Investor Demand for Leverage: Evidence from Closed-End Funds and the Launch of Levered Exchange-Traded Funds [*]

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ABSTRACT

We provide novel evidence supporting investor demand for leverage as a *causal* driver of the equity closed-end fund discount (CEFD). Equity closed-end funds (CEFs) utilizing leverage trade at a relative premium, both compared to less-levered funds and themselves in less-levered periods. We use the introduction of the first levered exchange-traded funds (ETFs) in 2006 as a quasi-natural experiment to identify the channel. Following their introduction, the relative premium on levered CEFs decreases by 3%. We find CEFs also improve their performance (alpha) after the introduction of levered ETFs, consistent with the levered-ETF shock sorting investor clienteles and fund managers responding to new competition. Finally, we show that a prominent measure of the CEFD has historically captured levered-fund information, but switches to capturing unlevered-fund information since a change in methodology in 2011. Our results have important implications for asset pricing and corporate finance studies on capital structure.

Keywords: Investor sentiment, leverage, levered closed-end fund, levered exchange-traded fund, non-fundamental demand

JEL Classification Numbers: G12, G14

1 Introduction

> Closed-end funds are boring. There is nothing new to study there. I hope you are not wasting your time studying closed-end funds.

> —An unnamed senior colleague

The closed-end fund discount (CEFD) is a measure of the aggregate discount (or premium) on closed-end funds' share prices relative to closed-end funds' net asset values (NAVs) per share. In theory, without market frictions, relative mispricing between closed-end fund prices and NAVs per share should be minimal and quickly corrected, as deviations represent violations of the law of one price. However, it is well-documented that closed-end fund shares trade at significant discounts relative to their NAVs per share. Rational explanations have been offered to explain this puzzle: managerial ability (Berk and Stanton (2007)), liquidity (Cherkes, Sagi, and Stanton (2008)), costly arbitrage capital (Pontiff (1996)), and management fees (Berk and Stanton (2007), Cherkes et al. (2008)). Others have concluded variations in the discount point to behavioral biases (Lee, Shleifer, and Thaler (1991)), and the aggregate CEFD is regularly used as one proxy for "investor sentiment" (Baker and Wurgler (2006)). Thus, while the discounts on closed-end funds have received a great deal of attention, clearly identifying a causal channel for the discounts has yet to be provided.

In this paper, we identify and provide support for an additional channel that drives the closed-end fund discount: investors' demand for leveraged exposure. While a relation between leverage and the CEFD has previously been documented in fixed income funds (Elton, Gruber, Blake, and Shachar (2013)), we provide novel identification that demand for leverage is a main driver of the CEFD. In other words, we document a causal relation between investors' demand for leverage and the CEFD. Our findings have broad implications for both asset pricing and corporate finance. On the asset pricing side, our findings suggest that investor demand for leverage may have pricing consequences, unrelated to expected

cash flows and discount rates, across a wide range of assets. On the corporate finance side, thousands of papers have studied firm capital structure choices. Because closed-end funds are transparent organizations and are uncontaminated by many frictions that exist in the corporate sector, our results suggest that a firm's debt policy may be partially determined by investor demand for leverage.

Demand for leveraged exposure in closed-end funds is identified in two steps. First, we show that high leverage equity closed-end funds (hereafter "CEFs") trade at a premium relative to low leverage funds. A one standard deviation increase in book leverage is associated with a 2.0% increase in the share price premium relative to NAV. We find similarly-sized effects both across funds and for a given fund across leverage choices over time. Although we find equity CEFs trade at slightly larger discounts than fixed income funds on average (a 1.9% lower premium), this is largely due to them using less leverage. In contrast, the incremental effect of leverage is significantly larger for equity funds: the marginal effect of leverage is 28-65% greater than among fixed income funds.

As funds' leverage choices are endogenously determined, the second step in our identification strategy exploits a quasi-natural shock to the CEF industry. We use the launch of the first levered exchange-traded funds (ETFs) in the summer of 2006. Upon their introduction, these levered ETFs provided a low cost alternative to levered CEFs. We utilize a difference-in-differences identification strategy using more- and less-levered funds before and after the shock.[1] Controlling for fund characteristics, date fixed effects, and historical fund performance, we show that the premium for more-levered equity CEFs relative to less-levered equity CEFs drops by 3.2% after levered ETFs are first introduced. In additional tests, we show the observed effect is robust to choosing varying estimation windows, both supporting a causal interpretation of the effect and suggesting the effect is long lived.

A natural question is that if investors demand leveraged exposure, why are they restricted

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[1]We use Bloomberg's leverage classification to sort funds.

to only these funds? While institutional and professional investors have other options, most retail investors lack viable alternatives. Margin accounts and derivative securities trading require special authorizations by brokerages, and importantly, trading on margin and trading derivative securities are explicitly banned in U.S. retirement accounts like individual retirement accounts (IRAs) and 401(k)s.[2] Thus, for many individual investors, the only means to gain magnified exposure prior to levered ETFs may have been via levered CEFs. Figure 1 provides anecdotal support for a view that leverage is a first-order concern for investors exploring CEFs. It depicts a screen shot from a CEF screener, typical of CEF sites, in April 2004, clearly showing leverage as one of the primary choice variables a customer would use to filter the choices. Thus, we argue that levered CEFs, and later levered ETFs, are special because they provide retail investors with a means to gain magnified exposure.

[**Insert Figure 1 Here**]

While we are agnostic regarding whether this demand for leverage is rational or driven by behavioral factors, we provide evidence arguing against two plausible rational explanations. First, we find a strong negative relation between fund leverage and alpha, suggesting investors are not attaining higher risk-adjusted performance via their choice of levered funds. Interestingly, we do observe a statistically significant improvement in levered equity CEFs' relative performance after competition arrives via the introduction of levered ETFs. Second, we also find significant decreases in the raw returns (and market betas) of funds as leverage increases. We take this as strong evidence that levered CEFs are not simply enabling investors to move their portfolios to optimal points further out on the risk-return frontier.

Having documented that demand for leverage is an important, albeit perhaps unexplained, determinant of CEFs premiums and discounts, we provide novel insights regarding one of the most commonly used indices of CEF discounts. The Baker-Wurgler CEFD is

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[2]Elton et al. (2013) also argues that retail investors have limited and expensive methods of accessing leverage.

widely used in academic studies, both as a measure of aggregate discounts in the CEF industry, and also as a proxy and control for investor sentiment. It is also one of five components that is used in the construction of the Baker-Wurgler Sentiment Index (Baker and Wurgler (2006)). In addition to documenting that demand for leverage is an important determinant of CEF discounts, we show that leverage plays a critical role in the Baker-Wurgler CEFD index. First, using a regression framework, we show that the Baker-Wurgler CEFD is strongly and positively associated with the NAV-weighted discount of our more-levered equity CEFs from 1996-2010. However, the relation is far weaker for the less-levered equity CEFs, and is in fact statistically insignificant when both are included simultaneously in the regression. However, in 2011 the Baker-Wurgler index changed its calculation method for the CEFD. Post 2011, the strong relation between the Baker-Wurgler CEFD and our more-levered equity CEFs diminishes, while the opposite is true for the less-levered equity CEFs. The results suggests that variation in the Baker-Wurgler CEFD from 1996-2010 may be driven largely by investors' demand for leveraged exposure.[3]

Our study of investor demand for leverage adds to several bodies of existing research. First, we provide valuable insights into the relation between CEF leverage and discounts. We not only confirm the positive association found for fixed income funds in Elton et al. (2013) holds for equity funds, but also show the effect is far larger for equity funds. By using the plausibly exogenous introduction of levered ETFs, we then provide the first evidence, for any CEFs, that the observed relation appears to be causal.

Second, we provide what we believe are the first results regarding the association between equity CEF leverage and performance. The negative relations between leverage and both alpha and returns reject two plausible rational explanations for investor demand for leverage.

