

# Momentum Strategies on S&P 500 Sector Indices

<b>Introduction:</b>	2
<b>I. Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency</b>	2
1. The strategy implemented	2
2. The sources of these profits	3
a) Riskier or more systematically linked stocks leading to a higher remuneration	3
b) Exposition to the identified risks factors	4
c) The specific component averaged covariance	4
3. Additional tests on financial and temporal- event factors	5
a) Profitability within size – beta subsamples	5
b) Profitability within seasonal / period effect	5
c) Stock returns around earnings announcement dates	5
4. Conclusion	6
a) An only short-term profitable strategy	6
b) Abnormal returns and delayed price reaction	6
<b>II. Article's Analysis</b>	7
1. Analysis	7
a) Momentum Strategy That Challenged the Contrarian Dominance of the Time	7
b) A rigorous methodology aimed at explaining returns	7
2. Commentary	8
a) Implementation of Constraints in Real-World Conditions	8
i) Underestimated transaction costs	8
ii) Liquidity constraints	8
b) Internal Fragilities of the Momentum Strategy	8
i) Temporal overlap and performance interpretation	8
ii) Self-fulfilling effects and behavioral feedback loops	9
c) Methodological Limits and Questionable Generalizability	9
i) Underestimation of real-world risk	9
iii) Implicit assumptions and problematic generalization	9
<b>III. Strategy implementation</b>	10
1. Methodology: Data, Assumptions, and Strategy Construction	10
a) General Assumptions and Methodological Framework	10
b) Strategy Variants, Weighting Rules, and Transaction Cost Structures	12
i) Weighting Rules	12
ii) Transaction Cost Structures	12
2. Implementation of long momentum strategies on the S&P 500 Sector Indices	13
a) Without Transaction Costs	13
b) With Linear Transaction Costs	14
c) With Dynamic Transaction Costs	14
3. Implementation of long / short momentum strategies on the S&P 500 Sector Indices	15
a) Without Transaction Costs	15
b) With Linear Transaction Costs	16
c) With Dynamic Transaction Costs	16
<b>Conclusion :</b>	17
<b>Annexes :</b>	18

## **Introduction:**

The Momentum strategies - buying stocks that have performed well in the past - as well as Contrarian strategies - shorting stocks that have performed poorly in the past - have been extensively analyzed in the literature. Many studies have shown that these strategies achieve abnormal returns and perform significantly better than their initial benchmarks. However, the interpretation and explanations for these returns are intensely debated within the literature, as they cannot be fully explained by systematic risk alone. Several hypotheses exist to explain these abnormal returns adjusted for systematic risk, such as mechanisms of short-term price pressure and lack of liquidity<sup>1</sup>, lead-lag effects resulting from delayed stock price reactions<sup>2</sup> or even the impact of earnings announcements.

This paper aims to analyze one of the seminal works - "Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency" by Jegadeesh and Titman, published in March 1993 in the Journal of Finance - and to use its insights to test long and long/short strategies on S&P 500 Sector Indices.

In the first part, we will provide a quick summary of the article. We will then offer a critical analysis of it. In the third part, we will implement long and long-short strategies on the S&P 500 Sector Index and analyze our results.

## **I. Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency**

The authors test a long/short strategy on NYSE and AMEX stocks over the period from 1965 to 1989. First, their strategy will be presented in detail. Next, the source of the profits generated by the strategy will be analyzed. The third section will focus on additional tests conducted to evaluate the robustness of the strategy under various financial and event-driven conditions. Finally, the last part will examine the performance of the strategy over longer holding periods, along with the authors' conclusions.

### **1. The strategy implemented**

The authors of these articles tested several strategies, all based within the same framework. They considered the past performance of stocks over a range from one quarter to four quarters and a holding period from one quarter to four quarters. By combining these factors, they tested a total of 16 strategies. They also considered strategies where they delayed the holding of stocks from the observation period (and the linked portfolio formation) by one week to avoid "*bid-ask spread, price pressure, and lagged reaction effect*," making the total tested strategies 32.

We will consider a specific example to illustrate their strategies: the J/K strategies, which consider the past performance of stocks during the last J quarters and hold them for K quarters. The authors analyzed the performance of the stocks over the last J quarters and ranked them in ascending order. They then considered the top and bottom deciles in terms of performance for these stocks. They bought the top decile and sold the bottom decile, holding this portfolio for K quarters (depending on the strategy, they may or may not wait one week after observation to buy/sell the stocks). The buy and sell portfolios are constituted of the selected stocks in an equally weighted manner. See [Appendix 1](#) to have an illustration of this strategy.

However, this strategy is applied every month, resulting in holding more than two portfolios after the first month. The selection of the new portfolio follows the framework described above. Each month, the strategy liquidates the portfolio held for K months and inserts a new one based on the J past performance of stocks. The strategy is equally invested within each portfolio, requiring a monthly rebalancing of the portfolio. See [Appendix 2](#) for an illustration.

The authors show their results presenting better performances than the index. See [Appendix 3](#) for some of their results. The most successful zero-cost strategy is the 12 months / 3 months strategy with a monthly yield of 1.31 % when there is no lag between the portfolio formation and the holding period and 1.49% with a one-week lag. They then acknowledge that these strategies are on average profitable.

---

<sup>1</sup> Jegadeesh (1990) and Lehmann (1990)

<sup>2</sup> Lo and MacKinlay (1990)

The rest of their paper is devoted to the analysis of these excess returns' origin, with several tests devoted to it that will be summarized within the next two subsections. Their tests are based on the 6 months / 6 months strategy with no lag between the portfolio formation and the holding period.

## 2. The sources of these profits

The authors modelize stocks as being influenced by three components: the unconditional expected return, the unconditional unexpected return on a factor mimicking portfolio and a firm-specific component. More precisely:

$$r_{it} = \mu_i + b_i f_t + e_{it}$$

$r_{it}$ : the return on security  $i$  at time  $t$

$\mu_i$ : the unconditional expected return of security  $i$ ,

$f_t$ : the unconditional unexpected return on a factor mimicking portfolio i.e a common factor impacting all the stocks.

$b_i$ : the factor sensitivity of security  $i$  to the factor mimicking portfolio

$e_{it}$ : the specific component for the security  $i$  at time  $t$

We have the following properties:

$$\begin{aligned} E(f_t) &= E(e_{it}) = 0 \\ \text{Cov}(e_{it}, f_t) &= 0, \quad \forall i \\ \text{Cov}(e_{it}, e_{jt-1}) &= 0, \quad \forall i \neq j \end{aligned}$$

The momentum strategy 6 months / 6 months implies by construction:

$$E[(r_{it} - \bar{r}_t)(r_{it-1} - \bar{r}_{t-1})] > 0 \text{ with } \bar{r}_t \text{ the averaged return of all securities at time } t.$$

The authors do the observation that their strategy i.e equally weighted from decile portfolio was correlated by a factor of 0.95 with the Weighted Relative Strength Strategy (WRSS). The J/K WRSS strategy can be constructed as the following: we look at the performance of the stocks over the  $J$  last periods and we also look at the return of the equally weighted index composed of all these stocks. We then subtract it to all stocks' performance to have their relative performance. We long the stocks having outperformed and short the others. The weight within each portfolio is done by ranking them from their relative performance (we long more the best actions than the relatively good one and on the contrary for the short portfolio).

Because of this proximity between these two strategies, the authors use the WRSS profit formula to analyze their strategy:

$$E[(r_{it} - \bar{r}_t)(r_{it-1} - \bar{r}_{t-1})] = \sigma_\mu^2 + \sigma_b^2 \text{Cov}(f_t, f_{t-1}) + \overline{\text{Cov}}_i(e_{it}, e_{it-1})$$

$\sigma_\mu^2$ : cross-sectional variance of expected returns ( $\text{Var}(\bar{r}_t)$ )

$\sigma_b^2$ : cross-sectional variance of factor sensitivities ( $\text{Var}(b_i)$ )

$\bar{r}_t$ : the average return for all stocks at time  $t$

$$\overline{\text{Cov}}_i(e_{it}, e_{it-1}) = \frac{1}{N} \sum_{i=1}^N \text{Cov}(e_{it}, e_{it-1})$$

If the outperformance can be attributed to the factor  $\sigma_\mu^2$  or  $\sigma_b^2$ , these performances are either due to stocks with higher average returns or stocks with a high  $b$ . However, this will therefore exclude the hypothesis of market inefficiency as it can be seen as an overcompensation for bearing the systematic risk. However, if it is mostly explained by the third term, it would suggest eventual market inefficiency.

The author respectively tested the free factors.

### a) Riskier or more systematically linked stocks leading to a higher remuneration

The authors draw the observation that the stocks selected in the portfolio have higher betas than the sample as well as smaller market capitalization. However, the betas of the past losers are higher than the past winners, leading to

a total beta of the portfolio being negative. Moreover, the losers have also smaller market capitalizations than the winners, leading the authors to exclude the relative strength profits are not linked with  $\sigma_\mu^2$ .

b) *Exposition to the identified risks factors*

To assess the hypothesis that the performances are linked to the exposition to identified risks factors, the authors have a look at the serial covariance:

$$Cov(\bar{r}_t, \bar{r}_{t-1}) = \bar{b}_t Cov(f_t, f_{t-1})$$

With  $\bar{b}_t = \frac{1}{N} \sum_{i=1}^N b_{ti}$  the average sensibility factor to the serial covariance of factor-related for each stock within the portfolio. However, the authors find the serial covariance for the 6 months / 6 months to be negative, excluding therefore the hypothesis it is a source for the relative strength profits.

c) *The specific component averaged covariance*

However, the authors find the serial covariance of market models residuals for individual stocks to be on average positive, leading them to apply further investigations. This evidence, according to them, “*suggest that the relative strength profits may arise from stocks underreacting to firm-specific information. However, this evidence is also potentially consistent with an alternative model in which some stocks react with a lag to factor realizations*”.

They therefore introduce a new model to try examining whether the relative strength profits can arise from a lead-lag relationship in stocks' price by supposing the stock can overreact or underreact to the common factor.

$$r_{it} = \mu_i + b_{1i}f_t + b_{2i}f_{t-1} + e_{it}$$

$r_{it}$ : the return on security i at time t

$\mu_i$ : the unconditional expected return of security i,

$f_t$ : the unconditional unexpected return on a factor mimicking portfolio at time t

$b_{1i}$ : the factor sensitivity of security i to the factor mimicking portfolio at time t

$b_{2i}$ : the factor sensitivity of security i to the factor mimicking portfolio at time t-1

If  $b_{2i} > 0$ , it would mean the stock reacts with a lag to the factors, while a negative value might lead that the stock overreacts and is being corrected the next time period.

Given this model, and by using the WRSS profit for equally weighted index formula due to the proximity between their strategies, and supposing the common factors to be serially uncorrelated, the authors derive the following equation lead-lag model:

$$E[(r_{it} - \bar{r}_t)(r_{it-1} - \bar{r}_{t-1})] = \sigma_\mu^2 + \delta \sigma_f^2$$

$$Cov(\bar{r}_t, \bar{r}_{t-1}) = \bar{b}_1 \bar{b}_2 \sigma_f^2$$

With:

$$\bar{b}_1 = \frac{1}{N} \sum_{i=1}^N b_{1i},$$

$$\bar{b}_2 = \frac{1}{N} \sum_{i=1}^N b_{2i},$$

$$\delta = \frac{1}{N} \sum_{i=1}^N (b_{1i} - \bar{b}_1)(b_{2i} - \bar{b}_2)$$

and  $\sigma_f^2$  the variance of the identified common factors.

If  $\delta > 0$ , the lead-lag effect improves the WRSS profit and therefore reinforces the momentum effect. On the contrary,  $\delta < 0$  reduces the profits and incentives to go for a contrarian strategy.

If the lead-lag effect is an important source for the performance and still within the paradigm of the lead-lag model<sup>3</sup>, we have:

$$E[(r_{it} - \bar{r}_t)(r_{it-1} - \bar{r}_{t-1})|f_{t-1}] = \sigma_\mu^2 + \delta f_{t-1}^2$$

<sup>3</sup> In the non-lead-lag model, we would have  $E[(r_{it} - \bar{r}_t)(r_{it-1} - \bar{r}_{t-1})|f_{t-1}] = \sigma_\mu^2 + \sigma_b^2 \rho f_{t-1}^2$  with  $\rho$  the first order serial correlation of the factor portfolio returns.

This model enables the authors to test for the lead-lag effect: if the lead-lag is important,  $f_{t-1}^2$  should be high. On the contrary, if the profits only come from only the autocorrelation between the common factors affecting the portfolio, we would see a negative relationship between  $f_{t-1}^2$  and the WRSS profits.

By doing a linear regression that will not be detailed here<sup>4</sup>, the authors assume, after an analysis of the results, that there the WRSS profits do not come from a lead-lag effect. They confirm their approach by applying it to two sub periods resulting in both times with a negative coefficient for the relationship between the returns of the portfolio in the next 6 months and the past 6 months' returns.

Having therefore found results that may lead to an idiosyncratic originated performance for the performance, the authors try the strategy including fixed transaction of 0.5%. For the 6 months / 6 months portfolio, the semiannual turnover is 84.8%, with a yearly adjusted-risk return<sup>5</sup> of 9.29%. This performance is mostly due to the winners within the portfolios, which most of the time have a negative beta.

### 3. Additional tests on financial and temporal- event factors

The authors apply then further tests to verify their analysis is not biased by several factors, such as the expected return of the selected stock compared to the benchmark, seasonal / period effect or earning announcements effects/

#### a) Profitability within size – beta subsamples

The authors implement the 6 months / 6 months strategy for three subsamples of beta (low, medium high) and market capitalizations (small, medium, large). If the profits come from differences in the expected returns, the profits should be lower for subsample with low-beta or large market capitalization. They find that the abnormal returns have the same magnitude among all groups, with only a little discount for more liquid – large – stocks. They therefore conclude that if the profits are from the idiosyncratic serial correlation, they are not linked to differences within the systematic risk but an eventual market inefficiency: winners keep winning and losers keep losing.

#### b) Profitability within seasonal / period effect

First, the authors look to see if there is a seasonal effect. In order to, they assess the strategy (in total return here), on three stocks sub-samples in terms of market capitalization (small, medium and large). For the three sub-samples issued portfolios, they observe a loss of on average 7% during January: the smaller the firm, the bigger the negative impact is. Other seasonal patterns are detected: the returns are “fairly low in August”, and particularly high in April, November and December. Their explanation for April is that the corporations have to transfer money for tax deduction in the previous year, helping the winners by a phenomenon of price pressure, the portfolios applying the strategy increasing their exposition. On another aspect, the performances for November and December may be led by the portfolio managers selling their losers for “tax or window dressing reasons”. They however do not provide an explanation for January.

The authors also extend their strategy to another period than the one they are looking at (1965 – 1989). To summarize, the profits of the strategy are much lower for the period 1927 – 1940 justified by the authors by the high volatility at this period with companies with strong betas and a lot of difficulties, leading the strategy to select very highly risked companies. The strategy is therefore overexposed to extreme risks within the market, an aspect we will develop in our analysis of the paper. On the contrary, the strategy worked well for the period 1941 – 1964 because of its similarity with the period they elaborated the strategy on.

#### c) Stock returns around earnings announcement dates

Let us assume that stocks consistently underreact to information about a firm's future earnings. Then, the winners should have positive returns on their earnings announcements and the contrary for the losers. To apprehend the earnings announcement's effects, the authors look at the period 1980 – 1989. They continue to select winners and losers based on deciles of past six-month returns. They then examine the returns of these stocks in the interval of two days before their earnings announcement to one day after (3 days) and look at these intervals during a window of the next 36 months. For the first 6 months, the return from the winners is on average over 0.7% of the losers. They compute that because there are two announcements in six months, these “earning returns” explained 25% of

<sup>4</sup> Page 12

<sup>5</sup> i.e the return of the portfolio within the CAPM paradigm and by taking the 1-month Treasury Bill interest rate as risk-free rate.

the profit done by the WRSS. The difference is close to zero between months 7 and 11, then reverses to -0.7% between months 11 and 18, indicating a delayed correction. The difference is then near 0. Correlating previous studies, their results are an indicator that the WRSS' profits are partially due to an initial underreaction of the market participants, and therefore not only due to the systematic risk.

#### 4. Conclusion

##### *a) An only short-term profitable strategy*

If the strategy indeed exploits a market inefficiency, it may be a temporary one that will be corrected after. The authors looked at the average portfolio returns during each of the next 36 months following the formation date. Positive returns after the holding period might indicate a stocks' selection with higher superior unconditional expected returns than the average while a negative return might indicate that the change of prices during the holding period is only temporary. Except for the first month, the authors find positive returns of the portfolio. However, the average monthly return becomes negative during the second day and during the first half of the third. They find that half of the excess returns of the first year are dissipated within the next two following. The returns estimated being not very precise, the results for the second and third years are not statistically significant. Therefore, they cannot exclude that the 12 first month's returns are only temporary. They bring a beginning of possible explanation, stating the global risk of the portfolio changes over time, the assets being first very risky and diminishing after (evidence shown with a beginning negative beta increasing near to 0 by the bottom).

##### *b) Abnormal returns and delayed price reaction*

The authors showed that the 6 months / 6 months strategy produces abnormal returns (12.01% per year on average) during the period 1965 – 1989. There are many elements that tend to show it is not linked either to their systematic risk or lead-lag effect. Half of the excess returns for the first year are lost within the next two following. Stocks in the winner's part of the portfolio present higher returns than the losers' one, but only during the 8 first months. To observe the return's structure, the authors then suggest as an opening is that investors buying past winners and selling past losers move temporarily prices of their long-term values, creating a temporary overreaction. Alternatively, it may be possible that investors underreact about the short-term companies' perspectives while overreaction for the long-term ones, as these information are more ambiguous than the ones about short-term. They explain that their paper cannot elude this question, but that it showed a systematic bias for investors that should be further investigated.

## II. Article's Analysis

### 1. Analysis

#### *a) Momentum Strategy That Challenged the Contrarian Dominance of the Time*

The article by Jegadeesh and Titman represents a key turning point in empirical finance research. In the late 1980s and early 1990s, most studies that questioned market efficiency focused on contrarian strategies; that is, approaches that involved buying past losers and selling past winners. These strategies were based on the idea that investors tend to overreact to news, pushing prices too far in one direction, only for them to eventually revert to their fundamental values. A central reference in this literature is the work by De Bondt and Thaler (1985, 1987), who found that, over long horizons (typically 3 to 5 years), stocks that had previously performed poorly ended up outperforming those that had previously done well. This long-term reversal effect was interpreted as evidence of investor overreaction and was one of the earliest empirical challenges to the Efficient Market Hypothesis (EMH). In contrast to this dominant contrarian perspective, Jegadeesh and Titman introduce a strategy that is, at first glance, completely opposite: a momentum strategy, which involves buying stocks that have recently performed well and selling those that have performed poorly as explained within the first part.

It is important to highlight that momentum and contrarian strategies are not necessarily contradictory. In fact, many studies (e.g., Lehmann, 1990; Lo and MacKinlay, 1990) suggest that momentum effects dominate in the medium term (3 to 12 months), while contrarian effects appear in the long term (3 to 5 years). This suggests that price dynamics on financial markets vary by time horizon, and that different forms of inefficiency may coexist depending on how investors process information over time.

Moreover, it's worth noting that shorting underperforming stocks can also be part of a momentum strategy. Selling short on stocks that have declined, on the expectation that this trend will continue, is aligned with the same core idea: that past performance contains predictive power in the short to medium term.

#### *b) A rigorous methodology aimed at explaining returns*

One of the key strengths of Jegadeesh and Titman's article lies in the rigor of their methodology. The authors do not simply aim to demonstrate that momentum strategies are profitable; they seek to understand the origin of that profitability. This explanatory ambition gives their approach a particularly structured and thoughtful dimension.

But their effort goes well beyond empirical testing. The authors also propose a theoretical framework based on a one-factor model similar to the CAPM. This model allows them to decompose the potential sources of momentum profits into cross-sectional differences in expected returns, serial correlation in the common factor, serial correlation in the common factor and serial correlation in firm-specific return components.

The results presented by Jegadeesh and Titman are both empirically strong and theoretically nuanced. One of the key takeaways from their study is that financial markets do not instantly incorporate firm-specific information, as the strong form of the Efficient Market Hypothesis would suggest. Instead, their findings reveal a gradual and differentiated assimilation of information according to its nature, creating opportunities for excess returns in the short to medium term.

Importantly, the authors avoid making overgeneralized or ideological claims. They emphasize the temporary nature of momentum profits: most of the gains from the "winners – losers" strategy occur within the first 6 to 12 months, after which performance tends to decline or even reverse. This reversion indicates that markets eventually correct pricing errors, preventing long-term structural arbitrage.

This two-phase dynamic, initial underreaction followed by delayed adjustment, is consistent with insights from behavioral finance. Investors may be influenced by cognitive biases such as the representativeness heuristic (Kahneman & Tversky, 1982), which leads them to over extrapolate past trends, or overconfidence (Daniel, Hirshleifer & Subrahmanyam, 1998), which causes them to place undue faith in their private information. These biases can drive prices to drift further from fundamentals before eventually correcting.

Moreover, the study shows that momentum does not perform uniformly across time. The findings around January returns are particularly striking: the strategy generates significant losses in this month, especially among small-cap stocks. These anomalies may be linked to tax-loss selling, window dressing by institutional investors, or other

behavioral and seasonal effects. Such patterns remind us that market inefficiencies must be analyzed in their temporal and contextual dimensions.

Finally, while the momentum strategy is shown to deliver positive net returns even after accounting for transaction costs, it is not without risk and variability. Its performance is sensitive to specific periods and is subject to considerable volatility. This reinforces the idea that market inefficiency is not absolute or constant, but rather a reflection of bounded rationality and behavioral frictions among investors.

## 2. Commentary

### *a) Implementation of Constraints in Real-World Conditions*

While Jegadeesh and Titman's article demonstrates the statistical profitability of a momentum strategy on historical data, it overlooks several practical limitations that could significantly reduce, or even eliminate, these profits in real-world portfolio management. Two critical aspects in particular deserve closer attention: transaction costs and liquidity constraints.

#### *i) Underestimated transaction costs*

The authors apply a uniform, fixed transaction cost of 0.5% per trade in their robustness checks. This assumption is both simplistic and unrealistic. In practice, transaction costs are dynamic: they vary with the liquidity of the assets, the size of the order, market conditions, and crucially, the predictability of the strategy. A momentum strategy, by nature, tends to expose its directional intent to market participants. If market makers or other counterparties detect a pattern of systematic buying of winners and selling of losers, they can adjust spreads or raise execution costs by front-running or strategically widening quotes. This could severely erode the returns observed in backtests.

Moreover, the short-selling component of the strategy is treated simplistically, with no consideration of the costs associated with borrowing shares. Shorting requires either stock lending, which can be expensive, especially for illiquid small-cap stocks, or the use of derivatives like CFDs or options, which introduce additional layers of cost and complexity. Since the authors do not specify the shorting mechanism used, it is difficult to assess the true operational feasibility of the proposed strategy.

#### *ii) Liquidity constraints*

Momentum strategies tend to concentrate on stocks with extreme past performance, which often fall into the small-cap segment as noted also by the authors. These securities typically have low trading volumes, wide bid-ask spreads, and higher slippage risk, especially when constructing a portfolio with significant capital.

This issue becomes even more relevant when combined with seasonality effects. The paper documents a sharp underperformance of the strategy in January, a month that frequently coincides with reduced liquidity in equity markets, particularly for small-cap stocks. The interaction between momentum effects and seasonal liquidity constraints could amplify hidden execution costs or even make large-scale implementation infeasible without causing significant market impact.

### *b) Internal Fragilities of the Momentum Strategy*

Beyond the practical limits of implementation, the momentum strategy also exhibits several internal weaknesses in its design. These relate both to the way performance is measured over time and to the potential feedback effects the strategy may generate on markets, especially if adopted widely.

#### *i) Temporal overlap and performance interpretation*

One often-overlooked methodological issue in momentum studies is the temporal overlap of portfolios. In a "6-month / 6-month" momentum strategy with monthly rebalancing, a single stock can appear in multiple consecutive portfolios. This implies that month-to-month performance is not statistically independent, potentially biasing the interpretation of average returns and standard errors.

