Reading tomorrow's newspaper: Predictability in ETF returns

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Abstract: We study the persistence of ETF premiums and discounts. Following a day of high or low premiums or discounts over NAV, ETFs tend to maintain a premium or discount for up to five days, though there is some regression to the mean. Premiums also predict distinct patterns of returns in the following day. Overnight returns following a premium have large drops in prices following a high premium, but significantly high returns the next day. Surprisingly, the NAV returns over the next day also tend to be positive. Discounts show a similar, but opposite pattern with smaller magnitudes. We conclude that ETF premiums and discounts have some ability to predict future returns, including the fundamental returns of the underlying assets.

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1. Introduction

The ETF industry has grown tremendously over the last decade. The number of ETFs has grown from 1 in 1993 to 1,134 at the end of 2011 and now represent over $1 billion in assets.[1] The majority of ETFs represent exchange trade index funds. These funds attempt to track some sort of index and suffer the typical tracking errors of all passive investing.

In this study, we focus on a tracking issue unique to ETFs. Because ETFs trade on an exchange, the value of each share is determined in part by the trading that occurs. The price per share can easily deviate from the value per share in the underlying portfolio and investors measure this through a Price/NAV ratio. (NAV is the equivalent of a mutual fund NAV and represents the value of the fund's portfolios divided by the number of shares outstanding.) A Price/NAV ratio of one means the ETF trades at parity; greater than one means the shares trade at a premium to the underlying assets; and less than one means the exchange shares trade at a discount. ETFs are structured to prevent premiums and discounts by allowing investors to create and redeem shares at NAV at any time, creating a relatively liquid arbitrage opportunity.

We document that the built-in correction doesn't always work. We observe premiums and discount occur frequently and persist for at least five days. We also observe large changes in returns unrelated to market changes. Overnight returns (closing price to opening price) after a high premium (low discount) day are overwhelmingly large and negative (positive) , while next day returns (opening price to closing price) are large and positive (negative). The NAV returns of the underlying assets also follow the ETF next day returns. Succinctly, large premiums and discounts predict short run ETF and index returns.

[1] Data from Tables 13 and 14 of the 2011 ICI Mutual Fund Industry Handbook.

This surprising result appears to be robust to time period, controlling for bid-ask bounce, excluding *ex dividend* days, and for overall market movements. While we cannot directly address if this phenomena is tradeable, we do note that the impact on NAV returns implies that ETF prices affect the underlying asset valuations. We also cannot observe what trading behavior led to and follows the price distortions.

The rest of this paper has been structured as follows. Section 2 provides a background on ETF research. Section 3 summarizes our data and describes the mechanism of ETF share creation and redemption. Section 4 provides the empirical results. Section 5 concludes.

2. Background

Very little academic research has focused exclusively on ETFs. Of the studies that do exist, most focus on either the market quality for ETFs or the competition between index ETFs and index mutual funds. We provide one of the most extensive looks at short run returns around high and low Price/NAV ratios.

Engle and Sarkar (2006) also study ETF premiums and focus on why prices deviate. Using a sample of 21 domestic and 16 international equity ETFs, Engle and Sarkar show that domestic ETFs average a small end-of-day premium over NAV of 1.1 basis points (bps) while foreign ETFs average almost 35 bps. Engle and Sarkar analyze two reasons for a premium: market frictions and limits to arbitrage. The premium for domestic funds largely disappears once microstructure frictions are included. But the authors also cite stale prices, anticipated dividends, and (in some cases) non-equity holdings as distorting prices.

Petajisto (2011) examines the issue of ETF premiums using a more comprehensive sample of ETFs from 2007-2010. Petajisto particularly addresses the issue of stale prices and finds that premiums still persists. This premium persistence leads to a long-short strategy generating nearly 10% abnormal return per year, even after adjusting for the stale price effect.

Given end-of-day prices, it seems these obvious price distortions should be quickly arbitraged. Petajisto does find significantly higher share creation activity following high premiums, so someone does trade for the alpha. Engle and Sarkar (2006) explore the limits to ETF arbitrage and note that domestic shares usually get delivered at the end of the day and so have no immediate effect on intra-day distortions. An ETF arbitrageur therefore cannot quickly act on trading day distortions. Domestically traded ETFs on international indexes provide even greater barriers; the ETF price moves, but the underlying index is not currently active. Creation and redemption is further complicated by delays in buying or selling the foreign stocks in the ETF basket, which creates additional price risk. The premium therefore gives ETFs an extra level of uncertainty compared to traditional index funds, whose values only change with the end-of-day NAV.

