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Overreaction of Exchange-Traded Funds During the Bubble of 1998–2002

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This study of overreaction is motivated by the unique characteristics of exchange-traded funds (ETFs), which should contribute to market efficiency. Since ETFs represent portfolios of stocks, they may not be as susceptible to short-term overreaction as individual stocks. In addition, they can be traded throughout the day and can be sold short, which might further limit potential overreaction. Yet, the tradability of ETFs may allow unusual pressure on ETF prices that is not initiated by price movements of all the component stocks.

We find substantial overreaction of ETFs during normal trading hours (9:30 a.m. to 4 p.m.) and after hours, which presents opportunities for feedback traders. Extreme price movements of ETFs occur more frequently after hours. Yet, the after-hours correction of extreme price movements that occurred that day is more pronounced than the day correction of extreme stock price movements that occurred in the previous after-hours period, even after controlling for ETF type and other potential confounding effects. The degree of overreaction is also more pronounced for international ETFs.

The phenomenon of under/overreaction cuts directly to the heart of market efficiency. If markets are truly efficient, all relevant information should be immediately and fully reflected in the stock price. Underreaction indicates this is not the case; information is instead incorporated over a period of time. Overreaction, on the other hand, suggests that stock prices consistently overshoot, and their reversals can be predicted from past price movements.

A study of broad market indices by Richards [1997] finds evidence of overreaction. In the past, such inefficiencies were not exploitable because indices were not actively traded. Today, however, the advent of exchange-traded funds (ETFs) makes further study appropriate. In contrast with stock market indices of the past, ETFs offer investors the opportunity to actively trade the market. In the past, investors who sought to invest in the "market" could choose mutual funds that mirrored their index of choice. However, mutual fund investors can only transact once per day at the closing net asset value (NAV) set by the fund manager. Unlike mutual funds, ETFs are traded on exchanges throughout the day at prices set by the market. They also allow investors to sell securities short without the constraint of the "uptick" rule. ETFs should be properly priced by the market since they are not subject to constraints on intraday trading and short sales.

This article attempts to determine whether ETFs are subject to particular forms of overreaction. We also assess whether the pricing behavior of ETFs during normal hours differs from after hours. Most of the after-hours trading occurs in a ninety-minute night session just after the normal trading hours, and a ninety-minute early morning session preceding the next day's normal trading hours. The normal and after-hours periods, distinguished by their respective levels of liquidity and trading behavior, could experience different degrees of overreaction.

We do find substantial overreaction of ETFs during the normal and after-hours trading periods. Furthermore, much of the reversal (correction) occurs in the trading period immediately following the ETF's extreme stock price movements, which are more prevalent after hours.

However, the after-hours reversals of extreme price movements during normal trading hours are more pronounced than the normal period reversals that occurred in the previous after-hours period. This implies that the extreme stock price movements during the day reflect a greater degree of overreaction than those in the after hours period. In addition, the degree of overreaction is more pronounced for international ETFs. These results hold even after controlling for other factors.

The remainder of the paper is organized as follows: The second section discusses the literature related to overreaction. The third section presents our hypotheses, and the fourth section provides the research design. The fifth section presents the results and the final section offers conclusions.

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Literature Review

Our theories about the pricing of ETFs are based on 1) theoretical studies that explain mispricing, and 2) empirical research on under- or overreaction.

Theory of Over- or Underreaction

Poterba and Summers [1988] suggest that transition periods may exist when stock prices deviate from their fundamental values in illogical ways. Some research may explain the deviations, such as Griffin and Tversky [1992], who suggest that people tend to place too much emphasis on the strength of new information. When applied to stock valuation, this theory may explain why investors overreact to rumors or to facts.

Daniel, Hirshleifer, and Subrahmanyam [1998] present a version of the investor overconfidence theory, which suggests that individuals overestimate the value of information they generate privately and underestimate publicly available information. Tversky and Kahneman [1974] show that the heuristics used by individuals to make decisions under uncertainty may result in "systematic errors" (p. 1124). In violation of Bayes' rule, individuals do not consider prior probabilities when making their assessments, but rather arrive at subjective probabilities of occurrence based on how similar, or "representative," the event is to their preconceived notions. This representativeness heuristic can lead investors to drive values beyond their correct valuations, resulting in the empirical phenomenon of overreaction documented here.

Possible under- or overreaction attracts feedback traders who may attempt to arbitrage the mispricing. Cutler, Poterba, and Summers [1990] suggest that stock price behavior may be influenced by feedback traders who trade based on recent price movements rather than fundamental factors. If stock market pricing can't be explained by fundamentals, feedback traders can capitalize on price movements that deviate from the fundamental values, providing support for studies finding evidence of overreaction.

Barberis, Shleifer, and Vishny [1998] acknowledge the possibility of feedback traders. But they believe that investors who attempt to correct mispricing risk the possibility that it will not be corrected, at least in the short run. That is, even if a price has deviated from its fundamental value, it may stray farther until there is sufficient force from feedback traders to correct it.

Empirical Research on Over- and Underreaction

Overreaction has been researched in the context of individual stocks as well as market indices, with mixed results. Most overreaction studies identify stocks as winners and losers on the basis of past price performance, and then track subsequent abnormal gains to the winner and loser portfolios. Positive (negative) cumulative abnormal returns following large positive (negative) price movements indicate underreaction, while reversals of returns indicate overreaction. DeBondt and Thaler [1985] find that, thirty-six months after portfolio formation, loser portfolios outperform the market on average, while winner portfolios underperform on average. Most of the overreaction is in the second and third year following portfolio formation.

Jegadeesh [1990] examines market efficiency and the serial correlation of returns. He finds significant negative first-order serial correlation in monthly stock returns and significant positive serial correlation in twelve-month returns, suggesting overreaction in the short term and underreaction in the long term. Similarly, Chan [2003] cites many studies that document a long-term drift following specific events, which he attributes to underreaction.

A related issue is how the degree of overreaction may depend on the market of concern. Da Costa [1994] finds that Brazilian stocks experience price reversals over two-year periods. Bremer, Hiraki, and Sweeney [1997] find a small degree of overreaction for Japanese loser stocks, but conclude that economic profits are not possible. Richards [1997] documents overreaction of stock market indices when using horizons beyond one year to measure performance, but finds that the degree of overreaction varies among markets.

More recently, a study by Baytas and Cakici [1999] assessed stock market overreaction in seven industrialized markets including the U.S. They find evidence of long-term overreaction for all countries except the U.S. They also find that the degree of overreaction and the characteristics to which it is related vary among countries. In some countries, overreaction is tied to the stock's price level. In others, it is tied to firm size. This study sheds new light on the topic because it suggests that results can vary among markets even when controlling for time period, the model used to identify winners and losers, and the model used to estimate abnormal returns in the subsequent holding period. Results may be partially dependent on the characteristics of a particular market and on the investors who trade there.

Previous research does not offer direct implications for ETFs because, as tradable composites of stocks, they exhibit unique characteristics. This tradability allows for potential arbitrage to eliminate mispricing, and therefore overcomes market imperfections that prevailed when stock indexes were not tradable. Furthermore, none of the previous research assesses the pricing dynamics of ETFs (or stock indexes in general) during the normal versus after-hours trading periods. This study builds on the existing work by testing for overreaction of ETFs and by comparing overreaction during normal hours versus after hours.

