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Empirical analysis of ETF intraday trading

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Abstract

We investigate the trading of benchmark Exchange traded funds (ETFs), leveraged ETFs, and leveraged inverse ETFs that are matched based on their tracking index or sector. We find that ETF trading is very active and average daily trading volume for the most active ETF is more than $25 billion during the period of March 2007 to December 2009. The daily turnover ratio of leveraged and leveraged inverse ETFs are about four to six times the turnover ratio of the benchmark ETFs on average, and spreads and price volatility of the leveraged and leveraged inverse ETFs are also significantly larger than those of the benchmark ETFs. Trading volume and turnover ratio of all ETFs increased significantly during and after the financial crisis and the active trading is further enhanced when the price movement of benchmark ETFs is large. We also find that small trades dominate trading of all ETFs, and yet they do not play an important role in daily price movements. In addition, we find a U-shaped and an L-shaped intraday pattern for trading volume and return volatility, respectively. These empirical results are important for individual investors, especially those who do not have sophisticated trading experience and lack resources for collecting and processing private information.

JEL classification: G14

Keywords: Exchange traded funds; Leveraged ETFs; Leveraged inverse ETFs; Bear market; Financial crisis; Intraday trade pattern; Basket securities

1. Introduction

Exchange traded funds (ETFs) have become increasingly popular in recent years because they offer investors the benefits of easy transaction and diversification. According to the

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National Stock Exchange, ETF trading volume averaged 1.9 billion shares per day in 2009, and assets in United States listed exchanged traded products totaled $791 billion at the end of December 2009, which is a 47% increase from the previous year (Laise, 2010). The monthly industry review of Barclays Global Investors shows that ETFs accounted for 33% of all U.S. stock trading volume through the first three quarters of 2009.[1] In addition, the number of leveraged and leveraged inverse ETFs, first introduced to the market by Proshares in 2006, increased greatly during the financial crisis because of the embedded leverage features.[2] However, limited empirical evidence exists on how ETFs are traded and whether the trading is affected by different market environments. In addition, it is unclear whether the trading pattern of the innovative ETFs differs from that of benchmark ETFs, although theories suggest that leveraged and leveraged inverse ETFs are suitable only for short-term traders because the embedded path-dependent option could lead to value destruction for a buy-and-hold investor (Cheng and Madhavan, 2009; Guedj, Li, and McCann, 2010).

To provide a better understanding of these issues for individual investors, who are generally regarded as uninformed traders (Grossman, 1976; Grossman and Stiglitz, 1980; Patel et al., 1991) and lack sophisticated trading experience in financial products (Warther, 1995; Indro, 2004), we show detailed empirical analyses of ETF intraday trading using high-frequency data. To illustrate the trade patterns of different types of ETFs, we match 22 triplets of ETFs (22×3): benchmark ETFs, leveraged ETFs, and leveraged inverse ETFs. ETFs in each triplet track the same index or sector, but they differ in their return generating process. Benchmark ETFs are designed to provide the same amount ($1\times$) of daily return as the tracking index, leveraged ETFs are designed to double the daily return ($2\times$) of the tracking index, whereas leveraged inverse ETFs bet on the occurrence of a bear market and generate twice the negative daily return ($-2\times$) of the tracking index. We use these matched ETFs to investigate several empirical issues.

First, we analyze the evolution in trading activities of these ETFs during the period of March 2007 to December 2009 and test how ETF trading is affected by different market conditions. We divide the whole test period into three sub-periods: March 2007–October 2007 (pre-crisis period); November 2007–February 2009 (crisis period); and March 2009–December 2009 (recovery period). These three sub-periods span a unique cycle of normal-crisis-recovery in the recent U.S. equity markets. Given the fact that leveraged ETFs are designed to double the daily return of the tracking index, it is natural to expect the trading volume of leveraged ETFs to be high when the overall stock market and tracking index go up. A symmetric situation holds for leveraged inverse ETFs. In addition, theoretical models predict that leveraged ETFs are suitable only for short-term investing (Cheng and Madhavan, 2009), but no hard empirical evidence exists. Thus, the current study provides direct evidence on this issue, which would help less sophisticated investors make better investment decisions on ETF trading.

Second, we investigate how the trading of ETFs in the same triplet is correlated with each other. As Roll, Schwarz, and Surahmanyam (2010) indicate, how trading volumes of multiple contingent claims on the same asset are correlated is not well understood because volume plays a limited role in theories of contingent claims pricing (Black and Scholes, 1973). Boney, Doran, and Peterson (2007) analyze the effect of the Standard & Poor's Depository Receipts (SPDR) on conventional S&P 500 index funds and find that index mutual funds are adversely impacted by the SPDR. Similarly, Barnhart and Rosenstein (2010) find that the introduction of ETFs leads to a reduction in the trading volume of closed-end funds. However, Guedj and Huang (2009) suggest the coexistence of open-ended mutual funds and ETFs with different liquidity clienteles. Agapova (2010) shows that Vanguard's ETFs and its index funds are not substitutes but are in fact complements. Given the substantial structural differences between conventional mutual funds and ETFs and the mixed results, we strive to help individual investors understand this issue better by using closely matched ETFs that track the same index or sector.

Third, we examine which trade size, small, medium, or large, dominate ETF trading and how investors' preferences for trade size in ETF trading are affected by overall market conditions and by the daily price change of the tracking index. Practitioners indicate that ETFs are popular for both big and small investors because of the diversification and high liquidity benefits (Laise, 2010), but anecdotal evidence suggests that ETFs are popular among institutional investors. For example, State Street indicates that 17 of the 20 largest mutual funds and 15 of the 20 largest hedge funds invest in ETFs and all of the largest university endowments include ETFs in their top-10 holdings.[3] Lauricella, Pulliam, and Gullapalli (2008) indicate that leveraged ETFs are popular among hedge funds and institutions. Thus, the analysis of trade size in the current study helps shed light on who are the major ETF investors, small individual investors or large institutional traders. We admit, however, that the results based on trade data have limitations because trade data do not contain trader identity nor do the data indicate whether a trade represents a complete order or a part of broken-up large order.[4]

Fourth, we investigate whether any specific trade size drives daily price movements of ETFs. The central point of this question is whether investors trade ETFs for liquidity reasons or for private information. Asymmetric information theory (Kyle, 1985) implies that informed traders take advantage of their private information and maximize trading profits by spreading trades over multiple periods. Similarly, stealth trading theory (Barclay and Warner, 1993) indicates that informed traders split large orders into medium size trades to hide their identity and private information to minimize transaction costs. Consistent with the stealth trading theory, Chakravarty (2001) finds that medium-sized trades are the primary drivers of price movement and the result is because of institutional investors. In addition, the liquidity migration models developed by Subrahmanyam (1991) and Gorton and Pennacchi (1993) predict that basket securities attract liquidity traders away from composite securities because of lower transaction costs.[5] Furthermore, Admati and Pfleiderer (1988) show that informed traders strategically time their trades when liquidity trading is concentrated to prevent the revelation of their private information. Combining Admati and Pfleiderer's theory of informed investors' strategic trading and the liquidity migration models of Subrahmanyam (1991) and Gorton and Pennacchi (1993), we conjecture that if liquidity traders have a preference for a particular trade size (small or medium), these types of trades are further reinforced by informed traders. Thus, the dominant trade size also drives price movement because of the camouflaged informed traders.[6]

Fifth, we examine intraday patterns in ETF trading and test whether any differences exist in intraday trade patterns among different ETFs. The microstructure literature suggests that stock trading is more active at the open and close than during the mid-day period and has a

U-shaped intraday pattern, which is primarily driven by private information (see e.g., Admati and Pfleiderer, 1988) or both private information and public announcements (Atkins and Basu, 1995). However, whether a U-shaped volume pattern exists for ETF trading is not clear because it is hard for any investor to obtain private information for all stocks tracked by an ETF. In addition, financial experts advise investors to avoid trading ETFs at the open and the close because the market is more volatile and ETF prices are more likely off track from their net asset values during open and close periods (Salisbury, 2008; Laise, 2010). Furthermore, no hard evidence exists on whether or not the intraday trading pattern differs among benchmark, leveraged, and leveraged inverse ETFs. The evidence in this study helps explore potential factors that affect intraday trading pattern.

Using intraday high frequency data of 22 triplets of ETFs from March 2007 to December 2009, we have the following main findings. First, the trading is very active for all ETFs compared with common stocks traded in the U.S. markets.[7] The average daily turnover ratio is 13% for the benchmark ETFs, 21% for leveraged ETFs, and 34% for leveraged inverse ETFs during the whole test period. The trading became more active once the financial crisis started in November 2007, and the daily turnover ratio reached 30% and 43% for leveraged ETFs and leveraged inverse ETFs, respectively. The high turnover ratios imply short-holding periods: 3.3 days on average for leveraged ETFs and 2.3 days for the leveraged inverse ETFs during the financial crisis, which are consistent with the prediction of Cheng and Madhavan (2009) that leveraged and inverse ETFs are mainly for short-term traders. In addition, the active trading of leveraged and leveraged inverse ETFs is accompanied with high intraday price volatility and large spreads.

Second, ETF trading is more active not only during the financial crisis and recovery periods, but also when the price movement of the benchmark ETFs is large. More importantly, the trading of ETFs in the same triplet is positively correlated with each other. The results based on various tests such as Spearman correlation tests, orthogonal regressions, and mixed effect regressions are consistent and robust. Consistent with the coexistence theory of Guedj and Huang (2009) and the empirical evidence of Agapova (2010), the results imply that the introduction of new, innovative ETF products offers a new venue for investors, attracts different investor groups, and improves rather than impairs the trading of existing ETFs. This finding also adds to the literature on trading volumes of multiple contingent claims on the same asset (Roll, Schwarz, and Surahmanyam, 2010).

Third, small trades dominate ETF trading and the number of small trades accounts for more than 80% of total daily trades and small trade volume accounts for more than 50% of daily volume during the whole test period. In addition, the dominant role of small trades further increases during and after the financial crisis. Further, small trades are more active when the price movement of benchmark ETFs is large. Medium size trades account for 38% of daily volume for benchmark ETFs during the whole period, and about 47% for the leveraged ETFs and 38% for the leveraged inverse ETFs. The proportion of medium size trades, measured in both number of daily trades and daily volume, declined substantially when the financial crisis started in November 2007. Large trades account for a very small portion (less than 0.1%) of daily trading and the variation is marginal during different time periods and under different market conditions. These results imply that ETF trading is popular among small investors and the popularity increased during the financial crisis and recovery periods.