The research on ETF premiums differs from the research ETF tracking. Initial research demonstrates that ETFs underperform their underlying index and attribute this to transaction costs and market quality (e.g., Elton, Gruber, Comer, and Li (2002)). Market quality (measured by spreads and liquidity) for ETFs have improved since 2001, with exchanges having smaller spreads and higher liquidity (Chou and Chung, 2006; Boehmer and Boehmer, 2003). Both studies indicate that the size and quantity of ETFs available have increased, along with the improved market quality for ETF shares.

Relative to the existing literature, we contribute on several fronts. We implement the largest sample of ETFs to date, including equity ETFs from 2000 to 2010. In this context, we explore the extent to which premiums persist. We then explore the returns around high premium

ETFs and the impact of bid-ask bounce on following day returns. Finally, we test whether premiums differ significantly between ETF styles.

3. Data

In this section, we describe the ETF share creation process and how that leads to distortions in price. We then discuss our data sources and provide some descriptive statistics.

A. ETF share price and NAV

Like a mutual fund, an ETF has a Net Asset Value (NAV) that represents the value of the assets divided by the total number of shares of the fund. Also like mutual funds, the NAV fluctuates throughout the day, but the fund reports the end-of-day (4:00 pm) NAV every day to calculate daily returns and market values. An investor always buys and sells mutual fund shares at end-of-day NAV, regardless of when they bought the shares.

ETF investors, however, have two options to buy and sell shares. First, they could buy the shares on the stock exchange just like any individual companies stocks. Second, they could get shares by trading with one of the ETFs Authorized Participants (APs). Only APs have direct access to the ETF and they have the ability to create new ETF shares by delivering the equivalent underlying basket of shares in the ETF's portfolio. For example, an S&P 500 ETF will deliver 100,000 shares in the ETF to any AP that delivers the component stocks of the S&P 500 in the same weight to the ETF. Sell transactions work similarly, with the AP receiving the underlying basket of stocks in exchange for ETF shares.

The "in kind" transactions of APs are intended to serve as an auto-correct for the exchange shares. If prices exceed NAV, an investor could buy at NAV through the AP and sell on the exchange at market price to earn the difference in value (less transaction costs). Likewise, prices below NAV would encourage investors to buy at market price and exchange the shares for the underlying basket at NAV through the AP. The net buy and sell pressure should push price back towards NAV. As seen in Petajisto (2011), however, ETF exchange shares trade at a small premium to NAV and this premium tends to persist through time.

B. ETF share price and NAV

To study these premiums, we use data from the CRSP Mutual Fund database for all equity ETFs January 2nd, 2000 to February 8th, 2011. We join this data to the CRSP Stock database on CUSIP to get opening and closing market prices, closing bid and ask prices, and exchange returns. Finally, we get daily TNA from TrimTabs, Inc., an investment fund data provider. We focus on equity ETFs and require that all ETFs have at least 80% equity.

Within this sample, we calculate an ETF's daily Price/NAV ratio as the closing price (from CRSP stock) divided by closing NAV (from CRSP mutual fund). We observe some cases of very large (greater than 2) and very small (less than .5) ratios and further investigation suggests these are data entry errors. We trim the top and bottom 1% to exclude these errors. We also examine the impact of bid-ask bounce by calculating the same ratio using the mid-point of the Bid and Ask prices as the numerator (though not all ETFs have this data).

We next focus on the daily returns calculation. From CRSP Mutual Fund we get the daily return based on NAV (plus distributions) and from CRSP Stock we get the daily return based on closing prices (plus distributions). We next calculate to sub-components of the exchange return. We first estimate the "overnight return" as:

$$r_{i,t}^{Overnight} = \frac{P_{i,t}^{Opening}}{P_{i,t-1}^{Closing}} - 1$$

and the "day return" as:

$$r_{i,t}^{Day} = r_{i,t}^{Total} - r_{i,t}^{Overnight}$$

where:

$r_{i,t}^{Overnight}$ is the overnight return for ETF *i* on day *t*;

$P_{i,t}^{Opening}$ is the opening price from CRSP for ETF *i* on day *t*;

$P_{i,t-1}^{Closing}$ is the closing price from CRSP for ETF *i* on day *t*-1 (the previous day);

$r_{i,t}^{Day}$ is the return from opening to closing for ETF *i* on day *t*, and;

$r_{i,t}^{Total}$ is the total daily exchange return from $P_{i,t-1}^{Closing}$ to $P_{i,t}^{Closing}$ including distributions.

