Master Thesis: Improving Residual Momentum

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Abstract

Earlier research shows that total return momentum strategies experience time-varying exposures to factor reversals, as well as that ranking stocks on residual returns with the Fama and French 3-factor model seems to mitigate this problem. I show that using factor models that carry greater explanatory value than FF3 successfully reduce exposures to factor reversals even better than FF3. Hence, further improving the risk-return relationship. Residual momentum portfolios are contrarian to total return momentum portfolios not negatively affected by the length of the holding period, and show great robustness in times of economic downturn.

Contents

1 Introduction

Traditionally, trading strategies that bet on stock-momentum select stocks based on total historic returns (Jegadeesh and Titman, 1993). These trading strategies earn a premium by buying recent winners and funding this through shorting recent losers, creating a zero net-investment, top-minus-bottom decile portfolio. However, according to Grundy and Martin (2001), momentum portfolios suffer from time-varying factor exposures, which makes momentum portfolios more volatile and therefore diminishes the risk-return relationship. Blitz et al (2011) showed that creating momentum portfolios by residualizing returns with the Fama and French 3-factor model (1993), and subsequently selecting stocks based on residual returns, instead of total returns, reduces these time-varying factor exposures. This reduction improves the risk-return relationship, effectively doubling the Sharpe ratio.

Since the paper of Blitz et al (2011), the literature on empirical asset pricing has been expanding rapidly. This results in more advanced factor models that carry greater explanatory value like the Fama and French 5-factor model (2015), and the augmented q-factor model by Hou et al (2021). This thesis applies these more advanced factor models to residualize returns and construct residual momentum portfolios for 16 different combinations of formation- and holding periods (each can be either 3, 6, 9 or 12 months). I find that residualizing returns with either FF5 or q^5 both improves the risk-return relationship of (residual) momentum portfolios. This improvement is both risk- and return based. Generally, the more advanced the factor model, the larger the improvement for each portfolio, holding the formation and holding period equal. Furthermore, it becomes clear that this improvement is due to the reduction of dynamic factor exposures, which can be observed through the implication of the conditional framework in the spirit of Blitz et al (2011) and Grundy and Martin (2001). In addition, residual momentum portfolios show no decreased performance when the holding period lengthens, which is contrary to earlier findings on traditional momentum strategies. Finally, I find that residual momentum portfolios where returns are residualized for FF3 suffer the largest drawdowns measured in magnitude and duration. This provides evidence that residualizing returns with more advanced factor models results in more robust momentum portfolios during economic downturn.

The empirical findings in this paper contribute to the not-yet-so extensive research on residual momentum, and show that continued empirical research on more complete factor models can positively effect (residual) momentum portfolios. Also, the results in this paper are more in line with behavioral biases (e.g. Hong and Stein, 1999) motivating the returns of (residual) momentum portfolios than risk-based explanations. Regarding practical implications, the results imply that implementing the most advanced factor model at hand to construct residual momentum portfolios is likely to deliver a better risk-return relationship compared to using less advanced factor models or traditional momentum strategies. The implementability of (residual) momentum strategies is still highly dependent on the level of transaction costs as the portfolios considered in this paper require monthly rebalancing.

In what follows, Section 2 will discuss the relevant literature concerning (residual) momentum strategies. Section 3 and 4 discuss the data and methodological approach to construct momentum portfolios. Section 5 and 6 present the results and show how robust these results are given some methodological adjustments. Section 7 concludes.

2 Literature review

This section will first cover total return momentum strategies, considering its successes and its drawbacks, to eventually arrive at residual return momentum strategies with the use of factor models. Here, the theory behind the residual momentum strategies and how they are constructed is motivated. Second, this section will address the short- and long-term reversal effects that are relevant for the success of (residual) momentum strategies. Lastly, I will address the performance of (residual) momentum strategies over time. While discussing the relevant literature, the main research questions of this paper will be presented.

2.1 Total return momentum

The total return momentum strategy is one of the most profound anomalies in the empirical literature, and has shown very strong returns over the last century. The first to document the momentum strategy were Jegadeesh and Titman (1993), whom found that investment strategies that buy recent winners and short recent losers generate significant positive returns. In their paper, 16 strategies were conducted for momentum based on 3, 6, 9 or 12 month formation- and holding periods. Here, the formation period dissects the winners from the losers over the previous 3, 6, 9 or 12 months. This procedure enables us to construct a winner-loser portfolio. The holding period refers to how long a portfolio is held by an investor. The robustness of such a momentum strategy has long been proven due to its longevity and the presence found in European markets (Rouwenhorst, 1998), as well as in Asian markets (Chui, Titman and Wei, 2000), with the exception of Korea and Japan.

However, the economic rationale behind the momentum strategy is not as strong as compared to other factors like size and value (Fama and French, 1993). The main argumentation behind momentum strategies is either related to traditional compensation for risk theories, or based on investor behavior. The explanation for momentum returns based on investor behavior has been argued to be related to over- or underreaction to news (De Bondt and Thaler, 1985; Hong and Stein, 1999).

Underreaction is explained as not incorporating stock-specific news, or a slow spread of information. This causes stock prices to slowly move towards its intrinsic value. Early work in the field of asset pricing by Ball and Brown (1968) already showed that investors underreact to earnings information. Merton (1987) argues that this underreaction is caused by limited ability to process information, and attention constraints of investors. Barberis, Shleifer and Vishny (1998) argue that when new information arises, investors suffer from conservatism bias as investors have a tendency to overweight prior information when adjusting their beliefs. Hong and Stein (1999) provide evidence that investors can profit by trend chasing due to this underreaction to stock-specific news.

On the contrary, overreaction to news pressures stock prices upwards, away from its intrinsic value. This overreaction can lead to price reversals and has shown to be the Achilles heel of the momentum strategy (Daniel and Moskowitz, 2016). Barberis, Shleifer and Vishny (1998) argue that investors think that firms that have had extraordinary performance in the past, will continue to show high performance levels in the future. This is called representative heuristic bias. Hong and Stein (1998) and Daniel, Hirshleifer and Subrmanyam (1998) show that delayed overreaction is related to investors suffering from self-attribution bias. Here, investors attribute positive performance of their portfolios to their superior stock-selection skills. As a result, investors become overconfident and push prices further upwards.

While investor behavior-based explanations form the bulk of the empirical evidence, there are also risk-based explanations that seek to explain returns of momentum strategies. Asness (1997) and Berk et al (1999) show that stocks with risky cash flows and large growth opportunities have amplified momentum returns. In addition, Pastor and Stambaugh (2003) document that about half of the premium for momentum returns can be explained by a liquidity risk factor. This finding is also backed by Sadka (2006). Chordia and Shivakumar (2002) and Ahn et al (2003) found that macroeconomic risk and time-varying risk are important factors in driving momentum returns. Despite both these behavioral and risk-based explanations, and the fact that the robustness of momentum strategies has long been proven, there is still no general consent as to what justifies these momentum profits.

A disadvantage of traditional momentum strategies concerns transaction costs. First of all, momentum strategies require frequent rebalancing, which evidently leads to high transaction costs. Also, Korajczyk and Sadka (2004) provide evidence that the profits of momentum portfolios are concentrated in stocks that have high transactions costs. This limits the returns that the most profitable stocks provide to your portfolio. De Groot et al (2001) and Keim and Madhaven (1997) show that the bottom quintile of stocks ranked on market capitalization can have up to ten times the amount of transaction costs compared to the top quintile of stocks ranked on market capitalization. Furthermore, profitability of momentum strategies are strongly dependent on macroeconomic variables that are related to business cycles (Chordia and Shivakumar, 2002), which explains the disappointing returns on momentum strategies during the 1930's and the post 2000 period (Blitz et al, 2011). How can we account for these drawbacks?

2.2 Factor models

In this section, I will go briefly through the origin and idea behind factor models to eventually arrive at more recent models that are relevant for residualizing returns in momentum strategies.

The first factor model in the asset pricing literature that has clear predictions about the risk-return relationship of an asset was the capital asset pricing model (CAPM). The CAPM tries to measure systematic risk, and thus provide a risk-based explanation for returns. This model was provided by Sharpe (1964) and Lintner (1965). In their respective papers, the authors rely on the assumption that investors try to minimize variance for a given level of return, or maximize return for a given level of variance (Markowitz, 1952;1959).

Fama and French (1993) build on the CAPM by extending it with two additional factors; size and value. Here, small firms should earn a premium compared to large firms, and undervalued firms (measured as high book-to-market value) should earn a premium compared to overvalued firms. Shortly after, the momentum anomaly was discovered. Fama and French admit that momentum is the main embarrassment of their 3-factor model as it fails to capture the continuation of short-term momentum anomalies. Subsequently, Carhart (1997) extends the Fama and French 3-factor model with a fourth factor; momentum. Despite a large base of empirical evidence, proving the robustness of a momentum factor, Fama and French refrain from using momentum in their factor models. In 2015, Fama and French propose a 5-factor model that extends the previous 3-factor model with a profitability factor and an investment factor. These two additional factors are robust to macroeconomic times as both are relative measures. The fourth factor examines profitability of a stock relative to other firms. Similar for the fifth factor (investment), which examines the degree of investment relative to other firms. In Fama and French (2018), they elaborate more on as to why they omitted such a well-researched factor like momentum in earlier research; *"We include momentum factors (somewhat reluctantly) now to satisfy insistent popular demand. We worry, however, that opening the game to factors that seem empirically robust but lack theoretical motivation has a destructive downside: the end of* *discipline that produces parsimonious models and the beginning of a dark age of data dredging that produces a long list of factors with little hope of sifting through them in a statistically reliable way."*

Recently, Hou et al (2021) provided us with the augmented q-factor model (q^5 model). The q^5 model incorporates factors for the market, size, investment, return on equity and expected growth. Where the factor for expected growth constitutes the difference between the original q-factor model (Hou et al, 2015) and the q^5 model. Hou et al (2021) finds in a comparison between different factor models (including FF5) that the q^5 model carries the strongest explanatory power for a large number of anomalies, exhibiting the lowest alpha, and substantially outperforming other factor models.

2.3 Residual return momentum

How do these factor models relate to residual momentum? Residual momentum portfolios are quantitatively constructed in a similar way to total return momentum portfolios. Based on a formation period, winning stocks are bought, and losing stocks are shorted. Effectively creating a zero net-investment winner-minus-loser portfolio. The difference between the two lies in the fact that the selection procedure over the formation period is based on residual returns, not total returns. Blitz et al (2011) show that the risk-return relationship of the momentum strategy improves when returns are residualized with the Fama and French 3-factor model (1993), effectively doubling the Sharpe ratio by reducing the variance of returns. Blitz et al (2011) argue that residualizing returns limits the time-varying exposures to F&F factors, which causes residual return momentum to outperform total return momentum.

This was first illustrated by Grundy and Martin (2001), whom showed that momentum loads positively (negatively) on systematic factors when these factors have positive (negative) returns during the formation period. The total return momentum strategy loses when the sign of the factor returns over the holding period is opposite to the sign of the factor returns over the formation period. They argue that the factor component makes up part of a stock's total return. And, as a result, an investment in total return momentum portfolios is in fact an investment in factors themselves.

Since the paper of Blitz et al (2011), more extensive factor models have been documented in the empirical literature. The ones considered in this paper are the Fama and French 5-factor model (2015), and the augmented q-factor model (q^5 model) by Hou et al (2021). In theory, one would expect that residualizing returns with more comprehensive factor models, that carry greater explanatory value, should further single-out momentum returns and limit time-varying exposures to systematic factors. Following the empirical literature on residual momentum, and the recently discovered factor models, the first research question can be formed:

1. Can we improve the risk-return relationship of the residual momentum strategy by residualizing returns with more advanced factor models (i.e. FF5 and q^5 model)?

The next step in dissecting possible improvements in the risk-return relationship of residual momentum portfolios is originating the cause of improvement. Can we increase the profitability, or eliminate unnecessary risk? Blitz et al (2011) find persistence in common factor returns in the Fama & French factors for the market, size and value. This 'persistence' means that it is more likely than not that the sign of the returns over the formation period is equal to the sign of the returns over the holding period. Given such persistence in common factor returns, dynamic factor exposures might possibly contribute positively to a total return momentum strategy. However, Blitz et al (2011) find that FF3 exposures contribute roughly to 50% of the risk and 25% of the profits in total return momentum strategies. Reducing these exposures therefore improves the risk-adjusted returns, because a disproportional large component of the risk of total return momentum strategies can be attributed to the common-factor component. When residualizing with more advanced factors like the the Fama and French 5-factor (2015) model, and the Hou et al (2021) augmented q-factor model, it is relevant to examine if these models also have factors that carry persistence in returns. And, if they do, if it is beneficial to reduce these dynamic factor exposures on total return momentum strategies which should subsequently lead to an improved risk-return relationship.

2. Does residualizing returns with more advanced factor models (i.e. FF5 and q^5 model) successfully neutralize dynamic exposures to the respective factors in residual momentum portfolios?

2.4 The short- and long-term reversal effect

Essential to the success of the total return momentum strategies as documented by Jegadeesh and Titman (1993), is the omittance of the most recent week or month in the formation period. Leaving a week or month between the formation period and the holding period boosts momentum returns because of the short-term reversal effect. Jegadeesh (1990) and Lehman (1990) document these short-term reversals. These papers show that trading strategies contrarian to traditional momentum strategies are profitable. Namely, strategies that buy losers and short winners based on returns over the previous week or month earn significant abnormal returns. If not omitted from the formation period in momentum strategies, the most recent week or month would dilute momentum returns because a portfolio that buys winners and shorts losers based on the most recent week or month earns a negative premium.

Rather than overreaction, the success of these short-term reversal strategies may reflect lack of liquidity or short-term price pressures because these strategies are transaction intensive and based on short-term price movements. Jegadeesh and Titman (1991) support this interpretation by providing evidence on the relationship between bid-ask spreads and short-term return reversals.