Fourth, although small trades dominate the trading in all ETFs, small trades do not play a significant role in daily price movement. Different from the evidence of stealth trading documented by Barclay and Warner (1993) and Hansch and Choe (2007) based on individual securities, the results in the current study suggest that investors trading ETFs do so mainly for liquidity and portfolio rebalance considerations rather than for private information reasons. The results are intuitive as it is difficult for any investors to have private information for all securities tracked by an ETF.

Fifth, a U-shaped intraday trading volume exists for all ETFs. The trading in the first and last hour accounts for 44.5% of benchmark ETFs daily volume, whereas it accounts for 48.4% of daily volume for leveraged ETFs and 48.0% for leveraged inverse ETFs. The main differences in the U-shaped intraday volume pattern between the benchmark and other ETFs is that the trading of leveraged and leveraged inverse ETFs is more active than benchmark ETFs at the market open. Given the fact that it is not possible for any investor to possess private information for all stocks traded by an ETF, the observed U-shaped volume pattern in ETFs implies that factors other than private information can also lead to more active trading at the open and the close of stock market. Differing from the U-shaped pattern of intraday price volatility on individual securities, the ETFs experience an L-shaped volatility pattern. The volatility at market opening is substantially larger than all other periods and plunges immediately after 30-mintues of trading. In addition, the opening price volatility of leveraged and leveraged inverse ETFs is about five or six times larger than that of the matched benchmark ETFs.

2. Data and sample description

We collect ETF information from three main sources: ETF center of Finance.Yahoo.com, Proshares.com, and direxionfunds.com. Intraday trade and quote data are retrieved from the NYSE Trade and Quote (TAQ) database, and the number of shares outstanding and other financial data are obtained from the Center for Research in Security Prices (CRSP) database. Among many ETFs currently traded in U.S. stock markets, we match and select 22 triplets of ETFs (22 × 3) that track the same index or sector but are designed to generate 1× (benchmark ETFs), 2× (leveraged ETFs), and −2× (leveraged inverse ETFs) the daily return of the tracking index. Although there are a dozen ETFs that generate 3× and −3× return of the tracking index/sector, we do not include them in the sample for three main reasons. First, some of the 3× return ETFs either do not track the same index/sector as the 22 triplets do or they do not have complete triplets. Second, most of the 3× return ETFs began to be listed in exchanges in 2008 or later and do not fall within our test period. Third, all of the 22 leveraged and leveraged inverse ETFs in our sample are offered by Proshares, whereas most of the 3× return leveraged ETFs are offered by Direxion. We also exclude −1× inverse ETFs since there are only eight −1× ETFs that track the same index/sector as our 22 triplets do and all other −1× ETFs track different indexes/sectors.[8]

We choose March 2007 to December 2009 as our test period since it covers a cycle of normal-crisis-recovery in the recent U.S stock markets. October 2007 and March 2009 are two pivotal months during the entire test period. On October 31, 2007, the Nasdaq Composite Index (ÎXIC) reached a recent high point of 2,859 and started to slide thereafter. The index plunged to a recent low point of 1,268 on March 9, 2009, which was a decline of 55.6%. Thus, to understand how different market conditions affect investor's trading behavior in ETFs, we classify the period of March to October 2007 as the pre-crisis period, November 2007 to February 2009 as the crisis period, and March to December 2009 as the recovery period.

Table 1 presents the basic information for the 22 triplets of ETFs. To provide a preliminary view of ETF trading, we first rank ETFs based on their average daily dollar trading volume in each of the three categories: benchmark ETFs, leveraged ETFs, leveraged inverse ETFs. The most (least) active ETFs in each category are assigned a score of 9 (0). Then, we compute the average ranking score of each triplet and rank the 22 triplets from the highest to the lowest based on their mean ranking score. The most actively traded triplet is the one that tracks the S&P 500 index: SPY, SSO, and SDS, and each of these ETFs have the highest ranking score in their category. For example, SPY has an average daily trading volume of $25 billion, ranked top among the 22 benchmark ETFs. The average daily trading volume of SSO is about $829 million, which is the most actively traded ETF in the leveraged group, and SDS is the most active leveraged inverse ETF with an average daily trading volume of $1.96 billion. The second most actively traded triplet is QQQQ, QLD, and QID, which track the Nasdaq 100 index, and in third place is the triplet of IYF, UYG, and SKF that tracks the financial sector. The average age since inception for most of the benchmark ETFs is about 8.5 years, whereas the age for the most leveraged and leveraged inverse ETFs is about 1.6 years.

3. Empirical analysis

3.1. Univariate analysis of daily trading activities and liquidity

To get an overall view of daily trading activities and liquidity of different types of ETFs, we conduct a univariate analysis and report the results in Table 2, Panel A. Trade activities are measured by the number of trades per day, trade size (shares), daily trading volume, and daily turnover ratio, which is defined as the ratio of daily trading volume to the number of shares outstanding.[9] In addition to these trade variables, we compute daily return and standard deviation of intraday trade returns. Following the microstructure literature, we use four liquidity measures: (1) quoted spread in dollars, which is the difference between quoted ask price and quoted bid price; (2) quoted spread as a percentage of quoted midpoint (i.e., 0.5 × (quoted ask + quoted bid)); (3) effective spread in dollars, which is computed as D × (trade price – quoted midpoint), where *D* equals 1 for buyer initiated trades and −1 for seller initiated trades; buys and sells are determined using the Lee and Ready (1991) method; and (4) effective spread as a percentage of quoted midpoint.

The first four rows present the mean values of daily trade and liquidity measures for the 22 benchmark ETFs. The trading of benchmark ETFs is very active, with an average number

Table 1 Summary information for ETF triplets

Tracking index/sector	Benchmark ETFs (1×)				Leveraged ETFs (2×)				Leveraged inverse ETFs (−2×)				Overall rank of ETFs
	Ticker	Age	Volume (million $)	Rank	Ticker	Age	Volume (million $)	Rank	Ticker	Age	Volume (million $)	Rank	
S&P 500	SPY	15.5	25,116.8	9	SSO	2.1	828.9	9	SDS	2.1	1961.7	9	9.0
Nasdaq 100	QQQQ	9.4	5,621.8	9	QLD	2.1	689.9	9	QID	2.1	1,287.1	8	8.7
Financials	IYF	8.2	250.4	7	UYG	1.5	377.9	8	SKF	1.5	1573.5	9	8.0
Russell 2000	IWM	8.2	4,920.2	8	UWM	1.5	65.5	7	TWM	1.5	378.4	7	7.3
Dow 30	DIA	10.5	1,903.3	8	DDM	2.1	178.7	7	DXD	2.1	384.1	7	7.3
Real Estate	IYR	8.1	771.5	7	URE	1.5	51.2	6	SRS	1.5	446.6	8	7.0
Oil & Gas	IYE	8.1	38.9	3	DIG	1.5	183.3	8	DUG	1.5	275.6	6	5.7
S&P MidCap 400	IJH	8.2	58.2	4	MVV	2.1	17.4	6	MZZ	2.1	43.1	6	5.3
Basic Materials	IYM	8.1	53.8	3	UYM	1.5	48.4	6	SMN	1.5	65.3	6	5.0
S&P Small Cap 600	IJR	8.2	97.1	5	SAA	1.5	2.1	5	SDD	1.5	4.8	4	4.7
Russell 2000 Growth	IWO	8.0	201.9	6	UKK	1.5	1.1	4	SKK	1.4	2.6	3	4.3
Technology	IYW	8.2	14.8	2	ROM	1.5	6.9	5	REW	1.5	5.2	5	4.0
Russell 2000 Value	IWN	8.0	147.4	5	UVT	1.5	0.7	2	SJH	1.4	3.1	4	3.7
Russell 1000 Growth	IWF	8.2	168.0	6	UKF	1.5	1.0	3	SFK	1.5	1.2	1	3.3
Russell 1000 Value	IWD	8.2	157.5	6	UVG	1.5	0.5	1	SJF	1.5	1.5	2	3.0
Utilities	IDU	8.1	8.9	2	UPW	1.5	1.0	3	SDP	1.5	1.6	2	2.3
Russell MidCap Growth	IWP	7.0	48.3	3	UKW	1.5	0.5	2	SDK	1.5	1.1	1	2.0
Consumer Services	IYC	8.1	6.1	1	UCC	1.6	0.4	0	SCC	1.5	6.9	5	2.0
Industrials	IYJ	8.1	5.3	0	UXI	1.5	1.1	3	SIJ	1.5	2.9	3	2.0
Health Cares	IYH	8.1	6.6	1	RXL	1.5	1.2	4	RXD	1.6	0.5	0	1.7
Russell MidCap Value	IWS	7.0	71.2	4	UVU	1.5	0.3	0	SJL	1.5	0.6	0	1.3
Consumer Goods	IYK	8.1	3.0	0	UGE	1.6	0.5	1	SZK	1.5	1.7	3	1.3
Average		8.5	1,803.2			1.6	111.8			1.8	293.1		

Notes: This table reports average daily dollar trading volume (in million $), age, ranking score of each ETFs, and the overall rank score of each triplet of ETFs from March 1, 2007 to December 31, 2009. Benchmark ETFs are those that are designed to generate approximately 1% return (1×) when a tracking index/sector has 1% return, whereas the leveraged ETF and the Leveraged Inverse ETF that track the same index/sector have 2% (2×) and −2% (−2×) returns, respectively. Age is the number of years since inception for each ETF. ETFs in each category (i.e., benchmark, leveraged, and leveraged inverse) is ranked and assigned a score (9 = highest and 0 = lowest) based on their average daily dollar trading volume. Then, a mean ranking score is computed for each triplet of ETFs and reported in the last column. The sample ETFs are reported in the order of their overall ranking score from the highest to the lowest.

