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The Short of it: Factor Momentum*

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Abstract

This thesis studies factor momentum among different factor constructions. I find that factor momentum strategies applied to zero-investment cost factors, constructed from the short legs of the factors with an offsetting position in a size adjusted market portfolio, result in Sharpe ratios higher than factor momentum strategies that use traditional long-short factor constructions. The effect of sentiment on factor momentum strategies differs by factor construction, factor momentum form and formation period. Furthermore, I show that factor momentum strategies that buy long leg winning factors and sell short leg losing factors outperform other factor momentum strategies.

JEL classification: G11; G12

Keywords: Factors; Anomalies; Momentum; Legs

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Contents

1	Introduction	1
2	Literature review	2
2.1	Momentum	2
2.2	Factor momentum	4
2.3	Sentiment	6
2.4	Short sale constraints and sentiment	6
3	Data	8
4	Methodology	9
4.1	Factor construction	9
4.2	Cross-sectional factor momentum	12
4.3	Time-series factor momentum	13
4.4	Regressions	15
5	Results	16
5.1	Autocorrelation	16
5.2	Factor momentum strategies	17
5.3	Sentiment	23
6	Robustness	29
6.1	Formation period	29
6.2	Factor set	32
7	Conclusion	35
	References	37
	Appendix	41

1 Introduction

Jegadeesh and Titman (1993) found that a strategy that buys the best performing stocks and sells the worst performing stocks, continues to earn high returns in subsequent periods. This pattern became known as the momentum effect and is one of the most robust anomalies in the financial literature. It has been found across a wide range of asset classes and appears in different forms. This poses a challenge for the weak form of the efficient market hypothesis, since past price information should not predict future returns.

Recent literature documented that a momentum effect exists among factors, past factor returns predict future factor returns. Arnott et al. (2019) argue that industry momentum is a by-product of factor momentum. Ehsani and Linnainmaa (2019) even argue that momentum in individual stocks stems from momentum in factor returns and Gupta and Kelly (2019) show that factor momentum is a global phenomenon.

Several studies find that the short legs of the factors are the main source of factor returns, possibly caused by short sale constraints (Avramov et al., 2017; Stambaugh et al., 2012). Short sale constraints prevent rational arbitrageurs from trading away overpricing, which is more prevalent in factors' short legs (Stambaugh et al., 2012).

How factor momentum strategies will be affected by the asymmetric behavior of long and short legs remains a question. In this paper, I investigate the profitability of factor momentum strategies for the long legs, short legs and long-short spreads.

If short sale constraints prevent rational arbitrageurs from correcting overpricing, I expect overpricing to build up over time, resulting in a higher autocorrelation in overpriced stocks. Because overpricing is more prevalent in the factors' short legs, I expect a stronger return autocorrelation in factors' short legs. I combine the expectation of stronger autocorrelation in factor's short legs with the finding that autocorrelation is the main driver of factor momentum (Ehsani & Linnainmaa, 2019). Following that reasoning, I hypothesize that factor momentum will be more profitable for the short legs of the factors.

Then I combine the idea of a stronger return autocorrelation when overpricing is stronger with the finding of Stambaugh et al. (2012) that overpricing is more prevalent following high sentiment. Following this reasoning, I hypothesize that factor momentum is more profitable

following high sentiment periods.

I construct long-short factors using the traditional approach, and zero-investment cost long (short) factors from the long (short) legs of the factors and an opposite position in a size adjusted market portfolio, following a similar approach as recent work from Blitz et al. (2020). Consistent with my first hypothesis, I find that the Sharpe ratios of cross-sectional and time-series factor momentum strategies are highest for the short factors. Following the return decomposition framework of Lewellen (2002), Lo and MacKinlay (1990), and Moskowitz et al. (2012) I find that autocorrelation is the main driver of the high factor momentum returns of the short factors. The evidence for my second hypothesis is mixed. Factor momentum strategies using the long-short and long factors earn lower or equal returns following high sentiment. For the short factors there is weak evidence that returns are higher following high sentiment when the formation period is twelve months, but this does not hold for a formation period of one month.

Furthermore, I propose a zero-investment cost strategy that takes a long position in the long leg winners and a short position in the short leg losers. This strategy has a Sharpe ratio of up to 1.06, the highest of this study. The remainder of this paper is organized as follows. Section 2 gives an overview of the relevant literature. Section 3 and section 4 cover the data and methodology. Section 5 and section 6 report the results and the robustness of the results. Finally, section 7 concludes.

2 Literature review

2.1 Momentum

The seminal work of Jegadeesh and Titman (1993) presented the momentum factor in its most well known form. They construct a cross-sectional momentum strategy that takes long positions in the best performing stocks and short positions in the worst performing stocks. This strategy yields a return of up to 1.49% per month, is robust for a wide range of formation and holding periods ranging from three to twelve months and cannot be explained by systematic risk factors. Explanations for a momentum effect trace to two main groups,

behavioral explanations and rational explanations.

Behavioral explanations are provided in different forms. Barberis et al. (1998), argue that investors initially underreact to positive news such as earnings announcement. This is called conservatism bias, the tendency that people tend to react slowly to new news. If then a company has a series of good positive earnings announcement, by the so-called representativeness bias, people tend to extrapolate this and form overoptimistic expectations, causing the prices to overreact.

The self attribution bias of Daniel et al. (1998) suggests that overconfident investors react asymmetric to public information. The investors reacts positive to public information that confirms their beliefs, and neglects public information that weakens their beliefs. This behaviour results in momentum, followed by a correction when the overconfident investors realize their initial beliefs were overoptimistic.

Hong and Stein (1999) develop a model with two types of traders. Newswatchers and momentum traders. Private news obtained by newswatchers diffuses slowly into the prices, which generates momentum. Then, momentum traders trade on this momentum effect, preserving the momentum. The momentum traders continue buying after the stock reaches its fundamental value, resulting in overpricing, which is later reversed.

Next to the behavioral explanations discussed above there are rational explanations. Berk et al. (1999) argue that momentum can be caused by firms' time-varying systematic risks. Conrad and Kaul (1998) argue that the momentum effect reflects stocks' average returns. Moskowitz and Grinblatt (1999) argue that the momentum effect is caused by industry momentum. Other papers suggest that it are firm-specific characteristics such as dividend growth rates (Johnson, 2002) or revenues, costs, growth options and shutdown options (Sagi & Seasholes, 2007) that drive momentum. There is debate of whether momentum is profitable after transaction costs. Lesmond et al. (2004) argue that the stocks that profit most from momentum, are the ones with the highest trading costs. Once taking this into account, momentum's profitability vanishes.

Despite the many attempts to explain the momentum effect, Novy-Marx (2012) shows that none of the above mentioned explanations can explain his observation of the term structure of momentum. He finds that returns in the past twelve to seven month have

predictive power, whereas returns at a shorter horizon are largely irrelevant, and returns longer than twelve months ago are irrelevant when controlling for value.

The momentum effect has been shown in a wide range of asset classes such as mutual funds (Brown & Goetzmann, 1995; Carhart, 1997; Grinblatt et al., 1995; Hendricks et al., 1993), industries (Moskowitz & Grinblatt, 1999), Hedge Funds (Baquero et al., 2005; Jagannathan et al., 2010), corporate bonds (Jostova et al., 2013), equity index, currency, commodity and bond futures (Asness et al., 2013; Moskowitz & Grinblatt, 1999) and government bonds (Asness et al., 2013).

Moreover, the momentum effect has been shown in different forms, other than the conventional cross-sectional form. Among these are time-series factor momentum (Moskowitz et al., 2012), Sharpe Ratio momentum (Rachev et al., 2007), residual momentum (Blitz et al., 2011), and intermediate momentum (Novy-Marx, 2012). In recent years the literature started to focus on factor momentum.

2.2 Factor momentum

Harvey et al. (2016) give an overview of 313 factors that have been claimed to have return predicting power beyond asset pricing models. However, the profitability of many factors diminished or disappeared after publication, possibly due to investors learning about the return predictability and because of improved arbitrage conditions (Chordia et al., 2011; McLean & Pontiff, 2016; Schwert, 2003). Some factors, among which the momentum effect, has been shown to remain profitable after publication (Asness et al., 2013). Driven by the combination of diminishing anomaly profits and persistent momentum profits, Avramov et al. (2017) find that momentum can be used to select the best performing anomalies. First they notice that there is a strong autocorrelation of anomaly returns over different time horizons in a set of 15 anomalies they examine. Given this strong autocorrelation, they form a strategy that invests in momentum among anomalies. They split anomalies in their long and short legs, based on the expected anomaly return and take equal long positions in the five long-leg winner anomalies and equal short positions in the five short-leg loser anomalies. This cross-sectional factor momentum strategy has a Fama French three-factor alpha between 0.77% and 0.91% per month. Furthermore, they find that the strategy's risk

adjusted returns are substantially higher when sentiment is high than when sentiment is low. Between 1.42% and 1.73% when sentiment is high and between 1.09% and 1.18% when sentiment is low.

Arnott et al. (2019) show that cross-sectional factor momentum subsumes industry momentum. Industry momentum is caused by its factor loadings rather than being an independent phenomenon. On the other hand, factor momentum cannot be explained by stock momentum, industry momentum or the factors of the Fama French five-factor model. They use a set of 51 factors, but show that factor momentum typically also emerges by using just two randomly selected factors. Furthermore, they find that factor momentum is profitable for different formation and holding periods, but most profitable when the formation and holding periods are one month. Factor momentum is not limited to small stocks and remains profitable when adding a lag between the formation and holding periods. Furthermore, conversely to stock momentum, factor momentum shows positive spikes, instead of crashes.

Using a set of 65 factors, Gupta and Kelly (2019) construct a time-series factor momentum strategy in the spirit of Moskowitz et al. (2012) and find this strategy outperforms cross-sectional factor momentum, although they are highly correlated. Contrary to stock momentum, time-series factor momentum remains profitable over a wide range of formation periods from one month up to five years. Furthermore, they find that the outperformance of factor momentum is robust to trading costs and factor momentum exists in global markets.

Ehsani and Linnainmaa (2019) show that factor momentum not only explains industry momentum, adjusted momentum, intermediate momentum and Sharpe ratio momentum, but also stock momentum. Momentum is not a distinct factor, but rather aggregates autocorrelations found in all other factors. Furthermore, they provide a comparison of return drivers between time-series and cross-sectional factor momentum, using framework of Lewellen (2002), Lo and MacKinlay (1990), and Moskowitz et al. (2012). They find time-series factor momentum (3.92% annualized) outperforms cross-sectional (2.40% annualized) factor momentum. That is because the time-series strategy profits more from the autocorrelation in factor returns. In the cross-sectional strategy this is partly offset by the lead-lag relationship among factor returns. A high return on one factor typically also predicts high

returns on other factors. The lead-lag component of the cross-sectional strategy bets that a high return on one factor would mean low returns on the other factors.

2.3 Sentiment

In contrast with classical finance theory, Baker and Wurgler (2006) show that investor sentiment influences stock prices. The influence of sentiment on the cross-section of stock returns is explained through two channels. First, stocks with the most subjective valuations are the stocks most prone to speculation, which is triggered by sentiment. Second, stocks with different characteristics face arbitrage constraints to a different extent. Generally, the stocks with the most subjective valuations are also the ones that are hardest to arbitrage. Furthermore, some characteristics that do not have unconditional predictive power, have predictive power when conditioning on sentiment.

Yu and Yuan (2011) investigate the difference in the relation between the market's expected excess return and its conditional variance during high and low sentiment periods. They find that there is a positive relation between the market's expected excess return and the market's conditional variance during low-sentiment periods. In contrast, they find a nearly flat relation during high-sentiment periods. They attribute this difference to the participation of sentiment traders. These sentiment traders are expectedly more naive and could have a lower understanding of risk.

2.4 Short sale constraints and sentiment

Miller (1977) argues that impediments to short selling prevent rational traders to arbitrage away overpricing. Then, when investors have different opinions about an asset's value, the asset's price will reflect to some extent the opinion of the overoptimistic investors, because the asset will not be shorted by investors with more negative opinions.

Short sale impediments exist in the stock market for multiple reasons. First, institutional investors are often not allowed to take short positions. Second, investors that are allowed to take short positions face "noise-trader" risk. Even if an investor has a correct view of the value of an overpriced asset it may be risky to take a short position. That is because

the investor faces the risk that before the price moves towards the true value, in the short term the asset's price could move further away from its true value. This will require extra capital from the investor and could force the investor to close its position at a loss (De Long et al., 1990; Shleifer & Vishny, 1997). Savor and Gamboa-Cavazos (2011) show indeed that short sellers who aim to profit from overpricing reduce their positions after suffering losses. Furthermore, Shleifer and Vishny (1997) explain that even if investors are not restricted by capital constraints, they might close a short position after adverse price movements because the short-term losses could lead to fund outflows. Third, behavioral biases prevent investors from taking short positions. Individual investors barely take short positions, 0.29% of their positions is short, which is 0.78% of their portfolio's value (Barber & Odean, 2008). Fourth, shorting can be expensive (D'avolio, 2002), and the stocks with the highest expected return from a short position are also the ones that are most expensive to short Drechsler and Drechsler (2014).

Stambaugh et al. (2012) combine the notion that short sale constraints will result in some stocks being overpriced with the intuition that overpricing is more prevalent when the general view of the market is more optimistic, that is following high sentiment periods. They provide several insights in the relation between anomalies and sentiment. First, anomalies are stronger following high sentiment. The intuition is that overpricing is the main form of mispricing and overpricing is stronger following high sentiment periods. Second, the short legs of anomalies have lower returns, meaning they are more profitable, following high sentiment periods than following low sentiment periods. Due to short sale constraints, overpricing is the main form of mispricing and overpricing concentrates in the short legs. Overpricing is higher during high sentiment periods. Third, long leg anomaly returns are similar following high sentiment periods as following low sentiment periods. This is because long leg stocks are unlikely to be underpriced, as underpricing would be corrected by arbitrage. Long legs could be overpriced, but overpricing should be smallest in the long legs of the cross-section.

3 Data

I obtain monthly stock return and shares-outstanding data from the Center of Research in Securities Prices (CRSP). I include only common stocks (share codes 10 and 11). The CRSP data includes all stocks listed on the New York Stock Exchange (NYSE) since 1925, American Stock Exchange (AMEX) since 1962 and NASDAQ since 1972. I obtain annual accounting data from Compustat and follow the commonly used approach of Fama and French (1993) in assuming that accounting data is available six months after the end of the fiscal year. For example, I use accounting information from the fiscal year that ended in year $t - 1$ when I sort stocks into portfolios at the end of June in year t .

I compute returns on the factors I construct from July 1963 to December 2019.¹ Some factors, such as Low Volatility and Long-Term-Reversal use return data prior to 1963. Several factors enter the sample at a date later than July 1963, due to limited population in the necessary Compustat fields in the early periods.

I obtain monthly sentiment data from the sentiment index constructed by Baker and Wurgler (2006).² This sentiment index covers the period from July 1965 to December 2018, and is constructed from six components. The dividend premium, the first day returns of IPOs, the IPO volume, the closed-end fund discount and the equity share in new issues.³

Additionally, I obtain data for the regressions I run on the Fama French three-factor model from the Kenneth French library.⁴

¹I obtain data for the QMJ factor from the AQR database, available at <https://www.aqr.com/Insights/Datasets>. The QMJ factor requires daily return data, which I cannot use because of limited computational power.

²Available at <http://people.stern.nyu.edu/jwurgler/>

³I use the version of the sentiment index that is updated in March 2019. Unlike the sentiment index of 2006 and 2007 this updated version does not use NYSE turnover as an indicator for sentiment anymore. This is motivated as follows. “Turnover does not mean what it once did, given the explosion of institutional high-frequency trading and the migration of trading to a variety of venues.”

⁴Available at http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

4 Methodology

4.1 Factor construction

I use the merged CRSP-Compustat data to construct factors a similar way as Fama and French (1993) construct their HML factor. Each year t from 1963 to 2019 at the end of June, NYSE, AMEX and Nasdaq stocks are allocated into two size portfolios. Small when the stocks market equity (ME) was below the median ME and Big when ME was above the median ME in year $t - 1$. The stocks are also allocated into three portfolios based on an independent sort on the specific factor characteristics. Breakpoints are at the 30 percent and 70 percent levels. Stocks at the bottom 30 percent are allocated into the Low portfolio, stocks between the 30 percent and 70 percent levels are allocated into the Middle portfolio and stocks above the 70 percent level are allocated into the High portfolio. The Low portfolio consists of stocks that according to the original research paper have the lowest expected return and the High portfolio consists of stocks that have the highest expected return. The factor returns of the long-short factors are calculated as the value weighted returns of the portfolio constructed as follows.

$$Long - Short = \frac{1}{2}(Small\ High + Big\ High) - \frac{1}{2}(Small\ Low + Big\ Low) \quad (1)$$

Next to the long-short factors, I construct zero-investment cost long factors and short factors separately. For the long factors and short factors I follow a similar approach as used by Blitz et al. (2020) to make factors market neutral. I offset the long or short position by taking an opposite position in a size adjusted market portfolio. Intuitive would be to take an opposite position in a value weighted market portfolio. However, because the factors are constructed half small cap and half big cap, this would result in size distortions. Similarly to Blitz et al. (2020) I constructed the market portfolio by taking taking a position of 50 percent in a small market portfolio and a position of 50 percent in a big market portfolio. The small market portfolio is constructed by the average of nine small portfolios from the 2x3 portfolio sorts of the value, profitability and investment factors. The big market portfolio is the average of the nine big portfolios of these portfolio sorts. Equation (2) shows the

construction of the small market portfolio.

$$\begin{aligned}
Mkt_{Small} = & \frac{1}{9}(Small\ Low\ BM + Small\ Middle\ BM + Small\ High\ BM \\
& + Small\ Low\ OP + Small\ Middle\ OP + Small\ High\ OP \\
& + Small\ Low\ Inv + Small\ Middle\ Inv + Small\ High\ Inv)
\end{aligned} \tag{2}$$

Similarly, I construct the big market portfolio,

$$\begin{aligned}
Mkt_{Big} = & \frac{1}{9}(Big\ Low\ BM + Big\ Middle\ BM + Big\ High\ BM \\
& + Big\ Low\ OP + Big\ Middle\ OP + Big\ High\ OP \\
& + Big\ Low\ Inv + Big\ Middle\ Inv + Big\ High\ Inv)
\end{aligned} \tag{3}$$

adding the small and big market portfolios results in the size neutral market portfolio.

$$Mkt_{neutral} = \frac{1}{2}(Mkt_{Small} + Mkt_{Big}) \tag{4}$$

The market and size neutral long factors follow from

$$Long = \frac{1}{2}(Small\ High + Big\ High) - Mkt_{neutral} \tag{5}$$

similarly, I construct the market and size neutral short factors.

$$Short = \frac{1}{2}(Small\ Low + Big\ Low) - Mkt_{neutral} \tag{6}$$

For each factor construction I also design a combination factor. This factor is an equal weighted average of all factors available in that period.

The number of factors I use starts with 29 in 1963 and increases to 51 by 1983. Table A1 in the appendix shows an overview of the factors used, the authors, the year of publication and the start date for this study. Table 1 reports the average monthly returns of the factors. All long-short factors, except the Advertchg factor, have on average positive returns, of which 24 are significant at the 5% level. The long-short combination factor has an average return of 0.18% per month (t-statistic = 6.26). Forty-five of the long factors have positive average

Table 1: Factor returns

This table reports the factors, average monthly returns, standard deviations and Newey-West adjusted t -statistics. The long-short factors are constructed as following. Each year t from 1963 to 2019 at the end of June, NYSE, AMEX and Nasdaq stocks are allocated into two size portfolios. Small when the stocks market equity (ME) was below the median ME and Big when ME was above the median ME in year $t - 1$. The stocks are also allocated into three portfolios based on an independent sort on the specific factor characteristics. Breakpoints are at the 30 percent and 70 percent levels. Stocks at the bottom 30 percent are allocated into the Low portfolio, stocks between the 30 percent and 70 percent levels are allocated into the Middle portfolio and stocks above the 70 percent level are allocated into the High portfolio. The Low portfolio consists of stocks that according to the original research paper have the lowest expected return and the High portfolio consists of stocks that have the highest expected return. The factor returns of the long-short factors are calculated as the value weighted returns of (Small and High + Big and High)/2 - (Small and Low + Big and Low)/2. The factor returns of the long factors are calculated as the value weighted returns of (Small and High + Big and High)/2 - (Small Mkt + Big Mkt)/2. The factor returns of the short factors are calculated as the value weighted returns of (Small and Low + Big and Low)/2 - (Small Mkt + Big Mkt)/2.