Hypotheses

Our hypotheses focus on 1) whether ETFs are subject to overreaction, 2) whether the overreaction is conditional on the trading period, and 3) how the degree of overreaction is conditional on ETF-specific characteristics.

Overreaction of ETFs

Because an ETF represents a portfolio of stocks, it may be less susceptible to unusual share price jumps that reflect overreaction. The ease of trading ETFs in an open market allows for quick correction if the price strays from its proper value. Access to intraday trading without short-sale constraints should allow investors to take advantage of predictable mispricing in the market. Thus, ETF prices should reflect all available information. Our null hypothesis is that ETFs will not experience overreaction.

We also consider a counter hypothesis. ETFs enable investors to easily take positions in stock composites, which could allow for more rapid and volatile price movements of those composites. The ease of trading may increase participation by uninformed or "noise" traders. Kyle [1985] describes a scenario where the presence of uninformed traders provides depth to the market and allows informed traders to "hide." Extending his work to the overreaction hypothesis, we suggest that informed traders will benefit at the expense of uninformed traders' mispricings, causing the overreaction of noise traders to be systematically corrected by informed traders.

DeLong et al. [1990] describe the market as a contest between noise traders driven by market sentiment and arbitrageurs with rational expectations. Consequently, the price of an asset may deviate from its fundamental value. This theory may also explain the behavior of a tradable asset that reflects a sector or a market. That is, the pricing of an asset like an ETF that represents a sector or a market is also subject to the dynamics between noise traders and arbitrageurs, causing the price to stray from its fundamental valuation. Accordingly, our alternate hypothesis is that ETFs will experience overreaction and subsequent reversals (corrections). We test this hypothesis by identifying large stock price movements in ETFs and measuring abnormal returns after those movements.

Overreaction During Normal Trading Hours versus After Hours

Our null hypothesis is that a large stock price movement of an ETF during normal trading hours will not elicit a market response after hours. In addition, a large stock price movement of an ETF after hours will not elicit a market response in the following normal trading period. The null hypothesis is based on the premise that trading behavior during normal hours is similar to trading behavior after hours. If the same types of traders trade during normal hours and after hours, any price discrepancy occurring during one period should be corrected within that period. Under these conditions, large stock price movements of ETFs in one period should not be followed by a predictable adjustment in the next period.

If, however, trading behavior during normal hours is distinctly different from that after hours, an ETF with an extreme stock price movement in one period may experience a reversal in the next. This theory does not require that all informed traders participate strictly during normal hours or after hours. Instead, it suggests that noise traders and feedback traders may trade in either period. However, extreme stock price movements that reflect price discrepancies may occur in one period, but not be corrected in that period. Consequently, a different set of feedback traders transacting in the following period may be able to capitalize on (and therefore correct for) those price discrepancies. In essence, feedback traders trading after hours may exploit price discrepancies caused earlier by noise traders that have not yet been corrected. Similarly, feedback traders may exploit price discrepancies during normal trading hours that were caused by noise traders in the previous after-hours period that have not been corrected.

Normal and after-hours periods may rightfully be considered as two separate markets because of differences in liquidity and types of market participants.[1] The liquidity of a security can change within the day in a given market (see Stoll and Whaley [1990] and Foster and Viswanathan [1993]), and can vary among markets. The average trading volume per after-hours period is 70 million shares, versus 1.2 billion traded each day on the New York Stock Exchange.[2]

Barclay and Hendershott [2004] suggest that the after-hours market is characterized by less volume than regular trading sessions. They estimate the implied bid-ask spread using Roll's [1984] measure, and find that after-hours trades are more costly than those made during the regular trading sessions. By assuming that liquidity-motivated traders will choose to trade during the less expensive day session, they conclude that the after-hours market has a higher proportion of informed traders to uninformed traders than the normal day market.[3]

Cox and Peterson [1994] show how overreaction can vary among U.S. stock exchanges due to liquidity differences. Richards [1997] shows how overreaction can vary among country markets, which he attributes to differences in liquidity and stock volatility. Baytas and Cakici [1999] document how overreaction can vary among markets when each country's stocks are traded on a separate market.

We extend the definition of markets from stock exchanges within the U.S. or across national borders to different trading sessions within a twenty-four-hour period. ETFs may be subject to different trading behavior and liquidity during normal trading hours versus after hours. Thus, after-hours trading may correct for unusually large price movements of ETFs that occurred during normal trading hours, and trading during normal hours may correct for unusually large price movements of ETFs that occurred in the previous after-hours period. This is because an extreme stock price movement of an ETF during normal hours may be viewed as excessive by feedback traders who trade after hours, and vice versa. We investigate separately the market efficiency of ETFs during normal trading hours and after hours.

ETF-Specific Characteristics That May Affect the Degree of Overreaction

We expect the degree of overreaction of an ETF to be conditional on the following characteristics specific to the ETF.

Size of trigger. According to Daniel, Hirshleifer, and Subrahmanyam [1998], investors place more weight on recent information than on prior information, and overemphasize recent stock price movements, causing overreaction. Thus, a more extreme stock price movement may represent a greater degree of overreaction and lead to a larger reversal.

Trading volume. More liquid ETFs should be less susceptible to mispricing because a sufficient number of investors are involved. Conversely, less liquid ETFs may be more susceptible to mispricing, since there may be fewer informed traders who maintain prices at or near their fundamental values.

Cox and Peterson [1994] identify liquidity as a significant factor in explaining reversals of returns. After controlling for the bid-ask bounce and market liquidity, they find no evidence of overreaction. If our findings of overreaction are primarily driven by the effects of market liquidity, we would expect it to be the dominant force in explaining the cross-sectional variation in degree of overreaction among ETFs.

Volatility. More volatile ETFs are more likely to overreact. Richards [1997] makes a similar argument for stock indexes over a long-term period, but more volatile stocks may also be more susceptible to mispricing in the short run.

Type. ETFs are classified as international, sector, or broad-based. Broad-based ETFs may be less susceptible to temporary mispricing (and therefore to overreaction) because they represent widely diversified portfolios of U.S. stocks. International ETFs may be more susceptible to mispricing because they may exhibit more price sensitivity to other systematic factors such as the foreign country or currency, for which information is less readily available.

Research Design

Our tests of overreaction require the following elements of a research design:

1. *The type of securities assessed.* Related studies vary substantially in terms of the types of securities assessed. Atkins and Dyl [1990] focus on large stocks traded on the New York Stock Exchange; Bremer and Sweeney [1991] assess Fortune 500 stocks. Cox and Peterson [1994] include smaller stocks traded on the Nasdaq market. Foreign stocks have also been assessed: Da Costa [1994] focuses on Brazilian stocks, and Bremer, Hiraki, and Sweeney [1997] on Japanese stocks.

The overreaction of stock indexes has also been tested. Richards [1997] focuses on extreme stock price movements of stock indexes. Our focus on a sample of ETFs is closely related to studies on stock indexes, but is different in that the tradability of ETFs allows investors to capitalize on any pricing discrepancies.