Table 2 Daily trading and liquidity measures of triplet ETFs

Period	Number of trades	Trade size (shares)	Volume (shares 000)	Turnover ratio	Daily return (%)	Return SD (%)	Quoted spread ($)	Quoted spread (%)	Effective spread ($)	Effective spread (%)
Panel A: Mean values of daily trading and liquidity										
Benchmark ETFs (1×)										
3/07–10/07	20,309	510	16,913	0.09	0.06	0.05	0.10	0.11	0.05	0.06
11/07–2/09	58,387	325	26,838	0.16	−0.19	0.05	0.08	0.13	0.05	0.09
3/09–/12/09	50,806	262	19,584	0.12	0.23	0.03	0.04	0.09	0.09	0.16
Whole period	47,053	350	22,316	0.13	0.00	0.05	0.07	0.11	0.06	0.10
Leveraged ETFs (2×)										
3/07–10/07	333	441	143	0.11	0.10	0.54	0.25	0.35	0.36	0.51
11/07–2/09	17,585	381	6,337	0.30	−0.40	0.47	0.28	0.71	0.23	0.58
3/09–/12/09	15,819	383	7,818	0.14	0.47	0.23	0.11	0.46	0.08	0.33
Whole period	12,968	394	5,316	0.21	−0.02	0.41	0.22	0.56	0.21	0.49
Leveraged inverse ETFs (−2×)										
3/07–10/07	5,320	419	1,615	0.15	−0.09	0.40	0.24	0.37	0.26	0.50
11/07–2/09	27,640	312	5,858	0.43	0.28	0.39	0.38	0.45	0.27	0.31
3/09–12/09	26,485	231	6,335	0.34	−0.52	0.24	0.19	0.40	0.14	0.31
Whole period	21,948	312	4,981	0.34	−0.04	0.35	0.29	0.42	0.23	0.36

Panel B: Daily trading and liquidity variable ratios of leveraged ETFs to the matched benchmark ETFs

	Number of trade	Trade size	Volume	Turnover ratio	Daily return	Return SD	Quoted spread	Quoted spread	Effective spread	Effective spread
3/07–10/07	0.08	1.25	0.08	3.97	1.46	18.84	4.04	4.50	8.09	9.39
11/07–2/09	0.53	1.52	0.83	5.52	1.86	14.46	4.44	6.98	6.90	10.37
3/09–12/09	1.23	1.68	1.62	2.99	1.92	8.80	2.94	6.06	3.35	6.76
Whole period	0.63	1.50	0.89	4.41	1.79	13.71	3.93	6.22	6.08	9.09

Panel C: Daily trading and liquidity variable ratios of leveraged inverse ETFs to the matched benchmark ETFs

3/07–10/07	0.36	1.19	0.34	6.52	−1.84	13.01	3.72	4.74	6.67	9.95
11/07–2/09	1.02	1.20	1.20	7.11	−1.83	12.47	7.56	4.75	9.19	5.97
3/09–12/09	1.31	0.97	1.43	6.09	−1.88	9.88	5.68	5.26	6.84	6.45
Whole period	0.95	1.13	1.07	6.63	−1.86	11.85	6.22	4.92	8.01	7.03

Notes: Panel A reports mean values of daily trading and liquidity statistics for each of the three ETF groups. Panel B reports the daily trading and liquidity variable ratios of leveraged ETFs to the matched benchmark ETFs, and Panel C reports the ratios of leveraged inverse ETFs to the matched benchmark ETFs. The whole test period from March 1, 2007 to December 31, 2009 is divided into three sub-periods: 3/07–10/07 (pre-crisis period), 11/07–2/09 (financial crisis period), and 3/09–12/09 (recovery period). Turnover ratio is computed as daily total trading volume divided by the number of shares outstanding. Daily return is computed as current day's closing price/previous day's closing price–1. Quoted spread ($) is the difference of quoted ask and quoted bid price corresponding to a trade. Quoted spread (%) is the quoted spread ($) divided by the midpoint of quoted bid and ask price. Effective spread ($) is computed as $D \times$ (Trade Price–Quoted midpoint), where D equals 1 for buyer initiated trades and -1 for seller initiated trades, and buys and sells are determined using the Lee and Ready (1991) method. Effective spread (%) is effective spread ($) divided by the midpoint of quoted bid and ask price. Other variables are self-explanatory. We first compute daily mean values of the reported variables for each ETF in each sub-period and in the whole period. Then, we obtain and report grand averages for each ETF group.

of 47,053 trades per day, a daily volume of 22.3 million shares, and an average turnover ratio of 0.13 during the whole sample period. In addition, the trading during the financial crisis period and the recovery period is more active than in the pre-crisis period. The increase in daily trading volume is about 59% from 16.9 million shares in the pre-crisis period to 26.8 million shares in the crisis period, and the increase is about 16% from pre-crisis period to the recovery period (19.6 million shares). Although the average trade size declines from 510 shares before the crisis to 262 shares during the recovery period, the daily turnover ratio increases from 0.09 in the pre-crisis period to 0.16 and 0.12 during the crisis and recovery periods, respectively. The average daily return is close to zero during the whole period, and it varies from 0.06% in the pre-crisis period to −0.19% (0.23%) in the crisis (recovery periods). The standard deviation of intraday trade returns remains around 0.03% ~ 0.05%. During the whole period, the quoted spreads are about $0.07 per share and 0.07% of the quoted midpoint, and the effective spreads are about $0.06 per share and 0.10% of quoted midpoint.

The next four rows report the daily trading of the 22 leveraged ETFs. The daily trading volume increases from about 143,000 shares during the pre-crisis period to 6.3 million and 7.8 million shares during the crisis and recovery periods. Although the total daily trading volume is smaller than that of the benchmark ETFs, the turnover ratios of leveraged ETFs are higher than those of the benchmark ETFs. In the pre-crisis period, the average turnover ratio is 0.11, and it increases to 0.30 in the crisis period and 0.14 in the recovery period, with an average turnover ratio of 0.21 during the whole test period. Similar to the benchmark ETFs, the average trade size declines from 441 shares in the pre-crisis period to around 380 shares in the crisis and recovery periods. The average daily return is about −0.02% during the whole period, ranging from −0.4% in the crisis period to 0.47% in the recovery period. The standard deviation of intraday trade return varies from 0.54% in the pre-crisis period to 0.23% in the recovery period, which is substantially larger than the corresponding numbers for benchmark ETFs. In addition, all of the four spread measures are much larger than those of benchmark ETFs, especially during the crisis period. For example, the quoted spreads are about $0.28 per share and 0.71% of the quoted midpoint during the crisis period, compared with only $0.08 per share and 0.13% of the quoted spreads for the benchmark ETFs during the same period. Consistent with the microstructure literature (e.g., Chung, Li, and McInish, 2005), the smaller spreads of benchmark ETFs are likely driven by the large trading volume, long-trading history, and large capitalization of these ETFs.[10]

The last four rows in Panel A of Table 2 report the mean values of daily trade and liquidity measures of the 22 leveraged inverse ETFs. The average daily trading volume and spread measures are similar to those of the leveraged ETFs, but daily turnover ratios are much higher than those of both the benchmark and leveraged ETFs. The average turnover ratio is 0.34 during the whole period and 0.43 during the crisis period, which implies that the average holding period is about 2.3 days, consistent with Cheng and Madhavan's (2009) theory that leveraged and leveraged inverse ETFs are mainly for short-term traders. The average daily return is −0.04% during the whole period, with −0.09% in the pre-crisis, 0.28% during the crisis, and −0.52% in the recovery period.

To provide a better understanding of how the trade and liquidity of leveraged and leveraged inverse ETFs differs from the benchmark ETFs, we compare trade and liquidity variables for each triplet ETFs. Table 2, Panel B reports the mean value ratios of leveraged

ETFs to the benchmark ETFs. The average number of trades per day for the leveraged ETFs is about 63% of the matched benchmark ETFs in the whole test period, and it increases from 8% in the pre-crisis period to 123% in the recovery period. The trade size of leveraged ETFs is about 1.5 times that of the matched benchmark ETFs during the whole period. The daily trading volume of the leveraged ETFs is only about 8% of the benchmark ETF in the pre-crisis period, but it increases to 83% and 162% in the crisis and recovery period, respectively. The average turnover ratio of the leveraged ETFs is about 4.4 times the turnover ratio of the matched benchmark ETFs in the whole period. Although the benchmark ETF is designed to generate 100% of the tracking index return, while the leveraged ETFs are supposed to provide 200% of the tracking index return, the average daily return ratio of leveraged ETFs to the matched benchmark ETFs is only 1.79 times during the whole test period. The discrepancy is because of tracking errors caused by daily rebalancing and the path-dependent features of leveraged ETF returns.[11] The standard deviation of intraday returns of leveraged ETFs is about 13.7 times that of the benchmark ETFs during the whole period. Spread ratios range from 3.93 for quoted dollar spread to 9.09 for percentage effective spread.

Panel C of Table 2 reports the trade and liquidity variable ratios of the leveraged inverse ETFs to the matched benchmark ETFs. Similar to the results reported in Panel B of Table 2, the trading of the leveraged inverse ETFs is more active than the matched benchmark ETFs, especially during and after the financial crisis. For example, the turnover ratio of the leveraged inverse ETFs is 7.11 times the turnover ratio of the benchmark ETFs in the crisis period. The daily average return of the leveraged ETFs is a negative 1.86 times that of the matched benchmark ETF during the whole period. Both the standard deviation and spread measures of leveraged inverse ETFs are substantially larger than those of the benchmark ETFs.

In summary, the univariate results clearly indicate that the trading of leveraged ETFs and leveraged inverse ETFs is more active than the benchmark ETFs, especially with regards to the turnover ratio and during the financial crisis period. In addition, both the leveraged and leveraged inverse ETFs have substantially higher price volatility and larger spreads. These imply that investors need to take the high risk and large transaction costs into consideration for investing in leveraged ETFs.

3.2. Trade correlation

Given the fact that the ETFs in a triplet track the same index/sector, it is interesting to know whether the trading of one ETF may compete, complement or substitute for the trading of the other two ETFs in the same triplet. A related issue is whether each type of ETF attracts a unique group of investors or whether they are different simply only in return generating process. To test this possible effect, we first conduct a non-parametric Spearman correlation test of total daily trading volume, daily turnover ratio, and daily buy and sell volumes of the triplet ETFs. Panel A of Table 3 reports the Spearman correlation coefficients between the benchmark and the matched leveraged ETFs. It is clear that the trading of benchmark ETFs and the matched leveraged ETFs is highly positively correlated. For example, the correlation coefficient of trading volume measured in number of shares between the benchmark and the leveraged ETFs is 0.61, the correlation coefficient of turnover ratio is 0.66, and buy and sell volume have similar positive and significant correlations. The Spearman correlation coeffi-

Table 3 Spearman correlation of daily trading

	Trade Volume	Turnover ratio	Buy volume	Sell volume
Panel A: Spearman correlation between benchmark and the matched leveraged ETFs				
Benchmark ETFs	Leveraged ETFs			
Trade volume	0.61	0.56	0.61	0.60
	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Turnover ratio	0.66	0.66	0.66	0.65
	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Buy volume	0.61	0.56	0.61	0.60
	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Sell volume	0.61	0.56	0.61	0.60
	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Panel B: Spearman correlation between benchmark and the matched leveraged inverse ETFs				
Benchmark ETFs	Leveraged inverse ETFs			
Trade volume	0.60	0.61	0.60	0.60
	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Turnover ratio	0.73	0.71	0.72	0.72
	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Buy volume	0.60	0.61	0.60	0.60
	(<0.001)	(0.001)	(<0.001)	(<0.001)
Sell volume	0.60	0.62	0.60	0.60
	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Panel C: Spearman correlation between leveraged ETFS and the matched leveraged inverse ETFs				
Leveraged ETFs	Leveraged inverse ETFs			
Trade volume	0.84	0.77	0.83	0.84
	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Turnover ratio	0.80	0.75	0.79	0.79
	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Buy volume	0.83	0.76	0.83	0.84
	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Sell volume	0.84	0.76	0.83	0.83
	(<0.001)	(<0.001)	(<0.001)	(<0.001)

Notes: This table reports the Spearman correlation of daily trading variables of benchmark ETFs, leveraged ETFs, and leveraged inverse ETFs. Turnover ratio is computed as the ratio of daily trading volume divided by the number of shares outstanding. Buy, Sell, and Trade Volume are daily buy, sell, and total trade volume in number of shares. The numbers in parentheses are the p-values of correlation coefficient tests.

cients between the benchmark ETFs and the leveraged inverse ETFs reported in Panel B of Table 3 are similar to those reported in Panel A. The correlation coefficients between the leveraged ETFs and the leveraged inverse ETFs are reported in Panel C, and the results show that the Spearman correlation coefficients between these two groups of ETFs are actually larger than those reported in Panels A and B. These results suggest that different types of ETFs attract different investor groups and trading in one ETF does not necessarily substitute for the trading of other ETFs in the same triplet.

