Momentum Strategies for the ETF-Based Portfolios

April 2019

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Abstract

We compared performance of past 'winners' and past 'losers' over the look-ahead period of one month for various portfolios that consist of the US ETFs and the holdings of the US equity Select Sector SPDRs in 2007 – 2017 and 2011 - 2017. Namely, we verified the conventional pattern described in the literature according to which there is mean reversion (i.e. past losers outperform past winners in near future) for short past periods and persistent momentum (i.e. past winners outperform past losers in near future) for longer past periods. We also compared performance of the momentum-based strategies with that of the equal-weight benchmark portfolios (EWBPs). We found that performance of the momentum strategies depends on portfolio holdings and whether the bear market of 2008 is included in the data sample. The conventional momentum pattern was statistically significant only for a multi-asset ETF portfolio in both 2007-2017 and 2011 -2017, and for the proxies of the SPDR S&P500 ETF and the Industrials Select Sector SPDR ETF in 2011 – 2017. However, we found other, sector-specific momentum patterns that may be explored for arbitraging past winners and past losers of the equity sector ETF holdings between themselves and/or with their EWBPs.

Key words: portfolio management; momentum strategies; ETFs

JEL: G10, G11

Momentum equity trading strategies have received significant attention in academia (see Jegadeesh & Titman (2011) for a review) and from practitioners (Asness et al (2014); Gray & Vogel (2016)). In a nutshell, the conventional momentum pattern implies that the winners in past short-term periods (less than three months) underperform past losers in the next one to three months, i.e. exhibit mean reversion of returns. On the other hand, the winners in longer past periods (about a year) outperform past losers in the next one to three months, which implies persistent momentum.

Momentum profitability may be caused by positive serial correlations in risk factor returns. However, Fama & French (1996), Grundy & Martin (2001), and Jegadeesh & Titman (2001) found that this correlation is very small, and the Fama-French three-factor model does not explain momentum profits. As Jegadeesh & Titman (2011) stated, a natural cause of momentum profits is behavioral effects, namely, investors' delayed reaction to information (Delong et al (1990); Barberis et al (1998)).

In this work, we tested the conventional momentum pattern for several portfolios that consist of a) major US exchange-traded funds (ETFs), and b) holdings of several US equity ETFs, including the SPDR S&P 500, PowerShares of NASDAQ 100, and nine Select Sector SPDRs. ETFs have become one of the most popular passive investment vehicles because of their low transaction costs and high liquidity (Ben-David et al. 2017). While passive funds managed about $8 trillion or 20% of aggregate investment fund assets in June 2017, the ETFs' share of passive fund assets at that time exceeded 40% (Sushko & Turner (2018)).

In some studies, compound returns for a chosen time interval are used for testing performance of the momentum strategies. To avoid possible bias of the starting date, we considered buying past winners and past losers on each day within the chosen data sample and collected statistics of returns

for one-month look-ahead periods. This allowed us to test statistical significance of the differences between the look-ahead returns of past losers and past winners. Such an approach is an extension of the random entry protocol offered for back-testing of high-frequency trading strategies (Schmidt (2009)). The distributions of momentum-based returns are negatively skewed. Therefore, the t-test and the Wilcoxon test can yield opposite conclusions. We subscribe to the opinion that honoring the Wilcoxon's rejection of the null hypothesis when the t-test does not reject it can lead to false positives (Sawilowsky (2005)). False positives may be less attractive for risk averse investors than false negatives as far as choosing trading strategy is concerned. Therefore, thorough examination of statistical significance of return anomalies is required (Novy-Marx (2014); Harvey et al (2016)). We think also that investors are concerned mostly with total returns, and mean returns compared with the t-test are a better proxy to total returns than median returns compared with the Wilcoxon test. Therefore, our ultimate conclusions are based on the t-test p-values. In this work, we found that p-values for paired t-tests were notably lower than the p-values for unpaired t-tests. We have chosen to rely on paired t-tests because the returns of past winners and past losers were calculated on the same days and hence were affected by the same market conditions. Still, we provide both paired and unpaired p-values to illustrate their differences. We used paired t-test p-values equal or lower than 0.10 for rejecting the null hypothesis. Hence, when we state that the strategy/portfolio A *outperforms* the strategy/portfolio B, we imply that the difference between their look-ahead monthly returns is statistically significant with the paired t-test p-value <= 0.10.

We also compared performance of the momentum strategies with that of equal-weight benchmark portfolios (EWBPs). Most of the market indexes and ETFs have market cap weighting. However, since the momentum-based winner/loser baskets are equally weighted, we believe that the relevant benchmarks should be equally weighted, too.

Momentum strategies may dramatically underperform during the bear markets (Grundy & Martin (2001); Barroso & Santa-Clara (2015); Daniel & Moskowitz (2016)). Therefore, we considered two data samples, 2007–2017 and 2011–2017, so that the latter did not include the bear market of 2007 – 2009.

