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Financial Innovation, Investor Behavior, and Arbitrage: Implications from the ETF Market

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Abstract

Regular and levered ETFs are markedly different financial innovations. Regular ETFs improve liquidity: they are more liquid than their underlying stocks. In contrast, although the levered ETF market has a substantially higher turnover, it also has a significantly higher bid-ask spreads and larger price impacts. Our interpretation is that levered ETFs are appealing to short-term levered speculators. The aggregate cost levered ETF investors incur is around 10% of the market capitalization, or around $2 billion, each year. Moreover, regular ETF investors appear to be momentum traders, while levered ETF investors are contrarians: For regular (levered) ETFs, their monthly fund flows are strongly positively (negatively) correlated with past returns. Finally, arbitrage forces push ETF prices partially towards their NAVs, and this mechanism is less effective for levered ETFs than for regular ones.

JEL Classification Numbers: G11, G23.

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1 Introduction

Exchange-traded funds (ETFs) are becoming an increasingly significant asset class in the last two decades. The aggregate market capitalization is around \$2 trillion at the end of 2014. One interesting recent development is the emergence of levered ETFs. Levered long ETFs attempt to provide daily returns that are 2 or 3 times of the returns of their benchmark indices, while levered short ETFs, or inverse levered ETFs, attempt to generate daily returns that are –2 or –3 times of their index returns. Since the introduction of levered ETFs in June 2006, the total market capitalization has been growing steadily, and is over \$30 billion at the end of 2014. For convenience, we will refer to levered long and levered short ETFs as "levered ETFs," and refer to those without embedded leverage as "regular ETFs."

These innovations offer an opportunity to study a number of issues. For example, one prominent theory of financial innovation emphasizes the motive to create "information insensitive" securities to reduce adverse selection and enhance market liquidity (see, e.g., Gorton and Pennacchi (1990), DeMarzo and Duffie (1999)). On the one hand, regular ETFs appear consistent with this insight, since index returns are less sensitive to firm-specific information. On the other hand, levered ETFs seem to aim for the opposite: they increase information sensitivity through embedded leverage. How do these features affect market liquidity? How much do investors pay to use these financial innovations? Moreover, the ETF market offers a nice setup to study investor behavior. For example, how do ETF investors respond to past returns? When an underlying index increases, do investors move to the long or the short side of levered ETFs? Finally, the ETF market also offers an opportunity to analyze limits of arbitrage, since we can observe both ETF prices and fundamental values—net asset values (NAVs). For instance, how do ETF prices track their

NAVs over time? Is there a difference across regular and levered ETF markets? This paper addresses the above questions and our main findings are the following.

First, consistent with the insight from Gorton and Pennacchi (1990), we find that regular ETFs are significantly more liquid than their underlying stocks. Specifically, for each regular ETF, we identify the index that the ETF tracks, and the underlying stocks for that index. We find that the average turnover is 21% per month for the underlying stocks, but is 235% per month for their corresponding ETFs. The average bid-ask spread is 8.0 basis points for the underlying stocks, but is only 5.0 basis points for the ETFs. The average of the logarithm of Amihud (2002) liquidity ratio is -2.53 for the underlying stocks and -2.85 for the ETFs. Note that the liquidity ratio measures the price impact in a market. A higher liquidity ratio means a larger price impact, and hence a lower market liquidity. That is, compared to the underlying stocks, regular ETFs are more liquid—they have higher turnover, smaller bid-ask spreads and smaller price impact. For all three measures, the t-statistics for the differences between the regular ETFs and their underlying stocks are well above 3.

How about the levered ETFs? Holding underlying indices constant, the average turnover is 2.68 times per month for regular ETFs, but is 6.42 times per month for levered ETFs; That is, the turnover in the levered ETF market is several times higher than that in the regular ETF market. However, this does *not* imply that the levered ETF market is more liquid. We find that levered ETFs have significantly *higher* bid-ask spreads and *larger* price impact. The average bid-ask spread is 3.1 basis points for regular ETFs, but is 9.9 basis points for levered ones. Similarly, the average log liquidity ratio is -4.1 and -1.86 for regular and levered ETFs, respectively. For all three measures, the t-statistics for the differences between regular and levered ETFs are well above 5.

Second, our evidence suggests that despite the high bid-ask spreads and large price impacts, levered ETFs are appealing to some investors who are interested in very short-term levered speculation. Indeed, the average holding period is about 3 days in this market. Hence, levered ETF investors pay a significant cost to access this market. Our estimated cost is around 10% of the market capitalization, or more than \$2 billion, per year.[1] To assess the cost to levered ETF investors, we utilize a special feature in this market: Levered ETFs are usually issued in pairs. For each index, one ETF aims to provide x-time ($x = 2, 3$) daily return of the index, while the other aims to provide $-x$-time daily return of the same index. This offers an easy way to assess costs. Consider a portfolio which invests \$1 in each ETF, and re-balances daily to keep the same exposure to the two ETFs. For convenience, we refer to this portfolio as a "long-long" portfolio. If the two ETFs deliver the returns they are designed to generate, this portfolio return should always be zero regardless of the underlying index return. In our sample, however, the average return of this portfolio is -2.31% per year. Hence, one can interpret this as levered ETF investors facing a cost of 2.31% a year. Note that this measure does not include the costs investors incur when they trade in the secondary market. In our sample, the average turnover of levered ETFs is around 6.42 times per month. Hence, a bid-ask spread of 9.9 basis points implies a transaction cost of roughly 7.63% ($= 6.42 \times 12 \times 9.9$ b.p.) per year. Therefore, the total cost that levered ETF investors incur is, at least, 9.94% (=2.31%+7.63%) per year. This amounts to over \$2 billion for the market size towards the end of our sample.