Besides the short-term reversal effect, there is also a long-term reversal effect documented based on historic return data. De Bondt and Thaler (1985) show that over 3- to 5-year holding periods momentum returns flip. Opposite to the short-term reversal effect, the long-term reversal effect is not caused by price pressure or lack of liquidity. De Bondt and Thaler (1985) argue that at first, investors overreact to unexpected or dramatic news events. This is one explanation for the observed momentum strategy. In the long haul, the sign of the returns flips and the market 'corrects' the overreaction, leading to positive abnormal returns for a portfolio that buys losers and shorts winners if the portfolio is held for 3 to 5 years.

De Bondt and Thaler do not observe reversals with formation periods as short as one year. However, if an investor implements longer formation- and holding periods, the chance of being exposed to this long-term reversal effect increases. Meaning, a (residual) momentum portfolio that has both a 12-month formation- and holding period might not show a reversal effect, but can show diminished returns compared to a (residual) momentum portfolio where the formation- and holding period are shorter. This is because such a strategy requires a 24-month period of the same sign of returns for the portfolio to be profitable.

On the contrary, very short holding periods means frequent rebalancing, which leads to higher transaction costs that also diminish returns. However, longer holding periods can still require frequent rebalancing if the overlapping portfolios approach by Jegadeesh and Titman (1993) is applied. Here, an investor holds a series of portfolios that are selected in the current month as well as in the previous $K - 1$ months, where K is the holding period. Subsequently, we can form the third research question:

3. Do longer holding (formation) periods worsen the risk-return relationship of residual momentum portfolios?

2.5 Performance over time

In the paper of Blitz et al (2011), the improved risk-return relationship is mainly caused by a large decrease in volatility, where returns stay virtually the same when comparing residual return momentum with total return momentum over the 1930-2009 period. Here, most of the volatility of the traditional momentum strategy is clustered in periods of economic downturn. Especially the 1930's great depression, and the post-2000's tech-bubble and financial crises were impediments to the success of total return momentum strategies. This finding is consistent with Chordia and Shivakumar (2002), whom showed that profits to momentum strategies can be explained by common macroeconomic variables that are related to the business cycle. Here, Blitz et al (2011) shows a 14.7 percent gain per annum in times of economic expansion, and 8.7 percent loss per annum during times of economic recession. When returns are residualized for FF3, residual momentum shows positive returns in all macroeconomic environments. This can be explained by the fact that residualizing returns limits exposures to F&F factors, making residual momentum nearly market-neutral by construction. Effectively earning 5.6 percent per annum in times of economic recession.

The post-2000 period so far has dealt with somewhat harsh macroeconomic weather. Especially, when we consider the early 2000's tech-bubble and the 2008-2012 financial crises. And, most recently, the novel COVID-19 virus has had its negative effects on financial markets. In theory, residualizing returns with more extensive factor models like FF5 and q^5 should make residual momentum even more neutral to the market as these models carry greater explanatory value than FF3. Following the above, the fourth research question can be formed:

4. Does residualizing returns with more advanced factor models (i.e. FF5 and q^5 model) make residual momentum strategies even more robust in the post-2000 period?

3 Data

This section will address the data used to conduct the analyses and data cleaning procedures to arrive at the data set used for the empirical analyses.

3.1 Data origin

This paper uses monthly stock price data from CRSP during the 1970-2020 period. Here, returns will be used to calculate momentum, where returns consist of capital gains (stock price increases), and dividends. F&F factors MKFRT, SMB, HML, RMW and CMA are used from the webpage of K.R. French. q^5 factors R_{Mkt}, R_{Me}, R_{IA}, R_{Roe} and R_{Eg} are used from the q-factor data library. These factors represent excess returns on factor-mimicking portfolios and are percentage based. Therefore, these factors need to be divided by 100 to equalize them numerically to the stock price data from the CRSP database. Hereafter, F&F factors and q^5 factors are merged with the stock price data set from CRSP, such that each company has monthly stock price data and both monthly F&F and q^5 factors. Observations that are not present in all three datasets (F&F factors, q^5 factors and stock price data), are dropped from the sample. This leaves us a fully merged, complete data set ready for data cleaning procedures.

3.2 Data cleaning

Following common data cleaning procedures documented by Blitz et al (2011) and Fama and French (1993;2015), this dataset only includes non-financial (SIC codes outside range 6000-6999), common stocks (CRSP share code 10 and 11) that are listed on the NASDAQ, NYSE or AMEX (exchange code 1, 2 or 3). Stocks that have a mean price below $1 during their listed period are dropped from the sample to account for microstructure issues.

In addition, this paper will estimate firm-specific α_i and β_i. I use an estimation period requirement of at least 36 observations to ensure a sufficient number of observations for an accurate estimation. Observation 1 to 36 for each stock are dropped from the sample because these observations do not have α_i and β_i estimates. If a stock has less than 36 months of stock price data, it is dropped entirely from the sample. Removing entire companies leaves some survivorship bias concerns as companies that do not pass the three-year threshold of being listed on public markets might influence residual momentum returns. This could be the case when such short-listed stocks are incorporated in a 'real-life' (residual) momentum portfolio after a few months of being listed. When these stocks greatly affect the returns of the respective portfolios, the data will not recognise the influence these stocks have had as the minimum threshold of 36 months causes the stocks to be omitted from the data set. However, the excluded companies only contribute up to 4 percent of the total number of monthly stock price observations. Therefore, it is expected that the risk of survivorship bias by removing these observations due to the estimation of α_i and β_i to be only marginal. Section 4 will further elaborate on the estimation of α_i and β_i.

After the data cleaning process, no duplicates were found based on company code and monthly date. This leaves a data set of roughly 1.8 million monthly stock price observations for a little over 15,000 companies, which is roughly 120 observations per company on average. This means that a company in the data set was listed for about 10 years on average in the 1970-2020 period.

4 Methodology

In this section, I will extensively discuss the empirical set-up of this paper and methodology used to construct (residual) momentum portfolios. In addition, it will also be addressed how the performance of these portfolios are tested.

4.1 General specifications

In this paper, residual return momentum portfolio returns are calculated for 48 different strategies. The strategies can differ based on the formation period (4x), holding period (4x) or factor model used to calculate residual returns (3). This leaves 4x4x3 = 48 different residual momentum strategies. In addition, I will also construct 16 (formation 4x holding 4x) portfolios where stocks are ranked on total returns to be able to observe the effect of residualizing returns. The formation- and holding periods can be either 3, 6, 9 or 12 months, which is in line with Jegadeesh and Titman (1993). Using different lengths for formation- and holding periods allows us to examine the effect the difference in length has on residual momentum portfolio returns. Furthermore, for each strategy, the most recent month in the formation period is excluded to account for the short-term reversal effect (Jegadeesh, 1990; Lehmann, 1990). Effectively, a formation period of 12 months consists of an 11-month period ($t-12$ to $t-1$) where returns are evaluated to be able to pick recent 'winners' and 'losers'.

Following Jegadeesh and Titman (1993), I will use portfolios with overlapping holding periods. This means that for a given month t, the residual momentum strategies will hold a series of portfolios that are selected in the current month as well as in the previous $K-1$ months, where K is the holding period. Specifically, such a strategy selects stocks based on the past J months and holds them for K months, where J is the formation period.

4.2 Residualizing returns

To minimize the time-varying exposures to different factors as described in Blitz et al (2011), the first step is to residualize the returns. I will construct residual returns using three different factor models as presented below:

$$r_{it} - rf_t = \alpha_i + \beta_{1i} MKTRF_t + \beta_{2i} SMB_t + \beta_{3i} HML_t + \epsilon_{it} \quad (1)$$

$$r_{it} - rf_t = \alpha_i + \beta_{1i} MKTRF_t + \beta_{2i} SMB_t + \beta_{3i} HML_t + \beta_{4i} RMW_t + \beta_{5i} CMA_t + \epsilon_{it} \quad (2)$$

$$r_{it} - rf_t = \alpha_i + \beta_{1i} R_{Mkt} + \beta_{2i} R_{Me} + \beta_{3i} R_{IA} + \beta_{4i} R_{ROE} + \beta_{5i} R_{EG} + \epsilon_{it} \quad (3)$$

Equation (1), (2) and (3) represent the F&F 3-factor model, F&F 5-factor model and augmented q-factor model (q^5 model), respectively. r_{it} denotes returns of stock i at month t. rf_t is the risk-free rate at time t. F&F factors $MKTRF_t, SMB_t, HML_t, RMW_t, CMA_t$ represent the excess returns on factor mimicking portfolios for the market, size, value, profitability and investment. q^5 model factors $R_{Mkt}, R_{Me}, R_{IA}, R_{ROE}, R_{EG}$ represent the excess returns on factor mimicking portfolios for the market, size, investment, return on equity and expected growth. The size and investment factors that are in both the F&F factor models and q^5 model are not identical. Also, SMB_t is calculated differently in FF5 compared to how it is calculated in FF3. Effectively, the discrepancy is only marginal. The market factors $MKTRF_t$ and R_{Mkt} are the same, where the notation is adopted from the representative papers. α_i and β_i are parameters to be estimated for each equation for each representative factor. ϵ_{it} is the error term of stock i at month t.

This paper follows the research of Blitz et al (2011) by estimating parameters α_i and β_i over 36-month rolling windows, from $t-36$ to $t-1$, to ensure we have a sufficient number of observations to accurately estimate of the stock exposures to F&F factors and q^5 model factors. The estimated alpha is not subtracted from total returns in the calculation of residual returns because this parameter generally serves as a measure of misspecification in the model of expected returns. Also, at least two thirds of the estimation period of alpha falls outside the formation period for portfolios ($t-36$ to $t-12$ in a 12-month formation period). If alpha is included in the calculation of residual returns, then stocks that experienced large excess returns in the period $t-36$ to $t-12$ and low excess returns in the period $t-12$ to $t-1$, would provide a high alpha and rank low on residual returns. In that case, the resulting residual momentum strategy might also reflect the long-term reversal effect as documented by De Bondt and Thaler (1985). Intuitively, residual returns are part of the total returns that are not explained by the respective factors where total returns are residualized for. By rearranging the linear multivariate Equations (1), (2) and (3) we can calculate residual returns $\epsilon_{it} + \alpha_i$ as presented in Equation (4), (5) and (6).

$$\epsilon_{it} + \alpha_i = (r_{it} - rf_t) - \beta_{1i} MKTRF_t - \beta_{2i} SMB_t - \beta_{3i} HML_t \tag{4}$$

$$\epsilon_{it} + \alpha_i = (r_{it} - rf_t) - \beta_{1i} MKTRF_t - \beta_{2i} SMB_t - \beta_{3i} HML_t - \beta_{4i} RMW_t - \beta_{5i} CMA_t \tag{5}$$

$$\epsilon_{it} + \alpha_i = (r_{it} - rf_t) - \beta_{1i} R_{Mkt} - \beta_{2i} R_{Me} + \beta_{3i} R_{IA} - \beta_{4i} R_{ROE} - \beta_{5i} R_{EG} \tag{6}$$

The estimated residual returns as described above are winsorized at the 0.06th percentile on both tails of the distribution. Winsorizing residualized returns at this particular percentile prevents returns from becoming smaller than -100 percent, and helps to correct any large outliers that emerged due to the residualization process of total returns.

Blitz et al (2011) standardize residual returns by their standard deviation over the same period. They argue that raw residual returns can be a noisy measure in which they refer to Gutierrez and Pirinsky (2007). However, the following is mentioned in the paper by Gutierrez and Pirinsky (2007); *"We can confirm that our results are qualitatively similar if we do not standardize the residual return and instead define abnormal-return winners and losers using a cross-sectional decile sort of residual returns."* Also, when looking at the actual risk-return relationship improvement in the paper by Blitz et al (2011), we can see that for a 1-month holding period (only period where value is disclosed) standardized residual returns exhibit a Sharpe ratio of 0.90, compared to 0.89 if residual returns are not standardized. Given this very marginal improvement, I will refrain from using standardized residual returns.

4.3 Constructing portfolios

After residualizing total returns with three different factor models, I will construct twelve residual momentum variables (4 formation periods x 3 residual returns) that provide residual returns over each formation period for each month in the dataset. These residual momentum variables allow us to examine which stocks have performed well over the considered formation period. The calculation of these residual momentum variables is presented in Equation (7).

$$R_{it} = [\prod_{n=t-12}^{N} (\epsilon_{in} + \alpha_i + 1)] - 1, N = t - 1 \tag{7}$$

In Equation (7), R_{it} represents compounded residual returns from $t-12$ to $t-1$ of stock i at time t. In total, this residual momentum return variable is calculated twelve times. Where $\epsilon_{in} + \alpha_i$ can vary in three different ways, depending on which factor model is used to residualize total returns. The formation period used can vary in four different ways; $(t-12; t-1)$, $(t-9; t-1)$, $(t-6; t-1)$ or $(t-3; t-1)$.

Hereafter, I will sort each of these 12 variables into deciles. Where '10' represents the stocks with the highest residualized returns over the formation period, and '1' represents the stocks with the lowest residualized returns in the formation period. For instance, stock i that falls in the top 10 percent highest residualized returns over the formation period at time t will receive value '10'. Using quintiles, or even terciles to sort winners and losers will likely show similar results. However, the use of deciles singles out the best and worst performing stocks even more, and is therefore applied in this paper. The use of quintiles and terciles to apply (residual) momentum strategies to can be useful in the case of a small pool of stocks to choose from to ensure the portfolio holds a sufficient number of stocks to stay well diversified.