We found that the presence of the conventional momentum pattern and performance of the momentum strategies in general depends on portfolio holdings and on whether the bear market of 2007 - 2009 is included in the data sample. In particular, the conventional momentum pattern was statistically significant only for the multi-asset ETF portfolio in both 2007-2017 and 2011 -2017, and for the proxies of the SPDR S&P500 ETF and the Industrial Select Sector SPDR ETF in 2011 – 2017. However, we found other, sector-specific momentum patterns that may be explored for arbitraging past winners and past losers of the equity sector ETF holdings between themselves and/or with their EWBPs.

TRADING MODEL AND DATA

For each portfolio, we considered the top decile performers and the bottom decile performers as the past winners and the past losers, respectively. Past performance was estimated for the lookback periods (LBPs) in the range from one month to one year. One month was chosen as the look-ahead period for which we compared performance of equally weighted baskets of past winners and past losers. We used 21 trading days as the proxy to one month; hence the three-month and the one-year periods correspond to 63 and 252 trading days, respectively. Returns were calculated using daily closing adjusted prices downloaded from finance.yahoo.com.

Most of the major US ETFs of our interest were released for public trading in the late 1990s; some of them - as recently as in 2005. At first, we considered two portfolios of the US ETFs that were traded publicly at least since the beginning of 2006. Reserving one year for calculating past returns, we estimated look-ahead one-month performance of equally weighted baskets of past winners and past losers traded each day in 2007 - 2017. We compared these results with those for 2011 – 2017 that exclude the effects of the bear market of 2007 - 2009. The ETF portfolio 1 contained 28 US equity ETFs. A gold ETF, five international equity ETFs and five bond ETFs were added to the ETF portfolio 1 to form the multi-asset ETF portfolio 2. Holdings of both portfolios are listed in the Exhibit A1 in Appendix.

Furthermore, we considered portfolios formed with the holdings of various US equity ETFs in January 2018. To avoid survival bias, portfolio holdings were included in the winner/loser baskets and the EWBPs only when they were traded during the entire LBPs for which past performance was estimated. Therefore, we call these portfolios the ETF *proxies*. Namely, we considered proxies to the SPDR S&P 500, PowerShares of NASDAQ 100, and nine Select Sector SPDRs.

In some momentum studies (Jegadeesh & Titman (1993); Fama & French (1996)), the last month of the one-year LBP was skipped to address one-month reversal in stock returns described by Lo & MacKinlay (1990), and Boudoukh et al (1994). We compared performance of the momentum strategy with and without skipping the last month of the one-year LBP for all portfolios considered in this work.

RESULTS AND DISCUSSION

The ETF based portfolios

Performance statistics for the ETF portfolio 1 in 2007 – 2017 is given in Exhibit 1. It is based on 2747 monthly returns. For the one-month and the six-month LBPs, past losers outperformed past winners. However, former losers outperformed EWBP only at the six-month LBP.

Exhibit 1. Performance statistics for the ETF portfolio 1 in 2007 – 2017

Basket size	Lookback, days	Basket returns		p-values		Benchmark returns	p-values			
				Winners vs losers			Winners vs benchmark		Losers vs benchmark	
		Winners	Losers	Unpaired	Paired		Unpaired	Paired	Unpaired	Paired
3	21	0.64%	0.86%	0.17	**0.01**	0.86%	0.13	**0.00**	0.97	0.92
3	63	0.85%	0.87%	0.89	0.82	0.86%	0.95	0.85	0.94	0.84
3	126	0.72%	0.96%	0.14	**0.02**	0.86%	0.33	**0.01**	0.51	**0.08**
3	252	0.78%	0.75%	0.85	0.77	0.86%	0.60	0.17	0.54	0.14
3	252[1)]	0.81%	0.81%	1.00	1.00	0.86%	0.75	0.41	0.80	0.52

[1)] Last month skipped.

Statistics for 2011- 2017 is based on 1740 monthly returns. For this period, former losers at the one-month LBP outperformed both former winners and EWBP (see Exhibit 2). We did not find persistent momentum for the ETF portfolio 1 with the one-year LBP. Skipping the last month of the one-year LBP in both time periods does not change our conclusions.

Exhibit 2. Performance statistics for the ETF portfolio 1 in 2011 – 2017

Basket size	Lookback, days	Basket returns		p-values		Benchmark returns	p-values			
				Winners vs losers			Winners vs benchmark		Losers vs benchmark	
		Winners	Losers	Unpaired	Paired		Unpaired	Paired	Unpaired	Paired
3	21	0.95%	1.31%	**0.01**	**0.00**	1.14%	0.13	**0.00**	0.20	**0.00**
3	63	1.11%	1.04%	0.58	0.33	1.14%	0.83	0.55	0.44	**0.02**
3	126	1.01%	1.13%	0.40	0.15	1.14%	0.32	**0.01**	0.94	0.83
3	252	1.05%	1.00%	0.74	0.56	1.14%	0.48	**0.07**	0.31	**0.01**
3	252[1)]	1.15%	1.09%	0.69	0.50	1.14%	0.92	0.79	0.75	0.40

[1)] Last month skipped.