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[3]Notably, from 1987-2010 the Baker-Wurgler CEFD relied on the "Herzfeld Closed-End Average," which was featured weekly in *Barron's* and was computed using a set of 15 diversified, equity U.S.-traded CEFs. Since 2011, the Baker-Wurgler CEFD is computed using Morningstar data on non-levered funds. See Jeffrey Wurgler's website for additional detail.

Furthermore, the improvement in performance after the introduction of levered ETFs provide novel results of a managerial response to a competitive threat.

Third, we provide important insights into a common measure of the average CEFD, which is also frequently used as a proxy (or a component of a broader proxy) of investor sentiment. While Lee et al. (1991) and Neal and Wheatley (1998) argue and provide compelling evidence that discounts and premiums on CEFs are indicative of market-wide investor sentiment, we show these measures may be driven by very specific and identifiable subsets of the CEF universe. These insights may help future researchers identify what aspects of CEFs make them valuable measures of sentiment. We therefore also complement the analysis in Baker and Wurgler (2006) and Baker and Wurgler (2007) by understanding the historical drivers of the CEFD. Finally, our analysis adds to a nascent literature studying non-fundamental demand in levered ETFs. Davies (2018) shows that flows into and out of levered ETFs provide signals of bullish and bearish sentiment among uninformed speculators.

2 Data and variables

We combine data from Bloomberg, the Center for Research in Security Prices (CRSP), and the U.S. Securities and Exchange Commission's (SEC) EDGAR databases to form our sample of CEFs. From Bloomberg, we retrieve static data including fund name, fund ticker, fund inception date, fund Committee on Uniform Security Identification Procedures identifier (CUSIP), fund asset class focus, fund use of leverage, fund leverage type, fund expense ratio, and fund leverage classification ("FUND_LEVERAGE," which is either "Y" or "N"). From Bloomberg, we also retrieve monthly information including fund shares outstanding, fund NAVs per share, share prices, share returns, and share volume. From CRSP, we retrieve static data including fund permno, fund share code, fund name, fund ticker, fund CUSIP, and fund descriptions. We also retrieve from CRSP monthly information including fund

shares outstanding, fund NAVs per share, share prices, returns, and share volume. From the SEC's EDGAR database, we text-process CEFs' semiannual financial statements (NSAR-A and -B forms) and collect their financial data.[4] We retrieve data on cash (item 74-A), total assets (item 74-N), net assets of common shareholders (item 74-T), shares outstanding (item 74-U), total expenses (item 72-X), and dividends per share (item 73-A1).[5,6]

To link the data from each source, we first match on fund CUSIP and verify manually that the match was correct. Of the remaining funds, we match on Central Index Key (CIK), when available, and verify manually that the match is correct. The remaining funds are matched by hand using Internet web searches and comparisons of fund descriptions. In total, our sample consists of 565 funds from Bloomberg, 1,002 funds from CRSP, and 878 funds from NSAR filings for our sample period from 1995 to 2016. Our sample has 508 CEFs that have data from all three data sources.

Figure 2 shows the number of CEFs in our sample over time. Each year we report fixed income fund and equity fund totals separately. Asset class focus (fixed income versus equity) are primarily based on Bloomberg classifications. We manually classify the funds that Bloomberg does not cover. Funds that include both fixed income and equities in their portfolios are classified as equity funds. As the figure shows, the number of fixed-income funds is approximately three times larger throughout the sample period. In 2016, the number of fixed income and equity funds are 325 and 188, respectively.

[Insert Figure 2 Here]

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[4]All registered investment companies are required under Section 30 of the Investment Company Act of 1940 to file NSAR-A and -B forms semiannually with the SEC. The registered investment companies include mutual funds, CEFs, and unit investment trusts. For the filing period of 1994-2016, there are 5,858 unique registered investment companies. From the register investment company pool, we identify 878 unique CEFs.

[5]We extract almost all financial information available in NSAR filings such as taxes (item 72-O) and interest (item 72-P). We do not utilize these other variables in this paper.

[6]We also use data from Jeffrey Wurgler's website and Kenneth French's website. From Jeffrey Wurgler's website, we retrieve the Investor Sentiment Index (Baker and Wurgler (2006)) and the variables used to construct the index. From Kenneth French's website, we retrieve information on the three factors (Fama and French (1993)) and three factor plus momentum (Carhart (1997)).

Figure 3 displays the total money invested in CEFs over time, in billions of dollars and again separately for fixed income and equity CEFs. In the most recent period (2016), fixed income funds had $187 billion in assets under management, while equity funds had $108 billion.[7] We note the total money invested in both fixed income and equity funds has generally increased every year, except for the financial crisis in 2008-2009.

[**Insert Figure 3 Here**]

In Table 1, we provide summary statistics for the main variables we consider in our analyses. The definitions of all variables are given in Appendix A. Panel A reports summary statistics for variables with observations available semiannually, while Panel B does the same for variables observed at the monthly level. All variables are winsorized at the top and bottom 1% of the distribution. The mean and median assets under management (AUM) are $463 and $265 million. Funds typically hold less than 1% cash, and the average debt to asset ratio (book leverage) is 0.23. Fund age ranges from 0 to 37 years. The average expense and payout ratios are 1.2% and 4.1%. Funds generally trade at a discount, with mean and median discounts of 6.5% and 5.7%. Because there is a mechanical connection between leverage and premiums (Cherkes et al. (2008)), in much of the analysis that follows we adjust premiums to correct for this mechanical effect. The average adjusted discount of 5% is slightly smaller than the non-adjusted. We note that in the results that follow we report premiums, such that a negative number indicates a discount, and a more negative number an increase in the discount. Market leverage that uses monthly market values of total assets is similar to book leverage. The average monthly return including dividends is 0.67%, and the average estimated alphas (forward-looking alpha) using the previous (subsequent) 36 months of returns for equity CEFs is -0.22% (-0.08%).

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[7]Investment Company Institute (ICI) CEF statistics offer a strong validation of our data. The total asset values that ICI published for 2017 are $166 billion and $109 billion for fixed income and equity CEFs respectively, which are similar to our numbers. ICI CEF statistics are available at https://www.ici.org/research/stats/closedend/cef_q2_18.

3   Introduction of Levered Exchange-Traded Funds

All ETFs are pooled investment vehicles which allow investors to buy a basket of assets at once.[8] Like CEFs, investors can buy or sell ETFs on a secondary market just as they would buy or sell a stock. However, unlike CEFs, shares in an ETF are added or removed on a primary market via the actions of third party arbitrageurs called authorized participants (APs). For levered ETFs, APs who are pre-qualified by the fund sponsor (e.g., ProShares) are allowed to exchange cash in the amount of the fund's NAV per share for new shares or vice versa. This process allows APs to exploit premiums or discounts between the fund's share price and the fund's NAV per share (and restore relative price efficiency between share price and NAV per share in the process). For example, if an ETF's share price gets too high relative to its NAV per share, APs create new shares. APs then sell these shares on the secondary market. APs conduct the opposite trade if a fund's share price get too low relative to its NAV per share. As such, ETF share prices are characterized by small premiums and discounts, especially relative to CEFs.[9]

Until June 21, 2006, all ETFs provided 1x exposure to a pre-specified benchmark. However, on that day, ProShares (part of ProFunds ETF Trust) launched a set of four ETFs designed to provide traders magnified exposure. The four ETFs' daily objective is to provide 2x exposure to well-known indices like the S&P 500 and the Dow Jones Industrial Average (before fees and expenses). Three weeks later, on July 13, 2006, ProShares announced four additional ETFs designed to provide magnified *short* exposure to well-known market indices. The set of levered ETFs announced during the summer of 2006 are provided in Table 2. Since

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[8]Like mutual funds, ETFs are formally registered with the SEC as investment companies under the Investment Company Act of 1940.