Third, in aggregate, regular ETF investors appear to be momentum traders, while levered ETF investors appear to be contrarians. For a regular ETF, a one percent increase in the underlying index return is, on average, accompanied by inflows of 43.1 basis points ($t = 10.08$) in the next month. That is, regular ETF investors appear to be trend chasers. In

[1] As a comparison, French (2008) finds that "investors spend 0.67% of the aggregate value of the market each year searching for superior returns."

contrast, levered ETF investors are doing the opposite. On average, a one percent increase in the fund return is accompanied by a 12.4 basis points outflow next month. That is, investors appear to be betting on the reversal of the fund return. Moreover, investors' fund flows are not justified by future returns. If anything, our evidence suggests that investors, in aggregate, trade in the "wrong" direction in the levered ETF market: fund flows appear to be negatively correlated with the future returns.

Fourth, the average premium in our sample is less than one basis point, suggesting that arbitrage forces are effective in bringing ETF prices towards their NAVs and that there is no mispricing on average. However, there is significant time variation in this premium. ETF returns appear to under-react to NAV-implied returns. Specifically, when the NAV of an ETF increases (or decreases) by 1%, the ETF price increases (or decreases), on average, by only 94 basis points. Arbitrage forces do not perfectly peg the price of an ETF to its NAV. Rather, NAV is the "moving target", to which arbitrage forces *partially* push the ETF price. This is a sensible strategy when arbitrageurs face costs when setting up their trades, similar to the intuition in the literature of optimal portfolio choice with transaction costs. For example, as in the model of Garleanu and Pedersen (2012), in an environment with predictable return and transaction costs, the optimal strategy is to "trade partially towards the current aim". Moreover, also consistent with this model, we find that the prices of levered ETFs converge to their NAVs more slowly than those of regular ETFs. For a regular (levered) ETF, when its NAV increases by 1%, its price increases by 0.97% (0.94%).

Our paper adds to the literature that emphasizes the role of financial innovation in facilitating speculation by showing that levered ETF investors appear to be willing to pay a large cost for trading in this market (Frazzini and Pedersen (2012), Simsek (2013), Shen, Yan and Zhang (2014)). Our paper is also related to the literature on ETFs. Bhattacharya et al (2013) analyze the effect of ETF on retail investors' trading behavior. Petajisto (2011) examines the efficiency of ETF pricing. Ben-David, Franzoni and Moussawi (2012) analyze the role of ETF in propagating shocks across markets, Da and Shive (2015) analyze the asset return correlations caused by ETFs. Yao and Ye (2015) study the effect of share split on the market liquidity of levered ETFs. Lu, Wang, and Zhang (2009) studies the long term returns of levered ETFs.

2 Data

We construct the list of all ETFs from the CRSP stock database identified by their share code of 73. Then, we merge this list with the CRSP Survivor-Bias-Free Mutual Fund database by the CUSIP number and only keep funds with etf_flag of "F" to make sure that the sample has only ETFs. The CRSP stock database has the record of every ETF's daily price, return and trading volume, while the CRSP mutual fund database provides fund name, ETF sponsor name, net asset value (NAV) and portfolio holdings. From Bloomberg, we obtain each ETF's benchmark index, leverage, and number of shares outstanding, is from Bloomberg.[2] It also classifies ETFs by the type of assets an ETF invests in, including equity, fixed income, commodity, alternative, mixed allocation, and specialty. Institutional ownership is obtained from Thomson Reuters Institutional Holdings database (i.e., 13F filings to the SEC).

Panel A of Table 1 reports the number of ETFs and their total market capitalization. The first ETF, SPDR S&P 500 ETF Trust (SPY), was created on January 22nd, 1993. Levered ETFs were invented much later. On June 19th, 2006, ProShares issued the first four pairs of levered ETFs. At the end of our sample, December 31st, 2014, there are 1200 regular ETFs and 352 levered ETFs, and the total market size are $1.9 trillion for regular

[2]Both CRSP and Bloomberg contain data on total number of shares outstanding, but CRSP data updated weekly or bi-monthly while Bloomberg has daily updates.

ETFs and over \$30 billion for levered ETFs.

Panels B and C report the summary statistics of monthly variables for regular and levered ETFs, respectively. *Return* refers to an ETF's monthly return based on exchange traded prices and adjusted for distributions. *NAV Return* refers to an ETF's monthly returns calculated using the fund's net asset value and adjusted for distributions. *Spread* is the closing bid-ask spread, i.e., the closing ask price minus the closing bid price divided by the average of the bid and ask prices, at the end of the month. The median of *Spread* is 18 basis points for regular ETFs, while 24 basis points for levered ETFs. *Turnover*, the monthly turnover rate, has a median of 0.23 for regular ETFs and a much higher median, 1.52, for levered ETFs. *Ln Illiq* is the logarithm of the Amihud (2002) illiquidity ratio (i.e., the absolute value of daily return to the dollar amount daily volume in \$billion) during a month. *Flow* refers to the ratio of net capital flow to the total net assets at the beginning of the month. *Cap* is the total market capitalization in \$billion. The median size is only \$10 million for regular ETFs and \$3 million for levered ETFs. *Ln Cap* is the log of *Cap*. *Premium* is the month-end closing price divided by month-end NAV minus one. On average, for both regular and levered ETFs, *Premium* is relatively small (i.e., a median of 3 basis points for regular and 0 for levered ETFs). But the standard deviation of *Premium* is sizeable (58 basis points for regular and 51 basis points for levered ETFs). *Index Vol* is the standard deviation of daily returns of an ETF's underlying index during the month. *IO* refers to institutional ownership, the fraction of shares outstanding held by institutional investors at the most recent quarter end. The median *IO* is 23.05% for regular ETFs, and is merely 3.65% for levered ones, indicating that levered ETF investors are predominantly retail investors. Finally, due to the concern that extreme outliers are caused by erroneous data, we winsorized *Turnover*, *Spread*, *Flow* and *Premium* at both 1% and 99% level for all ETFs.