Moreover, not all momentum strategies are created equal. Selecting stocks based on their past 1-month return is not comparable to selecting based on a 12-month history. The former is more likely to reflect noise or transitory



price movements, while the latter may capture information drift or longer-term trends. The authors do not explore this heterogeneity of time horizons, yet it may help explain the volatility and variability of momentum returns across different periods.

ii) *Self-fulfilling effects and behavioral feedback loops*

Another internal limitation arises from the behavioral feedback effects of the strategy itself. Momentum profits rely in part on the assumption that investors underreact to new information. But once a momentum strategy becomes widely known and implemented, it can itself become a source of price distortion. Systematically buying recent winners and selling losers may reinforce trends, creating a self-fulfilling pattern or even localized price bubbles.

Furthermore, the long leg of the strategy is more visible than the short leg. When many investors crowd into the same “winner” stocks, it becomes evident on the market and may further amplify the trend. In contrast, short positions are less transparent, leading to an asymmetry in how the market reacts to the two sides of the trade.

Finally, the authors do not address the strategic dimension of their own framework. In a setting where agents anticipate each other's actions, a momentum strategy may evolve into a mean field game, where performance depends not just on fundamentals, but also on collective investor behavior. This raises the issue of a critical size threshold, beyond which the strategy may cease to be effective, or even become counterproductive.

c) *Methodological Limits and Questionable Generalizability*

Beyond the construction and implementation of the strategy, several implicit methodological assumptions in the article deserve scrutiny. These concern the measurement of risk, the scope of the results, and the transferability of the strategy beyond the U.S. market.

i) *Underestimation of real-world risk*

While the authors report monthly average returns for the “winners – losers” portfolios, they do not provide any risk-adjusted performance metrics, such as the Sharpe ratio or portfolio volatility. This omission is important, as momentum strategies, by design, target the extremes of the market, and are therefore vulnerable to sharp reversals, particularly during periods of market stress.

Moreover, the strategy only involves 20% of the investment universe (10% long, 10% short), which results in a highly concentrated portfolio, typically in high-beta, low-capitalization stocks. These features increase exposure to both systematic and idiosyncratic risk. It would have been relevant to test alternative versions of the strategy using different quantile thresholds (e.g., 5/5%, 20/20%, or even asymmetric 20/10%) to examine how returns respond to changes in concentration.

In addition, several non-financial sources of risk are overlooked: management turnover, mergers and acquisitions, or delistings could significantly affect stock prices, independently of past return dynamics.

iii) *Implicit assumptions and problematic generalization*

The strategy is tested exclusively on the U.S. market, using CRSP data. However, U.S. equities are highly liquid, transparent, and widely arbitrated, unlike many European, Asian, or emerging markets. This casts doubt on the external validity of the results. Indeed, subsequent studies have found weaker momentum effects outside the U.S., or effects that disappear once transaction costs and market frictions are accounted for.

Moreover, the authors do not fully justify the use of short positions, despite showing that most of the returns come from the long side. Given the additional costs and risks of shorting, it would have been appropriate to test a long-only momentum strategy as a benchmark.

Finally, although the study identifies strong seasonality effects, such as the January reversal, it does not incorporate any seasonal adjustments or filters in its implementation. This omission raises concerns about the resilience of the strategy in real-world settings, especially outside the backtesting environment.

### III. Strategy implementation

Following our reading of this article, we conducted our own tests on these strategies. Specifically, we tested three long-only momentum strategies and three long-short momentum strategies. Additionally, we applied three different hypotheses regarding transaction costs, leading us to backtest a total of 18 strategies. Our analysis is based on monthly closing data for the SPX and its sub-indices, covering the period from October 2, 1989, to January 29, 2018. We also had access to a dataset containing the weights of each sub-index within the SPX.

However, we decided not to incorporate these weights into our strategy for two main reasons: the weights were undated, which prevented us from reconciling the calculation methodology. Applying static weightings to dynamically changing prices seemed irrelevant. Furthermore, the dataset included an index (S5REAL) that was created before all the other indices we analyzed, including the SPX benchmark. Using the weights would have forced us to make extrapolations, which we deemed inconsistent.

We will first present our different strategies and hypotheses. Then, we will discuss our results for the long-only strategies, followed by those for the long-short strategies.

#### 1. Methodology: Data, Assumptions, and Strategy Construction

##### a) *General Assumptions and Methodological Framework*

Before diving into the details of the strategies tested, it is essential to clearly define the data scope, the key assumptions, and the conventions adopted for portfolio construction and performance evaluation.

Unlike the original J/K momentum framework by Jegadeesh & Titman (1993), we do not apply the 1-week lag between return observation and execution. This choice reflects a cleaner signal extraction but may slightly overstate real-world implementability.

The analysis is based on a dataset spanning from September 25, 1989 to January 29, 2018. To ensure consistent monthly return calculations, we apply the following filters:

- September 1989 is excluded due to incomplete data at the start of the sample.
- January 2018 being almost complete is considered as a full month.
- Monthly returns are computed from end-of-month prices, defined as the last available trading day of each calendar month. Only the first month return is computed with the first and price of the month (October 1989).

We decided to work with performance evaluation, which are more interpretable and consistent with the traditional computation of portfolio values.

Importantly, for each strategy defined by an observation window of J months, no portfolio is built until these J months of data are available. For example, a strategy with a 6-month observation period and a 1-month holding period will only begin trading after the first 6 months of the dataset. This introduces a staggered start across strategies with different lookback windows, which may cause slight temporal biases when comparing performances. However, this can be considered as not significant because of the total number of used months.

We evaluate a comprehensive set of 14 strategy configurations, each defined by a pair:

- an observation period (J), used to rank assets based on past performance, and
- a holding period (K), during which the selected assets are held in the portfolio.

The combinations tested are as follows: [3/1, 3/3, 3/6, 3/9, 3/12, 6/3, 6/6, 6/12, 9/6, 9/9, 12/6, 12/12, 24/12, 24/24]. These choices are motivated by both academic precedent and strategic relevance:

- Short-term configurations such as (3,1) reflect more reactive momentum strategies, potentially capturing inefficiencies or market overreactions.
- Medium-term configurations, typically defined by observation windows between 3 and 12 months, are at the core of momentum literature.
- Longer observation windows like (24,12) or (24,24) allow us to test whether longer-term trends carry predictive power beyond the typical 12-month horizon.

All strategies are tested over the same historical period, with consistent monthly rebalancing logic aligned to each holding period. For each rebalancing period, we select the top 5 performing assets for the long-only strategy, and the top 5 and bottom 3 for the long-short strategy. Indeed, the total number of sub-indices we observe is 24. Shorting nearly one-fifth of the available sub-indices did not seem financially relevant and realistic to us due to the risks associated with such an approach.

As a result, and unlike the authors, we decided to adopt an asymmetrical approach regarding the number of sub-portfolios available in each leg of our strategy. However, for the equal-weighted strategies we backtested, the nominal proportion remains the same between the two legs, with short positions simply being overweighted on a per-unit basis.

This above-described paradigm approach ensures that all results are strictly comparable, and that any differences observed are attributable to the parameters of the strategy, not to data biases or timing inconsistencies.

Several simplifying assumptions are made to facilitate implementation. When a position is replaced (i.e., a subportfolio exits and a new one enters), it is counted as turnover. As a technical convention, we choose to count the initial portfolio allocation as a 100% turnover, even though, strictly speaking, it does not involve any asset replacement.

This decision is motivated by two factors. Transaction fees are applied from the very first investment, so it is consistent to reflect them in the turnover computation as well. It provides a clearer interpretation of average turnover, especially when assessing the true impact of transaction costs across strategies. For example, in a strategy that fully rebalances monthly (e.g., one month holding strategy), using a 0% turnover at the start would result in an average turnover of approximately 99.7%, while including the first period as 100% yields a clean, interpretable figure of exactly 100%. Over a sample of more than 300 months, the difference in the average turnover is marginal (about 0.3 percentage points), but we prefer to make this assumption explicit, ensuring full alignment between cost application and turnover accounting. If one were to adopt the “standard” convention (initial turnover = 0), the corresponding adjustment to the average turnover would simply be a downward correction of 0.3%. This approach can be applied to all strategies and results described below.

We assume the ability to invest in infinitesimal quantities, which is realistic given that we are investing in sub-indices or index-based instruments, not in single securities. Finally, as explained before, each strategy is tested independently but under identical conditions, including data range, rebalancing dates, and portfolio granularity. This ensures that any differences in results stem from the strategy parameters themselves, and not from external or calendar-related factors.

The strategies are assessed using the following metrics:

- Total return i.e Cash-on-Cash from the first portfolio to the last ones
- Monthly average return
- Annualized volatility, computed as the unbiased standard deviation (using  $N-1$  in the denominator). With over 300 monthly observations, this approximation is considered statistically reliable.
- Sharpe ratio, assuming a zero risk-free rate (Unadjusted Sharpe ratio).
- Maximum drawdown, measuring the largest peak-to-trough loss.
- Average drawdown, assessing the mean severity of losses during drawdown periods.
- Monthly average turnover in % of the nominal value of the strategy.
- Monthly average transaction costs in % of the nominal value of the strategy.

Standard deviation and Sharpe ratio may fail to capture extreme risks or path dependency, which justifies the inclusion of drawdown-based metrics.

From this point forward, we use the following terminology:

- Long/Short Portfolio: Refers to the entire set of long/short portfolios.
- Long/Short Subportfolio: Refers to a portfolio contained within the Long/Short Portfolio.
- Subindex: Refers to one of the underlying assets that we can long or short, and that may be included within a Subportfolio.
- Nominal: the sum of all the current positions within the Long and/or the Short portfolio.

## *b) Strategy Variants, Weighting Rules, and Transaction Cost Structures*

To explore the impact of portfolio construction choices on momentum performance, we implement a flexible framework allowing for the combination of two portfolio structures (long-only and long-short), three types of weighting schemes, and three different transaction cost models.

### *i) Weighting Rules*

We define different types of weighting rules, each of which determines how capital is allocated within and across portfolios:

**(1) Equally Weighted Allocation (Long Only and Long - Short):** At each rebalancing, the total nominal value of the portfolio is calculated. An equal distribution is applied between the Long and Short Portfolios, as well as within each Subportfolio and among the Subindices it contains. This strategy replicates the methodology used by the authors, making it essential for us to backtest.

**(2) Winners-Weighted Allocation (Increase-the-Winners - Long Only and Long - Short):** This strategy maintains a fixed allocation between the Long and Short Portfolios, set at 50%-50% for the tests presented. However, within each portfolio, the nominal allocation is distributed proportionally to the sum of the average performances of the underlying assets since their introduction into a Subportfolio, with negative performances systematically set to zero.

The newly introduced Subportfolio, having no past performance data, receives no allocation if at least one existing Subportfolio has a positive cumulative average performance. Otherwise, it is fully invested. The same logic applies within each Subportfolio, meaning that Subindices with an average negative return since their introduction receive no allocation, and subportfolios composed only of such assets also receive none. This rule gives more weight to the best-performing past portfolios, reinforcing strong signals.

**(3) Recent Winners-Weighted Allocation (Increase-the-Recent-Winners, Long Only):** This method applied the exact same logic as the is a short-term variation of the performance-weighted approach. The only difference is that it does not take the average returns since inception but consider only the average returns from the last three months. This therefore excludes the most recent portfolios and the subindex that have poorly performed the last three months. This strategy can be seen as a way to extend the observation period by three more months and to only invest within subindex having confirmed their good performance. Because it focuses only on the long side, it does not support full long/short symmetry. It is best suited for environments where short-term signals are expected to dominate.

**(4) Total Directional Allocation (Long - Short):** This more advanced rule adapts both the capital exposure and the internal allocation depending on the market environment and the most recent performance signals. The strategy looks at the last 3 benchmark monthly returns and computes their average: if the trend is positive, capital is fully allocated to the long leg, if the trend is negative, the strategy goes fully short and otherwise a 50/50 allocation is done between long and short (and also at the inception). The allocation for each subportfolio and their underlying is done as the two above allocations but with a more aggressive approach: the last return is used as a metric. Therefore, the nominal allocation for the Long or Short Portfolio is distributed based on the positive contribution of each subportfolio to the total positive performance of the portfolio. If the total performance is negative, the newly introduced subportfolio receives the entire allocation, distributed equally. Within the subportfolios, the same allocation rule based on the last return is applied. This allocation strategy is designed to be highly flexible, allowing it to react quickly to market signals—following the trend to capture performance and pull back when the market moves in the opposite direction. However, this strategy is risky, as it does not balance exposure. Moreover, the frequent and total liquidations of portfolios can severely impact performance due to transaction costs. This highly dynamic strategy is specifically designed to exploit short-term (monthly) market variations.

### *ii) Transaction Cost Structures*

We evaluate the robustness of strategies under different market frictions by introducing three transaction cost structures:

**(1) No Cost:** This ideal case helps us isolate the “pure” alpha of each strategy before adding any market frictions. It serves as a reference point.

**(2) Linear Transaction Costs:** A simple model where costs are proportional to the amount traded. In practice, we apply differentiated linear fees based on the strategy. For long-only, a flat fee of 50 basis points (0.50%) per trade is used. For long - short, we apply 50 bps on the long side and a higher fee of 65 bps on the short side, reflecting the higher costs typically associated with short selling.

**(3) Dynamic Transaction Costs:** This more realistic model increases the cost based on a fixed costs (0.1%) and the size of the trade relative. The larger the trade, the higher the additional cost per unit: a trade > 20M capital costs 1% more (1.1% in total proportionally applied), a trade > 10 costs 0.75%, a trade > 5M costs 0.4%, small trades below 1M are scaled from 0.2% to 0.05%. of capital may be cost-free. This reflects real market effects, such as limited liquidity and execution impact, especially for institutional-scale trades. We applied the same fixed costs and rules for both the long and short portfolios, considering that the bigger orders from the short portfolio (because composed of only 3 subportfolios for 5 for the long portfolio) leads it to make bigger trades and there to have higher average costs.

For each strategy, we test both long-only and long-short configurations, different weighting rules, and all transaction cost models.

This gives us 9 combinations per strategy structure (9 long, 9 long - short), allowing us to compare the impact of fees on raw performance, measure the sensitivity to weighting methods, and evaluate whether short selling improves net results.

## 2. Implementation of long momentum strategies on the S&P 500 Sector Indices

This section presents the results of momentum strategies applied in a long-only framework. The approach consists in investing exclusively in the top-performing sector indices over past periods, without any short-selling. We explore the sensitivity of the strategy to transaction costs and portfolio weighting schemes by testing different configurations while keeping the investment universe and capital base constant.

We will for the next of this paper design the equally weighted, increase the winners and increase the recent winners methods by the acronyms EW, IW, IRW.

### a) Without Transaction Costs

To begin, we assess the strategies in a frictionless environment, where no transaction costs are applied. This serves as a reference point to isolate the pure effect of momentum and the influence of allocation styles. The figures for the Equally Weighted (EW), Increase-the-Winners (IR), and Increase-the-Recent-Winners (IRW) allocations without transaction fees can be found in [Annex 4](#), [Annex 5](#), and [Annex 6](#), respectively.

We observe that all three allocations outperform the benchmark, with the best performance achieved by the 6/6 IRW portfolio (CoC = 33.45x vs. 8.44x for the benchmark). All strategies exhibit an average monthly return per unit of risk around 1%, compared to 0.72% for the benchmark, justifying their overall outperformance. The IRW allocation delivers the best CoC performance, but all strategies generate strong returns. The EW allocation is the least volatile, with an average volatility close to 15%, while the other strategies are about 1.5% more volatile.

However, these strategies are actually more volatile than their volatility suggests, with maximum drawdowns around -60%. Additionally, we observe that the average beta of all portfolios across allocations is very close to 1, indicating that this strategy has a strong exposure to systematic risk.

Seasonality effects are limited, except for June, where monthly performance tends to be slightly negative.

The performance of the strategies varies significantly depending on the Observation Period / Holding Period pair.

- For IR and IRW, short observation periods combined with short-to-medium holding periods (3/1, 3/9, 6/6) deliver the best performance.
- For EW, medium-length observation/holding periods (6/6, 9/6, 3/9) generate the strongest results.
- Additionally, the EW allocation exhibits a proportional turnover, as expected, with turnover rates 2 to 3 times higher than those observed in IR and IRW allocations.

These strategies exhibit notable risk profiles, which must be evaluated case by case.

- They have non-negligible volatility,
- A beta close to 1,
- And relatively low unadjusted Sharpe ratios.

These factors indicate significant risks, materialized by their drawdowns.

The IR strategy, in particular, experiences high average monthly drawdowns, ranging from -40% to -67%, whereas the other two strategies show more moderate variations: EW drawdowns range between -7% and -19%, IRW drawdowns fluctuate between -8% and -21%.

Despite these risks, the performance driver, while highly correlated with beta, appears to diverge slightly, suggesting potential differentiation in risk-return profiles.

#### *b) With Linear Transaction Costs*

The figures for the Equally Weighted (EW), Increase-the-Winners (IR), and Increase-the-Recent-Winners (IRW) allocations with linear transaction fees can be found in [Annex 7](#), [Annex 8](#), and [Annex 9](#), respectively.

The non-transaction-cost-related parameters previously discussed also apply to this section and the following one. Transaction costs have a significant impact on the performance of these strategies, especially those with very short holding periods, which exhibit high turnover and substantial performance deterioration. For instance, the 3/3 IRW strategy sees its CoC drop from 17x to 3.25x due to transaction costs. Portfolios with a 1-month holding period experience negative total returns across all allocation styles. Annual volatility remains stable, ranging from 15% to 18%, with no significant difference across allocation methods.

Risk-adjusted returns (Sharpe ratios) decline across the board. The IR strategy proves more resilient to the introduction of transaction costs compared to its counterparts (see annexes for further details), resulting in a better adjusted Sharpe ratio. EW exhibits lower volatility and turnover, leading to fewer transaction fees and, consequently, better overall performance. However, IRW still leads with the best Sharpe ratios.

Additionally, while some strategies maintain a monthly return similar to the benchmark, their total return differs significantly. This supports the idea that idiosyncratic risks and/or autocorrelations contribute to performance deviations beyond the beta effect in these strategies.

#### *c) With Dynamic Transaction Costs*

The figures for the Equally Weighted (EW), Increase-the-Winners (IR), and Increase-the-Recent-Winners (IRW) allocations with dynamic transaction fees can be found in [Annex 10](#), [Annex 11](#), and [Annex 12](#), respectively.

All three allocation strategies outperform the benchmark, with IRW achieving the highest total return, particularly for short observation periods and medium holding periods (L3/9: + 1732.51%). However, IW presents a more balanced performance profile, achieving competitive returns (L3/9: + 1572.65%) while demonstrating lower volatility and better cost control. The EW allocation, while less aggressive, still delivers solid returns (L6/6: + 1379.73%), making it a safer option for investors prioritizing stability. Its lower turnover and more diversified exposure contribute to smoother performance over time.

Despite their strong returns, IRW and IW exhibit significantly higher drawdowns compared to EW. IRW, in particular, gained an important sensitivity to short-term price fluctuations, leading to high maximum drawdowns near around -60%, -70%, much higher than with the linear costs. This strategy, by concentrating capital on recent outperformers, introduces higher idiosyncratic risk, suffers during market reversals and is exposed to high transaction costs because of its large trades.

Conversely, IW mitigates some of this risk by distributing capital based on longer-term winners, reducing extreme drawdowns (max drawdown range in average near -45%). The EW allocation, by spreading exposure equally, provides the most stable drawdown profile, with the lowest recorded max drawdown (-50% to -59%) and a more

controlled average drawdown (-9% to -17%). The beta of all strategies remains close to 1, indicating that their returns are highly correlated with the overall market. However, IRW's higher volatility (up to 18%) suggests greater exposure to short-term market turbulence compared to the more tempered risk profile of IW and EW. Transaction costs are high for IRW, slightly lower for EW, and relatively low for IR, which is consistent with its significantly lower turnover compared to its counterparts.

In conclusion, the dynamic allocation strategies do not provide a significant advantage over the equally weighted strategy (EW). These strategies introduce additional risk and high turnover, making their performance highly volatile and strongly impacted by transaction costs. Their effectiveness is highly dependent on market conditions, both in terms of the benchmark's performance and external factors (liquidity, market depth, availability of assets). The few instances of outperformance relative to EW are rare and come at the cost of insufficiently compensated risk, as evidenced by the low unadjusted Sharpe ratios and the high maximum drawdowns.

Optimizing the EW allocation parameters (e.g., number of long subportfolios, observation period, and holding period) could likely enhance its outperformance relative to the benchmark. It would be interesting to explore alternative dynamic allocation strategies that are still winners-oriented but incorporate constraints, such as volatility targeting or capped portfolios, to mitigate excessive risk while maintaining return potential.

### 3. Implementation of long / short momentum strategies on the S&P 500 Sector Indices

We will for the next of this paper design the equally weighted, increase the winners, increase the recent winners and fully directional allocation methods by the acronyms EW, IW, IRW and FD.

The EW allocation strategy completely fails in the long-short framework, with all portfolio configurations yielding negative or very weak total returns (between 20% and 40%). Surprisingly, despite these poor results, volatility remains low across all transaction cost scenarios, consistently below 10%. Additionally, transaction fees remain relatively low, never exceeding 20 basis points of monthly performance.

The most likely explanation for this failure is that the shorted stocks tend to be more volatile and experience sharp reversals, exposing the strategy to unexpected and sustained losses. This significant nominal loss on the short leg leads to a progressive reduction in exposure to the performance factor, meaning the long portfolio receives progressively less capital. Over time, this feedback loop causes the strategy to lose its ability to generate returns, ultimately preventing further growth. Given the persistent underperformance of the EW allocation in the long-short setting, we will exclude it from further analysis in the next three subsections. Instead, we will focus exclusively on the Increase-the-Winners (IR) and Fully Directional (FD) strategies, which provide a more structured and adaptable approach to capital allocation.

#### a) *Without Transaction Costs*

The figures for the Equally Weighted (EW), Increase-the-Winners (IR), and Full Directional (FD) allocations without transaction fees can be found in [Annex 13](#), [Annex 14](#), and [Annex 15](#), respectively.

Both strategies outperform the benchmark. However, while IR reaches a maximum CoC of x21, the FD allocation achieves a minimum of x39 (3/1) and a maximum of x94 (compared to x8.44 for the benchmark). Thus, the FD allocation significantly outperforms the IR allocation.

However, this exceptional performance comes at the cost of much higher volatility, around 27% compared to 16% for IR. On the other hand, IR has a maximum drawdown twice as large (-50% vs. -25% for ID), while both strategies have a similar average drawdown.

The FD strategy has a slightly higher beta than IR (1.06 vs. 1.02), though this difference is negligible. Due to FD's high volatility, its Sharpe ratio is slightly lower than that of IR (0.68 vs. 0.72). However, its turnover is significantly higher, about twice that of IR, which is logical given its rebalancing method. Indeed, when FD performs a rebalancing (i.e., when the market trend shifts), it liquidates its entire portfolio.

Despite these significantly higher transaction costs, FD may still outperform IR. Without friction, we can conclude that FD is a highly risky but also highly rewarding strategy, well-suited to the dynamics of the SPX and its underlying assets. Less risky but with a relatively lower return per unit of risk, the IR allocation remains

*b) With Linear Transaction Costs*

The figures for the Equally Weighted (EW), Increase-the-Winners (IR), and Full Directional (FD) allocations without transaction fees can be found in [Annex 16](#), [Annex 17](#), and [Annex 18](#), respectively.

The IR strategy does not withstand the introduction of transaction costs. While its performance is indeed superior to the benchmarks, it is not sufficient to escape the fee compression effect described earlier. If performance is not enough to offset the impact of fees - especially for a dynamic strategy like this one, which has a high turnover - the amount of capital available for leverage decreases, ultimately dooming the strategy. It also experiences significant maximum drawdowns, some as severe as -97% and -82%, which are enough to render the strategy unviable. For this reason, we will not consider IR in the context of transaction costs due to its weak performance.

However, the FD strategy continues to show strong outperformance despite transaction costs, except for the 3/1 portfolio, with a minimum CoC of x15 and a maximum CoC of x34.5. This time, the maximum performance is achieved with slightly longer holding periods, between 6 and 12 months, whereas previously, the best combination was 6/3. The Sharpe ratio decreases slightly with transaction costs, dropping to around 0.55, which is expected. Volatility remains very high, and maximum drawdowns increase significantly for certain combinations, particularly those with shorter holding periods (x2).

