Cross-ETF Arbitrage

Spencer Andrews [†]

Brian J. Henderson [‡]

Adam Reed [§]

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ABSTRACT

We find that Exchange-Traded Funds (ETFs) are more expensive to borrow than stocks, and we provide an explanation for this difference. This phenomenon is due to features specific to the ETF lending market rather than due to the stocks the ETFs hold, as ETF loan fees tend to be higher than the average of their constituent stocks. We find that for most indices, one ETF tends to capture the majority of the short interest. This "short favorite" ETF tends to have low loan fees, while the "non-favorite" ETFs tend to be much more expensive to short and are less liquid. Demonstrating the magnitude of ETF loan fee differences within each index, we examine the returns to a within-index, cross-ETF arbitrage strategy which is profitable due to persistent loan fee differences across ETFs tracking the same index. Cross-ETF arbitrage returns are quite high and stable. Even when we partially constrain an investor's ability to fully lend out their long position, we still find that the cross-ETF arbitrage strategy is profitable for about 2/3 of the indices in our sample. The results shed light on limits to arbitrage in the market for exchange-traded funds and provide an explanation for the high ETF loan fees that we observe.

[†]Research Economist, Office of Financial Research, U.S. Department of the Treasury; spencer.andrews@ofr.treasury.gov; Website

[‡]George Washington University; bjhndrsn@gwu.edu; Website

[§]Kenan-Flagler Business School, University of North Carolina; adam_reed@unc.edu; Website

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1 Introduction

Short selling constraints have been shown to be a major contributor to economic inefficiencies. Short selling loan fees, in particular, have received significant attention from practitioners, regulators and academics, and high loan fees have been shown to be a significant driver of inefficiencies. Up to this point, our understanding of these fees is based on common stocks, and to some extent, corporate bonds. However, there is very little evidence on loan fees for portfolios of these assets, namely exchange-traded funds (ETFs).

We find that ETF loan fees are too high. We show that unlike equities, where 68% of stock / loan days have loan fees under 100 basis points, only 33% of ETF loan fees are under 100 basis points. Similarly, the median loan fee for ETFs is 162.9 basis points while the median loan fee for stocks is much lower, at 20.7 basis points.[1]

How do we know ETF loan fees are too high? In theory, the availability of the create / redeem mechanism for ETFs should link the loan fees of the ETFs' constituents to the loan fee of the ETF itself. In other words, in the absence of ETF lending frictions, we would expect ETF loan fees to be equivalent to the weighted average of the constituent stock loan fees. Using this insight, we propose a new method of evaluating ETF loan fees by reconstructing ETF holdings and calculating the difference between average loan fees on the holdings and loan fees on the ETFs. Using this method, we document that ETF loan fees are consistently above what would be expected based on the loan fees of their underlying constituents. In particular, we find that the distribution of the abnormal loan fees (the difference between the ETF loan fee and the weighted average of the ETF constituent loan fees) has a mean of 207 basis points, and a median of 145 basis points.

As a potential explanation for this phenomenon, we provide an interesting insight about the market in ETFs, namely that there tends to be a "short favorite" ETF for many indices. For example, two ETFs track the S&P Midcap 400 Index (ticker SPTRMDCP): iShares' IJH and Vanguard's IVOO. The total short interest in ETFs tracking this index is heavily skewed as IJH accounts for 97.2% of the index's total short interest and IVOO

[1] Bhojraj and Zhao (2021) also find that ETF loan fees are higher than stock loan fees. They argue that this fact is due to institutional features which are unique to ETFs: regulations restricting investment companies from owning ETFs (which lowers ETF loan supply) and the fact that the create-to-lend mechanism, which is meant to alleviate supply constraints, is limited due to costs and frictions.

accounts for only 2.8%. Using total short interest (in dollars), we assign short favorite and non-favorite labels to ETFs that track the same index.

We find that the short favorites have certain, intuitively sensible, characteristics that correlate with their status as a short favorite. When testing the cross-sectional correlations between a dummy variable which captures whether an ETF is a short favorite or not, it is apparent that the short favorite ETFs tend to have an earlier inception date, have higher trading volume, and trade at a higher premium relative to NAV. These characteristics are intuitively plausible and help explain why an ETF might be an attractive short holding relative to other ETFs tracking the same index.

As a way of demonstrating the economic magnitude of this discrepancy in loan fees, we construct a trading strategy that relies on the difference in loan fees between ETFs that track the same index. Specifically, the cross-ETF arbitrage strategy involves buying the ETF with the highest loan fee among ETFs tracking an index and selling short the ETF with the lowest loan fee tracking that index.

Assuming the long position can be lent out so that the arbitrageur can capture the loan fee, this strategy is persistently and strongly profitable for every index, as it allows the investor to capture the loan fee difference between ETFs that track the same index. We find that across the 26 indices which have multiple tracking ETFs, the average annual profitability of this strategy would be about 3.1% with an annual Sharpe ratio of 3.4.[2]

Of course, the assumption that an investor would be able to fully lend out their long position in the aforementioned arbitrage strategy is potentially unrealistic. To account for this fact, we also compute the profitability of a utilization-adjusted strategy, in which we assume a certain percentage of each long position can be lent out based on the loan utilization of that ETF during each month.[3]

Constraining the percentage of the long position that can be lent out always causes the profitability of the cross-ETF arbitrage strategy to decline; however, even with this constraint, the strategy is still generally profitable. For 17 out of the 26 indices we consider, the strategy still yields a positive return on average. Across all 26 strategies, the average

[2]The Sharpe ratio is high largely due to the fact that a long-short strategy between two ETFs tracking the same index yields a very low-volatility return series.

[3]Loan utilization is defined as $\frac{\% Shares on Loan}{\% Shares Available to be Lent}$.

annual profitability is 0.6%, with an annual Sharpe ratio of 0.7. The most profitable index for cross-ETF arbitrage in our sample is LT01TRUU (the Bloomberg US Treasury: 1-3 Year Total Return Index), which yields a utilization-adjusted annual return of 5.7% with an annual Sharpe ratio of 3.9.[4]

We also explore an additional "conditional" cross-ETF arbitrage strategy. We recognize that an arbitrageur may not choose to initiate the arbitrage strategy if the profitability has recently been negative. In this conditional version of the strategy, we allow the investor to abstain from entering the strategy if the profitability in the previous month was negative. We find that this strategy yields largely similar returns, since returns to the arbitrage strategy are rarely negative.

The insight that there are favorites and non-favorites provides a partial explanation for the high loan fee phenomenon. We posit that the lack of liquidity in the non-favorite ETFs leads to low demand for those ETF in general, since all things being equal, investors, both long and short, prefer more liquidity to less. This leads to low ownership of the non-favorite ETFs in general, and low holdings among institutional investors in particular, which leads to a lack of loan supply and a higher loan fee.[5]

1.1 Literature Review

This paper primarily contributes to the short selling and asset management literatures and is especially related to papers at the intersection of the two research areas. First, Blocher and Whaley (2016) show that ETF managers tend to slant holdings toward stocks with higher lending fees. While we do not test this finding, we find that the weighted average of constituent stocks do not explain ETFs' high loan fees. Like our paper, Bhojraj and Zhao (2021) also show that ETF lending fees are significantly higher than stock lending fees, although they argue that this fact is due to institutional features unique to ETFs: regulations restricting investment companies from owning ETFs (which lowers ETF loan supply) and the fact that the create-to-lend mechanism, which is meant

[4]Tracking error is the obvious divergence from a pure arbitrage strategy. However, this is not a large concern for our purposes for two reasons. First, tracking error is low on average. Second, if the long and short ETFs both have tracking error, and that error is correlated between the two ETFs, which we expect it would be, then tracking error would be less of a concern from the arbitrageur's point of view. We still aim to explore why this arbitrage opportunity exists: possibly due to trading costs, operational risks, lack of investor awareness, or lack of ability to capture loan fees paid.

[5]We plan to rigorously test this hypothesis in a future update.

to alleviate supply constraints, is limited due to costs and frictions.[6] This paper is also related to Box, Davis, Evans, and Lynch (2021), which shows (using minute-by-minute returns) that there is little evidence that ETF arbitrage impacts the underlying stocks. Finally, Karmaziene and Sokolovski (2022) study short selling of ETFs around the 2008 short-sale ban, and they find an increase in short sales of the most liquid ETF (SPY), suggesting that investors were shorting SPY to circumvent the ban. The result suggests that ETF shorts relax short-sale constraints' adverse effects on liquidity.

The short selling literature establishes stock loan fees as an important limit to arbitrage. Equity lending fees predict overvaluation and subsequent realized returns (see Jones and Lamont (2001), Asquith, Pathak, and Ritter (2004), Boehmer, Jones and Zhang (2007), Rapach, Ringgenberg, and Zhou (2016), Kelley and Tetlock (2016), and Drechsler and Drechsler (2021)), predict price inefficiency (see Saffi and Sigurdsson (2010)), are driven by idiosyncratic episodes (see Geczy, Musto, and Reed (2002)), exhibit commonality (see Andrews, Lundblad, and Reed (2022)), and are highly predictable in part due to rational ex-ante expected returns (see Andrews (2022)). Our paper contributes to this literature by examining ETF loan fees, rather than stock loan fees, and shedding light on the interesting fact that ETF loan fees tend to be high relative to their constituent stocks.

There is a growing literature that studies ETFs and their effects on underlying securities. Huang, O'Hara, and Zhong (2018) show evidence that industry ETFs are beneficial for informational efficiency, as they help investors to hedge industry-specific risks. Ben-David, Franzoni, and Moussawi (2018) show that ETF trading can cause liquidity shocks to propagate to the underlying securities, which results in higher volatility of those underlying securities. Brown, Davies, Ringgenberg (2019) show that flows into ETFs provide signals of non-fundamental demand shocks. Saglam, Tuzun, and Wermers (2019) studies the impact of ETFs on the liquidity of the underlying stocks, and they find that stocks with high ETF ownership experience decreased liquidity during major market stress events.

This paper is also related to papers that study the effects of ETFs on illiquid underlying securities. Agapova and Volkov (2018) show that higher ETF ownership of a corporate bond is associated with lower bond returns and volatility, although ETF flows

[6]We plan to test the relationship between these findings and our findings in a future update.

can be associated with higher volatility of bond returns. Bae and Kim (2020) show illiquid ETFs are more likely to deviate from their underlying indices and could be riskier than their underlying portfolios. Shim and Todorov (2021) show that many bond ETFs exchange creation or redemption baskets which represent a fraction of ETF holdings, rather than the full portfolio of holdings, and this results in high basket turnover and persistent premiums and discounts on the ETF. Similarly, Brogaard, Heath, and Huang (2021) show that passive funds systematically underweight or omit illiquid index assets.