Factor	Long - Short			Long			Short		
	\bar{r}	SD	$t(\bar{r})$	\bar{r}	SD	$t(\bar{r})$	\bar{r}	SD	$t(\bar{r})$
Abninv	0.20	2.81	1.63	0.14	1.25	2.52	-0.07	2.10	-0.70
Acc	0.15	1.59	2.08	0.01	1.26	0.09	-0.14	1.24	-2.81
Ad2me	0.15	2.54	1.24	0.12	2.00	1.19	-0.03	1.38	-0.52
Advertchg	-0.05	1.32	-0.96	0.03	1.34	0.49	0.08	1.35	1.10
Ato	0.14	2.27	1.43	0.01	0.95	0.37	-0.08	1.01	-1.81
Atochg	0.10	1.36	1.68	0.05	1.27	0.88	-0.09	1.25	-1.59
Capto	0.20	2.07	2.15	0.05	1.12	1.00	-0.15	1.18	-2.83
Cash	0.10	2.45	1.01	0.01	1.35	0.18	-0.09	1.24	-1.91
Cegth	0.03	1.47	0.54	0.02	0.86	0.45	-0.02	1.11	-0.38
CFP	0.31	2.90	2.47	0.20	1.58	2.95	-0.11	1.47	-1.73
CMA	0.18	1.72	2.37	0.07	0.88	1.76	-0.11	1.13	-2.25
Dcap	0.06	1.88	0.75	0.00	1.32	0.06	-0.05	0.82	-1.50
DP	0.05	2.71	0.41	0.04	2.18	0.42	-0.01	1.24	-0.13
Entbm	0.14	2.95	0.75	0.05	1.63	0.51	-0.09	1.83	-0.85
Entmult	0.20	1.90	2.46	0.09	1.08	2.32	-0.10	1.08	-2.12
EP	0.29	2.97	2.19	0.18	1.52	2.58	-0.11	1.59	-1.56
Fscore	0.26	2.27	2.77	0.08	1.13	2.28	-0.17	1.69	-2.14
GS5	0.01	1.71	0.19	0.02	0.96	0.45	0.01	1.01	0.11
HML	0.24	2.82	1.91	0.14	1.57	1.97	-0.10	1.34	-1.72
Inv	0.20	1.41	3.40	0.07	0.94	1.80	-0.07	1.61	-0.94
Inv2at	0.14	1.74	1.75	0.08	0.79	2.28	-0.12	0.94	-3.00
Issue1	0.19	1.67	2.68	0.05	0.79	1.22	-0.15	1.19	-2.95
Issue5	0.25	1.47	4.07	0.09	0.82	2.57	-0.16	0.85	-4.78
Lnoachg	0.26	1.76	3.18	0.14	1.08	2.69	-0.12	1.15	-2.34
LowVol	0.00	4.85	0.02	0.01	2.19	0.07	0.00	2.77	0.02
LTR	0.12	2.29	1.19	0.07	1.50	1.11	-0.05	1.06	-1.04
Lvg	0.12	2.93	0.96	-0.02	1.72	-0.19	-0.02	1.67	-0.22
Lvgbm	0.00	2.98	0.02	0.05	1.77	0.65	-0.07	1.29	-1.27
Ncoachg	0.25	1.68	3.53	0.11	1.12	2.37	-0.14	1.09	-2.96
Noa	0.24	1.57	3.66	0.05	0.91	1.44	-0.19	0.86	-5.28
Nwcchg	0.18	1.42	2.93	0.06	1.17	1.11	-0.12	1.27	-2.48
Ol	0.18	1.90	2.20	0.06	1.31	1.03	-0.12	0.94	-2.78
Oscore	0.09	2.33	0.87	0.02	0.95	0.53	-0.07	2.09	-0.73
Pm	0.03	2.37	0.27	-0.01	0.97	-0.35	-0.09	0.93	-2.33
Pmchg	0.08	1.44	1.50	-0.02	1.06	-0.50	-0.05	1.46	-0.77
Ppachg	0.20	1.62	2.74	0.06	0.89	1.57	-0.14	1.13	-2.70
QMJ	0.38	2.23	3.76	-0.31	0.92	-6.28	-0.69	1.71	-7.86
RMW	0.26	2.12	2.73	0.08	0.95	1.99	-0.18	1.33	-2.93
Roa	0.14	2.12	1.55	0.01	0.95	0.35	-0.12	1.41	-1.99
Roe	0.14	2.04	1.53	0.02	0.85	0.46	-0.12	1.56	-1.72
Seasonal	0.36	2.17	3.97	0.11	1.30	1.76	-0.25	1.23	-5.19
SMB	0.22	3.08	1.81	0.14	1.50	2.31	-0.08	1.64	-1.25
SP	0.36	2.62	2.89	0.20	1.63	2.66	-0.16	1.13	-2.96
STR	0.51	3.07	4.60	0.21	1.89	3.10	-0.30	1.44	-5.34
Susgr	0.09	1.79	1.12	0.01	0.96	0.26	-0.08	1.19	-1.49
Turnover	0.09	3.49	0.70	-0.02	1.82	-0.32	-0.11	1.93	-1.49
UMD	0.57	3.86	3.75	0.24	1.65	3.51	-0.33	2.55	-3.18
Xfin	0.33	2.04	3.58	0.07	0.91	2.15	-0.26	1.38	-3.88
Xrd2at	0.07	3.46	0.40	0.01	2.47	0.05	-0.06	1.57	-0.87
Xrd2mv	0.35	3.19	2.51	0.22	2.30	2.24	-0.13	1.44	-1.98
Zscore	0.04	2.42	0.34	-0.03	1.37	-0.47	-0.07	1.43	-1.04
Combination	0.18	0.61	6.26	0.06	0.28	5.13	-0.12	0.60	-4.22

returns of which 17 are significant. The long combination factor has a modest return of 0.06% (t-statistic = 5.13). Forty-nine of the short factors have on average negative returns, of which 24 are significant. The short combination factor has an average return of -0.12% (t-statistic = -4.22).

In section 6 I restrict the set of factors to those that are commonly used in practice by investors and are easy to invest in by the means of ETFs for instance.

4.2 Cross-sectional factor momentum

I construct a cross-sectional factor momentum strategy (XSFM) and a time-series factor momentum strategy (TSFM). In this section the XSFM strategy will be explained. The XSFM strategy weights factors relative to their return during a formation period. Initially I apply a formation period from from $t - 12$ to $t - 1$, although other formation periods are considered in several analysis. The strategy is rebalanced monthly.

I decompose the returns following the decomposition framework of Lewellen (2002) and Lo and MacKinlay (1990). The factors are weight relative to the factors return in excess of the mean return of all factors during the formation period. Therefore, the portfolio weight of factor f in month t equals

$$w_{f,t}^{XSFM} = \frac{1}{F}(r_{f,-t} - \bar{r}_{-t}), \quad (7)$$

where $w_{f,t}^{XSFM}$ is the weight of factor f in month t , $r_{f,-t}$ is the average return of factor f during the formation period $-t$, and \bar{r}_{-t} is the cross-sectional average return of all factors during the formation period $-t$. The portfolio return then equals

$$\pi_t^{XSFM} = w_{f,t}^{XSFM} r_{f,t} = \frac{1}{F} \sum_{f=1}^F (r_{f,-t} - \bar{r}_{-t}) r_{f,t}, \quad (8)$$

where $r_{f,t}$ is the return of factor f in month t . By taking expectations I get

$$E[\pi_t^{XSFM}] = \frac{1}{F} \sum_{f=1}^F cov(r_{f,-t}, r_{f,t}) - cov(\bar{r}_{-t}, \bar{r}_t) + \frac{1}{F} \sum_{f=1}^F (\mu_f - \bar{\mu})^2, \quad (9)$$

where μ_f is the unconditional expected return of factor f , and $\bar{\mu}$ is the mean expected return of all factors. Rewriting the expected portfolio return in matrix notation allows to decompose the portfolio returns into the different components.

$$\begin{aligned} E[\pi_t^{XSFM}] &= \frac{1}{F}Tr(\Omega) - \frac{1}{F^2}1'\Omega 1 + \sigma_\mu^2 \\ &= \frac{F-1}{F^2}Tr(\Omega) - \frac{1}{F^2}(1'\Omega 1 - Tr(\Omega)) + \sigma_\mu^2, \end{aligned} \quad (10)$$

where $\Omega = E[(r_{f,-t} - \mu)(r_{f,t} - \mu)']$ is the autocovariance matrix of the returns of the factors, $Tr(\Omega)$ is the trace of the autocovariance matrix, and σ_μ^2 is the cross-sectional variance of mean factor returns. This notation allows to decompose cross-sectional factor momentum into three components.

1. Autocovariance. Factors that have performed well during the formation period continue to perform well.
2. Cross-serial covariance. A factor that have performed well during the formation period predicts that the other factors will perform well the next period.
3. Cross-sectional variance of mean returns. Factors with the highest unconditional expected returns also have the highest realized returns.

I multiply the terms in equation (10) by a scaling factor S^{XSFM} such that the weights of the long and the short positions each add up to one.⁵

$$S^{XSFM} = 2 \sum_{f=1}^F \frac{1}{|w_{f,t}^{XSFM}|}, \quad (11)$$

4.3 Time-series factor momentum

Next to the XSFM strategy, I also construct a time-series factor momentum strategy (TSFM). This strategy weights factors based on the difference between their return during

⁵In the return decomposition analysis as reported in Table 3, only the XSFM strategy with a formation period of twelve months is scaled with this scaling factor. The returns of the other strategies are scaled so that the volatility of their returns equals that of the XSFM strategy with a twelve month formation period. In the remainder of this paper all XSFM strategies are scaled with the scaling factor of equation (11).

the formation period and zero. Again, I use a base case formation period from $t - 12$ to $t - 1$ and the strategy is rebalanced monthly.

Goyal and Jegadeesh (2018) argue that the outperformance of time-series stock momentum over cross-sectional stock momentum is due to a net long position. Since I construct all factors as zero-investment cost, this critique is eliminated.

The TSFM strategy simply weights each factor by its return during the formation period.

$$w_{f,t}^{TSFM} = \frac{1}{F} r_{f,-t}, \quad (12)$$

where $w_{f,t}^{TSFM}$ is the weight of factor f in month t for the time-series factor momentum strategy. The portfolio return then equals

$$\pi_t^{TSFM} = w_{f,t}^{TSFM} r_{f,t} = \frac{1}{F} \sum_{f=1}^F r_{f,-t} r_{f,t}, \quad (13)$$

following the method of Moskowitz et al. (2012), rewriting in matrix notation and taking expectations gives:

$$E[\pi_t^{TSFM}] = \frac{1}{F} E\left[\sum_{f=1}^F r_{f,-t} r_{f,t}\right] = \frac{1}{F} \sum_{f=1}^F [cov(r_{f,-t}, r_{f,t}) + \mu_f^2] = \frac{1}{F} Tr(\Omega) + \frac{1}{F} \sum_{f=1}^F \mu_f^2, \quad (14)$$

Equation (14) allows to decompose the TSFM returns to two components

1. Autocovariance. Factors that have performed well during the formation period continue to perform well.
2. Mean of squared returns

In all analysis, except the return decomposition as reported in Table 3, I multiply the terms in equation (13) by a scaling factor S^{TSFM} such that the weight of the long and the

short positions together is two.⁶

$$S^{TSFM} = 2 \sum_{f=1}^F \frac{1}{|w_{f,t}^{TSFM}|}, \quad (15)$$

4.4 Regressions

There is no uniform approach to show autocorrelation. Avramov et al. (2017) use Fama-Macbeth regressions, Gupta and Kelly (2019) use AR(1) regressions and Ehsani and Linainmaa (2019) use dummy regressions. I regress the factor returns on the average return during a past time horizon.⁷

$$r_{f,t} = \alpha_{f,t} + \beta r_{f,-t} + \epsilon_{f,t}, \quad (16)$$

where $R_{f,t}$ is the return of factor f in month t , $d_{f,-t}$ is the average return of factor f a past time horizon $-t$.

To calculate the benchmark adjusted return of the strategies, I regress the strategy returns on the factors of the Fama-French three-factor model.

$$r_t = \alpha + \beta_1 MKT_t + \beta_2 SMB_t + \beta_3 HML_t + \epsilon_{f,t}, \quad (17)$$

where r_t is the strategy's return in month t , α is the risk-adjusted excess return, MKT_t is the excess return of the market over the risk-free rate, proxied by 1-month T-bills, in month t , SMB_t is the return of the size factor in month t and HML_t is the return of the value factor in month t .

I also run the regression as in equation (16) conditional on the level of sentiment.

$$r_{f,t} = \alpha_H d_{H,t} + \alpha_L d_{L,t} + \beta d_{H,t} r_{f,-t} + \beta d_{L,t} r_{f,-t} + \epsilon_{f,t}, \quad (18)$$

where $d_{H,t}$ is a dummy variable taking the value of 1 following high sentiment periods and 0 otherwise, $d_{L,t}$ is a dummy variable taking the value of 1 following low sentiment periods

⁶In the return decomposition analysis, the returns of the TSFM strategies are scaled so that the volatility of their returns equals that of the XSFM strategy with a twelve month formation period.

⁷In Table A3 and Table A4 in the appendix I regress the factor return on a dummy variable that takes the value of 1 if returns were positive during the past time horizon and 0 otherwise.

and 0 otherwise. Following Stambaugh et al. (2012), I classify sentiment as high (low) when the sentiment level in the previous month is above (below) the median sentiment level of the Baker and Wurgler sentiment index.

I obtain the strategies' benchmark adjusted returns conditional on the level of sentiment by running the following regressions.

$$r_t = \alpha_H d_{H,t} + \alpha_L d_{L,t} + \beta_1 MKT_t + \beta_2 SMB_t + \beta_3 HML_t + \epsilon_{f,t}, \quad (19)$$

5 Results

5.1 Autocorrelation

As a first test to examine the persistence in factor returns I regress for each factor its return in month t on its average return from month $t - 12$ to month $t - 1$, as described in equation (16). Table 2 reports the estimates from the regressions. Forty-six of the long-short factors have a positive autocorrelation, which is significant (at the 5% level) for 18 factors. The long-short combination factor has a correlation coefficient of 0.20 (t-statistic = 1.61). For the long factors the correlation is stronger and more significant, resulting in a value of 0.22 (t-statistic = 1.83) for the combination factor. The short factors show the strongest autocorrelation structure, only one factor has a negative correlation, and the correlation of the combination factor is 0.25 (t-statistic = 1.93).

Table A2 in the appendix shows that the conclusions remain the same, and are consistent with Gupta and Kelly (2019), when returns from month t are regressed on the returns from month $t - 1$.

Additionally, Table A3 and Table A4 in the appendix report estimates from regressions of factor returns on a dummy variable that takes the value of one if the average previous return was positive, and zero otherwise. The results provide more insight on several aspects. First, the returns of the long-short factors stem primarily following positive returns, consistent with Ehsani and Linnainmaa (2019). Second, following negative returns, the short factors show the most negative returns. Particularly the short QMJ factor stands out with an average monthly return of -0.88% (t-statistic = -11.11) following a negative return month. Third,

Table 2: Factor return autocorrelation

This table reports the coefficients of regressions of the factor returns in month t on the average monthly factor return from month $t - 12$ to month $t - 1$. The reported t-statistics are Newey-West adjusted and standard errors from the combination factor are clustered by factor and month to obtain the t-statistics. The sample period is from July 1964 to December 2019.

Factor	Long - Short		Long		Short	
	β	$t(\beta)$	β	$t(\beta)$	β	$t(\beta)$
Abninv	0.15	1.73	0.07	0.69	0.16	1.41
Acc	0.30	2.79	0.36	2.20	0.06	0.40
Ad2me	0.30	2.57	0.36	2.22	0.23	1.78
Advertchg	-0.18	-1.05	0.24	2.15	0.39	2.70
Ato	0.02	0.12	-0.16	-0.84	0.13	0.79
Atochg	0.09	0.63	0.07	0.35	0.08	0.46
Capto	0.08	0.60	0.12	0.86	0.10	0.88
Cash	0.18	1.55	0.23	1.78	0.11	1.16
Cegth	0.25	1.46	0.16	1.27	0.20	1.72
CFP	0.19	2.02	0.18	1.72	0.26	2.48
CMA	0.18	1.75	0.19	1.37	0.24	2.50
Dcap	0.10	0.49	0.09	0.53	0.34	1.81
DP	0.07	0.57	0.11	0.95	0.14	1.02
Entbm	0.30	2.94	0.30	2.46	0.27	1.91
Entmult	0.04	0.28	-0.23	-1.26	0.29	2.28
EP	0.18	1.80	0.20	1.96	0.20	1.48
Fscore	0.07	0.68	-0.13	-0.75	0.24	2.32
GS5	0.34	2.54	0.29	2.02	0.24	2.29
HML	0.21	2.47	0.24	2.32	0.21	2.16
Invq	0.09	0.67	0.33	2.71	0.12	0.97
Invq2at	0.29	3.23	0.22	1.54	0.06	0.42
Issue1	0.04	0.20	0.16	1.11	0.18	1.64
Issue5	-0.02	-0.28	0.05	0.50	0.02	0.21
Lnoachg	0.09	0.51	0.22	1.90	0.04	0.19
LowVol	0.13	1.11	0.08	0.76	0.16	1.21
LTR	0.38	3.69	0.29	2.18	0.37	3.03
Lvg	0.23	1.46	0.30	2.44	0.30	1.63
Lvgbm	0.33	1.60	0.26	1.62	0.21	1.31
Ncoachg	-0.06	-0.49	0.15	1.35	0.11	0.68
Noa	0.35	3.09	0.26	2.27	0.38	3.31
Nwchg	0.10	0.73	0.29	1.61	-0.01	-0.08
Ol	0.26	2.07	0.13	0.92	0.42	4.58
Oscore	0.24	2.60	0.34	2.42	0.24	2.02
Pm	0.26	3.23	0.09	0.74	0.14	1.20
Pmchg	-0.06	-0.45	0.19	1.29	0.34	4.28
Ppachg	0.25	2.09	0.22	1.68	0.26	2.48
QMJ	0.25	1.60	0.58	5.11	0.45	3.37
RMW	0.25	2.87	0.16	1.39	0.34	2.84
Roa	0.19	1.27	0.25	2.00	0.18	1.17
Roe	0.26	2.70	0.21	2.11	0.32	3.82
Seasonal	0.12	1.00	0.28	2.32	0.03	0.20
SMB	0.18	0.99	0.29	1.77	0.13	0.73
SP	0.33	2.25	0.32	1.78	0.36	2.76
STR	0.04	0.24	-0.05	-0.25	0.21	1.13
Susgr	0.23	2.35	0.21	1.58	0.22	1.91
Turnover	0.09	0.55	0.09	0.52	0.15	1.13
UMD	-0.00	-0.03	0.06	0.44	0.00	0.04
Xfin	0.08	0.86	-0.09	-0.52	0.28	2.23
Xrd2at	0.25	1.88	0.21	1.40	0.21	1.22
Xrd2mv	0.20	2.20	0.09	0.88	0.23	1.38
Zscore	0.20	1.49	0.23	1.43	0.24	1.98
Combination	0.20	1.61	0.22	1.83	0.25	1.93

the magnitude and significance of factor premium predictability is stronger when returns are regressed on the returns of month $t - 1$ compared to months $t - 12$ to $t - 1$.

5.2 Factor momentum strategies

The evidence of an autocorrelation structure is strong among all factor constructions and the results suggest the strong potential to exploit the time-series predictability for the short factors. In what follows I decompose the returns of two strategies that buy past winning factors and sell past losing factors and so profit from time-series predictability. Specifically,

I create a cross-sectional factor momentum (XSFM) strategy, as described in section 4.2 and a time-series factor momentum (TSFM) strategy, as described in section 4.3. I decompose the returns of both strategies into different sources as shown in equation (10) and equation (14). For comparability, the returns for the different strategies and formation periods are in the decomposition scaled such that its volatility equals that of XSFM with a formation period of twelve months. The decompositions are applied for formation periods of twelve, six, three, and one months.

Table 3 reports the results of the decompositions. Panel A shows the results for the long-short factors, panel B for the long factors and panel C for the short factors. The results indicate that the time-series predictability of the factors can be exploited. Generally, the returns follow a U-pattern across the different formation periods, with the highest volatility-adjusted returns for the one month formation period strategies. The time-series predictability is strongest for the short factors and the short factors show the highest volatility-adjusted returns for most specifications. Consistent with Ehsani and Linnainmaa (2019) I find autocorrelation as the main driver of factor momentum. This finding is independent of the formation period, momentum form and factor construction. The cross-correlation components are small and positive, meaning a negative contribution to the overall XSFM returns. A high return on one factor leads to high returns on all other factors in the following period. The cross-correlation components are strongest for the short factors and weakest for the long factors. This is consistent with Blitz et al. (2020), who find that factors are positively correlated on the short legs, and have a close to zero correlation on the long legs. Furthermore, the TSFM strategies outperform the XSFM strategies among all specifications except for the long-short factors with a formation period of three months. The highest volatility-adjusted returns are 0.70% per month for the long-short TSFM strategy with a one month formation period followed the short TSFM strategies with twelve and one month formation periods with a return of 0.69%.

To gain more insights into the drivers of the factor momentum strategies, I split the XSFM and TSFM strategies into a winners (W) portfolio, and a losers (L) portfolio. I regress the returns on the factors of the Fama-French three-factor model, as shown in equation (17). Table 4 reports the estimates from these regressions, panel A shows the estimates from

Table 3: Factor momentum return decomposition

This table reports the return decomposition for the cross-sectional and time-series momentum strategies. The decomposition shows monthly returns, reported for formation periods from $t - 12$ to $t - 1$ (12), $t - 6$ to $t - 1$ (6), $t - 3$ to $t - 1$ (3), and $t - 1$ (1) months. Panel A reports the return decomposition for the long-short factors. Panel B reports the return decomposition for the market neutral long factors. Panel C reports the return decomposition for the market neutral short factors. The sample period is from July 1964 to December 2019.