3 Empirical Analysis

3.1 Financial Innovation

One prominent theory of financial innovation emphasizes the motive to create "information insensitive" securities to reduce adverse selection and enhance market liquidity. For example, according to Gorton and Pennacchi (1990), since index returns are less sensitive to firm-specific information, ETFs should be less subjective to adverse selection, and have better market liquidity than their underlying stocks. This idea has also been applied to other issues such as security design DeMarzo and Duffie (1999) and banking Dang et al (2014). However, we are not aware of any empirical test of this prediction.

We conduct the test of this prediction on regular ETFs, and report the results in Panel A of Table 2. It shows that regular ETFs are significantly more liquid than their underlying stocks. Specifically, for each regular ETF, we identify the index that the ETF tracks, and the underlying stocks for that index. As shown in the first row, the market capitalization weighted average turnover of the underlying stocks is 21% per month. In contrast, the average turnover for ETFs is 235% per month. That is, on average, ETF shares are traded more than twice each month. The t-statistic for the difference in turnover is 8.8. Moreover, the average bid-ask spread is only 5.0 basis points for the ETFs, and 8.0 basis points for their underlying stocks, with the t-statistic for the difference being 3.4. Finally, the last column shows that the average of the logarithm of the Amihud (2002) liquidity ratio is -2.85 for ETFs, and -2.53 for their underlying stocks, with a t-statistic for the difference being 6.4. Note that the liquidity ratio measures the price impact in a market. A lower liquidity ratio means a smaller price impact, and hence a higher market liquidity. That is, the evidence in the regular ETF market is consistent with the prediction from Gorton and Pennacchi (1990): compared to the underlying stocks, regular ETFs are more liquid—they have higher turnover, smaller bid-ask spreads and smaller price impact.

However, levered ETFs appear to be exactly the opposite of the prediction of the above adverse-selection-based theory: they increase, rather than decrease, information sensitivity. This is unusual since levered ETFs are mostly marketed to retail investors, who are presumably less informed. How does this affect their market liquidity?

To address this issue, we identify all indices on which there exist both regular and levered ETFs. In this subsample, as shown in Panel B, the average turnover is 2.68 times per month for regular ETFs, but is 6.42 times per month for levered ETFs; the t-statistics for the difference is 5.2. That is, the turnover in the levered ETF market is several times higher than that in the regular ETF market. Note that due to the embedded leverage, investors' "effective" turnover is even larger. Suppose, for example, the leverage is 2. If an investor acquires \$1 of the ETF, it is equivalent to buying \$2 of the corresponding regular ETF. The third row shows that after adjusting for the embedded leverage, the effective turnover is 13.58. That is, this is equivalent to turnover the regular ETFs 163 times a year.

The above evidence suggests that levered ETFs are traded extremely actively. The average holding time is around 3 business days. However, this does *not* imply that the levered ETF market is more liquid. For example, the second column shows that levered ETFs have significantly *higher* bid-ask spreads. Holding underlying indices constant, the average bid-ask spread is 3.1 basis points for regular ETFs, but is 9.9 basis points for levered ones, with a t-statistic for the difference being 8.5. Note that due to the embedded leverage, to adjust for a certain amount of exposure, investors do not have to trade as much. Even after taking into account of this, the leverage adjusted bid-ask spread is still 5.4 basis points. The t-statistic for the difference between a regular ETF's bid-ask spread and the leverage-adjusted bid-ask spread of a levered ETF is 7.2. The third column shows that the price impact in the levered ETF market is significantly larger. The average log liquidity ratio is -4.10 and -1.86 for regular and levered ETFs, respectively. The t-statistics for the difference is 14.8. Even after adjusting for the embedded leverage, the price impact is still significantly larger in the levered ETF market, implying that the levered ETF market is less liquid.

In summary, the levered ETF market is not as liquid as the heavy turnover implies. The overall evidence suggests that, *despite* their iliquidity, levered ETFs seem appealing to some investors who have very short investment horizons. This is consistent with some recent studies that emphasize the role of financial innovation in facilitating speculation (e.g., Frazzini and Pedersen, (2012), Simsek (2012) and Shen, Yan and Zhang (2012)).

3.2 Cost Measure

The heavy trading in the levered ETF market, despite the large bid-ask spreads and price impacts, implies that investors must have incurred a large cost. We try to quantify the cost in this section. The special structure of ETF pairs offers a nice way to make cost assessment. ETF sponsors usually issue levered ETF pairs for each index: one ETF aims to provide x-time ($x = 2, 3$) daily return of the index, while the other aims to provide $-x$-time daily return of the same index. Consider a portfolio which invests \$1 in each ETF, and re-balances daily to keep the same exposure to the two ETFs. For convenience, we refer to this portfolio as a "long-long" portfolio. If the two ETFs deliver the returns they are designed to provide, the return of the long-long portfolio should be zero regardless of the underlying index return. That is, it is a zero-sum game between the investor of the x-time ETF and that of the $-x$-time ETF. Perhaps due to market frictions and management fees, the realized returns of the long-long portfolio can differ from 0, and so provide a measure of the cost to investors in levered ETFs.

Table 3 reports the returns of this long-long portfolio. The first column of Panel A shows that during our sample from 2006 to 2014, the average return of the long-long portfolio is -2.31% per year, with a t-statistic of 4.9. Hence, one can interpret this as levered ETF investors paying a cost of 2.31% a year. An implicit assumption behind the above cost measure is that the total market capitalization for the x-time ETF is the same as that for the $-x$-time ETF, while in reality the sizes of the two ETFs are often imbalanced. To examine if this violation meaningfully affects the cost measure, we make the following adjustment. We calculate the long-long strategy return for each pair of ETFs as the average return of the pair, weighted by each ETF's market capitalization on the previous day. We then take an average of the long-long strategy returns across all pairs, weighted by the total market cap of each pair. This adjustment barely changes the cost measure.

