Journal of Investment Strategies **8**(2), 69–88
DOI: 10.21314/JOIS.2019.110

Research Paper

Can shorting leveraged exchange-traded fund pairs be a profitable trade?

George Tsalikis and Simeon Papadopoulos

Department of Accounting and Finance, University of Macedonia, 156 Egnatia Street, GR-546 36 Thessaloniki, Greece; emails: gtsalikis@uom.edu.gr, spapado@uom.gr

(Received June 30, 2018; revised March 10, 2019; accepted June 3, 2019)

ABSTRACT

In this paper, we examine if investors can profit from the underperformance of leveraged exchange-traded funds (ETFs) in long holding periods. One strategy involves shorting equal amounts of positive and negative leveraged ETFs that follow the same benchmark in order to obtain volatility decay as profit. The profitability of this strategy is independent of the direction of the underlying index. A theoretical framework is presented regarding the conditions under which this strategy can be profitable. When empirically tested for two years in four S&P 500 leveraged ETFs for monthly holding periods, this strategy produced a profit for both the ± 2 and the ± 3 pairs. However, after considering shorting fees for the funds, the profitability of this strategy for both pairs was highly diminished. We also examine a different method of going long in an index by shorting bear funds and compare this with purchasing bull funds for the same period. When empirically tested for two years in four S&P 500 leveraged funds for monthly holding periods, shorting the bear funds produced slightly higher average profits and risk-adjusted returns than going long the bull funds, even after accounting for shorting fees.

Keywords: leveraged exchange-traded funds (ETFs); volatility; compounding effect; price deviations; pair trading; short selling.

Corresponding author: G. Tsalikis

Print ISSN 2047-1238 | Online ISSN 2047-1246

1 INTRODUCTION

Leveraged exchange-traded funds (LETFs) are funds that trade in stock markets, and their goal is to deliver a steady multiple of the daily returns of an index. Their underlying indexes can include stock indexes, bonds, currencies, commodities and real estate (Charupat and Miu 2014). In order to achieve the advertised multiple, LETFs employ financial derivatives such as index futures or total return swaps.[1] Bull (or long) ETFs usually aim to obtain a daily return that is two or three times the daily return of their underlying indexes, whereas bear (or short) ETFs aim to obtain a return that is -1, -2 or -3 times the daily return of their underlying indexes.

LETFs are mandated to rebalance their exposures at the end of each trading day, or else they would not be able to preserve the advertised constant leverage ratios. For example, if an underlying index increases in one day, a bull fund replicating this index will become under-leveraged for the next trading day and will need rebalancing so as to guarantee that new investors purchasing the fund will receive the advertised leverage ratio. The same goes for bear funds as well, and typically higher required adjustments lead to higher transaction costs for that particular day. Therefore, unlike traditional ETFs, which are passively managed, LETFs need daily active management, which inevitably causes higher management fees. Most LETFs have management fees that are close to 1% per year or even higher. Management fees can be increased or decreased depending on interest rates and derivative costs.

Although LETFs might perform as intended on a daily basis, there is no assurance that the stated multiple will be achieved for longer holding periods. A few years after LETFs' introduction in the US market in 2006, some investors filed lawsuits against LETF providers, accusing them of misleading investors about the performance targets of their products.[2] As a result, in 2009 the Financial Regulatory Industry Authority (FINRA) and the Securities and Exchange Commission (SEC) explicitly warned buy-and-hold investors of the high risks related to investing in LETFs for long holding periods (Tang and Xu 2013).

Leveraged ETFs stand for a very small fraction of the global ETF market. Bull and bear ETFs represent only 1.3% of global assets in exchange-traded products (Lettau and Madhavan 2018). The sum of assets under management (AUM) of leveraged ETFs in 2017 was US$77.1 billion with 834 LETFs. Of these, 419 were bull funds with assets worth US$43.6 billion, and 415 were bear funds with assets worth

[1] According to Giannetti (2017), inspections of LETFs holdings reveal that swaps are the main – and, in the case of bear funds, the exclusive – form of leverage.

[2] The first LETFs were introduced by ProFund Advisors LLC in the summer of 2006 in three leverage multiples: $2\times$, $-1\times$ and $-2\times$.

US$33.5 billion. Most LETFs trade in the United States, and by the end of 2017 American LETFs had assets worth US$54.2 billion invested in 273 products.[3]

Because of their design, LETFs are not well suited to buy-and-hold investors, as the constant leverage ratios will inevitably lead funds' long-term return to deviate significantly from the advertised multiple of the benchmark index return. This deviation depends on many factors, such as the leverage ratio of the fund, the return of the index, the volatility of the index, the length of the holding period and the path that the underlying benchmark follows during that period. It has been well documented (especially during the 2007–9 financial crisis) that in highly volatile paths LETFs tend to underperform significantly, even over short periods of time; this phenomenon is frequently described in the academic literature as volatility decay (Avellaneda and Zhang 2010; Cheng and Madhavan 2009; Guo and Leung 2014; Leung and Ward 2015). LETFs have often been criticized by the press as frequently underperforming their advertised objectives, leading to portfolio losses. Leveraged ETFs' negative exposure to the volatility of their underlying index results in price decay when the market is flat with no significant upward or downward trend. For example, imagine an index that increases by 10% one trading day and then decreases by 9.0909% the next trading day. A perfectly replicating 2× bull fund would go up 20% on day one and down 18.1818% on day two. Although on the second day the underlying index will be back to its initial price, the LETF will be down by 1.81816%. In this scenario, LETF holders have lost almost 2% in two trading days. This is just the normal mathematical behavior of compounding in a leveraged and daily rebalanced portfolio.

In theory, investors could benefit in such markets by shorting leveraged ETF pairs. Compounding is not the only problem for LETF holders, as LETF management needs to rebalance the fund's positions every day in order to keep a constant leverage exposure to the underlying index. This active management generates costs that inevitably reduce the performance of the leveraged funds (Wagalath 2014). An investor going short equal amounts of a $+n$ and $-n$ leveraged fund following the same benchmark would be market neutral and positively exposed to volatility.[4] In theory, the higher the volatility, the higher the profit. For example, between January 1, 2009 and December 31, 2009, SSO (+2) gained 35.85% and SDS (−2) lost

[3] Data was collected from the ETFGI website, https://etfgi.com.