The average transaction costs are not excessively high, around 20 basis points, with a few combinations reaching 50 basis points. This is lower than the fixed short fees set at 65 basis points, suggesting that the portfolio is rarely fully liquidated, thereby reducing its exposure to transaction costs. The requirement to average over three days serves as a selective criterion, making the portfolio more passive than it could be - i.e., it tends to rebalance its sub-portfolios and sub-indices rather than frequently taking strong directional positions.

*c) With Dynamic Transaction Costs*

The figures for the Equally Weighted (EW), Increase-the-Winners (IR), and Full Directional (FD) allocations without transaction fees can be found in [Annex 19](#), [Annex 20](#), and [Annex 21](#), respectively.

Surprisingly, the results show a clear improvement in performance compared to the linear-cost setting. The annualized return nearly doubles, with some configurations reaching exceptional levels (CoC x561 for 6/12). The Sharpe ratio increases, approaching its cost-free level (0.62 compared to 0.68 without costs). Volatility remains at the same levels, while maximum drawdowns tend to decrease.

These results, although counterintuitive, confirm our previous hypothesis: this strategy performs full rebalancing very rarely and instead marginally updates its weights. As a result, transaction costs remain low, allowing the strategy to regain performance. Furthermore, since the strategy is based on recent performance, it is highly likely that it remains invested in the same sub-indices within its sub-portfolios for extended periods, further reducing turnover, which averages around 20% and reaches approximately 45% in some configurations.

Interestingly, the 6/3 portfolio, despite having a 45% turnover, achieves a CoC of x47.3, even though it has one of the highest average costs (0.21%). This clearly demonstrates that the strategy generates enough performance to more than compensate for its fees. However, given the thresholds observed, for an average turnover of 45%, average costs of 0.21% suggest that the majority of trades are small and inexpensive, primarily consisting of rebalancing transactions.



## **Conclusion :**

This project highlights several key insights regarding the design and implementation of momentum-based strategies. First, we observe that highly dynamic long-only strategies tend to underperform compared to simpler allocation rules. In particular, the equally-weighted allocation consistently delivers more robust results. This suggests that, in a structurally upward-trending market like the S&P 500, it's often more effective to stay exposed through a stable allocation rather than trying to adapt constantly. The benchmark's growth, amplified by market-cap effects, contributes positively to returns when long positions are held in strong-performing sectors. However, strategies that seem effective in a frictionless environment often fail in real markets, as their returns are insufficient to absorb even modest transaction costs — particularly when applied to large volumes.

While long-only strategies remain appealing despite transaction costs (although, after deducting potential management fees, a low-cost SPX ETF might be more advantageous), long-short strategies generally fail to remain profitable under realistic cost assumptions — with the exception of our directional strategy, which stands out due to its particularly high returns. Furthermore, when moving to long/short strategies, reactivity becomes far more critical. Without a fast-responding signal, portfolios may be exposed to sharp corrections, which heavily penalize delayed adjustments. In these cases, short-term momentum signals provide better protection and improve the net performance of the strategy.

Interestingly, some of our long - short configurations display characteristics similar to alpha generation. However, upon closer inspection, we observe that many of these portfolios exhibit high market exposure (beta) and volatility levels that exceed those of the benchmark. This raises questions about whether the excess return truly represents alpha or if it is compensation for taking on additional risk. Further testing, such as controlling idiosyncratic volatility or decomposing performance into risk factors, would be needed to clarify this point, as the authors did.

In particular, our directional long/short strategy emerges as a promising framework. Its flexibility and performance merit further investigation, especially through an extended historical backtest. However, it is important to recognize that our results are highly specific to the U.S. equity market, which benefits from a relatively steady upward drift and strong sector diversification. While not all risk indicators were computed, it is clear that the strategy carries significant risk and may underperform over short horizons (for instance VaR). In more volatile or structurally different markets, a monthly rebalancing frequency might be too slow, potentially exposing the strategy to correction risk. More generally, it is essential to assess whether these strategies can be applied to other asset classes or geographical regions, in order to distinguish performance components that are specific to the U.S. market.

To improve the strategies, one could consider incorporating beta or volatility control mechanisms or enforcing stricter turnover constraints to reduce noise and trading costs. Another direction would be to introduce performance- and holding-based mechanisms that depend on the specific composition of each sub-portfolio, thus making the overall strategy more adaptive. Additionally, the strategy could be de-risked during historically underperforming months (for instance January), by temporarily exiting the market. This would require comparing the cost of a short swap overlay versus a full liquidation and subsequent re-entry. For strategies that allocate dynamically based on past performance, such a shift would imply a different rebalancing schedule, which should be carefully analyzed. Introducing a cash allocation option (i.e Treasury Bills in this study) would also be valuable, enabling the strategy to stay out of the market when signals are weak or contradictory. Finally, the use of leverage should be considered to fully exploit upward or downward trends in the long and short legs of the portfolio.

An additional and promising idea is to explore derivative overlays on top of the long/short structure. For example, a risk-tolerant investor could enhance the strategy by using options to protect entry points—such as buying puts to cap losses on short positions. While this may slightly reduce expected returns, it would provide meaningful downside protection and improve risk-adjusted performance. The cost of such "insurance" could be modeled and optimized. Testing option-enhanced versions of the strategy could yield deeper insights into how momentum can be leveraged in real-world portfolio construction.

## Annexes :

### Appendix 1 : Illustration of the J/K strategy at time t

Initial worth :	\$ 100 000.00				
Stocks	J quarters past performance	Decile	Long / Short	Portfolio	Weights within the portfolio hold for K quarters
Stock A	18.5%	Top Decile	Long	Long component	25% / 25K
Stock B	16.2%	Top Decile	Long		25% / 25K
Stock C	12.8%	Neutral			
Stock D	11.4%				
Stock E	9.7%				
Stock F	8.1%				
Stock G	7.5%				
Stock H	6.9%				
Stock I	5.8%				
Stock J	4.3%				
Stock K	-1.2%				
Stock L	-2.5%				
Stock M	-3.8%				
Stock N	-5.0%				
Stock O	-6.3%				
Stock P	-7.8%				
Stock Q	-8.5%				
Stock R	-9.9%				
Stock S	-11.2%	Bottom Decile	Short	Short component	25% / 25K
Stock T	-12.5%	Bottom Decile	Short		25% /25K

### Appendix 2: Illustration of rebalancing for the holding period K = 3 months one month after initiation and N months after initiation (N > 3).

After one month of the strategy's implementation					
Portfolio	Value - Month 0	Value - Month 1	Ex exposure	Post rebalancing exposure	Net value exposure
Pf 1	\$ 100 000.00	\$ 110 000.00	100%	50.0%	\$ 55 000.00
Pf 2			0.0%	50.0%	\$ 55 000.00

After N month of the strategy's implementation (K = 3)					
Portfolio	Value - Month N-1	Value - Month N	Ex exposure	Post rebalancing exposure	Net value exposure
Pf 1 - hold 1 months	\$ 37 000.00	\$ 40 000.00	33%	33.33%	\$ 34 166.67
Pf 2 - hold 2 months	\$ 26 000.00	\$ 27 500.00	33%	33.33%	\$ 34 166.67
Pf 3 - hold 3 months	\$ 42 000.00	\$ 35 000.00	33%	0.0%	\$ -
Pf 4			0.0%	33.33%	\$ 34 166.67

### Appendix 3:

**Table I**

#### **Returns of Relative Strength Portfolios**

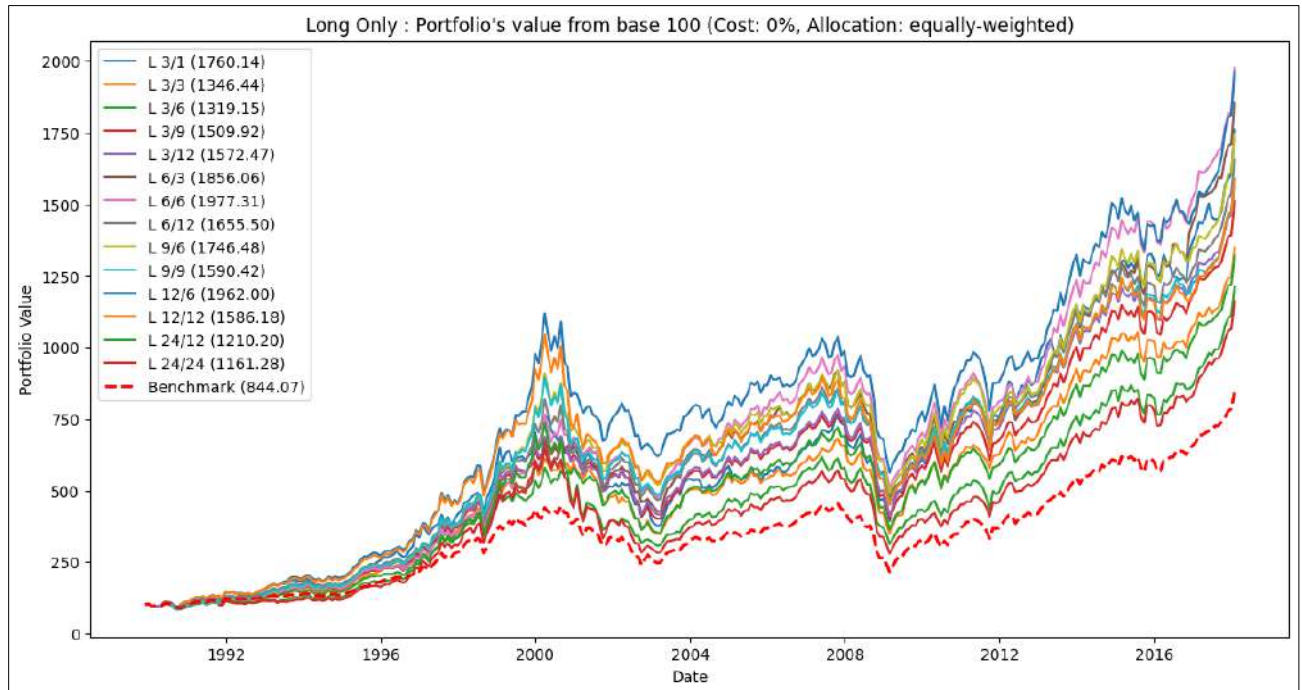
The relative strength portfolios are formed based on  $J$ -month lagged returns and held for  $K$  months. The values of  $J$  and  $K$  for the different strategies are indicated in the first column and row, respectively. The stocks are ranked in ascending order on the basis of  $J$ -month lagged returns and an equally weighted portfolio of stocks in the lowest past return decile is the *sell* portfolio and an equally weighted portfolio of the stocks in the highest return decile is the *buy* portfolio. The average monthly returns of these portfolios are presented in this table. The relative strength portfolios in Panel A are formed immediately after the lagged returns are measured for the purpose of portfolio formation. The relative strength portfolios in Panel B are formed 1 week after the lagged returns used for forming these portfolios are measured. The  $t$ -statistics are reported in parentheses. The sample period is January 1965 to December 1989.

		Panel A					Panel B				
$J$		$K =$	3	6	9	12	$K =$	3	6	9	12
3	Sell		0.0108 (2.16)	0.0091 (1.87)	0.0092 (1.92)	0.0087 (1.87)		0.0083 (1.67)	0.0079 (1.64)	0.0084 (1.77)	0.0083 (1.79)
3	Buy		0.0140 (3.57)	0.0149 (3.78)	0.0152 (3.83)	0.0156 (3.89)		0.0156 (3.95)	0.0158 (3.98)	0.0158 (3.96)	0.0160 (3.98)
3	Buy-sell		0.0032 (1.10)	0.0058 (2.29)	0.0061 (2.69)	0.0069 (3.53)		0.0073 (2.61)	0.0078 (3.16)	0.0074 (3.36)	0.0077 (4.00)
6	Sell		0.0087 (1.67)	0.0079 (1.56)	0.0072 (1.48)	0.0080 (1.66)		0.0066 (1.28)	0.0068 (1.35)	0.0067 (1.38)	0.0076 (1.58)
6	Buy		0.0171 (4.28)	0.0174 (4.33)	0.0174 (4.31)	0.0166 (4.13)		0.0179 (4.47)	0.0178 (4.41)	0.0175 (4.32)	0.0166 (4.13)
6	Buy-sell		0.0084 (2.44)	0.0095 (3.07)	0.0102 (3.76)	0.0086 (3.36)		0.0114 (3.37)	0.0110 (3.61)	0.0108 (4.01)	0.0090 (3.54)
9	Sell		0.0077 (1.47)	0.0065 (1.29)	0.0071 (1.43)	0.0082 (1.66)		0.0058 (1.13)	0.0058 (1.15)	0.0066 (1.34)	0.0078 (1.59)
9	Buy		0.0186 (4.56)	0.0186 (4.53)	0.0176 (4.30)	0.0164 (4.03)		0.0193 (4.72)	0.0188 (4.56)	0.0176 (4.30)	0.0164 (4.04)
9	Buy-sell		0.0109 (3.03)	0.0121 (3.78)	0.0105 (3.47)	0.0082 (2.89)		0.0135 (3.85)	0.0130 (4.09)	0.0109 (3.67)	0.0085 (3.04)
12	Sell		0.0060 (1.17)	0.0065 (1.29)	0.0075 (1.48)	0.0087 (1.74)		0.0048 (0.93)	0.0058 (1.15)	0.0070 (1.40)	0.0085 (1.71)
12	Buy		0.0192 (4.63)	0.0179 (4.36)	0.0168 (4.10)	0.0155 (3.81)		0.0196 (4.73)	0.0179 (4.36)	0.0167 (4.09)	0.0154 (3.79)
12	Buy-sell		0.0131 (3.74)	0.0114 (3.40)	0.0093 (2.95)	0.0068 (2.25)		0.0149 (4.28)	0.0121 (3.65)	0.0096 (3.09)	0.0069 (2.31)

#### Appendix 4:

Long Only strategy:

1. Observation period / Holding period in months
2. Top 5 pfs for the Long portfolios
3. Costs = 0%
4. Allocation: Equally weighted

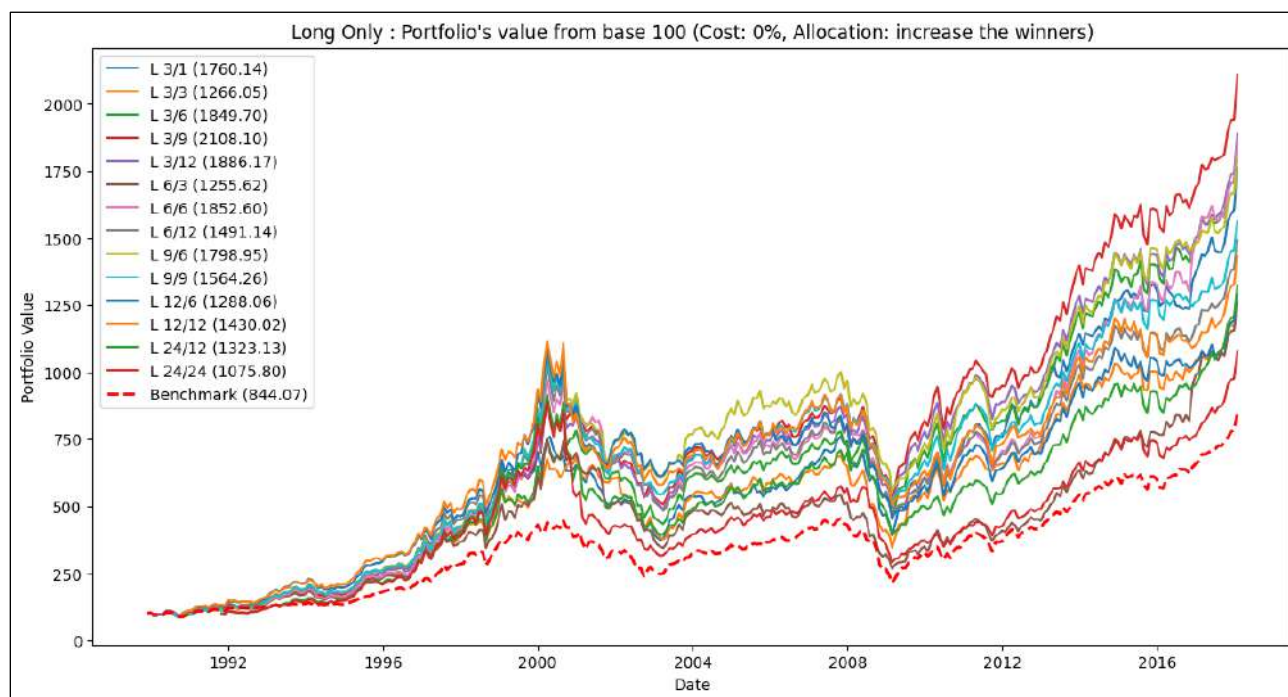


Info	SPX	L 3/1	L 3/3	L 3/6	L 3/9	L 3/12	L 6/3	L 6/6	L 6/12	L 9/6	L 9/9	L 12/6	L 12/12	L 24/12	L 24/24
Total Return	744.07%	1660.14%	1246.44%	1219.15%	1409.92%	1472.47%	1756.06%	1877.31%	1555.50%	1646.48%	1490.42%	1862.00%	1486.18%	1110.20%	1061.28%
Monthly Return	0.72%	0.96%	0.87%	0.86%	0.90%	0.91%	0.98%	1.00%	0.94%	0.97%	0.94%	1.01%	0.95%	0.91%	0.90%
Unadjusted Annual Sharpe	0.61	0.73	0.69	0.69	0.73	0.74	0.75	0.77	0.74	0.75	0.73	0.78	0.72	0.64	0.63
Annual Volatility	14.18%	15.77%	15.06%	15.06%	14.89%	14.86%	15.80%	15.59%	15.27%	15.58%	15.48%	15.56%	15.96%	17.13%	17.11%
Max Drawdown	-52.56%	-50.55%	-48.67%	-49.53%	-47.93%	-47.60%	-48.26%	-47.72%	-47.71%	-46.58%	-48.79%	-49.71%	-56.89%	-58.37%	-56.63%
Average Drawdown	-10.73%	-10.94%	-8.39%	-8.05%	-8.22%	-7.81%	-7.92%	-8.38%	-10.23%	-10.73%	-12.41%	-13.13%	-16.69%	-19.14%	-17.16%
Monthly Beta	-	1.02	1.02	1.02	1.01	1.01	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01
Average Costs Fees	-	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Monthly Turnover	-	100.00%	33.31%	16.67%	11.13%	8.33%	33.34%	16.67%	8.32%	16.66%	11.09%	16.65%	8.33%	8.32%	4.17%
January Perf	0.14%	0.685%	0.366%	0.364%	0.451%	0.622%	0.666%	0.735%	1.066%	0.763%	0.994%	0.938%	1.096%	1.259%	1.328%
February Perf	0.40%	0.475%	0.479%	0.837%	1.053%	0.894%	1.128%	1.406%	1.265%	1.434%	1.388%	1.637%	1.348%	0.446%	0.169%
March Perf	1.43%	1.809%	1.636%	1.575%	1.594%	1.586%	1.560%	1.505%	1.390%	1.591%	1.445%	1.432%	1.214%	1.225%	1.356%
April Perf	1.57%	1.613%	1.096%	0.881%	1.052%	1.262%	0.902%	0.883%	1.196%	0.940%	1.077%	0.818%	1.241%	1.664%	1.900%
May Perf	1.05%	0.818%	1.095%	1.132%	1.328%	1.292%	1.285%	1.338%	1.279%	0.904%	0.996%	1.046%	0.932%	0.908%	0.769%
June Perf	-0.47%	-1.003%	-0.383%	-0.106%	-0.152%	-0.247%	0.396%	0.312%	-0.064%	0.195%	0.031%	0.158%	0.056%	0.207%	-0.027%
July Perf	0.87%	1.283%	1.328%	1.252%	1.313%	1.253%	1.440%	1.368%	1.173%	1.175%	1.128%	1.104%	0.940%	0.759%	0.744%
August Perf	-0.96%	-0.571%	-0.704%	-0.857%	-0.866%	-0.884%	-0.997%	-0.771%	-0.915%	-0.763%	-0.820%	-0.574%	-0.739%	-0.910%	-0.933%
September Perf	-0.38%	0.486%	0.178%	-0.125%	-0.102%	-0.112%	-0.175%	-0.249%	-0.291%	-0.234%	-0.275%	-0.010%	-0.078%	0.081%	-0.177%
October Perf	1.65%	1.117%	1.214%	1.394%	1.328%	1.546%	1.178%	1.384%	1.551%	1.579%	1.663%	1.870%	2.018%	2.126%	2.257%
November Perf	1.54%	2.732%	1.951%	1.951%	1.851%	1.805%	1.991%	1.831%	1.801%	1.814%	1.628%	1.544%	1.510%	1.395%	1.804%
December Perf	1.69%	1.855%	2.170%	2.100%	1.975%	1.952%	2.439%	2.273%	2.049%	2.236%	2.029%	2.094%	1.800%	1.707%	1.501%

## Appendix 5:

Long Only strategy :

1. Observation period / Holding period in months
2. Top 5 pfs for the Long portfolios
3. Costs = 0%
4. Allocation: Increase the winners