Subsequently, I will create zero-net-investment top-minus-bottom decile portfolios that buy the winning stocks with decile value '10', and short the losing stocks with decile value '1'. Consistent with most empirical literature, equal weights will be assigned to the stocks in both decile 10 and 1. The portfolios can be held for four different holding periods (3, 6, 9, or 12 months) using the overlapping portfolio's approach of Jegadeesh and Titman (1993), where for a given month t, the residual momentum strategies will hold a series of portfolios that are selected in the current month as well as in the previous $K-1$ months, where K is the holding period. This means that 3x4x4=48 trading strategies will be considered. These strategies can differ from each other in the way residualized returns are calculated (3x), the considered formation period (4x), or the considered holding period (4x).

4.4 Testing residual momentum strategies

Having constructed the zero-net-investment top-minus-bottom decile (residual) momentum portfolio's, I will test if each portfolio yields significant positive abnormal returns over the holding period. Here, t-tests on all 64 strategies will be applied to test if their monthly returns over the 1970-2020 period are significantly differ from zero. For these t-tests, Newey-West (1987) standard errors that are consistent for heteroskedasticity and autocorrelation with a correction of six lags will be used. Six lags are deemed most appropriate considering a data set spanning several decades with monthly observations. These t-tests under null hypothesis equal to zero will show if there is a particular holding period, formation period or factor model to calculate residual returns that significantly improves residual momentum returns.

After having analyzed the significance of average monthly returns for all portfolios, this paper will use a risk-adjusted measure to examine the portfolios. I will evaluate the performance of the residual momentum strategies over the holding period by examining returns, volatilities, Sharpe ratios and alphas. To estimate the alphas, this paper follows Grundy and Martin (2001) and Blitz et al (2011). In these papers, a conditional framework was constructed that accounts for the dynamic factor exposures of factor models on momentum strategies. Regarding the factor models; the FF3, FF5 and the q^5 model are considered. Leading to the following conditional framework regressions:

$$r_t - rf_t = \alpha_i + FF3 + FF3_{UP} + \epsilon_{it} \tag{8}$$

$$r_t - rf_t = \alpha_i + FF5 + FF5_{UP} + \epsilon_{it} \tag{9}$$

$$r_t - rf_t = \alpha_i + q^5 + q^5_{UP} + \epsilon_{it} \tag{10}$$

In the equations above, r_t depicts the return on a residual momentum portfolio at time t.

FF3, FF5 and q^5 refer to the factors in the factor models described in Equation (1), (2), and (3). $FF3_{UP}$, $FF5_{UP}$ and q^5_{UP} also refer to these same factors. However, the latter three consist of interaction variables that are equal to the excess return on factor mimicking portfolios when the premiums on the factors are positive over the formation period $((t-12; t-1)$, $(t-9; t-1)$, $(t-6; t-1)$ or $(t-3; t-1))$, and zero otherwise. Portfolios will only be regressed on the same factor model where the respective portfolio was residualized for. Meaning, momentum portfolios that were residualized for FF3, are regressed on Equation (8), where Equation (8) can still vary according to the specified formation period that was used to construct $FF3_{UP}$.

The main contribution of such a conditional framework based on factor realizations is that it allows us to analyze if persistence in factor returns carries unnecessary risk, and if residualizing returns successfully neutralizes these factor exposures and therefore improves the risk-return relationship when using residual returns instead of total returns. In these regressions, the resulting alphas and betas are especially important, as a significant alpha shows that part of the return is left unexplained by systematic risk covered in the respective factor model, and betas show how strongly a factor still explains returns after residualization. To draw conclusions as to how well residualization has eliminated factor exposures, I will also regress these conditional models on total return momentum portfolios using the same formation- and holding periods. This leads to only 16 total return momentum portfolios as no factor models are required to apply a total return momentum strategy.

5 Empirical findings

This section provides an extensive comparison of residual momentum strategies and their empirical implications. The goal is to thoroughly answer the research questions as presented in the literature review in section 2.

5.1 Returns (residual) momentum portfolios

Having constructed the (residual) momentum portfolios, this paper will start to analyze the performance of these strategies by evaluating returns for all 64 different portfolios considered in this paper. Where portfolios can differ in formation period, holding period or factor model used to residualize returns. Table 5.1 shows average monthly returns for (residual) momentum portfolios over the 1970-2020 period. In Panel A, we can observe that average monthly returns of total return momentum portfolios are significant for all formation- and holding periods considered. Also, the formation period seems to be positively related to portfolio returns, while the holding period shows a negative relationship to returns. These findings are in line with the literature documented by Jegadeesh and Titman (1993).

Panel B, C and D show average monthly returns on residual momentum portfolios when returns are residualized for FF3, FF5 or q^5, respectively. Returns for all 48 residual momentum portfolios are significantly different from 0, showing large positive returns on a monthly basis. This finding confirms the evidence of Blitz et al (2011) regarding residual returns for FF3. Similar to total return momentum, the returns of residual momentum portfolios also seem to be positively influenced by the formation period, and negatively by the holding period. However, we can not yet answer the research question regarding the influence of formation- and holding periods on returns for residual momentum portfolios, as we need a risk-based measure to evaluate the performance of these portfolios.

Table 5.1 Average monthly returns for J-month/K-month (residual) momentum portfolios

J	K=	3	6	9	12
Panel A : Total return					
3		0.0072**	0.0080**	0.0072**	0.0064**
		(0.0013)	(0.0012)	(0.0011)	(0.0010)
6		0.0115**	0.0116**	0.0105**	0.0077**
		(0.0020)	(0.0018)	(0.0016)	(0.0015)
9		0.0132**	0.0132**	0.0105**	0.0073**
		(0.0023)	(0.0021)	(0.0019)	(0.0018)
12		0.0136**	0.0118**	0.0089**	0.0061**
		(0.0025)	(0.0023)	(0.0021)	(0.0019)
Panel B : Residual FF3					
3		0.0116**	0.0113**	0.0106**	0.0097**
		(0.0009)	(0.0008)	(0.0007)	(0.0006)
6		0.0178**	0.0170**	0.0158**	0.0138**
		(0.0013)	(0.0011)	(0.0010)	(0.0009)
9		0.0209**	0.0198**	0.0177**	0.0153**
		(0.0014)	(0.0013)	(0.0011)	(0.0010)
12		0.0220**	0.0202**	0.0178**	0.0158**
		(0.0015)	(0.0013)	(0.0012)	(0.0011)
Panel C : Residual FF5					
3		0.0140**	0.0132**	0.0125**	0.0115**
		(0.0011)	(0.0009)	(0.0008)	(0.0007)
6		0.0205**	0.0196**	0.0183**	0.0163**
		(0.0015)	(0.0013)	(0.0011)	(0.0010)
9		0.0238**	0.0224**	0.0204**	0.0181**
		(0.0016)	(0.0014)	(0.0012)	(0.0011)
12		0.0254**	0.0234**	0.0210**	0.0190**
		(0.0016)	(0.0014)	(0.0012)	(0.0011)
Panel D : Residual q^5					
3		0.0182**	0.0170**	0.0159**	0.0147**
		(0.0012)	(0.0010)	(0.0009)	(0.0008)
6		0.0256**	0.0241**	0.0224**	0.0200**
		(0.0016)	(0.0014)	(0.0013)	(0.0011)
9		0.0291**	0.0271**	0.0246**	0.0220**
		(0.0018)	(0.0016)	(0.0014)	(0.0012)
12		0.0300**	0.0275**	0.0248**	0.0224**
		(0.0019)	(0.0016)	(0.0014)	(0.0013)

Note. Portfolios are constructed as zero net-investment, top-minus-bottom decile portfolios that buy winning stocks with decile value "10", and short the losing stocks with decile value "1". Portfolios can differ in formation period J, and holding period K. Panel A, B, C and D show returns on momentum portfolios for total returns, and when total returns are residualized for FF3, FF5 and q^5, respectively. $*p < 0.05$ $**p < 0.01$, standard errors are in parentheses.

In addition, for each considered J-month/K-month residual momentum portfolio, the respective q^5 residualized portfolio always shows higher returns than the respective FF3 or FF5 residualized portfolio. Here, for example, the highest-return residual momentum portfolio for FF3 is 12-month/3-month, which shows average returns of 2.20 percent per month. Where the

12-month/3-month residual momentum portfolio for FF5 shows average returns of 2.54 percent per month, and 12-month/3-month for q^5 shows 3.00 percent per month. This pattern is consistent for all compared portfolios.

The findings from table 5.1 partly answer the first research question as to whether or not residualizing total returns with more advanced factor models like FF5 and q^5 improves the risk-return relationship of residual momentum portfolios, as we only answered the return-based part of the question. If residualizing with more advanced factor models greatly heightens the volatility of such a strategy, the risk-return relationship of such a portfolio does not improve. Hence, we will next evaluate the risk-based part of residual momentum portfolios.

5.2 Persistence in common factor returns

According to the empirical literature on residual momentum, the gain in performance by selecting stocks based on residual returns lies in the fact that these residual returns are not as vulnerable to dynamic factor exposures compared to total returns. Thus, limiting the volatility of the respective portfolios. As Grundy and Martin (2001) argued, a bet on total return momentum is an implicit bet on factor returns as well. Blitz et al (2011) extended proof on this 'bet' by showing that the FF3 factors show persistence in returns as the chance that factor returns over the formation period had the same sign over the holding period was larger than 50 percent.

Table 5.2 Persistence in common factor returns - Fama & French (1993; 2015)

	TREND_MktRF				TREND_SMB				TREND_HML				TREND_RMW				TREND_CMA			
J	K=3	6	9	12	3	6	9	12	3	6	9	12	3	6	9	12	3	6	9	12
3	75%	68%	65%	65%	61%	52%	51%	52%	67%	58%	58%	57%	72%	65%	64%	65%	67%	60%	58%	59%
	(14.0)	(9.1)	(7.8)	(7.4)	(5.4)	(1.0)	(0.7)	(1.1)	(8.6)	(4.0)	(4.0)	(3.6)	(11.5)	(7.8)	(7.3)	(7.5)	(8.8)	(4.7)	(3.9)	(4.2)
6	73%	76%	71%	71%	59%	62%	55%	56%	63%	65%	62%	60%	72%	75%	71%	71%	66%	68%	62%	63%
	(12.6)	(14.5)	(11.3)	(11.1)	(4.4)	(5.8)	(2.5)	(2.9)	(6.3)	(7.7)	(5.7)	(5.1)	(12.1)	(13.8)	(11.1)	(11.2)	(8.4)	(9.4)	(5.8)	(6.3)
9	73%	73%	75%	72%	58%	58%	61%	57%	62%	61%	64%	61%	74%	73%	75%	72%	66%	65%	67%	64%
	(12.7)	(12.4)	(14.0)	(11.5)	(3.9)	(3.9)	(5.3)	(3.3)	(6.1)	(5.6)	(6.9)	(5.3)	(12.9)	(12.7)	(14.3)	(12.1)	(8.1)	(7.4)	(8.9)	(6.9)
12	76%	75%	75%	77%	58%	57%	56%	60%	64%	64%	63%	65%	73%	73%	72%	75%	69%	67%	67%	70%
	(14.4)	(14.2)	(14.2)	(15.9)	(3.8)	(3.4)	(2.9)	(5.1)	(7.1)	(6.8)	(6.5)	(7.6)	(12.7)	(12.2)	(12.0)	(13.7)	(9.8)	(8.9)	(8.6)	(10.4)

Note. This table shows results for persistence in common factor returns for Fama and French factors market (MktRF), size (SMB), value (HML), profitability (RMW) and investment (CMA) over the period 1970-2020. For each factor, a formation and holding period is considered. Here, formation period J can be either 3, 6, 9 or 12 months, excluding the most recent month. Holding period K can also be 3, 6, 9 or 12 months. T-statistics are reported in parentheses that test whether or not the reported probability is different from 50 percent.

Using a similar analysis to Blitz et al (2011), this paper shows in table 5.2 that there is persistence in common factor returns for the Fama and French 1993 and 2015 factors. This 'persistence' is depicted as the chance that factor returns over the considered formation period are equal to the considered holding period. When there is no persistence in factor returns, one should expect a 50 percent chance that formation- and holding period factor returns are equal.[1] From the t-statistics in parentheses, it becomes clear that all factors for almost all

[1] Two other possible effects that might cause the percentages to be different from 50 percent are positive autocorrelation in factor returns and positive factor premiums. If factor returns have a 70 percent chance of being positive, then the chance that the sign of the returns is the same would be 0.7x0.7+0.3x0.3 = 58 percent.

different formation- and holding periods show persistence in common factor returns. Only the size factor, SMB, shows no persistence in common factor returns for 6, 9 and 12 month holding periods as the respective t-statistics 1.0, 0.7 and 1.1 indicate that the chance that the sign of the returns over the formation- and holding period are both positive, or both negative is not significantly different from 50 percent. Regarding the other factors, MktRF and RMW show the strongest persistence in common factor returns. Here, values range between 65 and 77 percent, and 64 and 75 percent that the sign of the returns in the formation period is equal to the sign of the return over the holding period, respectively.

In addition, the same analysis is conducted to examine persistence in common factor returns for the augmented q-factor model by Hou et al (2021). The results are provided in table 5.3.[2] The table provides strong evidence that all factors for all different formation- and holding periods show persistence in common factor returns. This becomes clear in the fact that all t-statistics resulting from the difference-in-means tests indicate that the observed percentage is different from 50 percent. Similar to the Fama and French factors, the size factor in the q^5 factor model shows the least amount of persistence in factor returns. Factors R_{ROE} and R_{EG} show large percentages. Here, values range between 70 and 83 percent, and 78 and 91 percent, respectively. This indicates that these factor returns keep on moving in the same direction frequently.