[4] This strategy is market neutral provided the same notional amounts of leveraged ETF pairs are shorted. This means that as the market moves upward or downward the investor should periodically rebalance their positions or else they will be long or short biased to the underlying index. If the market moves significantly with no rebalancing of the portfolio, an investor can end up with double exposure to one side or the other. Rebalancing frequently will, of course, lead to additional transaction costs for investors.

46.99%; hence, a portfolio that shorted equal amounts of this pair of ETFs would gain 11.14% minus the loan fees paid for shorting the ETFs.[5]

In this paper, we investigate whether it could be feasible for an investor to profit from the price decay that LETFs tend to exhibit in the long run. One trading strategy involves shorting equal amounts of bull and bear funds following the same underlying index in order to obtain volatility decay as profit and be market neutral. We also present a theoretical framework regarding the conditions under which this strategy is profitable. The interesting part regarding shorting LETF pairs is that investors can make profits both in upward and downward markets, as they are long exposed to the volatility of the benchmark index but not to its return. We incorporate shorting costs in our study as we want to test the profitability of this strategy in trading conditions that are as close to real life as possible.

Trading history shows us that stock markets have an upward drift and, in the long run, will appreciate in price. Therefore, most investors are willing to take long positions in the market. Further, many studies have shown that bear funds underperform faster than their bull counterparts. We examine an alternative strategy of going long on an index that tries to exploit this inherent expected decay in bear funds' returns over time. We assess the performance of going long US$1 on a bull fund versus going short US$1 on the corresponding bear fund. Again, we incorporate shorting costs in our study to test this strategy in real-life trading conditions.

2 LITERATURE REVIEW

Since their inception in 2006, many studies have tried to figure out the price dynamics of LETFs and determine under which conditions they are a sound investment. Trainor and Baryla (2008) find that LETFs match their advertised daily multiples; however, when examining longer holding periods, they find that the returns of the examined funds are not in line with the naive expected return of their underlying indexes. They also find that the effect of compounding is higher as the holding period increases. Hougan (2009) also finds that the daily returns of LETFs do not differ from their daily multiples substantially. Weekly LETF returns are also close to their advertised multiple; LETF returns start to deviate for monthly and three-month holding periods. Charupat and Miu (2010) study Canadian LETFs and point out that they trade at higher premiums or discounts than unleveraged ETFs. Moreover, they also find

[5] Proshares Ultra S&P 500 (SSO) seeks to mimic daily investment results corresponding to twice the daily performance of the S&P 500 index, whereas ProShares UltraShort S&P 500 ETF (SDS) seeks daily investment results corresponding to twice the inverse of the daily performance of the S&P 500.

that LETFs can deliver their advertised performance over holding periods of up to a week but start to erode in longer holding periods, especially for bear funds. Murphy and Wright (2010) assess the ability of twelve commodity-based LETFs to achieve their stated objectives and find that their average daily returns are not significantly different from those objectives. In the long run, most of the funds do not perform as expected, although some of the examined funds perform better than their stated multiples. However, Murphy and Wright advise against using LETFs in buy-and-hold investment strategies. Lu *et al* (2012) study the path dependence of American LETFs and conclude that they are not suitable for investors wanting to employ buy-and-hold strategies. However, LETF investors with an investment horizon of less than one month can get returns close to the stated multiple. Shum and Kang (2013) find that LETF performance deviates from their target multiple for holding periods that exceed one month. They also find that the longer the holding period, the higher the size of the deviation. In addition, Shum and Kang find evidence that bear funds deviate from their target returns faster than their bull counterparts as the holding period increases. Trainor and Carroll (2013), on the other hand, find that volatility decay can be offset by a trending market on certain occasions. They show that when volatility levels are as low as they were in the 1990s and mid-2000s, leveraged funds can be held for periods beyond one year. Rompotis (2016) studies the performance and volatility of LETFs investing in emerging market stock indexes. He finds that bull funds can deliver their target returns over a weekly holding period, whereas bear funds can only do so over a two-day period. Tsalikis and Papadopoulos (2018) assess the performance since inception of both European and American LETFs and find that they perform as intended for daily holding periods. LETF performance begins to deviate when the holding period is increased to one month. Tsalikis and Papadopoulos also find that bear funds deviate from their target return more quickly than bull funds as the holding period lengthens.

Not much academic research has been published regarding shorting leveraged ETFs. Jiang and Peterburgsky (2017) study trading strategies between ± 3 leveraged ETF pairs by simulating daily returns over a forty-eight-year period and find that many of them outperform the S&P 500 index on a risk-adjusted basis. The Sharpe ratio is maximized when shorting the $-3\times$ fund and the $+3\times$ fund in a 2:1 ratio but not in a 1:1 ratio. Hessel *et al* (2018) show that when shorting LETF pairs, the expected return of this strategy is high when the weighted sum of various orders of autocorrelations is negative and the volatility of the benchmark index is high. They empirically examine triple-leveraged ETF pairs following six indexes and find that in four of the six markets the shorting pair strategy can produce average monthly returns of more than 1%. They conclude that the profitability of shorting pairs can be increased by deploying the strategy when the volatility of the underlying index in the previous month is high enough. These two studies do not include the cost

of borrowing. Dobi and Avellaneda (2012) analyze twenty-one bull and bear ETF pairs for various time periods between 2009 and 2011. They suggest that, without taking borrowing costs into account, shorting LETFs produces slippage and is profitable. However, when the high costs of short selling are factored in, these profits are decreased and some pairs exhibit negative returns. Dobi and Avellaneda conclude that short selling leveraged ETFs may be profitable, but investors are exposed to risk in trending markets and to considerable short-selling fees. To our knowledge, their study was the first and only one to incorporate stock loan fees, thus providing useful insights in real market conditions.