Strategy	Formation period			
	12	6	3	1
Panel A: Long - Short				
Cross-sectional autocovariance	0.46	0.39	0.65	0.71
(-1) \times Cross-covariance	-0.06	-0.05	-0.04	-0.05
Variance of mean returns	0.06	0.04	0.02	0.02
Cross-sectional factor momentum	0.41	0.34	0.58	0.64
Time-series autocovariance	0.44	0.43	0.41	0.68
Mean of squared returns	0.17	0.13	0.10	0.06
Time-series factor momentum	0.57	0.52	0.46	0.70
Panel B: Long				
Cross-sectional autocovariance	0.48	0.36	0.35	0.65
(-1) \times Cross-covariance	-0.02	-0.01	-0.03	-0.04
Variance of mean returns	0.09	0.06	0.04	0.03
Cross-sectional factor momentum	0.49	0.38	0.33	0.60
Time-series autocovariance	0.48	0.37	0.36	0.65
Mean of squared returns	0.13	0.09	0.06	0.04
Time-series factor momentum	0.55	0.41	0.38	0.64
Panel C: Short				
Cross-sectional autocovariance	0.62	0.55	0.50	0.84
(-1) \times Cross-covariance	-0.18	-0.17	-0.15	-0.18
Variance of mean returns	0.16	0.10	0.07	0.05
Cross-sectional factor momentum	0.54	0.44	0.39	0.66
Time-series autocovariance	0.48	0.43	0.41	0.65
Mean of squared returns	0.26	0.17	0.12	0.08
Time-series factor momentum	0.69	0.56	0.49	0.69

regressions for XSFM, and panel B for TSFM. For the long-short XSFM strategy most of the returns, alpha and Sharpe ratio stem from the winners. The strategy earns an average return of 0.49% (t-statistic = 4.08) per month, with an alpha of 0.53% (t-statistic = 4.57). The strategy has a small negative exposure to the market premium and HML factor and a positive exposure to the SMB factor, of which only the exposure to the market premium is significant at the 10% level. For the long XSFM strategy most of the return, alpha and

Table 4: Factor momentum returns

This table reports monthly returns, Sharpe ratios and estimates of regressions from the returns of the factor momentum strategies on the factors of the Fama French three-factor model. The strategies are decomposed into the winner (W) portfolio and the loser (L) portfolio. The formation period is from month $t - 12$ to month $t - 1$, and the strategies are rebalanced monthly. The t-statistics are Newey-West adjusted. Panel A reports the results for the cross-sectional factor momentum strategy. Panel B reports the results for the time-series factor momentum strategy. The sample period is from July 1964 to December 2019.

	Long - Short			Long			Short		
	W-L	W	L	W-L	W	L	W-L	W	L
Panel A: Cross-sectional factor momentum									
Return	0.49	0.42	-0.06	0.30	0.21	-0.08	0.31	0.03	-0.28
t(Return)	4.08	6.59	-0.90	4.30	5.94	-2.25	4.96	0.68	-6.50
Sharpe	0.50	0.79	-0.13	0.54	0.69	-0.30	0.62	0.10	-0.92
alpha	0.53	0.45	-0.08	0.30	0.21	-0.09	0.35	0.04	-0.31
t(a)	4.57	7.13	-1.27	4.79	6.42	-2.52	5.54	1.07	-8.07
Mkt	-0.10	-0.10	-0.00	-0.04	-0.02	0.02	-0.07	0.02	0.09
t(Mkt)	-1.77	-2.96	-0.12	-1.45	-1.28	1.50	-2.17	1.36	4.15
SMB	0.27	0.13	-0.15	0.17	0.11	-0.06	0.11	0.11	0.00
t(SMB)	1.46	1.28	-1.66	1.67	2.22	-1.12	1.11	2.09	0.02
HML	-0.14	0.01	0.15	-0.06	-0.03	0.03	-0.08	-0.14	-0.06
t(HML)	-0.88	0.18	2.06	-0.63	-0.63	0.61	-1.05	-3.14	-1.42
Panel B: Time-series factor momentum									
Return	0.62	0.52	-0.09	0.33	0.25	-0.08	0.40	0.06	-0.34
t(Return)	5.19	6.57	-1.44	4.95	5.80	-2.68	5.59	1.27	-6.07
Sharpe	0.62	0.82	-0.20	0.60	0.73	-0.33	0.70	0.17	-0.87
alpha	0.66	0.55	-0.11	0.33	0.24	-0.09	0.44	0.07	-0.37
t(a)	5.70	7.38	-2.06	5.44	6.24	-2.95	6.08	1.68	-7.85
Mkt	-0.13	-0.14	-0.01	-0.04	-0.02	0.02	-0.10	0.01	0.11
t(Mkt)	-2.21	-3.28	-0.25	-1.43	-1.25	1.50	-2.65	0.76	4.39
SMB	0.26	0.12	-0.14	0.18	0.13	-0.05	0.11	0.13	0.02
t(SMB)	1.35	1.16	-1.55	1.76	2.40	-1.00	0.94	1.92	0.45
HML	-0.09	0.08	0.17	-0.06	-0.04	0.02	-0.02	-0.14	-0.13
t(HML)	-0.54	0.82	2.27	-0.66	-0.72	0.56	-0.17	-2.63	-2.52

Sharpe ratio also stem from the winners. The average return of the winners is 0.21% (t-statistic = 5.94) compared to -0.08% (t-statistic = -2.25) for the losers, resulting in a winner - loser return of 0.30% (t-statistic = 4.30). The alpha of the winner - loser portfolio is 0.30% (t-statistic = 4.79). In contrast, for the short XSFM strategy most of the returns, alpha and Sharpe ratio stem from the loser portfolio. The average return of the losers is -0.28% (t-statistic = -6.50), compared to 0.03% (t-statistic = 0.68) for the winner portfolio. This results in a winner - loser return of 0.31% (t-statistic = 4.96) and a winner - loser alpha of 0.35% (t-statistic = 5.54).

Table 5: Long leg winners - Short leg losers

This table reports monthly returns of Long factor winner (LW) - Short factor loser (SL) strategies and estimates of regressions from the returns on the factors of the Fama-French three-factor model. The results are reported for strategies with formation periods from $t - 12$ to $t - 1$ (12), and $t - 1$ (1) months. The t-statistics are Newey-West adjusted. The sample period is from July 1964 to December 2019.

	XSFM LW - SL		TSFM LW - SL	
	12	1	12	1
Return	0.49	0.56	0.59	0.65
t(Return)	7.17	8.76	6.99	8.62
Sharpe	0.88	1.06	0.91	1.06
alpha	0.51	0.60	0.61	0.69
t(a)	7.98	8.77	7.98	9.16
Mkt	-0.11	-0.14	-0.13	-0.16
t(Mkt)	-3.00	-5.03	-3.13	-5.13
SMB	0.11	0.01	0.11	-0.01
t(SMB)	1.17	0.18	1.05	-0.12
HML	0.03	0.11	0.09	0.15
t(HML)	0.29	2.15	0.92	2.71

For the TSFM strategies the conclusions are similar to XSFM, but returns, alphas and Sharpe ratios are higher. This is consistent with Ehsani and Linnainmaa (2019) and Gupta and Kelly (2019). The Sharpe ratios are highest for the short factors, independent of the momentum form.

Consider my first hypothesis, that factor momentum is more profitable for factors' short legs. The evidence indeed suggest that a factor momentum strategy that construct zero-investment costs factors from the factors' short legs and an offsetting market position outperforms the long-short factors, and long zero-investment cost long factors on a risk adjusted basis.⁸ In Section 6 I repeat the regressions for strategies based on a formation period of one month.

Furthermore, the separation of winners and losers returns in Table 4 suggests high potential profits for a strategy in the spirit of Avramov et al. (2017), which takes long positions in the long leg winners and short positions in the short leg losers (LW - SL). I construct a comparable strategy, but I weight the positions relative to the returns during the formation period as written in equation (7) and equation (12), for XSFM and TSFM respectively, whereas Avramov et al. (2017) gives an equal weight to the five best performing long legs

⁸Table A6 and Table A7 in the appendix show that the conclusions hold for subsets of only small stocks and only big stocks.

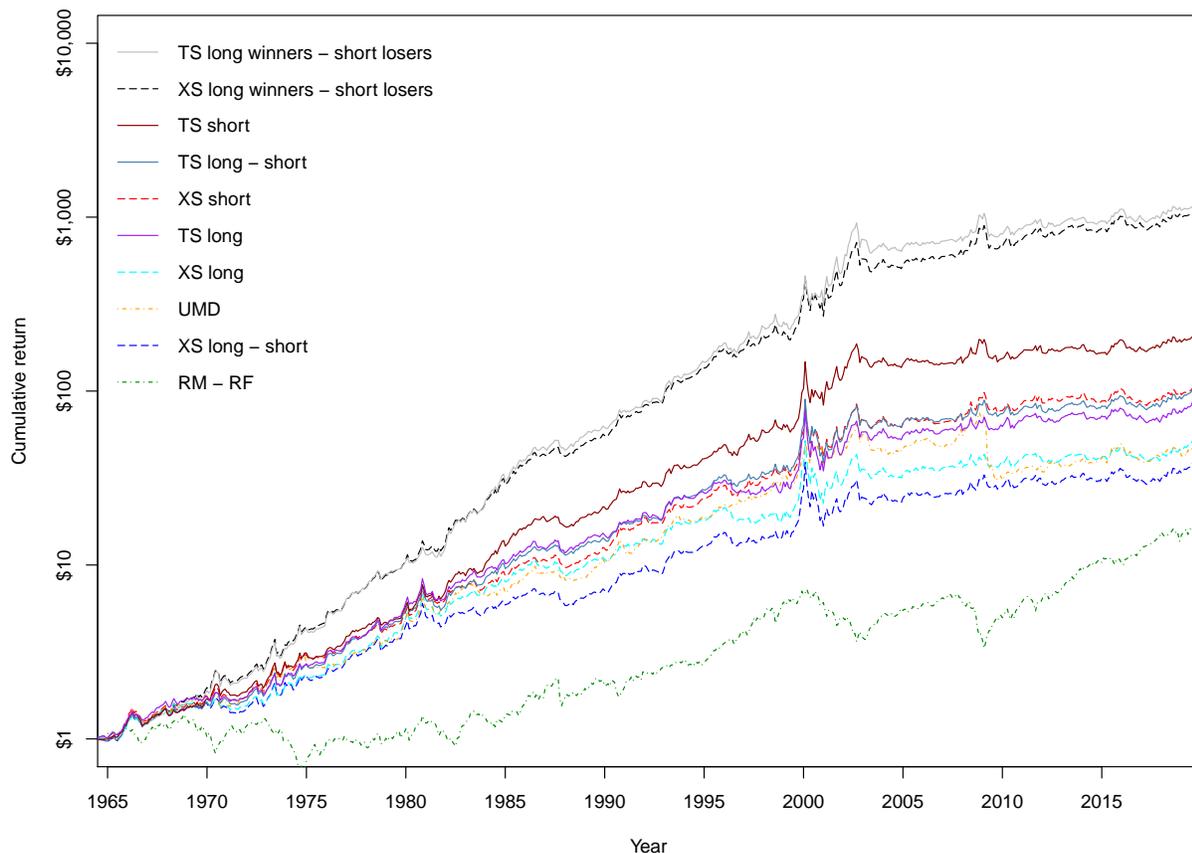


Figure 1: Cumulative return of factor momentum strategies with a formation period of twelve months, July 1964-December 2019

This figure plots the cumulative return for multiple factor momentum strategies examined in this study. The UMD factor and the excess return of the market over 1-month T-bills (RM-RF) are also displayed. All strategies are scaled so that the ex-post volatility is equal to the excess return of the market.

and the five worst performing short legs.

In Table 5 the returns of this strategy are reported. Similarly to the results of Table 4, the TSFM strategy outperforms the XSFM strategy. The returns of the TSFM LW - SL strategy with a formation period of twelve months is 0.59% per month (t-statistic = 6.99) and the three-factor model alpha is 0.61% (t-statistic = 7.98). This is slightly less than the results of the long-short TSFM strategy reported in Table 4, but the advantage of the LW - SL strategy comes in terms of volatility. The Sharpe ratio for the LW - SL strategies range

from 0.88 to 1.06, the highest of all strategies observed in this study.⁹

Figure 1 displays the cumulative performance of different strategies over time. The strategies are leveraged such that the ex-post volatility levels are equal to that of the excess return of the market. Several features stand out. First, The XSFM and TSFM strategies are highly correlated. Second, the factor momentum strategies suffer less from crashes than stock momentum. Particularly, during the global financial crisis stock momentum crashed substantially compared to the various factor momentum strategies. Third, the cumulative return of the long winners - short losers strategies report a cumulative return that is more than ten times as big as the cumulative return of stock momentum.

5.3 Sentiment

Considering my second hypothesis, that overpricing is more prevalent following high sentiment periods, resulting in a stronger autocorrelation structure and in stronger factor momentum, I perform several of the previous analysis, but now conditioning on the level of sentiment. Table 6 reports the factor returns conditional on sentiment. Consistent with Stambaugh et al. (2012), the long-short factors returns are generally higher following high sentiment. Thirty-eight of the long-short factors has a higher return following high sentiment and the combination factor has an average return of 0.29% (t-statistic = 6.84) following high sentiment months and a return of 0.09% (t-statistic = 3.02) following low sentiment months. The difference of 0.20% (t-statistic = 3.88) is significant. For the long factors there is on average no substantial difference between high and low sentiment. Twenty-seven factors have a higher return following high sentiment. The long combination factor returns on average 0.06% (t-statistic = 2.67) following high sentiment and 0.07% (t-statistic = 4.29) following low sentiment, the difference between high and low sentiment is insignificant. Only three of the short factors have a higher return following high sentiment. The short combination factor has an average return following high sentiment of -0.23% (t-statistic = -5.28) and -0.03% (t-statistic = -0.99) following low sentiment. The differences between high and low sentiment of -0.20% is significant (t-statistic = -4.08).

⁹Table A8 in the Appendix shows that the strategies remain profitable when considering subsets of only small stocks and only big stocks.

Table 6: Factor returns conditional on sentiment.

This table reports the factor returns and Newey-West adjusted t-statistics conditional on the level of sentiment in the previous month. The sentiment level is classified as High when the sentiment in the previous month is above the median sentiment level of the index of Baker and Wurgler (2006), and Low when below. The sample period is from August 1965 to December 2018.

Factor	High		Long - Short				High - Low		High		Long		High - Low		High		Short		High - Low	
	r	t(r)	r	t(r)	r	t(r)	r	t(r)	r	t(r)	r	t(r)	r	t(r)	r	t(r)	r	t(r)	r	t(r)
Abninv	0.45	2.54	-0.05	-0.31	0.50	2.29	0.15	2.35	0.11	1.28	0.04	0.39	-0.30	-2.06	0.16	1.58	-0.46	-2.81		
Acc	0.07	0.70	0.25	2.50	-0.18	-1.28	-0.15	-1.48	0.17	2.53	-0.33	-2.58	-0.23	-3.15	-0.08	-1.07	-0.15	-1.46		
Ad2me	0.33	1.79	-0.01	-0.06	0.33	1.48	0.22	1.42	0.03	0.24	0.19	0.97	-0.11	-1.18	0.04	0.48	-0.14	-1.23		
Advertchg	0.02	0.23	-0.13	-1.77	0.15	1.41	0.04	0.45	0.01	0.21	0.03	0.23	0.02	0.20	0.15	1.70	-0.12	-0.86		
Ato	0.22	1.47	0.06	0.45	0.16	0.90	0.01	0.23	0.02	0.37	-0.01	-0.11	-0.14	-2.17	-0.03	-0.50	-0.11	-1.22		
Atochg	0.15	1.94	0.05	0.59	0.10	0.83	0.08	0.96	0.01	0.20	0.07	0.70	-0.14	-1.72	-0.04	-0.58	-0.10	-0.90		
Capto	0.34	2.71	0.07	0.52	0.12	1.38	0.12	1.61	-0.02	-0.34	0.14	1.39	-0.22	-3.09	-0.10	-1.21	-0.13	-1.16		
Cash	-0.05	-0.31	0.22	1.61	-0.27	-1.31	-0.09	-1.01	0.08	1.20	-0.18	-1.57	-0.04	-0.69	-0.14	-2.05	0.10	0.91		
Cegth	0.04	0.37	0.05	0.73	-0.02	-0.13	-0.04	-0.71	0.08	1.69	-0.12	-1.62	-0.08	-1.03	0.03	0.51	-0.10	-1.16		
CFP	0.57	2.90	0.09	0.63	0.48	1.99	0.27	2.42	0.14	1.72	0.13	0.99	-0.31	-3.07	0.05	0.61	-0.35	-2.89		
CMA	0.31	2.79	0.09	0.84	0.22	1.39	0.04	0.75	0.09	1.48	-0.04	-0.54	-0.27	-3.49	-0.01	-0.09	-0.26	-2.67		
Dcap	0.03	0.26	0.08	0.80	-0.05	-0.40	-0.08	-0.97	0.07	1.08	-0.15	-1.55	-0.11	-2.04	-0.01	-0.20	-0.10	-1.50		
DP	0.32	1.82	-0.18	-1.10	0.50	2.16	0.26	1.71	-0.17	-1.42	0.42	2.35	-0.06	-0.74	0.01	0.18	-0.08	-0.74		
Entbm	0.41	1.69	-0.17	-0.73	0.58	1.82	0.12	0.94	-0.00	-0.02	0.13	0.70	-0.29	-2.09	0.16	1.26	-0.45	-2.51		
Entmult	0.34	2.82	0.09	0.86	0.26	1.64	0.11	1.93	0.08	1.62	0.03	0.40	-0.23	-3.06	-0.01	-0.08	-0.23	-2.39		
EP	0.64	2.99	-0.04	-0.25	0.68	2.62	0.30	2.55	0.05	0.72	0.25	1.77	-0.34	-3.34	0.09	1.06	-0.43	-3.35		
Fscore	0.42	2.88	0.09	0.81	0.33	1.81	0.06	0.98	0.09	1.63	-0.03	-0.32	-0.36	-2.79	-0.01	-0.07	-0.36	-2.40		
GS5	-0.13	-1.09	0.16	1.64	-0.29	-2.00	-0.08	-1.37	0.12	2.07	-0.21	-2.48	0.05	0.64	-0.04	-0.66	0.08	0.93		
HML	0.52	2.84	0.01	0.06	0.51	2.07	0.27	2.60	0.02	0.22	0.25	1.66	-0.26	-2.91	0.01	0.15	-0.27	-2.37		
Invq	0.23	2.78	0.18	2.19	0.06	0.53	0.01	0.09	0.15	2.68	-0.14	-1.91	-0.24	-2.53	0.06	0.69	-0.30	-2.34		
Invq2at	0.24	2.03	0.09	0.74	0.16	0.97	0.01	0.20	0.13	2.73	-0.12	-1.93	-0.23	-3.97	-0.04	-0.91	-0.18	-2.45		
Issue1	0.31	2.65	0.07	0.85	0.24	1.80	0.05	0.75	0.03	0.86	0.02	0.26	-0.26	-3.29	-0.04	-0.67	-0.22	-2.43		
Issue5	0.31	3.12	0.22	2.82	0.10	0.78	0.14	2.33	0.06	1.28	0.08	1.15	-0.18	-3.22	-0.16	-3.75	-0.01	-0.22		
Lnoachg	0.16	1.46	0.38	3.44	-0.22	-1.42	0.03	0.48	0.26	3.67	-0.22	-2.28	-0.13	-1.72	-0.13	-1.88	-0.00	-0.01		
LowVol	0.50	1.80	-0.46	-1.53	0.96	2.38	0.21	1.62	-0.19	-1.58	0.41	2.27	-0.29	-1.86	0.27	1.47	-0.56	-2.37		
LTR	0.20	1.20	0.10	0.66	0.10	0.46	0.13	1.34	0.05	0.50	0.08	0.61	-0.07	-0.87	-0.05	-0.74	-0.02	-0.19		
Lvg	0.38	1.99	-0.11	-0.66	0.49	1.90	-0.20	-1.51	0.22	1.84	-0.42	-2.48	-0.03	-0.21	-0.02	-0.14	-0.00	-0.01		
Lvgbm	-0.17	-0.69	0.25	0.91	-0.42	-1.21	0.18	1.57	-0.09	-0.89	0.27	1.68	-0.20	-2.35	0.02	0.32	-0.22	-2.04		
Ncoachg	0.18	1.73	0.35	3.47	-0.17	-1.17	-0.00	-0.06	0.25	3.83	-0.26	-2.40	-0.19	-2.60	-0.10	-1.68	-0.09	-0.90		
Noa	0.37	4.13	0.12	1.37	0.24	1.99	0.08	1.44	0.02	0.34	0.06	0.87	-0.29	-6.17	-0.11	-2.18	-0.18	-2.74		
Nwcchg	0.13	1.54	0.27	3.02	-0.14	-1.15	-0.10	-1.22	0.20	3.25	-0.30	-3.12	-0.23	-3.07	-0.06	-0.88	-0.16	-1.59		
OI	0.37	3.01	0.01	0.05	0.36	2.19	0.13	1.53	-0.02	-0.31	0.16	1.35	-0.23	-3.62	-0.03	-0.52	-0.20	-2.34		
Oscore	0.37	2.44	-0.18	-1.40	0.55	2.95	0.07	1.17	-0.03	-0.50	0.10	1.18	-0.30	-2.09	0.15	1.55	-0.45	-2.77		
Pm	0.24	1.46	-0.15	-1.05	0.40	1.85	-0.12	-2.10	0.07	1.27	-0.19	-2.50	-0.16	-2.69	-0.05	-1.00	-0.11	-1.42		
Pmchg	0.04	0.59	0.12	1.38	-0.08	-0.64	0.03	0.47	-0.08	-1.04	0.11	1.09	-0.21	-1.94	0.07	0.89	-0.29	-2.16		
Ppachg	0.33	3.20	0.10	0.95	0.23	1.61	0.04	0.61	0.10	1.59	-0.06	-0.78	-0.29	-3.85	0.00	0.02	-0.29	-3.09		
QMJ	0.66	4.92	0.16	1.09	0.50	2.44	-0.32	-4.88	-0.30	-3.90	-0.03	-0.26	-0.98	-8.27	-0.46	-4.28	-0.52	-3.53		
RMW	0.47	2.85	0.08	0.68	0.39	2.10	0.12	1.97	0.03	0.47	0.09	1.17	-0.35	-3.42	-0.05	-0.82	-0.29	-2.44		
Roa	0.26	2.13	0.04	0.31	0.22	1.17	0.03	0.54	-0.01	-0.08	0.04	0.42	-0.23	-2.72	-0.05	-0.53	-0.18	-1.49		
Roe	0.29	2.13	0.01	0.04	0.29	1.56	0.00	0.04	0.02	0.34	-0.02	-0.23	-0.29	-2.51	0.01	0.17	-0.30	-2.18		
Seasonal	0.28	2.42	0.51	3.45	-0.23	-1.24	-0.01	-0.10	0.25	2.87	-0.26	-2.11	-0.28	-4.56	-0.26	-3.57	-0.03	-0.28		
SMB	0.05	0.31	0.39	2.13	-0.34	-1.34	0.06	0.67	0.20	2.35	-0.14	-1.21	0.00	0.05	-0.19	-1.88	0.19	1.44		
SP	0.61	3.50	0.14	0.85	0.46	2.00	0.31	2.94	0.10	0.94	0.21	1.51	-0.30	-3.98	-0.05	-0.65	-0.25	-2.55		
STR	0.51	3.18	0.45	2.42	0.07	0.30	0.12	1.13	0.27	2.47	-0.15	-1.23	-0.40	-4.98	-0.18	-2.17	-0.22	-2.03		
Susgr	0.18	1.55	0.01	0.10	0.17	1.01	-0.04	-0.60	0.05	0.81	-0.08	-1.00	-0.21	-2.72	0.04	0.52	-0.25	-2.36		
Turnover	0.37	1.80	-0.20	-1.34	0.57	2.44	0.10	0.89	-0.14	-1.92	0.23	1.97	-0.28	-2.28	0.07	0.72	-0.34	-2.43		
UMD	0.75	4.10	0.44	1.64	0.32	0.98	0.23	2.34	0.27	2.56	-0.05	-0.34	-0.53	-4.46	-0.17	-0.92	-0.36	-1.70		
Xfin	0.58	3.92	0.10	0.99	0.48	2.69	0.12	1.76	0.03	0.84	0.09	1.28	-0.46	-4.32	-0.07	-1.04	-0.40	-3.21		
Xrd2at	-0.05	-0.20	0.16	0.90	-0.21	-0.71	-0.16	-0.90	0.15	1.17	-0.31	-1.50	-0.11	-0.98	-0.01	-0.07	-0.10	-0.78		
Xrd2mv	0.35	1.76	0.34	1.88	0.01	0.04	0.14	1.01	0.30	2.32	-0.15	-0.93	-0.21	-2.18	-0.04	-0.54	-0.17	-1.37		
Zscore	0.12	0.74	-0.06	-0.38	0.18	0.83	-0.06	-0.74	-0.01	-0.09	-0.06	-0.47	-0.18	-1.96	0.05	0.52	-0.23	-1.71		
Combination	0.29	6.84	0.09	3.02	0.20	3.88	0.06	2.67	0.07	4.29	-0.01	-0.19	-0.23	-5.28	-0.03	-0.99	-0.20	-4.08		

Table 7: Factor return autocorrelation conditional on sentiment.