[9]For more discussion of the levered ETF market, see Davies (2018).

the original eight launched in the summer of 2006, nearly 300 additional levered ETFs have been offered to investors. There are now levered ETFs providing magnified exposures to bond indices, commodities, currencies, emerging markets, and market volatility indices.

[Insert Table 2 Here]

The launch of these levered ETFs took several years to receive approval from regulatory agencies. On June 5, 2002, ProFunds ETF Trust filed its Notification of Registration (Form N-8A) and Registration Statement for Open-End Management Investment Companies (Form N-1A) with the SEC. Filing these forms were the first steps in launching the funds. Over the next four years, ProFunds amended their Form N-8A several times in an effort to receive SEC approval. As the funds approached approval, ProFunds ETF Trust began laying the foundation for day-to-day operations by hiring Chief Investment Officer (CIO) Agustin Fleites on August 22, 2005.[10] The hire signaled that the funds, whose launch seemed highly speculative until then, were finally nearing SEC approval. On June 21, 2006, the funds launched and investors were able to substitute their demand for levered CEFs to levered ETFs. A complete timeline for the launch of the funds is located in Table 3.

[Insert Table 3 Here]

We argue that the launch of levered ETFs provided a shock to investors' demand for levered CEFs. Specifically, levered ETFs have two advantages relative to levered CEFs: (i) the fees on the ProShare funds launched in the summer of 2006 ranged from 0.89% - 0.95%, while the average and median fees on levered CEFs were 1.40% and 1.20% and (ii) the ETF mechanism is designed to minimize share discounts/premiums relative to NAV, unlike CEFs which are characterized by large deviations (typically discounts). One important difference between levered CEFs and levered ETFs is that the latter is passively managed while the

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[10]See Hoffman (2006) and Donoghue (2005) for press articles covering the launch of the funds and investors' anticipation of them.

former is not. This difference may serve as an advantage or disadvantage depending on investors' preferences; if investors simply want leveraged exposure they may prefer (or at least be indifferent to) the passively managed ETFs. Alternatively, some investors may prefer active asset selection. The extent to which these preferences affect the substitution of investor demand from CEFs to ETFs is an empirical question.

In our main analysis, we use June 2006 as the treatment month for the demand shock. Until June 2006, many levered CEF investors, who are primarily retail investors, lacked alternative means to access leverage.[11] However, after the launch investors could choose between levered CEFs and levered ETFs. As a robustness test, we exclude all observations between August 2005 and June 2006, which corresponds to the period of time after which ProFunds signaled, via their hiring of CIO Agustin Fleites, that the launch of levered ETFs was imminent.

4 Results

4.1 Leverage and the Closed-End Fund Discount

We first explore whether there is an observable relation between the amount of leverage used by CEFs and the premium (or discount) at which their shares trade relative to underlying net asset value. As described in Section 2, we follow Cherkes et al. (2008) in adjusting for the mechanical impact of leverage on the observed premium. Table 4 reports the results of monthly regressions of adjusted premiums on leverage and other explanatory variables of interest. All specifications include month fixed effects, and report t-statistics for standard

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[11]Unlike derivatives and margin accounts which require special authorizations, any investor with a brokerage account may purchase levered CEFs and levered ETFs. Furthermore, 401(k)s and Individual Retirement Accounts (IRAs) in the United States prohibit the use of derivatives or margin while no prohibitions exist for levered CEFs and levered ETFs.

errors clustered by month to account for cross-sectional correlation within months.[12] As leverage information is only available at the semiannual level, monthly estimates of leverage must be interpolated. In Panel A, we simply use the leverage reported in the most recent NSAR report available at that time (Book leverage), where book leverage is defined as the book value of debt divided by the market value of total assets. Specifications (1) and (3) report a single coefficient for the association between premiums and leverage for all CEFs in our sample, while specifications (2) and (4) allow for a different relation among equity CEFs than that among fixed income funds. The last two specifications differ from the first two by including fund-level fixed effects among the controls.

[**Insert Table 4 Here**]

Regardless of the specification, we see a statistically and economically strong positive relation between a fund's premium relative to net asset value and the amount of leverage used in its portfolio. Across specifications, a one-percent increase in leverage is associated with a 8.7-10.5 basis point increase in the premium (or more often a reduction in the discount as funds typically trade at a discount). In economic terms, leverage one standard deviation above the mean translates to a roughly 1.7 percentage point smaller discount, relative to a mean (median) discount of 6.5% (5.7%). The coefficients on the indicator variable, Equity CEF, suggest that equity CEFs trade at a 1.9-2.8 percentage point lower premium relative to fixed income funds, all else equal. However, the interaction of leverage and the equity CEF indicator suggests that the incremental value of leverage in equity funds is 65% larger than that in fixed income CEFs (see specification (2)). We believe the positive effect of leverage on premiums for equity CEFs, and that the effect is stronger for equity funds than fixed income funds, are both novel contributions to the literature. Cherkes et al. (2008) find a positive association between leverage and premiums, but only report the result for

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[12]Our results are robust to clustering at the semiannual level (i.e. the frequency of the NSAR reports from which leverage data is collected).

all funds combined. Fixed income funds outnumber domestic equity funds in their sample roughly three to one. Similarly, Elton et al. (2013) report a positive relation, but in a sample consisting solely of fixed income funds.

Beyond the positive association between premiums and leverage, we find mixed results regarding the relation between fund premiums and a fund's expense ratio. In the initial specifications the relation is negative and significant, consistent with earlier studies that find funds with higher fees on average trade at larger discounts (Cherkes et al. (2008)). After inclusion of fund fixed effects however we find a weak positive relation. Thus, it appears for any given fund, on average a higher premium is associated with higher fees. It may be that funds increase their fees when they are performing well, i.e. here the causality runs in the opposite direction. This would be consistent with prior studies such as Berk and Stanton (2007), and explain why the sign on expense ratio switches with the inclusion of fund fixed effects.

Although debt is never observed more often than semiannually, the results in Panel A also do not update asset values, for which monthly updates are available. We denote leverage measured with these updated asset values as Market leverage. To the extent the reader believes this is a better measure, or that our results might be affected by the difference, we re-run the same regressions with market leverage and report the results in Panel B of Table 4. We find that both the economic and statistical significance for the connections between premiums and leverage are essentially unchanged.

The above results illustrate a strong positive connection between leverage and a fund's share price relative to NAV per share, despite leverage also being associated with higher fund fees.[13] One of the most obvious rational explanations of this relation would be that leverage is associated with some degree of improved performance. We therefore next examine the

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[13]In unreported regressions, we find a strong and significant positive relation between a fund's leverage and its fees. Details are available from the authors upon request.

degree to which funds that choose relatively higher leverage, or the periods during which any given fund has higher leverage as compared to itself during other periods, are associated with better results for fund investors. For these results we focus exclusively on equity CEFs.

[**Insert Table 5 Here**]

In Panel A of Table 5, a fund's performance is measured by the alpha of its 36-month forward-looking return, where alpha is measured relative to a four-factor model (three factors plus momentum as in Carhart (1997)). The first two specifications use book leverage, while the third and fourth use market leverage. All regressions again include month fixed effects, with the second and fourth adding fund-specific fixed effects. In every specification the coefficients are negative and statistically significant. A one standard deviation increase in leverage (about 14 percentage points regardless of book or market) is associated with a 3-12 basis point decrease in monthly alpha over the following 36 months, suggesting that if anything higher leverage is associated with worse performance measured by alpha. Panel B reports the results of similar tests where the dependent variable is instead a fund's raw returns, again over the ensuing 36-month period. Statistical significance across specifications is generally weaker for these raw return regressions. Somewhat surprisingly the relation between leverage and performance not adjusting for risk in columns 2 and 4 with fund fixed effects is negative and significantly so in column (4): the point estimate suggests that a one standard deviation increase in leverage is associated with a 42 basis point decrease in monthly returns.