The overnight return represents the hypothetical return to an investor who bought the last share sold yesterday and sold the first share bought today. The day return represents the hypothetical return to an investor who bought the first share today, received all cash flows for that day, and sold the last share today. The overnight return effectively represents both the effects of overnight news as well as the bid-ask bounce between closing and opening and any reaction to the end of prior day Price/NAV ratio. The day return represents the impact of daily news. The end result is that we have decomposed the typical daily return into two components to examine how the market reacts to large and small Price/NAV ratios.[2]

We require complete data for returns, closing prices, and style for our sample. This gives our final dataset includes 786,907 observations of 762 equity ETFs covering 2,792 trading days, roughly XX% of the total number of ETFs in CRSP. We provide the summary statistics for our sample in Table 1.

[Insert Table 1 here]

[2] We decompose the return into two components and assume the effects are additive instead of multiplicative. If we assume the return should be compounded and multiply our returns, we get virtually identical results—the returns are too small to generate an economically important difference.

The average (median) fund earns 3 bps (7 bps) per day, around 8% (19%) per year assuming 252 trading days per year. The mean overnight return is higher, at 8 bps, but the day return is a negative 5 bps per day. In both mean and median exchange returns, the overnight return represents the most gains, and the day return provides little advantage on average. Overnight and day returns display more variation than exchange returns with a both standard deviations being near 3%. As expected, mean NAV returns track exchange returns closely and the mean difference is zero.

Turning to ratios, the bid-ask spread (scaled by price) represents 0.39% of price on average, but less than 0.2% of price for the median. For a $40 share, this represents a spread of around $0.15. The Price/NAV ratio is 1.0009, meaning the average price exceeds NAV by 9 bps ($0.036 at $40 a share). Median Price/NAV comes in lower (2 bp), so the premiums are skewed towards 1. The 10th percentile being less than one suggests that a significant number of ETFs actually trade at a discount to NAV. The results using the Bid-Ask Midpoint price (instead of closing) gives similar results, though with a slightly tighter distribution.

Finally, we present the distribution of styles. We define an ETF as an index fund if it tracks a general U.S. index (not a sector index). Foreign funds include all sample ETFs tracking foreign equities (including non-U.S. indexes and sectors). Sector funds include all sample ETFs tracking a sector index (including foreign sectors). Leveraged funds include 130/30 funds, “2x”, “3x”, “-2x”, “-3x”, and other funds that return some multiple of an index. Non-index funds include non-traditionally weighted index funds (such as those using fundamental weights, quantitative weights, or qualitative weights), actively managed ETFs, and any other non-index based fund. These style definitions overlap, so the percentages presented will exceed 100%. For example, a Japanese electronics ETF will be counted in both Foreign and Sector. About one quarter of the sample contains traditional indexes and 32% of ETFs invest in foreign indexes. Sectors dominate the sample with 41% of the observations being tied to a specific industry in some way. Leverage and Nonindex ETFs represent the smallest groups in the sample.

Like the prior literature, we find that most ETFs carry a small premium on their exchange prices. We also observe significant differences between the overnight returns and the day returns for ETFs. In the next section, we will examine the extent to which these premiums persist, how returns react following a high premium closing price, and the profitability of investors trading on these premiums.

4. Empirical test

A. Persistence

In this section, we begin by examining the degree to which premiums occur and persist, and how the market reacts to these premiums. We begin by sorting all ETFs by Day +0 Price/NAV ratio and assigning them into deciles. In Table 2, we present the average Day +0, Day +1 and Day +5 Price/NAV ratios by each decile.

[Insert Table 2 here]

In general, the middle eight deciles show little persistence. These groups start at a small premium or discount on Day +0 and revert to sample average (1.0009) by the next day. The lowest decile shows some persistence, starting with a 92 bp discount on Day +0 and still showing still maintaining a discount on Day +5. But, the Day +1 change in the ratio represents a 71 bp move towards parity. The highest decile has a premium of 1.46% over NAV. This premium drops to 0.69% by Day +1, but remains virtually unchanged by Day +5. This provides the first initial support that premiums persist, though the effect is isolated in the top and bottom deciles.

To get a better idea of the time trends, we present both the preceding and following five day average Price/NAV ratios in Figure 1 for the first (bottom), third, eighth, and tenth (top) deciles. Generally, those ETFs with the most extreme ratios had relatively extreme ratios over the prior and following five days. The changes, though, from Day -1 to Day +0 and from Day +0 to Day +1 are very large, suggesting that the persistence represents only one part of the story. The third and eighth show a similar, albeit diminish, pattern.