Table 5.3 Persistence in common factor returns - Hou et al (2021)

	TREND_R_{ME}				TREND_R_{IA}				TREND_R_{ROE}				TREND_R_{EG}			
J	K=3	6	9	12	3	6	9	12	3	6	9	12	3	6	9	12
3	65%	58%	56%	56%	71%	64%	64%	64%	77%	71%	70%	70%	85%	80%	79%	78%
	(7.5)	(3.8)	(3.1)	(3.0)	(11.2)	(7.3)	(7.1)	(7.3)	(15.9)	(11.3)	(10.3)	(10.8)	(23.8)	(18.2)	(17.7)	(16.8)
6	63%	65%	60%	60%	72%	75%	70%	70%	76%	79%	74%	74%	85%	86%	86%	84%
	(6.6)	(7.5)	(4.7)	(4.9)	(11.9)	(13.8)	(10.4)	(10.7)	(15.1)	(17.7)	(13.5)	(13.5)	(23.6)	(25.8)	(24.8)	(22.5)
9	64%	63%	65%	61%	75%	74%	76%	73%	81%	81%	82%	80%	89%	89%	90%	89%
	(6.8)	(6.3)	(7.8)	(5.6)	(13.9)	(13.3)	(15.1)	(12.8)	(18.6)	(18.6)	(20.6)	(17.8)	(30.2)	(29.5)	(31.9)	(29.5)
12	64%	62%	62%	65%	77%	75%	75%	78%	82%	81%	81%	83%	91%	90%	90%	91%
	(6.8)	(5.9)	(6.0)	(7.7)	(15.2)	(13.9)	(14.0)	(16.2)	(19.7)	(18.8)	(18.8)	(20.8)	(33.9)	(32.7)	(32.3)	(34.7)

Note. This table shows results for persistence in common factor returns for Hou et al (2021) factors' size (R_{ME}), investment (R_{IA}), return on equity (R_{ROE}) and expected growth (R_{EG}) over the period 1970-2020. For each factor, a formation and holding period is considered. Here, formation period J can be either 3, 6, 9 or 12 months, excluding the most recent month. Holding period K can also be 3, 6, 9 or 12 months. T-statistics are reported in parentheses that test whether or not the reported probability is different from 50 percent.

5.3 Conditional Frameworks

In this section, I will discuss the results for the conditional frameworks as presented by Equation 8, 9 and 10. A comparison is drawn between residual return momentum and total return momentum strategies to observe the effect of neutralizing dynamic factor exposures on the risk-

However, for the analyses in this paper, the fact that there is persistence in factor returns is more important than the mechanics behind it. Hence, this issue will not be further addressed.

[2] The market factor R_{Mkt} from the q^5 model is omitted from the table as it represents the same market as $MktRF$ in FF3 and FF5 and therefore would not contain any new information.

return relationship of (residual) momentum portfolios.

From the previous section, it has become clear that both Fama and French factors (1993; 2015), and especially Hou et al (2021) factors show strong persistence in returns. Given this evidence, we can form expectations about the effect it has on the risk-return relationship of portfolios that have exposure to this persistence. That is, total return momentum portfolios. How large is the profitability caused by the exposure to persistence in factor returns? How much risk is involved when the sign of the factor returns reverses? And, what happens when these exposures are neutralized by using residual returns? To address these questions, a conditional framework in the spirit of Grundy and Martin (2001) and Blitz et al (2011) is applied.

5.3.1 Residual momentum - FF3

First, a comparison between total return momentum portfolios and FF3 residual return momentum portfolios is made. The results are displayed in table 5.4. Panel A shows that total return momentum has strong exposure to the Fama and French (1993) factors market, size and value. Total return momentum loads negatively on these factors after negative factor returns, and positively after positive factor returns. For example, let us consider the 3-month/3-month total return momentum portfolio in Panel A. The beta for the size factor after positive returns over the formation period is 36.40, significant at the 1 percent level. While if we consider both negative and positive formation period returns, the beta for the size factor is -22.69, also significant at the 1 percent level. The difference in betas shows that factor exposures can positively contribute to the profitability of momentum portfolios, but that it is conditional on the sign of the factor returns over the formation period.

Panel B in table 5.4 shows that momentum portfolios that are constructed based on residual returns, where returns are residualized for FF3, show far smaller factor exposures. Specifically, the (un)conditional betas to the Fama and French (1993) factors are roughly 2 to 4 times smaller (in absolute terms) for residual return momentum compared to total return momentum. If we again consider the 3-month/3-month portfolios, we can observe that the betas become less pronounced, changing from 36.40 to 11.26 and -22.69 to -9.44 for the conditional and unconditional factors for size while still staying significant, respectively. We can also observe that the adjusted R^2 value drops from 0.13 to 0.03. Less significant betas and lower adjusted R^2 values indicate that ranking stocks based on residual returns in momentum portfolios successfully reduces dynamic factor exposures that result from using total returns. Although these findings are consistent for all J-month/K-month (residual) momentum portfolios, they are particularly applicable to portfolios with small holding periods. Portfolios with 3-month holding periods, but also portfolios with 6-month holding periods, show larger adjusted R^2 values and more significant betas, indicating that these portfolios have more dynamic factor exposures. These findings are as expected in line with the findings of Blitz et al (2011).

Moving on, we can now examine what effect the neutralization of dynamic factor exposures is on the risk-return relationship of these portfolios. In table 5.4, I compare each J-month/K-month portfolio for total return momentum with its residual return momentum counterpart. Here, we can see that for all formation- and holding periods returns increase and volatilities decrease when using residual returns, which results in higher Sharpe ratios. This improved risk-return relationship for residual momentum compared to traditional momentum in not surprising. However, in contrast to earlier research the improvements of the portfolios are both risk-based and return-based.[3] Where earlier research from Blitz et al (2011) mainly found an improved risk-return relationship due to a reduction in volatility.

Table 5.4 Regression conditional up-factor model - FF3

J/K	Ret.	Vol.	Sharpe.	Alpha	MktRF	SMB	HML	$MktRF_{UP}$	SMB_{UP}	HML_{UP}	A.R^2
Panel A: J/K Total Return Momentum Portfolio's											
3/3	0.35	2.59	0.14	0.38**	-15.25**	-22.69**	-24.46**	10.63*	36.40**	29.32**	0.13
				(0.10)	(3.45)	(5.02)	(5.18)	(4.49)	(6.63)	(7.05)	
3/6	0.42	1.88	0.22	0.45**	-5.90*	-8.13*	-11.3**	5.50	15.45**	16.65**	0.04
				(0.08)	(2.62)	(3.81)	(3.94)	(3.41)	(5.04)	(5.36)	
3/9	0.35	1.61	0.22	0.36**	1.03	-6.30	-10.71**	-1.76	12.00**	15.66**	0.03
				(0.07)	(2.24)	(3.27)	(3.37)	(2.92)	(4.32)	(4.59)	
3/12	0.26	1.43	0.18	0.25**	2.72	-4.84	-8.38**	-2.86	9.98**	12.83**	0.03
				(0.06)	(1.98)	(2.88)	(2.97)	(2.58)	(3.80)	(4.04)	
Panel B: J/K Residual Return Momentum Portfolio's											
3/3	0.79	1.59	0.50	0.42**	-7.24**	-9.44**	-7.42**	6.88**	11.26**	5.78	0.03
				(0.07)	(2.33)	(3.39)	(3.50)	(3.04)	(4.48)	(4.76)	
3/6	0.76	1.14	0.67	0.41**	-3.68*	-4.14	-1.77	3.92	5.61	-1.34	0.01
				(0.05)	(1.74)	(2.53)	(2.62)	(2.27)	(3.35)	(3.56)	
3/9	0.69	0.92	0.75	0.33**	-1.14	-3.27	-2.65	0.86	4.46	4.00	0.00
				(0.04)	(1.45)	(2.12)	(2.19)	(1.89)	(2.80)	(2.97)	
3/12	0.60	0.85	0.71	0.23**	1.39	-3.04	-3.73**	-1.38	5.27*	1.52	0.01
				(0.04)	(1.36)	(1.98)	(2.04)	(1.77)	(2.61)	(2.78)	

Note. This table shows average monthly returns in excess of the risk-free rate, volatilities, Sharpe ratios, alphas and betas to the Fama and French (1993) (un)conditional factors $MktRF$, SMB, HML, $MktRF_{UP}$, SMB_{UP} and HML_{UP} and adjusted R^2 values for total- and residual return momentum portfolios. The conditional UP factors are not the same for each regression, as they are conditional on the sign of the returns over the formation period considered. The (residual) momentum strategy is defined as a zero-investment top-minus-bottom decile portfolio using the overlapping portfolios approach of Jegadeesh and Titman (1993). Here, residual returns are estimated using Equation (4). Alphas and betas are estimated using the conditional up-factor model as presented in Equation (8). Only 3-month formation period portfolios are disclosed to increase the readability. Table 9.1 in the Appendix shows all portfolios. $*p < 0.05$ $**p < 0.01$, standard errors are in parentheses. Values are in percentages, except for adjusted R^2.

Furthermore, if we consider the risk-adjusted returns for total return momentum in Panel A in table 5.4 we can observe that the alphas are roughly as high as the returns of the portfolio in excess of the risk-free rate. Hence, roughly zero percent of the returns of the total return momentum portfolios are explained by the conditional FF3 up-factor model. All the while the portion of the risk of total return momentum that can be attributed to these exposures is up to 13 percent (indicated by adjusted R^2 values up to 0.13). Therefore, on the contrary to what Blitz

[3]When using the terms 'risk-based' or 'return-based', I refer to risk and return in hindsight. How high was the volatility of a particular portfolio, and how well has it performed? Beforehand, risk and return are interrelated as a higher risk should lead to higher expected returns.

et al (2011) found, the common-factor component of total return momentum does not contribute to the profitability of total return momentum. I do find similar evidence that a disproportional large part of the risk can be attributed to the common-factor component. When examining the risk-adjusted return for residual return momentum in Panel B it becomes clear that the alphas are substantially smaller than the portfolio returns in excess of the risk-free rate. Indicating that a notable part of the returns of residual momentum portfolios is explained by the conditional FF3 up-factor model. On the contrary, adjusted R^2 values are considerably smaller, meaning that only a marginal part of the variability of residual momentum portfolios is explained by the model.

5.3.2 Residual momentum - FF5

Having drawn an analysis between total return momentum and residual return momentum when returns are residualized for FF3, we can now move on to more advanced factor models. From the literature review we know that since the paper of Blitz et al (2011), more advanced factor models have been implemented. This also means we can residualize returns with these more advanced factor models. This paper will first evaluate residual momentum portfolios when returns are residualized for FF5. Subsequently residual momentum portfolios residualized for q^5 will be analyzed.

Table 5.5 shows a comparison between total return momentum and residual return momentum when returns are residualized for FF5, presented in Panel A and B respectively. The portfolios are regressed on the conditional framework as presented in Equation 9. From Panel A it becomes clear that total return momentum also has strong exposure to the Fama and French (2015) factors market, size, value, profitability and investment. Total return momentum loads negatively on these factors after negative factor returns, and positively after positive factor returns. This finding is consistent with the findings in table 5.4 where factor exposures can positively contribute to the profitability of momentum portfolios, but that this is conditional on the sign of the factor returns over the formation period.

Panel B in table 5.5 shows that momentum portfolios that are constructed based on residual returns, where returns are residualized for FF5, show far smaller factor exposures. Similar to the results from table 5.4, table 5.5 shows that (un)conditional betas to the Fama and French (2015) factors are less significant, or lose their significance completely for residual return momentum compared to total return momentum. We can also observe that the adjusted R^2 value drops from 0.17 to 0.08. So, similar to residual momentum with FF3, we observe less significant betas and lower adjusted R^2 values, indicating that ranking stocks based on residual returns with FF5 also successfully reduces dynamic factor exposures that result from using total returns.

When evaluating the risk-return relationship of these portfolios in table 5.5, we can observe that for each J-month/K-month portfolio residual return momentum outperforms total return momentum if we take the Sharpe ratio as criterion. Again, similar to residual momentum for FF3, the improvement is both return- and risk-based. For all formation- and holding periods considered, returns rise and volatilities drop when using residual return momentum with FF5 compared to using total return momentum.