While we do not study the effects of ETF arbitrage on the constituent securities, we do compute the profitability of several cross-ETF arbitrage strategies and posit that there are relatively low-risk returns available for cross-ETF arbitrageurs.

2 Data

In this section, we discuss our data set and empirical strategy. In Section 2.1, we provide an overview of our data sources and describe our construction of key variables. In Section 2.2, we provide summary statistics for many of the variables included in our results.

2.1 Data Overview and Variable Construction

We begin the construction of our ETF-month panel with ETF Global data. From the ETF Global Industry dataset, we obtain variables including assets under management (AUM), average daily trading volume, asset class, creation unit size, creation fee, short interest, number of holdings, the ETF's discount or premium relative to NAV, and expense ratio. In addition to ETF-level variables, the ETF Global Constituents dataset also allows us to observe daily constituent lists for each ETF, along with the constituents' relative weights in the ETFs' portfolios.

We retrieve returns, prices, and dividend yields for ETFs and their constituent securities from CRSP. We obtain data on institutional ownership from the Thomson Reuters 13F dataset.

From a large equity lending database, we observe the quantity of shares lent, quantity of shares available to be lent, and loan fees from January 2012 through March 2015. Importantly, we have these data for ETFs and many of their constituent securities. While we are unable to match 100% of ETF constituent portfolios, we are able to match a high percentage of their portfolios on average. For most regressions, we impose the restriction that at least 50% of the ETF portfolios must be matched between the equity lending database and the ETF Global constituent lists.

We drop exchange-traded notes (ETNs) and any ETFs which have less than $100 million in AUM to limit the effect of potentially noisy small ETFs. We winsorize variables at the 95th percentile to limit the effect of outliers on our results.

We construct several novel variables for the purpose of this paper. First is a variable we call "Abnormal Loan Fee", which we calculate using the below formula:

$$AbnormalLoanFee_{i,t} = ETFLoanFee_{i,t} - \Sigma_{k=1}^{N} w_{i,k,t} * StockLoanFee_{i,k,t} \quad (1)$$

The Abnormal Loan Fee for ETF i in month t is equal to ETF i's loan fee in month t minus the weighted average of ETF i's constituents' loan fees (each stock indexed by k), where weights are determined based on the ETF portfolio weights. Thus, if an ETF has a positive abnormal loan fee, then the ETF is more expensive to short than it would be to short the basket of constituent securities.

We also construct a novel measure of ETF liquidity, which we call "AHR Liquidity." Within each month, we calculate each ETF's percentile ranking based on trading volume ($Pctile_{i,t}^{Volume}$ in the below formula) and bid-ask spread ($Pctile_{i,t}^{BAS}$). Hence, based on the below formula for AHR Liquidity, this variable represents an ETF's liquidity relative to other ETFs in a given month:

$$AHRLiquidity_{i,t} = \frac{Pctile_{i,t}^{Volume} + (1 - Pctile_{i,t}^{BAS})}{2} \quad (2)$$

Analogous to the "Abnormal Loan Fee" variable, we also calculate "Abnormal AHR Liquidity" for each ETF, which is the ETF-level AHR Liquidity measure minus the value-weighted average AHR Liquidity of the constituents, where value weights are determined by ETF portfolio weights.[7]

2.2 ETF Loan Fees Are High

In Table 1, we present summary statistics for many of our key variables. In Panel A, we compare summary statistics for loan fees associated with ETFs and stocks. Notably, we observe that the median ETF has a much higher loan fee (324.6 bp per annum) than the median stock (20.7 bp per annum). While 33.0% of our ETF sample has loan fees below 100 bp, we observe that 68.6% of the stock sample has loan fees below 100 bp.

Moreover, we note that there seems to be a higher degree of right-skewness among stock loan fees. While the 90th percentile of ETF loan fees is 486 bp, the 90th percentile of stock loan fees is 513 bp. This is consistent with several papers in the literature that document stocks undergoing special episodes, such as mergers and acquisitions (M&As) and IPOs, tend to have highly elevated lending fees (see, for example, Geczy, Musto, & Reed (2002)). While ETFs have a higher average loan fee, the stock loan fee distribution has more extreme values in the right tail.

In Panel B of Table 1, we document summary statistics for other key variables. For all variables, after comparing the 25th and 75th percentiles, we observe that there is significant cross-sectional variation.

[Table 1]

In Figure 1, we plot histograms comparing monthly ETF loan fees to monthly stock loan fees. We notice that ETF loan fees are more uniformly distributed than stock loan fees. Many stock loan fees cluster under 50 bp per annum, but we do not observe the same clustering for ETF loan fees. Moreover, as we observed in the summary statistics table, it is clear from these histograms that the average ETF has a much higher lending fee than the average stock.

[7] There is a limitation regarding the "abnormal" variables we constructed. For all regressions in which we do not include one of these "abnormal" variables, we are considering ETFs of all asset class focuses and regions (in other words, US equity ETFs, US bond ETFs, and international ETFs are all included). However, our ETF constituent lists are limited to US equity ETFs, so we are only able to construct the "abnormal" variables for US equity ETFs. This is why our sample size is significantly reduced for regressions which include the "abnormal" variables.

[Figure 1]

A natural question to explore is whether ETFs with high loan fees tend to hold stocks with high loan fees. In other words, are the high ETF loan fees we observe attributable to the constituent stocks they hold? To answer this question, we plot a histogram of abnormal loan fees in Figure 2.[8] We note that most ETFs have high abnormal loan fees, indicating that it is generally more expensive for investors to short ETFs than if they were to short the basket of constituent stocks. While there is clustering among abnormal loan fees around 0, many of the abnormal loan fees are quite high. This distribution rules out the possibility that the reason ETF loan fees are high is due to the constituents themselves.

[Figure 2]

Throughout the rest of the paper, we seek to gain understanding for why ETF loan fees are so high relative to the stocks they hold.

3 Empirical Analysis

In this section, we outline our main findings and provide interpretations of the results. In Subsection 3.1, we investigate the determinants of ETF lending market activity (short selling quantities and loan fees). We find that ETF lending quantities and fees are highly correlated with several measures of liquidity. Next, in Subsection 3.2, we document the presence of "short favorite" ETFs, which attract the vast majority of the short interest among ETFs tracking the same index. Moreover, we discuss the characteristics commonly associated with short favorite ETFs. We find that the short favorite ETFs tend to be much more liquid and have lower loan fees than non-favorite ETFs. Finally, in Subsection 3.3, we conclude by proposing a within-index, cross-ETF arbitrage strategy which capitalizes on large differences in loan fees among ETFs that track the same index. We find that this arbitrage strategy is persistently profitable for most indices, even when constraining an investor's ability to lend out his long position.

[8] We discuss the construction of this variable in 2.1.

3.1 Determinants of ETF Lending Market Activity

To understand the relationship between ETF lending quantities and ETF characteristics, Table 2 presents the results from running Fama-MacBeth (1973) regressions with several ETF lending quantity variables as the dependent variables: ETF short interest, ETF quantity on loan, and the ETF quantity available for lending. All three of these variables are scaled by the ETF shares outstanding so they capture the fraction of total shares. We control for several proxies for liquidity (ETF AHR Liquidity, Abnormal AHR Liquidity, Dollar Trading Volume, and AUM). Additionally, we include an array of variables plausibly related to short interest and loan supply, such as institutional ownership, the market price discount or premium to NAV, frictions creating shares (creation fee and creation unit size), expense ratio, dividend yield, net creations, and an indicator variable that takes the value one for ETFs having exchange traded options and zero otherwise.

[Table 2]

Scanning the columns of Table 2, the liquidity proxies are positively and significantly related to shorting and loan quantities. ETFs that have more dollar trading volume and larger assets under management (AUM) have greater fractions of their shares shorted and on loan. We interpret these results to indicate that there are multiple reasons to sell short and lend ETFs. On one hand, larger and more actively traded ETFs are more likely venues to express a short view. Additionally, illiquidity can influence shorting activity likely through arbitrage activity. This is reinforced by the negative and significant loading on the ETF "Discount/Premium" variable. Specifically, for an ETF trading at a premium to its NAV, an arbitrageur would be likely to profit from selling short the ETF.

Among the additional covariates, institutional ownership is also positively and significantly related to the quantity variables. This is consistent with the findings of Bhojraj and Zhao (2021) that SEC Rule 12(b)(1) restrictions on institutional ownwership of investment companies results in frictions that limit the supply of ETF shares available for lending.

Turning to the cost of borrowing ETF shares, Table 3 presents analysis of ETF lending market fees as well as abnormal loan fees (defined as the difference between the ETF loan fee and the weighted average loan fees of the constituent securities). Columns 1 to 4 present regression results using each of the four proxies for liquidity from Table 3 separately. Additionally, columns 5 to 8 repeat the analysis but use abnormal loan fees as the dependent variable.

[Table 3]

Scanning the columns of Table 3, all four liquidity proxies correlate negatively with the loan fee and the abnormal loan fee. This means that after controlling for other characteristics, more liquid ETFs have lower loan fees. The dollar trading volume and size (AUM) variables correlate negatively with loan fees, consistent with there being large, heavily traded ETFs that are more available for lending and thus less expensive to borrow. These results are consistent whether we use the ETF loan fee or the abnormal loan fee as the dependent variable. This consistency across ETF loan fees and abnormal loan fees suggests that the ETF dynamics drive the loan fees, not the cost-to-borrow of the ETF constituent securities. This pattern is consistent with the interpretation that ETF market frictions drive ETF loan fees, and thus shorting activity, as opposed to the frictions of the underlying securities.

Among other covariates, institutional ownership correlates negatively with fees and abnormal fees, consistent with the findings of Bhojraj and Zhao (2021) that SEC Rule 12(b)(1) restrictions on institutional ownwership of investment companies results in ETF lending market frictions. Greater institutional ownership results in lower ETF loan fees, and lower abnormal fees relative to the lending fees of their portfolio securities. Additionally, the ETF dividend yield is positively related to the loan fee.[9] Net creations are positively related to the lending fee. Authorized participants create new shares of the ETFs when there is excess demand for the shares relative to the supply. This is the condition that leads market prices to exceed their fundamental value, so creation activity likely correlates with arbitrageurs' short selling demand. Additionally, the availability of options is negatively related to both fees and abnormal fees, consistent with options

[9]We suspect that the dividend yield may be related to an institutional friction or correlated with another feature that may impact lending activity. We plan to further investigate this link in future versions of the paper.

creating an alternative way to take short positions without borrowing shares to conduct a short sale.