[Insert Figure 1 here]

We examine this persistence in a different way by creating a transfer table between days. As in Table 2, we construct deciles based on Day +0 Price/NAV ratios. We then compare the Day +0 rank to the decile rank on Day +1 and Day +5. Table 3 shows what percentage of funds in a Day +0 rank have a given rank on Day +1 in Panel A and Day +5 in Panel B. Each row sums to 100%. Under the assumption of pure random assignment, all cells should be near 10%. Under the assumption of absolute persistence, the cells where the deciles match should be 100% and all others would be zero. Matching deciles have been highlighted in bold.

[Insert Table 3 here]

Beginning with Panel A, we see that almost all ETFs have a slight tendency to stay in or near their same decile on the following day. For example, around 16% of 5th decile ETFs are still in the 5th decile on Day +1, and 46% are in the 4th, 5th, or 6th deciles. The lowest premium decile has some persistence. Over 42% of ETFs in the lowest decile stay in the bottom 20% and the top eight deciles all receive a relatively small number of the lowest discount ETFs. The highest premium decile shows the strongest persistent. Almost 60% of ETFs in the top decile stay in the top two deciles in the following day. The Day +5 results in Panel B show an almost identical distribution, suggesting that most of the changes in ratios occur in Day +1 and that ETFs tend to persist in their premiums/discounts over this longer time frame.

B. Returns

In this sub-section, we examine the returns around large premiums and discounts. As suggested in the previous sub-section, most of the change in premiums and discounts occur in the following day. We will focus on the returns for the day of the observe premium and the day after. As in Table 2, we rank each ETF into deciles by Price/NAV ratio. In Table 4, we present the exchange return, the overnight return (eq. 1), the day return (eq. 2) and the NAV returns. We present the median return and the percentage of positive returns in each case.

[Insert Table 4 here]

Panel A has the Day +0 returns (the 24 hours before the Price/NAV ratio is observed). The lowest ratio ETFs have negative Day +0 returns, though 42% of the returns are still positive. Most of these negative returns come from the Day return (-29 bp) and, surprisingly, the NAV return is actually positive. This certainly represents a case where the ETF has moved counter to the underlying asset. The highest ratio ETFs have positive Day +0 exchange returns. Most of this positive return comes from high overnight returns (nearly 1%) and the day returns are actually -58 bps. The NAV return is negative, too, so the day return partially offsets the overnight return, but not enough to track the NAV. The high Price/NAV ratio results from the exchange return and the NAV return moving in opposite directions.

We examine the next day impact in Panel B. The Day +1 exchange returns (the 24 hours after the Price/NAV ratio is observed) for the lowest decile are positive with most of the return due to a large, positive overnight return. Over 60% of these returns are positive. Meanwhile, the NAV return is negative, so the overnight return and NAV return work together to push the

Price/NAV ratio towards parity again. The highest decile show a similar, but opposite reaction. Overnight returns reach -1% and are positive only 20% of the time. The day returns, however, reach almost 0.83%, partially offsetting the overnight loss. NAV earns 32% with 64% of the observations having positive returns. The net effect for the highest decile would decrease the Price/NAV, but the net change would only be 42 bp, less than half the average ratio for the top decile reported in Table 2.

We examine several sub-samples and alternative constructions to confirm these results, though for brevity we will only discuss the results here. Price/NAV ratios tended to be higher in the first part of the sample and all of the documented affects are weaker (though still large) in the second half of the sample. We also examined the five styles separately. Index, Foreign, and Leverage funds had similar results as the full sample, but Sector and Nonindex funds rarely showed significant day returns or NAV returns. Our results were virtually identical when using the midpoint of the bid and ask prices instead of closing prices (opening bid and ask prices were unavailable for most funds). We also excluded days with dividends and found they had little effect on our overall results. In general, our results were robust to multiple specifciations.

Perhaps the most surprising results from ETF returns come from the 82 bp day return and the 32 bp NAV return for the highest Price/NAV ratio decile. In the first case, the day return should be tradeable, barring any concentration of returns in the first few minutes of trading. The second case suggests that the premium has some relation to the underlying assets. In both cases, the result could come from some risk factor event.

We test the relationship between the returns and risk factors by estimating the risk exposure and alpha of our top and bottom deciles. Within the deciles formed on Day +0, we calculate TNA-weighted Day +1 returns and get a time series of exchange, overnight, day, and

NAV returns. We then use OLS to estimate the factor loadings and intercept of a Carhart (1997) stock factor model using daily data. The result will give us the risk exposure and abnormal returns for both populations. We present these results in Table 5.

[Insert Table 5 here]

Beginning with the bottom Price/NAV decile, we see that the returns are partially explained by risk factors, but that most of the observed return comes from alpha. We also observe that NAV has generally smaller risk factors than exchange returns. Finally, day returns, while close to zero in Table 4, have a statistically significant -16 bps per day. The day return appears to track the NAV return better than indicated by looking at the raw returns.