3 EMPIRICAL ANALYSIS

3.1 Shorting LETF pairs

As discussed previously, LETF exposure to the volatility of the benchmark index leads to price decay, especially when the market has no significant upward or downward trend. Shorting LETF pairs can be profitable in such markets regardless of the direction the market moves. When shorting equal amounts of a $+n$ and $-n$ LETF following the same underlying index, investors are positively exposed to the volatility of the index. In theory, the higher the volatility, the higher the profit. The risk in this strategy lies in the possibility of a trending market combined with low volatility, which can in theory lead to LETF overperformance and therefore losses for investors that short pairs. Also shorting fees can be high enough to offset the gains of this strategy even when volatility decay is significant. The performance (P) of this strategy is

$$P = -0.5R_{\text{ETF}+} - 0.5R_{\text{ETF}-} - f_{\text{ETF}+} - f_{\text{ETF}-}, \tag{3.1}$$

where $R_{\text{ETF}+}$ and $R_{\text{ETF}-}$ are the returns of the shorted bull and bear funds, and $f_{\text{ETF}+}$ and $f_{\text{ETF}-}$ are the loan fees paid to short the bull and bear funds. It is well known that LETFs tend to perform better in low-volatility markets with significant trend and underperform in mean-reverting, high-volatility markets with insignificant trend. Tang and Xu (2013) have shown that the deviation for LETFs, positive or negative, can be approximated by the following formula:

$$r_{\text{ETF}} - n r_{\text{index}} = \frac{n^2 - n}{2} r_{\text{index}}^2 - \frac{(n^2 - n)T}{2} \sigma_{\text{index}}^2, \tag{3.2}$$

where n is the leverage ratio of the fund, r_{ETF} is the cumulative return for the leveraged fund for a holding period of T days and r_{index} is the cumulative return for its underlying index over the same period. Naive investors with little experience in trading LETFs would expect $r_{\text{ETF}} = n r_{\text{index}}$, which is rarely true for $T > 1$. $r_{\text{ETF}} - n r_{\text{index}}$ can be positive, which means that investors would have better returns

than naively expected when holding LETFs for more than one trading day, or negative, which means that investors would have worse returns than naively expected for more than one trading day. From this formula, we observe that $r_{\text{ETF}} > n r_{\text{index}}$ when $r^2_{\text{index}} > T\sigma^2_{\text{index}}$ because $n^2 - n > 0$ for $n \in (2, 3, -1, -2, -3)$. This means that leveraged ETFs' returns are positively related to the squared cumulative return of the underlying index and negatively related to holding periods and index variance. In 2009, for a holding period of one year ($T = 252$) from January 1, 2009 to December 31, 2009, SSO $+2\times$ fund had a cumulative return of 35.81%. S&P 500 had a return of 19.67% for the same period. Naive investors would expect 39.34% from the fund and, in their view, the fund underperformed by 3.53%. This deviation is explained by the market's high volatility that year; the daily σ for the S&P 500 in 2009 was 1.719% (27.29% annualized). The theoretical shortfall using (3.2) is

$$\frac{2^2 - 2}{2} 0.1967^2 - \frac{(2^2 - 2) \times 252}{2} 0.01719^2 = -3.57\%,$$

which is a good estimate.

Although naive investors may think that simply guessing the direction of the market (positive or negative) is enough for investing in LETFs, in fact, (3.2) shows that they have to take into account not only the direction of the market but the volatility of the benchmark index too. According to Giannetti (2017), investing in LETFs is a dual speculation on the direction and the volatility of their underlying indexes; therefore, investing in them requires high levels of sophistication.

By using (3.2) and assuming no loan fees are paid to short the LETFs, we transform (3.1) to

$$\begin{aligned} P &= -0.5(\text{RETF}_+ + \text{RETF}_-) \\ &= -0.5\Bigg(n r_{\text{index}} + \frac{n^2 - n}{2} r^2_{\text{index}} - \frac{(n^2 - n)T}{2} \sigma^2_{\text{index}} \\ &\qquad + (-n) r_{\text{index}} + \frac{(-n)^2 - (-n)}{2} r^2_{\text{index}} - \frac{((-n)^2 - (-n))T}{2} \sigma^2_{\text{index}} \Bigg) \\ &= 0.5 n^2 (T\sigma^2_{\text{index}} - r^2_{\text{index}}). \end{aligned} \tag{3.3}$$

Again, we observe that the squared cumulative return of the underlying index, the holding period and the underlying index variance determine the investor's return. This time, investors shorting LETF pairs are negatively affected by the squared cumulative return of the underlying index and positively affected by holding periods and index variance. When $r^2_{\text{index}} > T\sigma^2_{\text{index}}$, this strategy leads to losses. When $r^2_{\text{index}} < T\sigma^2_{\text{index}}$, however, it leads to gains, meaning investors are long volatility and short momentum. While investors purchasing LETFs suffer from volatility decay, investors shorting LETFs can profit by it. The investor's portfolio when using this

strategy is delta neutral, as it is insensitive to index price movements. In real market trading, of course, stock loan fees exist, and therefore we not only need $T\sigma^2_{\text{index}}$ to be higher than r^2_{index} but we also need $0.5n^2(T\sigma^2_{\text{index}} - r^2_{\text{index}})$ to be higher than $-f_{\text{ETF}+} - f_{\text{ETF}-}$, or else this strategy will not be profitable. For $n = \pm 2$,

$$0.5n^2(T\sigma^2_{\text{index}} - r^2_{\text{index}}) = 2(T\sigma^2_{\text{index}} - r^2_{\text{index}}),$$

and for $n = \pm 3$,

$$0.5n^2(T\sigma^2_{\text{index}} - r^2_{\text{index}}) = 4.5(T\sigma^2_{\text{index}} - r^2_{\text{index}}),$$

which means that shorting triple funds can be more than two times more profitable than shorting double funds in volatile markets but also more risky in trending markets.