To further investigate the correlation of trading activities of different types of ETFs and factors that likely affect ETF trading, we conduct various regression analyses. Because ETFs in each triplet track the same index/sector, it is likely that the trading of ETFs in the same triplet could be affected by the same set of macroeconomic factors. Thus, we need to control for multicollinearity among the independent variables when testing for trade correlation among the matched ETFs. To do this, we use orthogonal regressions through two steps. First, we estimate a time series OLS regression of buy volume for each ETF on a set of instrumental variables as follows:

$$Logbuyvol_{i,t} = a_0 + a_1 Mktcycle2_t + a_2 Mktcycle3_t + a_3 UP5\%_t + a_4 DW5\%_t + a_5 UP5\%_{t-1} + a_6 DW5\%_{t-1} + a_7 R_{m,t} + a_8 R_{m,t-1} + \mu_{i,t}, \quad (1)$$

where, $logbuyvol_{i,t}$ is the log transformation of buy volume for the i^{th} ETF on day t. *Mktcycle2* (*Mktcycle3*) is a dummy variable and equals 1 during November 1, 2007 through February 28, 2009 (March 1, 2009 through December 31, 2009) and zero otherwise. *UP5%* (*DW5%*) is a dummy variable and equals 1 if the price of the benchmark ETF goes up (down) by 5% or more on day *t*.[12] $R_{m,t}$ and $R_{m,t-1}$ are market returns based on the S&P 500 index on day t and $t-1$. We obtain the residuals from Eq. (1) and denote the residuals as $R\_logbuyvol1x_t$, $R\_logbuyvol2x_t$, and $R\_logbuyvo\text{-}2x_t$ for benchmark ETFs, leveraged ETFs, and leveraged inverse ETFs, respectively.

In the second step of the regression analysis, we use the residuals obtained in Eq. (1) and estimate the following time series OLS regression for each benchmark ETF:

$$Logbuyvol1x_{i,t} = b_0 + b_1 Mktcycle2_t + b_2 Mktcycle3_t + b_3 UP5\%_t + b_4 DW5\%_t + b_5 UP5\%_{t-1} + b_6 DW5\%_{t-1} + b_7 Opening\ Return_{i,t} + b_8 Daily\ Return_{i,t} + b_9 Daily\ Return_{i,t-1} + b_{10} Std.\ Dev.\ of\ return_{i,t} + b_{11} Logshvol1x_{i,t-1} + b_{12} R\_logshvol2x_t + b_{13} R\_logshvol\text{-}2x_t + \rho_{i,t}, \quad (2)$$

where, *Logbuyvol1x* is the log transformation of daily buy volume for the i^{th} benchmark ETF on day *t*, *Opening return* is computed as 100 × (current day open price/ previous day close price − 1). *Daily return* is calculated as 100 × (current day close price/ current day open price − 1). Std. Dev. of $\text{return}_{i,t}$ is the standard deviation of return based on intraday trade prices. $Logshvol1x_{i,t-1}$ is the log transformation of daily total trade volume for the i^{th} benchmark ETF on day $t-1$. Other variables are as explained previously. The dummy variables *Mktcycle2* and *Mktcycle3* control for overall market cycles, and all other variables are used to control for trade related factors.

We compute the mean values of regression coefficients and *t* statistics for all benchmark ETFs and report the results in Table 4, Panel A. To provide more detailed information for the regressions, we also count the number of coefficients that are positive (negative) and significant at the 0.1 or lower levels as "Pos-Sig" ("Neg-Sig"). We obtain z-statistics by dividing the sum of individual regression *t* statistics by the square root of number of coefficients.[13] The mean coefficients on *Mktcycle2* and *Mktcycle3* are 0.336 and 0.333, respectively. For the dummy variable of *Mktcycle2* (*Mktcycle3*), 18 (16) out of 22 individual coefficients are positive and significant at the 0.1 or lower levels. These results indicate that the trading volume of benchmark ETFs is much higher during the crisis and recovery periods than in the pre-crisis period, consistent with the univariate results reported in Panel A of Table 2. The coefficient on dummy variables *UP5%* and *DW5%* and their lagged variables

Table 4 Regression on daily buy volume

Panel A: Summary of OLS regression for benchmark ETFs

Variable	Mean Coeff.	Mean *t* stat	Pos-Sig	Neg-Sig	z-stat	*p*-value
Intercept	2.873	12.70	22	0	59.56	0.0000
Mktcycle2	0.336	6.09	18	0	28.56	0.0000
Mktcycle3	0.333	4.49	16	1	21.07	0.0000
UP5%	0.389	2.82	15	0	13.21	0.0000
DW5%	0.272	1.44	11	0	6.77	0.0000
Lagged UP5%	0.269	1.94	14	0	9.11	0.0000
Lagged DW5%	0.330	1.97	14	0	9.26	0.0000
Opening return	−0.002	−0.36	1	4	−1.69	0.0905
Daily return	−0.013	−1.72	1	6	−8.06	0.0000
Lagged daily return	−0.009	−1.59	1	7	−7.44	0.0000
Lagged logshvol1x	0.439	13.64	22	0	63.98	0.0000
R_logbuyvol2x	0.102	5.71	22	0	26.79	0.0000
R_logbuyvol-2x	0.136	6.07	19	0	28.45	0.0000
Std. dev. of return	0.281	−0.68	5	9	−3.18	0.0015
Adj-R^2						0.577

Panel B: Summary of OLS regression for leveraged ETFs

Variable	Mean Coeff.	Mean *t* stat	Pos-Sig	Neg-Sig	z-stat	*p*-value
Intercept	0.484	1.76	14	5	8.25	0.0000
Mktcycle2	0.661	6.32	20	1	29.64	0.0000
Mktcycle3	0.876	6.91	21	0	32.41	0.0000
UP5%	0.693	2.65	18	0	12.45	0.0000
DW5%	0.679	2.70	20	0	12.66	0.0000
lagUP5%	0.415	1.30	8	0	6.10	0.0000
lagDW5%	0.782	2.96	20	0	13.90	0.0000
Opening return	0.017	0.81	8	1	3.82	0.0001
Daily return	−0.001	−0.50	2	6	−2.36	0.0184
Lagged daily return	0.005	0.38	4	1	1.77	0.0775
Lagged logshvol2x	0.521	20.21	22	0	94.78	0.0000
R_logbuyvol1x	0.391	6.39	22	0	29.95	0.0000
R_logbuyvol-2x	0.131	3.36	18	0	15.76	0.0000
Std. dev. of return	−0.700	−4.31	0	21	−20.19	0.0000
Adj-R^2	0.627					

Panel C: Summary of OLS regression for leveraged inverse ETFs

Variable	Mean Coeff.	Mean *t* stat	Pos-Sig	Neg-Sig	z-stat	*p*-value
Intercept	0.891	5.20	19	1	24.41	0.0000
$Mktcycle2_t$	0.653	7.47	21	0	35.03	0.0000
$Mktcycle3_t$	0.670	7.08	21	0	33.23	0.0000
$UP5\%_t$	0.393	1.49	9	0	6.98	0.0000
$DW5\%_t$	0.202	0.80	7	0	3.75	0.0002
$UP5\%_{t-1}$	0.609	2.07	13	1	9.72	0.0000
$DW5\%_{t-1}$	0.135	0.35	4	2	1.66	0.0966
Opening return$_t$	0.018	1.24	6	0	5.82	0.0000
Daily return$_t$	0.010	1.25	8	0	5.84	0.0000
Lagged daily return$_{t-1}$	0.032	3.95	21	0	18.54	0.0000
Lagged logshvol-2x$_{t-1}$	0.475	16.51	22	0	77.45	0.0000
R_logbuyvol1x$_t$	0.308	6.63	20	0	31.08	0.0000
R_logbuyvol2x$_t$	0.083	3.35	19	0	15.70	0.0000
Std. dev. of return$_t$	−0.700	−3.95	0	20	−18.52	0.0000
Adj-R^2	0.568					

Notes: The dependent variable of the regression is the log transformation of daily buy volume (shares). For each ETF, we conduct time series OLS regression individually. Then, we compute and report cross sample mean values of regression coefficients, *t* stat and adjusted R^2 for benchmark ETFs (Panel A), leveraged ETFs (Panel B), and leveraged inverse ETFs (Panel C). *Mktcycle2* (*Mktcycle3*) is a dummy variable and equals 1 during November 1, 2007 through February 2, 2009 (3/01/09–12/31/09) and zero otherwise. *UP5%* (*DW5%*) is a dummy variable and equals 1 if daily price of the benchmark ETF goes up (down) by 5% or more. *Opening return* is computed as 100 × (current day open price/previous close price − 1). *Daily return* is calculated as 100 × (current day close price/current day open price − 1). *Logbuyvol1x*, *Logbuyvol2x*, and *Logbuyvol-2x* are log transformation of daily buy volume of benchmark ETF, leveraged ETF, and leveraged inverse ETFs, respectively. *R_logbuyvol1x*, *R_logbuyvol2x*, and *R_logbuyvol-2x* are the *Logbuyvol* regression residuals on a set of instrument variables for benchmark ETFs, leveraged ETFs, and leveraged inverse ETFs, respectively. $Logshvol_{t-1}$ is log transformation of total daily volume in the previous day. *Std. dev. of return* is the standard deviation of return based intra-day trade price. We obtain z-stat by dividing the sum of individual regression t-statistics by the square root of number of coefficients. Pos-sig (Neg-sig) indicates the number of coefficients that is positive (negative) at 0.1 or lower significance levels.

are positive and significant in most of the regressions, suggesting that trading is more active when the price movement of benchmark ETFs is large. The mean values on the coefficients of opening returns, daily returns, and lagged daily return are negative, but they are significant only in a few regressions, indicating that the effects of these variables on buy volume are marginal. The coefficients on lagged trading volume are positive and significant in all of the 22 regressions, which suggest trading momentum in ETFs. More importantly, the buy volume residuals of the leveraged ETFs and leveraged inverse ETFs are positively related to the buy volume of benchmark ETFs. Consistent with the positive Spearman correlation coefficient reported in Table 3, these results provide further evidence that trading of ETFs in the same triplet is positively correlated with each other.