To further understand the patterns observed in ETF lending market activity, we turn to an analysis of the role of the ETF sponsor. We estimate cross-sectional regressions of institutional ownership, loan fees, abnormal loan fees, and abnormal Amihud illiquidity using issuer fixed effects to explain the variation.[10] We regress the model twice for each dependent variable. The first specification includes a fixed effect for each ETF sponsor (with no constant), while the second includes a constant and omits the fixed effect for BlackRock so that the sponsor fixed effect coefficients can be interpreted relative to BlackRock.

[Table 4]

ETF lending variables (institutional ownership, loan fees, and abnormal loan fees) tend to be quite different depending on the ETF sponsor. Institutional ownership is high for BlackRock ETFs and lower for Charles Schwab, Fidelity, Guggenheim, and Vanguard. Charles Schwab tends to issue ETFs with particularly high loan fees, while ETFs issued by State Street (SSgA) tend to be low. Interestingly, the abnormal loan fees do not exhibit the same over/under patterns as the institutional ownership. This appears inconsistent with the Bhojraj and Zhao (2021) idea that institutional ownership is the key driver to ETF lending market frictions.

3.2 ETFs with Low Short Interest Have the Highest Loan Fees

To help explain why many ETF loan fees are so high, we turn our attention to groups of ETFs which track the same index. For most indices that have multiple tracking ETFs, one ETF tends to capture the majority of the short interest and trading volume. We denote the ETF that has the most short interest (in dollars) for each index as the "short favorite" ETF. We display the short favorites for indices with multiple tracking ETFs in Table 5.

[Table 5]

[10]To estimate an ETF's Abnormal Amihud Illiquidity, we take the difference between the ETF-level Amihud illiquidity measure and weighted average of constituent stocks' Amihud illiquidity measures.

In Table 5, we present a list of indices, along with the number of tracking ETFs we identify in our sample, the short favorite ETF, the oldest ETF, the most liquid ETF, and the lowest loan fee ETF. We also report the percentage of total index trading volume that is captured by the short favorite ETF, as well as the percentage of total index short interest that is captured by the short favorite ETF. Moreover, we report the AUM of the short favorite and short least-favorite ETFs, as well as the loan fee spread between the highest and lowest loan fees of ETFs which track each index.

We find that the short favorite ETF is often also the oldest ETF, the most liquid ETF, and the lowest loan fee ETF to track the index, although there are exceptions to this pattern. Moreover, for the 31 indices presented in the table, we find that the short favorite ETF captures over 50% of the index total trading volume for 26 out of 31 indices, showing that short favorites also tend to be highly liquid.

In Figure 3, we compare short favorite and non-favorite ETF loan fees. The distribution of the favorites has much more mass in the under-100 bp region of the distribution, while the non-favorite distribution has more mass on the right tail of the distribution. Non-favorite ETFs tend to be much more expensive to short.

[Figure 3]

Additionally, in Figure 4, we overlay histograms of the distribution of stock loan fees and the distribution of short favorite ETF loan fees. It is striking how similar the distributions of ETF and stock loan fees appear once we remove the non-favorite ETFs from the sample. Overall, it appears that our finding that ETF loan fees tend to be higher than stock loan fees is driven primarily by the less-liquid, less-frequently shorted "non-favorite" ETFs.

[Figure 4]

Recognizing the previous result may be due to non-favorite ETFs holding higher loan fee stocks, we also display the distribution of the abnormal loan fees for the favorite and non-favorite ETFs in Figure 5. The distributions of abnormal loan fees for short favorites and non-favorites are even more different when comparing the abnormal loan fee distributions.

[Figure 5]

A natural question to explore is, what ETF characteristics predict an ETF being the short favorite for an index? We explore this question in Table 6, in which we run Fama-MacBeth (1973) regressions of the short favorite dummy on ETF characteristics. We find that cross-sectionally, ETFs are more likely to be short favorites when they are highly liquid and when they trade at a premium relative to NAV. The fact that liquid ETFs are more likely to be short favorites is consistent with short sellers' preference for liquidity, which may reduce the riskiness of their short strategies. The fact that ETFs that trade at a premium are more likely to be short favorites is consistent with the interpretation that short sellers prefer to short ETFs exhibiting price premiums either with the aim of profiting on their expected price corrections or not experiencing further price divergence from net-asset-value.

[Table 6]

3.3 Cross-ETF Arbitrage

In our previous results, we demonstrated that even though two ETFs may track the same index, their lending fees can be quite different because of differences in investor appetite, which relates to liquidity, which in turn relates to lending fees. The fact that two ETFs can have almost identical economic exposure yet have two fairly different lending fees invites us to speculate about arbitrage strategies. If an arbitrage strategy appears to exist in at an economically meaningful scale, it would support the idea that there is some underlying economic cause for the differences in loan fees, and it is evidence against random, or uncaused, variations in loan fees.

As a way of demonstrating the economic importance of loan fee differences, we construct a trading strategy that profits from this difference in loan fees. The main idea is for the hypothetical arbitrageur to go long an ETF with a high loan fee and lend it out, thus capturing loan fees received, while going short an ETF with a low loan fee on the same index to benefit from the low cost of short selling. Intuitively, the profit from this strategy would come from differences in loan fees.

Risk from the strategy would be generated from two main sources. The first source would be differences in the underlying economic exposure, which, since the two ETFs track the same index, arises from differences in tracking error between the two ETFs. [11] The second source of arbitrage risk would be any unpredictable differences in loan fees received and loan fees earned, including the possibility that the loan fee for the shorted ETF increases. We will analyze both of these limits to arbitrage in our analysis.

To be specific, the formula for calculating cross-ETF arbitrage profits for index i in month t is the following:

$$ArbProfit_{i,t} = (R_{i,t}^{LongETF} - R_{i,t}^{ShortETF}) + \frac{(LoanFee_{i,t}^{LongETF} - LoanFee_{i,t}^{ShortETF})}{12 * 10000} \text{[12]} \qquad (3)$$

In the above equation, $R_{i,t}^{LongETF}$ represents the return generated by the ETF on the long end of the strategy which tracks index i in month t. The long ETF is chosen as the ETF tracking index i with the highest loan fee, whereas the short ETF is chosen as the ETF tracking index i with the lowest loan fee.[13]

Although tracking error differences and loan fee differences are the two limits to arbitrage that we analyze in our empirical setting, it is likely that other kinds of more investor-specific limits may also play a role for practitioners implementing such a strategy. These costs might include (i) trading costs, (ii) the fact that the trader may not receive the full amount of lent ETF shares' loan fees on the long side, and similarly, (iii) the cost of any markup above wholesale on ETF lending fees paid on the short side. There may also be some operational risk, but it's not clear that it would be any higher than that kind of risk on any other long - short strategy.

[Figure 7]

As examples of such strategies we focus on two indices, one stock index and one

[11]Tracking error is the obvious divergence from a pure arbitrage. Since tracking error is typically very small, this concern is limited. Furthermore, if the long and short ETFs each have tracking error, but that error is correlated, which we might expect it to be given shared economic motivations among ETF sponsors, it's less of a concern from the arbitrageur's point of view. The tracking errors may cancel each other out to some degree if they are positively correlated.

[12]The 12 in the denominator accounts for the fact that the loan fee is annualized, and we are calculating arbitrage profits on a monthly basis. We also divide by 10000 to convert the loan fee, which is in basis points, to be on the same scale as the returns.

[13]Empirically, almost the entire arbitrage profit comes from the loan fee difference, rather than the difference in ETF returns.

bond index. For stocks, we use the S&P Midcap 400 index (SPTRMDCP), in which we go long IVOO (Vanguard S&P Mid-Cap 400 Index Fund ETF) and we go short IJH (iShares Core S&P Mid-Cap ETF).[14] In Figure 7, we show the cumulative profitability from the arbitrage strategy over the course of the sample. We find that over the period from 8/2012 to 3/2015, there's an annual profit of 2.4%, with an annual Sharpe ratio of 3.1 due to the fact that a within-index arbitrage strategy yields a very stable series of returns. Of course it's not clear that all ETF shares in the hypothetical trader's long position will be lent, so we also present a version of the arbitrage strategy that is utilization-adjusted. In other words, we also compute returns to a strategy in which investors are constrained to lend out their full long position. With the utilization adjustment, the profitability of cross-ETF arbitrage within the SPTRMDCP index yields an annual profitability of 1.7% with an annual Sharpe ratio of 2.3.

Using the Bloomberg U.S. Treasury inflation notes index (LBUTTRUU), we find similar results. In this particular strategy we go long SCHP (Schwab US TIPS ETF) and short TIP (iShares TIPS Bond ETF), and we find an annual profit of 12.1% with an annual Sharpe ratio of 7.6. Utilization is a more significant constraint with this index, and in the utilization-adjusted strategy we find that the annual profit is 6.6% with an annual Sharpe ratio of 3.6.

[Table 7]

In addition to these two examples, we show the result for the entire cross section in Table 7. We show the profitability of these strategies for 26 different indices for which there exist at least two tracking ETFs.

The unadjusted average annual profitability is 3.1%, and the average annual Sharpe ratio is 3.4. This is evidence that in the large cross section of ETFs, there are a significant number of arbitrage opportunities stemming from differences in loan fees. In some cases, the Sharpe ratios are quite large. For example the Sharpe ratio is over 3 for 13 out of 26 indices. This is due to the fact that the risk to this strategy is relatively low since the strategy goes long and short the same index. Hence, the arbitrageur is able to capture

[14] It should be noted that this strategy does not always go long the same ETF and short the same ETF throughout the length of the period. Instead, on a monthly basis, the strategy goes long in the highest lending fee ETF and it goes short in the lowest lending fee ETF, and those ETFs change throughout the sample. In the case of the S&P Midcap 400 index, IVOO is the long choice and IJH is the short choice in 39 out of 39 months.

the loan fee difference without experiencing too much volatility due to the fact that the tracking errors of the long and short legs largely cancel each other out on average.

Of course, utilization can make an important difference on the long side for the hypothetical arbitrageur implementing this strategy. To capture this consideration, we also show the ETF arbitrage profitability adjusting for utilization. This adjustment takes ETF-specific utilization and uses it as a proxy for the hypothetical arbitrageur's utilization experience. We assume in this strategy that the arbitrageur will only be able to lend out a percentage of their long position based on the market-wide utilization for the long ETF.