Investors willing to short pairs should aim for ETFs with a high number of shortable shares available so that they can execute this trade. It is possible the brokerage firm may demand the short position be closed.[6] Also, for this strategy to be profitable, investors should aim for indexes that have a high future volatility.[7] Further, they should take into account the loan fees for the shares they will borrow and how volatile these can be. A low interest rate now can become high in the future, making the trade unprofitable. Finally, investors should take into consideration the fact that, when shorting, the potential losses are unlimited if one fund increases significantly in price.[8] While one of the LETFs may rise over 100%, it cannot go lower than 0% of its value, which can be a hazardous trade to start in a market that exhibits high momentum (positive or negative) for an extended number of trading days.

Next, we aim to backtest this strategy for leveraged ETF pairs. Finding extensive historical data for leveraged ETF loan fees proved to be a very difficult task: different brokers charge different fees depending on the ETF shares available for short selling, short-selling demand, etc, and therefore no official data is available. However, we were able to use daily loan fees from Interactive Brokers since July 2015.[9] For our

[6] The size of the account can play a role in assessing the probability of it being targeted by a brokerage firm when loaned shares must be returned to a lender (Jiang and Peterburgsky 2013).

[7] VIX indexes can show expected future volatility to investors over the next thirty days. According to Copeland and Copeland (1999), VIX is a market-determined estimate of market volatility and is better than historical estimates, as it adjusts to new information immediately.

[8] Investors can hedge that risk by purchasing call options for the shorted funds (if they are available). However, the cost of purchasing these may diminish their profits.

[9] Interactive Brokers is the largest US electronic brokerage firm by number of daily average revenue trades and is the leading foreign exchange broker.

TABLE 1 LETF characteristics considered in the study.

Name	Ticker	Leverage	AUM* (US$, millions)	Expense ratio	Inception date	Underlying index
ProShares Ultra S&P 500	SSO	2	1883	0.89%	06/19/06	S&P 500
ProShares UltraPro S&P 500	UPRO	3	898	0.94%	06/23/09	S&P 500
ProShares UltraShort S&P 500	SDS	−2	1421	0.90%	07/11/06	S&P 500
ProShares UltraPro Short S&P 500	SPXU	−3	688	0.90%	06/23/09	S&P 500

*AUM as of April 28, 2017.

study, we assess the performance of a trading strategy that shorts both $+n$ and $-n$ ETF pairs in the same weights (50%). We only use ± 2 and ± 3 pairs because a ± 1 pair would not have enough volatility decay, as $+1$ funds do not underperform under volatility as leveraged funds do. The shorted pairs we examined are SSO ($+2$) and SDS (-2), and UPRO ($+3$) and SPXU (-3). We use these pairs because they have very large AUM and follow a broad index (S&P 500). Investors should not have difficulties finding stocks to short under normal market conditions and therefore this trading strategy can be implemented.[10] In Table 1, we present the examined LETF characteristics.

We collected daily market prices for the funds from Yahoo Finance between July 13, 2015 and August 13, 2017 along with daily loan fees for the same time period from Interactive Brokers.[11] Our initial goal was to examine this strategy from the inception of the funds, but we were not able to collect loan fees from back then. As a result, we examined the performance of this strategy in disjointed, nonoverlapping one-month intervals, which provided us with twenty-five periods. The choice

[10] In some cases, regulators may ban short selling, thus making the examined strategy impossible to execute. In September 2008, the US SEC temporarily banned most short sales in nearly 1000 financial stocks.

[11] We conduct this analysis from the investor's perspective and therefore use market prices instead of net asset value prices for the ETFs.

TABLE 2 Performance of shorting LETF pairs (no shorting fees considered).

Time period (07/13/15–08/13/17)	Short 50% SSO (+2) & 50% SDS (−2)		Short 50% UPRO (+3) & 50% SPXU (−3)	
	Monthly profit (%)	Annualized profit (%)	Monthly profit (%)	Annualized profit (%)
1	0.28	3.34	0.59	7.37
2	1.00	12.72	3.30	47.70
3	0.35	4.31	−2.11	−22.62
4	0.32	3.89	1.87	24.86
5	0.48	5.90	0.98	12.45
6	0.47	5.74	0.65	8.05
7	0.71	8.89	1.72	22.66
8	−0.93	−10.60	−2.16	−23.08
9	0.21	2.55	0.25	3.06
10	0.25	3.01	0.42	5.22
11	0.13	1.60	0.19	2.36
12	0.53	6.56	1.19	15.20
13	0.11	1.33	0.06	0.73
14	0.21	2.49	0.54	6.62
15	0.29	3.58	0.49	6.01
16	0.29	3.59	0.43	5.26
17	−0.29	−3.42	−0.63	−7.29
18	0.19	2.28	0.26	3.16
19	0.03	0.35	−0.08	−1.01
20	−0.02	−0.30	−0.08	−0.92
21	0.05	0.57	0.14	1.65
22	0.003	0.05	0.007	0.09
23	0.03	0.34	0.17	2.05
24	0.20	2.44	0.19	2.28
25	1.02	12.90	1.62	21.23
Average	0.24	2.87	0.40	4.90

We use continuous compounding to calculate the annualized profit.

of one-month shorting allows us to have a large enough sample to produce significant results as well as enough time for volatility decay to come into play and erode the funds' performance. As shown by the majority of studies, one month is the time horizon at which most LETFs start to underperform. Holding periods of one week would be too short for the LETFs to underperform significantly. Initially, we do not take shorting fees into account. When this strategy is applied, we obtain the results that are reported in Table 2.

TABLE 3 VIX ETN characteristics considered in the study.

Name	Ticker	Leverage	AUM* (US$, millions)	Expense ratio	Inception date
iPath S&P 500 VIX short-term futures ETN	VXX	1	449	0.89%	01/29/09
iPath S&P 500 VIX mid-term futures ETN	VXZ	1	42.8	0.89%	01/29/09

*AUM as of January 22, 2019.