Columns 2–4 report the long-long portfolio returns by the categories of the underlying indices. Since most of our ETFs are based on stock indices, the long-long strategy loss for stock ETFs is almost the same as that in the overall sample. The long-long strategy loss is smaller for bond ETFs, -1.76% ($t = 7.5$), and is larger for commodity ETFs, -6.38% ($t = 4.5$).

What determines the long-long strategy return? First, levered ETFs attempt to track *daily* returns of underlying indices with x-time leverage ($x = \pm 2, 3$). Thus, they must adjust their underlying portfolio at a relative high frequency to keep their leverage ratios fixed. The transaction costs associated with the adjustments erode the net asset values (NAVs), and contribute to the low return from the long-long strategy. Following this intuition, we expect that the long-long strategy loss to be larger for 3-time levered ETF pairs, and for the pairs based on more volatile indices. As shown in Panel B of Table 3, the average long-long strategy return is -6.18% for 3-time ETF pairs and is -2.79% for 2-time pairs. Moreover, we sort ETFs based on the past month volatility of their underlying indices into two groups. The average long-long strategy return is -3.83% for the pairs in the high group, and is only -0.93% for the low group. In both cases, the cross-sectional differences are highly significant, both statistically and in economic terms. Second, part of the long-long strategy loss could be due to the overpricing of levered ETFs relative to their NAVs. Table 1 shows that although the average premium is within one basis point, there is significant variation overtime. We sort ETF pairs by their last month average premium. Panel A also shows that the long-long strategy loss is higher for the group with higher past month premium. Finally, the table also provides some evidence that the long-long strategy loss increases with market cap and the last month turnover of the ETF pairs. We don't find evidence that the long-long return changes with institutional ownership.

Note that the long-long strategy return is not the total cost for investors to access the opportunity for levered speculation. For example it does not include the transaction costs investors face when they frequently trade the levered ETFs in the secondary market. In our sample, the market cap weighted average turnover of levered ETFs is around 6.42 times per month. Hence, a bid-ask spread of 9.9 basis points implies a transaction cost of roughly 7.63% $(= 6.42 \times 12 \times 9.9 \text{ b.p.})$ per year. Therefore, the total cost that levered ETF investors incur is, at least, 9.94% (=2.31%+7.63%) per year. This amounts to over $2 billion for the market size towards the end of our sample. As a comparison, for the overall financial market, according to French (2008), "investors spend 0.67% of the aggregate value of the market each year searching for superior returns."

3.3 Investor Behavior

The above evidence suggests that regular and levered ETFs are markedly different financial innovations. While regular ETFs improve market liquidity levered ones appear to attract retail investors who are interested in short-term speculations, and trade heavily despite large bid-ask spreads and price impacts. In this section, we examine if regular and levered ETF investors display different trading behavior.

It is easy to see that regular and levered ETFs have different investor bases. For instance, as shown in Table 1, the median institutional ownership is 23% for regular ETFs, but is merely 3.65% for levered ETFs. That is, the levered ETF market is dominated by individual investors.

How do investors react to past returns? The first three columns of Table 4 suggest that, in aggregate, regular ETF investors are momentum traders. Specifically, we regress the monthly fund flow of an ETF on its return during the previous month. The first column shows that the coefficient is 0.431 ($t = 10.08$). That is, a one percent increase is the return of the ETF is associated with a 43.1 basis point increase in the flow to the fund next month. The second and third columns show that the fund flow responses are persistent. For example, the coefficient to the return at month $t-2$ is 0.127 ($t = 3.987$): a one percent increase is the return of the ETF is associated with a 12.7 basis point increase in the flow to the fund three month later.

In contrast, levered ETF investors appear to be contrarian: Monthly fund flows to levered ETFs are strongly negatively correlated with previous month returns. Column seven to nine report the results from a panel regression of monthly flows to levered ETFs on their past month returns. In column seven, the coefficient of return in month t is -0.124 ($t = 2.359$). That is, a one percent increase in the levered ETF return is accompanied by a 12.4 basis point more *outflow* in the next month. Columns eight and nine examine the persistence of this flow. Consistent with our interpretation that levered ETFs primarily attract short-term speculators, there is no evidence that fund flows are sensitive to returns more than one month ago.

We also examine a subset of regular ETFs, whose indices also have levered ETFs. For convenience, we call it the "matched sample." Presumably, levered ETFs are established on indices that investors are interested in speculating on. If those short-term speculators also trade in the regular ETFs, it should weaken the momentum behavior we have seen for the overall sample. Indeed, as we can see in columns four to six, the coefficient for return in month t is still positive and highly significant statistically, its magnitude is reduced to half.

Finally, to examine if the fund flows are "justified," i.e., if they can predict future returns, we regress an ETF's return on its fund flow in the previous month. As shown in column one of Table 5, fund flow has no predictive power for regular ETFs. The coefficient for Flow is almost zero with a t-statistic of 0.085. Moreover, for levered ETFs, fund flows are in the "wrong" direction. As shown in column seven, the coefficient for flow is -0.0566 ($t = 3.05$). That is, a higher flow to a levered ETF implies a *lower* future fund return. Finally, for the matched sample, the coefficient for flow is negative but statistically insignificant. That is, our evidence suggests that fund flows are not justified by future returns. If anything, there is some evidence that levered ETF investors move their allocations to the wrong direction.

3.4 Arbitrage

There is a well-established arbitrage mechanism in the ETF market. Through share creation and redemption, arbitrageurs can profit from deviations of ETF prices from NAVs. Moreover, both prices and NAVs of most ETFs can be accurately measured at the daily frequency. This offers a rich set of data to empirically examine the deviations of prices from fundamental values in a dynamic setup.