2. *The time horizon used to measure the extreme stock price movement.* The horizon has ranged from one day (Atkins and Dyl [1990], Bremer and Sweeney [1991]) to three years (DeBondt and Thaler [1985] and Richards [1997]). We use two separate time horizons: normal trading hours and the after-hours period. The day period represents normal trading hours (9:30 a.m. to 4 p.m.); after-hours reflects the period from the close of normal trading hours (4 p.m.) to the open of normal trading hours the next day (9:30 a.m.). Thus, the two periods together encompass a total of twenty-four hours.

3. *The size of the stock price movement (also called the "trigger").* For a one-day horizon, the typical minimum trigger to qualify for a sample in other studies is 10% for individual stocks. We use a minimum of 5%, since ETFs represent stock composites and should not be as volatile as individual stocks.

4. *The time horizon used to test for a correction.* This horizon is usually matched with the time horizon in which the extreme stock price movement is measured to qualify for the sample. For our sample, the time horizon is either the after-hours period following earlier extreme price movements during normal trading hours, or the normal hours following extreme price movements during the previous after-hours period.

5. *The method of measuring abnormal stock price movement.* Most studies testing short-term overreaction of stocks use the market model (Atkins and Dyl [1990]), the market-adjusted returns model (Da Costa [1994]), the mean-adjusted returns model (Cox and Peterson [1994]), or all three models to derive abnormal returns.

Since ETFs represent stock composites, they sometimes represent an entire market, and so the market model is not applicable. Consequently, we apply the mean-adjusted returns model to measure abnormal stock price movements in the period after the trigger is identified.

Data

Exchange-traded funds gained popularity during the bubble of 1998–2002. Although the SPDR, Standard & Poor's depository receipt (ticker symbol SPY), has been in existence since 1993, more focused ETFs, such as sector funds and international funds, have only recently been introduced.

ETFs in general are passively managed mutual funds designed to mirror indices. They trade around the clock on exchanges such as the American Stock Exchange (AMEX). Regular mutual fund investors can only transact once daily at the 4 p.m. closing net asset value (NAV). Furthermore, ETFs are unique in that investors have access to an arbitrage mechanism where, in the event of market mispricing or supply and demand imbalances, units of 50,000 shares of the ETF can be exchanged for the underlying assets and vice versa.

Our sample includes observations of daily opening and closing prices for AMEX-traded ETFs between August 1998 and August 2002. This period encompasses most of the trading of ETFs. The entire sample consists of 1,989 extreme ETF price changes that satisfy the minimum 5% trigger level. The numbers of extreme price increases (winners) and decreases (losers) across normal and after-hours periods by different types of ETFs are shown in Panel A of Table 1. As Panel B shows, of the entire sample, 1,035 (52%) are winners, and the remaining 954 (48%) are losers. A total of 268 observations (13%) qualify during the normal day period versus 1,721 (87%) after hours.

The sample is further segmented by ETF type. Again, these are classified as broad-based, sector, or international, and allow investors to add exposure to various segments of the market. Broad-based funds like the SPDR or the Nasdaq-100 Index Tracking Stock (ticker symbol QQQ) allow investors to allocate portions of their portfolios to diversified equities with minimal transaction costs. Sector funds like the iShares Dow Jones US Financial Sector fund (ticker symbol IYF) or the Select Sector SPDR Technology fund (ticker symbol XLK) allow investors to shift asset allocation to specific sectors of the equity market and yet remain diversified. Finally, international ETFs like the iShares MSCI EAFE fund (ticker symbol EFA) or the iShares MSCI Japan fund (ticker symbol EWJ) allow investors to gain exposure to international markets on a broad scale (EFA) or on a more focused scale (EWJ).

By definition, sector funds and international funds are more focused and less diversified than their broad-based counterparts. Our data show that the majority of extreme price movements are concentrated among the sector ETFs and the international ETFs. Panel B of Table 1 shows that 51% of the 268 extreme price movements during the day are attributed to international ETFs, and 43% are attributed to sector ETFs. Similarly, 38% and 45% of the 1,721 after-hours observations are attributed to international and sector ETFs, respectively. Of the 798 international ETF observations in our sample, 55% are winners and 45% are losers.

The specific proportion of normal hours observations versus after-hours observations varies by ETF

Table 1. *Distribution of Sample that Satisfies the 5% Trigger*

Panel A: Distribution of Winners and Losers across Days and After hours. Italicized are the percentage of total extreme price movements from far right column.

	Winners		Losers		
	Day	After hours	Day	After hours	Total
International ETFs	91 (11%)	346 (43%)	46 (6%)	315 (39%)	798 (100%)
Sector ETFs	61 (7%)	382 (43%)	55 (6%)	391 (44%)	889 (100%)
Broad-based ETFs	7 (2%)	148 (49%)	8 (3%)	139 (46%)	302 (100%)
Entire sample	159 (8%)	876 (44%)	109 (5%)	845 (42%)	1989 (100%)

Panel B: Distribution of Subsamples across Type of ETF. Italicized are the percentage of entire sample from bottom row.

	Total Day	Total After Hours	Total Winners	Total Losers
International ETFs	137 (51%)	661 (38%)	437 (42%)	361 (38%)
Sector ETFs	116 (43%)	773 (45%)	443 (43%)	446 (47%)
Broad-based ETFs	15 (6%)	287 (17%)	155 (15%)	147 (15%)
Entire sample	268 (100%)	1721 (100%)	1035 (100%)	954 (100%)

Note: The sample of ETF returns over the day and after hours periods is screened for a gain of at least 5% (winners) or lower than -5% (losers). Italicized numbers are the percentage of the total extreme price movements in the far right column.

type, but the after-hours observations dominate for each type. One explanation for this is that the underlying stocks in the international ETFs are traded on foreign stock exchanges after normal U.S. trading hours. Thus, large price movements of international ETFs after hours in the U.S. may reflect large price changes of the underlying foreign stocks that are being traded on foreign stock exchanges at that time. But this phenomenon would not explain the dominance of after-hours observations in the subsamples of U.S. broad-based and sector ETFs.

The high frequency of after-hours observations that qualify for the sample suggests that more pronounced movements in ETF prices occur after hours. Whether such a difference implies a greater degree of overreaction in one period versus the other can only be determined empirically.

Methodology

To identify the existence of overreaction following a large price movement, we first identify the expected reaction following such a move. We use a mean-adjusted expected return and a time-series standard deviation test following Brown and Warner [1980].[4] Expected returns ($\bar{R}$) are calculated using a 255-day estimation period ending fifteen days prior to the event, and are required to have at least ninety useable returns in the estimation period.

Expected returns for ETFs during normal trading hours are based on returns that occur during normal trading hours over the estimation period, while expected returns of ETFs after hours are based on returns after hours over the estimation period. This allows for possible differences between average returns during the day period versus after hours. The abnormal return in the twenty-four-hour period following each trigger is the mean-adjusted return using close-to-close prices following a trigger during normal trading hours and open-to-open prices following a trigger after hours. Therefore, the twenty-four-hour period following normal trading hours (in which a winner or loser ETF is identified) represents the following after-hours period and subsequent normal trading period; the twenty-four-hour period following a trigger after hours represents the following day and after-hours periods. The test statistic for abnormal returns is measured based on the "crude dependence adjustment" of Brown and Warner [1980].