Table 5.5 Regression conditional up-factor model - FF5

J/K	Ret	Vol	Sharpe	Alpha	MktRF	SMB	HML	RMW	CMA	$MktRF_{UP}$	SMB_{UP}	HML_{UP}	RMW_{UP}	CMA_{UP}	A.R^2
Panel A: Total Return Momentum Portfolio's															
3/3	0.35	2.59	0.14	0.28**	-8.39*	-18.75**	-21.66**	-5.17	0.59	4.48	16.79*	34.93**	36.33**	23.00*	0.17
				(0.10)	(3.58)	(4.98)	(6.03)	(6.28)	(9.30)	(4.55)	(7.56)	(6.77)	(9.22)	(11.21)	
3/6	0.42	1.88	0.22	0.42**	-3.56	-7.59*	-4.89	0.53	-16.45*	1.81	10.42	19.16**	12.00	18.19*	0.07
				(0.08)	(2.75)	(3.83)	(4.64)	(4.83)	(7.15)	(3.50)	(5.81)	(5.20)	(7.09)	(8.62)	
3/9	0.35	1.61	0.22	0.37**	0.85	-6.67*	-4.08	-4.46	-13.24*	-2.96	14.69**	13.56**	8.78	0.97	0.04
				(0.07)	(2.37)	(3.30)	(4.00)	(4.16)	(6.17)	(3.02)	(5.01)	(4.48)	(6.11)	(7.43)	
3/12	0.26	1.43	0.18	0.27**	2.22	-5.19	-2.80	-2.41	-13.31*	-3.75	12.25**	11.27**	2.99	3.28	0.03
				(0.06)	(2.09)	(2.91)	(3.53)	(3.67)	(5.44)	(2.66)	(4.42)	(3.95)	(5.39)	(6.55)	
Panel B: Residual Return Momentum Portfolio's															
3/3	1.03	1.73	0.60	0.57**	-1.15	-3.99	-3.82	2.50	3.86	2.09	6.86	-0.99	25.81**	15.87	0.08
				(0.07)	(2.59)	(3.60)	(4.36)	(4.54)	(6.72)	(3.29)	(4.89)	(5.46)	(6.66)	(8.10)	
3/6	0.95	1.23	0.77	0.58**	-1.05	-1.15	1.88	1.36	-3.56	0.90	0.24	-3.98	9.10*	6.02	0.01
				(0.05)	(1.94)	(2.70)	(3.28)	(3.42)	(5.06)	(2.47)	(3.68)	(4.11)	(5.01)	(6.09)	
3/9	0.88	1.00	0.88	0.51**	1.35	-2.71	2.99	-1.88	-1.89	-1.40	1.70	-2.37	7.45	-1.34	0.00
				(0.05)	(1.61)	(2.23)	(2.71)	(2.82)	(4.17)	(2.04)	(3.04)	(3.39)	(4.13)	(5.03)	
3/12	0.78	0.91	0.86	0.41**	2.50	-3.47	0.03	-1.91	0.82	-2.39	2.70	0.56	5.33	-4.69	0.00
				(0.04)	(1.49)	(2.07)	(2.51)	(2.61)	(3.87)	(1.89)	(2.81)	(3.14)	(3.83)	(4.66)	

Note. This table shows average monthly returns in excess of the risk-free rate, volatilities, Sharpe ratios, alphas and betas to the Fama and French (2015) (un)conditional factors $MktRF$, SMB, HML, RMW, CMA, $MktRF_{UP}$, SMB_{UP}, HML_{UP}, RMW_{UP} and CMA_{UP} and adjusted R^2 values for total- and residual return momentum portfolios. The conditional UP factors are not the same for each regression, as they are conditional on the sign of the returns over the formation period considered. The (residual) momentum strategy is defined as a zero-investment top-minus-bottom decile portfolio using the overlapping portfolios approach of Jegadeesh and Titman (1993). Here, residual returns are estimated using Equation (5). Alphas and betas are estimated using the conditional up-factor model as presented in Equation (9). Only 3-month formation period portfolios are disclosed to increase the readability. Table 9.2 in the Appendix shows all portfolios. $^*p < 0.05$ $^{**}p < 0.01$, standard errors are in parentheses. Values are in percentages, except for adjusted R^2.

Subsequently, if we again consider the risk-adjusted returns for total return momentum in Panel A in table 5.5 this time, we can observe that the alphas are again roughly the same size as the returns of the portfolio in excess of the risk-free rate. Hence, roughly zero percent of the returns of the total return momentum portfolios are explained by the conditional FF5 up-factor model. All the while the portion of the risk of total return momentum that can be attributed to these exposures is up to 17 percent (indicated by adjusted R^2 values up to 0.17). These findings are similar to the results in table 5.4. Thus, finding a disproportional risk-return relationship that can be attributed to the conditional up-factor model. When examining the risk-adjusted return for residual return momentum in Panel B we also observe similar findings to Panel B in table 5.4, where only a small part of the variability of residual momentum portfolios is explained by the model. All the while alphas are substantially smaller than portfolio returns in excess of the risk-free rate.

5.3.3 Residual momentum - q^5

Finally, the last conditional model as presented by Equation 10 is considered. Table 5.6 shows a comparison between total return momentum, and residual return momentum when returns are residualized for the augmented q-factor model (q^5), presented in Panel A and B respectively. From Panel A it becomes clear that total return momentum also has strong exposure to the q^5 factors market, size, investment, return on equity and expected growth by Hou et al (2021). Total return momentum loads negatively on these factors after negative factor returns, and positively after positive factor returns. Similar to the findings in table 5.4 and 5.5, table 5.6 shows that factor exposures can positively contribute to the profitability of momentum portfolios, but that this is conditional on the sign of the factor returns over the formation period. Overall, however, the dynamic factor exposures negatively affect returns of momentum portfolios.

Table 5.6 Regression conditional up-factor model - q5

J/K	Ret.	Vol.	Sharpe.	Alpha	R_{MKT}	R_{ME}	R_{IA}	R_{ROE}	R_{EG}	$R_{MKT_{UP}}$	$R_{ME_{UP}}$	$R_{IA_{UP}}$	$R_{ROE_{UP}}$	$R_{EG_{UP}}$	A.R^2
Panel A: J/K Total Return Momentum Portfolio's															
3/3	0.35	2.59	0.14	0.11	-6.85	-11.2*	-19.97*	-7.12	-6.24	4.45	25.39	35.25**	30.90**	30.47**	0.18
				(0.11)	(3.58)	(5.11)	(8.48)	(7.92)	(11.20)	(4.45)	(6.56)	(11.14)	(8.66)	(11.78)	
3/6	0.42	1.88	0.22	0.38**	-3.63	-2.52	-19.03**	-1.33	-12.55	2.47	10.60*	24.13**	15.65*	19.28*	0.08
				(0.09)	(2.75)	(3.92)	(6.51)	(6.08)	(8.59)	(3.41)	(5.03)	(8.55)	(6.65)	(9.04)	
3/9	0.35	1.61	0.22	0.38**	1.30	-6.63	-18.86**	-10.01	-7.74	-3.03	10.74*	20.71**	16.53**	9.12	0.05
				(0.07)	(2.37)	(3.39)	(5.62)	(5.25)	(7.43)	(2.95)	(4.35)	(7.38)	(5.74)	(7.81)	
3/12	0.26	1.43	0.18	0.28**	2.67	-5.75	-16.6**	-7.07	-7.03	-3.63	8.55*	18.82**	9.11	8.47	0.03
				(0.07)	(2.10)	(3.00)	(4.98)	(4.65)	(6.57)	(2.61)	(3.85)	(6.54)	(5.08)	(6.92)	
Panel B: J/K Residual Return Momentum Portfolio's															
3/3	1.45	1.82	0.80	0.76**	2.06	5.95	7.60	5.68	12.44	0.61	1.04	-9.39	5.81	21.69*	0.11
				(0.08)	(2.66)	(3.79)	(6.30)	(5.89)	(8.32)	(3.30)	(4.87)	(8.27)	(6.44)	(8.75)	
3/6	1.33	1.31	1.01	0.82**	1.54	1.22	4.69	5.14	0.84	0.02	1.78	-11.44	-0.94	19.04**	0.05
				(0.06)	(1.99)	(2.84)	(4.72)	(4.41)	(6.23)	(2.47)	(3.65)	(6.19)	(4.82)	(6.55)	
3/9	1.22	1.06	1.15	0.76**	1.42	-0.21	4.17	3.36	2.99	0.21	0.83	-11.66*	-2.29	9.96	0.02
				(0.05)	(1.65)	(2.35)	(3.90)	(3.64)	(5.15)	(2.04)	(3.01)	(5.12)	(3.98)	(5.42)	
3/12	1.10	0.96	1.15	0.67**	2.88	-1.08	-0.26	-2.09	2.16	-1.61	1.85	-6.46	2.03	7.29	0.01
				(0.05)	(1.52)	(2.16)	(3.59)	(3.36)	(4.74)	(1.88)	(2.78)	(4.72)	(3.67)	(4.99)	

Note. This table shows average monthly returns in excess of the risk-free rate, volatilities, Sharpe ratios, alphas and betas to the Hou et al (2021) (un)conditional factors R_{MKT}, R_{ME}, R_{IA}, R_{ROE}, R_{EG}, $R_{MKT_{UP}}$, $R_{ME_{UP}}$, $R_{IA_{UP}}$, $R_{ROE_{UP}}$ and $R_{EG_{UP}}$ and adjusted R^2 values for total- and residual return momentum portfolios. The conditional UP factors are not the same for each regression, as they are conditional on the sign of the returns over the formation period considered. The (residual) momentum strategy is defined as a zero-investment top-minus-bottom decile portfolio using the overlapping portfolios approach of Jegadeesh and Titman (1993). Here, residual returns are estimated using Equation (6). Alphas and betas are estimated using the conditional up-factor model as presented in Equation (10). Only 3-month formation period portfolios are disclosed to increase the readability. Table 9.3 in the Appendix shows all portfolios. $*p < 0.05$ $**p < 0.01$, standard errors are in parentheses. Values are in percentages, except for adjusted R^2.

Panel B in table 5.6 shows that momentum portfolios that are constructed based on residual returns, where returns are residualized for q^5, have smaller factor exposures. In fact, they entirely disappear. For example, if we again consider the 3-month/3-month portfolios, we can observe that the betas change from a significant 35.25 to an insignificant -9.39. and a significant -19.97 to an insignificant 7.60 for the conditional and unconditional factors for investment, respectively. We can also observe that the adjusted R^2 value drops from 0.18 to 0.11. So, similar to residual momentum with FF3 and FF5, we observe less significant betas and lower adjusted R^2 values, indicating that ranking stocks based on residual returns with q^5 also successfully reduces dynamic factor exposures that result from using total returns. However, where residual momentum portfolios for FF3 and FF5 still did show some level of dynamic factor exposure, it entirely disappeared for residual momentum portfolios for q^5.

When evaluating the risk-return relationship of these portfolios in table 5.6, we can observe that for each J-month/K-month portfolio residual return momentum outperforms total return momentum if we take the Sharpe ratio as criterion. Again, similar to residual momentum for FF3 and FF5, the improvement is both return- and risk-based. For all formation- and holding periods considered, returns rise and volatilities drop when using residual return momentum with q^5 compared to using total return momentum. Furthermore, if we compare both FF3 (table 5.4), FF5 (table 5.5) and q^5 (table 5.6) residual momentum portfolios, it becomes clear that using q^5 instead of FF3 or FF5 to residualize returns improves the risk-return relationship the most, indicated by higher Sharpe ratios. Interestingly, this improvement is not risk-based as volatilities are higher for residual momentum portfolios with q^5.

If we consider the risk-adjusted returns for total return momentum in Panel A in table 5.6 we can observe that almost all the alphas are roughly the same size as the returns of the portfolio in excess of the risk-free rate. Hence, roughly zero percent of the returns of the total return momentum portfolios are explained by the conditional q^5 up-factor model. All the while the portion of the risk of total return momentum that can be attributed to these exposures is up to 18 percent (indicated by adjusted R^2 values up to 0.18). These findings are similar to the results in table 5.4 and 5.5. Thus, finding a disproportional risk-return relationship that can be attributed to the conditional up-factor model. When examining the risk-adjusted return for residual return momentum in Panel B in table 5.6 we also observe similar findings to Panel B in table 5.4 and 5.5, where only a small part of the variability of residual momentum portfolios is explained by the model (low adjusted R^2 values). All the while alphas are substantially smaller than portfolio returns in excess of the risk-free rate.

Finally, we can conclude that residual returns for all three different factor models (FF3, FF5 and q^5) improve the risk-return relationship compared to total return momentum. Improvements are both due to higher profitability, and also lower volatility of the returns. Most notably, the more advanced the factor model, the better the risk-return relationship taking the Sharpe ratio as criterion (q^5 > FF5 > FF3). Therefore, the first research question can be answered; using more advanced factor models like FF5 and q^5 to residualize returns for momentum portfolios does improve the risk-return relationship compared to using just FF3. However, contrarian to the improvements with respect to total return momentum, improvements between residual momentum portfolios due to using a more advanced factor model are caused by a rather large increase in profitability, as volatilities increase as well.

When considering the second research question as to whether or not more advanced factor models are capable of successfully reducing dynamic factor exposures, table 5.5 and 5.6 show convincing evidence. Betas to the considered factors lose significance and adjusted R^2 values drop when returns are residualized with the more advanced factor models FF5 and q^5. In addition, regarding the significance of the betas, FF5 and q^5 seem to do an even better job at diminishing factor exposures than FF3 as the betas to these factors lose more significance when using residual returns compared to the betas of FF3 factors in table 5.4 in Panel B. These findings are more in line with behavioral biases (e.g. Daniel et al, 1998; Hong and Stein, 1999; Barberis et al, 1998) than risk-based explanations, which can be seen in the fact that most of the profits from total return momentum portfolios are explained by idiosyncratic factors.

Regarding the third research question about formation- and holding periods, I generally observed similar findings as to what Jegadeesh and Titman (1993) found. Formation periods are positively related to portfolio returns, and holding periods are negatively related to portfolio returns when considering the (residual) momentum strategy (table 5.1). Regarding the risk-return relationship, the findings in this paper indicate that total return momentum portfolios with longer holding periods generally have lower Sharpe ratios. For residual momentum portfolios, this problem with long holding periods seems to be resolved. Where even the best performing portfolio, taking the Sharpe ratio as criterion, is the 12-month/12-month residual momentum portfolio where returns are residualized for q^5. This finding is consistent with Gutierrez and Pirinsky (2007), whom found that where total return momentum profits revert at horizons beyond one year, residual momentum continues to generate positive returns. Therefore we can conclude that for residual return momentum portfolios both longer formation periods and longer holding periods positively influence the risk-return relationship,[4] and thus reject any concerns regarding the long-term reversal effect for residual momentum portfolios over the time-span considered in this paper.

5.4 Performance over time

Moving on, I investigate how total return and residual return momentum portfolios behave over the data set considered in this paper. Are there periods where reversals hurt total return momentum more? And, most importantly, does using more advanced factor models to arrive at residual returns improve the robustness of such strategies?

From the paper of Blitz et al (2011), we know that (residual) momentum strategies have an especially hard time during the 1930's and post 2000 period. As this paper examines the post

[4]This improvement is observed for periods up to 12 months. No conclusions can be drawn for periods beyond the 12-month horizon.