We have noted earlier in Table 1 that the average premium in our sample is less than one basis point, suggesting that arbitrage forces are effective in bringing ETF prices towards their NAVs and that there is no mispricing *on average*. How does the ETF price track its NAV over time?

To examine this question, we regress the ETF return on its contemporaneous NAV return. We restrict our sample to US equity ETFs only.[3] If the ETF price is perfectly pegged to its NAV, the coefficient for the NAV returns should be 1. However, the first column of Table 6 shows that the coefficient for NAV return is 0.943, which is significantly different from 1 ($t = 9.4$). It implies that when the ETF's fundamental value increases (decreases) by 1%, its price goes up (down) by only 94 basis points on average.

The above evidence shows that arbitrage forces cannot perfectly peg the price of an ETF to its NAV. Rather, NAV is the "moving target", to which arbitrage forces *partially* push the ETF price. This is a sensible strategy when arbitrageurs face costs when setting up their trades, similar to the intuition in the literature of optimal portfolio choice with transaction costs. For example, Garleanu and Pedersen (2012) find that in an environment with predictable return and transaction costs, the optimal strategy is to "trade partially towards the current aim".

This interpretation also suggests that when arbitrage cost is smaller, the ETF price should track its NAV more closely. We test this by comparing regular ETFs with levered ones. To the extent that arbitrage is more costly for levered ETFs, the coefficient for NAV return should be smaller for levered ETFs than that for regular ones. The second column of Table 6 shows that this is indeed the case. The coefficient for NAV Return is 0.975, and the coefficient for the interaction term $Levered \times NAV\ \ Return$ is -0.034 ($t = 3.2$), suggesting

[3] ETF returns are calculated based on prices recorded at 4pm. However, NAVs may be recorded at different time for ETFs on some asset classes such as currency and commodity. This dissynchronization creates problems for our inferences. Hence, we restrict our sample to ETFs based on US equities, where both prices and NAVs are recorded at the same time.

that the coefficient for NAV Return is 0.975 for regular ETFs and 0.941 (=0.975-0.034) for levered ones. That is, due to the higher arbitrage costs, levered ETF prices track their NAVs less closely.

4 Conclusion

We have documented that regular and levered ETFs are markedly difference financial innovations. Consistent with the adverse selection-based theory of financial innovation, we find that regular ETFs are more liquid than their underlying stocks, i.e., they have higher turnover, lower bid-ask spreads and price impact. In contrast, levered ETFs seem to aim for the opposite. Controlling for the underlying indices, the turnover in the levered ETF market is several times higher than that in the regular ETF market. However, this does *not* imply that the levered ETF market is more liquid, as we also find that levered ETFs have significantly *higher* bid-ask spreads and *larger* price impact.

Our interpretation is that regular and levered ETFs attract different investor bases. Regular ETFs attract investors with a motive for liquidity and diversification. Levered ETFs appear to attract investors who are interested in short-term levered speculations (their average holding period is around 3 days). They pay a substantial cost for their speculations—around 10% of the market capitalization, or over $2 billion, each year. Moreover, regular and levered ETF investors display different trading behaviors. Regular ETF investors appear to be momentum traders, while levered ETF investors are contrarians: For regular ETFs, monthly fund flows are strongly positively correlated with ETF returns during the previous several months. In contrast, for levered ETFs, monthly fund flows are strongly negatively correlated with their past month returns.

Finally, we find that the average premium in our sample is less than one basis point, suggesting that arbitrage forces are effective in bringing ETF prices towards their NAVs and that there is no mispricing on average. However, our evidence shows that arbitrage forces cannot perfectly peg the price of an ETF to its NAV. Rather, NAV is the "moving target", to which arbitrage forces partially push the ETF price. Due to limits of arbitrage, ETF prices only gradually converge to their fundamental values, and the convergence is slower for levered ETFs than for regular ones.

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Table 1. Summary Statistics

This table reports summary statistics of the main variables in our analysis. Panel A reports the number of ETFs and total market capitalization (in billion $) by leverage ratios at the end of each year from 2006 to 2014. Panel B reports the time-series averages of monthly cross-sectional statistics of each variable for regular ETFs. *Return* is the monthly return of levered ETFs compounded from daily returns. *NAV Return* is the monthly return that is compounded from hypothetical daily returns computed based on daily NAVs. *Spread* is the month-end closing bid-ask spread, ask price minus bid price divided by the average of bid and ask prices. *Turnover* is the sum of daily share turnover rate within each month. *Ln Illiq* is the log of the average of the ratio of the absolute value of daily returns to trading volume (in billion $) on each day of the month. *Flow* is the monthly capital flow rate. *Cap* is the market capitalization at the end of the month, denoted in $ billion. *Ln Cap* is the natural log of market capitalization in dollars. *IO* is the most recent report of institutional ownership from 13F filings. *Premium* is the month-end price to NAV ratio minus one. *Index Vol* is standard deviation of daily returns of ETF's benchmark index. Panel C reports summary statistics of these variables for levered and inverse ETFs. *Turnover*, *Spread*, *Flow* and *Premium* are winsorized within all ETF sample at both 1% and 99% level at each cross-section. The sample period spans from 2006/07 to 2014/12.