Performance statistics for the multi-asset ETF portfolio 2 in 2007 – 2017 and 2011 – 2017 is shown in Exhibit 3 and Exhibit 4, respectively. Momentum strategy follows the conventional pattern for the ETF portfolio 2 in that the past losers outperformed past winners at the one-month LBP, and past winners outperformed past losers at the one-year LBP. In 2007 – 2017, the last month of the one-year LBP had to be skipped for past winners to outperform EWBP. However in 2011 – 2017, only former losers at the one-month LBP outperformed EWBP.

Exhibit 3. Performance statistics for the ETF Portfolio 2 in 2007 – 2017

Basket size	Lookback, days	Basket returns		p-values		Benchmark returns	p-values			
		Winners	Losers	Winners vs losers			Winners vs benchmark		Losers vs benchmark	
				Unpaired	Paired		Unpaired	Paired	Unpaired	Paired
4	21	0.50%	0.72%	0.12	**0.03**	0.74%	**0.05**	**0.00**	0.91	0.78
4	63	0.80%	0.50%	**0.04**	**0.01**	0.74%	0.56	0.26	0.12	**0.00**
4	126	0.65%	0.74%	0.50	0.39	0.74%	0.45	0.17	0.95	0.88
4	252	0.83%	0.48%	**0.02**	**0.01**	0.74%	0.42	0.18	**0.09**	**0.00**
4	252[1)]	0.87%	0.58%	**0.06**	**0.02**	0.74%	0.26	**0.05**	0.31	**0.04**

[1)] Last month skipped.

Exhibit 4. Performance statistics for the ETF Portfolio 2 in 2011 – 2017

Basket size	Lookback, days	Basket returns		p-values		Benchmark returns	p-values			
		Winners	Losers	Winners vs losers			Winners vs benchmark		Losers vs benchmark	
				Unpaired	Paired		Unpaired	Paired	Unpaired	Paired
4	21	0.58%	1.05%	**0.00**	**0.00**	0.91%	**0.00**	**0.00**	0.26	**0.01**
4	63	0.81%	0.64%	0.18	**0.08**	0.91%	0.37	**0.09**	**0.03**	**0.00**
4	126	0.74%	0.74%	1.00	0.99	0.91%	0.12	**0.00**	0.16	**0.00**
4	252	0.79%	0.47%	**0.02**	**0.00**	0.91%	0.30	**0.02**	**0.00**	**0.00**
4	252[1)]	0.87%	0.60%	**0.04**	**0.01**	0.91%	0.72	0.42	**0.01**	**0.00**

[1)] Last month skipped.

Portfolios based on the holdings of the US equity ETFs

In this Section, we describe performance of the momentum strategy for portfolios formed by securities that constitued several US equity ETFs in January of 2018. First, we considered the

SPDR S&P500 ETF (SPY) that replicates the S&P 500 index. In this portfolio, past losers always outperformed past winners and EWBP in 2007 – 2017 (see Exhibit 5). Skipping the last month for the one-year LBP did not change the outcome. However, the conventional pattern held in 2011 – 2017: mean reversion was present at the one-month LBP and there was persistent momentum at the one-year LBP. In the latter case, past winners outperformed EWBP (see Exhibit 6).

Exhibit 5. Performance statistics for the SPY proxy in 2007 – 2017

Basket size	Lookback, days	Basket returns		p-values		Benchmark returns	p-values			
		Winners	Losers	Winners vs losers			Winners vs benchmark		Losers vs benchmark	
				Unpaired	Paired		Unpaired	Paired	Unpaired	Paired
50	21	1.18%	1.49%	0.12	**0.01**	1.23%	0.73	0.29	0.19	**0.00**
50	63	1.49%	1.73%	0.24	**0.07**	1.23%	**0.09**	**0.00**	**0.02**	**0.00**
50	126	1.41%	1.96%	**0.01**	**0.00**	1.23%	0.24	**0.00**	**0.00**	**0.00**
50	252	1.25%	1.71%	**0.04**	**0.01**	1.23%	0.91	0.80	**0.03**	**0.00**
50	252[1)]	1.26%	1.62%	**0.09**	**0.02**	1.23%	0.88	0.70	**0.07**	**0.00**

[1)] Last month skipped.

Exhibit 6. Performance statistics for the SPY proxy in 2011 – 2017

Basket size	Lookback, days	Basket returns		p-values		Benchmark returns	p-values			
		Winners	Losers	Winners vs losers			Winners vs benchmark		Losers vs benchmark	
				Unpaired	Paired		Unpaired	Paired	Unpaired	Paired
50	21	1.23%	1.36%	0.38	**0.09**	1.36%	0.32	**0.00**	0.97	0.91
50	63	1.49%	1.42%	0.66	0.46	1.36%	0.31	**0.00**	0.70	0.36
50	126	1.57%	1.51%	0.71	0.57	1.36%	**0.10**	**0.00**	0.36	**0.04**
50	252	1.56%	1.28%	**0.10**	**0.01**	1.36%	0.12	**0.00**	0.66	0.35
50	252[1)]	1.56%	1.20%	**0.03**	**0.00**	1.36%	0.12	**0.00**	0.32	**0.03**

[1)] Last month skipped.