In the absence of shorting fees, the strategy is profitable for both pairs. Shorting SSO (+2) and SDS (−2) was profitable for twenty-two of the twenty-five months, resulting in an average annualized profit of 2.87%. Although for most months trading produced profit, there was one month that resulted in a loss of 0.93% (10.60% annualized). During this month, the market experienced positive momentum, with S&P 500 gaining 8.44%. Shorting UPRO (+3) and SPXU (−3) was also profitable for twenty of the twenty-five months, resulting in an average annualized profit of 4.90%; this is almost double the profit of the previous pair, as expected by (3.3). The highest losses (23.08% annualized) occurred in the same month as for the previous pair, making it clear that positive (or negative) momentum is the biggest hazard of this portfolio. According to (3.3), any profits of shorting LETF pairs should have the same sign for a given testing period; the empirical results seem to suggest that (3.3) signs hold for twenty-three of the twenty-five examined periods, with the exceptions of periods 3 and 19. A possible explanation for the discrepancy in these two periods may be the high bid–ask spreads that LETFs tend to exhibit at times. Charupat and Miu (2010) found that LETFs often trade at larger premiums or discounts than traditional 1× ETFs, probably because arbitrage on LETFs is more difficult; thus, price deviations need to be high enough to make arbitrage worthwhile.

As discussed earlier, shorting LETF pairs can be market neutral and positively exposed to volatility. Investors can get volatility exposure by investing in financial instruments tied to VIX, such as ETFs and ETNs, and, again, be market neutral.[12] For comparison, we assess the performance of two ETNs following VIX in the exact same time periods. The ETNs examined are presented in Table 3.

VXX offers exposure to a daily rolling long position in the first- and second-month VIX futures contracts and reflects market participants' views of the future direction of the VIX index at the time of expiration of the VIX futures contracts comprising the

[12] Investors should keep in mind that exchange-traded notes (ETNs) are different from ETFs and carry the counterparty risk of issuing banks.

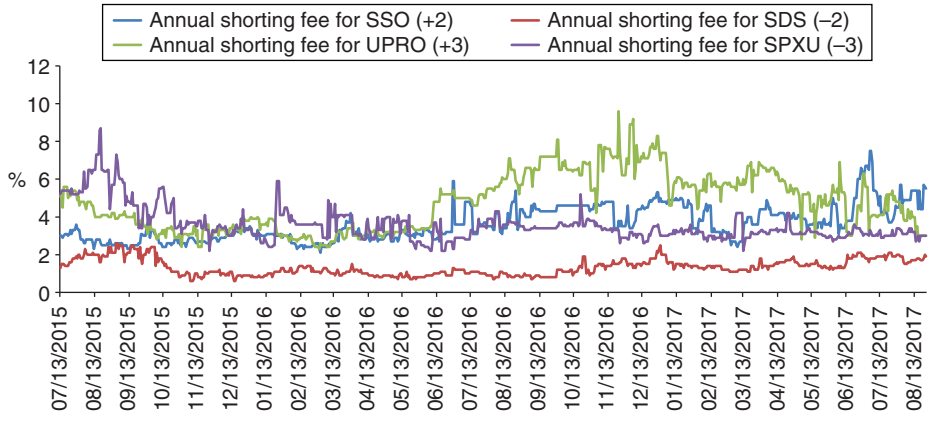
TABLE 4 Performance of VXX and VXZ.

Time period (07/13/15–08/13/17)	VXX monthly profit (%)	VXZ monthly profit (%)
1	−10.49	−3.55
2	62.34	30.23
3	−19.35	−12.95
4	4.57	1.88
5	6.19	2.43
6	8.06	2.29
7	13.33	9.13
8	−26.82	−14.38
9	−17.66	−5.14
10	−8.95	1.36
11	5.42	3.48
12	−28.87	−11.97
13	−21.38	−5.90
14	11.18	6.32
15	−13.80	−7.33
16	−11.21	−5.59
17	−16.00	−2.68
18	−18.78	−6.00
19	−17.76	−9.23
20	−5.50	−4.71
21	9.54	−4.56
22	−23.11	−7.81
23	−7.48	−4.22
24	−5.85	−7.38
25	11.69	4.98
Average	−4.83	−2.05

index (iPath Prospectus 2019). VXZ offers exposure to a daily rolling long position in the fourth-, fifth-, sixth- and seventh-month VIX futures contracts and reflects market participants' views of the future direction of the VIX index at the time of expiration of the VIX futures contracts comprising the index (iPath Prospectus 2019). VXZ has less volatility than VXX as it rolls in longer-term contracts (Avellaneda and Papanicolaou 2018).

In Table 4, we present the results of investing in VXX and VXZ. During the examined period, the average monthly profits for investors following VXX and VXZ were

FIGURE 1 LETF shorting fees.



negative, with losses of 4.83% and 2.05%, respectively. The monthly performance of the VIX ETNs in this period ranged from +62.34% to −28.87%. The shorted pairs' performance was not only higher but also more stable. This should not be a surprise, as VIX is much more volatile than equity indexes (Avellaneda and Papanicolaou 2018).

Next, we test the profitability of shorting LETF pairs after shorting fees for the leveraged funds are taken into account. In Figure 1, we present the shorting fees of the four leveraged funds in our study from July 13, 2015 to August 16, 2017.

We observe that bull funds have, on average, higher shorting fees than bear funds. The average annual shorting fee for SSO (+2) is 3.63% and for SDS (−2) is 1.33%. Similarly, the average annual shorting fee for UPRO (+3) is 4.75% and for SPXU (−3) is 3.57%. One possible explanation for this is that investors anticipating positive market movements would rather go long by purchasing 1× ETFs or bull ETFs than short bear ETFs via margin accounts and experience loan fees. This would lead to less demand for shorting bear funds, resulting in lower shorting fees. It is evident that the shorting fees for these funds, which can be as high as 9% some days, play an important role in the efficiency of the shorted portfolios.[13] When applying daily shorting fees to our shorted portfolios, profits are highly diminished. The results are presented in Table 5.

[13] Dobi and Avellaneda (2012) believe that the high shorting costs for leveraged ETFs may be an indication that the market seeks to short these funds and thus drives short rates up.