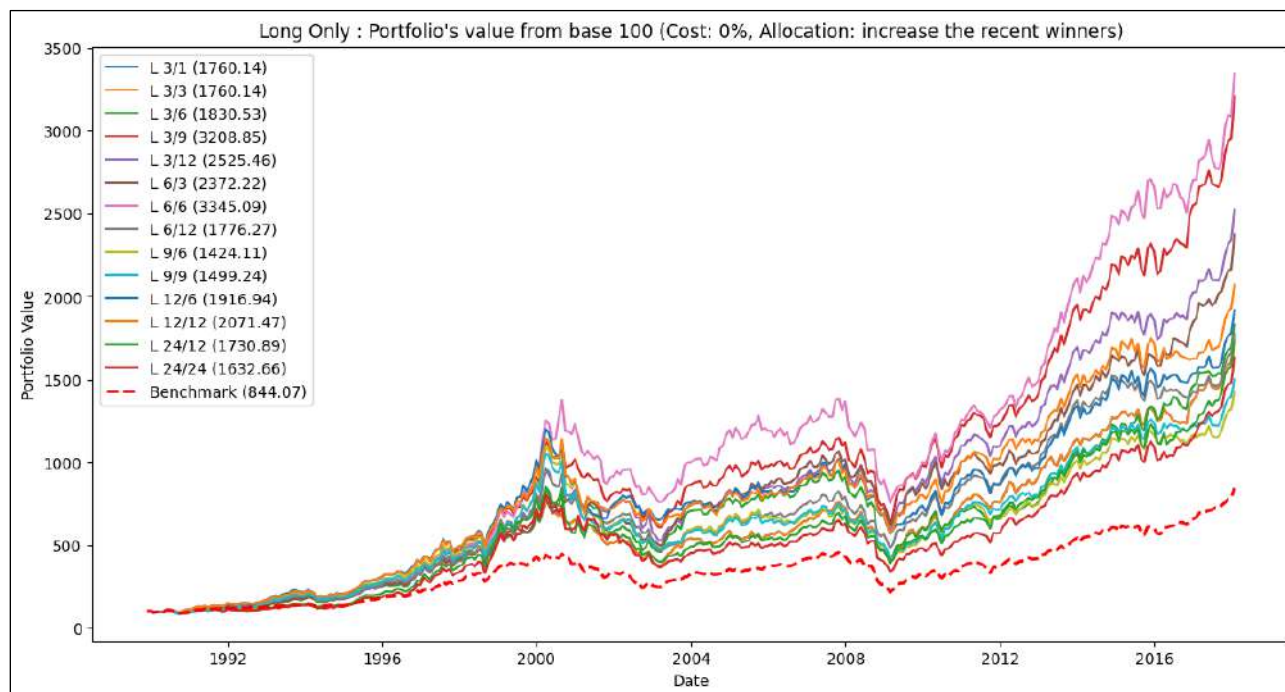


Info	SPX	L 3/1	L 3/3	L 3/6	L 3/9	L 3/12	L 6/3	L 6/6	L 6/12	L 9/6	L 9/9	L 12/6	L 12/12	L 24/12	L 24/24
Total Return	744.07%	1660.14%	1166.05%	1749.70%	2008.10%	1786.17%	1155.62%	1752.60%	1391.14%	1698.95%	1484.26%	1188.06%	1330.02%	1223.13%	975.80%
Monthly Return	0.72%	0.98%	0.87%	0.98%	1.02%	0.99%	0.89%	1.00%	0.93%	0.99%	0.95%	0.89%	0.93%	0.95%	0.88%
Unadjusted Annual Sharpe	0.61	0.73	0.62	0.72	0.74	0.72	0.60	0.69	0.67	0.72	0.69	0.66	0.68	0.65	0.61
Annual Volatility	14.18%	15.77%	16.76%	16.44%	16.42%	16.37%	17.82%	17.26%	16.66%	16.50%	16.44%	16.08%	16.26%	17.54%	17.45%
Max Drawdown	-52.56%	-50.55%	-48.77%	-44.42%	-42.89%	-44.71%	-64.29%	-52.47%	-54.82%	-47.71%	-51.14%	-57.72%	-54.74%	-57.18%	-67.12%
Average Drawdown	-10.73%	-10.94%	-9.29%	-8.56%	-8.16%	-9.17%	-20.46%	-14.80%	-16.94%	-12.23%	-15.28%	-16.80%	-18.05%	-20.83%	-28.35%
Monthly Beta	-	1.02	1.02	1.02	1.03	1.03	1.03	1.03	1.03	1.04	1.03	1.04	1.03	1.03	1.02
Average Costs Fees	-	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Monthly Turnover	-	100.00%	44.60%	17.27%	11.51%	8.33%	43.58%	18.07%	7.91%	17.31%	11.01%	17.47%	7.68%	7.90%	3.56%
January Perf	0.14%	0.885%	0.172%	0.342%	0.497%	0.488%	0.629%	0.703%	0.674%	0.856%	0.828%	0.603%	0.710%	0.966%	0.917%
February Perf	0.40%	0.475%	0.167%	1.012%	1.457%	1.359%	1.300%	1.679%	1.693%	1.620%	1.642%	1.281%	1.526%	0.583%	0.538%
March Perf	1.43%	1.809%	1.622%	1.783%	1.690%	1.675%	1.678%	1.491%	1.285%	1.695%	1.518%	1.373%	1.227%	1.172%	1.187%
April Perf	1.57%	1.613%	1.167%	0.626%	0.757%	0.756%	0.159%	0.126%	0.406%	0.237%	0.335%	0.094%	0.480%	0.972%	1.264%
May Perf	1.05%	0.818%	1.228%	1.300%	1.472%	1.406%	1.087%	1.290%	1.259%	0.769%	0.769%	0.923%	0.912%	0.853%	0.848%
June Perf	-0.47%	-1.003%	-0.147%	0.251%	0.205%	0.126%	0.812%	0.490%	0.326%	0.369%	0.314%	0.062%	0.191%	0.515%	0.488%
July Perf	0.87%	1.263%	0.495%	0.816%	1.023%	0.959%	0.862%	1.009%	0.990%	0.562%	0.692%	0.180%	0.340%	0.725%	0.845%
August Perf	-0.96%	-0.571%	-0.685%	-0.928%	-0.783%	-0.604%	-0.886%	-0.515%	-0.486%	-0.253%	-0.249%	-0.282%	-0.476%	-0.360%	-0.295%
September Perf	-0.38%	0.488%	0.938%	0.559%	0.292%	0.003%	-0.371%	-0.102%	-0.432%	-0.055%	-0.183%	0.205%	0.149%	0.594%	0.206%
October Perf	1.65%	1.117%	0.990%	1.460%	1.261%	1.265%	0.645%	0.870%	1.162%	1.357%	1.273%	1.816%	1.945%	1.471%	1.254%
November Perf	1.54%	2.732%	2.255%	2.154%	2.049%	2.021%	2.426%	2.268%	1.756%	2.017%	1.948%	2.037%	1.858%	1.802%	1.706%
December Perf	1.89%	1.855%	2.267%	2.419%	2.331%	2.302%	2.597%	2.740%	2.534%	2.669%	2.462%	2.271%	2.147%	2.300%	1.559%



## Appendix 6:

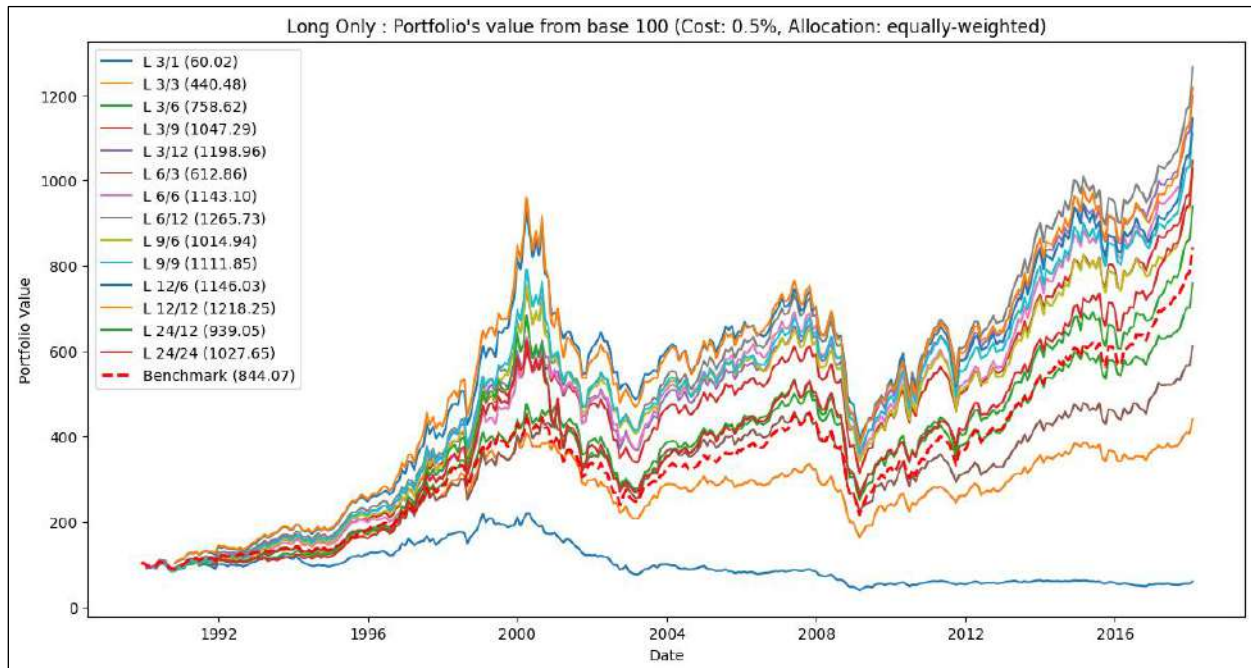
1. Observation period / Holding period in months
2. Top 5 pfs for the Long portfolios
3. Costs = 0%
4. Allocation: Increase the recent winners



Info	SPX	L 3/1	L 3/3	L 3/6	L 3/9	L 3/12	L 6/3	L 6/6	L 6/12	L 9/6	L 9/9	L 12/6	L 12/12	L 24/12	L 24/24
Total Return	744.07%	1660.14%	1660.14%	1730.53%	3108.85%	2425.46%	2272.22%	3245.09%	1676.27%	1324.11%	1399.24%	1816.94%	1971.47%	1630.89%	1532.66%
Monthly Return	0.72%	0.96%	0.96%	1.01%	1.15%	1.08%	1.05%	1.18%	0.97%	0.92%	0.93%	1.02%	1.04%	1.03%	1.02%
Unadjusted Annual Sharpe	0.61	0.73	0.73	0.66	0.82	0.78	0.81	0.82	0.73	0.66	0.69	0.75	0.76	0.70	0.68
Annual Volatility	14.18%	15.77%	15.77%	18.21%	16.86%	16.51%	15.53%	17.21%	16.07%	16.87%	16.18%	16.34%	16.56%	17.62%	17.93%
Max Drawdown	-52.86%	-50.55%	-50.55%	-58.53%	-45.84%	-43.96%	-42.16%	-45.52%	-51.62%	-61.90%	-59.90%	-52.59%	-49.84%	-53.31%	-57.72%
Average Drawdown	-10.73%	-10.94%	-10.94%	-11.28%	-8.68%	-8.17%	-6.55%	-10.54%	-13.79%	-21.11%	-19.58%	-16.44%	-13.67%	-17.03%	-18.13%
Monthly Beta	-	1.02	1.02	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.02	1.01	1.02	1.01
Average Costs Fees	-	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Monthly Turnover	-	100.00%	0.30%	31.04%	18.74%	11.41%	0.30%	32.59%	11.01%	30.19%	16.75%	31.40%	10.70%	10.37%	5.63%
January Perf	0.14%	0.885%	0.885%	0.334%	0.546%	0.689%	0.670%	0.808%	0.786%	0.555%	0.474%	-0.026%	0.043%	1.156%	1.327%
February Perf	0.40%	0.475%	0.475%	1.345%	1.463%	1.108%	0.929%	1.319%	1.097%	1.246%	1.383%	1.515%	1.391%	0.155%	0.134%
March Perf	1.43%	1.809%	1.809%	1.838%	1.900%	1.746%	1.510%	1.545%	1.157%	1.447%	1.187%	1.308%	0.879%	1.135%	1.250%
April Perf	1.57%	1.613%	1.613%	1.141%	1.223%	1.352%	1.075%	0.736%	1.270%	0.873%	0.669%	0.745%	1.659%	1.606%	1.669%
May Perf	1.05%	0.818%	0.818%	1.137%	1.520%	1.232%	1.276%	1.362%	1.157%	0.728%	0.931%	1.202%	0.860%	0.682%	0.520%
June Perf	-0.47%	-1.003%	-1.003%	0.275%	-0.031%	-0.234%	0.378%	0.470%	-0.211%	0.040%	-0.069%	0.121%	0.007%	0.040%	-0.063%
July Perf	0.87%	1.283%	1.283%	0.901%	0.947%	0.927%	1.171%	1.118%	0.783%	0.543%	0.641%	0.649%	0.993%	0.983%	0.752%
August Perf	-0.96%	-0.571%	-0.571%	-0.420%	-0.107%	-0.054%	-0.709%	0.285%	0.026%	-0.257%	-0.199%	-0.178%	-0.020%	0.083%	-0.098%
September Perf	-0.38%	0.486%	0.486%	0.140%	0.540%	0.423%	0.284%	0.818%	0.624%	-0.088%	0.352%	0.922%	0.744%	0.788%	0.765%
October Perf	1.65%	1.117%	1.117%	0.638%	0.949%	1.211%	1.057%	0.891%	1.181%	1.555%	1.545%	1.532%	1.709%	1.722%	1.354%
November Perf	1.54%	2.732%	2.732%	2.361%	2.562%	2.461%	2.226%	2.231%	1.754%	2.061%	1.911%	2.222%	2.160%	2.150%	2.823%
December Perf	1.69%	1.855%	1.855%	2.425%	2.321%	2.062%	2.777%	2.775%	2.057%	2.550%	2.261%	2.107%	2.016%	1.613%	1.704%

## Appendix 7:

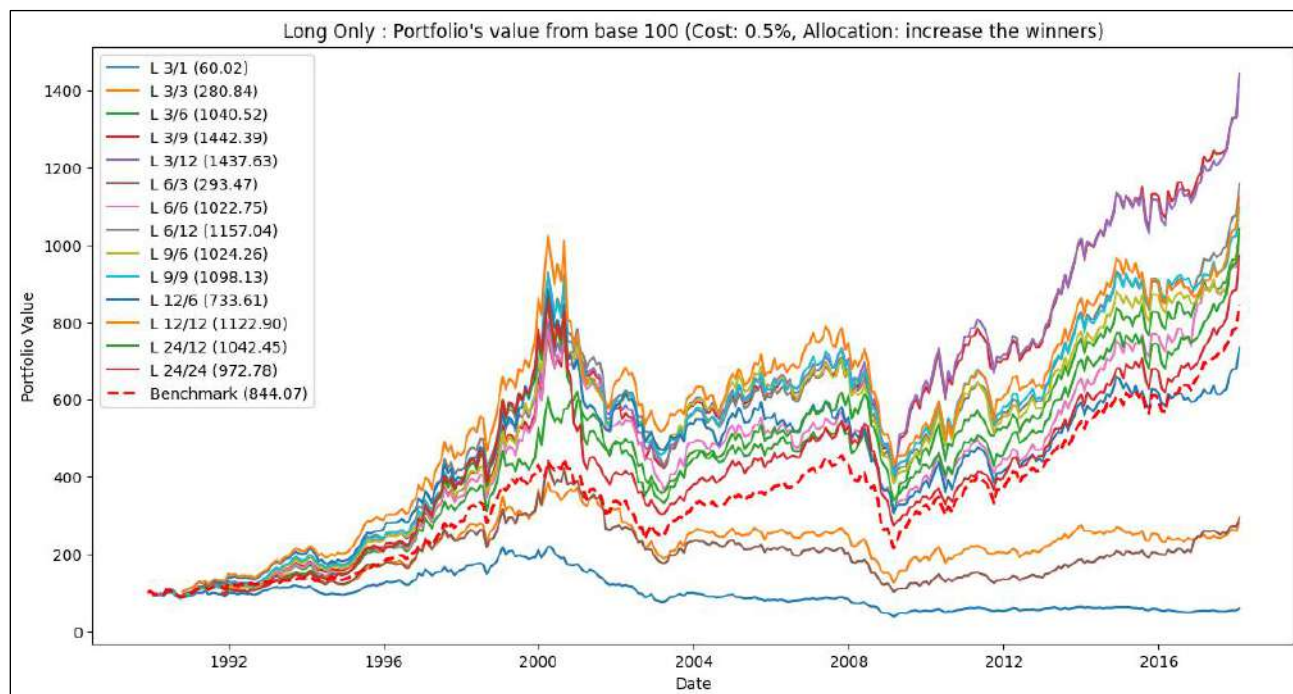
1. Observation period / Holding period in months
2. Top 5 pfs for the Long portfolios
3. Costs = 0.5%
4. Allocation: Equally weighted



Info	SPX	L 3/1	L 3/3	L 3/6	L 3/9	L 3/12	L 6/3	L 6/6	L 6/12	L 9/6	L 9/9	L 12/6	L 12/12	L 24/12	L 24/24
Total Return	744.07%	-39.98%	340.48%	658.62%	947.29%	1098.96%	512.86%	1043.10%	1165.73%	914.94%	1011.85%	1046.03%	1118.25%	839.05%	927.65%
Monthly Return	0.72%	-0.05%	0.53%	0.70%	0.79%	0.83%	0.65%	0.83%	0.86%	0.80%	0.83%	0.89%	0.87%	0.63%	0.86%
Unadjusted Annual Sharpe	0.61	-0.04	0.43	0.56	0.64	0.67	0.49	0.64	0.68	0.62	0.64	0.65	0.66	0.58	0.61
Annual Volatility	14.18%	16.62%	15.01%	15.03%	14.87%	14.86%	15.78%	15.56%	15.26%	15.56%	15.47%	15.54%	15.97%	17.12%	17.10%
Max Drawdown	-62.66%	-82.12%	-60.01%	-60.86%	-48.85%	-48.29%	-50.96%	-49.21%	-49.64%	-54.78%	-54.62%	-57.91%	-60.57%	-61.13%	-58.63%
Average Drawdown	-10.73%	-42.93%	-17.77%	-10.39%	-9.82%	-8.89%	-12.37%	-10.51%	-11.89%	-15.81%	-15.82%	-18.48%	-19.40%	-21.82%	-18.42%
Monthly Beta	-	1.02	1.02	1.02	1.01	1.01	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01
Average Costs Fees	-	1.00%	0.33%	0.16%	0.11%	0.08%	0.33%	0.16%	0.08%	0.16%	0.11%	0.16%	0.08%	0.08%	0.04%
Monthly Turnover	-	100.00%	33.20%	16.60%	11.08%	8.29%	33.23%	16.60%	8.28%	16.59%	11.04%	16.58%	8.29%	8.29%	4.16%
January Perf	0.14%	-0.121%	0.064%	0.201%	0.342%	0.540%	0.331%	0.566%	1.005%	0.595%	0.875%	0.776%	1.015%	1.178%	1.289%
February Perf	0.40%	-0.527%	0.156%	0.674%	0.945%	0.813%	0.791%	1.238%	1.184%	1.265%	1.280%	1.475%	1.267%	0.356%	0.130%
March Perf	1.43%	0.794%	1.298%	1.412%	1.485%	1.504%	1.222%	1.337%	1.306%	1.422%	1.333%	1.284%	1.132%	1.144%	1.317%
April Perf	1.57%	0.599%	0.760%	0.699%	0.943%	1.180%	0.578%	0.721%	1.115%	0.771%	0.964%	0.650%	1.160%	1.582%	1.860%
May Perf	1.05%	-0.188%	0.758%	0.971%	1.221%	1.211%	0.960%	1.176%	1.198%	0.738%	0.887%	0.878%	0.851%	0.828%	0.730%
June Perf	-0.47%	-1.991%	-0.716%	-0.272%	-0.258%	-0.326%	0.062%	0.151%	-0.144%	0.028%	-0.080%	-0.008%	-0.024%	0.127%	-0.065%
July Perf	0.87%	0.273%	0.990%	1.083%	1.205%	1.172%	1.102%	1.206%	1.092%	1.013%	1.021%	0.936%	0.860%	0.679%	0.705%
August Perf	-0.96%	-1.563%	-1.036%	-1.021%	-0.963%	-0.983%	-1.327%	-0.931%	-0.995%	-0.922%	-0.926%	-0.739%	-0.819%	-0.989%	-0.971%
September Perf	-0.38%	-0.517%	-0.155%	-0.292%	-0.214%	-0.192%	-0.507%	-0.415%	-0.371%	-0.394%	-0.382%	-0.176%	-0.161%	-0.002%	-0.217%
October Perf	1.65%	0.108%	0.876%	1.225%	1.214%	1.465%	0.840%	1.215%	1.470%	1.416%	1.555%	1.707%	1.936%	2.044%	2.217%
November Perf	1.54%	1.708%	1.613%	1.781%	1.738%	1.724%	1.651%	1.662%	1.520%	1.651%	1.520%	1.382%	1.429%	1.313%	1.765%
December Perf	1.69%	0.835%	1.828%	1.931%	1.882%	1.888%	2.098%	2.102%	1.966%	2.068%	1.920%	1.931%	1.719%	1.627%	1.462%

## Appendix 8:

1. Observation period / Holding period in months
2. Top 5 pfs for the Long portfolios
3. Costs = 0.5%
4. Allocation: Increase the winners

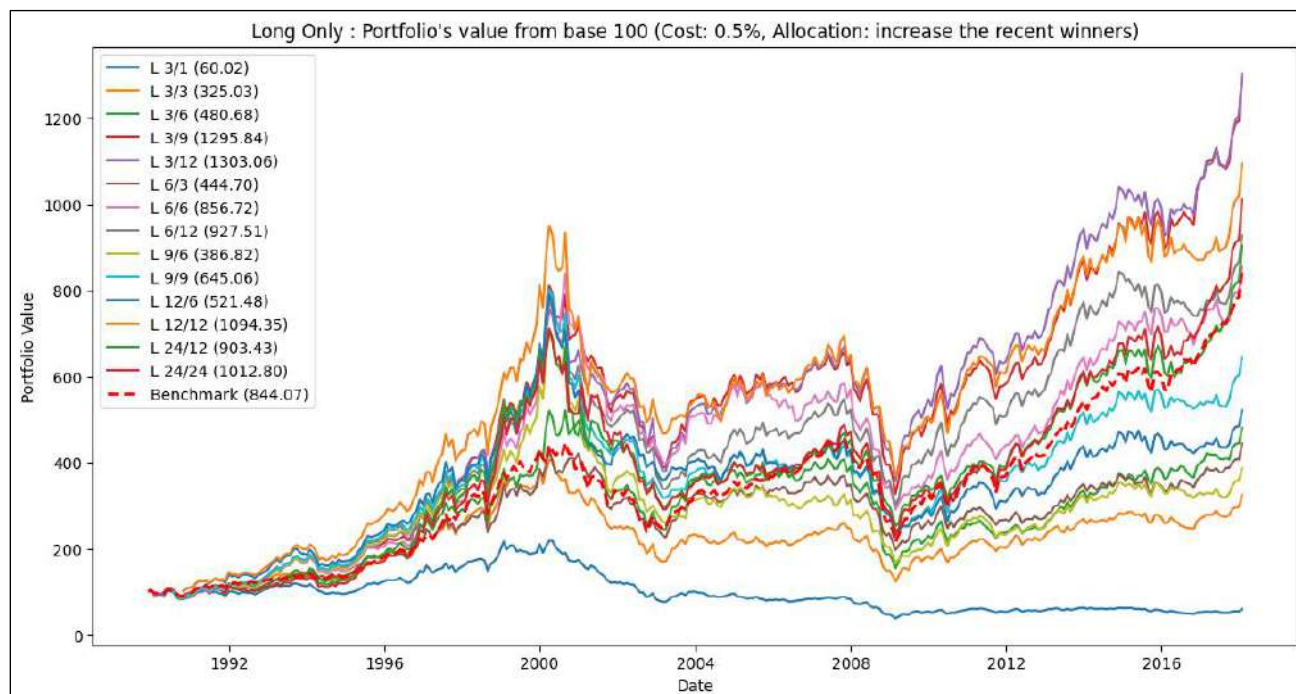


Info	SPX	L 3/1	L 3/3	L 3/6	L 3/9	L 3/12	L 6/3	L 6/6	L 6/12	L 9/6	L 9/9	L 12/6	L 12/12	L 24/12	L 24/24
Total Return	744.07%	-38.98%	180.84%	940.52%	1342.39%	1337.63%	193.47%	922.75%	1057.04%	924.26%	998.13%	633.61%	1022.90%	942.45%	872.78%
Monthly Return	0.72%	-0.05%	0.42%	0.81%	0.91%	0.90%	0.45%	0.82%	0.85%	0.82%	0.84%	0.72%	0.85%	0.87%	0.85%
Unadjusted Annual Sharpe	0.61	-0.04	0.30	0.59	0.66	0.66	0.31	0.57	0.61	0.60	0.61	0.54	0.63	0.60	0.59
Annual Volatility	14.18%	15.62%	16.76%	16.38%	16.40%	16.35%	17.72%	17.22%	16.64%	16.43%	16.43%	16.02%	16.25%	17.51%	17.44%
Max Drawdown	-52.56%	-82.12%	-67.27%	-50.61%	-47.70%	-49.05%	-78.39%	-60.21%	-58.07%	-55.83%	-56.11%	-64.86%	-57.92%	-60.17%	-68.25%
Average Drawdown	-10.73%	-42.93%	-25.68%	-12.19%	-10.30%	-10.95%	-35.70%	-20.12%	-19.28%	-17.35%	-18.67%	-28.96%	-21.02%	-23.93%	-29.75%
Monthly Beta	-	1.02	1.02	1.02	1.03	1.03	1.03	1.03	1.03	1.04	1.03	1.04	1.03	1.03	1.02
Average Costs Fees	-	1.00%	0.44%	0.17%	0.11%	0.08%	0.43%	0.18%	0.08%	0.17%	0.11%	0.17%	0.08%	0.08%	0.03%
Monthly Turnover	-	100.00%	44.49%	17.20%	11.45%	8.29%	43.49%	17.99%	7.88%	17.24%	10.96%	17.39%	7.65%	7.86%	3.54%
January Perf	0.14%	-0.121%	-0.348%	0.213%	0.420%	0.433%	0.162%	0.579%	0.617%	0.721%	0.744%	0.468%	0.650%	0.607%	0.891%
February Perf	0.40%	-0.527%	-0.263%	0.820%	1.374%	1.288%	0.766%	1.471%	1.627%	1.412%	1.546%	1.088%	1.462%	0.519%	0.508%
March Perf	1.43%	0.794%	1.162%	1.583%	1.587%	1.604%	1.274%	1.283%	1.214%	1.463%	1.423%	1.171%	1.173%	1.115%	1.154%
April Perf	1.57%	0.599%	0.786%	0.414%	0.629%	0.690%	-0.307%	-0.074%	0.336%	0.047%	0.234%	-0.085%	0.407%	0.913%	1.232%
May Perf	1.05%	-0.188%	0.771%	1.137%	1.346%	1.339%	0.674%	1.097%	1.187%	0.578%	0.647%	0.719%	0.839%	0.787%	0.821%
June Perf	-0.47%	-1.991%	-0.696%	0.067%	0.056%	0.047%	0.186%	0.294%	0.244%	0.185%	0.178%	-0.123%	0.125%	0.443%	0.459%
July Perf	0.87%	0.273%	0.036%	0.608%	0.865%	0.857%	0.383%	0.795%	0.903%	0.342%	0.558%	-0.055%	0.256%	0.645%	0.814%
August Perf	-0.96%	-1.563%	-1.058%	-1.109%	-0.897%	-0.701%	-1.305%	-0.646%	-0.571%	-0.366%	-0.385%	-0.434%	-0.562%	-0.450%	-0.333%
September Perf	-0.38%	-0.517%	0.523%	0.400%	0.159%	-0.105%	-0.842%	-0.274%	-0.524%	-0.174%	-0.299%	0.055%	0.043%	0.488%	0.164%
October Perf	1.65%	0.108%	0.554%	1.298%	1.143%	1.143%	0.325%	0.678%	1.052%	1.218%	1.155%	1.662%	1.835%	1.333%	1.214%
November Perf	1.54%	1.708%	1.818%	2.022%	1.959%	1.951%	2.027%	2.111%	1.885%	1.852%	1.867%	1.886%	1.787%	1.735%	1.678%
December Perf	1.69%	0.839%	1.824%	2.268%	2.243%	2.323%	2.131%	2.574%	2.473%	2.532%	2.389%	2.125%	2.080%	2.243%	1.528%