Cross-Sectional Analysis

The abnormal returns following extreme price movements are conditional on the following characteristics: 1) the period assessed (normal versus after hours), 2) the size of the extreme return (trigger) of the ETF, 3) the type of ETF, 4) the volatility of the ETF, and 5) the volume of the ETF. An extreme stock price movement is classified according to whether it occurred in the day or after hours with a dummy variable. The trigger is measured as the return that allowed the ETF to qualify for the sample based on the +5% or –5% threshold levels. Each ETF is classified as international, sector, or broad-based. The three types are separately coded using dummy variables representing international ETFs and sector ETFs. ETF volatility is measured as the standard deviation of returns over the past ninety days. An ETF's liquidity is measured as the average daily trading volume in the period in which the trigger occurred.

We apply the following multivariate model to all winners and losers to test for the significance of the trading period (normal versus after hours) while controlling for the other variables:

$$AR_j = \beta_0 + \beta_1 AFTERHOURS + \beta_2 TRIGGER + \beta_3 INTLDUM + \beta_4 SECTDUM + \beta_5 VOLAT + \beta_6 VOLUME + \varepsilon$$

where:

AR =	abnormal return during the period following the extreme return,
$AFTERHOURS$ =	the dummy variable, with a value of 1 if the extreme stock price movement occurs after hours and 0 otherwise,
$TRIGGER$ =	return of the ETF; must be > +5% or < –5% in a normal or after-hours period,
$INTLDUM$ =	the dummy variable, with a value of 1 if the ETF is an international fund and 0 otherwise,
$SECTDUM$ =	the dummy variable, with a value of 1 if the ETF is a sector fund and 0 otherwise,
$VOLAT$ =	the standard deviation of returns over the past ninety days for the ETF, and
$VOLUME$ =	the natural logarithm of the volume of shares traded for the ETF.

The model is tested for heteroskedasticity and corrected using White's [1980] test.

We also adapt the multivariate model to assess the cross-sectional variation in abnormal returns of the normal (day) and after-hours samples separately. In this case, the after-hours dummy variable does not apply and is excluded from the model. Since this particular analysis includes winners and losers in the same sample, a dummy variable, *LOSDUM*, is included to distinguish losers from winners. It is assigned a value of 1 if the extreme price movement represents a loss and 0 otherwise.

The coefficients in the analysis are restricted to be the same regardless of ETF type. To obtain estimates of coefficients for each type, we repeat the analysis separately for each subsample of ETFs by type. The dummy variables representing the type of ETF are not applicable for this analysis since all ETFs in each subsample are classified as the same.

Results

We first report the results for the estimation of abnormal returns following the extreme price movements of ETFs, and then for the cross-sectional analyses of abnormal returns.

Abnormal Returns for the Entire Sample

Column 1 of Table 2 shows the abnormal returns associated with the extreme stock price changes of ETFs that occurred during the day for the entire sample of winners and losers and the various subsamples. The abnormal returns following day triggers are shown in the third, fourth, and fifth columns, according to whether the extreme stock price change reflects a gain (winner) in Panel A or a loss (loser) in Panel B. For winners and losers, the results are shown for trigger levels of at least 5%, at least 6%, and at least 7%. The sample size is reduced when the minimum trigger level is higher.

Abnormal Returns After Hours Following Day Winners

Table 2 shows the abnormal returns of ETFs for the after-hours period (third column) following the day in which the extreme stock price movement occurred, and column 4 shows the returns for the following day period. These two periods comprise the twenty-four-hour period following the day when the extreme changes occurred, and results for this twenty-four-hour period are shown in the fifth column. The sixth column shows the proportion of the extreme stock price movement that is reversed in the subsequent period.

As shown in Panel A of Table 2, the day period winners experience a significant negative abnormal return after hours, regardless of the trigger level. At least 75% experienced negative abnormal returns after hours. Thus, the general results here are not due to outliers. The reversal after hours suggests that the extreme stock price movements during the day reflect an overreaction.

Notice in the sixth column that more than 50% of the mean extreme stock price movement of winners is reversed for the subsamples partitioned by different minimum trigger levels. Overall, a strong response follows an extreme stock price movement during the day. Apparently, some investors behave as feedback

Table 2. *Full Sample Abnormal Returns Following Day Triggers*

	Day (Period 0)	After hours (Period 1)	Day (Period 2)	24 Hour (Periods 1–2)	Proportion of the Overreaction Reversed in the Following Period (Pd 1 AR / Pd 0 AR)
Panel A. Winners					
Trigger > 5% (N = 159)	6.75	–3.69	–0.7	–4.28	54.67%
	(24.710)****	(–6.865)****	(–2.547)***	(–10.113)****	
	100%:0%	25%:75%	38%:62%	14%:86%	
Trigger > 6% (N = 77)	8.2	–4.21	–0.93	–5.09	51.34%
	(18.854)****	(–5.340)****	(–2.143)**	(–8.277)****	
	100%:0%	21%:79%	37%:63%	16%:84%	
Trigger > 7% (N = 45)	9.52	–4.99	–1.15	–6.13	52.42%
	(18.222)****	(–5.559)****	(–2.203)**	(–8.108)****	
	100%:0%	18%:82%	30%:70%	15%:85%	
Panel B. Losers					
Trigger < –5% (N = 109)	–6.61	6.59	0.16	6.82	99.70%
	(–18.645)****	(9.189)****	(0.439)	(12.213)****	
	0%:100%	94%:6%	60%:40%	96%:4%	
Trigger < –6% (N = 53)	–7.8	8.28	–0.22	8.02	106.15%
	(–14.663)****	(8.383)****	(–0.417)	(10.341)****	
	0%:100%	94%:6%	49%:51%	96%:4%	
Trigger < –7% (N = 27)	–8.93	8.47	0.34	8.75	94.85%
	(–13.780)****	(6.811)****	(0.519)	(9.131)****	
	0%:100%	93%:7%	62%:38%	96%:4%	

Note: Comparison period-adjusted abnormal returns are reported using a 255 day estimation period which ends 15 days prior to the large price move and require 90 days of usable returns. The t-statistics in parentheses are adjusted using the crude dependence adjustment. Proportion of positive observations:proportion of negative observations shown in italics.

*, **, ***, and **** indicate significance at the 10%, 5%, 1%, and 0.1% levels, respectively using a 1-tailed test for significance.

traders after hours and capitalize on the overreaction of ETFs that occurred earlier in the day.

One could argue that the correction after hours is wrong, and therefore does not verify that the earlier extreme price movement was an overreaction. Yet, abnormal returns continue to be negative and significant during the following day. More than 80% of the corrections over the twenty-four hours following the extreme movement during the day occur after hours.