We note that these results are gross returns/alphas before fees, implying realized performance would be worse. We conclude that while the use of leverage is associated with higher premiums, if anything it is generally associated with subsequent underperformance by the fund. We believe these findings are novel to the literature.

These results do not formally preclude investor rationality; for example, an investor's

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optimal portfolio could require leverage not easily attained elsewhere, in which case an investor might accept a slightly lower return in exchange for access to their optimal (levered) portfolio. However, the negative relation between leverage and raw returns in Panel B makes such a story harder to envision. Furthermore, in unreported results we find that in the cross section funds with higher leverage actually have lower betas on average.

4.2 A Quasi-natural Experiment: the Introduction of Levered Exchange-Traded Funds

Lacking a clear link between leverage and fund performance, and given the open question in the literature of what draws investors to CEFs in general, we consider the possibility that some investors have a demand for leverage not fully explained by fundamentals. In the presence of such demand–whatever the exact channel–these investors might be willing to pay extra for access to leverage. Historically, retail investors had fairly limited and usually expensive methods of accessing leverage (Elton et al. (2013)). Lacking better alternatives, a levered CEF could be an appealing investment vehicle. However, as described earlier in Section 3, the introduction of levered ETFs in June of 2006 would then represent a significant and reasonably exogenous competitive shock to the CEF industry, and particularly to the levered equity funds for which the new ETFs would be closer substitutes.

Using a difference-in-differences setting, we explore the impact of the introduction of levered ETFs on the relation between leverage and premiums in the equity CEF industry. The dependent variable is fund premiums at the monthly level, again adjusted for the mechanical effect of leverage on premiums. We define a fund as "Treated" if Bloomberg characterizes that fund as an active user of leverage.[14] The indicator variable "Post" is set to one for any monthly observation occurring after June of 2006. Our interest is then in how the differ-

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[14]We use the generic term "treated" here rather than the more descriptive "levered" because while on average the two are highly related, it is possible for a treated fund to at times have little leverage, and for untreated funds to have some leverage at least some of the time.

ence between more-levered and less-levered fund premiums changes after the introduction of levered ETFs.

[Insert Table 6 Here]

Table 6 reports the results for these regressions. All specifications include both month and fund fixed effects, with standard errors clustered by month. Specification (1) shows that difference between more-levered and less-levered fund premiums dropped by an average of 3.2 percentage points after the introduction of competition in the levered equity fund space. Given average pre-period difference of 5.6% (an average discount of 4.2% for more-levered and 9.8% for less-levered funds), the change appears highly economically significant in addition to being statistically significant. It appears, all else equal, that levered equity CEFs saw an economically significant drop in their prices relative to underlying net asset value. The next two specifications break out the relation between leverage and fund premiums into pre- and post-treatment periods, using continuous variables of book leverage and market leverage respectively. We find that in the pre-period, the relation between leverage and premium is consistent with the results in Table 4 for equity CEFs: a one percent increase in leverage is associated with a 14-16 basis point increase in the fund premium. However, after levered ETFs are introduced the incremental effect of leverage drops by approximately 50%, or 7-8 basis points relative to the pre-period estimate. The differences in every specification are statistically significant beyond the 1% level.

In addition to our main variables of interest, we also control for a number of plausibly important other explanatory variables. As one would expect, higher fund alpha is associated with higher fund premiums. With fund fixed effects, the point estimate on a fund's expense ratio is positive but generally not statistically significant.

One might worry that other things going on during the pre- or post-periods could be driving our results. Although our inclusion of month fixed effects should mitigate this con-

cern, we still re-run the above specifications using tighter windows around the introduction of levered equity ETFs. These results are reported in Appendix Table A.1. We find very similar results using 4-year (2003-2007) and 3-year (2004-2007) windows. Once we reduce the sample to a 2-year window (2005-2007), it appears we begin to lose power: the coefficient is still negative but no longer statistically significant. We note that in all cases we end the sample window in June of 2007 to avoid including the beginning of the financial crisis.

In the previous subsection, we showed that higher-levered CEFs on average command higher premiums, despite most measures pointing toward worse raw and risk-adjusted performance. As both leverage and performance are likely to some extent endogenous, we also examine to how the relations change after the shock of the introduction of levered ETFs. Table 7 reports the results of difference-in-differences tests similar to Table 6, except with fund alpha now as the dependent variable. In column (1), we see that more-levered equity CEFs (the "treated" group) in general show a dramatic relative improvement after the shock: forward-looking alphas increase by 27 basis points per month. Columns (2) and (3) show that prior to the shock, the negative relation between fund leverage and alpha is even larger than that reported earlier. However, after the shock the coefficient on the impact of leverage on alpha drops by approximately 60%. While we do not take these results as definitive, they are consistent with fund managers responding to a competitive threat by improving fund performance. They are also consistent with the notion that levered CEFs may have gotten by providing worse performance when their clientele seeking leverage lacked reasonable alternatives.

[**Insert Table 7 Here**]

4.3 The Use of the Closed-End Fund Discount as a Measure of Sentiment

4.3.1 History of the Closed-End Fund Discount

The field of behavioral finance has erupted in recent decades and many studies show that investors suffer from biases and irrational trading behaviors.[15] The aggregation of these biases and irrational behaviors is a type of non-fundamental demand referred to as "investor sentiment."[16] In theory, investor sentiment distorts asset prices and generates an additional source of risk and uncertainty unrelated to asset fundamentals.[17] Measuring investor sentiment, however, is difficult and empiricists must rely on observable measures as proxies. One popular measure of investor sentiment is the closed-end fund discount (CEFD), which has been shown to signal this type of non-fundamental demand: an increase in the CEFD represents a decrease in demand (lower investor sentiment) and a decrease in the CEFD represents an increase in demand (higher investor sentiment).[18] Lee et al. (1991) provide evidence that the CEFD measures investor sentiment: discounts on funds move together, discounts narrow when stocks held by retail investors do well, and new funds are started when seasoned funds sell at a premium or smaller discount.[19] Neal and Wheatley (1998) also provides evidence that the CEFD is related to investor sentiment, showing that aggregated discounts predict the size premium in stock returns.

Given the evidence that the CEFD reflects a dimension of investor sentiment, Baker and Wurgler (2006) include it as a component of its Baker-Wurgler Sentiment Index. Specifically, Baker and Wurgler (2006) construct a sentiment index using principal components analysis

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[15]See Hirshleifer (2001) and Barberis and Thaler (2003) for surveys of the behavioral finance literature.

[16]Baker and Wurgler (2007) defines investor sentiment as "a belief about future cash flows and investment risk that is not justified by the facts at hand."

[17]See, for example, the model of noise trader risk in De Long, Shleifer, Summers, and Waldmann (1990).

[18]The CEFD is calculated as the differences between the market prices of CEFs' shares and the value of the funds' underlying assets (NAV) per share

[19]See also Zweig (1973), and Chopra, Lee, Shleifer, and Thaler (1993).