We use a similar procedure to estimate the trading volume for leveraged ETFs. Specifically, the dependent variable of regression Eq. (2) is placed with $Logbuyvol2x_{i,t}$ for the leveraged ETFs, and the last three independent variables are replaced by the lagged total trading volume ($Logshvol2x_{i,t-1}$) and the residuals of benchmark ETFs and leveraged inverse ETFs obtained in regression Eq. (1), $R\_logbuyvol1x_t$ and $R\_logbuyvol\text{-}2x_t$, respectively. Other independent variables are the same as specified in Eq. (2). The mean values of the regression statistics for the leveraged ETFs are reported in Panel B, Table 4. Similar to the results of benchmark ETFs reported in Panel A, the coefficients on *Mktcycle2*, *Mktcycle3*, *UP5%*, *DW5%*, lagged *UP5%*, and lagged *DW5%* are all positive and significant, suggesting that the trading of leveraged ETFs is more active during the crisis and recovery periods and when the price movement of benchmark ETFs is large. In addition, all the coefficients on lagged trading volume and buy volume residuals of *R_logbuyvol1x* and *R_logbuyvol-2x* are positive, suggesting that trading of benchmark ETFs and the leveraged inverse ETFs is positively correlated with the trading of leveraged ETFs. Regression results for leveraged inverse ETFs are reported in Panel C of Table 4. The results are consistent with those reported in Panels A and B except that the coefficients on lagged daily returns is positive in 21 out of 22 regressions.

In addition to the OLS regressions reported in Table 4, we conduct several robustness tests. First, we replace log buy volume with log sell volume as the dependent variable and test how sell volume of the matched ETFs is correlated with each other by repeating regressions (1) and (2). Second, we use log total daily trading volume and test how the overall trading of the matched ETFs is correlated with each other. Third, we use a mixed effects method to estimate an equation similar to Eq. (2) by adding ETF age as an additional control variable. The advantage of the mixed effect method is that it controls for both fixed and random effects simultaneously. Fourth, we conduct two-stage least square regressions to control for possible endogeniety issues. The results of these robustness tests (unreported) are qualitatively consistent with those reported in Table 4.[14]

In summary, the trading volume of ETFs in the same triplet is positively correlated, and the results are consistent using different regressions and robust after controlling for various market wide and ETF specific factors. The positive correlation of trading volume of ETFs in the same triplet suggests that each type of ETF attracts different investor groups, and trading of one ETF does not substitute for the trading of other ETFs. These results are consistent with the prediction of Guedj and Huang (2009) and the empirical result of Agapova (2010).

3.3. Trade size and market condition

Despite the significant increase in the popularity of ETF trading, there is no hard evidence in the literature as to who are the major ETF investors. To understand this issue better, we analyze trade size under different market environments. Although we cannot identify who initiates each trade because of the limitation of publicly available data, the trade size analysis provides indirect evidence on whether small or large traders dominate the ETF trading because trade size is expected to be small (large) for individual (institutional) investors, ceteris paribus. A trade is classified as "small" if trade size is equal to or less than 500 shares, "medium" if the trade size falls between 501 and 10,000 shares, or "large" if trade size is greater than 10,000 shares.[15]

Table 5, Panel A, reports univariate results on the proportion of small, medium, and large trades to total daily trades. The first four rows are the results for the benchmark ETFs. It is clear that small trades dominate benchmark ETF trading and the dominant role becomes more pervasive during the financial crisis and recovery periods. For example, before the financial crisis, the number of small trades accounts for 81.5% of total daily trades with an average trade size of 179.9 shares, and the proportion increases to 88.7% and 92.9% during the crisis and recovery periods, respectively, with an average ratio of 88.4% during the whole test period. In terms of trading volume, small trades account for 39.8% of total daily volume before the crisis, and increase to 56.7% during the crisis period and 65.8% in the recovery period. Medium size trades account for 11.5% of total daily trades or 38.4% of total daily trading volume during the whole test period. Medium size trades decline both in number of trades and in volume over the test period. Before the crisis, medium size trades account for 18.3% total trades, and decline to 11.2% during the crisis and account for only about 7% during the recovery period. In terms of volume, medium size trades account for 51.9% before the crisis, declining to 38.4% and 28.6% during the crisis and recovery periods, respectively. Large trades account for only about 0.1% of the total number of trades or 5.8% of total daily trading volume during the whole period. The proportion of large trades varies in the three periods, but the difference is much smaller compared with the changes for small and medium trades.

The four rows in the middle of Panel A report the results for the leveraged ETFs. The small trades account for 82.6% of total daily trades or 51.6% of daily volume during the whole period. These numbers are smaller than those of benchmark ETFs, but small trades still present a large proportion of the leveraged ETF trading. The number of small trades increases from 79.3% in the pre-crisis period to 82.0% and 85.9% during the crisis and recovery periods, respectively. Medium trades account for 20.6% of trades or 48.1% of volume before the crisis, and decline to 14% of trades and 41.6% of daily volume in the recovery period. Similar to the benchmark results, large trades account for only about 0.1% of total trades or about 1.9% of daily trading volume during the whole period. The last four rows report the results for leveraged inverse ETFs. The results are similar to those of leveraged ETFs.

Panel B of Table 5 reports the proportion of trades for different trade size based on daily price movement of benchmark ETFs. The analysis helps to explain whether price movement affects the trading behavior of different trade size groups. As we discussed in the previous section, we classify a trading day as *UP5%*, *DW5%*, and *Normal* days based on the daily return of benchmark ETFs. The first three rows in Panel B report the proportion of trades for

Table 5 Univariate analysis of trade size under different trading environment

Period	Small: Trade no. ratio	Small: Volume ratio	Small: Trade Size (shares)	Medium: Trade no. ratio	Medium: Volume ratio	Medium: Trade Size (shares)	Large: Trade no. ratio	Large: Volume Ratio	Large: Trade Size (shares)
Panel A: Trade size in different periods									
Benchmark ETFs									
3/07–10/07	0.815	0.398	179.9	0.183	0.519	1,518.3	0.002	0.083	46,776.7
11/07–2/09	0.887	0.567	168.0	0.112	0.384	1,263.6	0.001	0.048	52,897.2
2/09–12/09	0.929	0.658	168.6	0.070	0.286	1,151.5	0.000	0.055	58,000.4
Whole period	0.884	0.558	170.9	0.115	0.384	1,282.4	0.001	0.058	53,862.6
Leveraged ETFs									
3/07–10/07	0.793	0.512	191.3	0.206	0.481	1,341.9	0.001	0.008	16,395.8
11/07–2/09	0.820	0.502	188.2	0.179	0.484	1,208.8	0.000	0.014	21,308.9
2/09–12/09	0.859	0.547	179.5	0.140	0.416	1,261.8	0.001	0.037	23,482.2
Whole period	0.826	0.516	186.4	0.173	0.465	1,244.2	0.001	0.019	22,299.4
Leveraged Inverse ETFs									
3/07–10/07	0.834	0.525	192.5	0.166	0.459	1,451.4	0.001	0.017	22,944.8
11/07–2/09	0.878	0.591	173.8	0.121	0.397	1,216.7	0.000	0.012	22,962.9
2/09–12/09	0.931	0.703	160.0	0.068	0.284	1,119.2	0.000	0.012	21,553.8
Whole period	0.885	0.610	173.5	0.114	0.376	1233.8	0.000	0.013	22,518.2
Panel B: Trade size analysis under different market condition									
Benchmark ETFs									
DW5%	0.907	0.615	163.7	0.093	0.350	1,167.5	0.000	0.035	39,708.0
Normal	0.883	0.555	171.2	0.117	0.386	1,287.9	0.001	0.059	54,366.8
UP5%	0.916	0.628	163.4	0.084	0.333	1,154.6	0.000	0.039	50,782.4
Leveraged ETFs									
DW5%	0.835	0.482	189.7	0.164	0.493	1,261.8	0.001	0.025	25,866.5
Normal	0.826	0.519	186.2	0.173	0.463	1,240.8	0.001	0.018	21,306.6
UP5%	0.807	0.428	193.3	0.191	0.528	1,312.7	0.002	0.044	34,608.3
Leveraged Inverse ETFs									
DW5%	0.904	0.637	161.5	0.095	0.349	1,130.4	0.000	0.014	31,143.9
Normal	0.884	0.607	174.3	0.116	0.379	1,238.0	0.000	0.014	21,970.1
UP5%	0.919	0.667	152.8	0.080	0.320	1,200.3	0.000	0.014	21,582.0

Notes: This table reports the trade variable ratios of small, medium, and large trades to the corresponding variables of daily total trades. Each trade is classified as one of the three trade size groups: small for trade size ≤ 500 shares; medium for 500 < trade size ≤ 10,000 shares; large for trade size >10,000 shares. Each trading day is classified as *UP5%* (*DW5%*) if the price of benchmark ETF goes up (down) by 5% or more, otherwise it is classified as *Normal*.

different trade size groups for the benchmark ETFs. During the *UP5%* days, the proportion of small trades is 91.6%, and during *DW5%* days, it is 90.7%, whereas it is only about 88.3% during normal days. As for trading volume, small trades account for a smaller portion of total trades (55.5%) during normal days than during *UP5%* days (62.8%) and *DW%* days (61.5%). In contrast, the proportion of medium size and large size trades is larger during normal days than during *UP5%* and *DW5%* days.

The middle three rows of Panel B of Table 5 reports the results for the leveraged ETFs. The proportion of small trades account for 82.6% of total trades during normal days, which is smaller than during the *DW5%* days (83.5%) but larger than the *UP5%* days (80.7%). The volume of small trades is also larger during normal days, 51.9% of total daily volume, compared with 48.2% during *DW5%* days and 42.8% during *UP5%* days. Differing from benchmark ETFs, the medium size trades account for 46.3% of total daily volume during normal days, which is smaller than during *DW5%* days (49.3%) and *UP5%* days (52.8%). The proportion of large trades is also smaller during normal days (1.8%) than during *DW5%* days (2.5%) and *UP5%* days (4.4%).