Furthermore, we considered the PowerShares QQQ ETF that replicates the NASDAQ 100 index. Similarly to SPY in 2007 – 2017, the QQQ past losers outperformed past winners at both one-month and one-year LBPs (see Exhibit 7). But there was no statistically significant difference between performances of past losers and past winners in 2011 – 2017 (see Exhibit 8). Both past winners and past losers outperformed the EWBPs in 2007 – 2017, and in 2011 - 2017 when the LBPs were equal or higher than three months.

Exhibit 7. Performance statistics for the QQQ proxy in 2007 – 2017

Basket size	Lookback, days	Basket returns		p-values		Benchmark returns	p-values			
		Winners	Losers	Winners vs losers			Winners vs benchmark		Losers vs benchmark	
				Unpaired	Paired		Unpaired	Paired	Unpaired	Paired
10	21	1.82%	2.08%	0.19	**0.02**	1.70%	0.50	**0.07**	**0.04**	**0.00**
10	63	2.38%	2.44%	0.78	0.66	1.70%	**0.00**	**0.00**	**0.00**	**0.00**
10	126	2.56%	2.54%	0.91	0.87	1.70%	**0.00**	**0.00**	**0.00**	**0.00**
10	252	2.40%	2.80%	**0.06**	**0.00**	1.70%	**0.00**	**0.00**	**0.00**	**0.00**
10	252[1)]	2.26%	2.50%	0.27	**0.10**	1.70%	**0.00**	**0.00**	**0.00**	**0.00**

[1)] Last month skipped.

Exhibit 8. Performance statistics for the QQQ proxy in 2011 – 2017

Basket size	Lookback, days	Basket returns		p-values		Benchmark returns	p-values			
		Winners	Losers	Winners vs losers			Winners vs benchmark		Losers vs benchmark	
				Unpaired	Paired		Unpaired	Paired	Unpaired	Paired
10	21	1.95%	2.11%	0.39	0.14	1.87%	0.63	0.27	0.16	**0.00**
10	63	2.52%	2.49%	0.89	0.84	1.87%	**0.00**	**0.00**	**0.00**	**0.00**
10	126	2.55%	2.61%	0.78	0.69	1.87%	**0.00**	**0.00**	**0.00**	**0.00**
10	252	2.70%	2.65%	0.79	0.70	1.87%	**0.00**	**0.00**	**0.00**	**0.00**
10	252[1)]	2.62%	2.52%	0.64	0.49	1.87%	**0.00**	**0.00**	**0.00**	**0.00**

[1)] Last month skipped.

We also compiled performance statistics for the proxies of Select Sector SPDR ETFs. Generally. these portfolios did not exhibit the conventional momentum pattern. For example, the Consumer Discretionary Select Sector SPDR ETF (XLY) proxy in 2007 – 2017 had no statistically significant difference between performances of past losers and past winners (see Exhibit 9). Yet they both outperformed EWBP at the LBPs of three months and higher. In 2011 – 2017, past winners always outperformed past losers. Past winners also outperformed EWBP at the six-month and one-year LBPs (see Exhibit 10).

Exhibit 9. Performance statistics for the XLY proxy in 2007 – 2017

Basket size	Lookback, days	Basket returns		p-values		Benchmark returns	p-values			
		Winners	Losers	Winners vs losers			Winners vs benchmark		Losers vs benchmark	
				Unpaired	Paired		Unpaired	Paired	Unpaired	Paired
9	21	1.42%	1.45%	0.93	0.88	1.36%	0.76	0.44	0.71	0.35
9	63	1.67%	1.77%	0.68	0.52	1.36%	**0.09**	**0.00**	**0.09**	**0.00**
9	126	1.79%	1.69%	0.70	0.59	1.36%	**0.02**	**0.00**	0.19	**0.01**
9	252	1.61%	1.61%	0.99	0.99	1.36%	0.16	**0.00**	0.34	**0.05**
9	252[1)]	1.57%	1.35%	0.37	0.24	1.36%	0.24	**0.01**	0.95	0.89

[1)] Last month skipped.

Exhibit 10. Performance statistics for the XLY proxy in 2011 – 2017

Basket size	Lookback, days	Basket returns		p-values		Benchmark returns	p-values			
		Winners	Losers	Winners vs losers			Winners vs benchmark		Losers vs benchmark	
				Unpaired	Paired		Unpaired	Paired	Unpaired	Paired
9	21	1.33%	1.06%	0.11	**0.01**	1.42%	0.54	0.13	**0.03**	**0.00**
9	63	1.49%	1.28%	0.29	**0.10**	1.42%	0.69	0.36	0.43	0.11
9	126	1.59%	1.36%	0.24	**0.09**	1.42%	0.29	**0.03**	0.71	0.44
9	252	1.74%	1.31%	**0.03**	**0.00**	1.42%	**0.04**	**0.00**	0.55	0.24
9	252[1)]	1.75%	1.22%	**0.01**	**0.00**	1.42%	**0.04**	**0.00**	0.26	0.02

[1)] Last month skipped.