1970 period, only the latter is important. To investigate this issue, the development of cumulative returns are considered first. Figure 5.1 displays the cumulative returns for all three different residual momentum strategies, as well as total return momentum. Only the 12-month/3-month J/K period is considered to increase the readability, as well as that findings are similar throughout different formation- and holding periods (figure 9.1 to 9.15 in the Appendix show cumulative returns for all different J/K (residual) momentum portfolios). From figure 5.1 we can observe that all three different residual momentum portfolios follow similar trends, where the biggest hiccup in cumulative returns can be found in the financial crisis period. The financial crises, but also the IT-bubble, have had by far the greatest effect on total return momentum portfolios. Here, cumulative returns stayed virtually flat in the first decade of the 21st century.

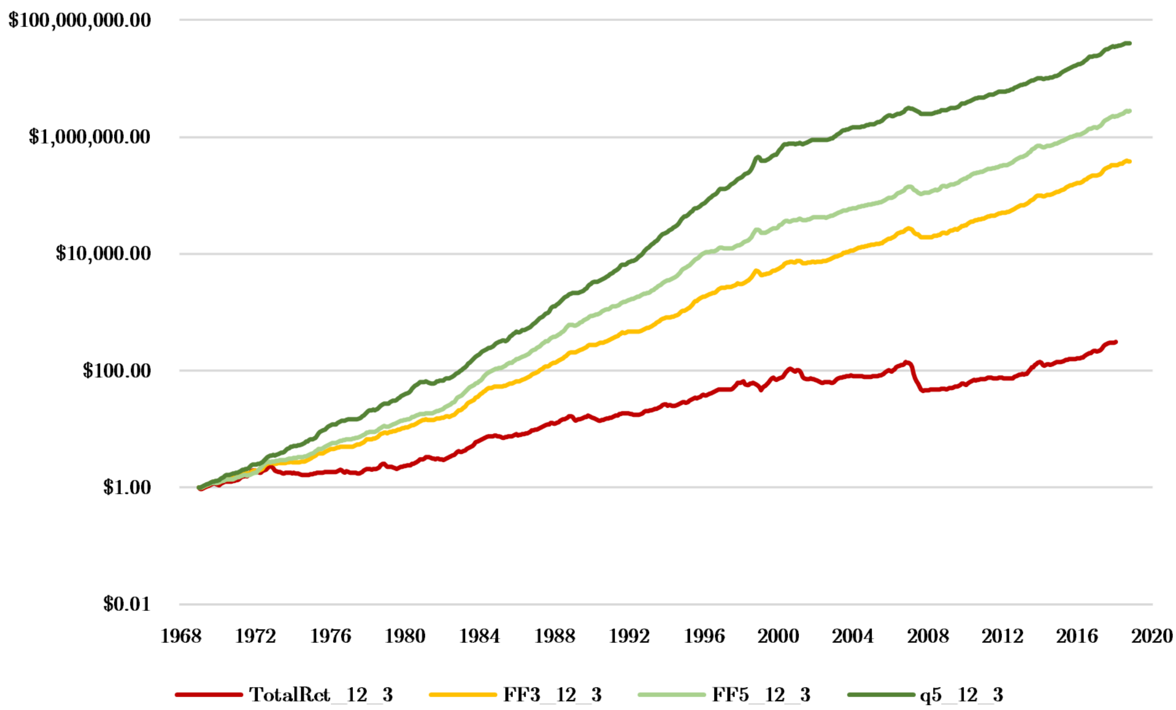

Figure 5.1: Cumulative returns (residual) momentum portfolios 12-month/3-month

Figure 5.2 shows the drawdown of these (residual) momentum strategies. The drawdown at a given point in time is calculated by comparing the cumulative return at that point in time to the all-time high cumulative return up until that point. Therefore, the drawdown can be 0 percent at best when the cumulative returns have reached an all-time high. Otherwise, the drawdown is negative. From figure 5.2 we can observe that there are several periods where the magnitude and duration of drawdowns of total return momentum is much larger than the residual return momentum strategies. For example, total return momentum suffers drawdowns of -45 percent and -70 percent during the IT-bubble and financial crisis, respectively. All the while the drawdown of the residual momentum portfolio never goes below -30 percent. As expected, the greatest drawdown for residual momentum strategies was also during the financial crises. During the 1970's, total return momentum also suffered quite a large drawdown of -30 percent, which lasted for a decade. Here, the residual momentum portfolios did not seem to suffer at all.

Another interesting observations is that drawdowns for residual momentum portfolios where returns are residualized with FF3 are slightly larger than drawdowns for portfolios residualized for FF5 or q^5. Figure 9.16 to 9.30 in the Appendix show that this finding is consistent throughout most formation- and holding periods. Here, we must consider that the residual momentum portfolios for FF3 as presented in table 5.4 have lower volatilities than the residual momentum portfolios for FF5 and q^5 in table 5.5 and 5.6 respectively. Thus, lower volatilities do not necessarily lead to less pronounced drawdowns. This can be explained by the fact that volatility is also defined by positive deviations from the mean.

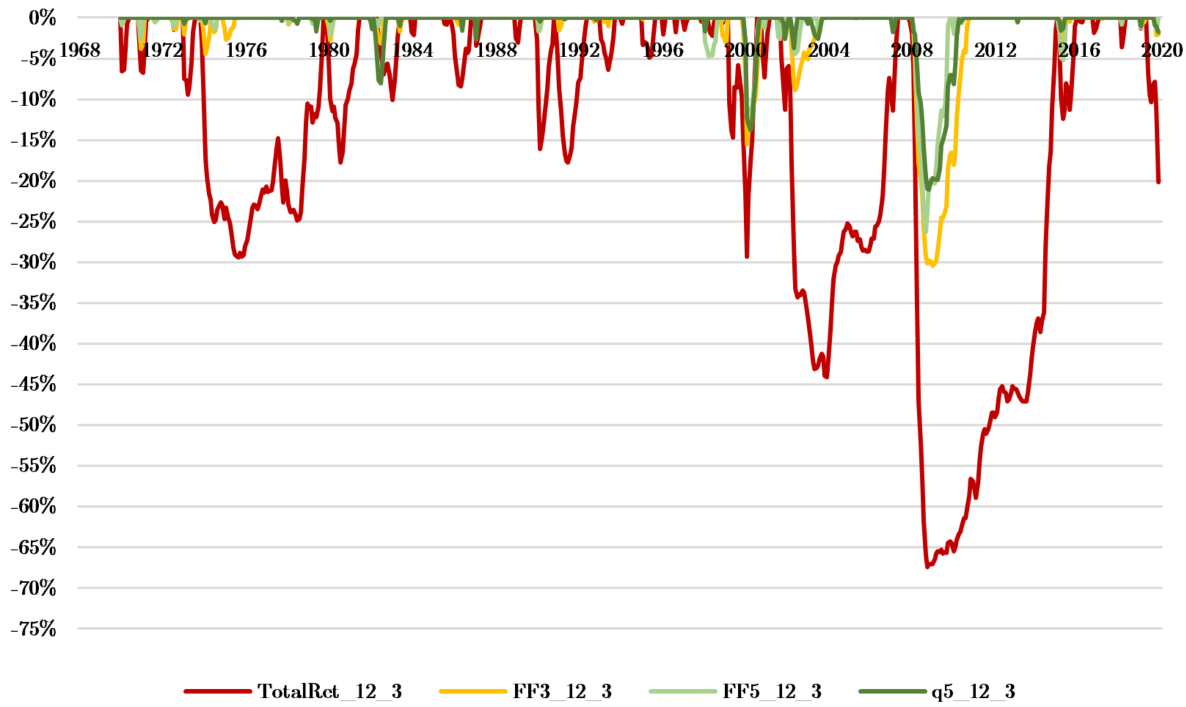

Figure 5.2: Drawdown (residual) momentum 12-month/3-month

To investigate the effect of these drawdowns on (residual) momentum portfolios, I list the performances of total return and residual return momentum portfolios in table 5.7. Table 5.7 shows average monthly returns per decade for each (residual) momentum portfolio in the 12-month/3-month period. While the 2000's have been a tumultuous period for financial markets, showing a decreased performance for all four strategies, the total return momentum strategy is the only strategy that has returns that are not significantly different from zero during this period. Furthermore, the 1970's premium on total return momentum is still positive and quite substantial, but lacks statistical significance. Also, when comparing table 5.7 with figure 5.2, we can see that when the drawdowns were least pronounced (which was during the 80's and 90's), premiums on all (residual) momentum portfolios were the highest. If we consider the final decade in our data set, we can observe that (residual) momentum portfolios are again performing as they did in the pre-2000 period despite the aftermath of the financial crisis and the impact of COVID-19. Although I must note that financial markets recovered quickly from the initial hit of the COVID-19 crisis. And, due to government financial aid, some of the negative effects on financial markets may be postponed into the future. To enhance the readability, table 5.7 only discloses the 12-month/3-month formation and holding period. Nevertheless, these findings are consistent throughout all considered J/K (residual) momentum portfolios.

Table 5.7 Performance total return momentum versus residual return momentum 12-month/3-month

	Description	Tot.Mom	Res.Mom FF3	Res.Mom FF5	Res.Mom q5
1970's	Oil crisis and inflation	0.0073	0.0128**	0.0152**	0.0227**
		(0.0040)	(0.0029)	(0.0028)	(0.0028)
1980's	Deregulation and de-industrialization	0.0153**	0.0185**	0.0251**	0.0286**
		(0.0037)	(0.0033)	(0.0035)	(0.0040)
1990's		0.0138**	0.0225**	0.0270**	0.0394**
		(0.0035)	(0.0026)	(0.0031)	(0.0030)
2000's	IT-bubble and financial crises	-0.0010	0.0135**	0.0155**	0.0198**
		(0.0089)	(0.0047)	(0.0043)	(0.0056)
2010-2020	Financial crises and COVID-19	0.0135**	0.0231**	0.0248**	0.0211**
		(0.0038)	(0.0021)	(0.0024)	(0.0021)

Note. This table shows average monthly returns per decade for (residual) momentum portfolios considering only 12-month/3-month formation- and holding period. $*p < 0.05$ $**p < 0.01$, standard errors are in parentheses.

When answering the fourth research question; whether or not residualizing returns with more advanced factor models makes residual momentum strategies even more robust in the post-2000 period, drawdowns are the most important as it shows us the magnitude and duration of return reversals and how greatly a portfolio was effected during certain times. Drawdowns do seem to be the most pronounced for residual momentum portfolios residualized with FF3 in the post-2000 period. This picture is consistent throughout all considered J/K residual momentum portfolios. However, the improvement is only marginal compared to the improvement of using any of the three factor models to residualize returns versus using total returns.

6 Robustness checks

Examining four different formation- and holding periods and three different ways of calculating residual returns is a fairly strong check of the robustness of residual momentum strategies in itself. Even so, this paper will address additional checks to assess the robustness of these strategies. I will address survivorship bias and alternative estimation windows. There are several other robustness checks that can be valuable like using an alternative momentum definition or using only large cap stocks. However, for the sake of brevity, these checks are not included in this paper as I believe them to be already proven robust in other papers.

6.1 Survivorship bias

In the empirical analyses, the first 36 months of observations per stock are dropped, and if a stock has less than 36 months of stock price data it is omitted from the sample all together. This procedure is necessary because a minimum length of 36 months is required to estimate betas for residual return momentum portfolios. The same was done for total return momentum portfolios to ensure a sound comparison. Removing entire companies leaves some survivorship bias concerns as companies that do not pass the three-year threshold of being listed on public markets might influence residual momentum returns. To see if survivorship bias has had an effect on the analyses, I construct total return momentum strategies where observation 1 to 36 for each stock are not dropped from the sample, and compare the results to the total return momentum portfolios from the analyses where these observations are dropped. The comparison can be made as total return momentum strategies do not require α_i and β_i estimations to calculate residual returns. This will show if omitting stocks that have been listed for a period shorter than 36 months has an effect on the portfolios. The results in table 9.4, 9.5 and 9.6 in the Appendix show similarity regarding the dynamic factor exposures as to Panel A from table 9.1, 9.2 and 9.3. These are the same regressions, respectively. The risk-return relationship does seem to be somewhat affected, especially in the portfolios with shorter formation periods. Overall, the resulting improved risk-return relationship from using residual returns seems to be robust to excluding stocks with short return histories.

6.2 Alternative estimation window

In addition, this paper will also account for the estimation period as a whole by examining the effect of using a 24-month or 60-month estimation period. The methodological approach is - except for the estimation period to estimate α_i and β_i - exactly the same as described in Section 4. Table 9.7, 9.8 and 9.9 in the Appendix show results for the 24-month estimation period approach. Table 9.10, 9.11 and 9.12 in the Appendix show results for 60-month estimation periods. If we compare these results with our original analyses (Panel B in tables 9.1, 9.2 and 9.3 in the Appendix), we can observe that the risk-return relationship as measured by the Sharpe ratio seems to be negatively related to the length of the estimation period. However, regarding the dynamic factor exposures, I generally observe similar findings compared to the original analyses. Here, the results are robust to the estimation window considered.

7 Conclusion

The results in this paper show that the risk-return relationship of residual momentum portfolios can be improved by using more advanced factor models. Here, the improvement is both risk- and return based. I find that using factor models like FF5 and q^5 are better than FF3 at isolating the stock-specific component of momentum. The model that carries the greatest explanatory value, seems to residualize returns best. Furthermore, residual return momentum portfolios are not negatively influenced by the length of the holding period which is commonly found in total return momentum portfolios. Also, residual momentum portfolios where returns are residualized for FF5 or q^5 show less pronounced drawdowns (in magnitude and duration) in times of recession.

The findings in this paper are robust to different methodological assumptions, as we can observe the same effect of dynamic factor exposures for (residual) momentum portfolios when these alternative assumptions are implemented. Overall, the risk-return relationship as measured by the Sharpe ratio does change somewhat when using these different methodological assumptions. Empirically, this is not very relevant as the goal of this paper is to improve residual momentum given a methodological approach. Practically, when implementing a residual momentum strategy, these methodological discrepancies should be taken into account to optimize the risk-return relationship of a given residual momentum portfolio.