(PCA) across several proxies for investor sentiment: the CEFD, the value-weighted dividend premium (Baker and Wurgler (2000)), first-day returns on IPOs & IPO volume (Ibbotson, Sindelar, and Ritter (1994)), and the equity share in new issues (Baker and Wurgler (2000)). The Baker-Wurgler Sentiment Index is straightforward and simple to understand, covers a long time series (July 1965 - September 2015), and is a staple in asset pricing studies as a control for investor sentiment. However, despite its popularity, the inputs used in calculating the CEFD are not widely known. According to Jeffrey Wurgler's website, the time series of the CEFD is aggregated from several sources: from 1965 to 1985 using general equity fund data from Lakonishok, Shleifer, Thaler, and Vishny (1991); the 1986 data comes from CDA/Wiesenberger (a financial research firm acquired by Thomson Reuters in 1987); from 1987 to 2010 the Herzfeld index is used; and from 2011 to 2015 the CEFD is calculated from Morningstar data using unlevered general equity funds.[20]

4.3.2 Leverage and the Closed-End Fund Discount

Prior papers have concluded that behavioral biases must factor into understanding investors' willingness to buy CEF shares (Lee et al. (1991)) or the patterns in CEF premiums (Pontiff (1996)). Beyond simply not fitting a clear rational story, some researchers have suggested that CEF discounts can actually serve as a measure of investor beliefs, or sentiment, that are not rational (Baker and Wurgler (2006)). While the use of the CEFD as a measure of sentiment has met some debate (Qiu and Welch (2006)), its actual construction has been fairly opaque and largely beyond the scope of academic study. Given our findings of a strong connection between leverage and the discounts used in sentiment measures, in this section we attempt to fill a gap in the literature by examining the role of leverage in CEFD measures of sentiment.

The Baker and Wurgler measure of investor sentiment is a composite index representing

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[20]See the "Investor sentiment data" file located on Jeffrey Wurgler's website at https://people.stern.nyu.edu/jwurgler/.

the first principle component of five separate proxies, of which the CEFD is one (Baker and Wurgler (2006)). Given our findings above, we hypothesize that levered ETFs, and their appeal to some investors, might play an outsized role in the time-series variation of their CEFD measure. To test our hypothesis, we run regressions of the Baker and Wurgler CEFD on value-weighted discounts of the more-levered and less-levered equity CEFs. As described in the previous subsection, our sorting into these two groups follows fund characterizations in Bloomberg.

[**Insert Table 8 Here**]

Significant changes were made to the CEFD index used in the Baker-Wurgler measure in 2011. In particular, in 2011 the Herzfeld measure was replaced with a measure from Morningstar. Panel A of Table 8 shows the results for regressions using the sample from 1996-2010. In univariate regressions, we find that the point estimate on the more-levered funds in column (1) is more than double that of the less-levered funds in column (2), and has five times the explanatory power as measured by adjusted R-squared. When both are included together in column (3), the point estimate on the more-levered index remains essentially unchanged, while the coefficient on the less-levered index drops by 60%, flips signs, and loses statistical significance. The adjusted R-squared of the regression including both is also essentially unchanged as compared to using only the more-levered sample. In column (4) we create a single value-weighted index of all equity CEFs in our sample, and find this combined measure significantly underperforms the more-levered fund index.

Given the changes to the index in 2011, Panel B of Table 8 reports the results of similar regressions for the period since the index's reconstitution. While the more-levered funds index remains statistically significant, its adjusted R-squared in the univariate regression is half of that in Panel A. Similarly, the point estimate on the less-levered index is 35% larger than that on the more-levered index, and its adjusted R-squared now is four times

that in Panel A. When both are included simultaneously in column (3), it is now only the less-levered index that remains statistically significant, and the adjusted R-squared is similar to that for the result using only the less-levered index.

We believe these results have several important implications for researchers and future works. First, historically the information in the Baker and Wurgler measure largely reflected changes in more-levered funds. This would suggest anyone studying its drivers consider leverage as a key component or control variable in their work. Second, it appears the changes made to the index in 2011 are anything but cosmetic. Therefore, the results of any study using the measure across the sub-periods may be affected by the change itself. Researchers conducting such studies using the measure as an explanatory variable or control may want to ensure their results are robust to more consistent measures of the CEFD. Finally, some consideration may want to be given to creating an updated measure that is consistent through time.

5   Conclusion

This paper explores the relation between leverage and premiums mainly in equity closed-end funds. Consistent with previous findings for fixed income funds, we find a positive association between the two. While confirming the relationship holds for a previously untested subset of closed-end funds, we believe the contributions of the paper come from three novel aspects of our study.

First, the introduction of levered ETFs provide a plausibly exogenous shock to the equity CEF industry. This quasi-natural experiment allows us to provide the first causal evidence that leverage is affecting fund premiums. Second, we provide new results regarding the connection between fund leverage and performance. Our finding of a negative relationship presents a challenge to rational interpretations of investor demand for levered CEFs. Once

again, the introduction of levered ETFs provides an interesting setting to explore the relationship, and we find evidence that managers of levered equity CEFs significantly improve their performance in response to new competition.

Finally, our results provide important insights regarding one of the most commonly referenced measures of premiums and discounts in the CEF market. We show that through much of its history the index was primarily driven by changes in the discounts of levered CEFs, but that the change in data sources in 2011 significantly affected the information conveyed by the index. These last results not only provide new understanding into what drives the index, but may also suggest that future researchers consider whether the index as constituted is capturing what they intend it to.

Appendix A. Variable descriptions

Total assets (AUM)	is total assets value under management reported in the most recent NSAR file (item 74-N).
Net asset value (NAV)	is net assets value of common shareholders reported in the most recent NSAR file (item 74-T).
Cash	is the amount of cash reported in the most recent NSAR file (item 74-A).
Debt	is (Total assets - Net asset value), reported in the most recent NSAR file.
Book leverage	is Debt divided by Total assets, reported in the most recent NSAR file.
Market leverage	is by the sum of Debt and NAV per share times monthly shares outstanding. Both monthly NAV per share and shares outstanding are from CRSP.
Fund age	is the difference between a given year and fund inception year.
Expense ratio	is total expenses (item 74-N) divided by Net asset value reported in the most recent NSAR file.
Payout ratio	is dividends per share (item 73-A1) times shares outstanding (item 74-U) divided by the sum of Net asset value and dividends per share (item 73-A1) times shares outstanding (item 74-U) following Cherkes et al. (2008).
Premium	is the monthly share price divided by NAV per share. Both monthly share price and NAV per share are from CRSP.
Adjusted premium	is the monthly share price divided by NAV per share with a correction for a mechanical relation between leverage and premium following Cherkes et al. (2008). Both monthly share price and NAV per share are from CRSP.
NAV per share	is Net asset value divided monthly shares outstanding. Monthly shares outstanding are from CRSP.
Turnover	is monthly trading volume divided by monthly shares outstanding. Both monthly trading volume and shares outstanding are from CRSP.
Return	is monthly return including dividends from CRSP.
Alpha	is the estimated intercept in the percentage term for a given fund at a given month end from a regression of monthly returns on Fama-French three factors and Carhart's momentum factor for the previous 36 month period.
Alpha forward	is the estimated intercept in the percentage term for a given fund at a given month end from a regression of monthly returns on Fama-French three factors and Carhart's momentum factor for the subsequent 36 month period.

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Figure 1: Closed-End Fund Screener, April 2004

The figure displays a screen shot from a CEF screener in April 2004 (using internet archiver "Wayback Machine," https://archive.org/web/). The ability to select levered CEFs appears only under advisor and asset classification on the screening filters.

Figure 2: Number of closed-end funds over time

The figure displays the numbers of CEFs in our sample by their asset class focuses from 1995 to 2016. Asset class focuses are primarily based on Bloomberg classifications. In addition, we manually classify asset focuses of the funds that Bloomberg does not cover. Equity CEFs include funds with mixed asset focuses between fixed income and equity securities.