Panel A: # of ETFs and Market size by the end of each year

	# of ETFs						
Year	Regular ETFs	Levered ETFs					Total
	1x long	1x short	2x long	2x short	3x long	3x short	
2006	359	4	4	4	0	0	383
2007	561	9	26	30	0	0	691
2008	657	11	37	43	7	7	867
2009	702	12	42	48	13	13	958
2010	810	16	44	43	23	23	1108
2011	971	25	47	45	27	27	1313
2012	1030	26	47	45	27	23	1366
2013	1099	27	46	44	31	27	1449
2014	1200	27	50	44	32	23	1552

	Sum of Market Capitalization ($B)						
Year	Regular ETFs	Levered ETFs					Total
	1x long	1x short	2x long	2x short	3x long	3x short	
2006	425.0	0.4	0.5	1.3	0.0	0.0	429.4
2007	602.3	0.6	2.2	6.2	0.0	0.0	620.3
2008	514.9	1.0	8.5	8.5	0.6	0.3	552.6
2009	745.6	3.2	6.8	12.2	2.7	2.4	799.9
2010	964.9	3.7	7.7	11.6	4.4	2.8	1025.3
2011	1009.9	5.3	6.4	10.0	4.8	3.2	1069.4
2012	1306.5	4.5	7.4	7.7	4.5	2.8	1360.4
2013	1643.1	4.8	10.1	9.1	5.9	3.1	1709.2
2014	1938.1	4.5	8.5	6.9	8.3	3.0	2000.5

Panel B: Summary statistics of monthly variables for regular ETFs							
ETF Variables	**Mean**	**St Dev**	**P10**	**P25**	**P50**	**P75**	**P90**
Return	0.50%	3.82%	-3.79%	-1.60%	0.48%	2.56%	4.80%
NAV Return	0.49%	3.73%	-3.70%	-1.55%	0.50%	2.51%	4.67%
Spread	0.398%	0.660%	0.046%	0.092%	0.184%	0.393%	0.89%
Turnover	0.57	1.29	0.08	0.13	0.23	0.46	1.03
Ln Illiq	2.41	2.94	-1.69	0.48	2.59	4.66	6.18
Flow	4.64%	19.72%	-5.85%	-0.82%	0.02%	5.02%	17.77%
Cap ($B)	1.15	4.96	6.76	0.02	0.10	0.50	2220.96
Ln Cap	4.73	2.12	1.99	3.05	4.62	6.18	7.68
Premium	0.06%	0.58%	-0.53%	-0.16%	0.03%	0.28%	0.69%
Index Vol	1.35%	2.41%	0.62%	0.98%	1.23%	1.51%	1.88%
IO	30.90%	28.16%	4.83%	12.14%	23.05%	41.74%	64.55%
# of months	102						
# of ETFs	803.1						

Panel C: Summary statistics of monthly variables for levered ETFs							
ETF Variables	**Mean**	**St Dev**	**P10**	**P25**	**P50**	**P75**	**P90**
Return	-0.67%	10.77%	-13.02%	-8.29%	-0.91%	6.88%	12.05%
NAV Return	-0.66%	10.76%	-13.00%	-8.23%	-0.82%	6.95%	12.03%
Spread	0.390%	0.515%	0.047%	0.102%	0.241%	0.478%	0.852%
Turnover	3.41	4.21	0.39	0.71	1.52	4.19	10.90
Ln Illiq	2.28	2.85	-1.69	0.02	2.63	4.61	5.80
Flow	10.29%	28.47%	-15.10%	-1.98%	3.68%	17.42%	42.44%
Cap ($B)	0.18	0.44	0.01	0.01	0.03	0.15	0.47
Ln Cap	3.70	1.68	1.73	2.32	3.42	4.96	6.09
Premium	-0.01%	0.51%	-0.49%	-0.20%	0.00%	0.19%	0.47%
Index Vol	1.35%	0.51%	0.89%	1.08%	1.27%	1.52%	1.89%
IO	11.15%	18.75%	0.00%	0.00%	3.65%	15.53%	33.39%
# of months	102						
# of ETFs	128.2						

Table 2. Liquidity of ETF Portfolios, Regular ETFs, and Levered ETFs

This table compares three liquidity measures of regular ETFs with their underlying assets and the corresponding levered and inverse ETFs. *Turnover, Spread* and *Ln Illiq* are defined in Table 1 and are also winsorized within all ETF sample at both 1% and 99% level at each cross-section. In Panel A, we restrict to a subsample of regular ETFs whose underlying portfolio information is available. For regular ETF, the liquidity measures of its underlying portfolio are calculated as the mean of the liquidity measures of the assets in the portfolio, value-weighted by each asset's weight in portfolio (*Ln Illiq* is the log of the average illiquidity ratio of all assets in an ETF portfolio). In each month, we calculate the average of the liquidity measure for all regular ETFs and their underlying portfolios, value-weighted by an ETF's market capitalization at the end of the previous month. *Diff: Normal – Underlying* is the difference between the means of the liquidity measures of regular ETFs and their underlying portfolios. In Panel B, we restrict to a subsample where all the underlying indices have ETFs in both categories, i.e., normal versus levered/inverse. If multiple ETFs on an index in the same category, we aggregate the liquidity measures of these ETFs by their value-weighted averages, weighted by the market capitalization of these ETFs at the end of the previous month. Then, for each category, we obtain a time series of the three liquidity measures by taking a value-weighted average across all indices, weighted by the sum of market capitalization of all ETFs tracking the same index. We adjust *Turnover* by multiplying an ETF's level of leverage and adjust *Spread* and *Illiquidity* by dividing an ETF's level of leverage. *Diff: Normal – Levered* is the difference between the means of the liquidity measures of normal and levered ETFs. *Diff: Normal – Levered (w/ adjustment)* is the difference between the means of the liquidity measures of regular ETFs and adjusted liquidity measures of levered ETFs. *T* -statistics are reported in parenthesis. All *t*-statistics are Newey-West adjusted with a 3-month lag and reported in parenthesis. The sample is from 2006/07 to 2014/12.