The Industrial Select Sector SPDR ETF (XLI) proxy in 2011 – 2017 had the conventional momentum pattern, similarly to the SPY proxy. Namely, past losers outperformed past winners at the one-month LBP and past winners outperformed past losers at the one-year LBP. The past winners also outperformed EWBP at the three-month and longer LBPs lo(see Exhibit 11).

Exhibit 11. Performance statistics for the XLI proxy in 2011 – 2017

Basket size	Lookback, days	Basket returns		p-values		Benchmark returns	p-values			
		Winners	Losers	Winners vs losers			Winners vs benchmark		Losers vs benchmark	
				Unpaired	Paired		Unpaired	Paired	Unpaired	Paired
7	21	1.37%	1.63%	0.16	**0.02**	1.44%	0.64	0.26	0.28	**0.01**
7	63	1.67%	1.71%	0.85	0.77	1.44%	0.16	**0.00**	0.15	**0.00**
7	126	1.67%	1.94%	0.16	**0.03**	1.44%	0.17	**0.00**	**0.01**	**0.00**
7	252	1.71%	1.20%	**0.01**	**0.00**	1.44%	0.14	**0.00**	0.17	**0.00**
7	252[1)]	1.71%	1.15%	**0.01**	**0.00**	1.44%	0.14	**0.00**	**0.10**	**0.00**

[1)] Last month skipped.

This pattern, however, did not hold in 2007 – 2017 when past losers mostly outperformed both past winners and EWBP (see Exhibit 12).

Exhibit 12. Performance statistics for the XLI proxy in 2007 – 2017

Basket size	Lookback, days	Basket returns		p-values		Benchmark returns	p-values			
				Winners vs losers			Winners vs benchmark		Losers vs benchmark	
		Winners	Losers	Unpaired	Paired		Unpaired	Paired	Unpaired	Paired
7	21	1.14%	1.66%	**0.03**	**0.00**	1.36%	0.23	**0.00**	0.19	**0.01**
7	63	1.67%	1.59%	0.76	0.68	1.36%	**0.09**	**0.00**	0.35	**0.09**
7	126	1.51%	2.10%	**0.02**	**0.00**	1.36%	0.41	**0.04**	**0.00**	**0.00**
7	252	1.40%	1.85%	**0.08**	**0.02**	1.36%	0.85	0.65	**0.05**	**0.00**
7	252[1)]	1.41%	1.84%	**0.09**	**0.02**	1.36%	0.80	0.54	**0.05**	**0.00**

[1)] Last month skipped.

Performance statistics of the momentum strategies for the other Select Sector SPDR ETF proxies is listed in Appendix. With the exclusion of the Consumer Staples Select Sector SPDR Fund (XLP) proxy in 2011 – 2017 (Exhibit A9) and the Technology Select Sector SPDR Fund (XLK) proxy in 2007 – 2017 (Exhibit A10), skipping the last month for the one-year LBP did not change statistical significance of the differences between performances of the former winners and losers. On the other hand, keeping the last month in the one-year LBP for the Health Care Select Sector SPDR Fund (XLV) proxy, reveals significant outperformance of the former losers, which contradicts the conventional momentum pattern (Exhibit A15). Former losers at the one-year LBP outperformed also for the Energy Select Sector SPDR Fund (XLE) proxy in 2007 – 2017 (Exhibit A4) and for the Financial Select Sector SPDR Fund (XLF) proxy in 2007 – 2017 and 2011 – 2017 (Exhibits A6 and A7, respectively). However, former winners of the Utiity Select Sector SPDR Fund (XLU) proxy always outperformed former losers (see Exhibits A12 and A13).

Conclusions

Our results demonstrate that the conventional momentum pattern is anything but universal. For the portfolios and time periods considered in this work, this pattern existed only for the multi-asset ETF portfolio, and for the SPY and XLI proxies outside the bear market of 2007 - 2009. However, we found other, sector-specific momentum patterns that may be explored for arbitraging past winners and past losers of the equity sector ETF holdings between themselves and/or with their EWBPs.

Acknowledgements

We are grateful to the anonymous reviewers for the valuable comments to our work.