Comparison of After-Hours Reversals among Trigger Levels

The size of the reversal after hours during the following normal day period, and over the combination of those two periods, is more pronounced when a larger trigger level is used. For example, the ETFs that qualify for a +5% trigger experience a mean abnormal return of –3.69% after hours, while the ETFs that qualify for a +7% trigger experience a mean abnormal return of –4.99%. Similar results hold for the twenty-four-hour period following the day when the extreme stock price movement occurred.

Abnormal Returns After Hours Following Day Losers

As shown in Panel B of Table 2, the normal day period losers experience a significant positive abnormal return after hours, regardless of the trigger level. While results vary with the minimum trigger level used, at least 93% experienced positive abnormal returns after hours. These findings confirm market overreaction by the day loser ETFs. The abnormal returns during the following day are not significant.

For ETFs that qualify for the –5% trigger level, the mean abnormal return after hours is about equal to the mean extreme stock price movement that occurred earlier in the day. For the ETFs that qualify for the –6% or –7% trigger levels, the abnormal return after hours exceeds the extreme movement, on average. Thus, on average, the gain after hours completely offsets the loss during normal trading hours.

As with winners, the size of the reversal for losers after hours is more pronounced when the losers qualify for the higher trigger (larger loss) level. Note from the sixth column that at least 90% of the extreme stock price movements of losers is reversed for the subsamples partitioned by different trigger levels.

Abnormal Returns during the Day Following After-Hours Winners

Table 3 shows the abnormal returns following extreme stock price changes of ETFs that occur after hours for the overall sample. Results are segmented according to whether the extreme change reflects a gain (winner) in Panel A or a loss (loser) in Panel B, and are also segmented according to trigger level. The abnormal returns of ETFs are shown for the day period (third column) following the after-hours period in which the extreme stock price movement occurred, and are shown for the following after-hours period (fourth column) as well. These two periods comprise the twenty-four-hour period following the after-hours period in which the extreme changes occurred, and results for this period are shown in the fifth column. The sixth column shows the mean proportion of the extreme movement after hours that is reversed during normal hours the following day.

As shown in Panel A of Table 3, after-hours winners experience a significant negative abnormal return the next day, regardless of trigger level. For the –5% trigger, 82% of after-hours winners experienced negative abnormal returns the following day.

Abnormal Returns during the Day Following After-Hours Losers

As shown in Panel B of Table 3, after-hours losers experience a significant positive abnormal return the following day, regardless of trigger level. As the sixth column shows, for ETFs that qualify for the –5% trigger level, the abnormal return represents about a 39% reversal on average.

Comparison of Abnormal Returns between Day and After-Hours Winners

A comparison of the magnitude of reversal between the normal day and after-hours periods is shown in Table 4. For day winners qualifying for the 5% minimum trigger, the mean reversal after hours is –3.69%; for after-hours winners, the following day reversal is –1.93% on average. The mean difference between the two types of reversals is –1.76%, with a t-statistic of –4.194 and significance at the 0.001 level.

Thus, the degree of overreaction of ETF winners during the day is more pronounced than the degree of overreaction of ETF winners after hours. In other words, the after-hours correction of ETFs that experience extreme stock price gains during the day is more pronounced than the day correction of ETFs that experienced extreme gains during the previous after-hours period. For the 6% trigger level, the t-statistic from testing the difference in day and after-hours reversals is –2.703, which is significant at the 0.01 level. For the 7% trigger level, it is –2.056, significant at the 0.05 level.

Comparison of Abnormal Returns between Day and After-Hours Losers

A comparison of the magnitude of reversal between the day and after-hours periods is also conducted for los-

Table 3. *Full Sample Abnormal Returns following After Hours Triggers*

	After hours (Period 0)	Day (Period 1)	After hours (Period 2)	24 Hour (Periods 1–2)	Proportion of the Overreaction Reversed in the Following Period (Pd 1 AR / Pd 0 AR)
Panel A. Winners					
Trigger > 5% (N = 876)	7.02	–1.93	1.82	–0.19	27.49%
	(21.954)****	(–12.688)****	(5.68)****	(–0.706)	
	100%:0%	18%:82%	70%:30%	45%:55%	
Trigger > 6% (N = 474)	8.33	–2.29	2.21	–0.19	27.49%
	(20.715)****	(–11.804)****	(5.497)****	(–0.573)	
	100%:0%	17%:83%	71%:29%	46%:54%	
Trigger > 7% (N = 288)	9.5	–2.75	2.61	–0.32	28.95%
	(18.673)****	(–11.065)****	(5.128)****	(–0.746)	
	100%:0%	18%:82%	71%:29%	44%:56%	
Panel B. Losers					
Trigger < –5% (N = 835)	–6.97	2.74	–1.51	1.16	39.31%
	(–24.114)****	(19.855)****	(–5.232)****	(4.734)****	
	0%:100%	89%:11%	39%:61%	62%:38%	
Trigger < –6% (N = 488)	–8.12	3.36	–1.51	1.73	41.38%
	(–20.648)****	(17.442)****	(–3.854)****	(5.211)****	
	0%:100%	92%:8%	42%:58%	67%:33%	
Trigger < –7% (N = 281)	–9.42	4.09	–1.45	2.49	43.42%
	(–18.002)****	(15.811)****	(–2.779)***	(5.734)****	
	0%:100%	93%:7%	47%:53%	72%:28%	

Note: Comparison period-adjusted abnormal returns are reported using a 255 day estimation period which ends 15 days prior to the large price move and require 90 days of usable returns. The t-statistics in parentheses are adjusted using the crude dependence adjustment. Proportion of positive observations:proportion of negative observations shown in italics.
*, **, ***, and **** indicate significance at the 10%, 5%, 1%, and 0.1% levels, respectively using a 1-tailed test for significance.

Table 4. *Test of Difference in Mean Abnormal Returns*

Trigger	AR Following Day Trigger	AR Following After Hours Trigger	Mean Difference	T-Statistic
5% winner	–3.69%	–1.93%	–1.76%	–4.194****
6% winner	–4.21%	–2.29%	–1.92%	–2.703***
7% winner	–5.00%	–2.75%	–2.25%	–2.056**
5% loser	6.59%	2.74%	3.85%	8.764****
6% loser	8.28%	3.36%	4.92%	7.738****
7% loser	8.47%	4.09%	4.38%	3.946****

Note: T-test for difference in means of two samples assuming unequal variance using a two-tailed test for significance. The mean difference is calculated as AR following a day trigger less AR following an after hours trigger.
*, **, ***, and **** indicate significance at the 10%, 5%, 1%, and 0.1% levels, respectively using a 2-tailed test for significance.

ers. For day losers that qualify for the 5% trigger, the reversal after hours is 6.59%, while for after-hours losers the reversal is 2.74%. The mean after-hours reversal of the extreme stock movements of ETFs during the day is about 2.4 times the mean day reversal of extreme stock movements of ETFs after hours. The mean difference between the two types of reversals is 3.85%, with a t-statistic of 8.764 and significance at the 0.001 level.

Thus, the degree of overreaction of ETF losers during the day is more pronounced than the degree of overreaction of ETF losers after hours. As with winners, the after-hours correction of ETFs that experience extreme stock price losses during the day is more pronounced than the day correction of ETFs that experienced extreme losses in the previous after-hours period.