This table reports the factor the coefficients of regressions of the factor returns in month t on the average monthly factor return from month $t - 12$ to $t - 1$ and dummy variables indicating the level of sentiment. The Newey-West adjusted t-statistics are also reported. The sentiment level is classified as High when the sentiment in the previous month is above the median sentiment level of the index of Baker and Wurgler (2006), and Low when below. The sample period is from August 1965 to December 2018.

Factor	Long - Short						Long						Short					
	High		Low		High - Low		High		Low		High - Low		High		Low		High - Low	
	β	$t(\beta)$	β	$t(\beta)$	β	$t(\beta)$	β	$t(\beta)$	β	$t(\beta)$	β	$t(\beta)$	β	$t(\beta)$	β	$t(\beta)$	β	$t(\beta)$
Abninv	0.03	0.50	0.29	1.48	-0.26	-0.99	-0.04	-0.24	0.15	0.84	-0.19	-0.73	0.02	0.22	0.40	1.71	-0.38	-1.35
Acc	0.26	1.50	0.26	1.26	0.00	0.01	0.28	1.24	0.33	1.42	-0.05	-0.16	-0.13	-0.60	0.20	0.78	-0.34	-0.99
Ad2me	0.28	2.02	0.29	1.65	-0.02	-0.06	0.42	2.09	0.23	1.14	0.19	0.56	0.12	0.60	0.33	1.82	-0.21	-0.74
Advertchg	-0.12	-0.50	-0.37	-1.71	0.25	0.74	0.36	2.12	0.04	0.27	0.32	1.31	0.42	2.31	0.32	1.56	0.10	0.40
Ato	-0.29	-1.08	0.36	1.76	-0.65	-1.89	-0.21	-0.61	-0.13	-0.60	-0.08	-0.21	-0.18	-1.32	0.45	2.38	-0.64	-1.88
Atochg	0.01	0.07	0.09	0.42	-0.07	-0.23	-0.24	-0.74	0.47	2.12	-0.71	-2.10	-0.07	-0.30	0.22	1.13	-0.30	-0.89
Capto	0.06	0.26	0.11	0.56	-0.05	-0.17	0.17	0.80	0.10	0.51	0.07	0.22	0.12	0.58	0.07	0.37	0.05	0.17
Cash	0.10	1.50	0.32	1.16	-0.21	-0.54	0.15	1.93	0.33	1.29	-0.17	-0.42	0.03	0.29	0.27	1.00	-0.24	-0.71
Cegth	0.17	0.57	0.33	2.57	-0.16	-0.50	0.13	0.72	0.07	0.32	0.07	0.24	0.08	0.54	0.42	4.05	-0.34	-1.25
CFP	0.03	0.34	0.38	2.02	-0.35	-1.07	0.04	0.33	0.42	1.89	-0.38	-1.01	0.09	0.75	0.32	1.79	-0.23	-0.75
CMA	0.02	0.11	0.29	1.56	-0.27	-1.13	0.08	0.46	0.28	1.45	-0.21	-0.82	0.03	0.15	0.31	1.75	-0.29	-1.10
Dcap	-0.02	-0.16	0.40	1.37	-0.42	-1.76	-0.08	-0.57	0.39	1.41	-0.47	-1.66	0.39	2.54	0.17	0.74	0.22	0.93
DP	-0.39	-1.92	0.36	2.23	-0.76	-2.80	-0.03	-0.20	0.18	1.10	-0.21	-0.76	-0.27	-1.14	0.48	3.40	-0.76	-2.31
Entbm	0.24	1.75	0.27	1.15	-0.03	-0.11	0.40	2.02	0.07	0.33	0.33	0.99	0.15	1.38	0.38	1.30	-0.23	-0.53
Entmult	-0.18	-0.90	0.15	0.75	-0.33	-1.06	-0.37	-1.78	-0.17	-0.67	-0.20	-0.58	-0.01	-0.04	0.50	2.85	-0.51	-1.89
EP	0.12	1.26	0.08	0.36	0.04	0.13	0.17	1.71	0.15	0.81	0.03	0.10	0.10	0.67	0.08	0.41	0.02	0.06
Fscore	0.18	2.48	-0.19	-0.84	0.38	1.12	0.15	0.66	-0.49	-2.05	0.64	2.06	0.25	3.05	-0.02	-0.10	0.28	0.94
GS5	0.29	1.33	0.36	2.10	-0.07	-0.25	0.04	0.16	0.46	2.46	-0.42	-1.44	0.37	2.18	0.01	0.05	0.36	1.46
HML	-0.00	-0.02	0.48	2.89	-0.48	-1.98	0.05	0.45	0.50	2.35	-0.45	-1.72	-0.05	-0.35	0.41	2.70	-0.47	-1.44
Invq	0.12	0.80	0.04	0.18	0.09	0.33	0.27	1.35	0.32	2.06	-0.04	-0.19	-0.20	-1.71	0.33	1.63	-0.53	-2.43
Invq2at	0.17	1.25	0.35	2.20	-0.18	-0.92	0.10	0.57	0.26	1.69	-0.15	-0.61	0.06	0.33	-0.16	-0.77	0.22	0.79
Issue1	0.07	0.36	-0.05	-0.19	0.12	0.32	0.38	2.28	-0.27	-1.55	0.65	2.49	0.05	0.33	0.26	0.94	-0.21	-0.62
Issue5	0.13	0.70	-0.25	-1.50	0.37	1.38	0.25	1.12	-0.21	-1.37	0.47	1.60	0.07	0.42	-0.04	-0.21	0.11	0.40
Lnoachg	-0.06	-0.65	0.26	1.05	-0.32	-0.90	0.00	0.00	0.28	1.54	-0.28	-0.95	0.07	0.30	0.01	0.04	0.06	0.15
LowVol	-0.04	-0.21	0.18	0.96	-0.22	-0.80	-0.06	-0.40	0.10	0.50	-0.16	-0.58	0.01	0.04	0.20	1.06	-0.20	-0.74
LTR	0.29	1.50	0.43	3.50	-0.14	-0.49	0.22	0.96	0.30	1.68	-0.09	-0.25	0.24	1.20	0.54	3.07	-0.30	-1.10
Lvg	0.14	0.91	0.31	1.92	-0.17	-0.54	0.19	1.57	0.39	1.64	-0.19	-0.56	0.41	2.21	0.22	0.60	0.19	0.49
Lvgbm	0.33	1.72	0.32	1.05	0.01	0.02	0.27	1.39	0.15	0.86	0.12	0.37	0.01	0.05	0.49	2.68	-0.49	-1.81
Ncoachg	-0.10	-0.55	-0.07	-0.35	-0.04	-0.13	0.04	0.26	0.02	0.09	0.03	0.10	0.24	1.00	-0.13	-0.74	0.37	1.23
Noa	0.28	1.96	0.38	1.89	-0.11	-0.38	0.25	1.46	0.25	1.24	-0.00	-0.01	0.27	1.77	0.40	1.94	-0.13	-0.49
Nwcchg	0.11	0.66	0.07	0.30	0.05	0.21	0.11	0.41	0.38	1.63	-0.27	-0.83	-0.17	-0.81	0.07	0.28	-0.24	-0.73
OI	0.27	1.51	0.24	1.43	0.03	0.12	0.14	0.57	0.15	0.99	-0.01	-0.04	0.42	2.53	0.36	2.15	0.06	0.23
Oscore	0.21	1.89	0.10	0.52	0.12	0.33	0.26	1.48	0.40	1.92	-0.14	-0.49	0.23	1.39	0.09	0.62	0.14	0.37
Pm	0.22	1.65	0.20	1.12	0.02	0.07	-0.17	-0.64	0.21	1.06	-0.38	-1.15	0.07	0.55	0.14	0.61	-0.07	-0.16
Pmchg	-0.27	-1.04	0.04	0.21	-0.31	-0.97	0.18	0.86	0.18	0.87	0.00	0.01	0.33	2.87	0.20	1.27	0.13	0.49
Ppachg	0.14	0.60	0.29	1.48	-0.15	-0.52	0.09	0.46	0.29	1.67	-0.20	-0.75	0.10	0.47	0.20	1.06	-0.10	-0.34
QMJ	0.37	2.73	0.05	0.19	0.32	1.19	0.60	4.18	0.58	3.60	0.02	0.11	0.47	4.89	0.19	0.76	0.28	1.07
RMW	0.30	2.13	0.03	0.21	0.27	0.73	0.12	0.62	0.19	1.03	-0.07	-0.22	0.41	2.57	-0.02	-0.15	0.42	1.36
Roa	0.35	2.22	0.03	0.08	0.33	1.06	0.16	0.78	0.32	1.65	-0.17	-0.57	0.41	3.28	-0.13	-0.35	0.54	1.50
Roe	0.28	1.65	0.17	1.13	0.10	0.37	0.11	0.55	0.32	1.91	-0.21	-0.78	0.33	2.75	0.12	1.05	0.20	0.74
Seasonal	-0.04	-0.21	0.08	0.41	-0.12	-0.44	0.07	0.35	0.35	1.77	-0.28	-0.97	-0.16	-0.55	0.03	0.14	-0.18	-0.66
SMB	-0.09	-0.26	0.34	1.66	-0.42	-1.16	0.17	0.68	0.34	1.67	-0.17	-0.51	-0.19	-0.86	0.36	1.67	-0.56	-1.66
SP	0.29	2.07	0.31	2.07	-0.02	-0.06	0.32	2.14	0.28	2.12	0.04	0.14	0.29	1.97	0.33	1.76	-0.04	-0.14
STR	-0.18	-0.85	0.18	1.04	-0.36	-1.42	-0.61	-1.95	0.16	0.89	-0.77	-2.61	0.16	0.56	0.27	1.24	-0.11	-0.37
Susgr	-0.06	-0.36	0.48	3.29	-0.54	-2.27	-0.02	-0.07	0.36	2.27	-0.37	-1.15	-0.10	-0.52	0.49	2.59	-0.59	-2.16
Turnover	0.03	0.16	0.06	0.18	-0.03	-0.07	0.06	0.43	0.09	0.23	-0.03	-0.07	0.10	0.54	0.06	0.27	0.04	0.12
UMD	-0.24	-1.15	0.12	0.67	-0.36	-1.25	-0.29	-1.93	0.36	1.51	-0.65	-1.94	-0.08	-0.23	-0.01	-0.08	-0.07	-0.24
Xfin	-0.00	-0.03	-0.06	-0.28	0.06	0.23	0.00	0.00	-0.24	-1.33	0.24	0.79	0.15	0.94	0.17	0.60	-0.02	-0.05
Xrd2at	0.23	3.89	0.31	1.37	-0.08	-0.23	0.10	1.58	0.44	1.81	-0.34	-0.93	0.30	1.61	0.01	0.04	0.29	0.88
Xrd2mv	0.18	2.13	0.29	1.28	-0.11	-0.39	0.01	0.11	0.26	0.99	-0.24	-0.83	0.29	3.02	0.08	0.37	0.21	0.73
Zscore	-0.11	-0.70	0.54	3.09	-0.64	-2.59	0.01	0.08	0.57	2.87	-0.56	-2.14	-0.04	-0.20	0.34	1.98	-0.38	-1.26
Combination	0.32	1.99	0.05	0.28	0.27	1.10	0.28	1.40	0.19	1.28	0.09	0.36	0.13	1.06	0.20	1.25	-0.08	-0.29

Table 7 reports for each factor the correlation of its return with its average return of the previous twelve months, conditional on the level of sentiment, as shown in equation (16). For seventeen of the long-short factors the correlation is stronger following high sentiment. However, the long-short combination factor has a correlation of 0.32 (t-statistic = 1.99) following high sentiment compared to 0.05 (t-statistic = 0.28) following low sentiment. Fifteen of the long factors have a stronger correlation following high sentiment. For the long combination factor the correlation is 0.28 (t-statistic = 1.40) following high sentiment and 0.19 (t-statistic = 1.28) following low sentiment. The short factors show a different behavior, 21 of the short factors have a stronger correlation following high sentiment. The short combination factor has a correlation of 0.13 (t-statistic = 1.06) following high sentiment and 0.20 (t-statistic = 1.25) following low sentiment. Although the difference is insignificant, this makes the short combination factor the only combination factor with a stronger autocorrelation following low sentiment.

Table A5 in the appendix reports results of the regressions when the prior return is the return of the previous month. Again, for the majority of the long-short factors the correlation is stronger following low sentiment. For the long-short combination factor the correlation is 0.08 (t-statistic = 1.38) following high sentiment and 0.15 (t-statistic = 2.02) following low sentiment. The difference between high and low sentiment is -0.07 (t-statistic = -0.72). For the long combination factor the correlation is 0.15 (t-statistic = 2.41) following high sentiment and 0.13 (t-statistic = 2.65) following low sentiment, the difference is insignificant. Seventeen of the short factors still have a stronger correlation following high sentiment. For the short combination factor the correlation is 0.08 (t-statistic = 2.52) following high sentiment and 0.16 (t-statistic = 2.24) following low sentiment. The difference of -0.08 is insignificant (t-statistic = -0.78).

My second hypothesis, that factor momentum is stronger following high sentiment was motivated by the intuition that overpricing increases autocorrelation and that overpricing is stronger following high sentiment. The results regarding the autocorrelation are not consistent with this reasoning. For all factor constructions the majority of the factors has a stronger autocorrelation following low sentiment. For none of the combination factors there is a significant difference in correlation between high and low sentiment periods.

Table 8: Factor momentum returns conditional on sentiment

This table reports monthly returns, Sharpe ratios and estimates of regressions from the returns of the factor momentum strategies on the factors of the Fama-French three-factor model, conditional on the level of sentiment. The sentiment level is classified as High when the sentiment in the previous month is above the median sentiment level of the index of Baker and Wurgler (2006), and Low when below. The formation period is from month $t - 12$ to month $t - 1$, and the strategies are rebalanced monthly. The t-statistics are Newey-West adjusted. Panel A reports the results for the cross-sectional factor momentum strategy. Panel B reports the results for the time-series factor momentum strategy. The sample period is from August 1965 to December 2018.

	Long - Short			Long			Short		
	All	High	Low	All	High	Low	All	High	Low
Panel A: Cross-sectional factor momentum									
Return	0.50	0.40	0.59	0.30	0.26	0.34	0.32	0.33	0.31
t(Return)	4.02	2.62	3.67	4.20	2.94	3.84	4.93	4.26	3.52
Sharpe	0.51	0.36	0.72	0.54	0.40	0.76	0.63	0.56	0.72
alpha	0.53	0.55	0.56	0.30	0.31	0.30	0.36	0.42	0.31
t(a)	4.46	2.60	3.59	4.61	2.65	3.71	5.44	3.55	3.61
Mkt	-0.10	-0.13	-0.07	-0.04	-0.05	-0.03	-0.07	-0.08	-0.05
t(Mkt)	-1.71	-1.61	-0.99	-1.36	-1.29	-0.68	-2.10	-1.80	-1.49
SMB	0.28	0.30	0.21	0.18	0.20	0.14	0.11	0.12	0.08
t(SMB)	1.46	1.12	1.88	1.68	1.34	2.39	1.10	0.87	1.41
HML	-0.13	-0.17	-0.08	-0.05	-0.06	-0.04	-0.08	-0.10	-0.07
t(HML)	-0.82	-0.91	-0.69	-0.55	-0.47	-0.64	-1.02	-1.02	-1.20
Panel B: Time-series factor momentum									
Return	0.63	0.63	0.63	0.33	0.29	0.36	0.42	0.49	0.34
t(Return)	5.11	3.98	3.98	4.79	3.32	4.18	5.57	5.09	3.57
Sharpe	0.62	0.54	0.76	0.59	0.45	0.81	0.71	0.73	0.71
alpha	0.67	0.78	0.60	0.33	0.34	0.33	0.45	0.55	0.34
t(a)	5.57	3.66	3.80	5.18	3.04	4.00	5.96	4.14	3.48
Mkt	-0.13	-0.18	-0.09	-0.04	-0.06	-0.02	-0.09	-0.12	-0.07
t(Mkt)	-2.14	-2.13	-1.22	-1.34	-1.35	-0.63	-2.58	-2.23	-1.67
SMB	0.26	0.28	0.21	0.18	0.20	0.14	0.11	0.13	0.09
t(SMB)	1.34	1.00	1.95	1.76	1.37	2.51	0.94	0.72	1.80
HML	-0.08	-0.13	-0.05	-0.06	-0.06	-0.05	-0.01	-0.01	-0.04
t(HML)	-0.49	-0.67	-0.39	-0.59	-0.53	-0.67	-0.14	-0.04	-0.66

Table 8 reports estimates from regressions of the returns from the factor momentum strategies on the Fama-French three factor model conditional on the level of sentiment, as shown in equation (19). Panel A reports the results for the XSFM strategy, panel B for the TSFM strategy. For the long-short XSFM strategy most of the returns follow from low sentiment periods, 0.59% (t-statistic = 3.67) compared to 0.40% (t-statistic = 2.62) following high sentiment. The same applies to the long factors, although the alpha is slightly higher following high sentiment. The short factors have a slightly higher return following high

sentiment 0.33% (t-statistic = 4.26) compared to low sentiment, 0.31% (t-statistic = 3.52). The lower Sharpe ratio following high sentiment indicates a higher volatility following high sentiment. Several differences between XSFM and TSFM stand out. First, the TSFM long-short returns are equal between high and low sentiment, but the alpha is substantially higher following high sentiment, 0.78% (t-statistic = 3.66) compared to 0.60% (t-statistic = 3.80). Among all factor constructions, the difference between XSFM and TSFM returns seem to be caused following high sentiment periods. Returns, alphas and Sharpe ratios are slightly higher for TSFM following low sentiment, but substantially higher following high sentiment. Avramov et al. (2017) find that their equally-weighted cross-sectional factor momentum strategy earns higher returns during high sentiment periods. Their study, however, differs substantially from mine in terms of factor construction, momentum construction, factor set and sample period. Moreover, generally alphas are higher than returns following high sentiment and lower or equal than returns following low sentiment. This can be explained by differences in factor loadings. The factor momentum strategies load more negative on the market premium following high sentiment. Furthermore, the strategies load heavier on the SMB factor following high sentiment, but the returns of the SMB factor are substantially lower following high sentiment. Furthermore, the long-short and long strategies have a more negative exposure to the HML factor following high sentiment. The returns of the HML factor stem almost entirely following high sentiment periods.

Consider my second hypothesis, that factor momentum is more profitable following high sentiment. The results indicate that this is dependent on the factor construction and form of factor momentum. For the short factors, TSFM indeed has higher returns, alphas and Sharpe ratios following high sentiment. Short XSFM also has higher returns and alphas following high sentiment, but a lower Sharpe ratio. The Sharpe ratios indicate that returns are more volatile following high sentiment. Where the long-short XSFM strategy has a higher return, alpha and Sharpe ratio following low sentiment, the TSFM strategy has equal returns, a lower alpha, but a higher Sharpe ratio following low sentiment. For the long factors, returns and Sharpe ratios are higher following low sentiment, but alphas are higher following high sentiment.