## Appendix 9:

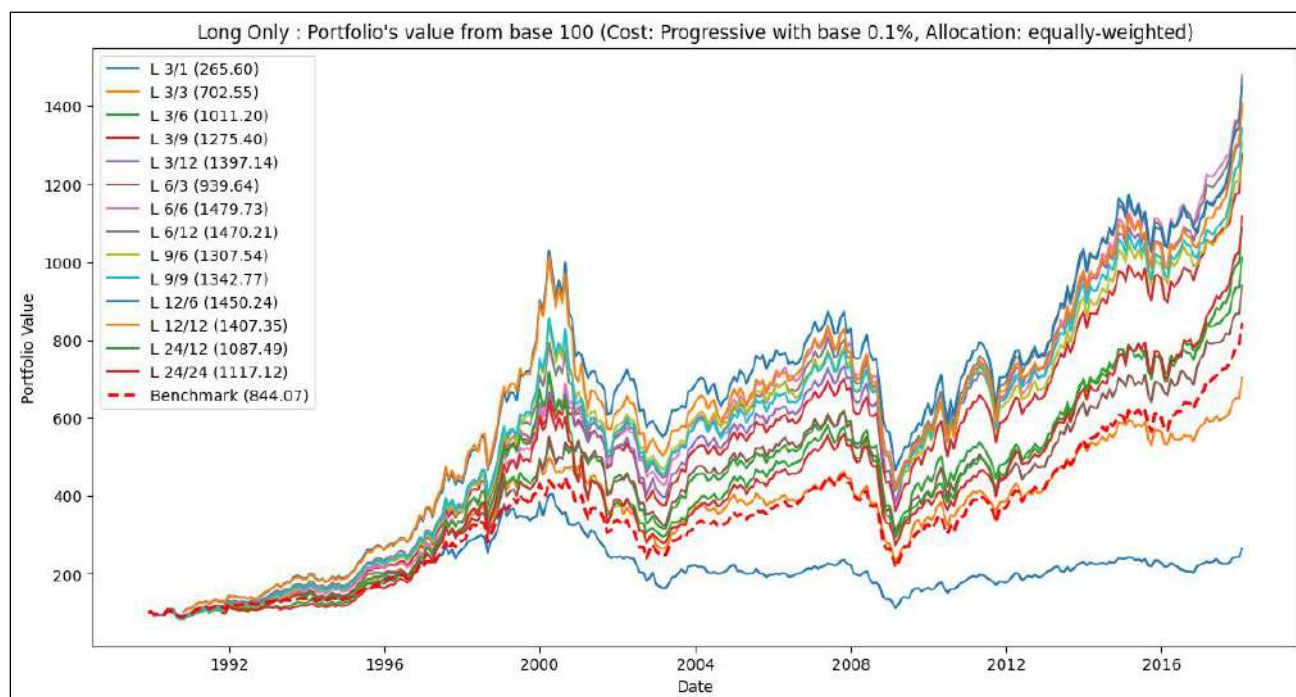
1. Observation period / Holding period in months
2. Top 5 pfs for the Long portfolios
3. Costs = 0.5%
4. Allocation: Increase the recent winners



Info	SPX	L 3/1	L 3/3	L 3/6	L 3/9	L 3/12	L 6/3	L 6/6	L 6/12	L 9/6	L 9/9	L 12/6	L 12/12	L 24/12	L 24/24
Total Return	744.07%	-39.98%	225.03%	380.68%	1195.84%	1203.06%	344.70%	756.72%	827.51%	286.82%	545.06%	421.48%	994.35%	803.43%	912.80%
Monthly Return	0.72%	-0.05%	0.45%	0.61%	0.88%	0.88%	0.55%	0.77%	0.78%	0.53%	0.68%	0.62%	0.85%	0.83%	0.87%
Unadjusted Annual Sharpe	0.61	-0.04	0.35	0.40	0.62	0.63	0.43	0.53	0.58	0.37	0.50	0.45	0.61	0.56	0.58
Annual Volatility	14.18%	15.62%	15.70%	18.30%	17.01%	16.68%	15.45%	17.30%	16.24%	16.97%	16.34%	16.39%	16.69%	17.76%	18.08%
Max Drawdown	-52.56%	-82.12%	-69.58%	-70.24%	-59.60%	-52.84%	-54.25%	-65.38%	-61.24%	-75.67%	-71.11%	-70.62%	-61.15%	-64.56%	-66.23%
Average Drawdown	-10.73%	-42.93%	-28.07%	-24.47%	-15.78%	-12.88%	-17.99%	-23.56%	-20.19%	-37.23%	-31.14%	-33.43%	-20.61%	-25.00%	-24.11%
Monthly Beta	-	1.02	1.02	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.02	1.01	1.02	1.01
Average Costs Fees	-	1.00%	0.00%	0.31%	0.19%	0.11%	0.00%	0.32%	0.11%	0.30%	0.17%	0.31%	0.11%	0.10%	0.05%
Monthly Turnover	-	100.00%	0.30%	30.92%	16.66%	11.36%	0.30%	32.47%	10.96%	30.08%	16.68%	31.28%	10.65%	10.33%	5.60%
January Perf	0.14%	-0.121%	0.380%	-0.060%	0.288%	0.482%	0.167%	0.397%	0.593%	0.163%	0.234%	-0.404%	-0.158%	0.956%	1.176%
February Perf	0.40%	-0.527%	-0.028%	0.997%	1.230%	0.906%	0.425%	0.955%	0.909%	0.904%	1.157%	1.158%	1.217%	-0.034%	0.004%
March Perf	1.43%	0.794%	1.300%	1.350%	1.673%	1.543%	1.003%	1.135%	0.969%	1.041%	0.937%	0.907%	0.893%	0.920%	1.091%
April Perf	1.57%	0.598%	1.105%	0.739%	0.900%	1.142%	0.570%	0.312%	1.054%	0.253%	0.419%	0.345%	1.460%	1.419%	1.521%
May Perf	1.05%	-0.188%	0.314%	0.817%	1.253%	1.040%	0.770%	0.955%	0.939%	0.314%	0.666%	0.784%	0.663%	0.494%	0.390%
June Perf	-0.47%	-1.991%	-1.498%	-0.111%	-0.321%	-0.422%	-0.124%	0.028%	-0.427%	-0.355%	-0.325%	-0.263%	-0.171%	-0.179%	-0.210%
July Perf	0.87%	0.273%	0.777%	0.495%	0.681%	0.724%	0.665%	0.726%	0.572%	0.110%	0.331%	0.229%	0.789%	0.734%	0.563%
August Perf	-0.96%	-1.563%	-1.068%	-0.870%	-0.414%	-0.232%	-1.206%	-0.095%	-0.168%	-0.574%	-0.524%	-0.614%	-0.248%	-0.135%	-0.278%
September Perf	-0.39%	-0.517%	-0.017%	-0.296%	0.284%	0.255%	-0.218%	0.359%	0.462%	-0.437%	0.187%	0.487%	0.596%	0.604%	0.638%
October Perf	1.65%	0.108%	0.612%	0.224%	0.630%	0.985%	0.552%	0.231%	0.981%	1.152%	1.286%	1.124%	1.495%	1.508%	1.186%
November Perf	1.54%	1.708%	2.219%	1.999%	2.288%	2.259%	1.715%	1.859%	1.566%	1.888%	1.657%	1.842%	1.935%	1.923%	2.688%
December Perf	1.69%	0.839%	1.346%	2.067%	2.123%	1.898%	2.263%	2.385%	1.919%	2.182%	2.076%	1.741%	1.842%	1.642%	1.570%

### Appendix 10:

1. Observation period / Holding period in months
2. Top 5 pfs for the Long portfolios
3. Costs = Progressive a floor at 0.1%
4. Allocation: Equally weighted

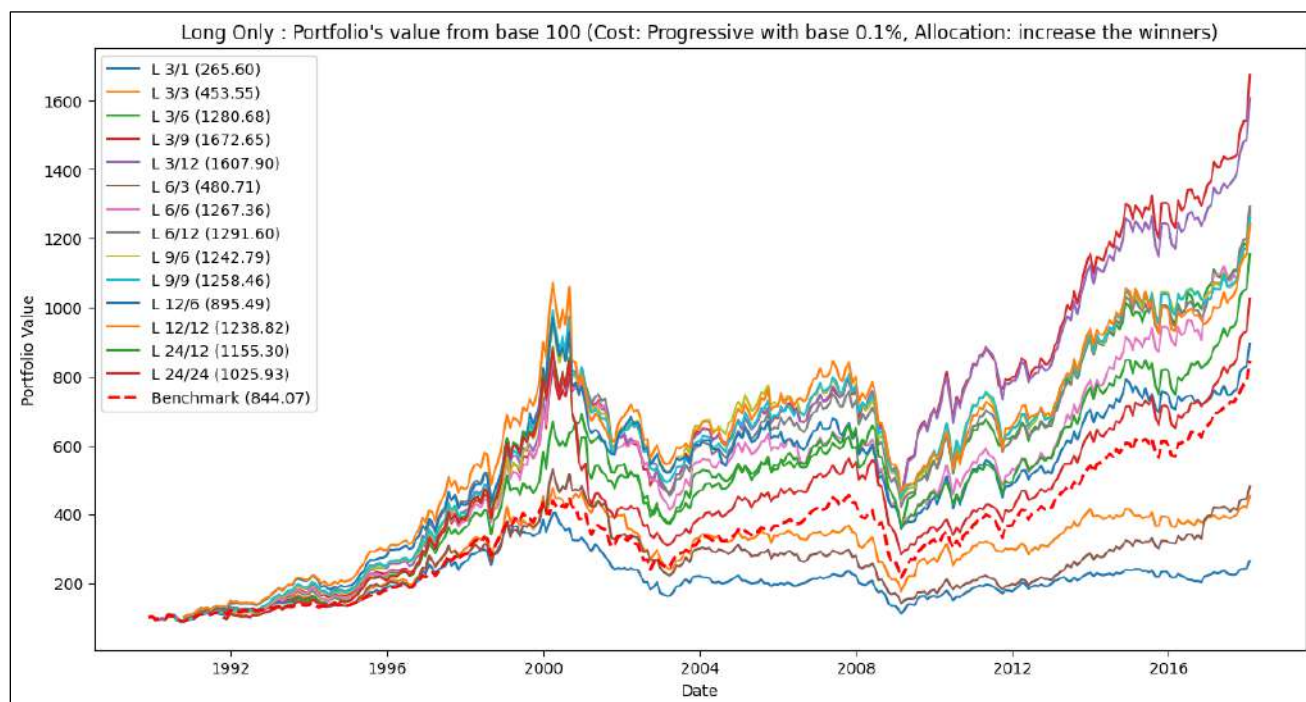


Info	SPX	L 3/1	L 3/3	L 3/6	L 3/9	L 3/12	L 6/3	L 6/6	L 6/12	L 9/6	L 9/9	L 12/6	L 12/12	L 24/12	L 24/24
Total Return	744.07%	165.60%	602.55%	911.20%	1175.40%	1297.14%	839.64%	1379.73%	1370.21%	1207.54%	1242.77%	1350.24%	1307.35%	987.49%	1017.12%
Monthly Return	0.72%	0.39%	0.67%	0.78%	0.85%	0.88%	0.78%	0.91%	0.91%	0.88%	0.89%	0.92%	0.92%	0.88%	0.89%
Unadjusted Annual Sharpe	0.61	0.30	0.54	0.63	0.69	0.71	0.59	0.70	0.71	0.68	0.69	0.71	0.69	0.62	0.62
Annual Volatility	14.18%	15.68%	15.03%	15.04%	14.89%	14.86%	15.78%	15.58%	15.27%	15.57%	15.48%	15.55%	15.97%	17.12%	17.11%
Max Drawdown	-52.56%	-72.36%	-53.88%	-50.20%	-48.38%	-47.94%	-50.07%	-48.51%	-48.15%	-51.13%	-51.74%	-54.75%	-56.73%	-59.12%	-57.21%
Average Drawdown	-10.73%	-31.41%	-12.71%	-9.11%	-8.98%	-8.27%	-10.43%	-9.43%	-10.85%	-13.43%	-14.10%	-16.18%	-17.96%	-20.24%	-17.54%
Monthly Beta	-	1.02	1.02	1.02	1.01	1.01	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01
Average Costs Fees	-	0.56%	0.19%	0.08%	0.05%	0.04%	0.20%	0.09%	0.04%	0.09%	0.05%	0.09%	0.04%	0.03%	0.01%
Monthly Turnover	-	100.00%	33.21%	16.62%	11.10%	8.31%	33.24%	16.62%	8.30%	16.61%	11.06%	16.60%	8.31%	8.30%	4.17%
January Perf	0.14%	0.322%	0.199%	0.285%	0.400%	0.586%	0.458%	0.645%	1.050%	0.673%	0.932%	0.846%	1.059%	1.225%	1.316%
February Perf	0.40%	-0.079%	0.292%	0.759%	1.003%	0.858%	0.919%	1.318%	1.229%	1.345%	1.337%	1.545%	1.312%	0.413%	0.157%
March Perf	1.43%	1.250%	1.441%	1.497%	1.544%	1.550%	1.348%	1.416%	1.353%	1.501%	1.393%	1.339%	1.177%	1.191%	1.344%
April Perf	1.57%	1.048%	0.902%	0.783%	1.002%	1.226%	0.701%	0.797%	1.161%	0.849%	1.024%	0.725%	1.204%	1.630%	1.888%
May Perf	1.05%	0.256%	0.900%	1.054%	1.279%	1.257%	1.085%	1.252%	1.243%	0.814%	0.947%	0.952%	0.895%	0.875%	0.756%
June Perf	-0.47%	-1.555%	-0.577%	-0.185%	-0.201%	-0.281%	0.191%	0.226%	-0.099%	0.106%	-0.021%	0.066%	0.020%	0.173%	-0.039%
July Perf	0.87%	0.713%	1.129%	1.171%	1.264%	1.217%	1.232%	1.282%	1.137%	1.090%	1.079%	1.009%	0.904%	0.725%	0.732%
August Perf	-0.96%	-1.138%	-0.899%	-0.935%	-0.908%	-0.918%	-1.198%	-0.856%	-0.950%	-0.848%	-0.870%	-0.867%	-0.775%	-0.943%	-0.945%
September Perf	-0.38%	-0.088%	-0.018%	-0.206%	-0.153%	-0.147%	-0.377%	-0.336%	-0.327%	-0.320%	-0.325%	-0.103%	-0.115%	0.046%	-0.186%
October Perf	1.65%	0.547%	1.016%	1.312%	1.275%	1.511%	0.973%	1.295%	1.515%	1.491%	1.612%	1.778%	1.961%	2.091%	2.244%
November Perf	1.54%	2.154%	1.754%	1.868%	1.799%	1.769%	1.784%	1.742%	1.565%	1.726%	1.576%	1.452%	1.472%	1.380%	1.791%
December Perf	1.69%	1.287%	1.971%	2.019%	1.923%	1.915%	2.230%	2.182%	2.013%	2.145%	1.977%	2.000%	1.763%	1.673%	1.488%

### Appendix 11:



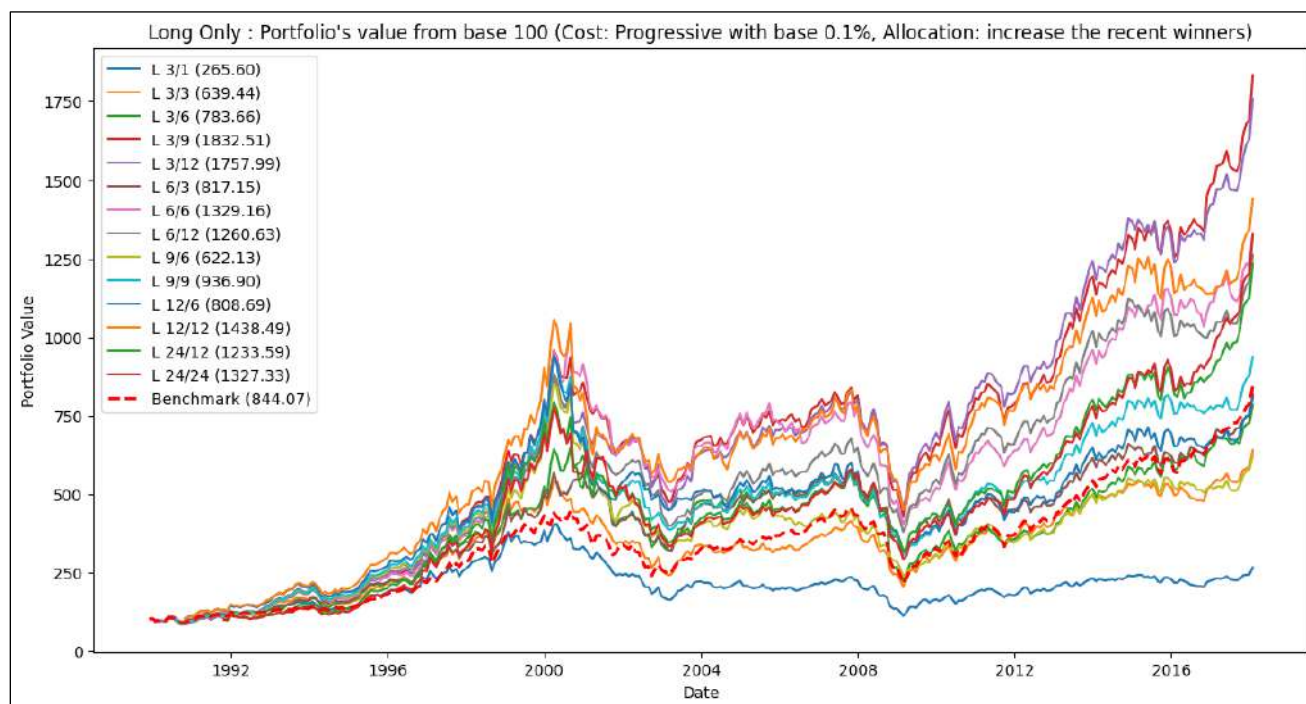
1. Observation period / Holding period in months
2. Top 5 pfs for the Long portfolios
3. Costs = Progressive with a floor at 0.1%
4. Allocation : Increase the winners



Info	SPX	L 3/1	L 3/3	L 3/6	L 3/9	L 3/12	L 6/3	L 6/6	L 6/12	L 9/6	L 9/9	L 12/6	L 12/12	L 24/12	L 24/24
Total Return	744.07%	165.60%	353.55%	1180.68%	1572.65%	1507.90%	380.71%	1167.36%	1191.60%	1142.79%	1158.46%	795.49%	1138.82%	1055.30%	925.93%
Monthly Return	0.72%	0.38%	0.57%	0.87%	0.96%	0.94%	0.80%	0.89%	0.88%	0.88%	0.88%	0.78%	0.88%	0.91%	0.87%
Unadjusted Annual Sharpe	0.61	0.30	0.40	0.64	0.69	0.69	0.41	0.62	0.64	0.64	0.64	0.58	0.65	0.62	0.60
Annual Volatility	14.18%	15.88%	16.81%	16.43%	16.41%	16.36%	17.79%	17.26%	16.65%	16.47%	16.44%	16.06%	16.26%	17.53%	17.44%
Max Drawdown	-52.56%	-72.36%	-62.88%	-48.14%	-45.77%	-47.61%	-73.13%	-58.09%	-56.91%	-53.85%	-54.69%	-63.07%	-56.92%	-59.10%	-67.68%
Average Drawdown	-10.73%	-31.41%	-19.93%	-10.79%	-9.47%	-10.32%	-31.16%	-18.34%	-18.38%	-15.86%	-17.61%	-24.74%	-19.79%	-22.63%	-29.04%
Monthly Beta	-	1.02	1.02	1.02	1.03	1.03	1.03	1.03	1.03	1.04	1.03	1.04	1.03	1.03	1.02
Average Costs Fees	-	0.56%	0.30%	0.11%	0.07%	0.05%	0.29%	0.11%	0.04%	0.11%	0.07%	0.11%	0.04%	0.04%	0.02%
Monthly Turnover	-	100.00%	44.50%	17.22%	11.47%	8.31%	43.50%	18.01%	7.89%	17.26%	10.97%	17.42%	7.66%	7.88%	3.55%
January Perf	0.14%	0.322%	-0.191%	0.252%	0.444%	0.452%	0.316%	0.621%	0.640%	0.764%	0.776%	0.515%	0.872%	0.833%	0.909%
February Perf	0.40%	-0.078%	-0.119%	0.886%	1.410%	1.320%	0.960%	1.542%	1.658%	1.480%	1.583%	1.152%	1.488%	0.542%	0.519%
March Perf	1.43%	1.250%	1.312%	1.655%	1.629%	1.636%	1.419%	1.366%	1.248%	1.543%	1.467%	1.242%	1.203%	1.150%	1.176%
April Perf	1.57%	1.048%	0.916%	0.492%	0.684%	0.723%	-0.157%	0.006%	0.373%	0.117%	0.279%	-0.017%	0.439%	0.949%	1.253%
May Perf	1.05%	0.296%	0.910%	1.200%	1.399%	1.371%	0.813%	1.172%	1.222%	0.645%	0.694%	0.792%	0.868%	0.820%	0.837%
June Perf	-0.47%	-1.556%	-0.541%	0.130%	0.109%	0.080%	0.335%	0.363%	0.280%	0.243%	0.226%	-0.069%	0.162%	0.476%	0.474%
July Perf	0.87%	0.713%	0.182%	0.683%	0.921%	0.896%	0.535%	0.857%	0.937%	0.407%	0.603%	0.023%	0.283%	0.670%	0.828%
August Perf	-0.86%	-1.138%	-0.938%	-1.057%	-0.863%	-0.668%	-1.171%	-0.800%	-0.537%	-0.341%	-0.335%	-0.380%	-0.531%	-0.413%	-0.315%
September Perf	-0.38%	-0.088%	0.659%	0.461%	0.216%	-0.069%	-0.684%	-0.203%	-0.489%	-0.121%	-0.256%	0.115%	0.077%	0.523%	0.181%
October Perf	1.65%	0.547%	0.694%	1.368%	1.192%	1.185%	0.436%	0.751%	1.090%	1.265%	1.193%	1.714%	1.879%	1.385%	1.231%
November Perf	1.54%	2.154%	1.969%	2.074%	1.997%	1.985%	2.184%	2.179%	1.722%	1.907%	1.902%	1.941%	1.822%	1.763%	1.694%
December Perf	1.69%	1.287%	1.975%	2.329%	2.282%	2.357%	2.291%	2.637%	2.500%	2.594%	2.424%	2.180%	2.107%	2.275%	1.545%