TABLE 5 Performance of shorting LETF pairs (shorting fees considered).

Time period (07/13/15–08/13/17)	Short 50% SSO (+2) & 50% SDS (−2)		Short 50% UPRO (+3) & 50% SPXU (−3)	
	Monthly profit (%)	Annualized profit (%)	Monthly profit (%)	Annualized profit (%)
1	0.07	0.88	0.14	1.68
2	0.80	10.06	2.86	40.29
3	0.15	1.77	−2.45	−25.71
4	0.16	1.93	1.23	15.83
5	0.32	3.91	0.71	8.89
6	0.29	3.57	0.21	2.59
7	0.54	6.67	1.42	18.42
8	−1.08	−12.19	−2.41	−25.41
9	0.03	0.32	−0.04	−0.46
10	0.09	1.10	0.15	1.79
11	−0.04	−0.45	−0.08	−0.98
12	0.33	4.04	0.86	10.81
13	−0.09	−1.03	−0.32	−3.81
14	−0.01	−0.17	0.11	1.37
15	0.07	0.82	0.05	0.62
16	0.04	0.48	−0.01	−0.15
17	−0.52	−6.03	−1.06	−12.03
18	−0.10	−1.14	−0.30	−3.53
19	−0.22	−2.56	−0.47	−5.44
20	−0.19	−2.23	−0.42	−4.95
21	−0.19	−2.20	−0.27	−3.24
22	−0.23	−2.69	−0.35	−4.15
23	−0.19	−2.30	−0.17	−2.05
24	−0.11	−1.27	−0.12	−1.40
25	0.74	9.25	1.29	16.62
Average	0.03	0.33	0.02	0.27

We use continuous compounding to calculate the annualized profit.

As we observe, shorting fees significantly lower the profitability of the strategy for both pairs. Shorting SSO (+2) and SDS (−2) was profitable for only thirteen of the twenty-five months, resulting in an average annualized profit of only 0.33%. The profits of shorting UPRO (+3) and SPXU (−3) were also highly diminished. The portfolio was profitable for only eleven of the twenty-five months, resulting in an average annualized profit of 0.27%. Although further research is required, it is our view that the cost of borrowing significantly lowers the possible gains anticipated

from shorting both the long and the short ETFs, and there are no profits without risk following this strategy.

Even after taking into account shorting fees this strategy outperformed holding VIX ETNs. This may be because one month is too much of a holding period for VIX ETNs, as they are best suited to and used for short-term investments. Further, VIX ETNs have high expense ratios, close to 1% per year, which depreciates them. The same goes for LETFs, which is a profit for investors willing to short them. Finally, VIX is negatively correlated to S&P 500, which gained 16.26% in the examined period. It would be interesting to compare the strategies examined in this paper in different time periods.

3.2 Comparison of buying bull funds with shorting bear funds

Previously, we speculated that investors would rather go long in the market by purchasing bull ETFs than short bear ETFs via margin accounts. After all, this would be the easiest thing to do. But would such a strategy, compared with simply going long, be profitable for investors? To answer this question, we examine the performance of going long US$1 on a bull fund versus going short US$1 on the corresponding bear fund. Shorting bear funds makes sense because, as shown in many studies, they tend to decay faster than bull funds (Shum and Kang 2013; Charupat and Miu 2010; Tsalikis and Papadopoulos 2018). Further, most investors are willing to take long positions in markets, as most markets have a tendency to proliferate in the long term, through either economic growth, commodity depletion or simple inflation (Trainor and Carroll 2013).

Again, using (3.2) derived from Tang and Xu (2013), we estimate that the expected performance of going long a bull fund with leverage n is

$$P = n r_{\text{index}} + \frac{n^2 - n}{2} r_{\text{index}}^2 - \frac{(n^2 - n)T}{2} \sigma_{\text{index}}^2, \tag{3.4}$$

whereas the expected performance of going short a bear fund with leverage $-n$ and a shorting cost of f is

$$\begin{aligned} P &= -\left((-n) r_{\text{index}} + \frac{(-n)^2 - (-n)}{2} r_{\text{index}}^2 - \frac{((-n)^2 - (-n))T}{2} \sigma_{\text{index}}^2 \right) - f \\ &= n r_{\text{index}} - \frac{n^2 + n}{2} r_{\text{index}}^2 + \frac{(n^2 + n)T}{2} \sigma_{\text{index}}^2 - f. \end{aligned} \tag{3.5}$$

For (3.5) to be profitable,

$$n r_{\text{index}} - \frac{n^2 + n}{2} r_{\text{index}}^2 + \frac{(n^2 + n)T}{2} \sigma_{\text{index}}^2$$

must be greater than f. For going long a bull fund to be more profitable than shorting a bear fund, that is, (3.4) > (3.5), we derive

$$\begin{aligned} & nr_{\text{index}} + \frac{n^2 - n}{2} r_{\text{index}}^2 - \frac{(n^2 - n)T}{2} \sigma_{\text{index}}^2 \\ & \quad > nr_{\text{index}} - \frac{n^2 + n}{2} r_{\text{index}}^2 + \frac{(n^2 + n)T}{2} \sigma_{\text{index}}^2 - f \\ & \quad \rightarrow \quad n^2 (r_{\text{index}}^2 - T\sigma_{\text{index}}^2) > -f. \end{aligned}$$

n^2 and f are always positive, and therefore when $r_{\text{index}}^2 > T\sigma_{\text{index}}^2$, going long is more profitable. For shorting a bear fund to be more profitable than going long a bull fund, that is, (3.4) < (3.5), we derive

$$n^2 (r_{\text{index}}^2 - T\sigma_{\text{index}}^2) < -f \quad \rightarrow \quad n^2 (T\sigma_{\text{index}}^2 - r_{\text{index}}^2) > f.$$

For shorting the bear fund to be more profitable than going long the bull fund, not only $r_{\text{index}}^2 < T\sigma_{\text{index}}^2$ but also $n^2 (T\sigma_{\text{index}}^2 - r_{\text{index}}^2)$ must be greater than the shorting costs.