Figure 3: Assets under management of closed-end funds over time

The figure displays fund size measured by total assets under management (AUM) in billons of dollars by their asset class focuses over the sample period from 1995 to the first of half of 2016. Asset class focuses are primarily based on Bloomberg classifications. In addition, we manually classify asset focuses of the funds that Bloomberg does not cover. Equity CEFs include funds with mixed asset focuses between fixed income and equity securities. The AUM data are from the semiannual NSAR filings.
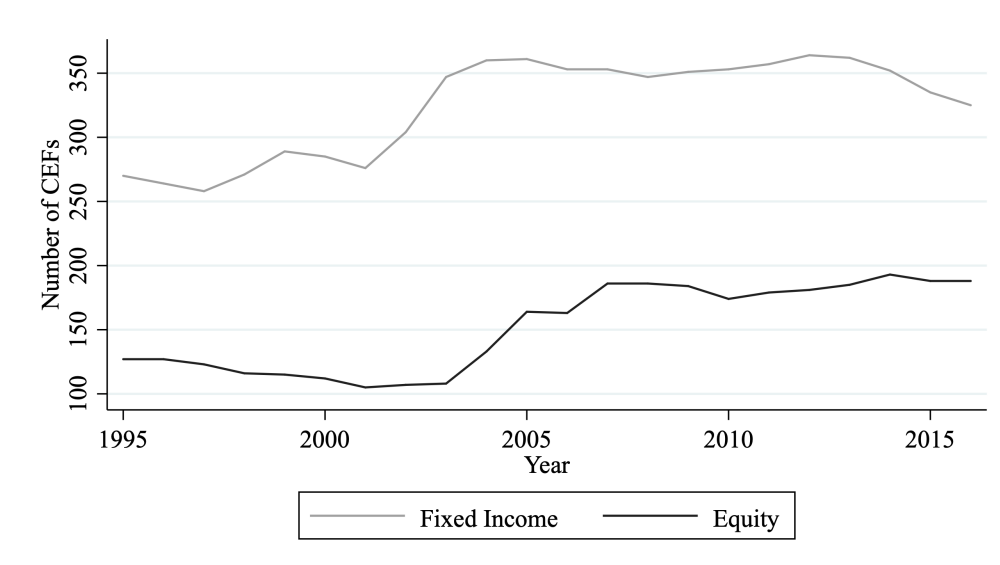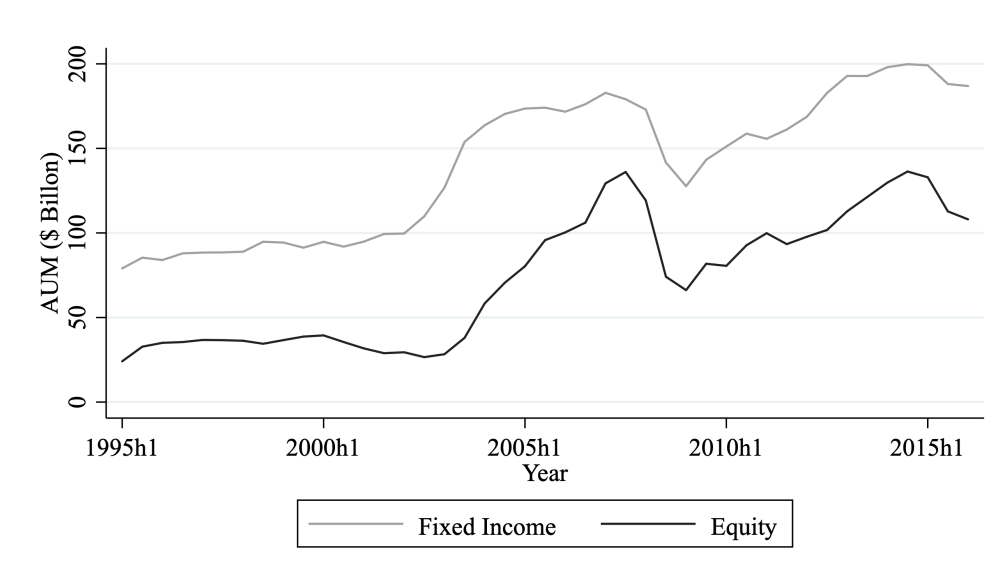
Figure 4: Premiums of closed-end funds over time

The figure displays premiums (adjusted for the mechanical relation between leverage and premium) by their asset class focuses over the sample period from 1995 to the first of half of 2016. Asset class focuses are primarily based on Bloomberg classifications. In addition, we manually classify asset focuses of the funds that Bloomberg does not cover. In (a), equity CEFs include funds with mixed asset focuses between fixed income and equity securities. In (b), we classify equity CFEs into highly levered vs barely levered equity funds based on Bloomberg's leverage use classifications. Premium data are from either Bloomberg and CRSP databases and at the monthly frequency.
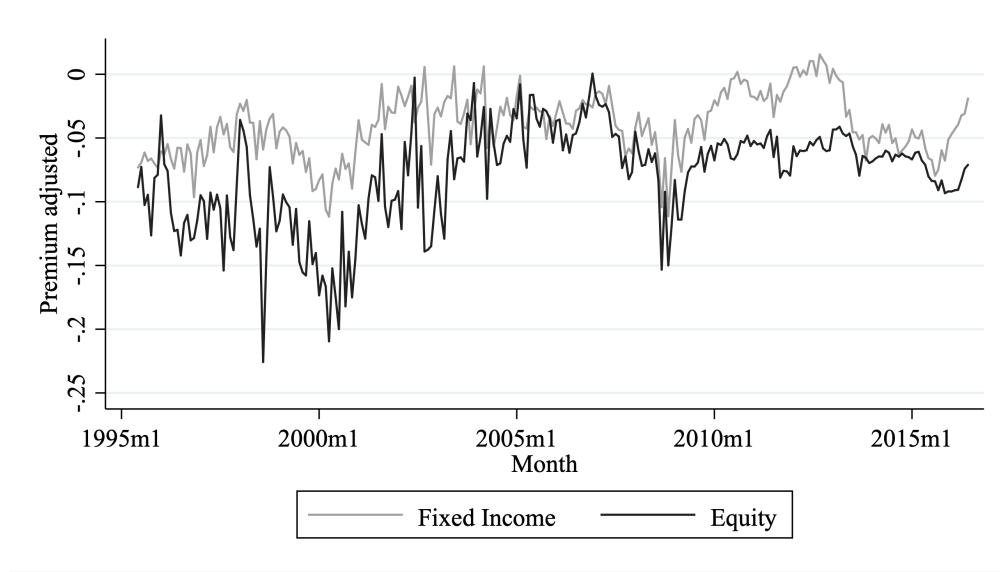
(a) Fixed income vs Equity Funds
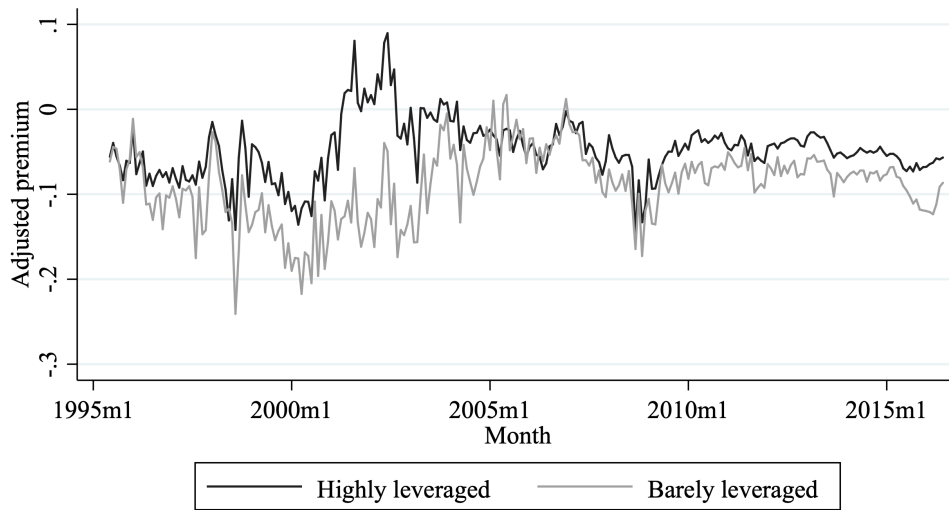
(b) Equity Funds: Highly Levered vs Barely Levered

Table 1: Summary statistics

Summary statistics are reported for our sample of 807 CEFs for the sample period from 1997 to 2016. Our sample is all CEFs with machine readable NSAR filings and having either Bloomberg or CRSP price and return data. Panel A and Panel B report variables that are available in the NSAR filings data (semiannual frequency) and the Bloomberg/CRSP data (monthly frequency), respectively. The definitions of all variables are given in Appendix A. Total assets, Net asset value, Cash, and Debt are in millions of dollars. Return, Alpha, and Alpha forwards are in the percentage terms. All variables are winsorized at the top and bottom 1% of the distribution.