## Appendix 12:

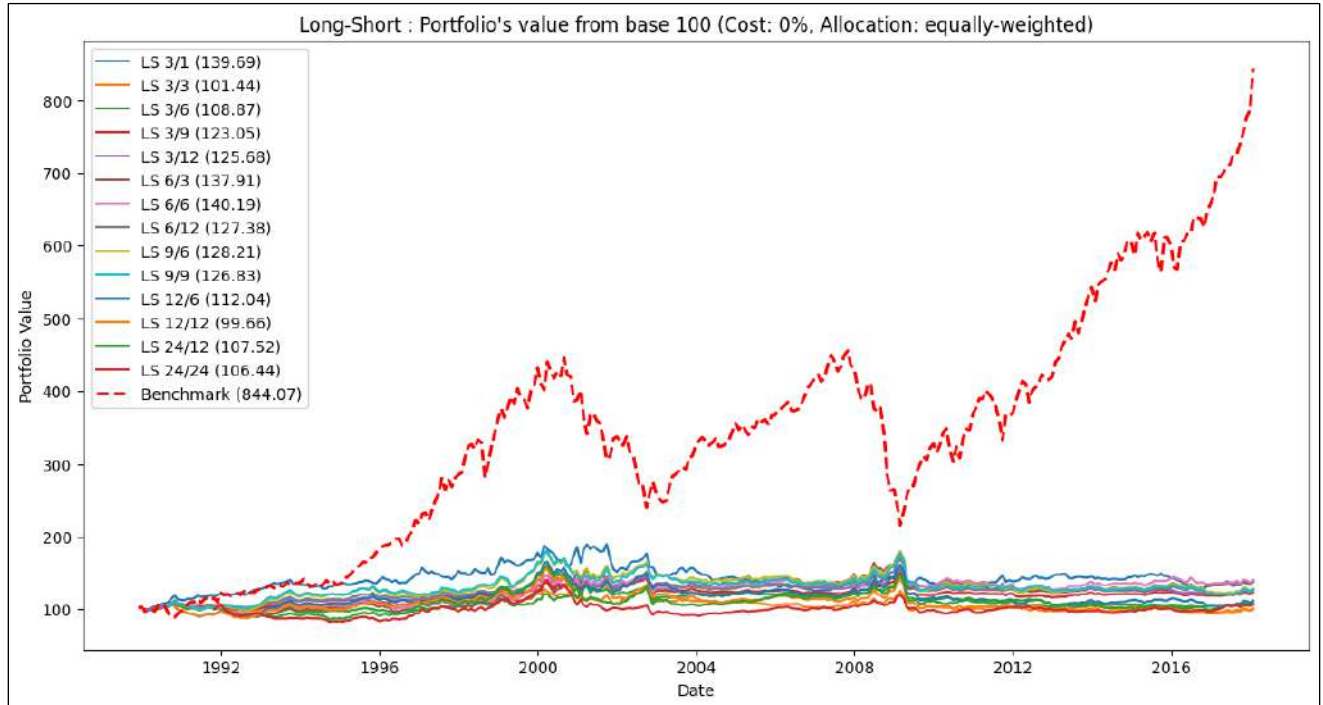
1. Observation period / Holding period in months
2. Top 5 pfs for the Long portfolios
3. Costs = Progressive with a floor at 0.1%
4. Allocation: Increase the recent winners



Info	SPX	L 3/1	L 3/3	L 3/6	L 3/9	L 3/12	L 6/3	L 6/6	L 6/12	L 9/6	L 9/9	L 12/6	L 12/12	L 24/12	L 24/24
Total Return	744.07%	165.60%	539.44%	683.66%	1732.51%	1657.99%	717.15%	1229.16%	1160.63%	522.13%	836.90%	708.69%	1338.49%	1133.59%	1227.33%
Monthly Return	0.72%	0.39%	0.65%	0.76%	0.99%	0.97%	0.73%	0.90%	0.87%	0.67%	0.79%	0.75%	0.93%	0.93%	0.96%
Unadjusted Annual Sharpe	0.61	0.30	0.50	0.50	0.70	0.70	0.57	0.62	0.64	0.48	0.58	0.55	0.67	0.63	0.64
Annual Volatility	14.18%	15.68%	15.72%	18.29%	16.99%	16.84%	15.47%	17.31%	16.20%	16.95%	16.31%	16.40%	16.68%	17.73%	18.04%
Max Drawdown	-52.56%	-72.36%	-62.40%	-65.73%	-55.36%	-48.11%	-45.41%	-60.91%	-56.92%	-72.08%	-67.18%	-66.30%	-57.30%	-60.09%	-62.27%
Average Drawdown	-10.73%	-31.41%	-19.06%	-18.41%	-13.13%	-10.45%	-10.59%	-19.10%	-17.48%	-32.72%	-26.33%	-28.43%	-17.86%	-21.09%	-20.92%
Monthly Beta	-	1.02	1.02	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.02	1.01	1.02	1.01
Average Costs Fees	-	0.56%	0.00%	0.20%	0.12%	0.06%	-0.00%	0.22%	0.06%	0.20%	0.10%	0.21%	0.06%	0.05%	0.03%
Monthly Turnover	-	100.00%	0.30%	30.94%	18.68%	11.37%	0.30%	32.49%	10.98%	30.10%	16.70%	31.30%	10.67%	10.35%	5.61%
January Perf	0.14%	0.322%	0.585%	0.096%	0.392%	0.573%	0.350%	0.534%	0.680%	0.304%	0.335%	-0.275%	-0.074%	1.041%	1.251%
February Perf	0.40%	-0.079%	0.173%	1.126%	1.323%	0.993%	0.606%	1.076%	0.989%	1.023%	1.249%	1.276%	1.253%	0.048%	0.076%
March Perf	1.43%	1.250%	1.500%	1.512%	1.773%	1.639%	1.187%	1.264%	1.055%	1.184%	1.051%	1.040%	0.773%	1.026%	1.189%
April Perf	1.57%	1.048%	1.305%	0.879%	1.029%	1.250%	0.755%	0.454%	1.166%	0.407%	0.540%	0.484%	1.553%	1.525%	1.615%
May Perf	1.05%	0.256%	0.512%	0.934%	1.357%	1.133%	0.958%	1.093%	1.048%	0.462%	0.787%	0.920%	0.750%	0.996%	0.481%
June Perf	-0.47%	-1.555%	-1.297%	0.029%	-0.223%	-0.342%	0.058%	0.162%	-0.329%	-0.211%	-0.211%	-0.134%	-0.096%	-0.078%	-0.130%
July Perf	0.87%	0.713%	0.986%	0.636%	0.775%	0.806%	0.853%	0.843%	0.664%	0.268%	0.467%	0.370%	0.876%	0.851%	0.669%
August Perf	-0.98%	-1.136%	-0.866%	-0.706%	-0.309%	-0.148%	-1.029%	0.024%	-0.078%	-0.526%	-0.398%	-0.479%	-0.165%	-0.041%	-0.192%
September Perf	-0.38%	-0.086%	0.188%	-0.139%	0.382%	0.331%	-0.039%	0.493%	0.538%	-0.304%	0.288%	0.628%	0.668%	0.891%	0.713%
October Perf	1.65%	0.547%	0.813%	0.380%	0.747%	1.076%	0.736%	0.378%	1.074%	1.298%	1.389%	1.261%	1.584%	1.617%	1.286%
November Perf	1.54%	2.154%	2.420%	2.147%	2.406%	2.381%	1.897%	1.997%	1.665%	1.845%	1.785%	1.984%	2.046%	2.037%	2.767%
December Perf	1.69%	1.287%	1.542%	2.197%	2.203%	1.975%	2.447%	2.516%	1.991%	2.319%	2.173%	1.871%	1.919%	1.725%	1.640%

### Appendix 13:

1. Observation period / Holding period in months
2. Top 5 pfs for the Long portfolios, Top 3 for the Short portfolios
3. Costs = 0%
4. Allocation: Equally weighted

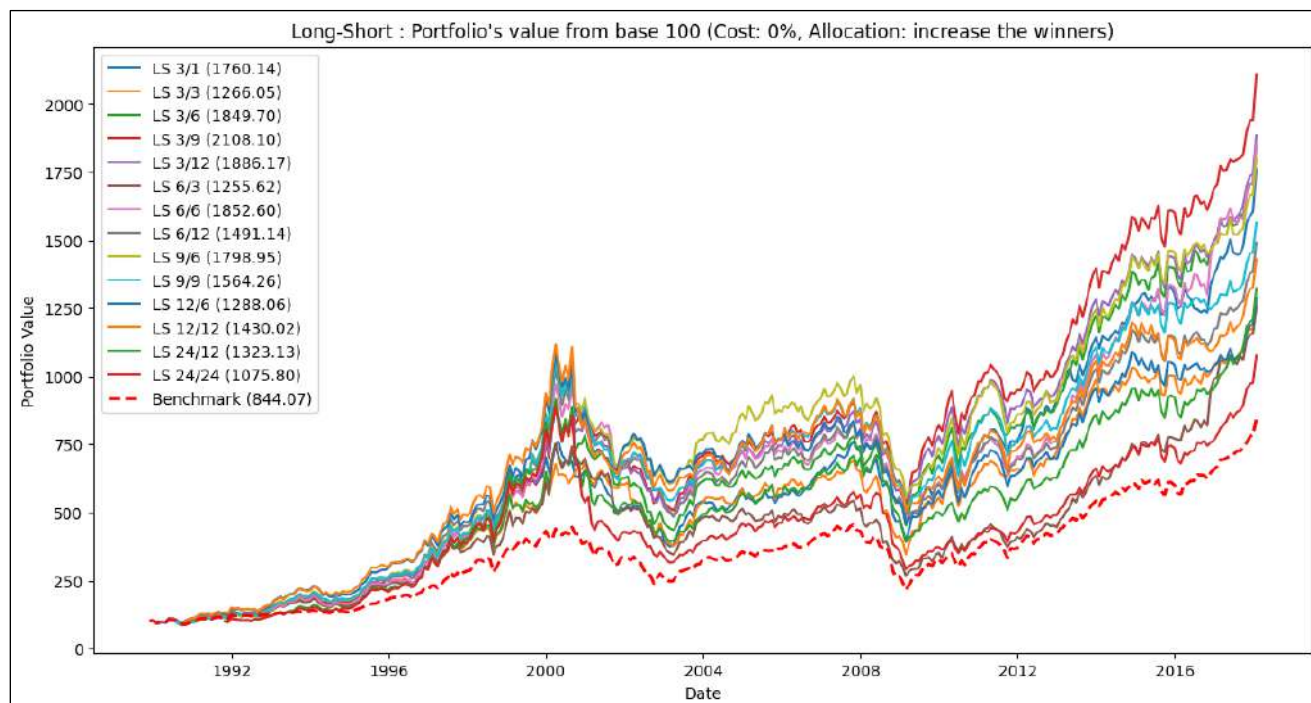


Info	SPX	LS 3/1	LS 3/3	LS 3/6	LS 3/9	LS 3/12	LS 6/3	LS 6/6	LS 6/12	LS 9/6	LS 9/9	LS 12/6	LS 12/12	LS 24/12	LS 24/24
Total Return	744.07%	39.89%	1.44%	8.87%	23.05%	25.68%	37.91%	40.19%	27.38%	28.21%	26.83%	12.04%	-0.34%	7.52%	6.44%
Monthly Return	0.72%	0.13%	0.03%	0.05%	0.08%	0.08%	0.14%	0.14%	0.09%	0.11%	0.10%	0.07%	0.03%	0.06%	0.04%
Unadjusted Annual Sharpe	0.61	0.18	0.05	0.08	0.15	0.18	0.17	0.18	0.16	0.15	0.15	0.09	0.04	0.08	0.07
Annual Volatility	14.18%	9.16%	8.28%	7.30%	6.46%	5.47%	9.84%	8.86%	7.13%	8.92%	8.21%	8.99%	8.15%	8.94%	7.42%
Max Drawdown	-52.56%	-34.05%	-31.31%	-27.67%	-22.89%	-21.76%	-30.29%	-29.27%	-28.32%	-32.20%	-33.34%	-36.84%	-39.32%	-38.17%	-33.98%
Average Drawdown	-10.73%	-16.15%	-15.91%	-12.71%	-10.41%	-9.60%	-14.02%	-12.56%	-13.77%	-18.22%	-17.16%	-19.40%	-20.98%	-22.99%	-21.49%
Monthly Beta	-	1.00	1.00	1.00	1.00	1.00	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
Average Costs Fees	-	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Monthly Turnover	-	100.00%	33.31%	16.68%	11.12%	8.32%	33.33%	16.67%	8.32%	16.66%	11.11%	16.66%	8.33%	8.32%	4.17%
January Perf	0.14%	0.217%	-0.221%	-0.182%	-0.068%	0.110%	-0.105%	0.055%	0.413%	0.239%	0.398%	0.350%	0.440%	0.586%	0.521%
February Perf	0.40%	0.373%	0.340%	0.511%	0.623%	0.475%	0.681%	0.852%	0.753%	0.777%	0.855%	0.847%	0.842%	0.428%	0.147%
March Perf	1.43%	0.132%	0.087%	0.098%	0.084%	0.072%	0.140%	0.053%	-0.175%	-0.054%	-0.239%	-0.239%	-0.458%	-0.373%	-0.230%
April Perf	1.57%	-0.175%	-1.114%	-1.494%	-1.287%	-1.009%	-1.769%	-1.734%	-1.198%	-1.738%	-1.455%	-1.649%	-1.211%	-0.766%	-0.430%
May Perf	1.05%	0.107%	-0.042%	0.077%	0.187%	0.130%	0.119%	0.211%	0.036%	0.058%	0.061%	0.027%	-0.062%	-0.047%	-0.145%
June Perf	-0.47%	-0.184%	0.397%	0.662%	0.637%	0.516%	1.117%	1.001%	0.736%	0.971%	0.863%	0.987%	0.830%	0.595%	0.304%
July Perf	0.87%	-0.295%	0.160%	0.233%	0.243%	0.193%	0.509%	0.428%	0.326%	0.372%	0.386%	0.128%	-0.022%	0.114%	0.058%
August Perf	-0.96%	0.446%	0.221%	0.169%	0.133%	0.080%	0.292%	0.262%	0.056%	0.074%	0.059%	-0.055%	-0.188%	-0.278%	-0.116%
September Perf	-0.38%	0.825%	0.570%	0.408%	0.496%	0.466%	0.483%	0.433%	0.406%	0.432%	0.428%	0.306%	0.218%	0.216%	0.022%
October Perf	1.65%	-1.003%	-0.685%	-0.568%	-0.503%	-0.308%	-0.710%	-0.487%	-0.276%	-0.252%	-0.177%	-0.081%	0.053%	0.083%	0.161%
November Perf	1.54%	0.642%	0.104%	0.132%	-0.022%	-0.127%	0.193%	-0.071%	-0.341%	-0.276%	-0.435%	-0.425%	-0.385%	-0.011%	0.341%
December Perf	1.89%	0.528%	0.589%	0.538%	0.434%	0.365%	0.742%	0.839%	0.408%	0.686%	0.455%	0.606%	0.258%	0.115%	-0.144%



### Appendix 14:

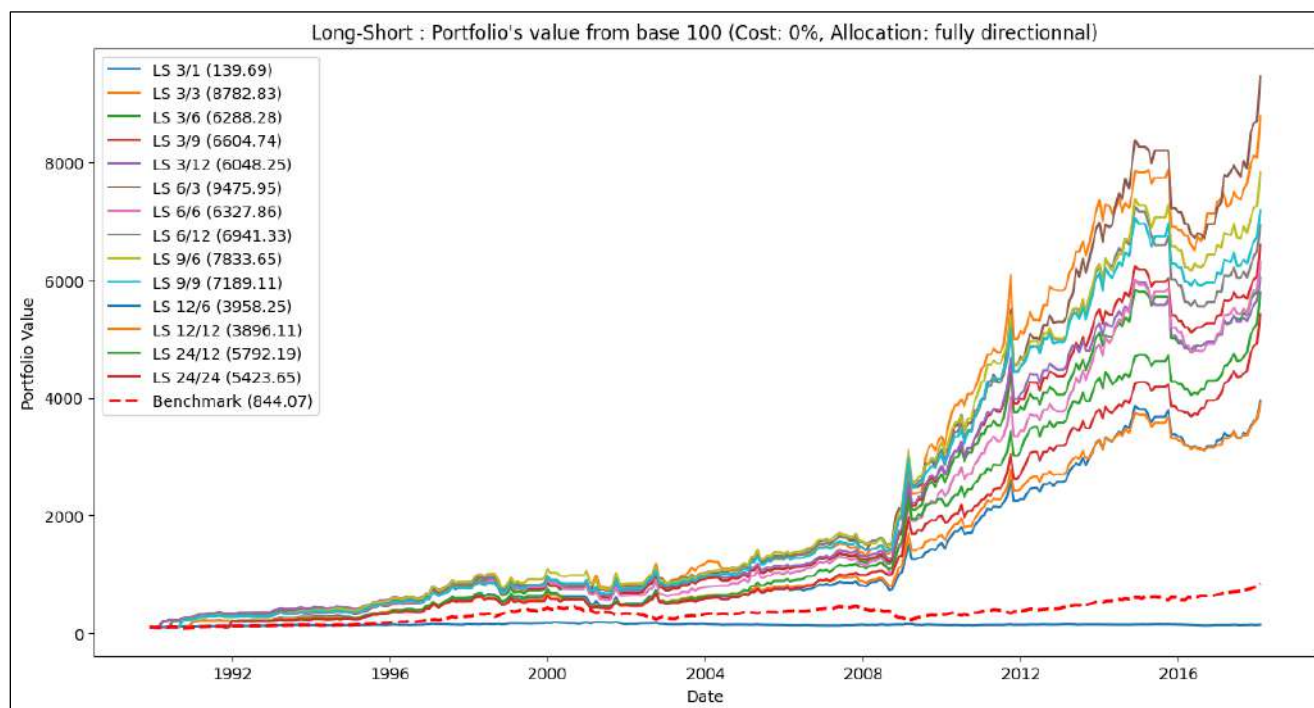
1. Observation period / Holding period in months
2. Top 5 pfs for the Long portfolios, Top 3 for the Short portfolios
3. Costs = 0%
4. Allocation: Increase the winners



Info	SPX	LS 3/1	LS 3/3	LS 3/6	LS 3/9	LS 3/12	LS 6/3	LS 6/6	LS 6/12	LS 9/6	LS 9/9	LS 12/6	LS 12/12	LS 24/12	LS 24/24
Total Return	744.07%	1680.14%	1166.05%	1749.70%	2008.10%	1786.17%	1155.82%	1752.80%	1391.14%	1698.95%	1464.28%	1188.06%	1330.02%	1223.13%	975.80%
Monthly Return	0.72%	0.98%	0.87%	0.98%	1.02%	0.99%	0.89%	1.00%	0.93%	0.99%	0.95%	0.89%	0.93%	0.95%	0.88%
Unadjusted Annual Sharpe	0.61	0.73	0.62	0.72	0.74	0.72	0.60	0.69	0.67	0.72	0.69	0.66	0.68	0.65	0.61
Annual Volatility	14.18%	15.77%	16.76%	16.44%	16.42%	16.37%	17.82%	17.28%	16.66%	16.50%	16.44%	16.08%	16.28%	17.54%	17.45%
Max Drawdown	-52.56%	-50.55%	-49.77%	-44.42%	-42.89%	-44.71%	-64.29%	-52.47%	-54.82%	-47.71%	-51.14%	-57.72%	-54.74%	-57.18%	-67.12%
Average Drawdown	-10.73%	-10.94%	-9.29%	-8.56%	-8.16%	-9.17%	-20.46%	-14.80%	-16.94%	-12.23%	-15.28%	-18.80%	-18.05%	-20.83%	-28.35%
Monthly Beta	-	1.02	1.02	1.02	1.03	1.03	1.03	1.03	1.03	1.04	1.03	1.04	1.03	1.03	1.02
Average Costs Fees	-	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Monthly Turnover	-	100.00%	44.60%	17.27%	11.51%	8.33%	43.58%	18.07%	7.91%	17.31%	11.01%	17.47%	7.68%	7.90%	3.56%
January Perf	0.14%	0.885%	0.172%	0.342%	0.497%	0.488%	0.629%	0.703%	0.674%	0.856%	0.828%	0.603%	0.710%	0.666%	0.917%
February Perf	0.40%	0.475%	0.187%	1.012%	1.457%	1.359%	1.300%	1.679%	1.693%	1.620%	1.642%	1.281%	1.528%	0.583%	0.538%
March Perf	1.43%	1.809%	1.622%	1.783%	1.690%	1.675%	1.678%	1.491%	1.285%	1.695%	1.518%	1.373%	1.227%	1.172%	1.187%
April Perf	1.57%	1.613%	1.167%	0.626%	0.757%	0.756%	0.159%	0.126%	0.406%	0.237%	0.335%	0.094%	0.460%	0.972%	1.264%
May Perf	1.05%	0.818%	1.228%	1.300%	1.472%	1.406%	1.087%	1.290%	1.259%	0.769%	0.769%	0.923%	0.912%	0.853%	0.848%
June Perf	-0.47%	-1.003%	-0.147%	0.251%	0.205%	0.126%	0.612%	0.490%	0.326%	0.369%	0.314%	0.082%	0.191%	0.515%	0.488%
July Perf	0.87%	1.283%	0.495%	0.816%	1.023%	0.959%	0.862%	1.009%	0.990%	0.562%	0.692%	0.180%	0.340%	0.725%	0.845%
August Perf	-0.96%	-0.571%	-0.685%	-0.928%	-0.783%	-0.604%	-0.885%	-0.515%	-0.486%	-0.253%	-0.249%	-0.282%	-0.476%	-0.360%	-0.295%
September Perf	-0.38%	0.486%	0.938%	0.559%	0.292%	0.003%	-0.371%	-0.102%	-0.432%	-0.055%	-0.183%	0.205%	0.149%	0.594%	0.206%
October Perf	1.85%	1.117%	0.990%	1.460%	1.261%	1.265%	0.845%	0.870%	1.162%	1.357%	1.273%	1.816%	1.945%	1.471%	1.254%
November Perf	1.54%	2.732%	2.255%	2.154%	2.049%	2.021%	2.426%	2.268%	1.756%	2.017%	1.949%	2.037%	1.858%	1.802%	1.708%
December Perf	1.69%	1.855%	2.267%	2.419%	2.331%	2.392%	2.597%	2.740%	2.534%	2.689%	2.462%	2.271%	2.147%	2.300%	1.559%

### Appendix 15:

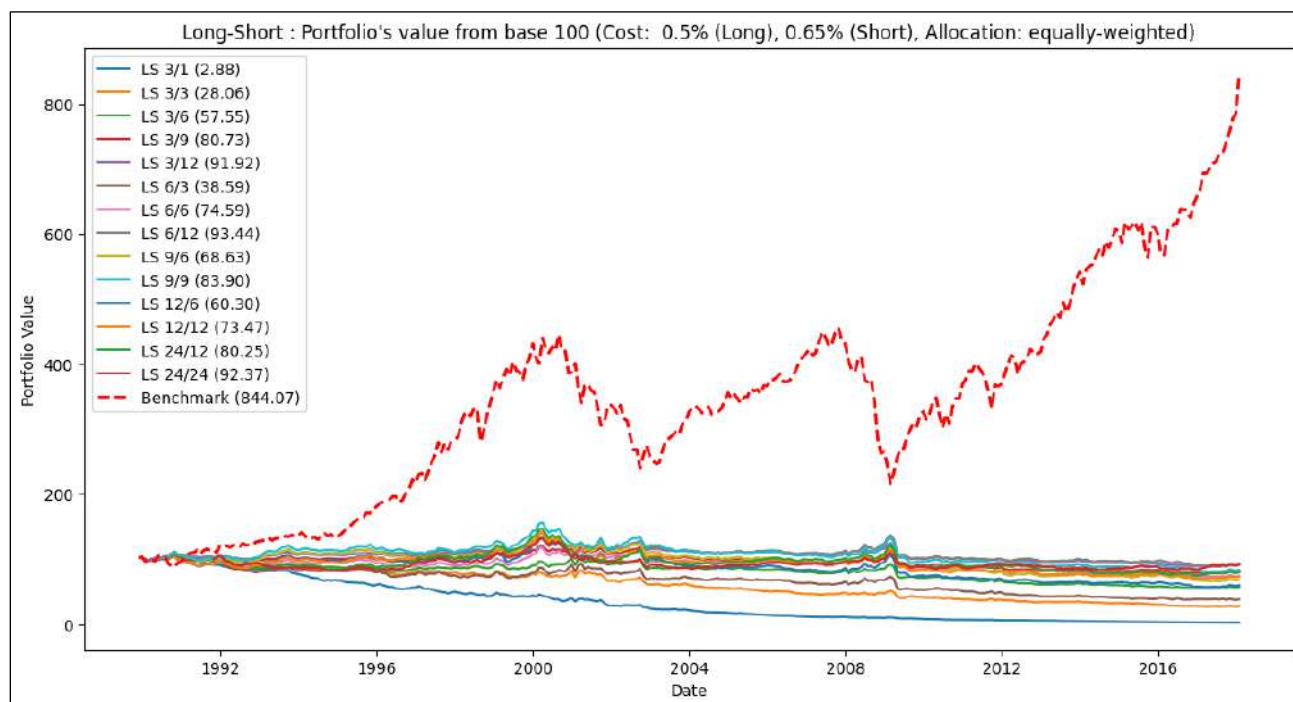
1. Observation period / Holding period in months
2. Top 5 pfs for the Long portfolios, Top 3 for the Short portfolios
3. Costs = 0%
4. Allocation: Fully directional