To be specific, the formula for calculating utilization-adjusted cross-ETF arbitrage profits for index i in month t is the following:

$$ArbProfit_{i,t} = (R_{i,t}^{LongETF} - R_{i,t}^{ShortETF}) + \frac{(\theta_{i,t}^{LongETF} LoanFee_{i,t}^{LongETF} - LoanFee_{i,t}^{ShortETF})}{12 * 10000}, \tag{4}$$

where the variable $\theta_{i,t}^{LongETF}$ represents the market-wide utilization for the long ETF tracking index i in month t and is between 0 and 1.

In the utilization-adjusted strategy columns of Table 7, we find that the annual profitability (and Sharpe ratios) are positive for 17 of the 26 ETF indices. Even after making this utilization adjustment, which only detracts from the theoretically possible profits to this strategy, some of the Sharpe ratios are quite large. In the three most profitable strategies the Sharpe ratio is over three, and for 11 out of 26 strategies, the Sharpe ratio is over one.

Furthermore the liquidity of the strategy is relatively high. In the column Short ETF Tvol %-ile, we present the percentile of stock liquidity based on trading volume.[15] In the S&P Midcap 400 index example, we find that the percentile of liquidity for the short ETF, IJH, is 96%. In other words, shorting IJH is like shorting the 96th percentile stock in terms of trading volume. Similarly, buying IVOO is like buying the 48th percentile stock. Based on liquidity alone, this is approximately equivalent to going long in the Ruby Tuesday (RT) stock and going short in the Nvidia (NVDA) stock, which gives the overall impression that many of these arbitrage pairs are reasonably liquid.

[15] These percentiles are measured against our stock universe, which is the entire CRSP universe in March 2015.

Moreover, in the "Conditional Strategy" columns, we calculate returns to an additional arbitrage strategy, in which the arbitrageur decides whether or not to enter the strategy based on whether the strategy was profitable in the previous month. This allows an investor to stay out of the strategy if it has recently earned negative returns. We find that this adjustment largely does not affect the profitability of the strategy, as negative returns are rare.

Overall, these results demonstrate that there are economically meaningful differences between the lending fees of ETFs tracking the same index. The fact that this arbitrage strategy exists, and appears to be profitable, is a way of conveying the fact that these lending fee differences are significantly larger than what we would expect from noisy, or random, variations and lending fees, and as such they support the idea that there may be some economically-driven differences in lending fees, potentially driven by the economic story we've outlined above.

4 Conclusion

We find that ETF loan fees are high. We show that unlike equities, where most stock - loan days have loan fees under 100 basis points, only about 1/3 of ETF loan fees are under 100 basis points. Similarly, the median loan fee for ETFs is 162.9 basis points while the median loan fee for stocks is much lower, at 20.7 basis points.

Since the availability of the create / redeem mechanism for ETFs should link the loan fees of the ETFs' constituents to the loan fee of the ETF itself, we know ETF loan fees are too high. Using this insight, we construct a new method of evaluating ETF loan fees by reconstructing ETF holdings and calculating the difference between average loan fees on the holdings and loan fees on the ETFs. Using this method, we document that ETF loan fees are consistently above what would be expected based on the loan fees of their underlying constituents.

We provide an interesting insight about the market in ETFs, namely that there tends to be a "short favorite" ETF for many indices. Using total short interest (in dollars), we assign short favorite and non-favorite labels. We find that the short favorites are generally more liquid. For the most part, the ETFs which capture the most short interest within an index also tend to have the highest trading volume among ETFs tracking the index.

We also find that the short favorites have certain, intuitively sensible, characteristics that correlate with their status as a short favorite. When testing the cross-sectional correlations between a dummy variable which captures whether an ETF is a short favorite or not, it is apparent that ETFs which are short favorites tend to have higher trading volume and trade at a higher premium relative to NAV. These characteristics are intuitively plausible and help explain why an ETF might be an attractive short target relative to other ETFs tracking the same index.

As a way of demonstrating the economic magnitude of this discrepancy in loan fees, we construct a trading strategy that relies on the difference in loan fees between ETFs which track the same index. Specifically, the cross-ETF arbitrage strategy involves buying long (and lending) the ETF with the highest loan fee among ETFs tracking an index and shorting the ETF with the lowest loan fee. This strategy is persistently and strongly profitable, as it allows the investor to capture the loan fee difference between ETFs which track the same index. We find that across the 26 indices which have multiple tracking ETFs, the average annual profitability of this strategy would be about 3.1% with an annual Sharpe ratio of 3.4. We also calculate the profitability of this strategy when we constrain the ability of an arbitrageur to fully lend out his long position based on market-wide loan utilization, and we still find that the strategy is persistently profitable for most indices.

The insight that there are "favorite" and "non-favorite" ETFs to short within each index provides a partial explanation for the high loan fee phenomenon. We posit that the lack of liquidity in the non-favorite ETFs leads to low demand for those ETF in general, since all things being equal, investors, both long and short, prefer more liquidity to less. This leads to low ownership of the non-favorite ETFs in general, and low holdings among institutional investors in particular, which leads to a lack of loan supply and a higher loan fee.

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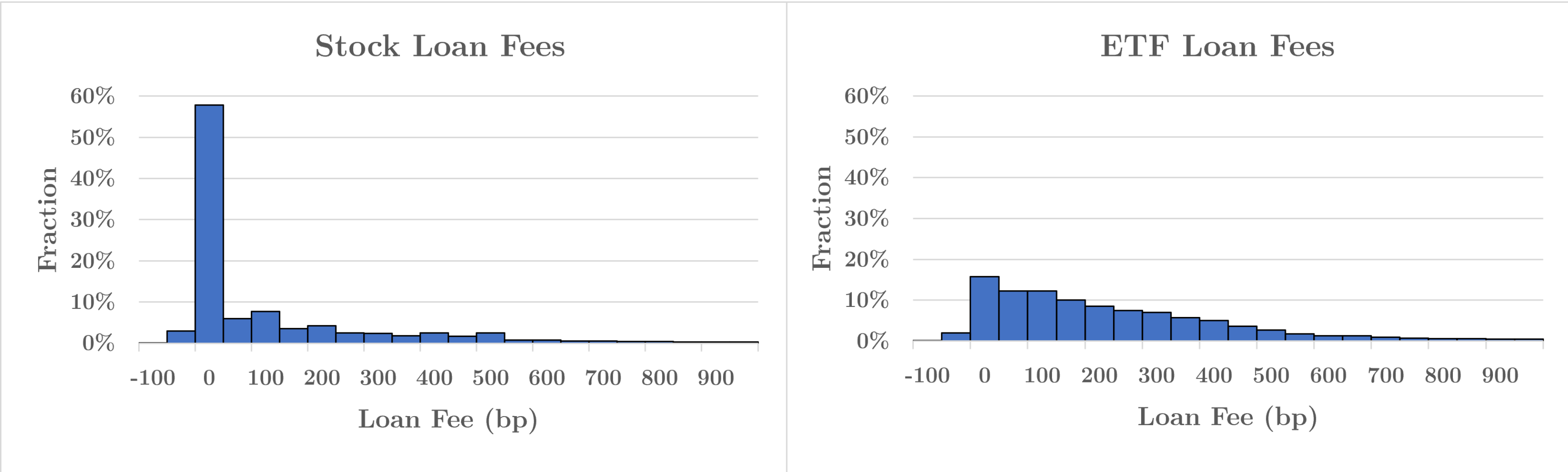

Figure 1. Histograms comparing stock loan fees to ETF loan fees. Overall, over the full sample, we observe that the average ETF has a much higher average loan fee than the median stock.

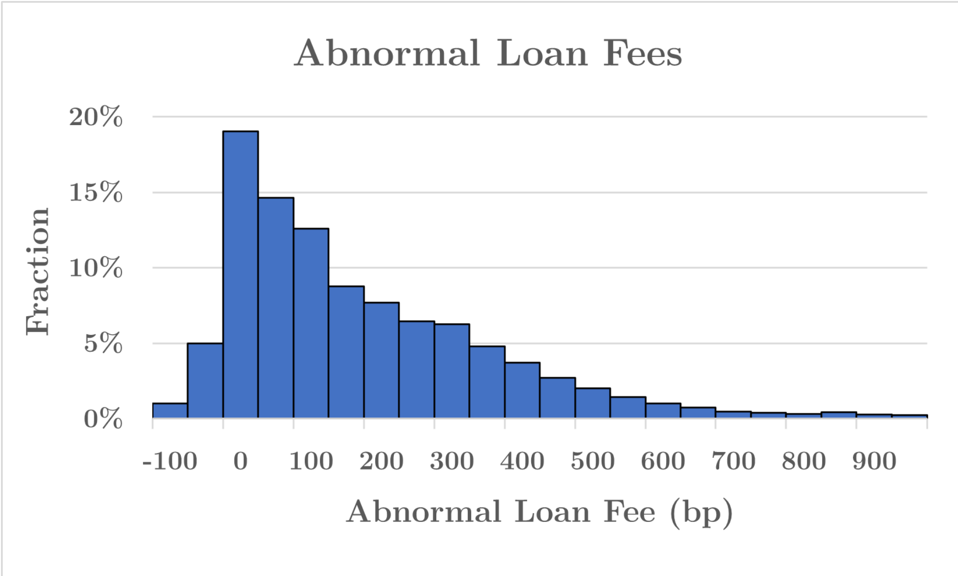

Figure 2. Histogram of abnormal loan fees. This plot displays the histogram of abnormal loan fees for the full sample. The abnormal loan fee is defined as the ETF loan fee minus the weighted average of ETF constituent loan fees, where weights are the ETF portfolio weights. The median abnormal loan fee is 146 bp, while the mean abnormal loan fee is 207 bp. Overall, we observe that ETFs tend to have higher lending fees than the constituents they hold in their portfolios.