Table 9: Factor momentum returns with a formation period of one month

This table reports monthly returns, Sharpe ratios and estimates of regressions from the returns of the factor momentum strategies on the factors of the Fama French three-factor model. The strategies are decomposed into the winner (W) portfolio and the loser (L) portfolio. The formation period is month $t - 1$, and the strategies are rebalanced monthly. The t-statistics are Newey-West adjusted. Panel A reports the results for the cross-sectional factor momentum strategy. Panel B reports the results for the time-series factor momentum strategy. The sample period is from August 1963 to December 2019.

	Long - Short			Long			Short		
	W-L	W	L	W-L	W	L	W-L	W	L
Panel A: Cross-sectional factor momentum									
Return	0.69	0.51	-0.18	0.38	0.25	-0.13	0.41	0.09	-0.32
t(Return)	6.17	8.53	-2.71	6.42	7.65	-4.38	6.64	1.97	-8.26
Sharpe	0.75	1.02	-0.35	0.74	0.94	-0.47	0.81	0.30	-1.00
alpha	0.76	0.55	-0.21	0.41	0.25	-0.16	0.45	0.10	-0.34
t(a)	6.36	8.56	-3.50	6.31	7.29	-4.34	7.28	2.88	-9.27
Mkt	-0.14	-0.13	0.01	-0.08	-0.04	0.04	-0.08	0.02	0.10
t(Mkt)	-2.87	-5.02	0.35	-3.16	-3.13	2.88	-2.34	1.16	5.71
SMB	0.06	0.03	-0.03	0.03	0.05	0.02	0.02	0.05	0.03
t(SMB)	0.45	0.46	-0.42	0.50	1.66	0.51	0.21	1.30	0.79
HML	0.00	0.09	0.09	0.01	0.01	0.01	0.00	-0.09	-0.09
t(HML)	0.05	1.81	1.76	0.18	0.56	0.17	0.03	-3.15	-3.24
Panel B: Time-series factor momentum									
Return	0.75	0.60	-0.15	0.39	0.27	-0.12	0.47	0.09	-0.38
t(Return)	6.37	8.34	-2.21	6.69	7.64	-4.10	6.84	1.70	-7.38
Sharpe	0.77	1.05	-0.29	0.77	1.01	-0.43	0.79	0.25	-0.94
alpha	0.82	0.63	-0.18	0.43	0.28	-0.15	0.50	0.10	-0.40
t(a)	6.56	8.57	-3.03	6.64	7.72	-4.23	7.10	2.59	-8.75
Mkt	-0.16	-0.16	0.00	-0.08	-0.04	0.04	-0.09	0.02	0.12
t(Mkt)	-3.07	-5.41	0.10	-3.32	-3.32	2.71	-2.62	1.19	6.24
SMB	0.06	0.01	-0.05	0.03	0.05	0.02	0.01	0.07	0.06
t(SMB)	0.46	0.15	-0.65	0.52	2.16	0.60	0.14	1.89	1.24
HML	0.02	0.15	0.13	0.01	0.00	-0.00	0.04	-0.12	-0.15
t(HML)	0.25	2.77	2.39	0.14	0.12	-0.14	0.58	-3.59	-3.96

6 Robustness

In this section I test how results vary if I choose another formation period or another factor set.

6.1 Formation period

I construct XSFM and TSFM strategies with a formation period of one month instead of twelve months. Table 9 reports the estimates from the regressions and several features are

Table 10: Factor momentum returns conditional on sentiment with a formation period of one month
This table reports monthly returns, Sharpe ratios and estimates of regressions from the returns of the factor momentum strategies on the factors of the Fama French three-factor model, conditional on the level of sentiment. The sentiment level is classified as High when the sentiment in the previous month is above the median sentiment level of the index of Baker and Wurgler (2006), and Low when below. The formation period is month $t - 1$, and the strategies are rebalanced monthly. The t-statistics are Newey-West adjusted. Panel A reports the results for the cross-sectional factor momentum strategy. Panel B reports the results for the time-series factor momentum strategy. The sample period is from August 1965 to December 2018.

	Long - Short			Long			Short		
	All	H	L	All	H	L	All	H	L
Panel A: Cross-sectional factor momentum									
Return	0.74	0.65	0.83	0.40	0.36	0.44	0.43	0.40	0.47
t(Return)	6.31	3.65	5.83	6.71	4.34	6.02	6.77	4.39	5.66
Sharpe	0.79	0.60	1.04	0.78	0.60	1.04	0.85	0.71	1.04
alpha	0.80	0.73	0.88	0.43	0.39	0.46	0.47	0.46	0.50
t(a)	6.42	3.70	6.60	6.33	3.68	6.66	7.37	4.06	6.20
Mkt	-0.14	-0.18	-0.10	-0.07	-0.09	-0.06	-0.07	-0.10	-0.04
t(Mkt)	-2.71	-2.23	-1.64	-2.97	-2.19	-1.83	-2.19	-2.43	-1.21
SMB	0.06	0.09	0.00	0.03	0.03	0.03	0.02	0.04	-0.03
t(SMB)	0.43	0.38	0.02	0.47	0.27	0.70	0.19	0.32	-0.64
HML	0.01	0.00	0.02	0.01	0.03	-0.01	0.01	-0.01	0.01
t(HML)	0.14	0.02	0.20	0.27	0.35	-0.21	0.10	-0.08	0.23
Panel B: Time-series factor momentum									
Return	0.80	0.73	0.87	0.42	0.38	0.45	0.50	0.48	0.51
t(Return)	6.63	4.02	5.94	6.81	4.59	6.07	7.14	4.82	5.71
Sharpe	0.81	0.65	1.05	0.81	0.64	1.06	0.83	0.70	1.03
alpha	0.86	0.81	0.92	0.45	0.41	0.47	0.53	0.53	0.54
t(a)	6.66	3.96	6.61	6.62	3.82	6.80	7.19	4.57	6.02
Mkt	-0.16	-0.21	-0.10	-0.08	-0.09	-0.06	-0.09	-0.14	-0.04
t(Mkt)	-2.80	-2.53	-1.58	-3.13	-2.31	-1.87	-2.46	-2.90	-1.09
SMB	0.06	0.08	0.01	0.03	0.03	0.03	0.01	0.01	-0.01
t(SMB)	0.40	0.34	0.16	0.49	0.30	0.65	0.12	0.11	-0.24
HML	0.03	0.01	0.03	0.01	0.03	-0.02	0.04	0.03	0.03
t(HML)	0.34	0.09	0.32	0.23	0.39	-0.36	0.66	0.27	0.41

noteworthy. First, returns, alphas and Sharpe ratios are higher when applying a formation period of one month compared to twelve months, consistent with Gupta and Kelly (2019). Second, the improvement of a one month formation period instead of twelve months is stronger for XSFM than for TSFM, again consistent with Gupta and Kelly (2019). Ehsani and Linnainmaa (2019) find a similar return for twelve month and one month formation periods for TSFM, however their factor set consists of only twenty factors. Third, also for a formation period of one month, the Sharpe ratios of the short factors are highest. Returns

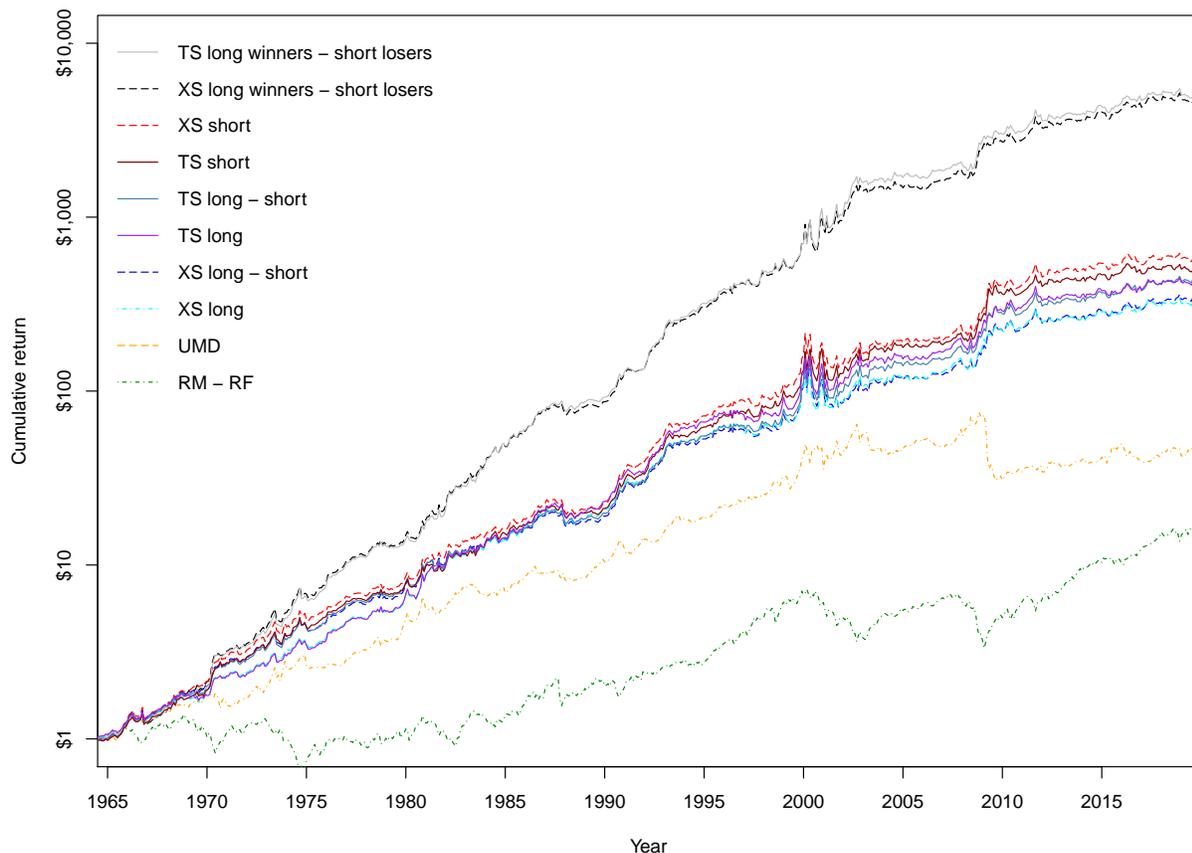


Figure 2: Cumulative return of factor momentum strategies with a formation period of one months, July 1964-December 2019

This figure plots the cumulative return for multiple factor momentum strategies examined in this study. The UMD factor and the excess return of the market over 1-month T-bills (RM-RF) are also displayed. All strategies are scaled so that the ex-post volatility is equal to the excess return of the market.

and alphas are highest for the long-short factors, indicating that the short factors are less volatile and scaling the short factors such that its volatility equals that of the long-short factors result in the highest returns and alphas for the short factors. I conclude that the short factors remain the most profitable on a risk-adjusted basis, for a formation period of one month.¹⁰

Next, I repeat the regressions of XSFM and TSFM returns conditional on sentiment with a formation period of one month instead of twelve months. Contrary to the results

¹⁰Table A9 and Table A10 in the appendix show that the high Sharpe ratios for the short factors does not stem from either small stocks only or big stocks only.

of a twelve month formation period, TSFM also performs better following low sentiment in terms of return, alpha and Sharpe ratio for all factor constructions. I conclude that the higher profitability observed for the short factors following high sentiment are not robust to a formation period of one month. The finding that the long-short and long factors perform better following low sentiment is robust to a formation period of one month.

Figure 2 shows cumulative returns of the various factor momentum strategies with a formation period of one month. Additionally, the cumulative returns of stock momentum and the excess return of the market are displayed. The strategies are leveraged such that the ex-post volatility levels are equal to that of the excess return of the market. Figure 2 strengthens the findings displayed in figure 1. In particular, the high performance of factor momentum strategies with a one month formation period, during the global financial crisis stands out. This is consistent with the findings of Arnott et al. (2019) and Gupta and Kelly (2019). Furthermore, the cumulative returns of the long winner - short loser strategies are extreme.

6.2 Factor set

One concern of factor research remains the gap between the literature and the use in practice by investors. Robeco, an international asset manager, mentions the following:

The debate about which factors are really worth consideration is still ongoing among academics. Over time, hundreds of different premiums have been documented in the academic literature, but only a handful seem worth exploiting. ... The most frequently targeted factors are value and size ... as well as momentum. ... On top of these factors, many academics and product providers also strongly advocate exposure to low risk ... and quality.¹¹

The literature showed that factor momentum is still profitable when using a limited set of factors. Ehsani and Linnainmaa (2019) find that a factor momentum strategy that alternates between a long and a short position in just one factor, could still earn a significant return. Arnott et al. (2019) add to the debate that selecting the six best factors increases the t-statistic of the return to 8.47 compared to 5.55 for their full set of 51 factors.

¹¹<https://www.robeco.com/docm/docu-201703-three-ways-to-succesfully-implement-factors.pdf>

Table 11: Factor momentum returns of seven practical factors with a twelve month formation period
This table reports monthly returns, Sharpe ratios and estimates of regressions from the returns of the factor momentum strategies on the factors of the Fama French three-factor model. The factors are CMA, HML, LowVol, QMJ, RMW, SMB and UMD. The strategies are decomposed into the winner (W) portfolio and the loser (L) portfolio. The formation period is from month $t-12$ to month $t-1$, and the strategies are rebalanced monthly. The t-statistics are Newey-West adjusted. Panel A reports the results for the cross-sectional factor momentum strategy. Panel B reports the results for the time-series factor momentum strategy. The sample period is from July 1964 to December 2019.

	W-L	W	L	W-L	W	L	W-L	W	L
Panel A: Cross-sectional factor momentum									
Return	0.55	0.52	-0.02	0.39	0.23	-0.16	0.47	-0.00	-0.47
t(Return)	3.23	5.83	-0.20	4.67	5.16	-3.21	4.96	-0.04	-6.80
Sharpe	0.41	0.66	-0.03	0.61	0.59	-0.48	0.65	-0.01	-0.97
alpha	0.62	0.59	-0.02	0.38	0.24	-0.14	0.55	-0.00	-0.55
t(a)	3.77	6.66	-0.23	4.87	5.67	-2.85	5.87	-0.06	-9.21
Mkt	-0.09	-0.20	-0.11	-0.02	-0.07	-0.05	-0.11	0.05	0.16
t(Mkt)	-1.20	-4.30	-2.93	-0.65	-3.14	-3.14	-2.58	2.40	5.44
SMB	0.31	0.14	-0.17	0.20	0.11	-0.09	0.09	0.10	0.01
t(SMB)	1.33	1.26	-1.39	1.92	2.33	-1.55	0.63	1.31	0.19
HML	-0.29	0.03	0.32	-0.07	0.01	0.07	-0.14	-0.15	-0.01
t(HML)	-1.61	0.31	3.14	-0.68	0.14	1.61	-1.48	-2.63	-0.16
Panel B: Time-series factor momentum									
Return	0.79	0.66	-0.12	0.41	0.25	-0.17	0.69	0.08	-0.60
t(Return)	4.42	4.84	-1.03	4.86	4.67	-3.24	5.62	1.17	-5.89
Sharpe	0.53	0.63	-0.16	0.63	0.58	-0.50	0.77	0.17	-0.86
alpha	0.88	0.77	-0.11	0.41	0.26	-0.15	0.78	0.06	-0.72
t(a)	4.89	6.48	-1.07	5.20	5.55	-3.37	6.73	1.01	-8.47
Mkt	-0.24	-0.31	-0.07	-0.05	-0.09	-0.04	-0.21	0.03	0.24
t(Mkt)	-2.73	-4.56	-1.96	-1.47	-3.25	-2.39	-4.07	1.34	5.90
SMB	0.35	0.08	-0.27	0.21	0.10	-0.10	0.10	0.18	0.07
t(SMB)	1.38	0.69	-1.84	1.99	2.44	-1.55	0.68	1.97	1.06
HML	-0.14	0.12	0.25	-0.05	0.04	0.09	-0.03	-0.11	-0.09
t(HML)	-0.64	1.01	2.04	-0.51	0.70	1.64	-0.20	-1.58	-1.07

I combine the message of Robeco with the evidence in the literature that factor momentum remains profitable with a limited factor set. Specifically, I construct XSFM and TSFM strategies that take only positions in seven factors, the size, value, investment and profitability factors of the Fama-French five-factor model and the low volatility, momentum and quality minus junk factors.¹² These factors are factors that are used by investors and are easy to get exposure to by the means of ETFs for instance. For these reasons, I call this the

¹²I added the investment and profitability factors to the factors brought forward by Robeco because I believe these factors can be considered practical factors too. In Table A11 and Table A12 in the appendix I exclude the investment and profitability factors and the conclusions remain similar.

Table 12: Factor momentum returns of seven practical factors with a one month formation period

This table reports monthly returns, Sharpe ratios and estimates of regressions from the returns of the factor momentum strategies on the factors of the Fama French three-factor model. The factors are CMA, HML, LowVol, QMJ, RMW, SMB and UMD. The strategies are decomposed into the winner (W) portfolio and the loser (L) portfolio. The formation period is month $t - 1$, and the strategies are rebalanced monthly. The t-statistics are Newey-West adjusted. Panel A reports the results for the cross-sectional factor momentum strategy. Panel B reports the results for the time-series factor momentum strategy. The sample period is from August 1963 to December 2019.

	W-L	W	L	W-L	W	L	W-L	W	L
Panel A: Cross-sectional factor momentum									
Return	0.88	0.64	-0.24	0.49	0.31	-0.19	0.56	0.13	-0.43
t(Return)	5.36	6.87	-2.08	6.34	6.77	-3.83	5.99	1.72	-7.34
Sharpe	0.65	0.79	-0.30	0.79	0.84	-0.54	0.72	0.26	-0.87
alpha	0.97	0.73	-0.24	0.52	0.33	-0.19	0.62	0.11	-0.51
t(a)	5.87	7.47	-2.46	6.07	7.00	-3.87	6.52	2.03	-9.21
Mkt	-0.17	-0.25	-0.08	-0.08	-0.09	-0.01	-0.10	0.07	0.17
t(Mkt)	-2.18	-5.89	-1.90	-2.18	-4.50	-0.76	-2.40	2.35	6.81
SMB	0.06	0.02	-0.04	0.06	0.05	-0.01	-0.01	0.02	0.03
t(SMB)	0.28	0.24	-0.39	0.66	1.19	-0.30	-0.11	0.41	0.59
HML	-0.02	0.14	0.16	0.03	0.08	0.04	-0.01	-0.08	-0.07
t(HML)	-0.20	2.01	2.33	0.54	2.31	1.50	-0.11	-1.73	-1.56
Panel B: Time-series factor momentum									
Return	1.01	0.77	-0.24	0.51	0.33	-0.19	0.68	0.13	-0.56
t(Return)	5.29	6.62	-1.74	6.31	6.49	-3.66	5.93	1.33	-6.93
Sharpe	0.65	0.76	-0.26	0.78	0.81	-0.50	0.71	0.21	-0.82
alpha	1.12	0.90	-0.22	0.55	0.35	-0.19	0.75	0.10	-0.66
t(a)	5.70	7.25	-2.22	6.16	6.75	-4.11	6.64	1.46	-8.61
Mkt	-0.24	-0.33	-0.09	-0.09	-0.11	-0.02	-0.15	0.07	0.22
t(Mkt)	-2.83	-6.12	-1.64	-2.54	-5.19	-0.81	-2.88	2.00	6.68
SMB	0.06	-0.06	-0.12	0.06	0.04	-0.03	-0.02	0.09	0.10
t(SMB)	0.30	-0.72	-1.12	0.68	1.10	-0.53	-0.16	2.03	1.78
HML	0.03	0.20	0.17	0.02	0.09	0.07	0.05	-0.08	-0.12
t(HML)	0.20	2.34	1.99	0.36	2.79	2.10	0.60	-1.35	-2.06

practical strategy. Table 11 reports estimates from regressions of the of the returns of XSFM and TSFM strategies with these practical factors and a formation period of twelve months on the Fama-French three-factor model. The results show that the XSFM and TSFM strategies remain profitable when using a set of practical factors. In fact, the practical winner-loser portfolios outperform the full set of 51 factors among all factor constructions in terms of return and alpha. In terms of Sharpe ratio, only the long-short Sharpe is higher for the full factor set. Moreover, also for the practical factors the Sharpe ratio is highest for the short factors. Table 12 repeats the analysis for a formation period of one month instead of

twelve months. Also for a one month formation period factor momentum with the practical factors is profitable. In this case the Sharpe ratios are highest for the long factors. This evidence shows that a factor momentum strategy is not restricted to a plethora of factors nor unrealistic factors.

7 Conclusion

In this study I examine the behavior of factor momentum among different factor constructions. I construct factors following the traditional Fama-French long-short approach, and zero-investment cost factors that consist of the factors' long (short) legs with an opposite position in a size adjusted market portfolio. The motivation is that short-sale constraints are preventing rational arbitrageurs from correcting mispricing, resulting in a stronger return persistence in the short factors. Furthermore, I examine the behavior of the different factor constructions conditional on the level of sentiment. The intuition is that factor momentum is driven by mispricing and mispricing is stronger following high levels of sentiment.

I find positive average autocorrelation in all three factor constructions, momentum strategies that trade on the time-series predictability of factors earn abnormal returns. The autocorrelation is strongest for the short factors. Factor momentum returns are mainly driven by autocorrelation in factor returns. The stronger autocorrelation for the short factors transfers into returns of factor momentum strategies so that strategies constructed from short factors outperform strategies constructed from long-short factors or long factors in terms of Sharpe ratios.