For losers that qualify for the –6% trigger level, the t-statistic from testing the difference in reversals of day and after-hours periods is 7.738, significant at the 0.001 level. For losers that qualify for the –7% trigger level, the t-statistic is 3.946, significant at the 0.001 level. These comparisons offer further support of more pronounced reversals after hours, which implies more pronounced overreaction during the day.

Comparison of Abnormal Returns among ETF Types

Since results may vary by ETF type, the analysis is repeated separately for each type in Table 5. Notice that international ETFs experience significant rever-

Table 5. *Abnormal Returns following Extreme Stock Price Movements for ETF subsamples*

	Day (Period 0)	After Hours (Period 1)	Day (Period 2)	24 Hour (Periods 1–2)
Panel A. Extreme price changes during the day				
Winners				
International ETFs (N = 91)	7.11	–5.14	0.12	–4.98
	(26.853)****	(–11.202)****	(0.468)	(–14.366)****
	100%:0%	10%:90%	47%:53%	10%:90%
Sector ETFs (N = 61)	6.32	–1.87	–1.68	–3.51
	(13.880)	(–2.04)**	(–3.684)****	(–4.786)****
	100%:0%	43%:57%	29%:71%	20%:80%
Broad-based ETFs (N = 7)	6.04	–0.62	–2.51	–2.21
	(6.045)****	(–0.291)	(–2.517)***	(–1.274)
	100%:0%	57%:43%	13%:88%	13%:88%
Losers				
International ETFs (N = 46)	–6.89	6.02	0.20	6.20
	(–18.963)****	(9.159)****	(0.543)	(12.430)****
	0%:100%	96%:4%	55%:45%	96%:4%
Sector ETFs (N = 55)	–6.53	7.09	0.08	7.32
	(–10.766)****	(5.792)****	(0.138)	(7.712)****
	0%:100%	93%:7%	62%:38%	96%:4%
Broad-based ETFs (N = 8)	–5.63	6.45	0.42	6.89
	(–10.704)****	(4.829)****	(0.798)	(6.006)****
	0%:100%	100%:0%	78%:22%	100%:0%
Panel B. Extreme price changes after hours				
Winners				
International ETFs (N = 346)	6.74	–2.45	2.28	–0.26
	(25.095)****	(–15.995)****	(8.491)****	(–1.341)*
	100%:0%	10%:90%	74%:26%	40%:60%
Sector ETFs (N = 382)	7.51	–1.89	1.79	–0.09
	(16.301)****	(–8.092)****	(3.88)****	(–0.229)
	100%:0%	19%:81%	68%:32%	49%:51%
Broad-based ETFs (N = 148)	6.39	–1.07	0.85	–0.29
	(12.640)****	(–4.764)****	(1.687)**	(–0.643)
	100%:0%	28%:72%	68%:32%	48%:52%
Losers				
International ETFs (N = 315)	–7.13	3.25	–2.17	1.00
	(–24.377)****	(19.810)****	(–7.418)****	(4.736)****
	0%:100%	91%:9%	30%:70%	63%:37%
Sector ETFs (N = 391)	–6.97	2.41	–1.65	0.71
	(–18.089)****	(13.257)****	(–4.293)****	(2.106)**
	0%:100%	86%:14%	38%:63%	57%:43%
Broad-based ETFs (N = 139)	–6.58	2.51	0.36	2.74
	(–13.132)****	(11.734)****	(0.713)	(6.038)****
	0%:100%	91%:9%	60%:40%	73%:27%

Note: Comparison period-adjusted abnormal returns are reported (in %) using a 255 day estimation period which ends 15 days prior to the large price move of + and –5% for winners and losers, respectively, and require 90 days of usable returns. The t-statistics in parentheses are adjusted using the crude dependence adjustment. Proportion of positive observations:proportion of negative observations shown in italics.
*, **, ***, and **** indicate significance at the 10%, 5%, 1%, and 0.1% levels, respectively using a 1-tailed test for significance.

sals. The 5% trigger is used again here, but the analysis is also applied to 6% and 7% triggers. The results are qualitatively similar but not reported here.

Panel A shows the results for winners and losers during the day, while Panel B shows after-hours results. The mean reversal following day winners and losers is significant. The reversal following after-hours winners and losers is also significant, but less pronounced. These results are consistent with those found for the entire sample.

Sector ETFs experience a significant reversal. Panel A shows that the reversal of day winners is less pronounced than the reversal of day losers. The reversal following day losers is more pronounced than the reversal following after-hours losers found in Panel B. These results are also consistent with those found for the entire sample.

Broad-based ETF day winners do not experience a significant reversal after hours, but do experience a significant reversal the following day. Broad-based

day losers experience a significant reversal after hours, and both experience significant reversals the following day. Yet the reversal following after-hours losers is less pronounced on average than the reversal following day losers.

A comparison among ETF types is also conducted to determine if the degree of overreaction is more noticeable for a particular type. Table 6 compares the reversals by type within the separate subsamples of day winners, day losers, after-hours winners, and after-hours losers. The 5% trigger level is again used to determine the ETFs that qualify for each sample. The results for the broad-based winner ETFs should be interpreted with caution, however, since only seven qualify as day winners while 148 qualify as after-hours winners.

Panel A of Table 6 summarizes the reversals (as measured by abnormal returns), while Panel B shows two-way comparisons. Panel B shows that the mean reversal of day winners is significantly more pronounced for international ETF day winners than for sector or broad-based ETF winners. For day losers, the mean reversal is significantly larger for international and sector ETFs than for broad-based ETFs.

For after-hours winners, the reversal of international ETFs is significantly more pronounced than for other types, and the reversal of sector ETFs is significantly more pronounced than for broad-based ETFs. For after-hours losers, the reversal is significantly higher for international ETFs than for other types. Overall, the results suggest that international ETFs tend to experience a greater degree of overreaction, leading to a more pronounced correction the following period.

Multivariate Analysis of ETF Winners and Losers

Results of the multivariate analyses of ETF winners and losers are shown in Tables 7 and 8. Table 7 shows results for the entire sample. For winner ETFs, the *AFTERHOURS* dummy variable is positive and significant, indicating that the reversal following an after-hours winner is more favorable (less unfavorable) than the reversal following a day winner. That is, the subsequent correction of after-hours winners is less pronounced than that of day winners. This finding corroborates the earlier comparisons of reversals following extreme gains during the day versus after hours. In addition, the trigger variable is negative and significant.

The coefficient of –0.412 indicates that the reversal (loss) is 41% of the preceding extreme price movement on average, after controlling for other factors. The *INTLDUM* variable is negative and significant, which suggests that the reversal is more pronounced for international ETF winners. This finding corroborates the earlier comparisons of reversals among the three ETF types.