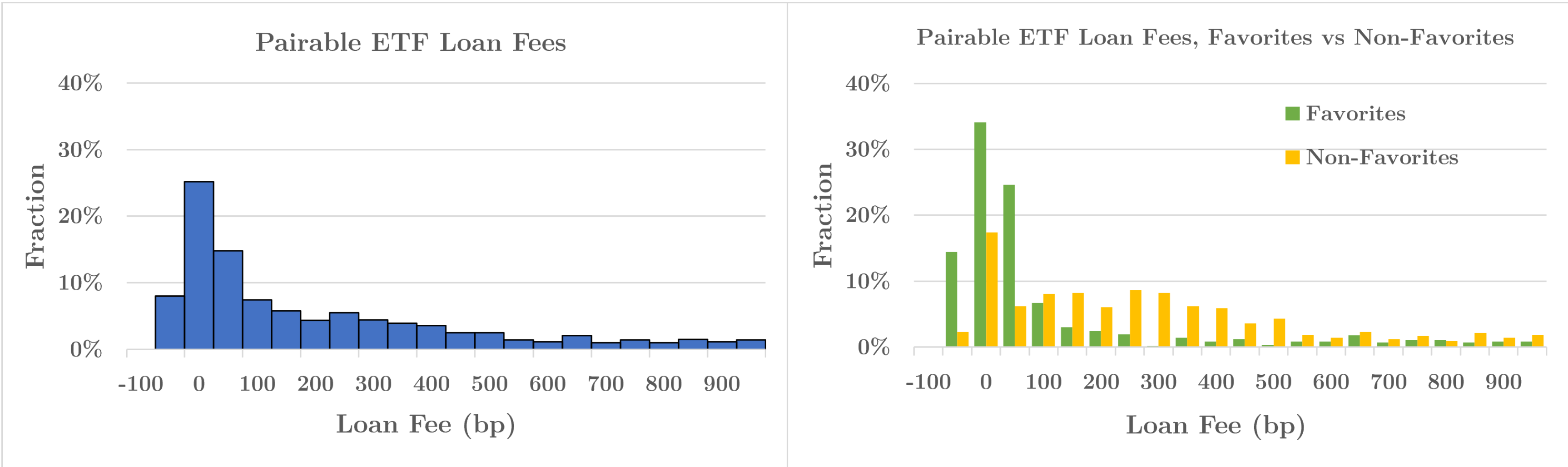

Figure 3. Histograms of ETF loan fees, comparing short favorites to non-favorites. The left plot displays the histogram of ETF loan fees for the subsample of indices which have at least 2 tracking ETFS. The right plot displays the histogram of ETF loan fees for the same "multi-ETF" indices, split between short favorite ETFs and non-favorite ETFs. The "favorite" ETF is defined for each index as the ETF which is the most heavily lent (based on quantity lent in dollars). An ETF must not be the only ETF to track an index to be considered a short favorite or non-favorite.

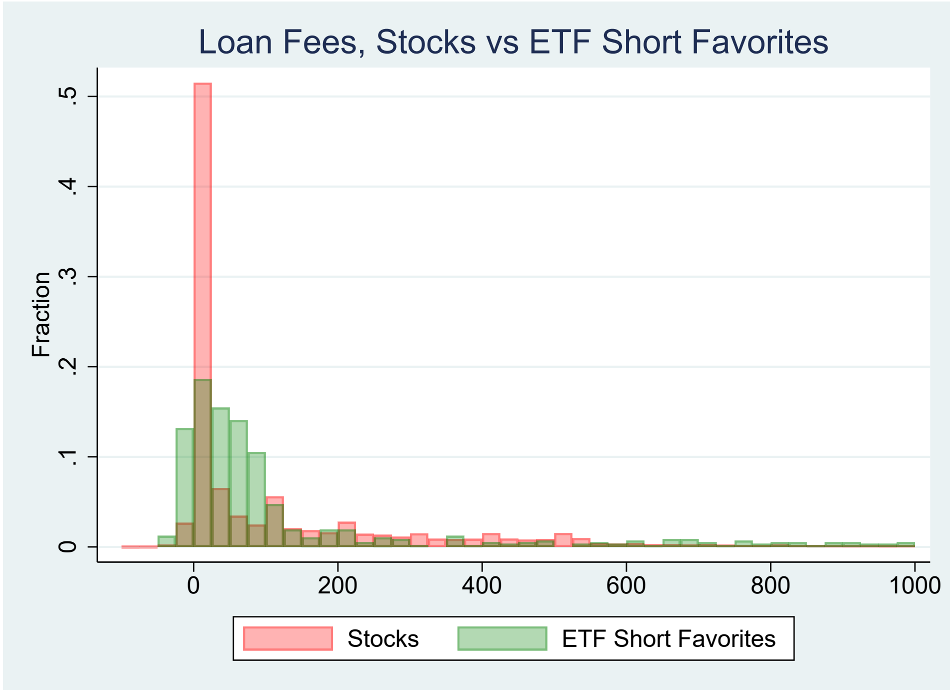

Figure 4. Histograms of stock and ETF short favorite loan fees. This figure displays the histogram of stock loan fees overlaid with the histogram of "short favorite" ETF loan fees. When removing the "non-favorite" ETFs, the distribution of ETF loan fees looks more like the distribution of stock loan fees. The "favorite" ETF is defined for each index as the ETF which is the most heavily lent (based on quantity lent in dollars). An ETF must not be the only ETF to track an index to be considered a short favorite or non-favorite.

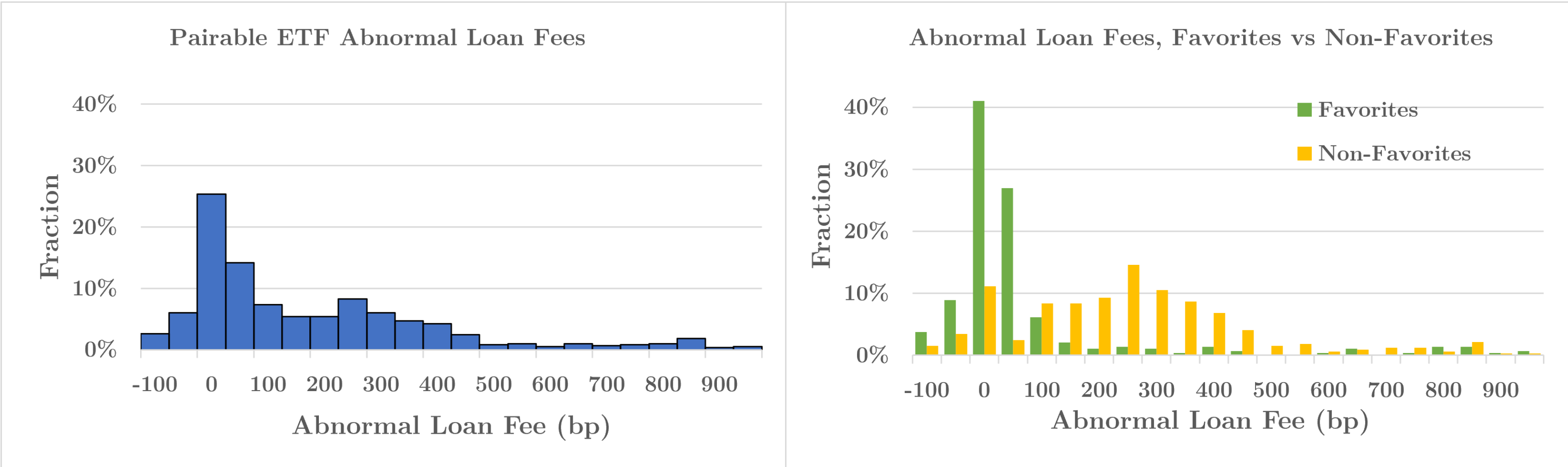

Figure 5. Histograms of abnormal loan fees, comparing short favorites to non-favorites. The abnormal loan fee is defined as the ETF loan fee minus the weighted average of ETF constituent loan fees, where weights are determined by ETF portfolio weights. The "favorite" ETF is defined for each index as the ETF which is the most heavily lent (based on quantity lent in dollars). The left plot displays a histogram of abnormal loan fees for all multi-ETF indices, while the right graph shows a histogram of abnormal loan fees split between short favorites (in red) and non-favorites (in green). An ETF must not be the only ETF to track an index to be considered a short favorite or non-favorite.

Figure 6. SSGA ETF Lending Advertisement. This ad shows the potential yield from lending SPY, even after constraining an investor's ability to lend based on the utilization rate. This ad showed up on one of the authors' LinkedIn page and provides evidence that some investors are aware of the potential profitability of ETF lending.

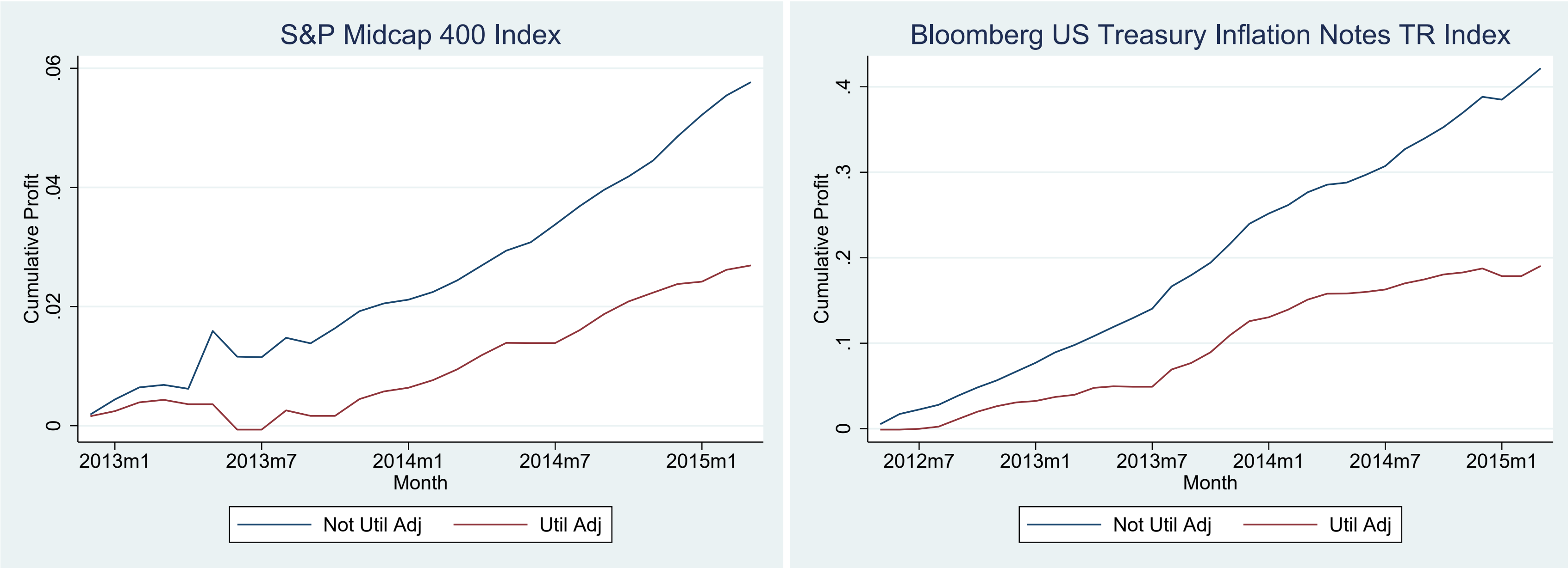

Figure 7. Cumulative cross-ETF arbitrage profits for two of the most profitable cross-ETF arbitrage indices. We plot profits for index SPTRMDCP (S&P Midcap 400 Index) and LBUTTRUU (Bloomberg US Treasury Inflation Notes TR Index) because they yield higher Sharpe ratios than any other indices in the sample when implementing our arbitrage strategy, adjusting for utilization. To implement the cross-ETF arbitrage strategy, an investor would need to find an index which has more than one ETF tracking it, and he would short the ETF with the low loan fee and long the ETF with the high loan fee. The investor would lend the ETF with the high loan fee and collect the fee as profit, while paying the loan fee on the low-fee ETF. The non-utilization-adjusted profits are calculated assuming that the investor can fully lend his long position, and thus the net arbitrage profit will simply be a difference in loan fees between the two ETFs. The utilization-adjusted profit is likely more realistic, which adjusts the aforementioned strategy to assume that the investor can only lend a certain percentage of his long position based on the long ETF's loan utilization ratio.