Furthermore, I find that the correlation of returns with the average return of the previous year for the long-short and long factors is stronger following high sentiment than following low sentiment. In contrast, the correlation is weaker for the short factors. However, the long-short and long factors earn higher or equal returns on factor momentum strategies following low sentiment than following high sentiment. For the short factors the factor momentum returns are higher following high sentiment when the formation period is twelve months, but this does not hold for a formation period of one month. Additionally I find that the returns are more volatile following high sentiment.

The expectation that factor momentum should be stronger following high sentiment was motivated by the idea that overpricing accumulates during high sentiment periods, resulting in a strong autocorrelation structure during high sentiment periods. The results do not support this expectation, autocorrelation is stronger following low sentiment periods. My intuition was that the accumulating overpricing is the driver of autocorrelation, and overpricing accumulates primarily following high sentiment periods. It might be, in fact, that it is the slow reversion towards fundamental prices following low sentiment periods that is the main driver of autocorrelation.

Additionally, I propose a zero-investment cost factor momentum strategy that takes long positions in the long leg winners and short positions in the short leg losers. This strategy is superior over the other strategies considered in this study and has a Sharpe ratio of 1.06 when using a formation period of one month, for cross-sectional and time-series strategies. The strategy has Sharpe ratios of 0.88 and 0.91 respectively for a formation period of twelve months.

Finally, to decrease the gap between research and practice, I show that factor momentum remains profitable when using a restricted set of seven factor that are used by investors in practice.

I propose several suggestions for further research. First, longer holding periods are worth investigating to assess the optimal strategy in practice. While I show that attractive gross returns and Sharpe ratios can be achieved when implementing factor momentum strategies using a set of practical factors, I do not take into account trading costs. To assess the net profitability of such a strategy trading costs need to be taken into account and less frequent rebalancing will enhance the net return.

Second, the sample I consider, consist of only US stocks. Research needs to be done to investigate if my conclusions hold in other markets. More so because of cross-sectional differences in short-sale constraints that markets are facing around the globe.

References

- Arnott, R. D., Clements, M., Kalesnik, V., & Linnainmaa, J. T. (2019). Factor momentum. *Available at SSRN 3116974*.
- Asness, C. S., Moskowitz, T. J., & Pedersen, L. H. (2013). Value and momentum everywhere. *The Journal of Finance*, *68*(3), 929–985.
- Avramov, D., Cheng, S., Schreiber, A., & Shemer, K. (2017). Scaling up market anomalies. *The Journal of Investing*, *26*(3), 89–105.
- Baker, M., & Wurgler, J. (2006). Investor sentiment and the cross-section of stock returns. *The journal of Finance*, *61*(4), 1645–1680.
- Baquero, G., Horst, J. t., & Verbeek, M. (2005). Survival, look-ahead bias, and persistence in hedge fund performance. *Journal of Financial and Quantitative analysis*, 493–517.
- Barber, B. M., & Odean, T. (2008). All that glitters: The effect of attention and news on the buying behavior of individual and institutional investors. *The review of financial studies*, *21*(2), 785–818.
- Barberis, N., Shleifer, A., & Vishny, R. (1998). A model of investor sentiment. *Journal of financial economics*, *49*(3), 307–343.
- Berk, J. B., Green, R. C., & Naik, V. (1999). Optimal investment, growth options, and security returns. *The Journal of finance*, *54*(5), 1553–1607.
- Blitz, D., Baltussen, G., & van Vliet, P. (2020). When equity factors drop their shorts. *Financial Analysts Journal*, *76*(4), 73–99.
- Blitz, D., Huij, J., & Martens, M. (2011). Residual momentum. *Journal of Empirical Finance*, *18*(3), 506–521.
- Brown, S. J., & Goetzmann, W. N. (1995). Performance persistence. *The Journal of finance*, *50*(2), 679–698.
- Carhart, M. M. (1997). On persistence in mutual fund performance. *The Journal of finance*, *52*(1), 57–82.
- Chordia, T., Roll, R., & Subrahmanyam, A. (2011). Recent trends in trading activity and market quality. *Journal of Financial Economics*, *101*(2), 243–263.

- Conrad, J., & Kaul, G. (1998). An anatomy of trading strategies. *The Review of Financial Studies*, 11(3), 489–519.
- Daniel, K., Hirshleifer, D., & Subrahmanyam, A. (1998). Investor psychology and security market under- and overreactions. *the Journal of Finance*, 53(6), 1839–1885.
- D’avolio, G. (2002). The market for borrowing stock. *Journal of financial economics*, 66(2-3), 271–306.
- De Long, J. B., Shleifer, A., Summers, L. H., & Waldmann, R. J. (1990). Noise trader risk in financial markets. *Journal of political Economy*, 98(4), 703–738.
- Drechsler, I., & Drechsler, Q. F. (2014). *The shorting premium and asset pricing anomalies* (tech. rep.). National Bureau of Economic Research.
- Ehsani, S., & Linnainmaa, J. T. (2019). *Factor momentum and the momentum factor* (tech. rep.). National Bureau of Economic Research.
- Fama, E. F., & French, K. R. (1993). Common risk factors in the returns on stocks and bonds. *Journal of financial economics*, 33(1), 3–56.
- Goyal, A., & Jegadeesh, N. (2018). Cross-sectional and time-series tests of return predictability: What is the difference? *The Review of Financial Studies*, 31(5), 1784–1824.
- Grinblatt, M., Titman, S., & Wermers, R. (1995). Momentum investment strategies, portfolio performance, and herding: A study of mutual fund behavior. *The American economic review*, 1088–1105.
- Gupta, T., & Kelly, B. (2019). Factor momentum everywhere. *The Journal of Portfolio Management*, 45(3), 13–36.
- Harvey, C. R., Liu, Y., & Zhu, H. (2016). and the cross-section of expected returns. *The Review of Financial Studies*, 29(1), 5–68.
- Hendricks, D., Patel, J., & Zeckhauser, R. (1993). Hot hands in mutual funds: Short-run persistence of relative performance, 1974–1988. *The Journal of finance*, 48(1), 93–130.
- Hong, H., & Stein, J. C. (1999). A unified theory of underreaction, momentum trading, and overreaction in asset markets. *The Journal of finance*, 54(6), 2143–2184.

- Jagannathan, R., Malakhov, A., & Novikov, D. (2010). Do hot hands exist among hedge fund managers? an empirical evaluation. *The Journal of Finance*, *65*(1), 217–255.
- Jegadeesh, N., & Titman, S. (1993). Returns to buying winners and selling losers: Implications for stock market efficiency. *The Journal of finance*, *48*(1), 65–91.
- Johnson, T. C. (2002). Rational momentum effects. *The Journal of Finance*, *57*(2), 585–608.
- Jostova, G., Nikolova, S., Philipov, A., & Stahel, C. W. (2013). Momentum in corporate bond returns. *The Review of Financial Studies*, *26*(7), 1649–1693.
- Lesmond, D. A., Schill, M. J., & Zhou, C. (2004). The illusory nature of momentum profits. *Journal of financial economics*, *71*(2), 349–380.
- Lewellen, J. (2002). Momentum and autocorrelation in stock returns. *The Review of Financial Studies*, *15*(2), 533–564.
- Lo, A. W., & MacKinlay, A. C. (1990). When are contrarian profits due to stock market overreaction? *The review of financial studies*, *3*(2), 175–205.
- McLean, R. D., & Pontiff, J. (2016). Does academic research destroy stock return predictability? *The Journal of Finance*, *71*(1), 5–32.
- Miller, E. M. (1977). Risk, uncertainty, and divergence of opinion. *The Journal of finance*, *32*(4), 1151–1168.
- Moskowitz, T. J., & Grinblatt, M. (1999). Do industries explain momentum? *The Journal of finance*, *54*(4), 1249–1290.
- Moskowitz, T. J., Ooi, Y. H., & Pedersen, L. H. (2012). Time series momentum. *Journal of financial economics*, *104*(2), 228–250.
- Novy-Marx, R. (2012). Is momentum really momentum? *Journal of Financial Economics*, *103*(3), 429–453.
- Rachev, S., Jašić, T., Stoyanov, S., & Fabozzi, F. J. (2007). Momentum strategies based on reward–risk stock selection criteria. *Journal of Banking & Finance*, *31*(8), 2325–2346.
- Sagi, J. S., & Seasholes, M. S. (2007). Firm-specific attributes and the cross-section of momentum. *Journal of Financial Economics*, *84*(2), 389–434.
- Savor, P. G., & Gamboa-Cavazos, M. (2011). Holding on to your shorts: When do short sellers retreat? *Available at SSRN 689162*.

- Schwert, G. W. (2003). Anomalies and market efficiency. *Handbook of the Economics of Finance*, 1, 939–974.
- Shleifer, A., & Vishny, R. W. (1997). The limits of arbitrage. *The Journal of finance*, 52(1), 35–55.
- Stambaugh, R. F., Yu, J., & Yuan, Y. (2012). The short of it: Investor sentiment and anomalies. *Journal of Financial Economics*, 104(2), 288–302.
- Yu, J., & Yuan, Y. (2011). Investor sentiment and the mean–variance relation. *Journal of Financial Economics*, 100(2), 367–381.

Appendix

Table A1: Factors

This table reports the factors, descriptions, authors, year of publication and the start date in this study.

Factor	Description	Authors	Publication	Start date
Abninv	Abnormal capital investment	Titman, Wei and Xie	2004	July 1966
Acc	Accruals	Sloan	1998	July 1971
Ad2me	Advertisement expense divided by market value	Chan, Lakonishok and Sougiannis	2001	July 1973
Advertchg	Change in expenditures on advertising	Chemmanur and Yan	2009	July 1975
Ato	Asset turnover	Soliman	2008	July 1967
Atochg	Change in asset turnover	Soliman	2008	July 1968
Capto	Capital turnover	Haugen and Baker	1996	July 1963
Cash	Cash	Palazzo	2012	July 1963
Cegth	Capital expenditure growth	Anderson and Garcia-Feijoo	2006	July 1966
CFP	Cash flow to price	Lakonishok, Shliefer and Vishny	1994	July 1963
CMA	Investment (asset growth)	Cooper, Gulen and Schill	2008	July 1963
Dcap	Debt capacity	Hahn and Lee	2009	July 1963
DP	Dividend yield	Litzenberger and Ramaswamy	1982	July 1963
Entbm	Enterprise component of book to market	Penman, Richardson, and Tuna	2007	July 1983
Entmult	Enterprise multiple	Loughran and Wellman	2011	July 1964
EP	Earnings to price	Basu	1983	July 1963
Fscore	F-score	Piotroski	2000	July 1963
GS5	Sales growth	Lakonishok, Shliefer and Vishny	1994	July 1963
HML	Book to market	Fama and French	1992	July 1963
Invg	Inventory growth	Belo & Lin	2012	July 1964
Invg2at	Inventory growth to assets	Thomas & Zhang	2002	July 1964
Issue1	Log growth of adjusted shares over 12 months	Pontiff and Woodgate	2008	July 1963
Issue5	Log growth of adjusted shares over 60 months	Pontiff and Woodgate	2008	July 1963
Lnoachg	Growth in long-term net operating assets	Fairfield, Whisenant, and Yohn	2003	July 1971
LowVol	Low volatility	Blitz & Van Vliet	2007	July 1963
LTR	Long term return reversal	De Bondt and Thaler	1984	July 1963
Lvg	Leverage	Bhandari	1988	July 1963
Lvgbm	Leverage component of book to market	Penman, Richardson, and Tuna	2007	July 1983
Ncoachg	Noncurrent operating assets	Soliman	2008	July 1964
Noa	Net operating assets	Hirshleifer, Hou, Teoh, and Zhang	2004	July 1964
Nwchg	Net working capital changes	Soliman	2008	July 1964
OI	Operating leverage	Novy-Marx	2010	July 1963
Oscore	O-score	Griffin and Lemmon	2002	July 1963
Pm	Profit margin	Soliman	2008	July 1963
Pmchg	Change in profit margin	Soliman	2008	July 1963
Ppachg	Changes in property, plant, and equipment divided by assets	Lyandres, Sun, and Zhang	2007	July 1964
QMJ	Quality Minus Junk	Asness, Frazzini, and Pedersen	2019	July 1963
RMW	Operating profitability	Fama and French	2015	July 1963
Roa	Return on assets	Cooper, Gulen and Schill	2008	July 1963
Roe	Return on equity	Haugen and Baker	1996	July 1963
Seasonal	Return seasonalities	Heston and Sadka	2008	July 1963
SMB	Market equity	Bankz	1981	July 1963
SP	Sales to price	Lewellen	2015	July 1963
STR	Short term reversal	Jegadeesh	1990	July 1963
Susgr	Sustainable growth	Lockwood and Prombutr	2016	July 1964
Turnover	Share volume	Gervais, Kaniel & Mingelgrin	2001	July 1963
UMD	Momentum	Jegadeesh and Titman	1993	July 1963
Xfin	External financing	Bradshaw, Richardson and Sloan	2006	July 1972
Xrd2at	Research and Development expenditure divided by total assets	Li	2011	July 1972
Xrd2mv	Research and Development expenditure divided by market value	Chan, Lakonishok and Sougiannis	2001	July 1972
Zscore	Z-score	Dichev	1998	July 1970

Table A2: Factor return autocorrelation with past month return

This table reports the coefficients of regressions of the factor returns in month t on the return in month $t - 1$. The reported t-statistics are Newey-West adjusted and standard errors from the combination factor are clustered by factor and month to obtain the t-statistics. The sample period is from August 1963 to December 2019.

Factor	Long - Short		Long		Short	
	β	$t(\beta)$	β	$t(\beta)$	β	$t(\beta)$
Abninv	0.08	1.81	0.06	1.47	0.10	2.96
Acc	0.08	1.77	0.06	4.94	0.05	0.80
Ad2me	0.10	2.16	0.16	4.51	0.04	0.61
Advertchg	-0.04	-0.61	0.04	0.55	0.13	3.75
Ato	0.09	1.83	0.04	1.09	0.11	2.06
Atochg	0.06	1.26	0.09	1.66	0.09	1.74
Capto	0.17	4.76	0.17	5.03	0.15	3.44
Cash	0.06	1.68	0.09	2.78	0.04	1.06
Cegth	0.09	2.91	0.07	1.50	0.08	2.90
CFP	0.11	2.73	0.11	3.04	0.10	2.14
CMA	0.13	2.71	0.12	2.52	0.14	3.02
Dcap	0.03	0.54	0.06	2.02	0.05	1.37
DP	0.16	3.71	0.14	2.62	0.14	3.68
Entbm	0.16	2.78	0.15	3.35	0.16	3.30
Entmult	0.08	1.80	0.02	0.58	0.12	2.39
EP	0.12	2.38	0.13	2.38	0.10	2.38
Fscore	0.07	1.22	-0.01	-0.22	0.10	1.58
GS5	0.15	3.37	0.10	2.76	0.16	3.10
HML	0.13	2.70	0.15	3.05	0.11	2.07
Invq	0.11	2.72	0.02	0.58	0.15	3.35
Invq2at	0.19	5.10	0.10	2.43	0.14	3.71
Issue1	0.08	1.25	0.18	3.59	0.07	1.69
Issue5	0.07	1.55	0.10	1.77	0.03	0.68
Lnoachg	0.10	1.91	0.13	2.67	0.05	1.23
LowVol	0.13	3.47	0.16	5.88	0.11	2.51
LTR	0.17	4.13	0.11	2.54	0.18	4.25
Lvg	0.09	1.38	0.13	2.33	0.17	2.40
Lvgbm	0.15	2.13	0.08	1.33	0.09	1.48
Ncoachg	0.07	1.44	0.09	1.96	0.06	1.29
Noa	0.00	0.10	0.03	0.90	0.00	0.07
Nwcchg	0.12	3.36	0.09	6.71	0.07	1.03
Ol	0.12	2.81	0.15	4.29	0.12	2.38
Oscore	0.12	2.84	0.09	1.85	0.09	2.10
Pm	0.17	6.16	0.05	1.10	0.11	1.85
Pmchg	0.06	1.31	0.16	3.56	0.19	6.51
Ppachg	0.13	3.71	0.15	4.16	0.13	3.69
QMJ	0.17	4.48	0.15	2.83	0.21	5.36
RMW	0.17	5.37	0.14	3.71	0.17	6.34
Roa	0.14	3.58	0.12	2.80	0.15	4.98
Roe	0.15	3.68	0.12	3.04	0.17	5.59
Seasonal	0.04	0.82	0.09	2.30	0.03	0.48
SMB	0.04	0.70	0.03	0.69	0.05	0.93
SP	0.15	2.44	0.17	2.81	0.11	1.92
STR	-0.02	-0.41	0.01	0.22	-0.02	-0.47
Susgr	0.12	2.49	0.10	2.42	0.11	2.49
Turnover	-0.05	-2.28	-0.09	-2.78	-0.00	-0.11
UMD	0.06	0.69	0.07	1.76	0.08	0.74
Xfin	0.14	6.00	0.10	1.96	0.14	6.61
Xrd2at	0.07	1.23	0.09	2.11	0.08	1.60
Xrd2mv	0.03	0.67	0.04	0.70	0.07	1.49
Zscore	0.10	1.81	0.07	1.09	0.12	2.52
Combination	0.10	2.02	0.10	2.12	0.11	2.22

Table A3: Average monthly factor returns conditional on their own past twelve month returns. This table reports the coefficients of regressions of the factor returns in month t on the average factor return from month $t - 12$ to $t - 1$.

$$r_{f,t} = \alpha_{f,t} + \beta d_{f,-t} + \epsilon_{f,t},$$

where $r_{f,t}$ is the return of factor f in month t , $d_{f,-t}$ is a dummy variable taking the value 1 if the average return of factor f during month $t - 12$ to $t - 1$ exceeds 0, and 0 otherwise. The reported t-statistics are Newey-West adjusted and standard errors from the combination factor are clustered by factor and month to obtain the t-statistics. The sample period is from July 1964 to December 2019.

Factor	Long - Short				Long				Short			
	α	$t(\alpha)$	β	$t(\beta)$	α	$t(\alpha)$	β	$t(\beta)$	α	$t(\alpha)$	β	$t(\beta)$
Abninv	0.03	0.14	0.31	1.25	0.11	1.23	0.05	0.46	-0.14	-1.43	0.14	0.71
Acc	0.02	0.17	0.21	1.36	-0.19	-2.10	0.34	3.11	-0.14	-2.26	-0.03	-0.23
Ad2me	-0.07	-0.40	0.44	1.75	-0.20	-1.13	0.56	2.65	-0.08	-0.99	0.09	0.69
Advertchg	0.01	0.09	-0.16	-1.36	-0.10	-1.11	0.25	2.19	-0.08	-0.67	0.29	1.99
Ato	0.12	0.84	0.02	0.10	0.07	1.04	-0.09	-1.16	-0.13	-2.34	0.12	1.40
Atochg	-0.03	-0.29	0.21	1.94	0.01	0.08	0.08	0.74	-0.11	-1.78	0.07	0.80
Capto	0.13	0.94	0.13	0.76	0.05	0.60	0.01	0.08	-0.19	-3.06	0.11	1.18
Cash	-0.02	-0.14	0.23	1.22	-0.06	-1.01	0.15	1.43	-0.13	-2.23	0.08	1.04
Cegth	-0.05	-0.46	0.13	1.01	-0.03	-0.50	0.06	0.93	-0.09	-1.55	0.15	1.73
CFP	0.05	0.23	0.42	1.72	0.04	0.27	0.23	1.66	-0.25	-3.26	0.29	2.58
CMA	0.07	0.71	0.20	1.49	0.01	0.23	0.09	1.25	-0.20	-3.44	0.20	2.44
Dcap	-0.00	-0.01	0.12	0.87	-0.02	-0.36	0.05	0.49	-0.11	-1.92	0.13	1.85
DP	-0.02	-0.14	0.13	0.69	-0.03	-0.24	0.13	0.85	-0.04	-0.61	0.07	0.74
Entbm	-0.36	-1.42	0.82	2.83	-0.19	-1.29	0.39	2.30	-0.20	-1.84	0.33	1.75
Entmult	0.16	1.16	0.06	0.39	0.16	1.87	-0.11	-1.08	-0.20	-3.56	0.21	2.19
EP	0.14	0.57	0.26	1.01	0.05	0.39	0.20	1.41	-0.21	-2.65	0.20	1.58
Fscore	0.22	1.07	0.05	0.22	0.06	0.78	0.03	0.24	-0.23	-3.09	0.20	1.29
GS5	-0.21	-1.89	0.46	3.11	-0.06	-1.20	0.17	2.05	-0.08	-1.51	0.17	2.21
HML	0.06	0.30	0.32	1.38	-0.03	-0.24	0.28	2.14	-0.22	-3.46	0.25	2.44
Inv	0.09	0.79	0.17	1.43	-0.00	-0.02	0.13	1.55	-0.16	-2.20	0.19	1.43
Inv2at	-0.14	-1.24	0.47	3.21	0.05	0.85	0.04	0.62	-0.14	-3.23	0.04	0.49
Issue1	0.11	0.81	0.13	0.82	-0.01	-0.15	0.10	1.45	-0.20	-3.66	0.16	1.66
Issue5	0.13	0.98	0.18	1.27	0.08	1.66	0.03	0.47	-0.18	-5.12	0.07	1.01
Lnoachg	0.15	1.47	0.16	1.08	-0.00	-0.04	0.22	2.25	-0.10	-1.52	-0.05	-0.46
LowVol	-0.34	-1.16	0.69	1.93	-0.11	-0.92	0.24	1.50	-0.18	-1.20	0.39	1.72
LTR	-0.23	-1.62	0.62	3.54	-0.04	-0.40	0.20	1.51	-0.15	-2.34	0.21	2.17
Lvg	-0.28	-1.36	0.73	3.28	-0.18	-1.55	0.34	2.14	-0.18	-1.20	0.36	1.88
Lvgbm	-0.42	-2.10	0.85	2.97	-0.16	-1.25	0.38	2.58	-0.21	-3.31	0.30	2.97
Ncoachg	0.20	1.77	0.07	0.52	0.01	0.09	0.17	1.88	-0.17	-3.11	0.08	0.84
Noa	0.02	0.18	0.33	2.41	-0.04	-0.73	0.16	2.20	-0.26	-6.72	0.24	3.06
Nwchg	0.04	0.39	0.23	1.78	-0.07	-1.03	0.23	2.52	-0.17	-2.92	0.09	0.83
OI	0.01	0.03	0.31	1.86	0.01	0.12	0.09	0.80	-0.23	-4.24	0.27	3.59
Oscore	-0.13	-0.88	0.41	2.04	-0.09	-1.98	0.23	3.02	-0.22	-1.76	0.31	1.81
Pm	-0.29	-2.08	0.64	3.56	-0.05	-1.05	0.06	0.77	-0.14	-3.19	0.13	1.36
Pmchg	0.04	0.49	0.05	0.51	-0.09	-1.46	0.15	1.59	-0.20	-2.05	0.30	2.32
Ppachg	-0.12	-1.14	0.51	4.06	-0.05	-0.85	0.19	2.28	-0.23	-4.22	0.25	2.65
QMJ	0.13	0.94	0.37	2.04	-0.39	-7.82	0.39	3.54	-0.74	-7.93	0.49	2.88
RMW	0.05	0.28	0.32	1.55	0.03	0.40	0.08	1.06	-0.28	-4.03	0.28	2.79
Roa	-0.04	-0.29	0.33	1.96	-0.10	-2.15	0.23	3.36	-0.13	-1.60	0.01	0.04
Roe	-0.09	-0.71	0.43	2.83	-0.06	-1.19	0.15	2.58	-0.26	-3.19	0.32	2.79
Seasonal	0.13	0.75	0.30	1.51	-0.02	-0.26	0.20	1.86	-0.25	-4.57	0.01	0.09
SMB	-0.05	-0.28	0.48	1.85	-0.05	-0.57	0.31	2.50	-0.16	-1.67	0.15	1.17
SP	-0.13	-0.62	0.74	3.11	-0.05	-0.38	0.38	2.47	-0.28	-4.86	0.34	3.56
STR	0.30	1.10	0.27	0.93	0.17	1.04	0.06	0.33	-0.33	-5.84	0.17	1.05
Susgr	-0.06	-0.60	0.29	2.04	-0.08	-1.79	0.19	2.47	-0.12	-1.95	0.10	1.05
Turnover	0.22	0.90	-0.23	-0.82	0.03	0.25	-0.08	-0.59	-0.12	-1.31	0.01	0.07
UMD	0.57	2.30	-0.01	-0.02	0.17	1.62	0.10	0.77	-0.37	-3.24	0.19	1.29
Xfin	0.18	1.18	0.21	1.21	0.10	1.47	-0.05	-0.59	-0.31	-3.87	0.22	1.75
Xrd2at	-0.24	-1.28	0.66	2.34	-0.20	-1.54	0.44	2.14	-0.20	-1.91	0.25	1.83
Xrd2mv	0.09	0.55	0.48	1.90	0.13	0.86	0.17	0.88	-0.22	-2.42	0.19	1.45
Zscore	-0.11	-0.77	0.29	1.25	-0.15	-2.14	0.26	2.14	-0.18	-1.90	0.23	1.82
Combination	-0.02	-0.26	0.34	3.56	-0.04	-1.48	0.19	3.77	-0.21	-5.93	0.21	3.64