Panel A: Regular ETFs versus their underlying assets

		Turnover	**Spread**	**Ln Illiq**
Underlying Assets	Mean	0.21	0.080%	-2.53
	St. Dev.	0.06	0.092%	0.34
Regular ETFs	Mean	2.35	0.050%	-2.85
	St. Dev.	1.39	0.045%	0.36
Diff: Normal – Underlying		2.14	-0.030%	-0.32
		(8.8)	(-3.4)	(-6.4)
# of months		102		
# of ETFs		311.4		

Panel B: Normal versus levered ETFs

		Turnover	**Spread**	**Ln Illiq**
Regular ETFs	Mean	2.68	0.031%	-4.10
	St. Dev.	*1.56*	*0.026%*	*0.34*
Levered ETFs	Mean	6.42	0.099%	-1.86
	St. Dev.	*5.08*	*0.070%*	*0.60*
Levered ETFs (w/ adjustment for leverage)	Mean	13.58	0.054%	-2.50
	St. Dev.	*9.98*	*0.038%*	*0.64*
Diff: Normal – Levered/Inverse		3.73	0.068%	2.24
		(5.2)	(8.5)	(14.8)
Diff: Normal – Levered (w/ adjustment)		10.90	0.022%	1.60
		(6.8)	(7.2)	(10.2)
# of months		102		
# of Indices		40.1		

Table 3. Long-long portfolio returns

Panel A reports the *Long-Long* strategy return for levered ETFS for the overall sample, and subsamples for stock ETFs, bond ETFs, and commodity ETFs. The *Long-Long* strategy return is average daily returns of each matched long-short levered ETF pair. All means are value weighted by ETFs total market capitalization at the end of previous trading day. Panel B sort the matched levered ETFs sample on each pair's last month *Turnover*, *Cap*, *Index Vol*, *Leverage*, and *Premium*. All variables are defined as in Table 1. Each month all pairs of levered ETFs are sorted into two halves (High and Low) based on each variable, then implement daily rebalanced long-long strategy within each group. All means are value weighted by each pair's total market capitalization at the end of previous trading day. Returns are annualized and Newey-West *t*-statistics with lag of 20-day are reported in parenthesis. The sample period spans from 2006/07 to 2014/12.

Panel A: Long-long portfolio return of paired levered ETFs

	All	**Stock**	**Bond**	**Commodity**
Long-Long return	-2.31%	-2.26%	-1.76%	-6.38%
	(-4.9)	(-5.1)	(-7.5)	(-4.5)
# of days	2140	2,132	1438	1534
# of pairs	50.6	43.4	4.23	3.99

Panel B: Return of long-long portfolios sorted on characteristics

Sort on:	**High**	**Low**	**High - Low**	# of days
Leverage	-6.18%	-2.79%	-3.39%	1548
	(-5.7)	(-6.9)	(-4.2)	
Index Vol	-3.83%	-0.93%	-2.87%	2118
	(-4.5)	(-3.4)	(-4.2)	
Premium	-3.57%	-1.73%	-1.84%	2118
	(-4.5)	(-3.0)	(-2.6)	
Turnover	-2.49%	-1.18%	-1.34%	2,118
	(-4.8)	(-3.4)	(-3.2)	
Cap	-2.39%	-1.93%	-0.47%	2118
	(-4.6)	(-4.9)	(-1.4)	

Table 4. Sensitivity of ETF Flows to Past Returns

This table presents the result of regressions of ETF flows on past returns. We regress a ETF's *Flow* at month t+1 on its past returns up to six months, controlling for the ETF's *Ln Cap*, *Turnover*, *Index Vol*, *Ln Illiq*, and *Premium* at month *t*. Month times *Category* fixed effects are also included (but not reported) in the regressions. *Category* classifies ETFs by the type of assets an ETF invests in, including equity, fixed income, commodity, alternative, mixed allocation, and specialty. Variables are defined as in Table 1. In columns (1) to (3), the regression is running on the sample of all regular ETFs, in columns (4) to (6) the regression is running on a matched subsample of regular ETFs whose underlying index also have levered or inverse ETFs, and in columns (7) to (9) the regression is running on the sample of levered ETFs. Standard errors are double clustered by ETF and by month, and *t*-statistics are reported in parenthesis. The sample period spans from 2006/07 to 2014/12.

Dep. Var.: **Flow$_{t+1}$**	All Regular ETFs			Matched Regular ETFs			Levered ETFs		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Return$_t$	0.431	0.439	0.431	0.221	0.256	0.247	-0.124	-0.120	-0.107
	(10.1)	(10.4)	(10.3)	(3.3)	(4.1)	(3.9)	(-2.3)	(-2.2)	(-2.0)
Return$_{t-1}$		0.155	0.159		0.0754	0.0968		-0.0383	-0.0411
		(4.4)	(4.8)		(0.9)	(1.2)		(-0.9)	(-1.0)
Return$_{t-2}$		0.134	0.127		0.0965	0.123		-0.0157	-0.0206
		(4.0)	(3.9)		(1.6)	(2.6)		(-0.3)	(-0.4)
Return$_{t-3}$			0.0233			-0.0357			-0.00335
			(0.9)			(-0.8)			(-0.1)
Return$_{t-4}$			0.0140			-0.0147			-0.000789
			(0.4)			(-0.3)			(-0.02)
Return$_{t-5}$			0.00737			0.0140			-0.0152
			(0.2)			(0.3)			(-0.3)
Ln Cap$_t$	-0.0596	-0.0476	-0.0394	-0.0189	-0.0148	-0.0102	-0.0769	-0.0725	-0.0675
	(-15.5)	(-15.0)	(-14.0)	(-3.7)	(-3.4)	(-3.2)	(-8.9)	(-9.2)	(-8.9)
Turnover$_t$	0.00194	-0.00106	-0.000762	0.00268	0.00154	0.00146	0.00388	0.00296	0.00177
	(0.7)	(-0.5)	(-0.4)	(1.6)	(0.9)	(1.0)	(2.5)	(1.9)	(1.4)
Index Vol$_t$	-0.0187	-0.0133	-0.0185	-1.566	-0.781	-0.421	4.850	4.344	4.156
	(-4.9)	(-4.0)	(-3.4)	(-2.2)	(-1.3)	(-0.8)	(5.2)	(6.2)	(6.3)
Ln Illiq$_t$	-0.0386	-0.0308	-0.0254	-0.00873	-0.00627	-0.00381	-0.0378	-0.0363	-0.0342
	(-14.4)	(-13.9)	(-12.7)	(-2.5)	(-2.1)	(-1.7)	(-7.3)	(-7.8)	(-8.1)
Premium$_t$	3.146	2.641	2.390	0.880	0.658	0.565	1.860	1.787	1.662
	(8.3)	(8.6)	(8.1)	(1.7)	(1.4)	(1.3)	(3.1)	(2.3)	(2.3)
Month*Category Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R2	0.12	0.10	0.09	0.15	0.16	0.16	0.16	0.13	0.121
Observations	68,282	66,357	63,365	4,939	4,894	4,828	11,953	11,587	11,021