Table 1. Summary Statistics

This table presents summary statistics for many of our key variables. These variables have been winsorized at the 1% and 99% levels. We have also imposed a portfolio matching restriction of at least 50% in order for an ETF to be included in the sample. AR1 coefficients are estimated based on a 1-month lag.

Panel A: Comparison of ETF and Stock Loan Fees

	10th	**25th**	**50th**	**75th**	**90th**	**Mean**	**SD**	**% Sample under 100bp**
ETFs	23.9	73.3	162.9	324.6	485.6	223.9	208.3	33.0%
Stocks	6.2	10.1	20.7	201.7	512.7	203.7	538.3	68.6%
ETF Favorites	2.6	23.0	65.6	194.2	532.6	167.5	245.9	65.2%
ETF Non-Favorites	30.7	157.8	285.2	427.2	788.8	355.6	324.0	15.8%

Panel B: Summary Statistics for Other Variables

Variable	**10th**	**25th**	**50th**	**75th**	**90th**	**Mean**	**SD**
Abnormal Loan Fee (bp)	13.8	54.9	145.5	309.8	468.7	207.4	206.2
Tracking Error (x10^{-3})	0.4	0.6	0.9	1.8	3.6	1.6	1.8
Discount/ Premium (x10^{-3})	-1.9	-0.2	0.2	0.8	2.2	10.8	251.0
Expense Ratio	0.10	0.20	0.38	0.55	0.65	0.40	0.31
Creation Unit Size (thousands)	25	50	50	50	50	52	25
Creation Fee	250	500	500	1000	2200	1094	1910
AUM ($, millions)	140	236	557	2010	6810	3090	10600
Daily $ Trading Volume ($, millions)	0.8	1.8	4.8	21.1	137.0	159.0	1360.0
Monthly ETF Return	-3.82%	-1.27%	1.63%	3.77%	5.63%	1.16%	4.06%
Abnormal ETF Return	-1.18%	-0.46%	-0.02%	0.37%	0.89%	-0.08%	1.82%
ETF Amihud Illiquidity (x10^{-7})	0.001	0.004	0.022	0.078	0.198	0.079	0.249
Abnormal Amihud Illiquidity (x10^{-7})	-0.110	-0.020	0.001	0.050	0.160	0.004	0.257
ETF AHR Liquidity	0.189	0.293	0.440	0.619	0.799	0.467	0.223
Abnormal AHR Liquidity	-0.387	-0.258	-0.087	0.116	0.293	-0.070	0.327

Panel C: AR1 Coefficients

Variable	**10th**	**25th**	**50th**	**75th**	**90th**	**Mean**	**SD**
ETF Loan Fee	0.39	0.58	0.71	0.83	0.91	0.68	0.21
Stock Loan Fee	0.36	0.56	0.75	0.88	0.95	0.69	0.25
ETF Qty Lent / Shrout	0.18	0.34	0.54	0.74	0.85	0.52	0.27
Stock Qty Lent / Shrout	0.38	0.67	0.84	0.93	0.96	0.75	0.24
ETF Qty Available / Shrout	0.28	0.46	0.66	0.82	0.93	0.63	0.26
Stock Qty Available / Shrout	0.69	0.83	0.92	0.96	0.98	0.87	0.15
Abnormal Loan Fee	0.41	0.56	0.69	0.81	0.90	0.66	0.20
AHR Liquidity	-0.15	-0.01	0.14	0.28	0.45	0.14	0.23

Table 2. Regressions of ETF Lending Quantities on ETF Characteristics

In this table, we display the results from Fama-Macbeth (1973) regressions on monthly data. We employ Newey-West standard errors with 4 lags. The short selling quantity variables (Short Interest, Quantity Lent, and Quantity Available) have all been scaled by shares outstanding. *ETF AHR Liquidity* is calculated as follows: within each month, we calculate the percentiles of the ETF among other ETFs based on bid-ask spread and trading volume. We then calculate the mean of the trading volume percentile and 1 minus the bid-ask spread percentile, such that AHR Liquidity is a measure of an ETF's liquidity relative to other ETFs. *Abnormal AHR Liquidity* is the ETF-level AHR Liquidity minus the value-weighted average of the ETF's constituents' AHR Liquidity. Note that in calculating constituents' AHR Liquidity measure, we calculated percentiles of stock bid-ask spreads and trading volumes relative to other stocks. *Dollar Trading Volume* is $ln(DollarTradingVolume)$ and *AUM* is $ln(AUM)$. *Institutional Ownership Pct* is the ETF's total institutional ownership as a percentage of shares outstanding. *Net Creations* is calculated as the monthly percent change in shares outstanding. We winsorize all variables at the 1% and 99% levels, and we impose a portfolio matching restriction of at least 50%.

	ETF Short Interest / Shares Out				ETF Qty Lent / Shares Out				ETF Qty Avail / Shares Out			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ETF AHR Liquidity	0.114***				0.027***				0.033***			
	(8.970)				(4.235)				(18.347)			
Abnormal AHR Liquidity		0.038***				0.010***				0.020***		
		(6.318)				(5.113)				(8.736)		
Dollar Trading Volume			0.024***				0.005***				0.006***	
			(13.427)				(9.916)				(19.236)	
AUM				0.003**				-0.001				0.006***
				(2.329)				(-1.333)				(10.737)
Institutional Ownership Pct	0.351***	0.366***	0.316***	0.376***	0.079***	0.082***	0.071***	0.087***	0.020***	0.022***	0.011**	0.024***
	(12.878)	(13.816)	(12.227)	(14.250)	(13.840)	(14.066)	(13.316)	(15.054)	(4.951)	(4.973)	(2.631)	(6.040)
Discount/Premium	-0.251***	-0.237**	-0.213**	-0.232**	-0.038***	-0.032***	-0.030**	-0.030***	0.009***	0.013***	0.018***	0.010***
	(-2.826)	(-2.723)	(-2.536)	(-2.695)	(-3.159)	(-3.090)	(-2.695)	(-2.866)	(2.879)	(3.563)	(4.775)	(3.317)
Creation Fee	-0.000	-0.000	-0.000	-0.000	0.000	0.000	0.000	0.000	0.000**	0.000**	0.000	0.000
	(-0.153)	(-0.679)	(-1.437)	(-1.100)	(1.494)	(1.388)	(0.589)	(1.118)	(2.072)	(2.062)	(1.536)	(1.257)
Creation Unit Size	0.000	0.000***	0.000*	0.000***	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.725)	(2.988)	(1.895)	(3.254)	(0.299)	(1.144)	(0.751)	(1.297)	(0.896)	(1.411)	(1.145)	(1.589)
Expense Ratio	-0.006	-0.012***	0.025***	-0.008*	0.004	-0.005**	0.014**	-0.009***	-0.014***	-0.018***	-0.004*	-0.005*
	(-1.233)	(-2.737)	(4.540)	(-1.928)	(0.590)	(-2.081)	(2.082)	(-4.181)	(-3.898)	(-6.013)	(-1.704)	(-1.969)
Dividend Yield	-0.461	0.024	-0.425	-0.435	-0.026	0.012	0.056	-0.085	0.098*	0.300***	0.171***	0.041
	(-1.555)	(0.078)	(-1.457)	(-1.631)	(-0.273)	(0.137)	(0.450)	(-1.110)	(1.982)	(3.865)	(3.048)	(0.587)
Net Creations	-0.103***	-0.107***	-0.079***	-0.108***	-0.032***	-0.032***	-0.027***	-0.036***	-0.016**	-0.017**	-0.010*	-0.012*
	(-5.255)	(-4.934)	(-4.640)	(-4.669)	(-3.851)	(-4.063)	(-3.196)	(-3.946)	(-2.683)	(-2.688)	(-1.758)	(-2.007)
Options Available	-0.011**	0.006	-0.031***	0.012*	-0.003	0.001	-0.007***	0.005***	0.001	0.004***	-0.002*	0.001
	(-2.570)	(0.930)	(-8.977)	(1.740)	(-1.520)	(1.352)	(-4.317)	(3.326)	(0.971)	(3.258)	(-1.719)	(0.560)
N	8545	8545	8545	8545	7310	7310	7310	7310	7310	7310	7310	7310
R^2	0.528	0.513	0.565	0.509	0.492	0.484	0.516	0.479	0.297	0.284	0.338	0.312

Table 3. Regressions of ETF Lending Fees on ETF Characteristics

In this table, we display the results from Fama-Macbeth (1973) regressions on monthly data. We employ Newey-West standard errors with 4 lags. The Abnormal Loan Fee variable is calculated as the ETF loan fee minus the value-weighted average of the constituent loan fees. *ETF AHR Liquidity* is calculated as follows: within each month, we calculate the percentiles of the ETF among other ETFs based on bid-ask spread and trading volume. We then calculate the mean of the trading volume percentile and 1 minus the bid-ask spread percentile, such that AHR Liquidity is a measure of an ETF's liquidity relative to other ETFs. *Abnormal AHR Liquidity* is the ETF-level AHR Liquidity minus the value-weighted average of the ETF's constituents' AHR Liquidity. Note that in calculating constituents' AHR Liquidity measure, we calculated percentiles of stock bid-ask spreads and trading volumes relative to other stocks. *Dollar Trading Volume* is $ln(DollarTradingVolume)$ and *AUM* is $ln(AUM)$. *Institutional Ownership Pct* is the ETF's total institutional ownership as a percentage of shares outstanding. *Net Creations* is calculated as the monthly percent change in shares outstanding. We winsorize all variables at the 1% and 99% levels, and we impose a portfolio matching restriction of at least 50%.