Table A4: Average monthly factor returns conditional on their own past month return.

This table reports the coefficients of regressions of the factor returns in month t on the return in month $t-1$.

$$r_{f,t} = \alpha_{f,t} + \beta d_{f,-t} + \epsilon_{f,t},$$

where $r_{f,t}$ is the return of factor f in month t , $d_{f,-t}$ is a dummy variable taking the value 1 if the return of factor f during month $t-1$ exceeds 0, and 0 otherwise. The reported t-statistics are Newey-West adjusted and standard errors from the combination factor are clustered by factor and month to obtain the t-statistics. The sample period is from August 1963 to December 2019.

Factor	Long - Short				Long				Short			
	α	$t(\alpha)$	β	$t(\beta)$	α	$t(\alpha)$	β	$t(\beta)$	α	$t(\alpha)$	β	$t(\beta)$
Abninv	0.00	0.01	0.39	1.89	0.07	0.87	0.12	1.32	-0.32	-3.29	0.50	3.19
Acc	0.11	1.00	0.06	0.47	-0.05	-0.64	0.11	1.20	-0.16	-2.17	0.04	0.38
Ad2me	-0.34	-2.15	0.95	4.28	-0.27	-2.13	0.77	4.41	-0.17	-2.05	0.27	2.34
Advertchg	-0.07	-0.97	0.03	0.30	-0.04	-0.53	0.13	1.11	-0.11	-1.00	0.36	3.10
Ato	-0.19	-1.43	0.60	3.34	-0.02	-0.39	0.07	1.02	-0.18	-3.24	0.23	2.73
Atochg	0.03	0.32	0.13	1.05	-0.07	-1.09	0.24	2.74	-0.20	-3.07	0.26	2.50
Capto	-0.20	-1.73	0.73	5.00	-0.11	-1.91	0.31	4.07	-0.31	-5.23	0.35	4.00
Cash	-0.07	-0.65	0.32	1.95	-0.06	-0.94	0.14	1.46	-0.16	-2.33	0.15	1.97
Cegth	-0.08	-0.89	0.21	1.85	-0.06	-1.17	0.14	2.06	-0.09	-1.61	0.16	2.00
CFP	-0.04	-0.24	0.64	3.28	0.03	0.33	0.30	2.65	-0.26	-3.56	0.32	3.03
CMA	-0.13	-1.44	0.59	4.33	-0.02	-0.48	0.17	2.42	-0.31	-5.03	0.41	4.98
Dcap	-0.08	-0.96	0.27	1.82	-0.10	-1.57	0.20	2.19	-0.09	-1.83	0.07	1.09
DP	-0.31	-2.33	0.71	3.47	-0.21	-1.91	0.52	3.38	-0.24	-3.59	0.48	5.28
Entbm	-0.37	-1.50	0.95	3.36	-0.19	-1.41	0.44	2.89	-0.31	-2.69	0.47	2.66
Entmult	0.06	0.52	0.26	1.92	0.08	1.34	0.01	0.16	-0.23	-4.10	0.28	3.31
EP	-0.03	-0.17	0.59	2.60	0.03	0.29	0.28	2.53	-0.29	-3.60	0.37	3.17
Fscore	0.15	1.33	0.18	1.20	0.09	1.49	-0.00	-0.03	-0.28	-3.27	0.25	2.03
GS5	-0.16	-1.56	0.35	2.76	-0.05	-0.90	0.14	1.77	-0.15	-2.54	0.30	3.69
HML	-0.11	-0.62	0.66	2.96	-0.05	-0.44	0.35	2.69	-0.30	-4.53	0.42	4.22
Invq	0.07	0.95	0.22	2.27	0.08	1.62	-0.01	-0.20	-0.32	-3.43	0.53	4.33
Invq2at	-0.17	-1.59	0.59	4.63	0.00	0.06	0.14	2.38	-0.22	-4.63	0.23	3.16
Issue1	0.05	0.42	0.28	1.98	-0.06	-1.18	0.20	2.92	-0.19	-3.33	0.10	1.19
Issue5	0.15	1.47	0.17	1.45	0.01	0.14	0.15	2.54	-0.18	-4.49	0.06	0.79
Lnoachg	-0.02	-0.19	0.49	3.06	0.00	0.01	0.24	2.64	-0.15	-1.96	0.06	0.53
LowVol	-0.65	-2.36	1.33	3.87	-0.26	-2.42	0.55	3.91	-0.30	-2.26	0.62	2.77
LTR	-0.14	-1.06	0.52	2.96	-0.07	-0.75	0.27	2.39	-0.20	-3.24	0.30	3.65
Lvg	-0.22	-1.23	0.65	3.20	-0.20	-1.82	0.37	2.38	-0.27	-2.20	0.50	3.17
Lvgbm	-0.52	-2.74	1.02	3.69	-0.17	-1.68	0.42	3.17	-0.23	-3.83	0.32	3.29
Ncoachg	0.03	0.26	0.40	3.03	0.03	0.46	0.15	1.70	-0.21	-3.49	0.15	2.00
Noa	0.16	1.83	0.15	1.44	0.02	0.47	0.06	0.81	-0.22	-5.21	0.07	1.16
Nwchg	0.04	0.54	0.25	2.20	-0.07	-1.00	0.23	2.74	-0.23	-3.38	0.24	2.43
Ol	-0.09	-0.82	0.50	3.53	-0.12	-1.55	0.34	3.46	-0.20	-3.65	0.17	2.07
Oscore	-0.17	-1.36	0.51	3.25	-0.07	-1.29	0.17	2.25	-0.25	-2.22	0.37	2.30
Pm	-0.36	-2.71	0.77	4.50	-0.06	-1.27	0.09	1.30	-0.14	-3.17	0.11	1.61
Pmchg	-0.03	-0.35	0.20	1.81	-0.16	-2.50	0.28	3.28	-0.30	-3.57	0.49	4.27
Ppachg	-0.03	-0.36	0.44	3.64	-0.06	-1.11	0.23	3.36	-0.30	-5.01	0.35	4.34
QMJ	0.00	0.03	0.67	3.94	-0.42	-9.44	0.32	3.88	-0.88	-11.11	0.60	4.75
RMW	-0.09	-0.63	0.64	3.83	-0.10	-1.65	0.31	4.39	-0.28	-4.14	0.23	2.44
Roa	-0.05	-0.42	0.35	2.34	-0.06	-1.06	0.14	1.91	-0.29	-3.90	0.34	3.79
Roe	-0.24	-2.08	0.72	5.18	-0.12	-2.32	0.26	3.91	-0.36	-4.62	0.50	4.63
Seasonal	0.22	1.63	0.23	1.30	0.00	0.00	0.19	1.72	-0.31	-4.96	0.15	1.46
SMB	-0.15	-0.98	0.71	3.18	-0.03	-0.31	0.30	2.55	-0.28	-3.19	0.40	3.16
SP	-0.04	-0.23	0.72	3.53	-0.08	-0.81	0.51	4.00	-0.27	-4.53	0.25	2.85
STR	0.56	2.90	-0.09	-0.42	0.22	1.88	-0.02	-0.17	-0.27	-4.19	-0.07	-0.66
Susgr	-0.09	-0.92	0.35	2.50	-0.07	-1.58	0.18	2.56	-0.21	-3.34	0.27	3.11
Turnover	0.27	1.49	-0.34	-1.61	0.03	0.33	-0.10	-0.92	-0.17	-1.88	0.13	0.94
UMD	0.29	1.11	0.46	1.51	0.10	1.01	0.24	1.84	-0.42	-4.49	0.25	1.24
Xfin	0.17	1.54	0.28	2.13	0.04	0.87	0.06	1.00	-0.38	-4.81	0.28	2.89
Xrd2at	-0.14	-0.83	0.41	1.55	-0.19	-1.57	0.39	2.08	-0.20	-2.28	0.28	2.47
Xrd2mv	0.11	0.71	0.43	1.67	0.05	0.38	0.31	1.88	-0.24	-2.43	0.23	1.97
Zscore	-0.15	-1.15	0.39	1.92	-0.17	-2.46	0.29	2.78	-0.19	-2.25	0.24	2.16
Combination	-0.06	-1.10	0.46	4.87	-0.06	-1.98	0.23	4.72	-0.26	-6.77	0.30	5.24

Table A5: One month factor return autocorrelation conditional on sentiment.

This table reports the factor the coefficients of regressions of the factor returns in month t on the factor return in month $t - 1$ and dummy variables indicating the level of sentiment. The Newey-West adjusted t-statistics are also reported. The sentiment level is classified as High when the sentiment in the previous month is above the median sentiment level of the index of Baker and Wurgler (2006), and Low when below. The sample period is from August 1965 to December 2018.

Factor	Long - Short						Long						Short					
	High		Low		High - Low		High		Low		High - Low		High		Low		High - Low	
	β	$t(\beta)$	β	$t(\beta)$	β	$t(\beta)$	β	$t(\beta)$	β	$t(\beta)$	β	$t(\beta)$	β	$t(\beta)$	β	$t(\beta)$	β	$t(\beta)$
Abninv	0.01	0.34	0.22	3.21	-0.21	-2.45	-0.06	-1.42	0.19	3.40	-0.25	-3.26	0.07	1.71	0.17	2.76	-0.10	-1.19
Acc	0.06	0.93	0.07	1.08	-0.01	-0.15	0.03	0.79	0.08	1.11	-0.05	-0.58	-0.01	-0.12	0.12	2.15	-0.13	-1.43
Ad2me	0.14	2.13	0.04	0.75	0.10	1.13	0.24	5.69	0.06	1.33	0.18	2.16	0.04	0.45	0.03	0.36	0.01	0.12
Advertchg	-0.11	-1.44	0.06	0.95	-0.17	-1.71	0.02	0.17	0.10	1.36	-0.08	-0.68	0.17	3.96	0.07	1.24	0.09	1.32
Ato	0.07	1.07	0.14	1.95	-0.07	-0.75	0.03	0.55	0.05	0.91	-0.02	-0.18	0.08	1.07	0.16	2.80	-0.09	-0.90
Atochg	0.03	0.37	0.09	1.28	-0.06	-0.62	0.06	0.77	0.17	2.81	-0.11	-1.32	0.07	0.99	0.11	1.62	-0.05	-0.43
Capto	0.18	3.73	0.17	2.65	0.01	0.18	0.19	4.06	0.13	2.59	0.06	0.90	0.14	2.08	0.17	2.95	-0.03	-0.34
Cash	0.04	0.77	0.10	1.41	-0.06	-0.95	0.07	1.61	0.12	1.75	-0.05	-0.55	0.02	0.34	0.08	1.14	-0.06	-0.80
Cegth	0.09	1.24	0.09	1.49	-0.01	-0.05	0.02	0.29	0.10	2.14	-0.08	-0.85	0.07	1.77	0.09	1.66	-0.02	-0.26
CFP	0.10	1.90	0.12	1.65	-0.01	-0.16	0.11	2.98	0.12	1.49	-0.00	-0.04	0.09	1.29	0.10	1.78	-0.02	-0.20
CMA	0.10	1.38	0.17	2.81	-0.07	-0.72	0.17	2.69	0.11	1.70	0.06	0.69	0.09	1.57	0.17	2.29	-0.07	-0.82
Dcap	0.01	0.28	0.05	0.86	-0.04	-0.57	0.03	0.78	0.10	1.55	-0.07	-0.79	0.07	1.78	0.04	0.68	0.03	0.39
DP	0.12	2.09	0.19	2.88	-0.07	-0.81	0.09	1.54	0.20	3.19	-0.10	-1.18	0.15	3.49	0.13	2.11	0.02	0.33
Entbm	0.16	2.02	0.21	2.71	-0.05	-0.49	0.18	2.69	0.15	1.58	0.04	0.31	0.12	2.13	0.28	3.78	-0.17	-1.72
Entmult	0.06	0.89	0.08	1.47	-0.02	-0.21	-0.04	-0.79	0.07	1.52	-0.11	-1.41	0.11	1.65	0.10	1.27	0.02	0.18
EP	0.11	1.65	0.10	1.45	0.01	0.07	0.15	2.24	0.09	1.26	0.07	0.72	0.06	1.17	0.11	1.76	-0.05	-0.56
Fscore	0.12	1.33	0.00	0.04	0.12	1.07	-0.04	-0.46	0.02	0.44	-0.07	-0.65	0.15	1.67	-0.01	-0.07	0.15	1.57
GS5	0.15	2.82	0.15	1.94	-0.00	-0.02	0.08	1.57	0.10	1.69	-0.02	-0.30	0.25	4.83	0.09	1.15	0.15	1.71
HML	0.10	1.72	0.20	2.76	-0.10	-0.94	0.10	1.82	0.21	3.15	-0.11	-1.25	0.09	1.44	0.14	1.92	-0.05	-0.46
Inv	0.08	1.63	0.12	2.03	-0.04	-0.51	0.02	0.36	0.01	0.19	0.01	0.12	0.07	1.48	0.23	3.73	-0.16	-2.21
Inv2at	0.14	2.76	0.25	4.38	-0.11	-1.56	0.10	1.96	0.09	1.33	0.02	0.21	0.11	1.92	0.14	2.70	-0.03	-0.44
Issue1	0.03	0.37	0.18	2.71	-0.14	-1.35	0.25	3.29	0.11	1.85	0.14	1.51	0.01	0.18	0.18	2.87	-0.17	-1.75
Issue5	0.12	1.41	0.03	0.47	0.10	0.91	0.17	1.84	0.02	0.25	0.15	1.17	0.08	1.64	-0.01	-0.08	0.08	0.97
Lnoachg	0.02	0.39	0.24	3.99	-0.23	-2.94	0.07	2.19	0.20	3.49	-0.12	-1.39	-0.00	-0.04	0.15	2.56	-0.15	-1.77
LowVol	0.07	1.82	0.20	3.17	-0.12	-1.61	0.13	3.25	0.19	3.06	-0.06	-0.77	0.03	0.66	0.19	2.94	-0.16	-2.06
LTR	0.22	3.85	0.13	2.15	0.09	1.08	0.11	1.36	0.12	2.42	-0.01	-0.16	0.22	3.42	0.15	2.43	0.07	0.77
Lvg	0.04	0.44	0.18	2.77	-0.14	-1.29	0.09	1.17	0.22	2.98	-0.14	-1.44	0.11	1.39	0.27	2.52	-0.16	-1.14
Lvgbm	0.09	1.04	0.28	3.58	-0.19	-1.77	0.05	0.51	0.15	1.97	-0.10	-0.95	0.04	0.42	0.19	3.26	-0.16	-1.60
Ncoachg	0.03	0.40	0.14	2.76	-0.11	-1.21	0.09	1.07	0.07	1.31	0.01	0.16	0.04	0.52	0.10	1.80	-0.06	-0.51
Noa	-0.04	-0.63	0.04	0.75	-0.07	-0.93	0.04	0.66	0.03	0.45	0.01	0.11	-0.07	-1.16	0.06	1.24	-0.13	-1.56
Nwcchg	0.09	1.54	0.14	2.37	-0.05	-0.67	0.04	0.92	0.14	1.83	-0.10	-1.06	0.01	0.18	0.13	1.78	-0.12	-0.99
Ol	0.15	2.53	0.07	1.08	0.07	0.87	0.17	3.12	0.13	2.65	0.04	0.56	0.13	1.54	0.08	1.09	0.05	0.48
Oscore	0.10	2.21	0.14	1.66	-0.04	-0.39	-0.02	-0.29	0.21	4.12	-0.23	-2.58	0.07	1.76	0.09	0.88	-0.02	-0.18
Pm	0.20	5.37	0.15	2.17	0.04	0.47	0.01	0.09	0.07	1.31	-0.06	-0.56	0.17	2.32	0.03	0.33	0.15	1.28
Pmchg	0.08	0.97	0.04	0.66	0.03	0.33	0.17	4.01	0.16	2.33	0.01	0.13	0.22	5.72	0.14	1.99	0.07	0.85
Ppachg	0.06	1.22	0.20	3.46	-0.13	-1.75	0.11	2.48	0.20	3.54	-0.09	-1.10	0.09	1.61	0.15	2.67	-0.06	-0.67
QMJ	0.17	3.63	0.16	2.29	0.01	0.10	0.13	1.36	0.18	2.73	-0.06	-0.51	0.16	2.89	0.22	3.28	-0.06	-0.48
RMW	0.15	3.15	0.18	2.69	-0.03	-0.24	0.13	2.97	0.15	2.91	-0.03	-0.32	0.14	3.04	0.19	2.59	-0.05	-0.54
Roa	0.12	2.25	0.15	2.45	-0.03	-0.33	0.08	1.11	0.17	3.23	-0.09	-1.06	0.12	2.53	0.17	2.73	-0.05	-0.55
Roe	0.15	2.66	0.15	2.18	0.00	0.04	0.10	1.75	0.14	2.46	-0.04	-0.50	0.15	3.17	0.18	2.42	-0.02	-0.24
Seasonal	-0.02	-0.32	0.09	1.06	-0.10	-0.99	0.05	1.10	0.12	1.34	-0.07	-0.62	-0.03	-0.51	0.08	1.12	-0.11	-1.24
SMB	-0.00	-0.04	0.07	1.01	-0.07	-0.82	-0.00	-0.04	0.06	0.97	-0.06	-0.64	0.01	0.14	0.09	1.12	-0.08	-0.80
SP	0.12	1.46	0.19	2.40	-0.07	-0.55	0.14	1.59	0.21	2.96	-0.07	-0.62	0.09	1.09	0.13	1.59	-0.04	-0.34
STR	-0.01	-0.11	-0.02	-0.32	0.01	0.12	0.02	0.28	0.01	0.11	0.01	0.14	-0.01	-0.13	-0.02	-0.30	0.01	0.08
Susgr	0.09	1.21	0.16	2.85	-0.07	-0.74	0.12	2.51	0.11	1.54	0.01	0.14	0.07	1.17	0.16	2.71	-0.08	-0.98
Turnover	-0.03	-0.71	-0.11	-2.15	0.07	0.98	-0.06	-1.60	-0.14	-2.88	0.08	0.83	0.03	0.52	-0.06	-0.98	0.09	0.77
UMD	-0.07	-0.93	0.17	1.90	-0.25	-2.00	0.05	0.56	0.12	1.90	-0.07	-0.72	-0.10	-0.99	0.22	2.37	-0.32	-2.28
Xfin	0.13	3.34	0.10	1.34	0.02	0.30	0.13	2.08	0.05	0.62	0.08	0.91	0.12	3.04	0.10	1.52	0.02	0.15
Xrd2at	0.06	0.78	0.09	1.76	-0.03	-0.30	0.06	0.85	0.14	2.70	-0.07	-0.89	0.09	1.15	0.06	0.81	0.03	0.30
Xrd2mv	0.01	0.15	0.05	1.05	-0.04	-0.36	0.01	0.09	0.09	1.54	-0.08	-0.85	0.07	1.21	0.05	0.79	0.03	0.23
Zscore	0.03	0.43	0.20	3.24	-0.17	-1.80	-0.00	-0.04	0.22	4.41	-0.22	-2.25	0.08	1.47	0.16	2.29	-0.08	-0.92
Combination	0.08	1.38	0.15	2.02	-0.07	-0.72	0.15	2.41	0.13	2.65	0.02	0.30	0.08	2.52	0.16	2.24	-0.08	-0.78

Table A6: Factor momentum returns small stocks, twelve month formation period

This table reports monthly returns, Sharpe ratios and estimates of regressions from the returns of the factor momentum strategies on the factors of the Fama French three-factor model. Only small stocks are included. The long and short factors are constructed as zero-investment cost factors by taking an offsetting position in a small stock only market portfolio. The strategies are decomposed into the winner (W) portfolio and the loser (L) portfolio. The formation period is from month $t - 12$ to month $t - 1$, and the strategies are rebalanced monthly. The t-statistics are Newey-West adjusted. Panel A reports the results for the cross-sectional factor momentum strategy. Panel B reports the results for the time-series factor momentum strategy. The sample period is from July 1964 to December 2019.