Variable	Mean	Std. Dev.	Minimum	Median	Maximum	# Obs.
Panel A: Semiannual frequency data from NSAR filings						
Total assets	462.813	540.446	0.000	265.278	7496.439	19898
Net asset value	340.623	399.068	0.000	202.673	5994.866	19898
Cash	2.076	8.526	0.000	0.091	572.500	19895
Debt	119.202	168.436	0.081	54.075	882.927	19898
Fund age	11.384	8.429	0.000	10.000	37.000	19898
Book leverage	0.232	0.158	0.001	0.298	0.504	19897
Expense ratio	0.012	0.007	0.002	0.010	0.044	19893
Payout ratio	0.041	0.035	0.000	0.035	0.286	19892
Panel B: Monthly frequency data						
Premium	-0.065	0.191	-1.775	-0.057	0.263	114524
Adjusted premium	-0.050	0.128	-1.120	-0.041	0.211	114439
Price	13.151	5.568	-6.050	13.270	34.310	117740
NAV per share	13.974	5.457	3.160	14.120	36.190	114686
Market leverage	0.233	0.160	0.001	0.300	0.518	114686
Turnover	0.051	0.034	0.011	0.042	0.201	117894
Return	0.672	4.949	-16.740	0.848	16.402	117891
Alpha	-0.218	1.053	-3.886	-0.132	2.448	34515
Alpha forward	-0.080	0.981	-3.476	-0.054	2.680	32580

Table 2: The introduction of the ProShares levered ETFs

The following table provides the set of levered ETFs launched by ProShares during the summer of 2006. The first set of ETFs provides 2x long exposure to pre-specified indices and the second set of ETFs provides 2x short exposure to the same indices.

Fund Name	Daily Objective	Ticker
Panel A: Set of ETFs announced on June 21, 2006		
Ultra QQQ ProShares	Double the NASDAQ-100 Index	QLD
Ultra S&P 500 ProShares	Double the S&P 500 Index	SSO
Ultra Dow30 ProShares	Double the Dow Jones Industrial Average	DDM
Ultra MidCap400 ProShares	Double the S&P MidCap 400	MVV
Panel B: Set of ETFs announced on July 13, 2006		
UltraShort QQQ ProShares	Double the inverse of the NASDAQ-100 Index	QID
UltraShort S&P 500 ProShares	Double the inverse of the S&P 500 Index	SDS
UltraShort Dow30 ProShares	Double the inverse of the Dow Jones Industrial Average	DXD
UltraShort MidCap400 ProShares	Double the inverse of the S&P MidCap 400	MZZ

Table 3: The introduction of the ProShares levered ETFs

The following table provides a timeline of the introduction of the ProShares levered ETFs by ProFunds ETF Trust.

Date	Event
06/05/2002	ProFunds ETF Trust files Notification of Registration (Form N-8A) and Registration Statement for Open-End Management Investment Companies (Form N-1A)
10/31/2002	ProFunds ETF Trust files amendment to Form N-1A
07/17/2003	ProFunds ETF Trust files amendment to Form N-1A
01/07/2004	ProFunds ETF Trust files amendment to Form N-1A
02/18/2005	ProFunds ETF Trust files amendment to Form N-1A
08/22/2005	ProFunds hires Agustin Fleites as Chief Investment Officer
11/08/2005	ProFunds ETF Trust files amendment to Form N-1A
05/22/2006	ProFunds ETF Trust files amendment to Form N-1A SEC Approves ProFunds levered and inverse ETFs
06/19/2006	ProFunds ETF Trust files amendment to Form N-1A and Registration of Securities (Form 8-A12B)
06/21/2006	2x levered long ETFs (QLD, SSO, DDM, and MVV) launch
07/13/2006	-2x levered short ETFs (QID, SDS, DXD, MZZ) launch

Table 4: Leverage and premium

The table reports results from OLS regressions to examine associations between funds' use of leverage and CEF premiums. The dependent variable is fund premiums adjusted for the mechanical relation between leverage and premium. Panel A and Panel B examine book and market leverage respectively. Book leverage is from the semiannual NSAR filings and the same book leverage value is used for the subsequent five months until the new NSAR is filed. Market leverage is the book value of debt divided market value of total assets, which is the sum of book value of debt and net asset value of shareholders. Equity CEF is a fund dummy variable that equals one if the fund's asset class focus is equity and mixed securities. Asset class focuses are primarily based on Bloomberg classifications. In addition, we manually classify asset focuses of the funds that Bloomberg does not cover. The definitions of all variables are given in Appendix A. t-statistics that are clustered by month to account for cross-sectional correlation are reported in parentheses. ***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively.

Panel A: Book leverage

| | Adjusted premium | | | |
	(1)	(2)	(3)	(4)
Book leverage	0.103***	0.0870***	0.105***	0.0978***
	(25.32)	(20.64)	(12.17)	(9.40)
Equity CEF	-0.0191***	-0.0283***		
	(-11.44)	(-11.14)		
Book leverage * Equity CEF		0.0564***		0.0278*
		(6.85)		(1.70)
Expense ratio	-0.420***	-0.441***	0.154*	0.154*
	(-5.01)	(-5.24)	(1.88)	(1.87)
Observations	114415	114415	114406	114406
Adjusted R^2	0.067	0.068	0.272	0.272
Month fixed effects	Yes	Yes	Yes	Yes
Other fixed effects	No	No	Fund	Fund

Panel B: Market leverage

| | Adjusted premium | | | |
	(1)	(2)	(3)	(4)
Market leverage	0.107***	0.0920***	0.116***	0.109***
	(27.40)	(22.72)	(14.29)	(10.87)
Equity CEF	-0.0183***	-0.0270***		
	(-11.06)	(-10.59)		
Market leverage * Equity CEF		0.0530***		0.0265*
		(6.34)		(1.74)
Expense ratio	-0.440***	-0.458***	0.144*	0.145*
	(-5.27)	(-5.45)	(1.76)	(1.77)
Observations	114415	114415	114406	114406
Adjusted R^2	0.068	0.069	0.272	0.272
Month fixed effects	Yes	Yes	Yes	Yes
Other fixed effects	No	No	Fund	Fund

Table 5: Leverage and performance

The table reports results from OLS regressions for equity CEFs to examine associations between funds' use of leverage and total returns and performance. Alpha forward in Panel A is the estimated intercept for a given fund from a regression of monthly returns on Fama-French three factors and Carhart's momentum factor for the subsequent 36 month period. Return in Panel B is monthly returns from Bloomberg/CRSP databases. Book leverage is from the semiannual NSAR filings and the same book leverage value is used for the subsequent five months until the new NSAR is filed. Market leverage is the book value of debt divided market value of total assets, which is the sum of book value of debt and net asset value of shareholders. The definitions of all variables are given in Appendix A. t-statistics that are clustered by month to account for cross-sectional correlation are reported in parentheses. ***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively.

