%)	–0.16*	–0.09*	–0.10*	–0.04	0.01	–0.03	–0.03	–0.00	–0.01	–0.03
	(–3.84)	(–3.03)	(–2.87)	(–1.37)	(0.52)	(–1.10)	(–1.04)	(–0.18)	(–0.54)	(–1.76)***
MOM (%)	0.10**	–0.18*	–0.17*	–0.19*	0.01	0.13*	–0.10*	–0.13*	–0.13*	0.12***
	(2.28)	(–6.33)	(–6.91)	(–7.97)	(0.31)	(2.81)	(–3.52)	(–5.37)	(–5.08)	(2.36)
Turnover (Turno) factor betas										
PB (%)	0.03	–0.05**	–0.04**	0.02	0.03***	–0.01	–0.08*	–0.02	0.04***	0.21*
	(1.05)	(–2.08)	(–1.94)	(0.89)	(1.76)	(–0.33)	(–3.42)	(–0.69)	(1.87)	(10.20)
MKT (%)	0.02	0.02	–0.01	–0.00	–0.02**	0.04***	0.03	0.05*	0.04**	–0.02***
	(0.50)	(0.69)	(–0.34)	(–0.15)	(–2.01)	(1.80)	(1.45)	(2.61)	(2.09)	(–2.11)
MOM (%)	0.17*	–0.06**	–0.08*	–0.10*	0.06*	0.15*	–0.05**	–0.07*	–0.06*	0.16*
	(5.10)	(–2.50)	(–3.90)	(–4.58)	(2.01)	(4.47)	(–1.98)	(–3.81)	(–3.25)	(4.30)

Notes: The trading-volume factor measures are calculated monthly as the difference between the equal-weighted return on both the highest-decile portfolio (D10) and the lowest-decile portfolio (D1) of S&P 500 stocks and Largest 1,000 stocks measured by (1) the average daily trading volume over the past three months (Dvol3mo) and (2) turnover as measured by the annualized trading volume as a percentage of shares outstanding (Turno). The Fama–French factors include RmRf, SMB, HML, and UMD (see notes to Table 4). Correlations are measured between the trading-volume factor monthly returns and the Fama–French factor monthly returns. The dependent variables are monthly portfolio returns for the lowest (1) and highest (5) quintiles sorted by price-to-book ratio (PB), market capitalization (MKT), and momentum as measured by the previous six-month return (MOM). The independent variables are the four Fama–French factors plus the trading-volume (turnover) factors. Only the trading-volume (turnover) factor betas are presented.

*Significant at the 99 percent level.
**Significant at the 95 percent level.
***Significant at the 90 percent level.

Dvol3mo or Turno). In 40 of the 60 regressions, the trading-volume factor coefficient is significant or marginally significant at the 10 percent level (i.e., *t*-statistics above 1.64 or below −1.64). In unreported results, we repeated our regressions by using the 25 Fama–French book-to-market and size portfolios as the dependent variables. In 58 of 100 regressions, the trading-volume factor coefficient is significant. Thus, our new trading measure may be a separate factor that contains unique information beyond these other recognized factors.

Conclusion

Consistent with previous research, our findings suggest that trading-volume measures proxy for more than liquidity: They are as much measures

of momentum as of investor interest or information content. For relatively illiquid (typically smaller) stocks, investors may demand a liquidity premium that results in a *negative* relationship between trading volume (as a proxy for liquidity) and stock returns. But for relatively liquid (typically larger) stocks—the focus of our study—we found that momentum and information effects may dominate and result in a *positive* relationship between trading volume and stock returns. Results are sensitive, however, to the nature of the market (i.e., bull or bear).

When we sorted stocks on each of the trading-volume and turnover measures, we found that the more heavily traded stocks tend to have higher subsequent returns (1–12-month holding periods) than the less heavily traded stocks. CAPM and Fama–French model regressions showed that the stock portfolios with the highest trading volume and turnover experience significant superior performance. We created new measures ("trading-volume factors") in the spirit of the Fama–French factors and investigated their properties. We found that their betas are generally significant when added to the Fama–French four-factor model and regressed against portfolio quintile returns based on PB, MKT, and MOM sorts.

Our study also contributes to the literature by shedding additional light on trading-volume measures and performance. We showed that two trading-volume measures—trailing three-month trading volume (i.e., shares) and turnover—are monotonically related to price-to-book and market capitalization. We also discovered a U-shaped relationship for momentum strategies—that is, past six-month "winners" and "losers" both tend to experience high trading volume and turnover.

Our results have a number of caveats. First, we focused on two measures of trading volume, and these measures are not necessarily strictly related to liquidity. Given that other ways exist to attempt to capture liquidity, we were unable to examine precisely the total performance impact of any liquidity-related screens. Second, we intentionally chose two narrow universes, with an intended bias toward the most heavily traded stocks. Third, as in many studies, our results are specific to particular periods of analysis, and further research can investigate other markets and other periods.

Although stocks with high trading volume probably tend to have performed well recently and are experiencing price momentum, our results are not driven exclusively by this conjecture because we controlled for a momentum factor. Even though we did not test information factors directly, the trading-volume and turnover measures may contain information that our results capture. We know that many investors appear to care about such trading-volume measures, and our results suggest that such attention is warranted.

Our study is meant to highlight the importance of trading volume as it pertains to various investment styles, and our findings clearly have important implications for portfolio managers. Our results suggest that trading volume is important for value managers but less so for momentum managers because both winners and losers tend to have high trading volume. Although other studies have shown that trading volume is related to size, price-to-book, and momentum, our study reveals the presence of trading-volume information, beyond these well-known relationships, in the context of our "priced" trading-volume factors. Indeed, our trading-volume factors may be related to some of the findings in the behavioral finance literature. Regardless of what a trading-volume measure might be a proxy for, it is an important consideration in any quantitatively based investment strategy. Thus, our results suggest that we may look at trading volume not only as a cost of trading (i.e., related to liquidity) but also as a source of information.

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This article qualifies for 1 CE credit.

Notes

1. See Liu (2006) for a more detailed discussion.
2. For an examination of trading costs related to the depth of trading around the change in minimum tick sizes for NYSE stocks from eighths to sixteenths, see Goldstein and Kavajecz (2000).
3. Jones and Lipson (2001) investigated trading costs for momentum traders around the change in minimum tick sizes for NYSE stocks from eighths to sixteenths.
4. See Campbell, Grossman, and Wang (1993), who presented a model and empirical evidence showing that returns accompanied by high volume tend to be reversed more strongly than low-volume returns.
5. See Holmström and Tirole (2001), who developed a theoretical model relating a security's expected return to its covariance with aggregate liquidity.
6. Bekaert, Harvey, and Lundblad (2005) also examined a measure of liquidity that captures the proportion of zero daily company returns in the context of emerging markets.
7. See Jegadeesh and Titman (1993).
8. The database measured the trading volume only on a rolling three-month basis. The trading-volume measure was adjusted for stock splits.
9. See http://mba.tuck.dartmouth.edu/pages/faculty/ken.french for more information on the Fama-French factors.
10. For the PB and MKT strategies, the long portfolio was in the lowest quintile, P1, and the short portfolio was in the highest quintile, P5 (i.e., long in value stocks and short in growth stocks; long in small stocks and short in large stocks). For the MOM variable, we reversed the strategy: long in the highest quintile, P5, and short in the lowest quintile, P1 (i.e., long in winners and short in losers).

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