Info	SPX	LS 3/1	LS 3/3	LS 3/6	LS 3/9	LS 3/12	LS 6/3	LS 6/6	LS 6/12	LS 9/6	LS 9/9	LS 12/6	LS 12/12	LS 24/12	LS 24/24
Total Return	744.07%	39.69%	8682.83%	6188.28%	6504.74%	5948.25%	9375.95%	6227.86%	6841.33%	7733.65%	7089.11%	3858.25%	3796.11%	5682.19%	5323.65%
Monthly Return	0.72%	0.13%	1.60%	1.47%	1.48%	1.45%	1.83%	1.50%	1.50%	1.57%	1.53%	1.36%	1.33%	1.52%	1.49%
Unadjusted Annual Sharpe	0.61	0.18	0.68	0.66	0.67	0.66	0.70	0.66	0.69	0.69	0.69	0.63	0.63	0.69	0.68
Annual Volatility	14.18%	9.19%	28.04%	26.93%	26.77%	26.46%	27.83%	27.39%	25.99%	27.23%	26.74%	25.93%	25.30%	26.59%	26.36%
Max Drawdown	-52.56%	-34.05%	-27.54%	-33.61%	-35.94%	-35.04%	-30.93%	-38.41%	-30.72%	-31.30%	-30.25%	-36.89%	-37.56%	-41.84%	-34.17%
Average Drawdown	-10.73%	-16.15%	-6.11%	-6.71%	-7.02%	-6.93%	-6.31%	-7.71%	-6.32%	-6.17%	-5.91%	-7.50%	-6.76%	-7.13%	-6.01%
Monthly Beta	-	1.00	1.07	1.07	1.06	1.06	1.07	1.06	1.05	1.06	1.05	1.05	1.04	1.03	1.03
Average Costs Fees	-	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Monthly Turnover	-	100.00%	46.67%	19.09%	12.62%	10.25%	45.35%	20.04%	8.91%	19.11%	12.89%	20.03%	9.34%	9.54%	4.87%
January Perf	0.14%	0.217%	1.572%	1.330%	1.585%	1.803%	1.610%	1.735%	1.783%	2.120%	1.949%	1.593%	1.465%	1.950%	2.042%
February Perf	0.40%	0.373%	3.336%	2.131%	2.188%	2.042%	3.162%	2.313%	2.296%	2.006%	2.285%	2.714%	2.695%	1.747%	1.592%
March Perf	1.43%	0.132%	4.717%	4.702%	4.679%	4.688%	1.265%	1.052%	0.768%	0.935%	0.730%	0.565%	0.427%	0.190%	0.310%
April Perf	1.57%	-0.175%	-0.391%	-0.210%	-0.209%	-0.196%	-0.094%	-0.105%	0.141%	-0.249%	-0.175%	0.164%	0.327%	0.887%	0.899%
May Perf	1.05%	0.107%	0.969%	1.148%	1.387%	1.217%	0.645%	0.716%	0.876%	1.220%	0.996%	0.748%	0.554%	0.554%	0.743%
June Perf	-0.47%	-0.184%	0.954%	1.185%	0.946%	0.770%	5.036%	4.902%	4.510%	0.929%	1.057%	1.128%	1.295%	1.040%	0.937%
July Perf	0.87%	-0.295%	1.868%	1.294%	1.362%	1.314%	1.361%	1.516%	1.350%	1.624%	1.453%	1.364%	1.236%	1.782%	1.645%
August Perf	-0.96%	0.446%	1.166%	1.709%	1.480%	1.394%	1.732%	1.189%	1.152%	1.582%	1.440%	0.508%	0.645%	1.193%	1.299%
September Perf	-0.38%	0.825%	2.533%	2.221%	2.353%	2.270%	2.736%	2.560%	2.550%	5.788%	5.727%	1.982%	1.970%	1.791%	1.878%
October Perf	1.65%	-1.003%	-0.979%	-1.033%	-1.272%	-1.073%	-1.009%	-1.181%	-0.771%	-0.964%	-0.806%	-0.940%	-0.803%	-0.331%	-0.451%
November Perf	1.54%	0.842%	1.460%	1.360%	1.603%	1.586%	1.413%	1.501%	1.523%	1.676%	1.728%	1.495%	1.494%	2.085%	1.982%
December Perf	1.69%	0.528%	1.942%	1.849%	1.707%	1.579%	1.762%	1.814%	1.773%	2.011%	1.889%	4.863%	4.650%	5.226%	4.936%

## Appendix 16:

1. Observation period / Holding period in months
2. Top 5 pfs for the Long portfolios, Top 3 for the Short portfolios
3. Costs = 0.5% (Long), 0.65% (Short)%
4. Allocation: Equally weighted

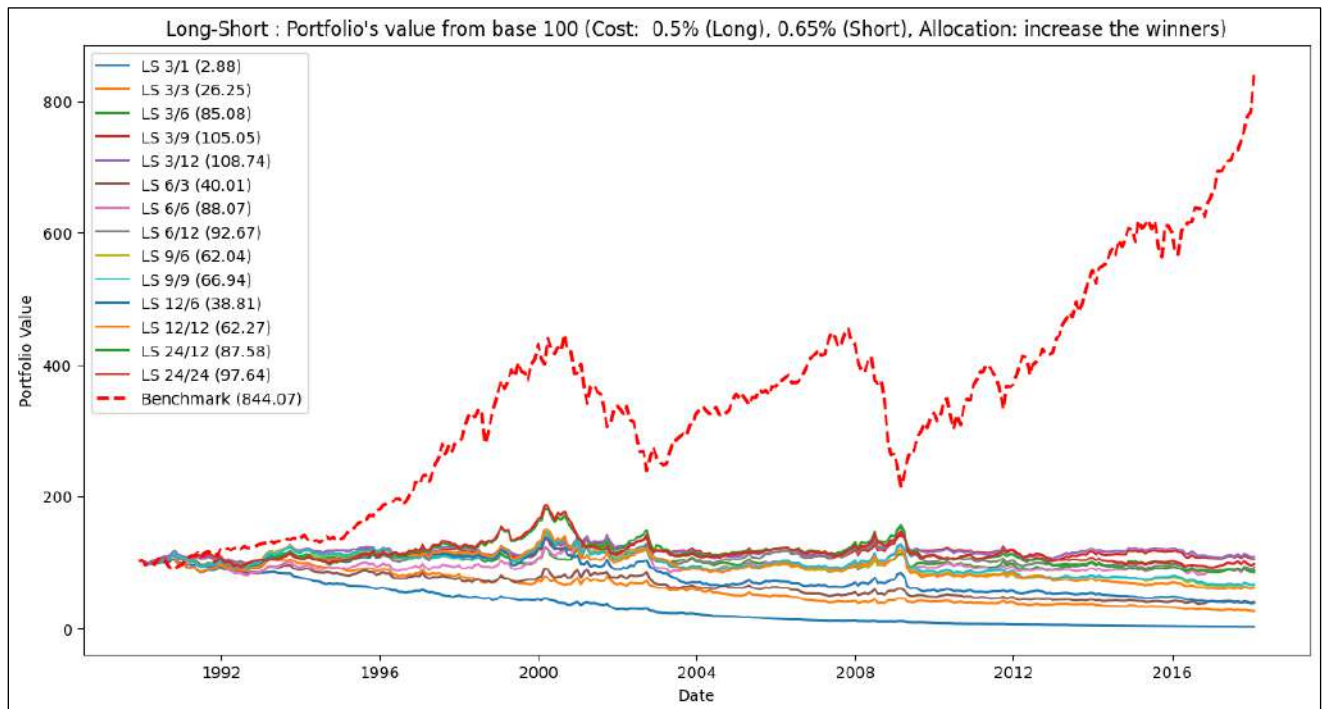


Info	SPX	LS 3/1	LS 3/3	LS 3/6	LS 3/9	LS 3/12	LS 6/3	LS 6/6	LS 6/12	LS 9/6	LS 9/9	LS 12/6	LS 12/12	LS 24/12	LS 24/24
Total Return	744.07%	-97.12%	-71.94%	-42.45%	-19.27%	-8.08%	-61.41%	-25.41%	-6.56%	-31.37%	-16.10%	-39.70%	-26.53%	-19.75%	-7.63%
Monthly Return	0.72%	-1.01%	-0.35%	-0.14%	-0.05%	-0.01%	-0.24%	-0.05%	0.00%	-0.06%	-0.02%	-0.12%	-0.07%	-0.04%	-0.00%
Unadjusted Annual Sharpe	0.61	-1.34	-0.51	-0.23	-0.08	-0.03	-0.30	-0.07	0.00	-0.11	-0.04	-0.16	-0.10	-0.05	-0.00
Annual Volatility	14.18%	9.07%	8.25%	7.29%	6.46%	5.47%	9.81%	8.88%	7.13%	8.91%	8.20%	8.97%	8.15%	8.93%	7.42%
Max Drawdown	-52.56%	-97.34%	-74.36%	-47.16%	-34.84%	-32.20%	-65.67%	-38.27%	-36.91%	-53.64%	-48.70%	-57.18%	-50.06%	-48.98%	-36.35%
Average Drawdown	-10.73%	-67.88%	-42.78%	-23.92%	-16.16%	-13.84%	-38.44%	-19.92%	-17.38%	-25.41%	-23.56%	-28.37%	-25.47%	-27.85%	-24.23%
Monthly Beta	-	1.00	1.00	1.00	1.00	1.00	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
Average Costs Fees	-	1.14%	0.38%	0.19%	0.13%	0.09%	0.38%	0.19%	0.09%	0.19%	0.13%	0.18%	0.09%	0.09%	0.05%
Monthly Turnover	-	100.00%	33.18%	16.60%	11.07%	8.29%	33.20%	16.59%	8.27%	16.58%	11.05%	16.58%	8.29%	8.28%	4.15%
January Perf	0.14%	-0.931%	-0.589%	-0.368%	-0.192%	0.017%	-0.487%	-0.137%	0.320%	0.046%	0.274%	0.165%	0.347%	0.493%	0.476%
February Perf	0.40%	-0.778%	-0.031%	0.325%	0.499%	0.363%	0.275%	0.660%	0.660%	0.584%	0.731%	0.660%	0.749%	0.336%	0.103%
March Perf	1.43%	-1.014%	-0.297%	-0.087%	-0.040%	-0.021%	-0.244%	-0.139%	-0.271%	-0.246%	-0.367%	-0.430%	-0.550%	-0.466%	-0.275%
April Perf	1.57%	-1.317%	-1.491%	-1.678%	-1.410%	-1.103%	-2.132%	-1.916%	-1.290%	-1.927%	-1.581%	-1.838%	-1.304%	-0.859%	-0.476%
May Perf	1.05%	-1.040%	-0.425%	-0.108%	0.063%	0.037%	-0.252%	0.025%	-0.056%	-0.134%	-0.077%	-0.165%	-0.154%	-0.139%	-0.190%
June Perf	-0.47%	-1.330%	0.011%	0.471%	0.514%	0.425%	0.731%	0.616%	0.644%	0.778%	0.734%	0.794%	0.738%	0.503%	0.260%
July Perf	0.87%	-1.435%	-0.223%	0.041%	0.119%	0.101%	0.124%	0.243%	0.233%	0.188%	0.263%	-0.064%	-0.114%	0.022%	0.013%
August Perf	-0.96%	-0.708%	-0.163%	-0.022%	0.010%	-0.011%	-0.093%	0.078%	-0.038%	-0.110%	-0.064%	-0.246%	-0.279%	-0.370%	-0.160%
September Perf	-0.38%	-0.332%	0.187%	0.216%	0.368%	0.374%	0.099%	0.241%	0.315%	0.247%	0.305%	0.114%	0.122%	0.120%	-0.024%
October Perf	1.65%	-2.135%	-1.068%	-0.759%	-0.532%	-0.399%	-1.090%	-0.679%	-0.369%	-0.436%	-0.300%	-0.247%	-0.040%	-0.011%	0.115%
November Perf	1.54%	-0.509%	-0.277%	-0.060%	-0.149%	-0.219%	-0.190%	-0.282%	-0.434%	-0.460%	-0.558%	-0.809%	-0.478%	-0.103%	0.296%
December Perf	1.69%	-0.623%	0.202%	0.346%	0.306%	0.269%	0.357%	0.446%	0.315%	0.493%	0.331%	0.420%	0.165%	0.022%	-0.189%

## Appendix 17:



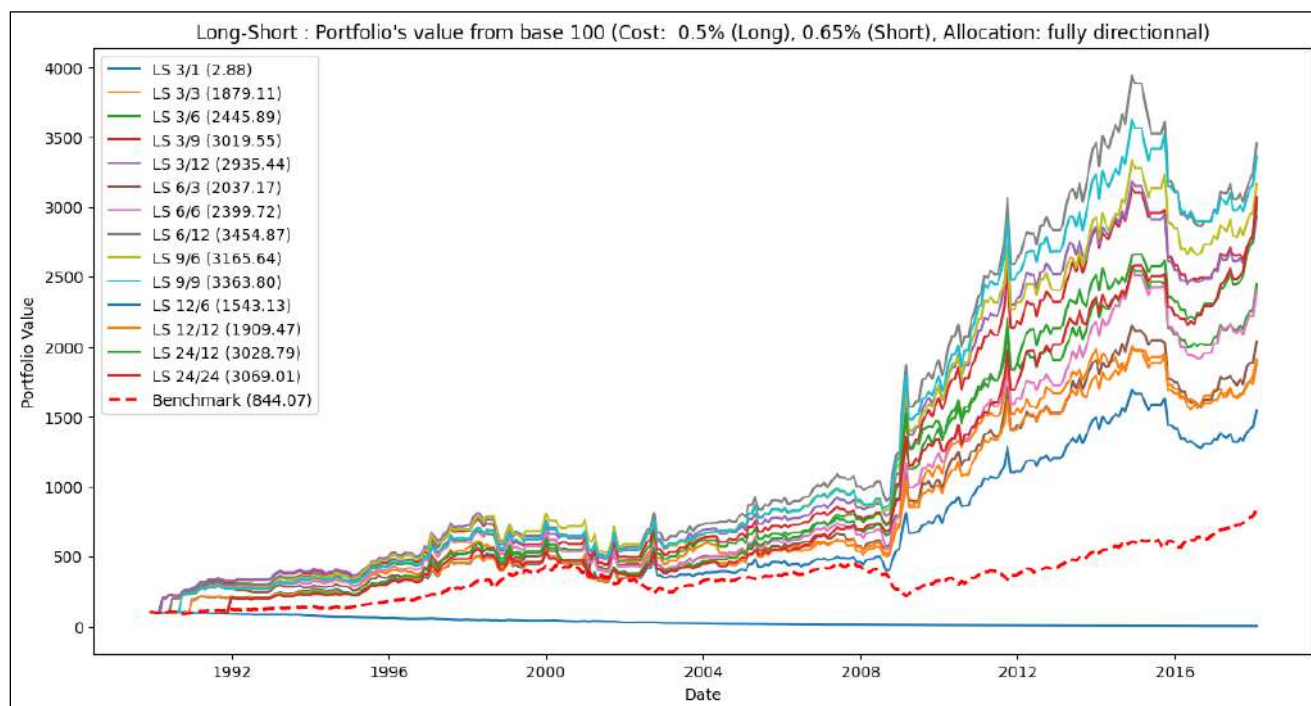
1. Observation period / Holding period in months
2. Top 5 pfs for the Long portfolios, Top 3 for the Short portfolios
3. Costs = 0.5% (Long), 0.65% (Short)%
4. Allocation : Increase the winners



Info	SPX	LS 3/1	LS 3/3	LS 3/6	LS 3/9	LS 3/12	LS 6/3	LS 6/6	LS 6/12	LS 9/6	LS 9/9	LS 12/6	LS 12/12	LS 24/12	LS 24/24
Total Return	744.07%	-97.12%	-73.75%	-14.92%	5.05%	8.74%	-59.89%	-11.93%	-7.33%	-37.98%	-33.06%	-61.19%	-37.73%	-12.42%	-2.36%
Monthly Return	0.72%	-1.01%	-0.34%	0.06%	0.06%	0.07%	-0.22%	0.02%	0.03%	-0.09%	-0.06%	-0.23%	-0.09%	0.01%	0.04%
Unadjusted Annual Sharpe	0.61	-1.34	-0.37	0.00	0.07	0.08	-0.22	0.02	0.03	-0.09	-0.07	-0.24	-0.10	0.01	0.05
Annual Volatility	14.18%	9.07%	11.11%	10.88%	10.70%	10.43%	11.76%	12.19%	11.53%	11.58%	11.52%	11.47%	11.18%	11.16%	10.83%
Max Drawdown	-52.56%	-97.34%	-76.63%	-31.85%	-27.70%	-26.49%	-66.74%	-36.19%	-43.60%	-57.61%	-55.13%	-72.17%	-60.31%	-53.10%	-50.31%
Average Drawdown	-10.73%	-67.86%	-45.04%	-15.71%	-13.09%	-13.44%	-41.37%	-21.10%	-20.34%	-26.08%	-27.41%	-36.89%	-29.77%	-27.53%	-27.76%
Monthly Beta	-	1.00	1.01	1.01	1.02	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02
Average Costs Fees	-	1.14%	0.43%	0.16%	0.10%	0.07%	0.43%	0.17%	0.07%	0.17%	0.10%	0.16%	0.07%	0.07%	0.03%
Monthly Turnover	-	100.00%	38.54%	14.57%	9.34%	6.53%	38.19%	15.32%	6.10%	15.03%	8.87%	14.63%	6.05%	6.54%	2.86%
January Perf	0.14%	-0.931%	-0.662%	-0.241%	-0.021%	0.077%	-0.407%	-0.029%	-0.048%	-0.125%	-0.055%	-0.214%	-0.125%	-0.055%	0.190%
February Perf	0.40%	-0.778%	0.078%	0.879%	0.936%	0.707%	0.457%	0.899%	1.043%	0.496%	0.683%	0.504%	0.728%	0.196%	0.376%
March Perf	1.43%	-1.014%	-0.305%	0.131%	-0.029%	-0.035%	-0.173%	0.008%	-0.381%	-0.246%	-0.590%	-0.292%	-0.417%	-0.597%	-0.567%
April Perf	1.57%	-1.317%	-1.274%	-1.738%	-1.577%	-1.340%	-1.873%	-2.280%	-1.998%	-2.305%	-2.146%	-2.041%	-1.743%	-1.279%	-0.981%
May Perf	1.05%	-1.040%	-0.435%	-0.285%	-0.343%	-0.421%	-0.940%	-0.358%	-0.475%	-0.676%	-0.808%	-0.757%	-0.587%	-0.224%	-0.047%
June Perf	-0.47%	-1.330%	-0.232%	0.625%	0.694%	0.813%	0.844%	1.025%	0.910%	0.893%	0.861%	0.449%	0.615%	0.931%	0.751%
July Perf	0.87%	-1.435%	-0.725%	-0.021%	0.085%	0.043%	-0.211%	0.064%	0.134%	-0.079%	0.051%	-0.803%	-0.623%	0.289%	0.371%
August Perf	-0.96%	-0.708%	-0.190%	0.217%	0.361%	0.216%	0.207%	0.895%	0.498%	0.317%	0.336%	0.129%	0.194%	0.130%	0.273%
September Perf	-0.38%	-0.332%	0.493%	0.460%	0.522%	0.462%	-0.044%	0.453%	0.374%	0.380%	0.419%	0.138%	0.359%	0.706%	0.567%
October Perf	1.85%	-2.135%	-1.186%	-0.755%	-0.725%	-0.780%	-1.114%	-0.861%	-0.532%	-0.440%	-0.448%	-0.369%	-0.143%	-0.556%	-0.577%
November Perf	1.54%	-0.509%	0.210%	0.526%	0.417%	0.431%	0.447%	0.296%	0.135%	0.046%	0.063%	-0.009%	-0.012%	0.300%	0.306%
December Perf	1.89%	-0.623%	0.069%	0.228%	0.430%	0.671%	0.241%	0.428%	0.762%	0.639%	0.795%	0.450%	0.843%	0.289%	-0.142%

## Appendix 18:

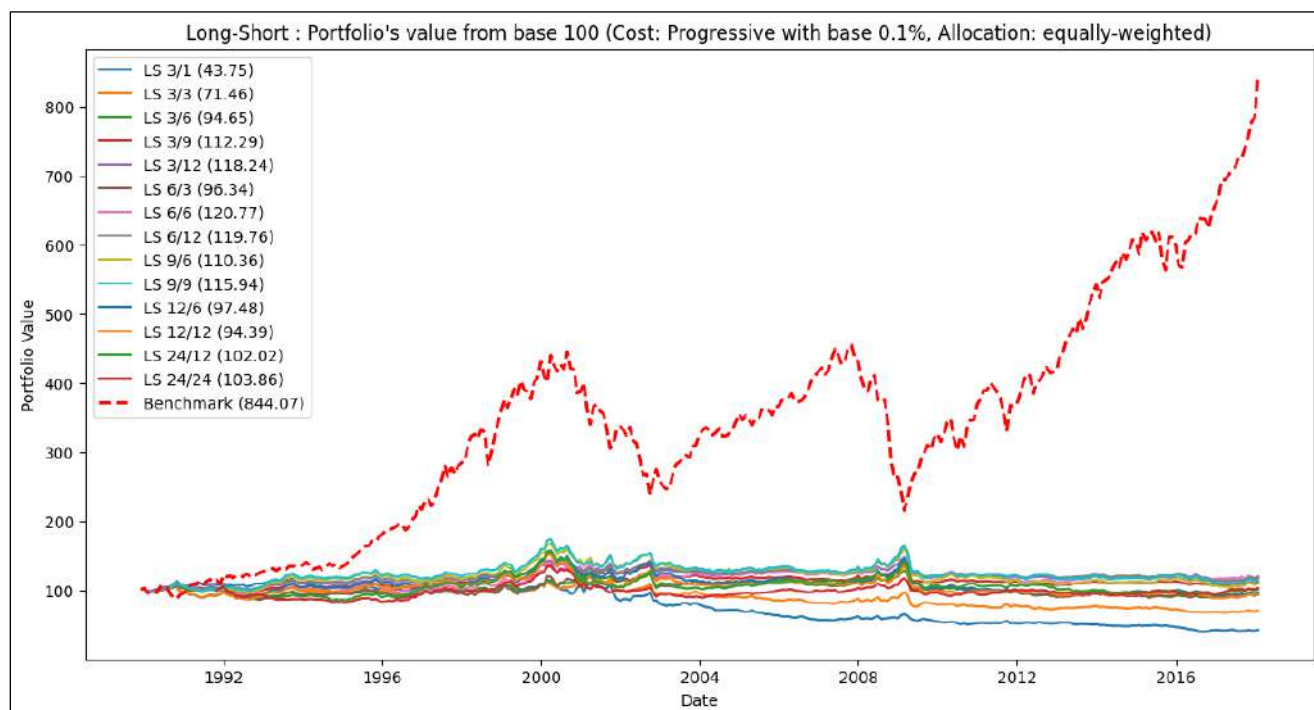
1. Observation period / Holding period in months
2. Top 5 pfs for the Long portfolios, Top 3 for the Short portfolios
3. Costs = 0.5% (Long), 0.65% (Short)
4. Allocation: Fully directional