The last three rows in Panel B of Table 5 report the results for leveraged inverse ETFs. The results for small and medium trades are similar to those of the benchmark ETF. Small trades account for a larger proportion of daily trades during *UP5%* (91.9%) and *DW5%* days (90.4%) than during normal days (88.4%), and the volume of small trades is only about 60.7% of daily volume during normal days compared with 63.7% during *DW5%* days and 66.7% during *UP5%* days. The medium trades account for 37.9% of daily trading volume during normal days, compared with 34.9% during *DW5%* days and 32.0% during *UP5%* days. Large trades account for 1.4% of daily trading volume and do not show much variation during different price movement days.

The overall results based on the univariate analyses indicate that small trades dominate ETF trading and the dominant role increases further during and after the financial crisis. In addition, small trades are more prevalent when the price movement of benchmark ETFs is large. The results indicate that the proportion of medium size trades declines after the financial crisis started in November 2007 and that the proportion of medium trades is larger (smaller) during normal days for benchmark and leveraged inverse ETFs (leveraged ETFs) than on other days. Large trades account for a very small proportion of daily trading and the variation is marginal during different time periods and under different market conditions. The results also imply that ETF trading is very popular among small investors and the popularity increased during the financial crisis and recovery periods.

3.4. Price movement and trading activities

We investigate whether any particular trade size groups drive daily price movement of ETFs. Existing literature shows that trade size is an important factor in investors' trade decisions since trade size not only reveals traders' private information and their demand for liquidity, but also directly influences price and transaction costs (e.g., Easley and O'Hara, 1987; Lin et al., 1995). The stealth trading theory suggests that informed traders use trade size strategically by splitting orders into medium size trades such that they do not reveal their private information (Barclay and Warner, 1993). A recent study by Hansch and Choe (2007) indicates that informed traders shift from medium size trades to small size trades around the year 2000 because of the increased ability of individual investors to obtain private information and the reduction of transaction costs for institutional investors. However, the stealth trading hypothesis may not be relevant for ETF trading since ETFs track indices or sectors and it is difficult for investors to obtain private information for ETFs. To investigate whether a certain trade size group has private information and affects the price movement for ETFs, we conduct the following regression using panel data for each trade size group and each type of the ETFs separately:

$$Return_{i,t} = c_0 + c_1R_{m,t} + c_2R_{m,t-1} + c_3Mktcycle2_t + c_4Mktcycle3_t + c_5Opening\ Return_{i,t} + c_6DailyReturn_{i,t-1} + c_7R\_logshvol1x_{i,t-1} + c_8R\_logshvol2x_{i,t-1} + c_9R\_logshvol\text{-}2x_{i,t-1} + c_{10}Size\_vol\%_{i,t} + c11LogBuyvol_{i,t} + \rho_{i,t}, \quad (3)$$

Where, $Return_{i,t}$ is the daily return computed as (close price/open price − 1) × 100 for the i^{th} ETF on day t; $R_{m,t}$ is the market return based on the S&P 500 index. *Size_vol%* in small trade regression is the proportion of small trade volume to total daily trade volume. *Size_vol%* in medium and large trade size regressions is defined the same as in the small trade regression. Other variables are defined in the previous regressions. We use residuals of trade volume variables (*R_logshvol*) to control for potential multi-collinearity problems among the independent variables.

Table 6 reports the regression results. A few things are obvious. First, both the current and lagged market returns are positively related to the returns of benchmark and leveraged ETFs, whereas they are negatively related to the returns of leveraged inverse ETFs. These results are not surprising since the indices and sectors tracked by ETFs are closely related with the overall stock market condition; therefore, both benchmark and leveraged ETF returns are positively correlated with market returns, whereas the returns of leveraged inverse ETFs are negatively related to market returns. Second, the coefficients on opening returns are positive and significant at the 0.01 level in all regressions, suggesting that the opening return conveys overnight information and is a good indicator of daily price movement. Third, the coefficients on lagged daily returns are negative and significant at the 0.01 level in all regressions, indicating possible autocorrelation in price movement. Fourth, lagged trading volume and current buy volume do not have significant effects on price movement.

Our primary interest is in *Size_vol%*, which captures the effect of a particular trade size group on ETF price movement. However, none of the coefficients on *Size_vol%* is significantly different from zero. Different from prior studies on individual equities, the results do not show that any particular trade size group is private information based and moves daily prices for ETFs. Consistent with the information diversification effect of Subrahmanyam (1991) and Gorton and Pennacchi (1993) and the empirical finding of Henker and Martens (2010), this evidence suggests that security specific private information is reduced through information diversification in the basket securities and that investors trade ETFs for liquidity and/or hedging considerations rather than private information.

Table 6 Daily return regressions

	Benchmark ETFs			Leveraged ETFs			Leveraged Inverse ETFs		
	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large
Intercept	−0.211	−0.200	−0.238	−0.087	−0.056	−0.450	0.152	0.076	−0.142
	(−2.28)**	(−2.24)**	(−1.53)	(−1.29)	(−0.68)	(−1.72)*	(1.61)	(0.74)	(−0.41)
Mkt return$_t$	0.987	0.987	1.048	1.889	1.900	2.117	−1.821	−1.830	−2.044
	(205.33)***	(205.27)***	(158.62)***	(187.87)***	(182.73)***	(98.68)***	(−176.23)***	(−168.99)***	(−98.82)***
Mkt return$_{t-1}$	0.155	0.155	0.190	0.406	0.395	0.454	−0.258	−0.252	−0.252
	(16.92)***	(16.91)***	(14.57)***	(22.60)***	(21.17)***	(11.93)***	(−14.22)***	(−13.00)***	(−6.97)***
Mktcycle2$_t$	−0.005	−0.001	0.018	−0.056	−0.062	−0.249	−0.166	−0.160	−0.065
	(−0.20)	(−0.06)	(0.50)	(−0.93)	(−0.92)	(−1.02)	(−2.84)***	(−2.49)**	(−0.39)
Mktcycle3$_t$	0.002	0.007	0.017	−0.011	−0.026	−0.139	−0.099	−0.100	−0.047
	(0.07)	(0.26)	(0.47)	(−0.15)	(−0.32)	(−0.50)	(−1.52)	(−1.40)	(−0.27)
Opening return$_t$	0.091	0.090	0.087	0.131	0.127	0.138	0.282	0.288	0.239
	(12.59)***	(12.58)***	(8.36)***	(17.39)***	(16.22)***	(8.56)***	(37.94)***	(36.79)***	(16.29)***
Daily return$_{t-1}$	−0.131	−0.131	−0.158	−0.158	−0.154	−0.191	−0.112	−0.112	−0.115
	(−16.42)***	(−16.41)***	(−14.26)***	(−19.84)***	(−18.67)***	(−12.72)***	(−14.28)***	(−13.37)***	(−8.24)***
R_logshvol1x$_{t-1}$	−0.034	−0.033	−0.029	−0.003	−0.001	0.021	0.008	0.006	−0.002
	(−2.31)**	(−2.25)**	(−1.23)	(−0.30)	(−0.14)	(0.82)	(0.83)	(0.53)	(−0.10)
R_logshvol2x$_{t-1}$	0.012	0.012	0.025	0.002	−0.009	−0.005	−0.045	−0.050	−0.072
	(1.83)*	(1.88)*	(2.42)**	(0.09)	(−0.39)	(−0.06)	(−3.00)***	(−3.12)***	(−1.95)*
R_logshvol-2x$_{t-1}$	−0.008	−0.009	−0.017	−0.022	−0.015	−0.009	0.047	0.061	0.063
	(−1.43)	(−1.48)	(−1.78)*	(−1.72)*	(−1.09)	(−0.16)	(2.19)**	(2.50)**	(0.71)
Size_vol%$_t$	0.012	0.003	−0.073	−0.006	−0.049	0.100	−0.107	0.083	0.868
	(0.27)	(0.06)	(−0.67)	(−0.08)	(−0.48)	(0.23)	(−1.24)	(0.76)	(1.53)
Log buyvol$_t$	0.033	0.032	0.035	0.029	0.030	0.077	−0.016	−0.022	0.007
	(2.32)**	(2.25)**	(1.42)	(1.66)*	(1.55)	(1.04)	(−0.81)	(−0.95)	(0.08)
Adj R^2	0.7940	0.7940	0.8102	0.7742	0.7768	0.7867	0.7626	0.7640	0.7507

Notes: Regressions are conducted separately for each ETF group (benchmark ETFs, leveraged ETFS, and leveraged inverse ETFs) and for each trade size group (small, medium, and large). The dependent variable of the regression is the daily return computed as 100 × (close price/open price − 1). The independent variables are explained as follows: ***Mkt return*** is the daily market return of S&P 500 index. ***Opening return*** is computed as 100 × (open price/previous close price − 1). *R_logshvol1x*, *R_logshvol2x*, and *R_logshvol-2x* are the regression residuals of daily trade volume (taking log transformation) on a set of instrument variables for benchmark ETFs, leveraged ETFs, and leveraged inverse ETFs, respectively. *Size_vol%* in small trade regression is the proportion of small trade volume to total daily trade volume. *Size_vol%* in medium and large trade size regressions is defined the same as in the small trade regression. *Logbuyvol* is log transformation of daily buy volume.

*, **, and ***Indicate 0.1, 0.05, and 0.01 significance levels, respectively.

3.5. Analysis of intraday trading patterns

The microstructure literature suggests that the U-shaped intraday volume pattern in stock trading is primarily driven by private information (see e.g., Admati and Pfleiderer, 1988) or both private information and public announcements (Atkins and Basu, 1995). However, whether a U-shaped volume pattern exists for ETF trading is not clear because it is hard for any investor to obtain private information for all stocks tracked by an ETF. In addition, given the leverage feature of leveraged and leveraged inverse ETFs, how the intraday trading pattern differs among benchmark, leveraged and leveraged inverse ETFs is not clear. Some anecdotal evidence suggests that the trading of leveraged ETFs is more active during the close than for other ETFs because hedge funds and institutional investors use leveraged ETFs to hedge against unwanted market moves and trading pros piggyback on the ETFs to make a quick profit in the final hour of the day (Lauricella et al., 2008). Others suggest that investors might want to avoid trading ETFs at the beginning and the end of a trading day because the market is more volatile and ETF prices are more likely to be off track from their net asset value (Salisbury, 2008; Laise, 2010). In this section, we compare the intraday pattern of the triplet ETFs and investigate factors that are likely to affect ETF intraday trading.