In addition, the effect of transaction costs is not considered in this paper, but of practical importance due to the frequency of rebalancing in (residual) momentum portfolios. In future research, residual momentum portfolios can be adjusted for transaction costs. Here, a liquidity-weighted approach can be implemented such that not merely winners and losers are selected, but also the liquidity of stocks is considered such that transaction costs are limited. Furthermore, the results in this paper have shown that the constantly expanding literature on asset pricing models can have great value for - in this particular case - residual momentum portfolios.

The findings in this paper are more in line with behavioral biases motivating the returns of (residual) momentum portfolios than risk-based explanations due to the large part idiosyncratic factors play in the explanation of returns. It is still unclear as to why momentum earns a premium in the first place, but an ever greater threat to efficient markets is that the stock-specific component of returns improves when using these factor models to residualize returns.

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9 Appendix

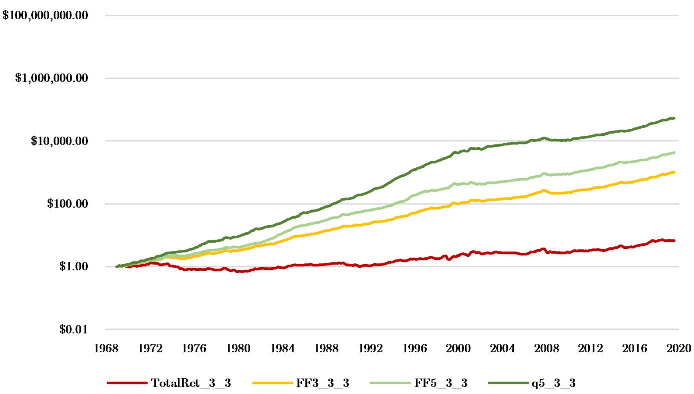

Figure 9.1: Residual momentum 3-month/3-month

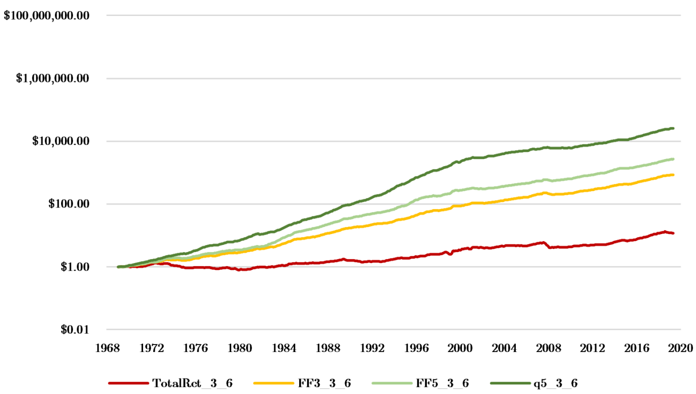

Figure 9.2: Residual momentum 3-month/6-month

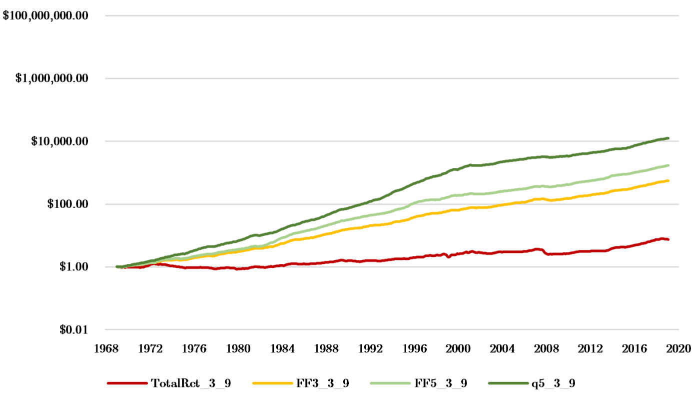

Figure 9.3: Residual momentum 3-month/9-month

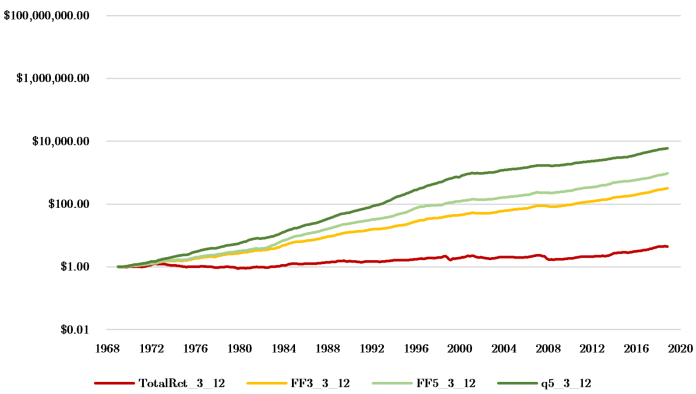

Figure 9.4: Residual momentum 3-month/12-month

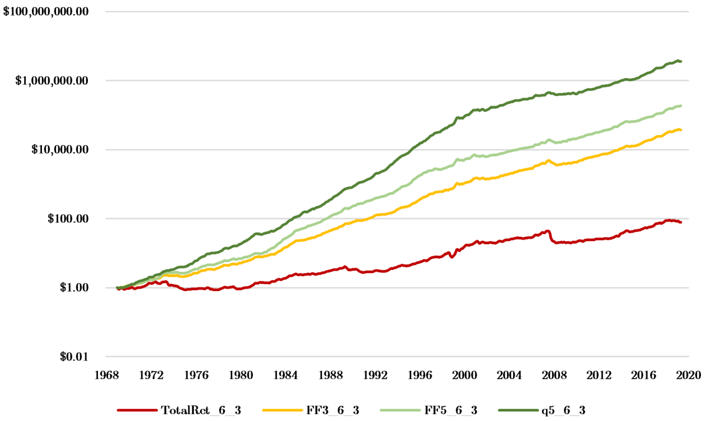

Figure 9.5: Residual momentum 6-month/3-month

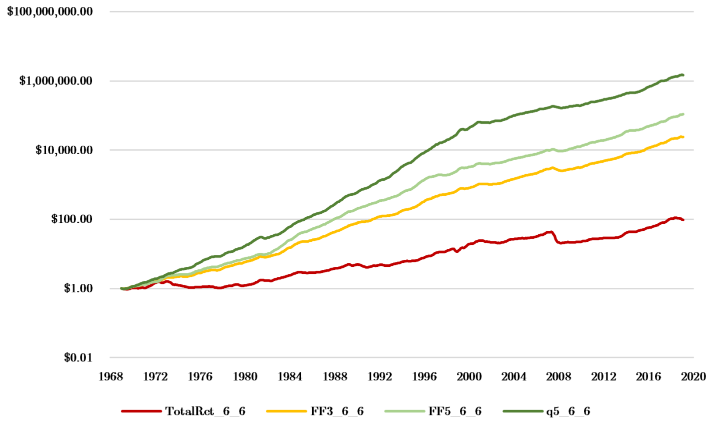

Figure 9.6: Residual momentum 6-month/6-month