A similar multivariate model is used to assess the entire sample of losers. The *AFTERHOURS* dummy variable is negative and significant, which suggests that the reversal following an after-hours loser is less pronounced than the reversal following a day winner. This finding is consistent with the earlier comparisons of abnormal returns for losers during the day versus after hours. The *TRIGGER* variable is negative and significant with a coefficient of –0.248, suggest-

Table 6. *Comparison of Abnormal Returns by Type of ETF*

Panel A. Summary of Abnormal Returns by Type following a 5% trigger

	International ETF	Sector ETF	Broad-based ETF
Day winners	–5.14%	–1.87%	–0.62%
Day losers	6.02%	7.09%	2.51%
After hours winners	–2.45%	–2.04%	–1.08%
After hours losers	3.25%	2.41%	2.51%

Panel B. Difference in Abnormal Returns (t-statistic in parentheses)

	AR intl–AR sector	AR intl–AR broad	AR sector–AR broad
Day winners	–3.27%	–4.52%	–1.25%
	(–3.80)****	(–4.65)****	(–1.14)
Day losers	–1.07%	3.51%	4.58%
	(–1.16)	(4.66)****	(8.03)****
After hours winners	–0.41%	–1.37%	–0.96%
	(–2.60)***	(–7.62)****	(–5.85)****
After hours losers	0.84%	0.74%	–0.10%
	(3.93)****	(3.21)***	(–0.51)

Note: For each of the four categories defined in the first column, the abnormal returns are displayed in the period following the extreme stock price movement based on a 5% trigger.

*, **, ***, and **** indicate significance at the 10%, 5%, 1%, and 0.1% levels, respectively using a 2-tailed test for significance.

Table 7. *Cross Sectional Regression of AR Following Extreme Price Movements for Full Sample of ETFs*

Sample	Intercept	AFTER HOURS	LOSDUM	TRIGGER	INTLDUM	SECTDUM	VOLAT	VOLUME	Adj-R2
Winners	0.001	0.013		–0.412	–0.013	–0.001	–0.137	0.000	0.2069
(N = 1035)	(0.13)	(3.49)****		(–5.83)****	(–5.96)****	(–0.41)	(–0.88)	(0.93)	
Losers	0.056	–0.042		–0.248	0.004	–0.002	–0.097	0.000	0.2193
(N = 954)	(6.15)****	(–7.98)****		(–2.20)**	(1.65)*	(–0.77)	(–0.74)	(–0.83)	
Day	0.012		0.012	–0.660	–0.019	0.007	–0.285	0.001	0.5963
(N = 268)	(0.53)		(0.76)	(–5.22)****	(–1.76)*	(0.61)	(–1.18)	(1.07)	
After hours	0.008		0.010	–0.260	–0.002	–0.002	–0.298	0.000	0.5355
(N = 1721)	(1.27)		(0.88)	(–3.10)**	(–1.62)	(–1.54)	(–3.75)****	(–0.76)	

Note: The next-period AR is regressed on the explanatory variables according to the following model. T-statistics in parentheses using standard errors adjusted for heteroskedasticity with White's (1980) adjustment. The *AFTERHOURS* variable is replaced with *LOSDUM* variable for the Day and After hours subsamples.

$$AR_j = \beta_0 + \beta_1 AFTERHOURS + \beta_2 TRIGGER + \beta_3 INTLDUM + \beta_4 SECTDUM + \beta_5 VOLAT + \beta_6 VOLUME + \varepsilon$$

*, **, ***, and **** indicate significance at the 10%, 5%, 1%, and 0.1% levels, respectively using a 1-tailed test for significance.

ing the reversal (gain) is approximately 25% of the preceding extreme price movement.

Multivariate Analysis of Extreme Price Movements

Table 7 shows the results from applying the multivariate model to all the observations where the extreme price movement happened during the day. The *TRIGGER* variable is negative and significant with a coefficient of –0.66, indicating that 66% of the extreme price movement of an ETF during the day is reversed after hours. The same model is estimated for all observations where the extreme price movement happened after hours. While the number of observations is much higher (N = 1,721 versus N = 268), the degree of reversal is lower. The *TRIGGER* coefficient is still negative and significant but the coefficient is –0.26, indicating a 26% reversal.

Cross-Sectional Results by Type of ETF

Since the sensitivity of abnormal returns to factors may vary with ETF type, additional cross-sectional analyses are conducted for each type, with results displayed in Table 8. For the sample of international ETF winners (Panel A), the *AFTERHOURS* dummy variable is positive and significant, which implies that the reversal (loss) is less pronounced for after-hours winners than day winners. The trigger variable is negative and significant, but the other variables are not significant.

For the sample of international ETF losers, the *AFTERHOURS* dummy is negative and significant, which implies that the reversal (gain) following after-hours losers is less pronounced than for day losers. The *TRIGGER* variable is negative and significant, but the other variables are not significant.

For the sector ETF winners (Panel B), *AFTERHOURS* is not significant. *TRIGGER* is negative and significant, which implies larger reversals in response to larger triggers. The *VOLAT* variable is negative and significant, which implies a larger reversal following an extreme stock price movement when the ETF is more volatile. For sector ETF losers, *AFTERHOURS* is negative and significant, implying less reversal for after-hours losers than day losers.

For the broad-based ETF winners (Panel C), the model is not significant, and this is the only subsample for which this is true. For the broad-based losers, *TRIGGER* is negative and significant, consistent with the results found for other subsamples of loser ETFs. In addition, *AFTERHOURS* is negative and significant, which is consistent with the results found for other loser ETFs.

While the sensitivity of abnormal returns to cross-sectional characteristics varies by ETF type, we offer two generalizations. First, the reversal is usually conditional on the size of the trigger, which implies greater overreaction for specific ETFs with more extreme stock price movements. Second, the reversal is more pronounced in response to the extreme price movements that occur during the day than those that occur after hours.

Conclusions

Exchange-traded funds (ETFs) differ from individual stocks because they represent composites of stocks. They differ from stock indexes in that they can be traded continuously in an open market and can even be sold short. The accessibility and ease of trading ETFs allow uninformed investors to take positions in stock composites, which could allow for more rapid and volatile price movements. Our analysis is based on extreme changes in the share price of ETFs that occur

Table 8. *Cross-sectional Regressions of Abnormal Returns following Extreme Price Movements*

Sample	Intercept	AFTER HOURS	LOSDUM	TRIGGER	VOLAT	VOLUME	Adj-R2
Panel A: International ETFs							
Winners	–0.015	0.022		–0.533	–0.242	0.000	0.3115
(N = 437)	(–1.28)	(4.48)****		(–5.81)****	(–1.26)	(1.09)	
Losers	0.008	–0.035		–0.667	–0.251	0.002	0.2785
(N = 361)	(0.41)	(–4.34)****		(–3.69)****	(–0.80)	(1.41)	
Day	–0.025		0.037	–0.546	–0.361	0.002	0.6062
(N = 137)	(–0.81)		(1.72)*	(–3.48)****	(–0.78)	(0.76)	
After Hours	0.011		–0.029	–0.612	–0.195	0.000	0.6487
(N = 661)	(1.19)		(–1.88)*	(–5.21)****	(–0.94)	(1.98)	
Panel B: Sector ETFs							
Winners	0.020	–0.006		–0.259	–0.433	0.000	0.0801
(N = 443)	(1.66)*	(–0.97)		(–2.90)**	(–2.17)**	(–0.57)	
Losers	0.070	–0.050		–0.097	–0.097	0.000	0.2808
(N = 446)	(6.05)****	(–7.63)****		(–1.35)	(–0.68)	(–0.10)	
Day	0.046		–0.045	–1.062	–0.288	0.002	0.5213
(N = 116)	(1.64)		(–1.25)	(–3.63)****	(–0.99)	(0.86)	
After Hours	0.001		0.025	–0.116	–0.302	0.000	0.4862
(N = 773)	(0.10)		(2.76)**	(–1.77)*	(–2.99)**	(–1.02)	
Panel C: Broad-based ETFs							
Winners	0.005	–0.008		–0.091	–0.353	0.000	–0.0015
(N = 155)	(0.35)	(–0.86)		(–0.77)	(–1.10)	(0.61)	
Losers	0.069	–0.066		–0.734	–0.438	–0.001	0.4447
(N = 147)	(2.65)**	(–3.22)**		(–6.34)****	(–0.86)	(–4.13)****	
Day	–0.059		0.019	–0.076	1.479	0.002	0.5476
(N = 15)	(–1.68)		(0.31)	(–0.19)	(1.17)	(1.01)	
After Hours	0.019		0.005	–0.222	–0.842	0.000	0.6002
(N = 287)	(2.85)***		(0.47)	(–2.22)**	(–3.79)****	(–1.57)	