Panel A

| | Alpha forward (%) | | | |
	(1)	(2)	(3)	(4)
Book leverage	-0.212*	-0.835***		
	(-1.82)	(-9.57)		
Market leverage			-0.233**	-0.749***
			(-2.04)	(-7.60)
Expense ratio	-4.577***	4.781***	-5.896***	4.502***
	(-3.34)	(3.82)	(-4.16)	(3.58)
Observations	32495	32491	31072	31065
Adjusted R^2	0.159	0.352	0.161	0.351
Month fixed effects	Yes	Yes	Yes	Yes
Other fixed effects	No	Fund	No	Fund

Panel B

| | Return (%) | | | |
	(1)	(2)	(3)	(4)
Book leverage	0.301	-0.920		
	(0.56)	(-1.59)		
Market leverage			-0.269	-3.028***
			(-0.51)	(-4.72)
Expense ratio	-17.61**	-4.746	-13.86*	-2.168
	(-2.11)	(-0.46)	(-1.73)	(-0.23)
Observations	36978	36978	35176	35168
Adjusted R^2	0.485	0.486	0.496	0.497
Month fixed effects	Yes	Yes	Yes	Yes
Other fixed effects	No	Fund	No	Fund

Table 6: Difference-in-differences of fund premiums

The table reports difference-in-differences tests for equity CEFs based on the advent of levered ETFs in June 2006 to examine treatment effects on premiums. See Section 3 for the details of the advent of levered ETFs. The dependent variable is fund premiums adjusted for the mechanical relation between leverage and premium. Treated is a fund dummy variable that equals one if the fund is an active leverage user based on Bloomberg's leverage use classifications. Book leverage is from the semiannual NSAR filings and the same book leverage value is used for the subsequent five months until the new NSAR is filled. Market leverage is the book value of debt divided market value of total assets, which is the sum of book value of debt and net asset value of shareholders. Post is a year-month dummy variable that equals one if the year-month is post the advent of levered ETFs in June 2006. All specifications include fund and month fixed effects. Treated and Post are subsumed by the fund and month fixed effects, respectively. The definitions of all variables are given in Appendix A. t-statistics that are clustered by month to account for cross-sectional correlation are reported in parentheses. ***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively.

| | Adjusted premium | | |
	(1)	(2)	(3)
Treated * Post	-0.0316***		
	(-6.20)		
Book Leverage		0.144***	
		(5.49)	
Book Leverage * Post		-0.0687***	
		(-3.25)	
Market Leverage			0.162***
			(6.47)
Market Leverage * Post			-0.0770***
			(-3.61)
Alpha	0.0211***	0.0209***	0.0208***
	(13.59)	(13.59)	(13.61)
Expense ratio	0.397**	0.245	0.259
	(2.14)	(1.31)	(1.39)
Observations	24527	24527	24527
Adjusted R^2	0.412	0.413	0.414
Month fixed effects	Yes	Yes	Yes
Other fixed effects	Fund	Fund	Fund

Table 7: Difference-in-differences of fund performance

The table reports difference-in-differences tests for equity CEFs based on the advent of levered ETFs in June 2006 to examine treatment effects on premiums. See Appendix B for the details of the advent of levered ETFs. The dependent variable is Alpha forward the estimated intercept in the percentage term for a given fund at a given month end from a regression of monthly returns on Fama-French three factors and Carhart's momentum factor for the subsequent 36 month period. Treated is a fund dummy variable that equals one if the fund is an active leverage user based on Bloomberg's leverage use classifications. Book leverage is from the semiannual NSAR filings and the same book leverage value is used for the subsequent five months until the new NSAR is filled. Market leverage is the book value of debt divided market value of total assets, which is the sum of book value of debt and net asset value of shareholders. Post is a year-month dummy variable that equals one if the year-month is post the advent of levered ETFs in June 2006. All specifications include fund and month fixed effects. Treated and Post are subsumed by the fund and month fixed effects, respectively. The definitions of all variables are given in Appendix A. t-statistics that are clustered by month to account for cross-sectional correlation are reported in parentheses. ***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively.

| | Alpha forward (%) | | |
	(1)	(2)	(3)
Treated * Post	0.274***		
	(5.73)		
Book leverage		-1.552***	
		(-12.40)	
Book leverage * Post		0.935***	
		(5.41)	
Market leverage			-1.354***
			(-11.09)
Market leverage * Post			0.793***
			(4.60)
Expense ratio	0.0341	2.020	1.250
	(0.03)	(1.59)	(0.96)
Observations	24148	24148	23157
Adjusted R^2	0.317	0.321	0.308
Month fixed effects	Yes	Yes	Yes
Other fixed effects	Fund	Fund	Fund

Table 8: Baker-Wurgler closed-end fund discount versus treated and untreated closed-end fund discounts

The table reports results from OLS regressions to examine the association between the CEFDs in our sample versus the CEFD used in most academic studies, the Baker-Wurgler CEFD (denoted $CEFD_{BW}$). We consider three CEFDs: the NAV-weighted more-levered CEFD (denoted $CEFD_{Treated}$), the NAV-weighted less-levered CEFD (denoted $CEFD_{Untreated}$), and the NAV-weighted combined CEFD (denoted $CEFD_{Combined}$). The dependent variable is $CEFD_{BW}$. $CEFD_{Treated}$, $CEFD_{Untreated}$, and $CEFD_{Combined}$ are standardized. Panel A reports the analysis over the window 1996-2010. Panel B reports the analysis over the window 2011-2016. ***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively.

Panel A: 1996-2010

| | $CEFD_{BW}$ | | | |
	(1)	(2)	(3)	(4)
$CEFD_{Treated}$	-2.522***		-2.753***	
	(-11.45)		(-10.46)	
$CEFD_{Untreated}$		-1.129***	0.423	
		(-3.78)	(1.58)	
$CEFD_{Combined}$				-1.997***
				(-7.69)
Observations	250	250	250	250
Adjusted R^2	0.491	0.090	0.497	0.301

Panel B: 2011-2016

| | $CEFD_{BW}$ | | | |
	(1)	(2)	(3)	(4)
$CEFD_{Treated}$	-3.928***		0.169	
	(-4.33)		(0.10)	
$CEFD_{Untreated}$		-5.303***	-5.470***	
		(-5.49)	(-2.88)	
$CEFD_{Combined}$				-4.598***
				(-5.14)
Observations	250	250	250	250
Adjusted R^2	0.248	0.351	0.338	0.320

Table A.1: Difference-in-differences of fund premiums for narrow time windows

The table reports difference-in-differences tests for equity CEFs based on the advent of levered ETFs in June 2006 to examine treatment effects on premiums. See Section 3 for the details of the advent of levered ETFs. The dependent variable is fund premiums adjusted for the mechanical relation between leverage and premium. Treated is a fund dummy variable that equals one if the fund is an active leverage user based on Bloomberg's leverage use classifications. Post is a year-month dummy variable that equals one if the year-month is post the advent of levered ETFs in June 2006. We repeat the same analysis in column (1) of Table 6 over the three narrower windows starting in June 2003, 2004, and 2005 respectively and ending in June 2007, to mitigate concerns related to potential effects from 2007-2008 financial crisis. All specifications include fund and month fixed effects. Treated and Post are subsumed by the fund and month fixed effects, respectively. The definitions of all variables are given in Appendix A. t-statistics that are clustered by month to account for cross-sectional correlation are reported in parentheses. ***, **, and * indicate statistical significance at 1%, 5%, and 10% level, respectively.

| | Adjusted premium | | |
	(1)	(2)	(3)
	June 2003- June 2007	June 2004 - June 2007	June 2005 - June 2007
Treated * Post	-0.0216***	-0.0166**	-0.00172
	(-2.91)	(-2.04)	(-0.21)
Alpha	0.0273***	0.0310***	0.0296***
	(8.06)	(7.87)	(4.61)
Expense ratio	0.393	-0.659	0.881
	(0.42)	(-0.61)	(0.68)
Observations	3779	3034	2233
Adjusted R^2	0.550	0.571	0.589
Month fixed effects	Yes	Yes	Yes
Other fixed effects	Fund	Fund	Fund