We next turn to the top Price/NAV ratio decile. As in the bottom decile, we observe significant (and typical) factor loadings for the returns and that exchange returns have generally higher exposures than NAV returns. The alphas generally exceed the raw returns in Table 4, suggesting that the observed effects are actually larger once accounting for market risk.

5. Conclusion

In this study, we study the persistence and returns surrounding high and low Price/NAV premiums for equity ETFs. We document some level of persistence in that the highest premium and lowest discount ETFs on a given day tend to be among the highest and lowest over the following five days. However, we also observe significant reversion from the daily high or low on the following day, suggesting a large return effect.

We document several large magnitude returns around extreme Price/NAV ratio ETFs. Following a high premium day, we observe large overnight drop between the prior closing price and the next day's opening price, suggesting that markets in part correct from the prior day highs. However, we also observe large positive returns during the following day on the exchange and in the underlying index. Large discount ETFs demonstrate a similar, but opposite and smaller effect. We interpret these results as large premiums having predictive power for the next day's index returns.

The economic interpretation behind these results suggests some level of market inefficiency. The existence of a premium or discount suggests either a liquidity problem or some other barrier to arbitrage that mitigates the self-correcting nature of ETF prices. It also isn't clear if there exists a true tradeable strategy to take advantage of these risk-free returns. Part of the correction in prices occurs overnight when liquidity approaches zero or at opening bell when a trader can't observe the most recent Price/NAV ratio. A trader could instead buy the NAV side of the trade, but these returns can be characterized as still risky—two days out of three have been positive—and require the trader to buy the entire index with appropriate weights.

More importantly, we lack sufficient data to understand the trading behavior that led to the premiums and discounts at closing, or how investors react the next day. Perhaps the most intriguing puzzle is why the index NAV returns seems to be predicted by the ETF prices. Further research at the microstructure level may give a better idea of predictability of ETF returns and how ETF investors can "read tomorrow's newspaper."

Citations

Boehmer, Beatrice, and Ekkehart Boehmer, 2003, Trading your neighbor's ETFs: Competition or fragmentation?, *Journal of Banking & Finance* 27, 1667-1703.

Carhart, Mark M., 1997, On persistence in mutual fund performance, *Journal of Finance* 52, 57-82.

Chou, Robin K., and Huimin Chung, 2006, Decimalization, trading costs, and information transmission between ETFs and index futures, *Journal of Futures Markets* 26, 131-151.

Elton, Edwin J., Martin J. Gruber, George Comer, and Kai Li, 2002, Spiders: Where are the bugs?, *Journal of Business 75*, 453-472.

Engle, Robert, and Debojyoti Sarkar, 2006, Premiums-discounts and exchange traded funds, *Journal of Derivatives* 36, 27-45.

Investment Company Institute, *2012 Investment Company Fact Book*, http://www.ici.org/pdf/2011_factbook.pdf, accessed 9/7/2012.

Petajisto, Antti, 2011, Inefficiencies in the pricing of exchange-traded funds, New York University working paper.

Figure 1 – Price/NAV ratio persistence

The table below provides Price/NAV ratios for a sample of ETFs, January, 2000, to February, 2011. The table presents the average Price/NAV ratio on the day of ranking (Day +0), as well as the five days before and after the ranking. Only the Bottom (first), Third, Eighth, and Top (tenth) deciles have been presented.