To provide a general understanding of ETF intraday trading patterns, we divide each trading day into thirteen 30-minute trading periods and compute the trading volume ratio of each period to the total daily trading volume. The cross section mean values for benchmark, leveraged, and leveraged inverse ETFs are plotted in Fig. 1a. A clear U-shaped intraday volume pattern exists for all ETFs. In the first 30 minute period, the trading of leveraged ETFs and leveraged inverse ETFs accounts for 17.9% and 17.4% of their daily volume, respectively, which is significantly larger than that of the matched benchmark ETFs (12.9%) during our whole test period. In the last 30 minute trading period, the trading volume ratio for the benchmark ETFs is 13.5%, which is slightly higher than that of the leveraged ETFs (12.6%) and leveraged inverse ETFs (12.4%). Together, the trading in the first and last hour accounts for 44.5% of benchmark ETFs daily volume, whereas it accounts for 48.4% of daily volume for leveraged ETFs and 48.0% for leveraged inverse ETFs. Given the fact that ETF trading is less likely because of private information, these results imply that factors other than private information can also contribute to more active trading at market open and close for securities. Fig. 1b shows the standard deviation of returns based on intraday period trading price. For each ETF on each day, we calculate the standard deviation of trade price returns in each of the 30-minute periods. Then we compute the cross-sectional mean values. The standard deviation is substantially larger in the first 30 minutes than in other periods and plunges to the normal level after 30 minutes, implying that the market is more volatile during the first 30 minutes of trading. Although all three ETF groups show an L-shaped pattern in intraday standard deviation, substantial differences exist among the three groups. The standard deviations of leveraged and leveraged inverse ETFs are much larger than that of the benchmark ETFs throughout the day and the largest difference appears in the first 30 minutes. The larger standard deviation of the leveraged and leveraged inverse ETFs is obviously driven by the built-in leverage feature of these ETFs.[16]

To investigate how opening period price volatility and other factors affect trading volume at the market opening, we estimate the following regression:

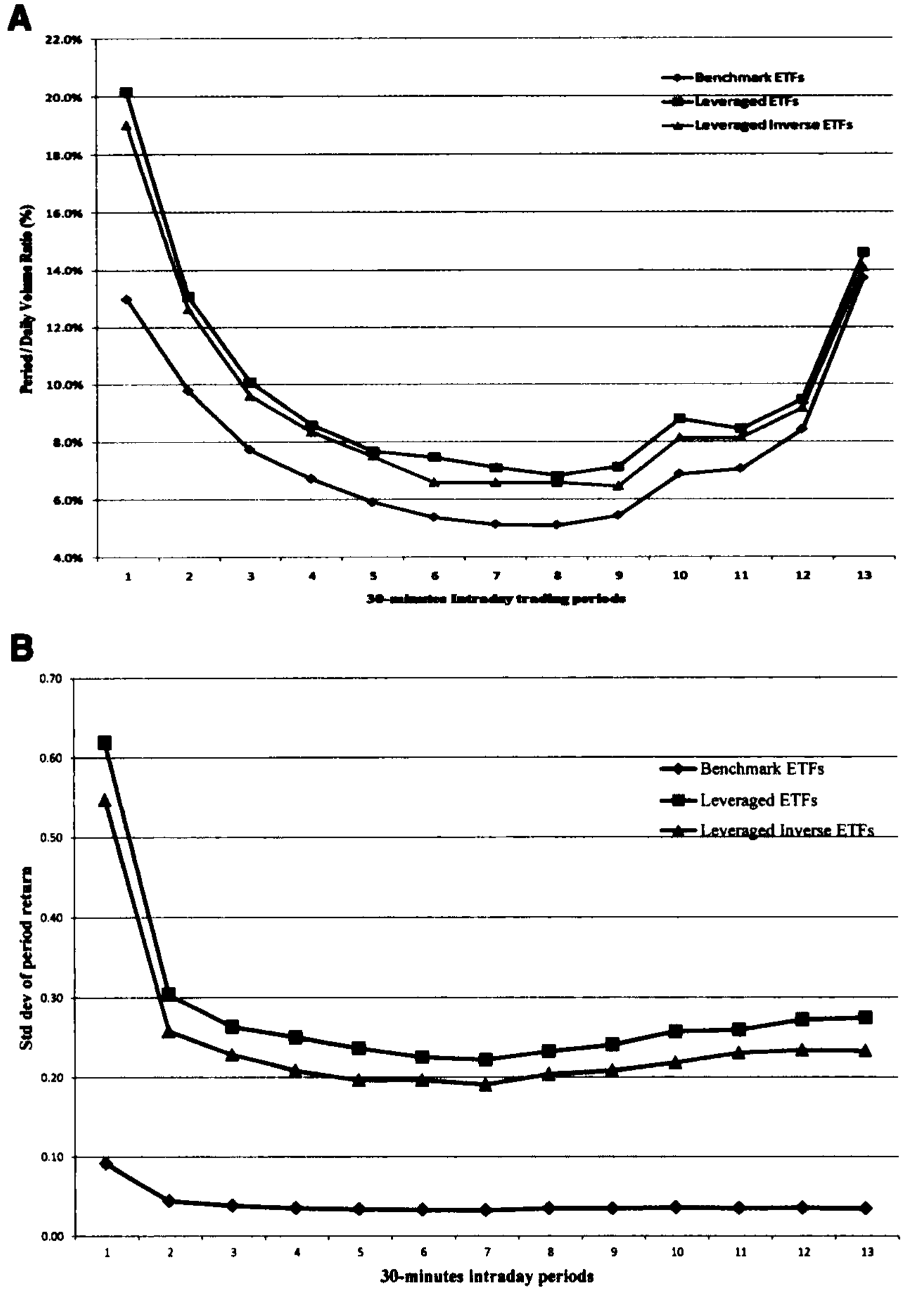

Fig. 1. (A) Trading period volume ratio. (B) Standard deviation of trading period returns.

$$OpenVol_{i,t} = d_0 + d_1 Mktcycle2_t + d_2 Mktcycle3_t + d_3 UP5\%_{i,t-1} + d_4 DW5\%_{i,t-1} + d_5 Opening\ Return_{i,t} + d_6 Dailyreturn_{i,t-1} + d_7 Std.\ Dev.\ of\ prd.\ return_{i,t} + \rho_{i,t} \quad (4)$$

The dependent variable *OpenVol* is the ratio of opening period volume to total daily volume. We include dummy variables *Mktcycle2* and *Mktcycle3* in the regression to capture the overall market environment during the crisis and recovery periods. Lagged *UP5%*, lagged *DW5%*, lagged *Return*, and *Opening Return* are included to investigate how the prior day's market movement and overnight news affect the trading volume in the opening period. *Std. Dev. of prd. return* is the standard deviation of returns during the first 30 minutes of trading.

We estimate Eq. (4) separately for benchmark ETFs, leveraged ETFs, and leveraged inverse ETFs using panel data and report the regression results in Models 1 to 3 in Panel A of Table 7.[17] The negative coefficients on *Myktcycle2* indicate that the trading volume in the first 30 minutes after the stock market opens is less active during the financial crisis period than during the pre-crisis period for all three ETF groups. Whereas, the coefficient on *Mktcycle3* is positive (negative) for benchmark ETFs (leveraged ETFs) and not significant for leveraged inverse ETFs, suggesting that opening trading is more active (less) during the recovery period for the benchmark (leveraged) ETFs. The coefficients on lagged *UP5%* and *DW5%* are negative and significant at the 0.1 and 0.05 levels for the benchmark ETFs, suggesting that opening trading is less active for the benchmark ETFs after days of large price movements. For leveraged ETFs, only the coefficient on lagged *DW5%* is negative and significant. None of the coefficients on Lagged *UP5%* and lagged *DW5%* is significant for the leveraged inverse ETFs. The opening return, capturing overnight information, is positively (negatively) related to the opening period trading of leveraged (leveraged inverse) ETFs. The return in the previous day does not affect opening period trading. Consistent with the results plotted in Fig. 1a,b, the opening period volume is positively related to the opening period volatility, especially for the leveraged and leveraged inverse ETFs.

As additional evidence, we also estimate Eq. (4) for all ETFs by adding dummy variables of *Leverage* and *Inverse* for the leveraged and leveraged inverse ETFs and report the result in Model 4 of Panel A. The positive coefficients on these two dummy variables confirm our results that opening trade for the leveraged and leveraged inverse ETFs are more active than that of the matched benchmark ETFs. Other results are consistent with those reported in Models 1 to 3.

For the trading volume ratio in the last 30-minute period, we estimate a regression equation similar to Eq. (4) by adding dummy variables $UP5\%_t$ and $DW5\%_t$ and replacing opening return with daily return since these variables help capture the current day market conditions. The results are reported in Panel B of Table 7. The coefficients on *Mktcycle2*, *Mktcycle3*, lagged *UP5%* and lagged *DW5%* are largely consistent with those reported in Panel A. The coefficients on *UP5%* are positive and significant at the 0.01 level for all ETFs, and the coefficient on *DW5%* are positive and significant at the 0.01 (0.1) level for benchmark (leveraged inverse) ETFs, and not significant for leveraged ETFs. The coefficient on daily returns is negative for benchmark and leveraged ETFs, but positive for leveraged inverse ETFs. These results in general indicate that the closing period is more active during large price movement days. The coefficients on the standard deviation of last period trading returns are negative for benchmark ETFs, but positive for the leveraged and leveraged inverse ETFs. We also estimate Eq. (4) for all ETFs by including dummy variables *Leverage* and *Inverse* for the leveraged and leveraged inverse ETFs and report the result in Model 8 of Panel B. Confirming the results reported in Fig. 1a, the negative coefficient on the dummy variable *Inverse* indicates that the trading volume of leveraged inverse ETFs is smaller than that of benchmark ETFs during the last 30 minutes before the stock market closes.