	Loan Fee (%)				Abnormal Loan Fee (%)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ETF AHR Liquidity	-1.676***				-1.591***			
	(-11.543)				(-10.804)			
Abnormal AHR Liquidity		-0.876***				-1.048***		
		(-6.700)				(-6.905)		
Dollar Trading Volume			-0.352***				-0.345***	
			(-7.828)				(-7.572)	
AUM				-0.428***				-0.410***
				(-9.102)				(-9.190)
Institutional Ownership Pct	-1.330***	-1.479***	-0.754**	-1.395***	-1.503***	-1.574***	-0.928***	-1.563***
	(-3.211)	(-3.660)	(-2.101)	(-3.812)	(-3.869)	(-4.162)	(-2.805)	(-4.516)
Discount/Premium	-0.230	-0.450**	-0.790***	0.026	0.281	0.115	-0.256**	0.530*
	(-1.121)	(-2.201)	(-3.229)	(0.168)	(1.422)	(0.602)	(-2.117)	(1.934)
Creation Fee	0.000	0.000	0.000	0.000**	0.000	0.000	0.000	0.000
	(0.824)	(1.015)	(1.492)	(2.313)	(0.175)	(0.257)	(0.879)	(1.622)
Creation Unit Size	0.000*	0.000	0.000	0.000	0.000**	0.000	0.000*	0.000
	(1.874)	(0.459)	(1.369)	(0.032)	(2.346)	(1.214)	(1.928)	(0.510)
Expense Ratio	1.056***	1.313***	0.403**	0.200	0.626***	0.802***	-0.023	-0.202
	(8.332)	(6.142)	(2.656)	(1.079)	(5.046)	(4.112)	(-0.133)	(-1.003)
Dividend Yield	46.818***	37.959***	42.459***	49.249***	39.268***	28.498***	35.079***	41.627***
	(6.299)	(4.506)	(6.297)	(5.555)	(4.325)	(2.841)	(4.009)	(3.946)
Net Creations	3.471***	3.472***	3.051***	3.061***	3.415***	3.422***	3.000***	3.020***
	(10.028)	(9.462)	(8.380)	(9.048)	(10.404)	(9.981)	(9.064)	(9.861)
Options Available	-0.508***	-0.683***	-0.233***	-0.269***	-0.568***	-0.675***	-0.286***	-0.337***
	(-11.675)	(-15.625)	(-2.870)	(-3.770)	(-11.708)	(-15.596)	(-3.994)	(-5.532)
N	7310	7310	7310	7310	7310	7310	7310	7310
R^2	0.311	0.296	0.347	0.348	0.315	0.309	0.351	0.351

Table 4. Issuer Fixed Effects

The regressions presented in this table are all cross-sectional. We drop any ETF sponsors that have fewer than 10 ETFs outstanding for this analysis. We winsorize all variables at the 1% and 99% levels, and we impose a portfolio matching restriction of at least 50%.

	Inst. Ownership		Loan Fee		Abnormal Loan Fee		Abnormal Amihud Illiquidity	
BlackRock	0.474***		1.957***		1.842***		0.003	
	(21.779)		(14.143)		(13.086)		(0.149)	
Charles Schwab	0.238***	-0.237***	8.327***	6.370***	8.594***	6.752***	0.018	0.014
	(8.223)	(-6.538)	(15.995)	(11.807)	(13.559)	(10.384)	(1.109)	(0.533)
Fidelity	0.399***	-0.075	4.238***	2.281***	4.160***	2.318***	-0.109	-0.112
	(8.125)	(-1.391)	(16.648)	(7.862)	(16.007)	(7.833)	(-1.574)	(-1.544)
First Trust	0.582***	0.108*	3.057***	1.099***	2.817***	0.975***	0.030**	0.027
	(10.345)	(1.783)	(14.508)	(4.356)	(13.580)	(3.887)	(2.515)	(1.076)
Global X	0.468***	-0.006	4.976***	3.019***	4.680***	2.838***	-0.184*	-0.187*
	(5.071)	(-0.067)	(7.313)	(4.341)	(7.296)	(4.315)	(-1.850)	(-1.837)
Guggenheim	0.401***	-0.074**	3.657***	1.700***	3.452***	1.610***	0.058**	0.054
	(17.732)	(-2.342)	(14.621)	(5.939)	(14.054)	(5.680)	(2.040)	(1.523)
Invesco	0.445***	-0.029					0.080***	0.077**
	(15.742)	(-0.811)					(3.790)	(2.527)
Northern Trust	0.922***	0.448***	4.482***	2.525***	4.389***	2.547***	0.017	0.014
	(73.191)	(17.785)	(5.212)	(2.894)	(4.824)	(2.762)	(0.230)	(0.180)
SSgA	0.737***	0.263**	1.607***	-0.350	1.432***	-0.410*	0.030**	0.027
	(7.273)	(2.533)	(8.061)	(-1.440)	(7.043)	(-1.658)	(2.136)	(1.040)
Vanguard	0.357***	-0.118***	1.946***	-0.012	1.833***	-0.009	-0.066*	-0.069
	(20.578)	(-4.228)	(9.611)	(-0.047)	(9.143)	(-0.038)	(-1.712)	(-1.563)
WisdomTree	0.380***	-0.094***	3.429***	1.471***	3.273***	1.431***	0.043	0.039
	(18.784)	(-3.177)	(8.540)	(3.459)	(8.192)	(3.374)	(0.802)	(0.686)
Constant		0.474***		1.957***		1.842***		0.003
		(21.779)		(14.143)		(13.086)		(0.149)
N	369	369	333	333	333	333	397	397
R^2	0.535	0.176	0.671	0.467	0.663	0.474	0.070	0.068

Table 5. List of ETF Favorites for Multi-ETF Indices, March 2015.

The "short favorite" is defined for each index as the ETF which captures the highest quantity lent in dollars. Instances in which the short favorite ETF is not the same as the oldest, most liquid, or lowest loan fee ETF to track the index are in bold. The "Loan Fee Spread" column indicates the difference between the highest and lowest loan fees on ETFs which track the index, as of March 2015.

Asset Class	Index Ticker	Index Name	Num ETFs	Short Favorite ETF (Highest $ Qty Lent)	Oldest ETF	Most Liquid ETF (Highest $ Tvol)	Lowest Loan Fee ETF	Short Favorite Trading Vol / Total Index Trading Vol	Short Favorite Qty Lent / Total Index Qty Lent	Short Favorite AUM ($MM)	Short Favorite Least AUM ($MM)	Loan Fee Spread
US Equity	DW25T	Dow Jones U.S. Broad Stock Market Total Ret Idx	2	SCHB	SCHD	SCHD	SCHD	44.7%	54.0%	4902	2898	197.4
US Equity	LBUSTRUU	Bloomberg US Agg Total Return Value Index	4	AGG	AGG	AGG	SAGG	91.9%	78.7%	23581	3	430.3
US Equity	RU10GRTR	FTSE Russell 1000 Growth Index	2	IWF	IWF	IWF	IWF	98.5%	99.3%	29241	386	374.1
US Equity	RU10INTR	FTSE Russell 1000 Index	2	IWB	IWB	IWB	IWB	97.5%	97.3%	11339	511	345.9
US Equity	RU10VATR	FTSE Russell 1000 Value Index	2	IWD	IWD	IWD	IWD	97.3%	98.8%	25973	374	123.4
US Equity	RU20GRTR	FTSE Russell 2000 Growth Index	2	IWO	IWO	IWO	IWO	99.1%	99.9%	7350	120	285.9
US Equity	RU20INTR	FTSE Russell 2000 Index	2	IWM	IWM	IWM	IWM	99.8%	99.9%	28661	490	147.5
US Equity	RU30INTR	FTSE Russell 3000 Index	2	IWV	IWV	IWV	IWV	98.7%	93.2%	6423	140	89.4
US Equity	SPTR	S&P 500 TR Index	3	SPY	SPY	SPY	SPY	95.8%	97.2%	190075	30630	25.6
US Equity	SPTRMDCP	S&P Midcap 400 Index	2	IJH	IJH	IJH	IJH	98.7%	97.2%	25855	389	355.8
US Equity	SPTRMG	S&P Midcap 400 Growth Index	2	MDYG	IVOG	MDYG	MDYG	30.0%	50.3%	230	369	648.0
US Equity	SPTRMV	S&P Midcap 400 Value Index	2	MDYV	IVOV	IVOV	MDYV	55.6%	82.0%	105	108	144.0
US Equity	SPTRSGX	S&P 500 Growth Index	3	IVW	IVW	IVW	IVW	93.4%	48.6%	13007	549	590.4
US Equity	SPTRSVX	S&P 500 Value Index	3	IVE	IVE	IVE	IVE	94.1%	84.5%	8335	252	424.2
Foreign Equity	ACDER	FTSE Developed Europe All Cap Index	2	VGK	VGK	VGK	VGK	58.1%	66.5%	12689	25335	13.5
Foreign Equity	M0DEHUSD	MSCI Germany US Dollar Hedged Index	2	DBGR	HEWG	HEWG	HEWG	83.5%	69.0%	1118	146	204.7
Foreign Equity	M0EFHUSD	MSCI EAFE US Dollar Hedged Index	2	DBEF	DBEF	DBEF	HEFA	78.2%	56.4%	6041	1718	212.3
Foreign Equity	M0JPHUSD	MSCI Japan US Dollar Hedged Index	2	DBJP	HEWJ	DBJP	HEWJ	40.4%	66.6%	865	299	57.6
Foreign Equity	NDUEACWZ	MSCI ACWI ex USA Index	2	CWI	ACWX	ACWX	ACWX	79.3%	81.9%	1760	704	34.5
Foreign Equity	NDUEEGF	MSCI Emerging Markets Index	2	EEM	EEM	EEM	VWO	82.0%	93.7%	30136	45705	12.4
Fixed Income	BFU5TRUU	Bloomberg US FRN <5 yrs Total Return Index	2	FLOT	FLOT	FLOT	FLOT	96.8%	94.6%	3351	376	508.2
Fixed Income	G1O2	ICE BofA 1-3 Year US Corporate Index	2	LDUR	TUZ	LDUR	LDUR	12.5%	71.9%	155	120	529.4
Fixed Income	IBOXHY	iBoxx USD Liquid High Yield Index	2	HYG	HYG	HYG	HYG	99.9%	100.0%	16564	56	540.6
Fixed Income	LBUTTRUU	Bloomberg US Treasury Inflation Notes TR Index	3	TIP	TIP	TIP	TIP	81.7%	97.4%	12807	1426	1600.9
Fixed Income	LT01TRUU	Bloomberg US Treasury: 1-3 Year Total Return Idx	3	SHY	SHY	SHY	SHY	89.3%	91.5%	7708	708	1332.9
Fixed Income	LT09TRUU	Bloomberg US Treasury: 7-10 Year TR Index	2	IEF	IEF	IEF	IEF	99.6%	100.0%	6465	49	290.5
Fixed Income	LT11TRUU	Bloomberg US Treasury: 20+ Year Total Return Idx	2	TLT	TLT	TLT	TBF	98.5%	99.9%	6537	922	7.6
Fixed Income	LT31TRUU	Bloomberg US Treasury Total Return USD Index	2	VGIT	VGIT	VGIT	SCHR	52.9%	68.9%	299	270	845.9
Fixed Income	LUMSTRUU	Bloomberg US MBS Index Total Return Value USD	2	MBB	MBB	MBB	MBB	97.3%	98.6%	6950	140	598.1
Fixed Income	LUTLTRUU	Bloomberg US Long Treasury Total Return Index	2	VGLT	TLO	VGLT	VGLT	46.2%	55.2%	232	326	184.7
Real Estate	DWRTFT	Dow Jones U.S. Select REIT Total Return Index	2	RWR	RWR	RWR	RWR	74.2%	91.9%	3282	1291	479.0