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Appendix

Exhibit A1. Holdings of the ETF portfolios considered in this work

Ticker	Name	Portfolio(s)
DIA	SPDR® Dow Jones® Industrial Average ETF	1-2
IBB	Nasdaq Biotechnology Ishares	1-2
IVE	iShares S&P 500 Value ETF	1-2
IVW	iShares S&P 500 Growth ETF	1-2
IWM	IWM (iShares Russell 2000)	1-2
IYR	DJ US Real Estate Ishares	1-2
IYT	DJ Transportation Average Ishares	1-2
IYZ	DJ US Telecom Ishares	1-2
KBE	SPDR S&P Bank ETF	1-2
KIE	SPDR S&P Insurance ETF	1-2
MDY	SPDR S&P MidCap 400 ETF	1-2
MDYG	SPDR S&P 400 Mid Cap Growth ETF	1-2
MDYV	SPDR S&P 400 Mid Cap Value ETF	1-2
PPA	PPA (Aerospace & Defense Powershares)	1-2
QQQ	QQQ (NASDAQ ETF)	1-2
SLY	SPDR S&P 600 Small Cap ETF	1-2
SLYG	SPDR S&P 600 Small Cap Growth ETF	1-2
SLYV	SPDR S&P 600 Small Cap Value ETF	1-2
SMH	Semiconductor ETF Market Vectors	1-2
SPY	S&P 500 ETF	1-2
XLB	SPDR S&P Materials	1-2
XLE	SPDR S&P Energy	1-2
XLF	SPDR S&P Financials	1-2
XLK	SPDR S&P Technology	1-2
XLP	SPDR S&P Consumer Staples	1-2
XLU	SPDR S&P Utilities	1-2
XLV	SPDR S&P Health Care	1-2
XLY	SPDR S&P Consumer Discretionary	1-2
EEM	iShares MSCI Emerging Markets ETF	2
EFA	iShares MSCI EAFE ETF	2
EWJ	Japan Index MSCI Ishares	2
EZU	iShares MSCI Eurozone ETF	2
FXI	iShares China Large-Cap ETF	2
GLD	SPDR Gold ETF	2
AGG	iShares Core US Aggregate Bond ETF	2
IEF	iShares 7-10 Year Treasury Bond ETF	2
LQD	iShares Investment Grade Corporate Bond ETF	2
SHY	iShares 1-3 Year Treasury Bond ETF	2
TIP	iShares TIPS Bond ETF	2

Exhibit A2. Performance statistics for the XLB proxy in 2007 – 2017

Basket size	Lookback, days	Basket returns		p-values		Benchmark returns	p-values			
		Winners	Losers	Winners vs losers			Winners vs benchmark		Losers vs benchmark	
				Unpaired	Paired		Unpaired	Paired	Unpaired	Paired
3	21	1.64%	1.04%	**0.02**	**0.00**	1.31%	**0.10**	**0.00**	0.25	**0.02**
3	63	1.92%	1.23%	**0.01**	**0.00**	1.31%	**0.00**	**0.00**	0.74	0.54
3	126	1.77%	1.90%	0.63	0.57	1.31%	**0.02**	**0.00**	**0.01**	**0.00**
3	252	1.40%	1.40%	0.99	0.99	1.31%	0.65	0.41	0.70	0.48
3	252[1)]	1.74%	1.46%	0.30	0.18	1.31%	**0.04**	**0.00**	0.51	0.24

Exhibit A3. Performance statistics for the XLB proxy in 2011 – 2017

Basket size	Lookback, days	Basket returns		p-values		Benchmark returns	p-values			
		Winners	Losers	Winners vs losers			Winners vs benchmark		Losers vs benchmark	
				Unpaired	Paired		Unpaired	Paired	Unpaired	Paired
3	21	1.01%	1.10%	0.69	0.59	1.23%	0.22	**0.02**	0.55	0.26
3	63	0.90%	1.21%	0.19	**0.08**	1.23%	**0.06**	**0.00**	0.94	0.90
3	126	1.24%	1.14%	0.68	0.60	1.23%	0.95	0.90	0.70	0.50
3	252	1.41%	0.66%	**0.00**	**0.00**	1.23%	0.31	**0.04**	**0.02**	**0.00**
3	252[1)]	1.77%	0.63%	**0.00**	**0.00**	1.23%	**0.00**	**0.00**	**0.01**	**0.00**

Exhibit A4. Performance statistics for the XLE proxy in 2007 – 2017

Basket size	Lookback, days	Basket returns		p-values		Benchmark returns	p-values			
		Winners	Losers	Winners vs losers			Winners vs benchmark		Losers vs benchmark	
				Unpaired	Paired		Unpaired	Paired	Unpaired	Paired
7	21	1.37%	1.03%	0.15	**0.00**	1.03%	0.11	**0.00**	0.99	0.97
7	63	1.35%	0.83%	0.03	**0.00**	1.03%	0.14	**0.00**	0.39	**0.00**
7	126	1.26%	1.17%	0.69	0.47	1.03%	0.29	**0.00**	0.57	**0.07**
7	252	1.01%	1.25%	0.32	**0.06**	1.03%	0.91	0.72	0.37	**0.00**
7	252[1)]	0.87%	1.25%	0.11	**0.00**	1.03%	0.46	**0.01**	0.35	**0.00**

Exhibit A5. Performance statistics for the XLE proxy in 2011 – 2017

Basket size	Lookback, days	Basket returns		p-values		Benchmark returns	p-values			
		Winners	Losers	Winners vs losers			Winners vs benchmark		Losers vs benchmark	
				Unpaired	Paired		Unpaired	Paired	Unpaired	Paired
7	21	1.00%	0.75%	0.33	**0.07**	0.64%	0.11	**0.00**	0.67	0.20
7	63	1.01%	0.56%	0.09	**0.00**	0.64%	**0.10**	**0.00**	0.78	0.43
7	126	1.04%	0.76%	0.3	**0.09**	0.64%	**0.07**	**0.00**	0.65	0.18
7	252	0.88%	0.81%	0.81	0.68	0.64%	0.29	**0.00**	0.52	**0.06**
7	252[1)]	0.77%	0.75%	0.93	0.87	0.64%	0.55	**0.10**	0.67	0.20

[1)] Last month skipped.