Table 5. Return Predictability of ETF Flows

This table presents the result of regressions of ETF future returns on ETF flows. We regress a ETF's future *Returns* over a month, over a quarter, and over a year relative to month *t*, separately, on the ETF's *Flow* at *t*, controlling for past returns, *Ln Cap*, *Turnover*, *Index Vol*, *Ln Illiq*, and *Premium* at month *t*. Month times *Category* fixed effects are also included (but not reported) in the regressions. *Category* classifies ETFs by the type of assets an ETF invests in, including equity, fixed income, commodity, alternative, mixed allocation, and specialty. Variables are defined as in Table 1. In columns (1) to (3), the regression is running on the sample of all regular ETFs, in columns (4) to (6) the regression is running on a matched subsample of regular ETFs whose underlying index also have levered or inverse ETFs, and in columns (7) to (9) the regression is running on the sample of levered ETFs. Standard errors are double clustered by ETF and by month, and *t*-statistics are reported in parenthesis. The sample period spans from 2006/07 to 2014/12.

	All Regular ETFs			Matched Regular ETFs			Levered ETFs		
Dependent Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Future Return	Month	Quarter	Year	Month	Quarter	Year	Month	Quarter	Year
Flow$_t$	0.000188	-0.00505	-0.0177	-0.0112	-0.0183	-0.0111	-0.0566	-0.0793	-0.0613
	(0.09)	(-1.2)	(-1.9)	(-1.7)	(-1.7)	(-0.5)	(-3.0)	(-3.2)	(-1.0)
Return$_t$	0.0680	0.106	0.195	0.0404	0.0221	0.0671	-0.00451	0.0569	0.159
	(1.9)	(1.8)	(1.5)	(0.7)	(0.2)	(0.4)	(-0.04)	(0.4)	(0.5)
Return$_{t-1\ to\ t-11}$	0.0110	0.0149	0.119	0.00525	-0.00703	0.106	0.0189	0.0500	0.299
	(1.2)	(0.8)	(3.4)	(0.4)	(-0.3)	(1.4)	(0.9)	(1.3)	(3.6)
Ln Cap$_t$	0.000274	0.00150	0.00778	0.000851	0.00251	0.0137	0.00370	0.0238	0.105
	(0.7)	(1.6)	(2.4)	(1.4)	(1.4)	(1.9)	(0.6)	(2.0)	(3.1)
Turnover$_t$	-0.000189	-0.000127	0.00228	0.000123	0.000390	0.00429	-0.00148	-0.00396	-0.00703
	(-0.9)	(-0.2)	(1.2)	(0.4)	(0.5)	(1.5)	(-1.9)	(-2.7)	(-1.6)
Index Vol$_t$	-0.109	-0.223	0.683	-0.214	-0.675	-0.573	-0.408	-0.805	0.0164
	(-0.5)	(-0.5)	(0.7)	(-0.6)	(-1.0)	(-0.3)	(-1.7)	(-0.7)	(0.003)
Ln Illiq$_t$	5.49e-05	0.000727	0.00561	0.000995	0.00290	0.0140	0.00102	0.0100	0.0523
	(0.2)	(1.1)	(2.3)	(1.9)	(1.9)	(2.4)	(0.3)	(1.5)	(2.8)
Premium$_t$	-0.513	-0.525	-0.988	-0.196	0.496	0.193	-0.179	1.041	-1.049
	(-4.6)	(-2.1)	(-1.8)	(-0.8)	(1.1)	(0.2)	(-0.2)	(0.7)	(-0.3)
Month*Category Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R2	0.65	0.66	0.654	0.75	0.75	0.79	0.03	0.05	0.17
Observations	57,697	55,420	46,043	4,709	4,551	3,851	9,939	9,571	7,991

Table 6. Regression of ETFs' price returns on NAV returns

The dependent variable is daily ETF price *Return* on day *t*. The independent variables are *NAV Return* at day *t* and *Premium* at day *t-1* in column (1). In column (2) the independent variable also includes a dummy variable, *Levered*, which equals one if it is a levered or inverse ETFs, and an interaction term of *Levered* and *NAV Return*. The regressions restrict to a subsample where all the underlying indices have both regular ETFs and levered ETFs. The sample only includes U.S. equity ETFs and is from 2006/07 to 2014/12. Standard errors are double clustered by ETF and by date, and *t*-statistics are reported in parenthesis (null hypothesis as indicated).

	Dep. Var.: Return$_t$	(1)	(2)
NAV Return$_t$		0.943	0.975
	H0: = 1	(-9.4)	(-3.3)
Premium$_{t-1}$		-1.071	-1.071
	H0: = -1	(3.3)	(3.3)
Levered			-0.00017
	H0: = 0		(-3.5)
Levered × NAV Return$_t$			-0.0338
	H0: = 0		(-3.2)
Day Fixed Effect		Yes	Yes
R2		0.96	0.96
Observations		238,482	238,482