Table 6. Relationship Between ETF Favorites and ETF Characteristics

The favorites dummy ($1_{ShortFavorite}$) is equal to 1 if an ETF has the highest quantity lent among other ETFs which track the same index within a given month. ETFs which do not have competitors in tracking an index are excluded. Most of the regressors have been de-meaned at the index level.

	$1_{ShortFavorite}$					
	(1)	(2)	(3)	(4)	(5)	
$1_{OldestETFtoTrackIndex}$	0.073					-0.017
	(1.296)					(-0.286)
$1_{ETFwithHighestTradingVolume}$		0.753***				
		(14.461)				
$1_{Top3Issuer}$			0.285***			0.141
			(3.535)			(1.513)
Ln(Dollar Trading Volume (Demeaned))				0.067***		0.034*
				(5.775)		(1.899)
Ln(AUM (Demeaned))					0.085***	0.021
					(4.890)	(1.195)
ETF Loan Fee (Demeaned)	-0.005	-0.004	-0.004	0.000	0.000	0.000
	(-1.091)	(-1.096)	(-1.077)	(0.233)	(0.930)	(0.703)
ETF Discount/Premium (Demeaned)	14.600	16.100**	20.645**	22.836***	18.882**	18.331**
	(1.664)	(2.033)	(2.077)	(2.763)	(2.526)	(2.670)
Expense Ratio (Demeaned)	0.040	0.406	0.342	0.007	0.047	0.015
	(0.991)	(1.139)	(0.955)	(0.196)	(1.300)	(0.375)
Creation Fee (Demeaned)	-0.002	-0.002	-0.002	0.000	-0.000***	0.000
	(-1.014)	(-1.019)	(-1.006)	(0.113)	(-3.850)	(0.412)
Creation Unit Size (Demeaned)	0.000	0.000	0.000	-0.000*	-0.000*	-0.000*
	(0.941)	(0.951)	(0.912)	(-1.885)	(-1.797)	(-2.014)
Tracking Error (Demeaned)	-5.830	-12.864	-11.639	4.030	-12.701*	-4.837
	(-0.662)	(-1.638)	(-1.219)	(0.584)	(-1.712)	(-0.393)
Qty Available to be Lent (Demeaned)	1.211***	1.458***	0.627**	-0.540	0.024	-0.333
	(3.243)	(2.970)	(2.024)	(-1.546)	(0.139)	(-1.093)
Constant	0.753***	0.053*	0.578***	-0.043	-0.790**	-0.092
	(16.195)	(1.846)	(6.690)	(-0.296)	(-2.546)	(-0.436)
Sample Size	905	905	905	905	905	905
T	39	39	39	39	39	39
Avg N	23	23	23	23	23	23
R^2	0.455	0.397	0.530	0.565	0.567	0.767

Table 7. Cross-ETF Arbitrage Profits

Table is sorted on Annual Sharpe Ratio (utilization adjusted). Only indices with at least 2 tracking ETFs with populated loan fees are included. Short and long leg trading volume percentiles are calculated based on the entire CRSP universe in March 2015, which is the last month of our sample.

		ETF Arbitrage, Not Adj for Utilization		ETF Arbitrage, Adjusted for Utilization			Conditional Strategy		Arbitrage Legs with CRSP Tvol %-iles, as of 3/15			
Index	Avg Max LF Difference	Annual Profitability	Annual Sharpe	Avg Utilization of Long Leg	Annual Profitability (Util Adj)	Annual Sharpe (Util Adj)	Annual Profitability	Annual Sharpe	Most Common Short Leg ETF	Short Leg ETF Tvol Pctile	Most Common Long Leg ETF	Long Leg ETF Tvol Pctile
LT01TRUU	930.9	9.4%	7.6	61.8	5.7%	3.9	5.5%	3.8	SHY	91	SCHO	56
LBUTTRUU	1094.2	12.1%	7.6	47.2	6.6%	3.6	6.0%	3.3	TIP	90	SCHP	57
DWRTFT	739.6	7.5%	7.4	53.9	4.5%	3.4	4.5%	3.4	RWR	82	SCHH	70
RU20INTR	241.0	2.3%	6.7	57.9	1.1%	2.5	0.8%	1.9	IWM	100	VTWO	63
SPTRMDCP	248.6	2.4%	3.1	80.6	1.7%	2.3	1.1%	1.5	IJH	96	IVOO	48
SPTRSGX	263.1	2.8%	4.0	51.0	1.5%	2.2	1.0%	1.5	IVW	93	SPYG	56
RU10GRTR	371.5	3.7%	6.0	46.4	1.6%	2.1	1.6%	2.2	IWF	96	VONG	52
LBUSTRUU	250.1	3.1%	3.2	54.1	2.0%	2.0	1.1%	1.1	AGG	98	LAG	60
RU10INTR	210.2	2.2%	4.3	52.0	0.8%	1.4	0.2%	0.4	IWB	93	VONE	52
NDUEEGF	14.8	2.2%	1.4	33.9	2.1%	1.4	1.0%	0.7	EEM	100	VWO	99
SPTRSVX	260.2	2.6%	2.2	76.7	1.7%	1.3	1.1%	0.9	IVE	90	SPYV	54
NDUEACWZ	283.9	3.4%	2.0	49.3	1.5%	0.9	0.8%	0.5	ACWX	76	CWI	59
DW25T	317.5	4.7%	1.2	78.5	2.6%	0.7	2.2%	0.6	SCHB	81	SCHD	83
RU10VATR	207.4	2.1%	5.1	11.4	0.1%	0.4	0.1%	0.3	IWD	96	VONV	58
SPTR	20.1	0.2%	0.8	9.6	0.1%	0.3	-0.2%	-0.6	SPY	100	VOO	98
ACDER	38.2	1.3%	0.3	24.7	1.1%	0.2	-0.4%	-0.1	VGK	98	VEA	97
RU20GRTR	294.6	2.8%	2.7	35.1	0.2%	0.2	-0.1%	-0.1	IWO	93	VTWG	39
M0EFHUSD	243.9	3.1%	3.8	55.6	-0.1%	-0.1	0.5%	0.5	HEFA	86	DBEF	96
SPTRMG	289.9	2.9%	1.6	54.4	-0.3%	-0.2	-0.8%	-0.4	MDYG	39	IVOG	50
LUTLTRUU	126.6	2.4%	4.9	65.4	-0.4%	-0.3	1.0%	0.7	VGLT	58	TLO	60
RU30INTR	173.5	2.1%	2.8	0.0	-0.4%	-0.6	-0.2%	-0.3	IWV	81	VTHR	26
LUMSTRUU	351.1	3.1%	2.6	26.1	-0.6%	-0.6	-0.7%	-0.7	MBB	83	MBG	38
BFU5TRUU	277.9	2.5%	2.7	34.5	-0.6%	-0.9	-0.3%	-0.5	FLOT	79	FLRN	35
LT31TRUU	457.8	4.5%	5.0	49.9	-1.4%	-1.0	-0.6%	-0.4	VGIT	56	SCHR	55
M0JPHUSD	124.2	-1.6%	-0.8	29.6	-6.1%	-3.4	-4.7%	-2.6	HEWJ	72	DBJP	67
G1O2	459.9	-0.5%	-0.8	17.8	-5.0%	-4.5	-5.0%	-4.5	LDUR	18	TUZ	41
Average	**308.5**	**3.1%**	**3.4**	**43.4**	**0.6%**	**0.7**	**0.5%**	**0.5**		**82.5**		**60.3**

Table 8. Differences in variables between first ETF to track an index and subsequent "redundant" ETFs

Difference in Variables, Oldest - Redundant			
Variable	**Mean**	**N**	***t*-statistic**
Net Expenses	-0.06	19	-1.425
Return (%)	0.00	20	1.402
Creation Unit Size	58541.67*	20	1.808
Net Creations	-0.03	20	-0.878
Creation Fee	1584.38**	20	2.035
Discount/Premium	0.02	20	0.964
Loan Fee (bp)	-363.22***	20	-5.301
Number of Loans	68.43***	20	3.232
Utilization (%)	17.28**	20	2.447
Abnormal Loan Fee (bp)	-373.65***	18	-4.949
Loan Tenure	15.46***	20	3.322
Qty Lent / Shrout (%)	1.75**	20	2.521
Qty Avail / Shrout (%)	2.69***	20	4.224
Inst Ownership / Shrout (%)	27.99***	19	5.397
AUM ($B)	24.1***	19	3.133
Daily Trading Volume ($M)	14.2**	19	1.985
AHR Liquidity	0.31***	20	6.816
Amihud Illiquidity (x10^8)	-7.59***	20	-4.622