Note: The next-period AR is regressed on the explanatory variables according to the following model. T-statistics in parentheses using standard errors adjusted for heteroskedasticity with White's (1980) adjustment. The AFTERHOURS variable is replaced with the LOSDUM variable for Day and After hours subsamples.

$$AR_j = \beta_0 + \beta_1 AFTERHOURS + \beta_2 LOSDUM + \beta_3 TRIGGER + \beta_4 VOLAT + \beta_5 VOLUME + \varepsilon$$

*, **, ***, and **** indicate significance at the 10%, 5%, 1%, and 0.1% levels, respectively using a 1-tailed test for significance.

within either normal trading hours or after hours (more than 5% in either direction). Based on an assessment of 1,989 extreme stock price movements of ETFs, we find substantial reversals on average, which implies a correction to investor overreaction.

Based on multivariate analyses, the reversals are consistently more pronounced for ETFs that experienced more extreme stock price movements. Second, the reversal is generally more pronounced for international ETFs. Third, there is a less pronounced reversal of extreme price movements that occurred after hours. Our findings support the proposition that informed traders in both the normal day and after-hours periods benefit at the expense of uninformed traders and systematically correct for their overreactions, particularly those that occurred during the day sessions.

Notes

1. Our definition of night includes any trading after the close of the normal trading day and before the open of the next day's normal trading hours. It therefore includes the early morning trading session.
2. See "The Market's Closed—Wake Up," *Business Week*, March 3, 2003, pp. 132–133.
3. In "The Market's Closed—Wake Up," Brooks McFeely, the president of Midnight Trader, an online service that collects market information, says, "the day-trading cowboys of the Internet era are no longer in the market. The dumb money is gone, and the more sophisticated investors are in charge."
4. A non-parametric bootstrapped version of the time-series standard deviation test was performed with no change to the level of significance. Results, therefore, are not reported.

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References

Atkins, A., and E. Dyl. "Price Reversals, Bid-Ask Spreads, and Market Efficiency." *Journal of Financial and Quantitative Analysis*, 25, (1990), pp. 535–547.

Barberis, N.C., A. Shleifer, and R. Vishny. "A Model of Investor Sentiment." *Journal of Financial Economics*, 49, (1998), pp. 307–343.

Barclay, M., and T. Hendershott. "Liquidity Externalities and Adverse Selection: Evidence from Trading After Hours." *Journal of Finance*, forthcoming, 2004.

Baytas, A., and N. Cakici. "Do Markets Overreact? International Evidence." *Journal of Banking and Finance*, (1999), pp. 1121–1144.

Bremer, M., T.R. Hiraki, and R.J. Sweeney. "Predictable Patterns after Large Stock Price Changes in the Tokyo Stock Exchange." *Journal of Financial and Quantitative Analysis*, 32, (1997), pp. 345–365.

Bremer, M., and R. Sweeney. "The Reversal of Large Stock Price Decreases." *Journal of Finance*, 46, (1991), pp. 747–754.

Brown, S.J., and J.B. Warner. "Measuring Security Price Performance." *Journal of Financial Economics*, 8, (1980), pp. 205–258.

Chan, W.S. "Stock Price Reaction to News and No-News: Drift and Reversal after Headlines." *Journal of Financial Economics*, 70, (2003), pp. 223–260.

Cox, D.R., and D.R. Peterson. "Stock Returns Following Large One-Day Declines: Evidence on Short-Term Reversals and Longer-Term Performance." *Journal of Finance*, 40, (1994), pp. 255–267.

Cutler, D.M., J.M. Poterba, and L.H. Summers. "Speculative Dynamics and the Role of Feedback Traders." *American Economic Review*, 80, (1990), pp. 63–68.

Da Costa, N.C.A. "Overreaction in the Brazilian Stock Market." *Journal of Banking and Finance*, 18, 1994, pp. 633–642.

Daniel, K., D. Hirshleifer, and A. Subrahmanyam. "Investor Psychology and Security Market Under- and Overreactions." *Journal of Finance*, 53, (1998), pp. 1839–1885.

DeBondt, W.F.M., and R.H. Thaler. "Does the Stock Market Overreact?" *Journal of Finance*, 40, (1985), pp. 793–805.

DeLong J.B., A. Shleifer, L. Summers, and R.J. Waldmann. "Noise Trader Risk in Financial Markets." *Journal of Political Economy*, 98, (1990), pp. 703–738.

Foster, F.D., and S. Viswanathan. "Variations in Trading Volume, Return Volatility, and Trading Costs: Evidence on Recent Price Formation Models." *Journal of Finance*, 48, (1993), pp. 187–211.

Griffin, D., and A. Tversky. "The Weighing of Evidence and the Determinants of Confidence." *Cognitive Psychology*, 24, (1992), pp. 411–435.

Jegadeesh, N. "Evidence of Predictable Behavior of Security Returns." *Journal of Finance*, 45, (1990), pp. 881–898.

Kyle, A. "Continuous Auctions and Insider Trading." *Econometrica*, (1985), pp. 1315–1336.

Poterba, J.M., and L.H. Summers. "Mean Reversion in Stock Prices: Evidence and Implications." *Journal of Financial Economics*, 22, (1988), pp. 27–59.

Richards, A.J. "Winner-Loser Reversals in National Stock Market Indices: Can They Be Explained?" *Journal of Finance*, 52, (1997), pp. 2129–2144.

Roll, R. "A Simple Implicit Measure of the Effective Bid-Ask Spread in an Efficient Market." *Journal of Finance*, 39, (1984), pp. 1127–1139.

Stoll, H., and R. Whaley. "Stock Market Structure and Volatility." *Review of Financial Studies*, 3, (1990), pp. 37–71.

Tversky, A., and D. Kahneman. "Judgment under Uncertainty: Heuristics and Biases." *Science*, 185, (1974), pp. 1124–1131.

White, H. "A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity." *Econometrica*, 48, (1980), pp. 817–838.