Exhibit A6. Performance statistics for the XLF proxy in 2007 – 2017

Basket size	Lookback, days	Basket returns		p-values		Benchmark returns	p-values			
				Winners vs losers			Winners vs benchmark		Losers vs benchmark	
		Winners	Losers	Unpaired	Paired		Unpaired	Paired	Unpaired	Paired
7	21	1.20%	1.21%	0.99	0.99	1.00%	0.32	**0.01**	0.45	**0.10**
7	63	0.99%	2.09%	**0.00**	**0.00**	1.00%	0.99	0.98	**0.00**	**0.00**
7	126	0.56%	1.97%	**0.00**	**0.00**	1.00%	**0.02**	**0.00**	**0.00**	**0.00**
7	252	0.24%	1.74%	**0.00**	**0.00**	1.00%	**0.00**	**0.00**	**0.02**	**0.00**
7	252[1)]	0.24%	1.67%	**0.00**	**0.00**	1.00%	**0.00**	**0.00**	**0.03**	**0.00**

Exhibit A7. Performance statistics for the XLF proxy in 2011 – 2017

Basket size	Lookback, days	Basket returns		p-values		Benchmark returns	p-values			
				Winners vs losers			Winners vs benchmark		Losers vs benchmark	
		Winners	Losers	Unpaired	Paired		Unpaired	Paired	Unpaired	Paired
7	21	1.27%	1.35%	0.66	0.37	1.34%	0.68	0.19	0.94	0.80
7	63	1.34%	1.43%	0.65	0.39	1.34%	0.96	0.88	0.61	0.11
7	126	1.34%	1.59%	0.21	**0.03**	1.34%	0.96	0.90	0.19	**0.00**
7	252	0.96%	1.34%	**0.05**	**0.00**	1.34%	**0.02**	**0.00**	0.99	0.98
7	252[1)]	0.97%	1.29%	**0.10**	**0.00**	1.34%	**0.02**	**0.00**	0.81	0.47

Exhibit A8. Performance statistics for the XLP proxy in 2007 – 2017

Basket size	Lookback, days	Basket returns		p-values		Benchmark returns	p-values			
				Winners vs losers			Winners vs benchmark		Losers vs benchmark	
		Winners	Losers	Unpaired	Paired		Unpaired	Paired	Unpaired	Paired
3	21	1.17%	1.75%	**0.00**	**0.00**	1.10%	0.56	0.29	**0.00**	**0.00**
3	63	1.28%	1.79%	**0.00**	**0.00**	1.10%	0.13	**0.01**	**0.00**	**0.00**
3	126	0.83%	1.78%	**0.00**	**0.00**	1.10%	**0.02**	**0.00**	**0.00**	**0.00**
3	252	1.13%	1.90%	**0.00**	**0.00**	1.10%	0.81	0.71	**0.00**	**0.00**
3	252[1)]	1.10%	1.64%	**0.00**	**0.00**	1.10%	1.00	1.00	0.00	0.00

Exhibit A9. Performance statistics for the XLP proxy in 2011 – 2017

Basket size	Lookback, days	Basket returns		p-values		Benchmark returns	p-values			
				Winners vs losers			Winners vs benchmark		Losers vs benchmark	
		Winners	Losers	Unpaired	Paired		Unpaired	Paired	Unpaired	Paired
3	21	1.41%	2.03%	**0.00**	**0.00**	1.33%	0.49	0.20	**0.00**	**0.00**
3	63	1.65%	2.11%	**0.00**	**0.00**	1.33%	**0.01**	**0.00**	**0.00**	**0.00**
3	126	1.58%	1.56%	0.90	0.87	1.33%	**0.04**	**0.00**	**0.08**	**0.00**
3	252	1.59%	1.49%	0.53	0.47	1.33%	**0.05**	**0.00**	0.22	**0.04**
3	252[1)]	1.70%	1.30%	**0.01**	**0.00**	1.33%	**0.01**	**0.00**	0.81	0.70

[1)] Last month skipped.

Exhibit A10. Performance statistics for the XLK proxy in 2007 – 2017

Basket size	Lookback, days	Basket returns		p-values		Benchmark returns	p-values			
		Winners	Losers	Winners vs losers			Winners vs benchmark		Losers vs benchmark	
				Unpaired	Paired		Unpaired	Paired	Unpaired	Paired
7	21	1.25%	1.79%	**0.00**	**0.00**	1.38%	0.45	**0.04**	**0.02**	**0.00**
7	63	1.73%	1.98%	0.22	**0.02**	1.38%	**0.04**	**0.00**	**0.00**	**0.00**
7	126	2.16%	1.71%	**0.03**	**0.00**	1.38%	**0.00**	**0.00**	**0.09**	**0.00**
7	252	1.86%	1.67%	0.37	0.15	1.38%	**0.00**	**0.00**	0.15	**0.00**
7	252[1)]	1.92%	1.52%	**0.06**	**0.00**	1.38%	**0.00**	**0.00**	0.49	0.11