	W-L	W	L	W-L	W	L	W-L	W	L
Panel A: Cross-sectional factor momentum									
Return	0.52	0.50	-0.03	0.29	0.21	-0.08	0.34	-0.02	-0.36
t(Return)	3.49	5.85	-0.34	3.30	4.18	-1.74	4.28	-0.37	-6.42
Sharpe	0.46	0.77	-0.05	0.42	0.51	-0.24	0.56	-0.05	-0.94
alpha	0.54	0.52	-0.02	0.30	0.21	-0.09	0.36	-0.04	-0.39
t(a)	3.69	5.89	-0.27	3.38	4.08	-1.88	4.38	-0.88	-7.13
Mkt	-0.10	-0.11	-0.01	-0.06	-0.03	0.03	-0.06	0.04	0.10
t(Mkt)	-1.47	-2.90	-0.46	-1.44	-1.18	1.52	-1.76	2.06	4.75
SMB	0.38	0.16	-0.21	0.21	0.12	-0.09	0.16	0.14	-0.02
t(SMB)	1.51	1.17	-1.91	1.59	1.67	-1.46	1.26	2.15	-0.34
HML	-0.13	0.01	0.14	-0.06	-0.03	0.03	-0.06	-0.10	-0.04
t(HML)	-0.69	0.08	1.60	-0.55	-0.49	0.59	-0.65	-1.94	-0.91
Panel B: Time-series factor momentum									
Return	0.68	0.63	-0.05	0.33	0.25	-0.08	0.45	0.01	-0.43
t(Return)	4.51	6.06	-0.73	3.81	4.15	-2.04	5.31	0.25	-6.43
Sharpe	0.59	0.83	-0.10	0.47	0.55	-0.25	0.68	0.03	-0.92
alpha	0.71	0.66	-0.05	0.33	0.24	-0.09	0.47	0.00	-0.47
t(a)	4.65	6.07	-0.85	3.85	4.04	-2.28	5.44	0.00	-7.45
Mkt	-0.13	-0.15	-0.02	-0.06	-0.03	0.03	-0.10	0.03	0.13
t(Mkt)	-1.85	-3.11	-0.60	-1.42	-1.02	1.71	-2.49	1.20	5.10
SMB	0.34	0.16	-0.18	0.21	0.13	-0.08	0.14	0.14	0.01
t(SMB)	1.34	1.03	-1.79	1.61	1.74	-1.39	0.95	1.85	0.08
HML	-0.09	0.06	0.15	-0.05	-0.02	0.02	-0.01	-0.10	-0.10
t(HML)	-0.44	0.49	1.82	-0.46	-0.37	0.54	-0.05	-1.73	-1.77

Table A7: Factor momentum returns big stocks, twelve month formation period

This table reports monthly returns, Sharpe ratios and estimates of regressions from the returns of the factor momentum strategies on the factors of the Fama French three-factor model. Only big stocks are included. The long and short factors are constructed as zero-investment cost factors by taking an offsetting position in a big stock only market portfolio. The strategies are decomposed into the winner (W) portfolio and the loser (L) portfolio. The formation period is from month $t - 12$ to month $t - 1$, and the strategies are rebalanced monthly. The t-statistics are Newey-West adjusted. Panel A reports the results for the cross-sectional factor momentum strategy. Panel B reports the results for the time-series factor momentum strategy. The sample period is from July 1964 to December 2019.

	W-L	W	L	W-L	W	L	W-L	W	L
Panel A: Cross-sectional factor momentum									
Return	0.38	0.34	-0.04	0.23	0.18	-0.05	0.32	0.09	-0.24
t(Return)	2.94	4.15	-0.61	2.98	3.67	-1.06	3.57	1.30	-3.67
Sharpe	0.38	0.56	-0.09	0.36	0.43	-0.14	0.49	0.19	-0.55
alpha	0.45	0.38	-0.07	0.25	0.19	-0.06	0.38	0.12	-0.27
t(a)	3.57	4.73	-1.18	3.27	3.65	-1.40	4.29	2.24	-4.50
Mkt	-0.09	-0.10	-0.01	-0.05	-0.02	0.03	-0.09	0.01	0.09
t(Mkt)	-1.57	-2.41	-0.22	-1.42	-0.96	1.71	-2.16	0.48	3.59
SMB	0.15	0.04	-0.12	0.14	0.13	-0.01	0.10	0.18	0.08
t(SMB)	1.23	0.57	-1.93	1.84	4.08	-0.10	0.99	2.92	2.33
HML	-0.18	0.01	0.19	-0.07	-0.06	0.01	-0.11	-0.23	-0.12
t(HML)	-1.29	0.12	3.12	-0.77	-1.26	0.20	-1.30	-4.54	-2.45
Panel B: Time-series factor momentum									
Return	0.46	0.39	-0.07	0.26	0.20	-0.05	0.39	0.12	-0.27
t(Return)	3.44	4.17	-1.00	3.29	3.64	-1.25	3.85	1.74	-3.60
Sharpe	0.45	0.57	-0.14	0.39	0.43	-0.16	0.52	0.23	-0.52
alpha	0.54	0.44	-0.10	0.28	0.22	-0.06	0.44	0.15	-0.29
t(a)	4.18	4.71	-1.66	3.68	3.87	-1.49	4.51	2.59	-4.31
Mkt	-0.12	-0.13	-0.01	-0.05	-0.03	0.02	-0.10	0.01	0.11
t(Mkt)	-1.93	-2.62	-0.33	-1.48	-1.19	1.54	-2.29	0.47	3.56
SMB	0.16	0.03	-0.13	0.15	0.15	-0.00	0.13	0.21	0.09
t(SMB)	1.18	0.46	-1.79	2.06	4.24	-0.08	1.01	2.50	2.03
HML	-0.14	0.07	0.20	-0.09	-0.10	-0.00	-0.07	-0.25	-0.18
t(HML)	-0.93	0.69	3.05	-1.04	-1.92	-0.10	-0.59	-3.67	-2.98

Table A8: Long leg winners - Short leg losers

This table reports monthly returns of Long factor winner (LW) - Short factor loser (SL) strategies and estimates of regressions from the returns on the factors of the Fama-French three-factor model. The strategies are divided into Small and Big. Small consists of small stocks only and big consists of big stocks only. The t-statistics are Newey-West adjusted. The sample period is from July 1964 to December 2019.

	Small				Big			
	XSBM LW - SL		TSFM LW - SL		XSBM LW - SL		TSFM LW - SL	
	12	1	12	1	12	1	12	1
Return	0.56	0.67	0.68	0.79	0.41	0.50	0.47	0.58
t(Return)	6.03	6.48	6.24	6.91	4.46	4.69	4.32	4.99
Sharpe	0.81	0.87	0.86	0.93	0.59	0.58	0.58	0.59
alpha	0.60	0.76	0.72	0.88	0.45	0.55	0.51	0.63
t(a)	6.23	6.83	6.54	7.42	4.80	4.93	4.78	5.14
Mkt	-0.13	-0.17	-0.16	-0.19	-0.11	-0.14	-0.14	-0.16
t(Mkt)	-3.18	-4.57	-3.30	-4.77	-2.54	-4.21	-2.60	-4.31
SMB	0.14	-0.03	0.12	-0.07	0.05	-0.08	0.06	-0.09
t(SMB)	1.05	-0.29	0.88	-0.64	0.74	-2.16	0.81	-2.22
HML	0.01	0.04	0.07	0.08	0.05	0.12	0.08	0.15
t(HML)	0.10	0.48	0.62	1.02	0.57	2.03	0.75	2.10

Table A9: Factor momentum returns small stocks, one month formation period

This table reports monthly returns, Sharpe ratios and estimates of regressions from the returns of the factor momentum strategies on the factors of the Fama French three-factor model. Only small stocks are included. The long and short factors are constructed as zero-investment cost factors by taking an offsetting position in a small stock only market portfolio. The strategies are decomposed into the winner (W) portfolio and the loser (L) portfolio. The formation period is month $t - 1$, and the strategies are rebalanced monthly. The t-statistics are Newey-West adjusted. Panel A reports the results for the cross-sectional factor momentum strategy. Panel B reports the results for the time-series factor momentum strategy. The sample period is from August 1963 to December 2019.

	W-L	W	L	W-L	W	L	W-L	W	L
Panel A: Cross-sectional factor momentum									
Return	0.73	0.61	-0.12	0.51	0.29	-0.22	0.39	0.01	-0.38
t(Return)	4.98	6.69	-1.51	5.26	4.95	-3.85	4.11	0.18	-5.62
Sharpe	0.60	0.90	-0.18	0.67	0.68	-0.49	0.50	0.02	-0.77
alpha	0.80	0.66	-0.13	0.56	0.32	-0.25	0.43	-0.01	-0.45
t(a)	5.01	6.88	-1.59	5.32	5.57	-4.07	4.12	-0.16	-6.35
Mkt	-0.16	-0.15	0.01	-0.10	-0.05	0.05	-0.07	0.05	0.12
t(Mkt)	-2.50	-4.62	0.33	-2.68	-2.23	2.46	-1.78	1.70	5.59
SMB	0.11	0.01	-0.10	0.05	0.05	-0.00	0.02	0.10	0.08
t(SMB)	0.61	0.13	-1.03	0.50	0.81	-0.04	0.20	1.76	1.21
HML	0.00	0.07	0.07	-0.03	-0.01	0.02	-0.02	-0.07	-0.04
t(HML)	0.01	1.14	1.16	-0.35	-0.23	0.43	-0.28	-1.59	-1.02
Panel B: Time-series factor momentum									
Return	0.81	0.71	-0.10	0.53	0.32	-0.21	0.50	0.03	-0.47
t(Return)	5.28	7.01	-1.26	5.36	4.91	-3.71	5.10	0.36	-6.04
Sharpe	0.65	0.96	-0.14	0.68	0.71	-0.45	0.58	0.05	-0.82
alpha	0.89	0.77	-0.12	0.58	0.34	-0.24	0.55	0.00	-0.54
t(a)	5.41	7.14	-1.43	5.41	5.04	-4.08	4.83	0.06	-6.95
Mkt	-0.18	-0.17	0.01	-0.10	-0.05	0.05	-0.10	0.05	0.15
t(Mkt)	-2.70	-5.44	0.19	-2.66	-2.40	2.35	-2.11	1.73	5.94
SMB	0.11	-0.03	-0.13	0.05	0.04	-0.01	0.01	0.12	0.11
t(SMB)	0.60	-0.31	-1.25	0.48	1.15	-0.14	0.11	2.31	1.58
HML	0.01	0.13	0.12	-0.03	-0.01	0.02	0.01	-0.09	-0.09
t(HML)	0.10	1.86	1.76	-0.44	-0.33	0.44	0.08	-1.92	-1.77

Table A10: Factor momentum returns big stocks, one month formation period

This table reports monthly returns, Sharpe ratios and estimates of regressions from the returns of the factor momentum strategies on the factors of the Fama French three-factor model. Only big stocks are included. The long and short factors are constructed as zero-investment cost factors by taking an offsetting position in a big stock only market portfolio. The strategies are decomposed into the winner (W) portfolio and the loser (L) portfolio. The formation period is month $t - 1$, and the strategies are rebalanced monthly. The t-statistics are Newey-West adjusted. Panel A reports the results for the cross-sectional factor momentum strategy. Panel B reports the results for the time-series factor momentum strategy. The sample period is from August 1963 to December 2019.

	W-L	W	L	W-L	W	L	W-L	W	L
Panel A: Cross-sectional factor momentum									
Return	0.63	0.45	-0.18	0.30	0.22	-0.08	0.50	0.22	-0.28
t(Return)	4.85	5.40	-2.28	3.62	4.10	-1.27	5.03	2.27	-3.28
Sharpe	0.61	0.71	-0.32	0.42	0.46	-0.18	0.51	0.30	-0.43
alpha	0.71	0.49	-0.22	0.34	0.23	-0.11	0.55	0.23	-0.32
t(a)	5.30	5.73	-3.01	4.08	4.25	-1.73	5.54	2.90	-3.79
Mkt	-0.12	-0.12	-0.00	-0.06	-0.03	0.03	-0.09	0.02	0.11
t(Mkt)	-2.78	-4.83	-0.09	-2.38	-1.74	2.14	-2.26	0.94	4.95
SMB	-0.06	-0.04	0.01	-0.03	0.06	0.09	-0.03	0.10	0.14
t(SMB)	-0.84	-1.26	0.36	-0.85	2.48	3.27	-0.70	3.47	4.30
HML	-0.01	0.10	0.11	-0.02	-0.04	-0.02	0.02	-0.14	-0.16
t(HML)	-0.12	2.05	2.46	-0.35	-1.21	-0.59	0.34	-4.04	-4.51
Panel B: Time-series factor momentum									
Return	0.69	0.52	-0.17	0.34	0.25	-0.09	0.59	0.26	-0.33
t(Return)	5.05	5.43	-2.04	3.88	4.26	-1.38	4.95	2.16	-3.38
Sharpe	0.63	0.74	-0.29	0.47	0.50	-0.19	0.50	0.28	-0.44
alpha	0.77	0.56	-0.20	0.39	0.28	-0.11	0.62	0.27	-0.35
t(a)	5.49	5.72	-2.88	4.39	4.66	-1.70	5.42	2.69	-3.73
Mkt	-0.13	-0.15	-0.01	-0.06	-0.04	0.03	-0.09	0.03	0.12
t(Mkt)	-2.86	-4.97	-0.59	-2.38	-2.10	1.68	-2.02	1.16	4.68
SMB	-0.06	-0.05	0.01	-0.03	0.06	0.09	-0.04	0.11	0.15
t(SMB)	-0.75	-1.24	0.20	-0.83	2.57	3.10	-0.64	3.45	4.06
HML	0.01	0.14	0.13	-0.03	-0.07	-0.04	0.06	-0.15	-0.21
t(HML)	0.09	2.53	2.78	-0.51	-2.04	-1.24	0.98	-3.50	-4.83

Table A11: Factor momentum returns of five practical factors, twelve month formation period

This table reports monthly returns, Sharpe ratios and estimates of regressions from the returns of the factor momentum strategies on the factors of the Fama French three-factor model. The factors are HML, LowVol, QMJ, SMB and UMD. The strategies are decomposed into the winner (W) portfolio and the loser (L) portfolio. The formation period is from month $t - 12$ to month $t - 1$, and the strategies are rebalanced monthly. The t-statistics are Newey-West adjusted. Panel A reports the results for the cross-sectional factor momentum strategy. Panel B reports the results for the time-series factor momentum strategy. The sample period is from July 1964 to December 2019.

	W-L	W	L	W-L	W	L	W-L	W	L
Panel A: Cross-sectional factor momentum									
Return	0.58	0.53	-0.05	0.43	0.24	-0.19	0.51	0.02	-0.49
t(Return)	2.92	5.17	-0.36	4.47	4.43	-3.51	4.79	0.31	-6.51
Sharpe	0.39	0.60	-0.06	0.61	0.54	-0.53	0.62	0.05	-0.94
alpha	0.68	0.61	-0.07	0.42	0.26	-0.16	0.61	0.03	-0.58
t(a)	3.60	6.12	-0.59	4.71	4.88	-3.19	5.73	0.45	-9.16
Mkt	-0.12	-0.23	-0.12	-0.02	-0.08	-0.06	-0.12	0.05	0.17
t(Mkt)	-1.38	-4.39	-2.65	-0.64	-3.28	-3.56	-2.70	1.85	5.41
SMB	0.33	0.18	-0.14	0.23	0.14	-0.09	0.09	0.09	-0.00
t(SMB)	1.24	1.48	-1.02	2.06	2.76	-1.45	0.55	0.98	-0.00
HML	-0.34	0.02	0.36	-0.07	0.01	0.08	-0.17	-0.17	0.00
t(HML)	-1.75	0.19	3.38	-0.64	0.18	1.62	-1.54	-2.65	0.04
Panel B: Time-series factor momentum									
Return	0.83	0.68	-0.15	0.45	0.25	-0.19	0.75	0.10	-0.65
t(Return)	4.06	4.45	-1.20	4.53	4.14	-3.45	5.56	1.32	-5.83
Sharpe	0.51	0.57	-0.19	0.60	0.51	-0.53	0.76	0.21	-0.82
alpha	0.94	0.81	-0.13	0.44	0.27	-0.17	0.87	0.08	-0.79
t(a)	4.60	6.02	-1.17	4.91	5.04	-3.40	6.62	1.12	-8.38
Mkt	-0.27	-0.36	-0.08	-0.06	-0.11	-0.05	-0.23	0.03	0.27
t(Mkt)	-2.90	-4.81	-2.24	-1.55	-3.56	-2.92	-4.25	1.33	5.84
SMB	0.38	0.11	-0.27	0.24	0.13	-0.11	0.12	0.18	0.07
t(SMB)	1.42	0.85	-1.83	2.09	2.63	-1.55	0.70	1.99	0.91
HML	-0.15	0.11	0.26	-0.04	0.05	0.09	-0.04	-0.11	-0.07
t(HML)	-0.69	0.82	2.07	-0.37	0.85	1.63	-0.31	-1.45	-0.75

Table A12: Factor momentum returns of five practical factors, one month formation period

This table reports monthly returns, Sharpe ratios and estimates of regressions from the returns of the factor momentum strategies on the factors of the Fama French three-factor model. The factors are HML, LowVol, QMJ, SMB and UMD. The strategies are decomposed into the winner (W) portfolio and the loser (L) portfolio. The formation period is month $t - 1$, and the strategies are rebalanced monthly. The t-statistics are Newey-West adjusted. Panel A reports the results for the cross-sectional factor momentum strategy. Panel B reports the results for the time-series factor momentum strategy. The sample period is from August 1963 to December 2019.

	W-L	W	L	W-L	W	L	W-L	W	L
Panel A: Cross-sectional factor momentum									
Return	0.94	0.66	-0.28	0.54	0.33	-0.21	0.62	0.15	-0.47
t(Return)	4.92	6.09	-2.26	5.79	6.08	-3.92	5.67	1.85	-7.14
Sharpe	0.61	0.71	-0.32	0.74	0.75	-0.54	0.70	0.28	-0.84
alpha	1.05	0.76	-0.29	0.56	0.35	-0.21	0.69	0.14	-0.55
t(a)	5.25	6.44	-2.71	5.77	6.28	-4.02	6.18	2.21	-8.52
Mkt	-0.20	-0.28	-0.09	-0.09	-0.11	-0.02	-0.11	0.07	0.18
t(Mkt)	-2.26	-5.26	-1.99	-2.25	-4.53	-1.03	-2.15	2.24	6.33
SMB	0.06	0.07	0.00	0.06	0.06	0.00	-0.01	0.00	0.01
t(SMB)	0.28	0.55	0.05	0.61	1.28	0.07	-0.05	0.07	0.14
HML	-0.06	0.13	0.19	0.03	0.09	0.05	-0.03	-0.08	-0.05
t(HML)	-0.43	1.57	2.67	0.49	2.19	1.59	-0.33	-1.73	-1.08
Panel B: Time-series factor momentum									
Return	1.06	0.80	-0.26	0.55	0.35	-0.20	0.73	0.14	-0.59
t(Return)	4.89	6.08	-1.70	5.88	5.91	-3.52	5.66	1.36	-6.75
Sharpe	0.61	0.69	-0.25	0.74	0.74	-0.49	0.68	0.21	-0.78
alpha	1.18	0.95	-0.23	0.59	0.37	-0.21	0.81	0.10	-0.70
t(a)	5.38	6.66	-2.16	5.82	6.18	-3.93	6.42	1.44	-8.09
Mkt	-0.27	-0.37	-0.11	-0.10	-0.13	-0.03	-0.16	0.08	0.24
t(Mkt)	-2.66	-5.84	-1.79	-2.69	-5.47	-1.15	-2.89	2.00	6.35
SMB	0.08	-0.03	-0.10	0.07	0.06	-0.02	-0.01	0.08	0.09
t(SMB)	0.34	-0.22	-0.98	0.73	1.22	-0.29	-0.09	1.90	1.17
HML	0.01	0.19	0.17	0.03	0.11	0.08	0.04	-0.06	-0.10
t(HML)	0.08	1.98	1.86	0.39	2.76	2.20	0.44	-1.04	-1.49