In Table 6, we present the results of comparing going long SSO (+2) with going short SDS (−2) as well as going long UPRO (+3) with going short SPXU (−3) by measuring performance and risk-adjusted performance. Again, we examine the performance of this strategy in disjointed, nonoverlapping one-month intervals, which provides us with twenty-five periods. For our analysis, we take into account the shorting costs of the bear funds.

As we observe, going short SDS (−2) has an average monthly positive return of 1.84% (24.48% if compounded annually) instead of 1.48% (19.29% if compounded annually), which was the performance of going long SSO (+2). Similarly, going short SPXU (−3) has an average monthly positive return of 2.68% (37.41% if compounded annually) instead of 2.22% (30.21% if compounded annually), which was the performance of going long UPRO (+3). For the examined period, shorting the short funds proved to be slightly better in terms of performance than purchasing the long funds. Also, the Sharpe ratio of shorting SDS (−2) was 1.19: higher than that of going long SSO (+2), which was 0.86. Similarly, the Sharpe ratio of shorting SPXU (−3) was 1.20, higher than that of going long UPRO (+3), which was 0.82. The Sharpe ratio for holding the S&P 500 in the same time period was 0.68. One possible explanation for the better performance of shorting bear funds is that while both strategies take long positions in the market and thus profit by the increase in the S&P 500, shorting bear funds also profits from volatility decay, which has been shown in many papers to be higher for bear funds than for bull funds.

TABLE 6 Performance of long $+n$ ETF versus short $-n$ ETF.

Time period (07/13/15–08/13/17)	Long SSO (+2)	Short SDS (−2)	Long UPRO (+3)	Short SPXU (−3)
1	1.08%	1.49%	1.49%	2.20%
2	−12.17%	−10.34%	−20.98%	−14.90%
3	5.71%	6.24%	11.19%	6.59%
4	3.13%	3.67%	4.82%	7.84%
5	−3.28%	−2.41%	−5.16%	−3.48%
6	−7.56%	−6.70%	−11.04%	−10.30%
7	−7.59%	−6.26%	−11.96%	−8.85%
8	17.75%	15.79%	27.32%	22.71%
9	3.85%	4.17%	6.06%	6.25%
10	0.41%	0.83%	0.47%	1.03%
11	3.27%	3.46%	4.83%	4.97%
12	5.15%	6.13%	7.44%	9.59%
13	3.15%	3.29%	4.79%	4.60%
14	−2.13%	−1.79%	−3.41%	−2.64%
15	−1.73%	−1.22%	−2.54%	−1.86%
16	2.27%	2.74%	3.32%	3.86%
17	9.10%	8.39%	13.93%	12.41%
18	1.17%	1.39%	1.77%	1.77%
19	4.16%	4.10%	6.39%	5.95%
20	5.23%	5.09%	7.83%	7.42%
21	−2.42%	−2.44%	−3.57%	−3.57%
22	4.09%	3.97%	6.09%	5.83%
23	3.38%	3.32%	5.01%	5.09%
24	1.18%	1.42%	1.81%	1.92%
25	−0.16%	1.71%	−0.28%	2.68%
Average	1.48%	1.84%	2.22%	2.68%
Standard deviation	0.20	0.18	0.32	0.26
Sharpe ratio	0.86	1.19	0.82	1.20

The standard deviations and Sharpe ratios are annualized.

Although these results are interesting, as shorting the short funds resulted in a better performance and a better risk-adjusted performance, further study for longer periods is definitely needed. A mere two years is a short period compared with the ten-plus years of history leveraged ETFs exhibit, and S&P 500 had a positive trend during previous years. It would be interesting to assess the performance of this

strategy during market crises. Any investor who wants to short should keep it in mind that potential losses are unlimited if not hedged. Meanwhile, for investors going long in leveraged ETFs, the maximum losses are their initial capital.

4 CONCLUSION

LETFs are new financial products traded on major exchanges with high liquidity. They have become very popular among investors in the past decade and possess swiftly growing AUM. The main appeal of LETFs is that leverage can amplify returns when the underlying index is moving in the desired direction. Investors can easily and inexpensively build leveraged positions without using options or margin accounts. Embedded leverage in these products reduces investors' constraints for outright leverage, which proves useful for hedging and increasing investment returns (Lundström and Peltomäki 2018)

In this paper, we examine whether it could be feasible for an investor to profit from the price decay that leveraged ETFs tend to exhibit in the long run. One trading strategy involves statically shorting equal amounts of both bull and bear funds that follow the same benchmark so as to capture the volatility decay as profit and be market neutral. Because bull and bear funds have, in theory, opposite daily returns on the same benchmark index, this strategy is not exposed to the benchmark index as long as the holding period is short. We also show that investors shorting LETF pairs are negatively affected by the squared cumulative return of the underlying index and positively affected by holding periods and index variance. Although we have chosen to short both funds with identical absolute leverage ratio values, it is obvious that portfolios which short LETFs with different leverage ratios can be constructed. When empirically tested for two years in S&P 500 leveraged funds for monthly holding periods, this strategy produces profit for both the ± 2 and the ± 3 pairs. However, after taking shorting fees into account, the profitability of this strategy for both pairs is highly diminished. Undoubtedly, investors willing to execute such trades should seriously consider shorting costs, which can be as high as 9% annually. In addition, this approach can only be executed for ETFs with a high number of shortable shares available. We also compare the profitability of shorting LETF pairs with that of investing in financial instruments tied to VIX, as investors can have a similar volatility exposure and be market neutral. Investing in VIX ETNs for the exact same period produced negative average monthly returns, possibly because one-month holding periods are considered too long for holding VIX investing products and VIX is negatively correlated to S&P 500, which rose in the examined period.