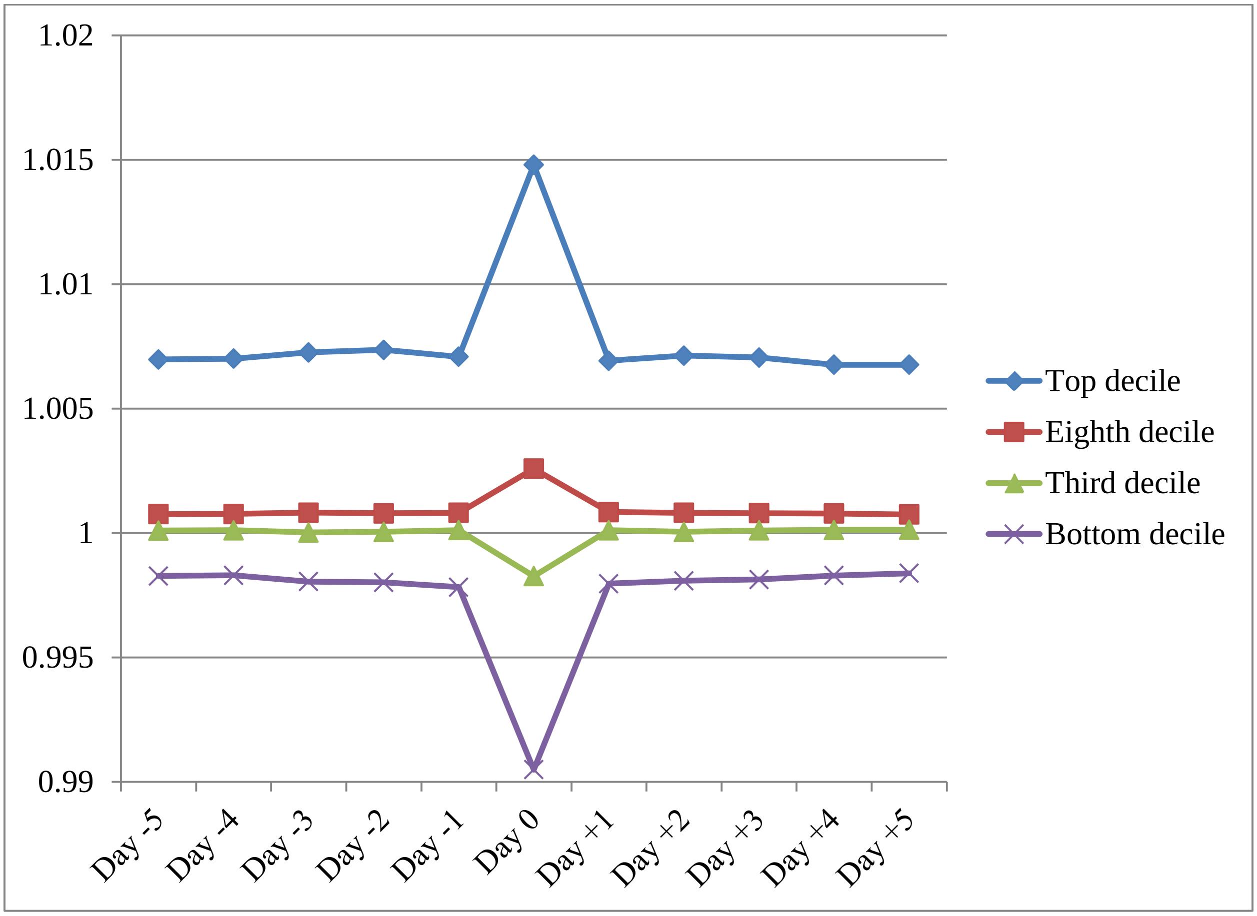

Table 1 – Summary statistics

The table below provides summary statistics of daily market and style data for a sample of ETFs, January, 2000, to February, 2011. For each variable, the N, mean, 10th, 50th, and 90th percentiles, and the standard deviation have been provided. *Exchange return* is defined as the daily return from prior day closing price to current day closing price, plus any cash flows, using exchange prices. *Overnight return* is the return from prior day closing price to current day opening price using exchange prices. *Day return* is the return from current day opening price to current day closing price, plus any cash flows, using exchange prices. *NAV return* is the return from prior day closing NAV to current day NAV, plus any cash flows. *Exchange – NAV return* is the difference between *Exchange return* and *NAV return*. *Bid-Ask spread* is the closing ask price minus the closing bid price scaled by closing price. *Price/NAV ratio* is the closing price divided by the closing NAV and *Mid-Point Price/NAV* ratio is the same, except using the mid-point of the closing bid and ask prices instead of closing price. *Index dummy variable* takes on a value of 1 if the ETF attempts to emulate a general market index, 0 otherwise. *Foreign dummy variable* takes on a value of 1 for any foreign invested ETFs, *Sector dummy variable* takes on a value of 1 for any industry specific ETFs, *Leveraged dummy variable* takes on a value of 1 for any ETF return some multiple of an index (including -1x), and *Nonindex dummy variable* takes on a value of 1 if the ETF has a non-benchmark approach (e.g., actively managed or fundamentally weighted ETFs).