The overall results suggest that ETF trading at the open and close is more active than

Table 7 Regression on trading volume in the first and last 30 min trading period

	Panel A: Period = 1				Panel B: Period = 13			
	Benchmark ETFs (Model 1)	Leveraged ETFs (Model 2)	Leveraged Inverse ETFs (Model 3)	All ETFs (Model 4)	Benchmark ETFs (Model 5)	Leveraged ETFs (Model 6)	Leveraged inverse ETFs (Model 7)	All ETFs (Model 8)
Intercept	0.129	0.217	0.186	0.139	0.127	0.156	0.135	0.134
	(90.09)***	(61.75)***	(62.64)***	(85.65)***	(89.06)***	(52.68)***	(53.48)***	(96.79)***
$Mktcycle2_t$	−0.012	−0.045	−0.022	−0.024	0.013	−0.022	−0.015	−0.005
	(−6.90)***	(−11.24)***	(−6.56)***	(−13.94)***	(8.07)***	(−6.58)***	(−5.18)***	(−3.42)***
$Mktcycle3_t$	0.019	−0.021	−0.002	0.002	0.030	−0.021	0.013	0.011
	(10.57)***	(−5.13)***	(−0.50)	(1.00)	(17.10)***	(−5.92)***	(4.29)***	(7.30)***
$UP5\%_t$					0.037	0.035	0.030	0.024
					(5.95)***	(3.43)***	(3.14)***	(5.15)***
$DW5\%_t$					0.031	0.012	0.015	0.024
					(5.67)***	(1.37)	(1.88)*	(6.05)***
$UP5\%_{t-1}$	−0.011	−0.002	−0.014	−0.005	0.004	−0.027	−0.043	−0.016
	(−1.92)*	(−0.17)	(−1.45)	(−1.12)	(0.70)	(−2.65)***	(−4.44)***	(−3.55)***
$DW5\%_{t-1}$	−0.012	−0.023	−0.010	−0.019	0.011	−0.016	−0.015	−0.016
	(−2.22)**	(−2.32)**	(−1.15)	(−4.51)***	(1.99)**	(−1.76)*	(−1.78)*	(−3.86)***
Opening return$_t$	0.000	0.001	−0.001	−0.000				
	(0.33)	(2.18)**	(−2.90)***	(−0.56)				
Daily return$_t$					−0.001	−0.001	0.001	−0.000
					(−2.68)***	(−2.23)**	(2.76)***	(−0.54)
Daily return$_{t-1}$	0.000	0.000	−0.000	0.000	0.001	−0.000	−0.001	−0.001
	(1.03)	(0.77)	(−0.92)	(1.15)	(1.50)	(−0.62)	(−3.86)***	(−3.74)***
Std. dev. of prd. return$_t$	0.006	0.018	0.026	0.021	−0.219	0.031	0.034	0.030
	(1.65)*	(10.41)***	(15.04)***	(20.61)***	(−14.57)***	(8.90)***	(9.24)***	(13.62)***
Leverage				0.058				0.003
				(36.32)***				(1.85)*
Inverse				0.048				−0.004
				(31.22)***				(−2.73)***
Adj R^2	0.0288	0.0185	0.0202	0.0686	0.0396	0.0120	0.0187	0.0110

Notes: This table reports panel data regressions of opening and closing period trading volume ratios. In Panel A (B), the dependent variable is the ratio of trading volume in the first (last) trading period to the total daily trading volume. In Models 1 to 3 and Models 5 to 7, regressions are conducted for benchmark ETFs, leveraged ETFs, and leveraged inverse ETFs separately. In Models 4 and 8, all ETFs are included in the regression with dummy variables of *Leverage* and *Inverse*. *Leverage* equals 1 for leveraged ETFs and zero otherwise; *Inverse* equals 1 for leveraged inverse ETFs and zero otherwise. Other independent variables include: *Mktcycle2* (*Mktcycle3*) is a dummy variable and equals 1 during November 1, 2007 through February 2, 2009 (3/01/09–12/31/09) and zero otherwise. *UP5%* (*DW5%*) is a dummy variable and equals 1 if the daily price of benchmark ETF goes up (down) by 5% or more. *Opening return* is computed as 100 × (open price/previous close price − 1). *Daily return* is calculated as 100 × (close price/open price − 1). Std. dev. of prd. return is the standard deviation of trade price returns in the corresponding trading period.

*, **, and *** indicate 0.1, 0.05, and 0.01 significance level, respectively.

during other periods of the day and this intraday pattern is affected not only by the price volatility during the open and close periods, but also by the market environment. The results partially support the anecdotal evidence that traders skip most of the day and the stock market's open and close is all that matters (Peterson, 2010).

4. Conclusions and discussions

Although ETFs account for more than one-third of U.S. stock trading and many new and innovative ETFs have been introduced to the market in recent years, limited evidence exists on how these popular investment products are traded. In addition, anecdotal evidence indicates that ETFs are one of the favorite investment products for individual investors. However, individual investors are generally uninformed and lack sophisticated trading experience in financial products. Thus, we strive to provide detailed empirical results to help individual investors understand how the new innovative ETFs are traded, and how the trading of similar ETFs is correlated with each other, and how various factors such as trade size, price volatility, liquidity, and intraday trade patterns differ across ETFs.

Using detailed high frequency intraday data, we investigate the intraday trade patterns of benchmark ETFs, leveraged ETFs, and leveraged inverse ETFs during March 2007 to December 2009, which covers a unique cycle of normal-crisis-recovery in the recent U.S. stock markets. The main results are summarized as follows. First, the trading is very active for all ETFs and the active trading becomes more pervasive once the financial crisis started in November 2007. The average number of trades per day for the benchmark ETF more than doubled and the increase in the number of daily trades for the leveraged ETFs is about 53 times during the financial crisis period. In addition, ETF trading is also more active when the price movement of the benchmark ETFs is large. Second, the trading of ETFs in the same triplet is positively correlated with each other, suggesting that the innovative ETFs attract different groups of investors and the trading of these innovative ETFs does not have adverse effects on the trading of benchmark ETFs. Third, small trades account for more than 80% of total daily trades and more than 50% of daily volume during the whole test period, and their dominant role further increases during and after the financial crisis. In sharp contrast, large trades are much less active and account for less than 0.1% of daily trading. Fourth, differing from the evidence of stealth trading on individual securities, small trades do not play a significant role in daily price movement. The results suggest that investors trading ETFs do so mainly for liquidity and portfolio rebalance considerations rather than for private information. Finally, a clearly U-shaped daily trading volume pattern exists for all ETFs. For the benchmark ETFs, the trading in the first and last hour accounts for 44.5% of daily volume, whereas it accounts for 48.4% of daily volume for leveraged ETFs and 48.0% for leveraged inverse ETFs. All ETFs experience an L-shaped volatility pattern. The volatility at market opening is substantially larger than all other periods and plunges immediately after 30-mintues. In addition, price volatility of leveraged and leveraged inverse ETFs is substantially larger than that of the matched benchmark ETFs, especially during the first 30 minutes at stock market open.

Notes

1 "ETF Landscape Industry Review," ETF Research and Implementation Strategy, Barclays Global Investors, October 2009.

2 The first four leveraged ETFs were introduced to the market by Proshares on June 19, 2006. These ETFs include QLD, DDM, SSO, and MVV, which track the Nasdaq 100, Dow 30, S&P 500, and S&P MidCap 400 indices, respectively, and are supposed to double the daily return of the tracking index. Then, on July 11, 2006, Proshares offered four leveraged inverse ETFs, QID, DXD, SDS, and MZZ, which track the same four aforementioned indices but double the daily return of the tracking index during a bear market. The benchmark ETF tracking the S&P 500 index (SPY) was the first ETF in the U.S. equity market and was offered by State Street on January 29, 1993. The benchmark ETFs that track the Dow 30, Nasdaq 100, and S&P MidCap 400 are DIA, QQQQ, and IJH, respectively. See Table 1 for detailed information for all matched triplet ETFs used in this study.

3 "Exchange Traded Funds: maximizing the opportunities for institutional investors," VisionFocus, State Street, December 2009.

4 Alexandar and Peterson (2007) compare trade data with order data for a sample of NYSE stocks and find that the results based on trade and order data are qualitatively similar.

5 Hegde and McDermott (2004) analyze how the introduction of ETFs affects the market's liquidity for underlying stocks. They find that the liquidity of Dow 30 composite stocks improved after the introduction of DIA but the effect of the introduction of QQQQ on the liquidity of Nasdaq 100 composite stocks was weak.

6 Henker and Martens (2010) analyze the information link between basket securities and the underlying stocks and find that the price of the portfolio of underlying stocks leads and is more informative than the basket price.

7 Chordia, Roll, and Subrahmanyam (2010) report that the average monthly turnover ratio of the stocks included in the S&P 500 index was 12.4% during 2001–2008 and reached the highest point of about 45% in 2008.

8 The following is a list of $-1\times$ ETFs that track the indexes/sectors included in our sample: PSQ-Nasdaq 100, DOG-Dow 30, SH-S&P 500, MYY-S&P MidCap400, RWW-Russell 2000, SBB-S&P Small Cap 600, SEF-Financial sector, and DDG-Oil & Gas sector.

9 Note that the trading activities analyzed in the current project do not include redemption and recreation of ETF shares, because most public investors cannot engage in redemption or recreation of ETFs and only qualified investors can redeem ETFs and only ETF trusts can recreate additional ETF shares.

10 As reported in Table 1, the average daily trading volume and age for the benchmark ETFs is \$1.8 billion and 8.5 years, compared with \$111.8 million and 1.6 years for the leveraged ETFs, and \$293.1 million and 1.6 years for the leveraged inverse ETFs. In addition, the unreported results show that the average size of benchmark ETFs

measured by total assets under management is $6.9 billion, whereas it is only $290.5 million and $333.1 million for the leveraged and leveraged inverse ETFs, respectively.

11 Trainor and Baryla (2008) show that a typical double leveraged (2×) ETF is likely to only magnify the index return by 1.4 times on an annual basis for holding periods out to ten years. Salisbury (2010) shows that ETFs missed their targets by an average of 1.25% points in 2009. Cheng and Madhavan (2009); Guedj, Li, and McCann (2010); and Barnhorst and Cocozza (2011) provide detailed explanations on the path-dependence of leveraged ETF returns and divergence from the returns of tracking index.

12 We are aware that benchmark ETF return is likely different from the tracking index return because of tracking errors. However, our focus here is on how the trading volume of ETFs in the same triplet is correlated after controlling for factors such as market wide price movement and market conditions. Thus, for convenience, we use the benchmark ETFs return instead of the tracking index return and this does not have any material effects on our results.

13 See Warner et al. (1988), Meulbroek (1992), and Chung et al. (2005) for a description of this method.

14 For brevity, these results are unreported, but are available from the authors upon request.

15 Although many studies use the same classification method (see e.g., Barclay and Warner, 1993; Boehmer and Boehmer, 2003), this classification is still arbitrary because there is no standard classification. We also classify trade size based on dollar trading volume as "small" if trade size is equal to or less than $10,000, "medium" if the trade size falls between $10,001 and $199,999, and "large" if trade size is greater than $200,000 (see Bessembinder and Kaufman, 1997). The results are qualitatively similar and therefore omitted for brevity.

16 To provide additional evidence on the standard deviation of the triplet ETFs, we calculate standard deviation of daily returns based on quoted midpoint and opening price. The unreported results show that the standard deviations of daily return based on quoted midpoint are 1.9%, 3.7%, and 3.8% for the benchmark ETFs, leveraged ETFs, and leveraged inverse ETFs, respectively. The standard deviations of daily return based on opening price are 2.0%, 4.0%, and 4.0% for the benchmark ETFs, leveraged ETFs, and leveraged inverse ETFs, respectively. Thus, the substantially larger standard deviations for the leveraged and leveraged inverse ETFs are also attributable to the use of high frequency data for computing standard deviation.

17 In addition to the panel data regressions, we also conduct OLS regression for each ETF and compute the mean values of regression statistics and mixed effect regressions for robustness tests. The results are qualitatively similar to the panel data regressions. For brevity, these results are not reported but available from the authors upon request.

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