Finally, we examine how a different method of going long in an index by shorting bear funds would perform compared with purchasing bull funds for the same period. This strategy makes sense in theory because bear funds tend to have higher

negative deviations from their target return than bull funds; this also tends to happen more quickly than in bull funds, therefore making them ideal candidates for short selling. When empirically tested for two years in S&P 500 leveraged funds for monthly holding periods, shorting SDS (-2) and SPXU (-3) produced slightly higher average profits and Sharpe ratios than going long SSO ($+2$) and UPRO ($+3$), respectively, even after accounting for shorting fees. These results are interesting, but further study for longer periods is needed as two years is a small sample and the S&P 500 had a positive trend in previous years. It would be worthwhile testing this strategy in periods of higher volatility, eg, the 2008–9 market crisis.

In the empirical part of this study, we examine paper strategies. However, in the real world, short selling leveraged funds for long periods might not be that easy, given the average holding periods for these funds are less than one month; therefore, short sellers may experience difficulties finding shares to borrow in order to start their short position, and they may have to close their positions earlier than they want. Also, investors that want to employ short selling should be aware that potential losses are unlimited if not hedged, while for investors going long in leveraged ETFs the maximum losses are their initial capital.

DECLARATION OF INTEREST

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

REFERENCES

Avellaneda, M., and Papanicolaou, A. (2018). Statistics of VIX futures and their applications to trading volatility exchange-traded products. *The Journal of Investment Strategies* **7**, 1–33 (https://doi.org/10.2139/ssrn.3028910).

Avellaneda, M., and Zhang, S. (2010). Path-dependence of leveraged ETF returns. *SIAM Journal of Financial Mathematics* **1**, 586–603 (https://doi.org/10.1137/090760805).

Charupat, N., and Miu, P. (2010). The pricing and performance of leveraged exchanged-traded funds. *Journal of Banking and Finance* **35**, 966–977 (https://doi.org/10.1016/j.jbankfin.2010.09.012).

Charupat, N., and Miu, P. (2014). A new method to measure the performance of leveraged exchange-traded funds. *Financial Review* **49**, 735–763 (https://doi.org/10.1111/fire.12055).

Cheng, M., and Madhavan, A. (2009). The dynamics of leveraged and inverse exchange-traded funds. *Journal of Investment Management* **7**, 43–62. URL: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1539120.

Copeland, M., and Copeland, T. (1999). Market timing: style and size rotation using the VIX. *Financial Analysts Journal* **55**, 73–81 (https://doi.org/10.2469/faj.v55.n2.2262).

Dobi, D., and Avellaneda, M. (2012). Structural slippage of leveraged ETFs. Working Paper, New York University. URL: www.math.nyu.edu/faculty/avellane/LETF_Dobi_Avellaneda_Sept2012.pdf.

Giannetti, A. (2017). The dynamics of leveraged ETFs returns: a panel data study. *Quantitative Finance* **17**, 745–761 (https://doi.org/10.1080/14697688.2016.1237035).

Guo, K., and Leung, T. (2014). Understanding the tracking errors of commodity leveraged ETFs. *Energy and Environmental Finance* **74**, 39–63 (https://doi.org/10.2139/ssrn.2389411).

Hessel, C., Nam, J., Wang, J., Cunyu, X., and Zhang, G. (2018). Shorting leveraged ETF pairs. *Journal of Trading* **13**(2). URL: http://journals.sfu.ca/iij/index.php/JOT/article/view/4324.

Hougan, M. (2009). How long can you hold leveraged ETFs? *Journal of Indices* **12**, 36–41.

Jiang, X., and Peterburgsky, S. (2017). Investment performance of shorted leveraged ETF pairs. *Applied Economics* **49**, 4410–4427 (https://doi.org/10.1080/00036846.2017.1282149).

Lettau, M., and Madhavan, A. (2018). Exchange-traded funds 101 for economists. *Journal of Economic Perspectives* **32**, 135–154 (https://doi.org/10.1257/jep.32.1.135).

Leung, T., and Ward, B. (2015). The golden target: analyzing the tracking performance of leveraged gold ETFs. *Studies in Economics and Finance* **32**, 278–297 (https://doi.org/10.1108/SEF-01-2015-0009).

Lu, L., Wang, J., and Zhang, G. (2012). Long term performance of leveraged ETFs. *Financial Services Review* **21**, 63–80 (https://doi.org/10.2139/ssrn.1344133).

Lundström, C., and Peltomäki, J. (2018). Optimal embedded leverage. *Quantitative Finance* **7**, 1077–1085 (https://doi.org/10.1080/14697688.2017.1408959).

Murphy, R., and Wright, C. (2010). An empirical investigation of commodity-based leveraged ETFs. *Journal of Index Investing* **1**, 14–23 (https://doi.org/10.3905/jii.2010.1.3.014).

Rompotis, G. (2016). Return and volatility of emerging markets leveraged ETFs. *Journal of Asset Management* **17**, 165–194 (https://doi.org/10.1057/jam.2016.2).

Shum, P., and Kang, J. (2013). Leveraged and inverse ETF performance during the financial crisis. *Managerial Finance* **39**, 476–508 (https://doi.org/10.1108/03074351311313825).

Tang, H., and Xu, X. (2013). Solving the return deviation conundrum of leveraged exchange-traded funds. *Journal of Financial and Quantitative Analysis* **48**, 309–342 (https://doi.org/10.1017/S0022109012000622).

Trainor, W., and Baryla, E. (2008). Leveraged ETFs: a risky double that does not multiply by two. *Journal of Financial Planning* **21**, 48–55.

Trainor, W., and Carroll, M. (2013). Forecasting holding periods for leveraged ETFs using decay thresholds: theory and applications. *Journal of Financial Studies and Research* **2013**, 715425 (https://doi.org/10.5171/2013.715425).

Tsalikis, G., and Papadopoulos, S. (2018). Assessing the performance of American and European leveraged exchange traded funds. *Investment Management and Financial Innovations* **15**, 165–182 (https://doi.org/10.21511/imfi.15(2).2018.15).

Wagalath, L. (2014). Modelling the rebalancing slippage of leveraged exchange-traded funds. *Quantitative Finance* **14**, 1503–1511 (https://doi.org/10.1080/14697688.2014.916817).