Variable	N	Mean	10th percentile	Median	90th percentile	Std. Dev.
Exchange return	787,641	0.0003	-0.0209	0.0007	0.0205	0.0225
Overnight return	786,907	0.0008	-0.0130	0.0006	0.0139	0.0294
Day return	786,907	-0.0005	-0.0176	0.0000	0.0158	0.0315
NAV return	787,641	0.0003	-0.0202	0.0007	0.0197	0.0221
Exchange - NAV return	787,641	0.0000	-0.0066	0.0000	0.0065	0.0099
Bid-Ask spread (% of price)	783,408	0.39%	0.05%	0.17%	0.82%	0.71%
Price/NAV ratio	787,641	1.0009	0.9956	1.0002	1.0071	0.0076
Mid-Point Price/NAV ratio	783,408	1.0009	0.9975	1.0000	1.0058	0.0069
Index dummy variable	787,641	24%	0	0	1	43%
Foreign dummy variable	787,641	32%	0	0	1	47%
Sector dummy variable	787,641	41%	0	0	1	49%
Leveraged dummy variable	787,641	9%	0	0	0	29%
Nonindex dummy variable	787,641	6%	0	0	0	23%

Table 2 – Price/NAV ratio by decile rank

The table ranks all ETFs on a given day into deciles by the end of day Price/NAV ratio (as defined in Table 1). The table presents the average Price/NAV ratio on the day of ranking (Day +0), the day after ranking (Day +1), and five days after ranking (Day +5).

Rank	**Day +0**	**Day +1**	**Day +5**
1 – Lowest Price/NAV ratio	0.9908	0.9980	0.9984
2	0.9965	1.0001	1.0000
3	0.9983	1.0001	1.0001
4	0.9993	1.0001	1.0001
5	0.9999	1.0002	1.0002
6	1.0005	1.0003	1.0003
7	1.0012	1.0005	1.0004
8	1.0026	1.0008	1.0007
9	1.0053	1.0019	1.0018
10 – Highest Price/NAV ratio	1.0146	1.0069	1.0068

Table 3 – Price/NAV ratio transfer table from Day +0 to Day +1 and Day +5

The table ranks all ETFs on a given day into deciles by the end of day Price/NAV ratio (as defined in Table 1). For a given day (Day +0), each cell shows what percentage of ETFs ended in a particular rank the next day (Day +1, panel A) or in five days (Day +5, panel B). Cells where the ranks matched (Day +0 rank equals Day +1/5 rank) are in bold.

Panel A: Transfer rate between Day +0 and Day +1

	Day +1 Rank									
Day +0 Rank	**1- Lowest**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10- Highest**
1 - Lowest	**29.94**	12.79	7.47	5.71	4.92	5.00	6.04	8.48	10.28	9.36
2	12.23	**14.36**	12.07	9.66	8.69	8.57	8.89	9.59	9.19	6.73
3	7.22	11.96	**13.78**	13.31	12.16	11.14	10.51	9.09	6.71	4.11
4	5.54	9.56	13.37	**14.88**	14.84	13.44	11.44	8.36	5.49	3.10
5	4.72	8.34	12.15	14.74	**15.92**	15.25	12.19	8.52	5.20	2.97
6	4.72	8.26	10.99	13.48	14.76	**15.79**	13.74	9.64	5.61	3.01
7	5.69	8.85	10.43	11.40	12.16	13.48	**14.42**	12.13	7.65	3.80
8	7.99	9.59	9.01	8.61	8.65	9.82	12.14	**14.63**	12.71	6.85
9	9.83	9.32	6.92	5.59	5.37	5.85	7.57	12.83	**20.81**	15.90
10 - Highest	9.30	6.85	4.53	3.35	3.06	3.07	3.88	6.94	16.56	**42.46**

Panel B: Transfer rate between Day +0 and Day +5

	Day 5 Rank									
Day 0 Rank	**1-Highest**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10-Lowest**
1 - Lowest	**27.52**	12.67	7.95	6.00	5.33	5.18	6.23	8.70	10.67	9.74
2	11.44	**14.01**	12.01	10.03	9.07	8.92	9.18	9.72	9.15	6.47
3	6.82	11.48	**13.49**	13.32	12.40	11.68	10.82	9.17	6.62	4.19
4	5.10	9.43	13.13	**15.02**	14.96	13.59	11.51	8.67	5.63	2.96
5	4.60	8.52	11.97	14.93	**15.62**	15.24	12.27	8.74	5.26	2.86
6	4.45	8.32	11.53	13.48	14.72	**15.65**	13.56	9.74	5.61	2.95
7	5.54	8.70	10.70	11.62	12.64	13.49	**14.34**	11.73	7.45	3.78
8	7.96	9.91	9.37	8.76	8.82	10.08	12.07	**13.82**	12.34	6.88
9	10.00	9.50	6.99	5.81	5.57	6.09	7.81	12.67	**19.92**	15.65
10 - Highest	9.97	6.95	4.49	3.27	3.19	3.19	4.12	7.37	16.85	**40.60**

Table 4 – Returns by Price/NAV ratio decile rank

The table below provides returns by Price/NAV ratio decile rank. On Day +0, ETFs are ranked by their closing Price/NAV ratio. Panel A shows the average exchange return, overnight return, day return, and NAV return (as defined in Table 1) for each decile on Day +0, as well as what percentage of observations were positive. Panel B shows the same data, except for Day +1.