Exhibit A11. Performance statistics for the XLK proxy in 2011 – 2017

Basket size	Lookback, days	Basket returns		p-values		Benchmark returns	p-values			
		Winners	Losers	Winners vs losers			Winners vs benchmark		Losers vs benchmark	
				Unpaired	Paired		Unpaired	Paired	Unpaired	Paired
7	21	1.60%	1.65%	0.79	0.63	1.58%	0.90	0.76	0.69	0.33
7	63	1.96%	1.90%	0.77	0.62	1.58%	**0.02**	**0.00**	**0.10**	**0.00**
7	126	2.60%	1.55%	**0.00**	**0.00**	1.58%	**0.00**	**0.00**	0.89	0.78
7	252	2.24%	1.82%	**0.05**	**0.00**	1.58%	**0.00**	**0.00**	0.23	**0.01**
7	252[1)]	2.23%	1.68%	**0.01**	**0.00**	1.58%	**0.00**	**0.00**	0.60	0.29

Exhibit A12. Performance statistics for the XLU proxy in 2007 – 2017

Basket size	Lookback, days	Basket returns		p-values		Benchmark returns	p-values			
		Winners	Losers	Winners vs losers			Winners vs benchmark		Losers vs benchmark	
				Unpaired	Paired		Unpaired	Paired	Unpaired	Paired
3	21	1.03%	0.39%	**0.00**	**0.00**	0.84%	0.14	**0.00**	**0.00**	**0.00**
3	63	1.00%	0.37%	**0.00**	**0.00**	0.84%	0.22	**0.00**	**0.00**	**0.00**
3	126	0.84%	0.43%	**0.01**	**0.00**	0.84%	0.97	0.92	**0.00**	**0.00**
3	252	0.91%	0.36%	**0.00**	**0.00**	0.84%	0.59	0.18	**0.00**	**0.00**
3	252[1)]	0.85%	0.52%	**0.03**	**0.00**	0.84%	0.94	0.84	**0.03**	**0.00**

Exhibit A13. Performance statistics for the XLU proxy in 2011 – 2017

Basket size	Lookback, days	Basket returns		p-values		Benchmark returns	p-values			
		Winners	Losers	Winners vs losers			Winners vs benchmark		Losers vs benchmark	
				Unpaired	Paired		Unpaired	Paired	Unpaired	Paired
3	21	1.28%	0.44%	**0.00**	**0.00**	1.11%	0.20	**0.01**	**0.00**	**0.00**
3	63	1.29%	0.40%	**0.00**	**0.00**	1.11%	0.18	**0.00**	**0.00**	**0.00**
3	126	1.09%	0.53%	**0.00**	**0.00**	1.11%	0.92	0.83	**0.00**	**0.00**
3	252	1.42%	0.33%	**0.00**	**0.00**	1.11%	**0.01**	**0.00**	**0.00**	**0.00**
3	252[1)]	1.35%	0.47%	**0.00**	**0.00**	1.11%	**0.06**	**0.00**	**0.00**	**0.00**

[1)] Last month skipped.

Exhibit A14. Performance statistics for the XLV proxy in 2007 – 2017

Basket size	Lookback, days	Basket returns		p-values		Benchmark returns	p-values			
		Winners	Losers	Winners vs losers			Winners vs benchmark		Losers vs benchmark	
				Unpaired	Paired		Unpaired	Paired	Unpaired	Paired
7	21	1.20%	2.12%	**0.00**	**0.00**	1.41%	0.15	**0.00**	**0.00**	**0.00**
7	63	1.27%	2.31%	**0.00**	**0.00**	1.41%	0.34	**0.04**	**0.00**	**0.00**
7	126	1.62%	2.50%	**0.00**	**0.00**	1.41%	0.13	**0.00**	**0.00**	**0.00**
7	252	1.73%	2.36%	**0.00**	**0.00**	1.41%	0.03	**0.00**	**0.00**	**0.00**
7	252[1)]	1.73%	2.11%	**0.03**	**0.00**	1.41%	**0.03**	**0.00**	**0.00**	**0.00**

Exhibit A15. Performance statistics for the XLV proxy in 2011 – 2017

Basket size	Lookback, days	Basket returns		p-values		Benchmark returns	p-values			
		Winners	Losers	Winners vs losers			Winners vs benchmark		Losers vs benchmark	
				Unpaired	Paired		Unpaired	Paired	Unpaired	Paired
7	21	1.27%	2.00%	**0.00**	**0.00**	1.62%	**0.02**	**0.00**	**0.02**	**0.00**
7	63	1.37%	2.11%	**0.00**	**0.00**	1.62%	**0.10**	**0.00**	**0.00**	**0.00**
7	126	1.80%	2.61%	**0.00**	**0.00**	1.62%	0.25	**0.03**	**0.00**	**0.00**
7	252	2.10%	2.36%	0.15	**0.07**	1.62%	**0.00**	**0.00**	**0.00**	**0.00**
7	252[1)]	2.12%	2.21%	0.61	0.49	1.62%	**0.00**	**0.00**	**0.00**	**0.00**

[1)] Last month skipped.