Info	SPX	LS 3/1	LS 3/3	LS 3/6	LS 3/9	LS 3/12	LS 6/3	LS 6/6	LS 6/12	LS 9/6	LS 9/9	LS 12/6	LS 12/12	LS 24/12	LS 24/24
Total Return	744.07%	-97.12%	1779.11%	2345.89%	2919.55%	2835.44%	1937.17%	2299.72%	3354.87%	3065.64%	3263.80%	1443.13%	1809.47%	2928.79%	2969.01%
Monthly Return	0.72%	-1.01%	1.14%	1.19%	1.25%	1.24%	1.17%	1.21%	1.28%	1.29%	1.30%	1.07%	1.12%	1.32%	1.32%
Unadjusted Annual Sharpe	0.61	-1.34	0.49	0.53	0.56	0.56	0.51	0.53	0.59	0.57	0.58	0.49	0.53	0.59	0.59
Annual Volatility	14.18%	9.07%	28.09%	27.11%	26.97%	26.67%	27.69%	27.40%	26.00%	27.27%	26.79%	26.00%	25.39%	26.85%	26.85%
Max Drawdown	-52.56%	-97.34%	-31.84%	-40.40%	-41.89%	-40.59%	-33.74%	-42.60%	-34.77%	-34.72%	-33.19%	-39.96%	-40.34%	-44.56%	-37.77%
Average Drawdown	-10.73%	-67.86%	-9.77%	-9.38%	-9.65%	-9.21%	-9.42%	-10.85%	-8.02%	-8.54%	-7.65%	-11.22%	-8.85%	-9.08%	-7.56%
Monthly Beta	-	1.00	1.07	1.07	1.06	1.06	1.07	1.06	1.05	1.06	1.05	1.05	1.04	1.03	1.03
Average Costs Fees	-	1.14%	0.50%	0.20%	0.13%	0.11%	0.49%	0.22%	0.10%	0.20%	0.14%	0.22%	0.10%	0.10%	0.05%
Monthly Turnover	-	100.00%	46.47%	19.00%	12.56%	10.20%	45.15%	19.94%	8.87%	19.02%	12.82%	19.93%	9.29%	9.49%	4.85%
January Perf	0.14%	-0.931%	1.057%	1.008%	1.322%	1.543%	1.085%	1.406%	1.547%	1.795%	1.705%	1.280%	1.225%	1.722%	1.835%
February Perf	0.40%	-0.778%	2.868%	1.804%	1.919%	1.791%	2.857%	1.939%	2.062%	1.685%	1.983%	2.386%	2.477%	1.505%	1.385%
March Perf	1.43%	-1.014%	4.237%	4.439%	4.466%	4.510%	0.798%	0.792%	0.590%	0.680%	0.522%	0.261%	0.240%	0.012%	0.159%
April Perf	1.57%	-1.317%	-0.826%	-0.491%	-0.481%	-0.438%	-0.574%	-0.412%	-0.102%	-0.594%	-0.446%	-0.126%	0.053%	0.667%	0.696%
May Perf	1.05%	-1.040%	0.532%	0.855%	1.142%	0.974%	0.139%	0.394%	0.640%	0.932%	0.731%	0.405%	0.322%	0.331%	0.565%
June Perf	-0.47%	-1.330%	0.487%	0.925%	0.722%	0.574%	4.540%	4.604%	4.273%	0.705%	0.846%	0.862%	1.102%	0.845%	0.755%
July Perf	0.87%	-1.435%	1.394%	1.064%	1.173%	1.150%	0.908%	1.276%	1.184%	1.401%	1.263%	1.139%	1.087%	1.633%	1.516%
August Perf	-0.96%	-0.708%	0.651%	1.422%	1.245%	1.182%	1.301%	0.892%	0.927%	1.311%	1.209%	0.204%	0.408%	0.971%	1.111%
September Perf	-0.38%	-0.332%	2.050%	1.895%	2.138%	2.038%	2.273%	2.292%	2.354%	5.503%	5.477%	1.716%	1.736%	1.549%	1.675%
October Perf	1.65%	-2.135%	-1.436%	-1.323%	-1.550%	-1.303%	-1.465%	-1.495%	-1.006%	-1.246%	-1.058%	-1.231%	-1.035%	-0.543%	-0.636%
November Perf	1.54%	-0.509%	1.194%	1.208%	1.469%	1.469%	1.147%	1.329%	1.414%	1.522%	1.613%	1.313%	1.395%	1.984%	1.897%
December Perf	1.69%	-0.623%	1.427%	1.538%	1.468%	1.369%	1.233%	1.507%	1.568%	1.718%	1.640%	4.522%	4.373%	5.015%	4.741%

## Appendix 19:

1. Observation period / Holding period in months
2. Top 5 pfs for the Long portfolios, Top 3 for the Short portfolios
3. Costs = Progressive with a floor at 0.1%
4. Allocation: Equally weighted

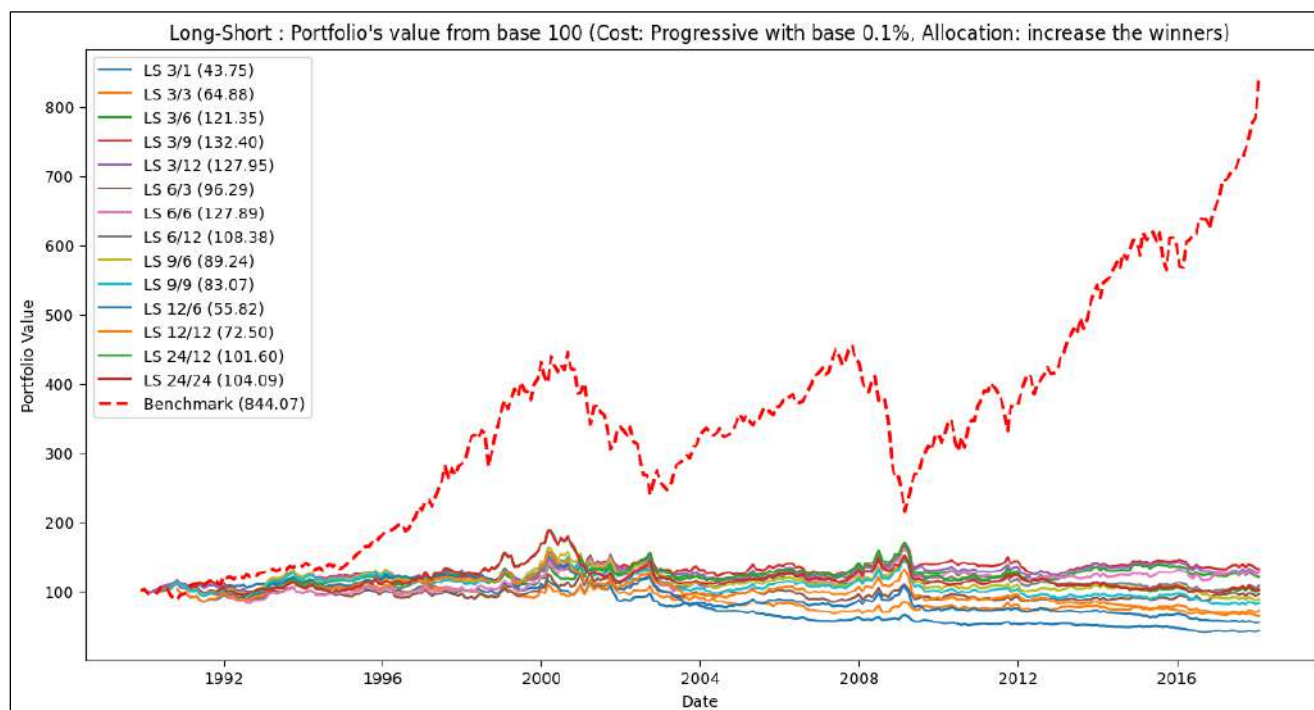


Info	SPX	LS 3/1	LS 3/3	LS 3/6	LS 3/9	LS 3/12	LS 6/3	LS 6/6	LS 6/12	LS 9/6	LS 9/9	LS 12/6	LS 12/12	LS 24/12	LS 24/24
Total Return	744.07%	-56.25%	-28.54%	-5.35%	12.29%	18.24%	-3.86%	20.77%	19.76%	10.36%	15.94%	-2.52%	-5.61%	2.02%	3.86%
Monthly Return	0.72%	-0.21%	-0.07%	0.01%	0.05%	0.06%	0.03%	0.09%	0.08%	0.06%	0.07%	0.03%	0.01%	0.04%	0.04%
Unadjusted Annual Sharpe	0.61	-0.28	-0.10	0.01	0.10	0.14	0.04	0.12	0.13	0.09	0.11	0.04	0.02	0.05	0.06
Annual Volatility	14.18%	9.14%	8.27%	7.30%	6.48%	5.47%	9.83%	8.88%	7.12%	8.92%	8.21%	8.98%	8.15%	8.94%	7.42%
Max Drawdown	-62.56%	-64.84%	-43.56%	-30.07%	-23.67%	-23.16%	-34.67%	-30.76%	-29.57%	-37.48%	-37.03%	-41.97%	-41.39%	-40.25%	-34.23%
Average Drawdown	-10.73%	-31.99%	-21.46%	-14.17%	-11.14%	-10.21%	-16.01%	-14.03%	-14.34%	-18.47%	-16.63%	-21.63%	-21.63%	-23.90%	-21.96%
Monthly Beta	-	1.00	1.00	1.00	1.00	1.00	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
Average Costs Fees	-	0.34%	0.10%	0.04%	0.03%	0.02%	0.11%	0.05%	0.02%	0.05%	0.03%	0.04%	0.02%	0.02%	0.01%
Monthly Turnover	-	100.00%	33.26%	16.66%	11.11%	8.31%	33.27%	16.64%	8.31%	16.64%	11.09%	16.63%	8.32%	8.31%	4.17%
January Perf	0.14%	-0.126%	-0.321%	-0.223%	-0.094%	0.092%	-0.213%	0.009%	0.394%	0.192%	0.371%	0.308%	0.423%	0.569%	0.514%
February Perf	0.40%	0.023%	0.238%	0.470%	0.596%	0.457%	0.552%	0.806%	0.734%	0.731%	0.828%	0.804%	0.825%	0.411%	0.139%
March Perf	1.43%	-0.215%	-0.018%	0.057%	0.057%	0.054%	0.031%	0.008%	-0.194%	-0.100%	-0.267%	-0.282%	-0.474%	-0.390%	-0.237%
April Perf	1.57%	-0.518%	-1.217%	-1.535%	-1.314%	-1.027%	-1.872%	-1.776%	-1.216%	-1.783%	-1.482%	-1.691%	-1.228%	-0.782%	-0.438%
May Perf	1.05%	-0.239%	-0.146%	0.037%	0.160%	0.112%	0.014%	0.167%	0.018%	0.012%	0.023%	-0.015%	-0.078%	-0.063%	-0.153%
June Perf	-0.47%	-0.530%	0.291%	0.620%	0.610%	0.498%	1.008%	0.957%	0.718%	0.925%	0.835%	0.943%	0.814%	0.579%	0.296%
July Perf	0.87%	-0.636%	0.056%	0.190%	0.216%	0.175%	0.401%	0.384%	0.307%	0.328%	0.359%	0.085%	-0.038%	0.097%	0.050%
August Perf	-0.96%	0.103%	0.116%	0.127%	0.106%	0.062%	0.183%	0.219%	0.037%	0.029%	0.032%	-0.098%	-0.204%	-0.295%	-0.124%
September Perf	-0.38%	0.478%	0.465%	0.366%	0.468%	0.448%	0.375%	0.388%	0.388%	0.387%	0.401%	0.263%	0.201%	0.198%	0.014%
October Perf	1.65%	-1.342%	-0.789%	-0.610%	-0.531%	-0.324%	-0.817%	-0.532%	-0.294%	-0.296%	-0.203%	-0.103%	0.036%	0.066%	0.153%
November Perf	1.54%	0.298%	0.000%	0.089%	-0.049%	-0.145%	0.085%	-0.116%	-0.360%	-0.320%	-0.461%	-0.466%	-0.402%	-0.028%	0.333%
December Perf	1.69%	0.181%	0.483%	0.497%	0.407%	0.347%	0.634%	0.593%	0.389%	0.640%	0.428%	0.564%	0.242%	0.099%	-0.152%

## Appendix 20:



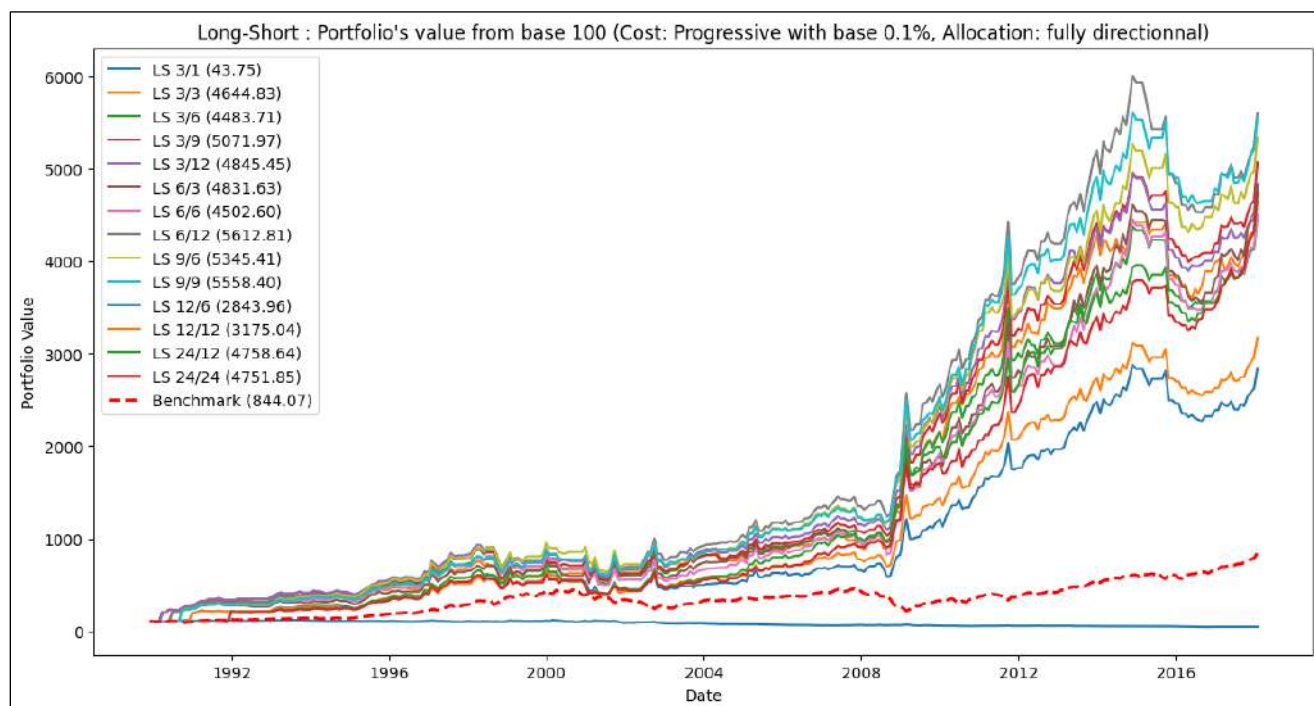
1. Observation period / Holding period in months
2. Top 5 pfs for the Long portfolios, Top 3 for the Short portfolios
3. Costs = Progressive with a floor at 0.1%
4. Allocation: Increase the winners



Info	SPX	LS 3/1	LS 3/3	LS 3/6	LS 3/9	LS 3/12	LS 6/3	LS 6/6	LS 6/12	LS 9/6	LS 9/9	LS 12/6	LS 12/12	LS 24/12	LS 24/24
Total Return	744.07%	-56.25%	-35.12%	21.35%	32.40%	27.95%	-3.71%	27.89%	8.38%	-10.76%	-16.93%	-44.18%	-27.50%	1.80%	4.06%
Monthly Return	0.72%	-0.21%	-0.08%	0.11%	0.13%	0.12%	0.05%	0.14%	0.08%	0.02%	0.00%	-0.12%	-0.04%	0.06%	0.06%
Unadjusted Annual Sharpe	0.61	-0.28	-0.08	0.12	0.15	0.14	0.05	0.13	0.08	0.02	0.00	-0.13	-0.05	0.06	0.07
Annual Volatility	14.18%	9.14%	11.07%	10.92%	10.71%	10.43%	11.74%	12.23%	11.51%	11.63%	11.52%	11.52%	11.18%	11.15%	10.84%
Max Drawdown	-52.56%	-64.84%	-44.64%	-26.89%	-25.36%	-24.20%	-32.69%	-32.38%	-41.05%	-46.72%	-48.78%	-64.73%	-56.00%	-47.73%	-47.78%
Average Drawdown	-10.73%	-31.96%	-23.16%	-10.88%	-10.97%	-11.81%	-19.69%	-18.46%	-18.83%	-22.59%	-24.32%	-32.82%	-27.66%	-25.20%	-26.65%
Monthly Beta	-	1.00	1.01	1.01	1.02	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02
Average Costs Fees	-	0.34%	0.17%	0.06%	0.03%	0.02%	0.17%	0.06%	0.02%	0.06%	0.03%	0.05%	0.02%	0.02%	0.01%
Monthly Turnover	-	100.00%	38.57%	14.61%	9.38%	6.55%	38.22%	15.36%	6.12%	15.08%	8.70%	14.68%	6.07%	6.57%	2.90%
January Perf	0.14%	-0.126%	-0.389%	-0.142%	0.043%	0.112%	-0.154%	0.066%	0.000%	-0.023%	-0.002%	-0.106%	-0.084%	-0.020%	0.204%
February Perf	0.40%	0.023%	0.357%	0.972%	1.006%	0.768%	0.749%	1.031%	1.088%	0.618%	0.760%	0.620%	0.768%	0.228%	0.391%
March Perf	1.43%	-0.215%	-0.002%	0.241%	0.036%	0.013%	0.087%	0.112%	-0.330%	-0.143%	-0.505%	-0.199%	-0.378%	-0.557%	-0.538%
April Perf	1.57%	-0.518%	-1.044%	-1.641%	-1.509%	-1.286%	-1.617%	-2.188%	-1.951%	-2.196%	-2.077%	-1.940%	-1.685%	-1.224%	-0.958%
May Perf	1.05%	-0.239%	-0.202%	-0.188%	-0.271%	-0.368%	-0.690%	-0.247%	-0.414%	-0.563%	-0.731%	-0.643%	-0.545%	-0.149%	-0.013%
June Perf	-0.47%	-0.530%	0.040%	0.749%	0.771%	0.859%	1.068%	1.145%	0.961%	1.013%	0.935%	0.559%	0.656%	0.972%	0.785%
July Perf	0.87%	-0.636%	-0.448%	0.090%	0.160%	0.091%	0.063%	0.178%	0.177%	0.017%	0.110%	-0.693%	-0.582%	0.329%	0.391%
August Perf	-0.96%	0.103%	0.082%	0.326%	0.416%	0.263%	0.469%	0.786%	0.643%	0.413%	0.395%	0.247%	0.242%	0.176%	0.291%
September Perf	-0.38%	0.478%	0.753%	0.569%	0.588%	0.511%	0.238%	0.547%	0.419%	0.464%	0.473%	0.240%	0.419%	0.750%	0.581%
October Perf	1.65%	-1.342%	-0.690%	-0.640%	-0.664%	-0.728%	-0.850%	-0.738%	-0.480%	-0.333%	-0.387%	-0.280%	-0.094%	-0.486%	-0.556%
November Perf	1.54%	0.298%	0.469%	0.635%	0.491%	0.475%	0.703%	0.426%	0.173%	0.196%	0.125%	0.128%	0.030%	0.343%	0.327%
December Perf	1.69%	0.181%	0.358%	0.325%	0.506%	0.714%	0.498%	0.556%	0.798%	0.763%	0.849%	0.562%	0.687%	0.331%	-0.124%

## Appendix 21:

1. Observation period / Holding period in months
2. Top 5 pfs for the Long portfolios, Top 3 for the Short portfolios
3. Costs = Progressive with a floor at 0.1%
4. Allocation: Fully directional



Info	SPX	LS 3/1	LS 3/3	LS 3/6	LS 3/9	LS 3/12	LS 6/3	LS 6/6	LS 6/12	LS 9/6	LS 9/9	LS 12/6	LS 12/12	LS 24/12	LS 24/24
Total Return	744.07%	-56.25%	4544.83%	4383.71%	4971.97%	4745.45%	4731.63%	4402.60%	5512.81%	5245.41%	5458.40%	2743.96%	3075.04%	4658.64%	4651.85%
Monthly Return	0.72%	-0.21%	1.41%	1.37%	1.41%	1.39%	1.43%	1.40%	1.43%	1.45%	1.45%	1.25%	1.27%	1.46%	1.45%
Unadjusted Annual Sharpe	0.61	-0.28	0.60	0.61	0.63	0.63	0.62	0.61	0.66	0.64	0.65	0.56	0.60	0.65	0.66
Annual Volatility	14.18%	9.14%	28.08%	27.06%	26.91%	26.59%	27.76%	27.42%	26.01%	27.29%	26.78%	25.98%	25.34%	26.74%	26.50%
Max Drawdown	-62.56%	-64.84%	-26.51%	-36.30%	-38.34%	-37.12%	-32.18%	-39.63%	-31.73%	-33.00%	-31.45%	-38.21%	-38.65%	-42.91%	-34.97%
Average Drawdown	-10.73%	-31.99%	-7.33%	-7.68%	-7.81%	-7.59%	-7.57%	-8.63%	-6.82%	-7.06%	-6.52%	-8.53%	-7.27%	-7.74%	-6.29%
Monthly Beta	-	1.00	1.07	1.07	1.06	1.06	1.07	1.06	1.05	1.06	1.05	1.05	1.04	1.03	1.03
Average Costs Fees	-	0.34%	0.21%	0.07%	0.04%	0.04%	0.21%	0.08%	0.03%	0.09%	0.05%	0.08%	0.03%	0.03%	0.01%
Monthly Turnover	-	100.00%	46.56%	19.05%	12.60%	10.23%	45.24%	20.00%	8.90%	19.07%	12.86%	19.99%	9.32%	9.52%	4.87%
January Perf	0.14%	-0.128%	1.368%	1.217%	1.496%	1.720%	1.376%	1.616%	1.709%	1.961%	1.875%	1.487%	1.398%	1.872%	1.987%
February Perf	0.40%	0.023%	3.136%	2.019%	2.107%	1.978%	2.932%	2.181%	2.240%	1.872%	2.176%	2.605%	2.649%	1.684%	1.547%
March Perf	1.43%	-0.215%	4.530%	4.619%	4.607%	4.639%	1.060%	0.961%	0.709%	0.830%	0.684%	0.489%	0.367%	0.131%	0.263%
April Perf	1.57%	-0.518%	-0.583%	-0.323%	-0.303%	-0.277%	-0.315%	-0.225%	0.060%	-0.412%	-0.278%	0.049%	0.228%	0.831%	0.856%
May Perf	1.05%	-0.239%	0.788%	1.050%	1.322%	1.150%	0.430%	0.602%	0.798%	1.096%	0.903%	0.621%	0.490%	0.474%	0.695%
June Perf	-0.47%	-0.530%	0.747%	1.096%	0.870%	0.715%	4.815%	4.808%	4.441%	0.838%	0.993%	1.043%	1.253%	0.994%	0.904%
July Perf	0.87%	-0.636%	1.681%	1.212%	1.302%	1.267%	1.170%	1.431%	1.299%	1.532%	1.389%	1.291%	1.188%	1.744%	1.624%
August Perf	-0.96%	0.103%	0.956%	1.607%	1.398%	1.327%	1.542%	1.086%	1.088%	1.468%	1.384%	0.403%	0.574%	1.124%	1.264%
September Perf	-0.38%	0.478%	2.328%	2.099%	2.290%	2.199%	2.536%	2.473%	2.498%	5.680%	5.651%	1.890%	1.904%	1.712%	1.833%
October Perf	1.65%	-1.342%	-1.161%	-1.145%	-1.386%	-1.155%	-1.197%	-1.292%	-0.851%	-1.088%	-0.906%	-1.053%	-0.873%	-0.401%	-0.497%
November Perf	1.54%	0.298%	1.355%	1.309%	1.560%	1.553%	1.296%	1.442%	1.489%	1.619%	1.689%	1.431%	1.469%	2.059%	1.962%
December Perf	1.69%	0.181%	1.732%	1.738%	1.629%	1.516%	1.524%	1.708%	1.712%	1.883%	1.789%	4.749%	4.569%	5.170%	4.894%