Panel A: Day +0 returns

Day +0 rank	**Exchange return**		**Overnight return**		**Day return**		**NAV return**	
	Median	**% Positive**	**Median**	**% Positive**	**Median**	**% Positive**	**Median**	**% Positive**
1 - Lowest	-0.0020	42%	0.0007	55%	-0.0029	36%	0.0030	63%
2	-0.0006	47%	0.0004	53%	-0.0009	45%	0.0018	58%
3	-0.0001	50%	0.0003	52%	-0.0002	49%	0.0010	55%
4	0.0006	53%	0.0002	52%	0.0006	53%	0.0011	55%
5	0.0008	54%	0.0001	51%	0.0009	55%	0.0007	53%
6	0.0011	55%	0.0003	52%	0.0011	57%	0.0006	53%
7	0.0012	56%	0.0003	53%	0.0013	57%	0.0003	52%
8	0.0014	56%	0.0006	55%	0.0015	57%	0.0000	50%
9	0.0017	57%	0.0007	54%	0.0016	59%	-0.0009	46%
10 - Highest	0.0021	58%	0.0096	78%	-0.0058	35%	-0.0017	43%

Panel B: Day +1 returns

Day +0 rank	**Exchange return**		**Overnight return**		**Day return**		**NAV return**	
	Median	**% Positive**	**Median**	**% Positive**	**Median**	**% Positive**	**Median**	**% Positive**
1- Lowest	0.0034	63%	0.0030	68%	0.0005	52%	-0.0022	41%
2	0.0021	58%	0.0021	66%	0.0004	51%	-0.0009	46%
3	0.0016	57%	0.0016	63%	-0.0001	50%	0.0001	51%
4	0.0012	55%	0.0014	62%	-0.0001	49%	0.0006	52%
5	0.0007	53%	0.0009	58%	-0.0001	49%	0.0006	53%
6	0.0004	52%	0.0006	55%	-0.0004	48%	0.0007	53%
7	0.0000	50%	0.0002	53%	-0.0002	49%	0.0009	54%
8	-0.0004	48%	-0.0001	49%	-0.0002	49%	0.0013	56%
9	-0.0009	47%	-0.0004	47%	-0.0001	50%	0.0023	60%
10 - Highest	-0.0013	45%	-0.0100	20%	0.0083	75%	0.0032	64%

Table 5 – Alphas by Price/NAV ratio decile rank

The table below provides risk factor and alpha estimates for ETFs in the top and bottom Price/NAV ratio decile rank Day +0. On Day +0, we rank ETFs by their closing Price/NAV ratio. Using end of day TNA, we form a portfolio of all the ETFs in the decile and calculate the exchange return, overnight return, day return, and NAV return for the portfolio on Day +1 (as defined in Table 1). We then fit this time series of returns to a Carhart (1997) factor model using OLS to estimate each coefficient. ***, **, * represent statistical significance at the 1%, 5%, and 10% level respectively. *p*-values are reported in brackets.

	Bottom decile				Top decile			
Factor	Exchange	Overnight	Day	NAV	Exchange	Overnight	Day	NAV
Alpha	0.0033***	0.0047***	-0.0016*	-0.0036***	-0.0023***	-0.0185***	0.0161***	0.0036***
	[0.000]	[0.000]	[0.090]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
MKT	0.9908***	0.3781***	0.6128***	0.6238***	1.0876***	0.3046***	0.7831***	0.8431***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
SMB	0.1243***	0.0886	0.0360	0.2157***	0.1189***	0.0229	0.0965	0.0242
	[0.001]	[0.557]	[0.811]	[0.000]	[0.000]	[0.784]	[0.245]	[0.474]
HML	0.0913***	0.1461	-0.0553	0.0967**	0.1948***	0.0629	0.1314*	0.1353***
	[0.007]	[0.284]	[0.686]	[0.011]	[0.000]	[0.410]	[0.084]	[0.000]
UMD	-0.0617***	-0.0159	-0.0462	-0.1077***	0.0176	-0.0514	0.0688	-0.0282
	[0.006]	[0.861]	[0.611]	[0.000]	[0.290]	[0.311]	[0.174]	[0.171]
N	2,787	2,787	2,787	2,787	2,787	2,787	2,787	2,787
R-squared	0.573	0.012	0.030	0.317	0.735	0.026	0.130	0.529