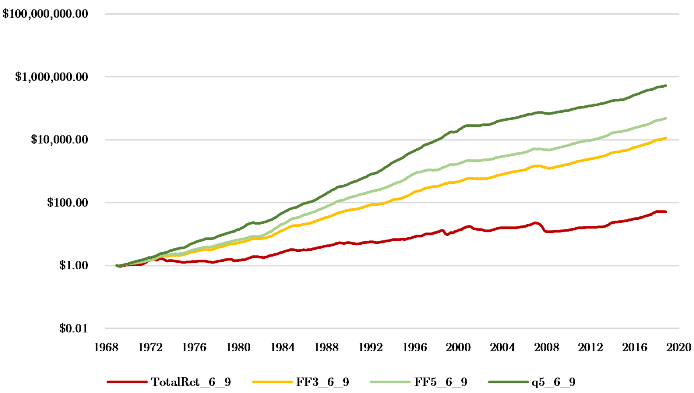

Figure 9.7: Residual momentum 6-month/9-month

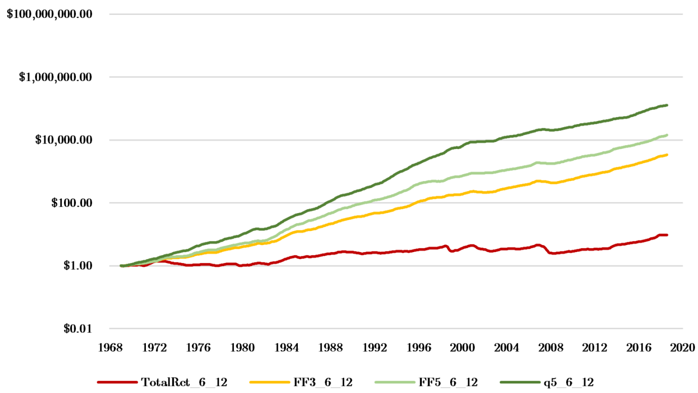

Figure 9.8: Residual momentum 6-month/12-month

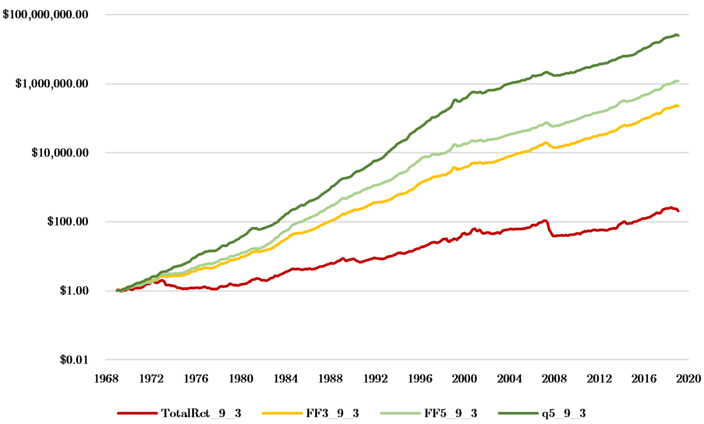

Figure 9.9: Residual momentum 9-month/3-month

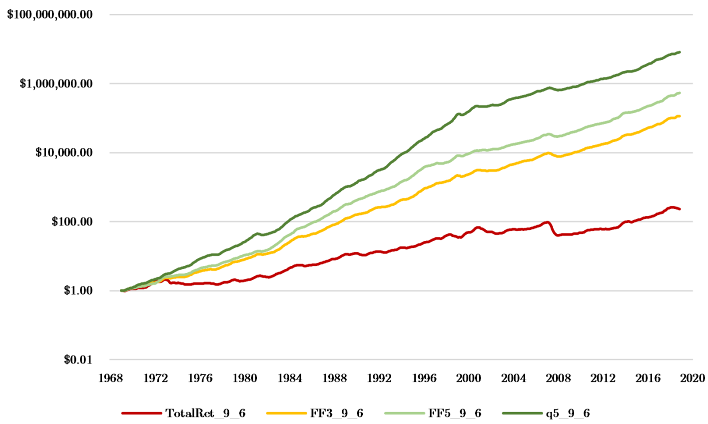

Figure 9.10: Residual momentum 9-month/6-month

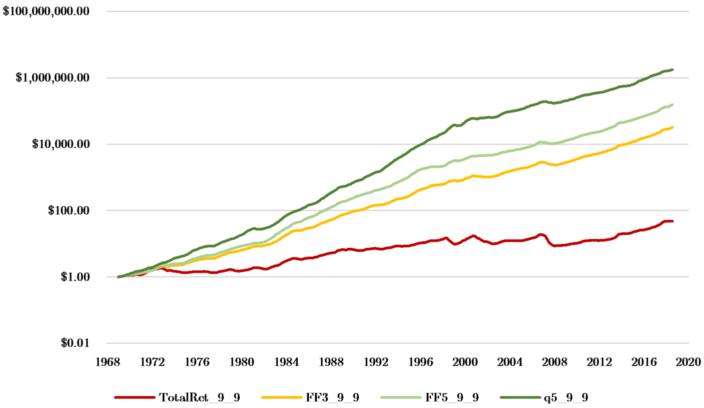

Figure 9.11: Residual momentum 9-month/9-month

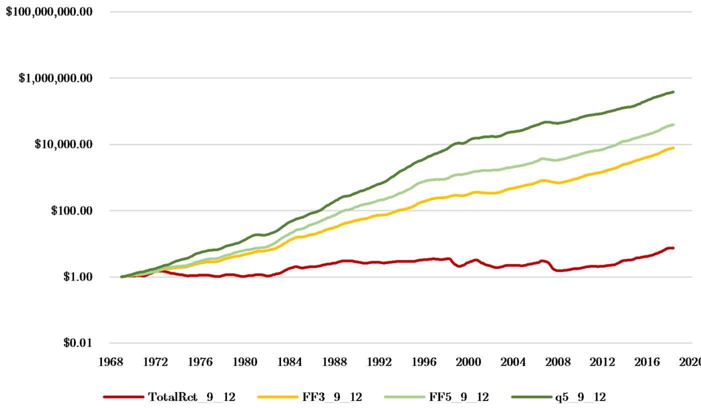

Figure 9.12: Residual momentum 9-month/12-month

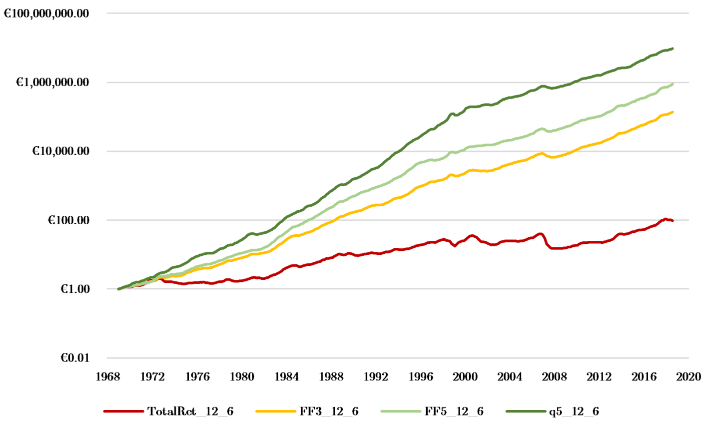

Figure 9.13: Residual momentum 12-month/6-month

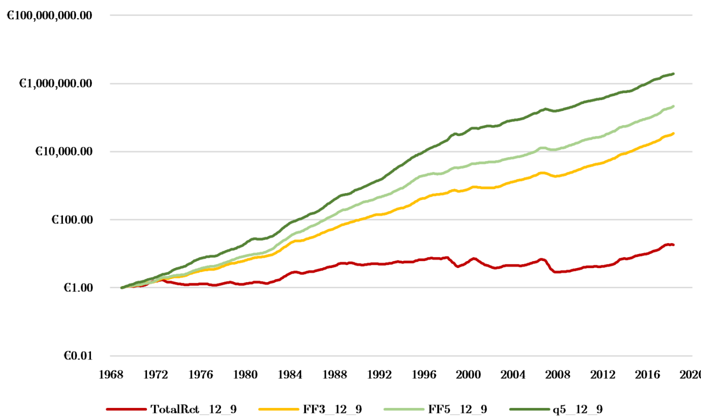

Figure 9.14: Residual momentum 12-month/9-month

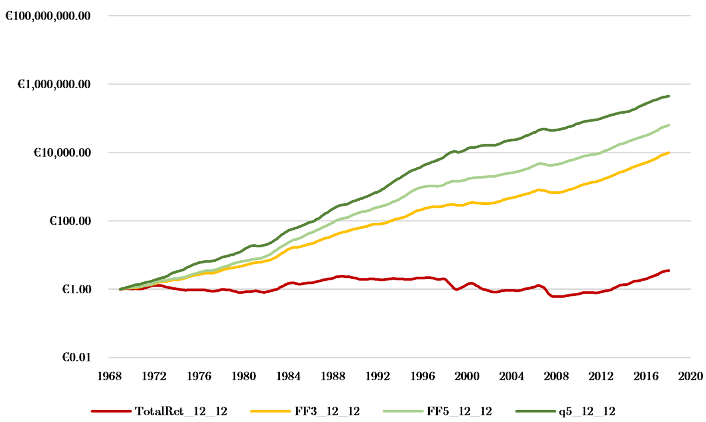

Figure 9.15: Residual momentum 12-month/12-month

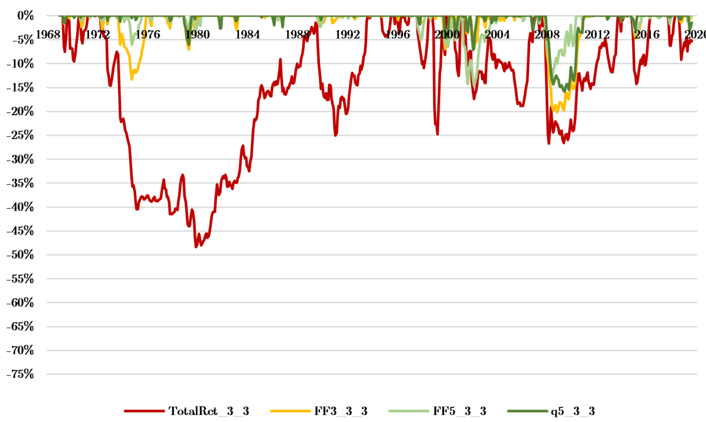

Figure 9.16: Drawdown 3-month/3-month

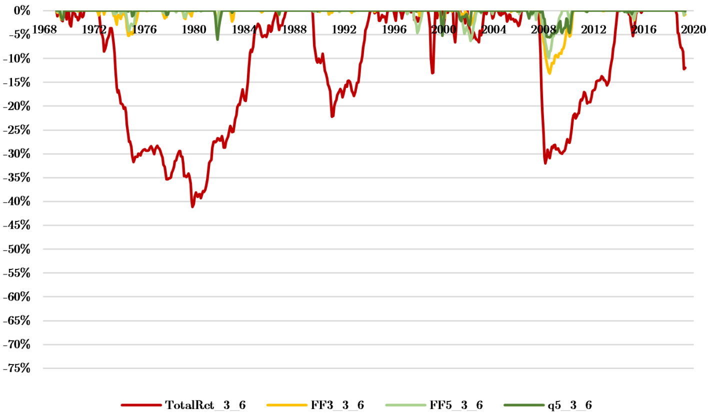

Figure 9.17: Drawdown 3-month/6-month

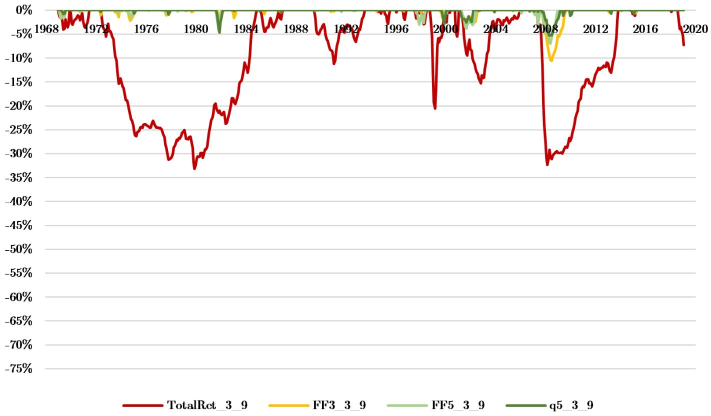

Figure 9.18: Drawdown 3-month/9-month

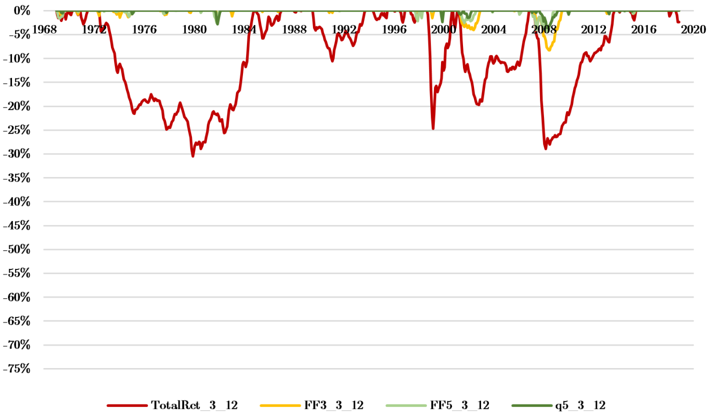

Figure 9.19: Drawdown 3-month/12-month

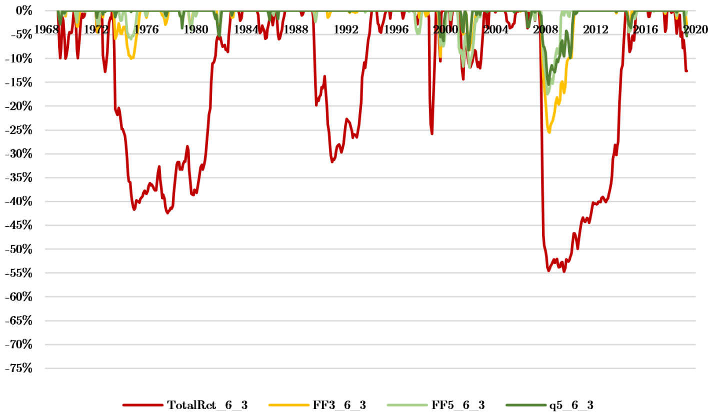

Figure 9.20: Drawdown 6-month/3-month

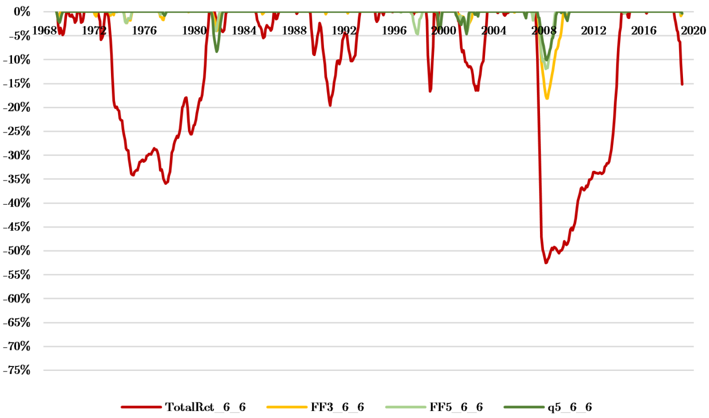

Figure 9.21: Drawdown 6-month/6-month

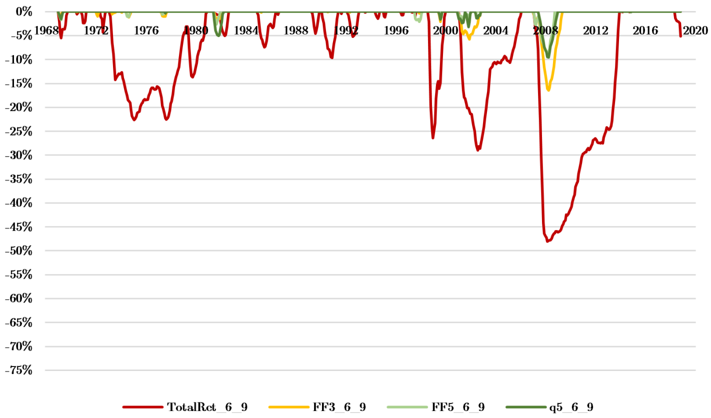

Figure 9.22: Drawdown 6-month/9-month

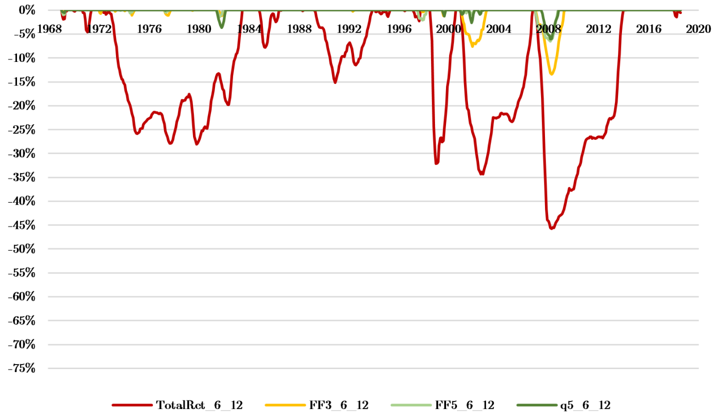

Figure 9.23: Drawdown 6-month/12-month

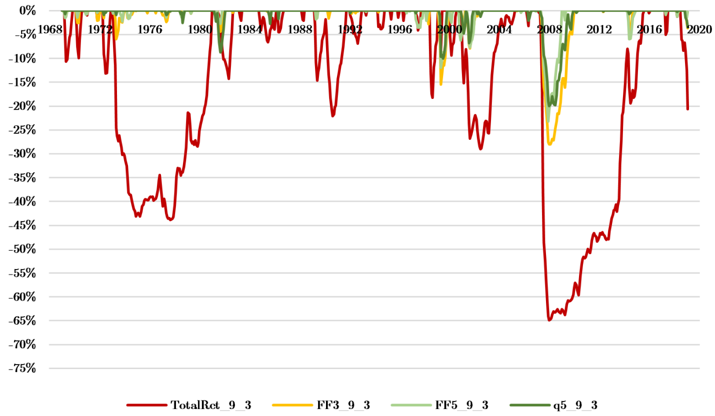

Figure 9.24: Drawdown 9-month/3-month

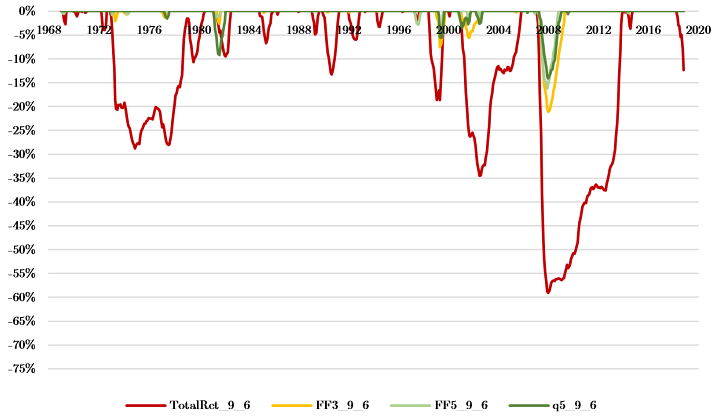

Figure 9.25: Drawdown 9-month/6-month

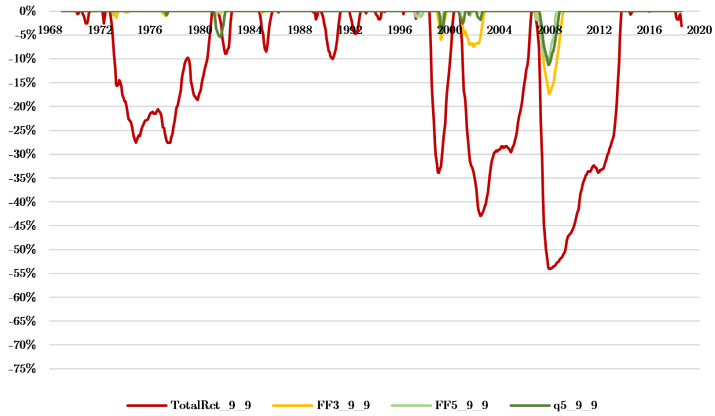

Figure 9.26: Drawdown 9-month/9-month

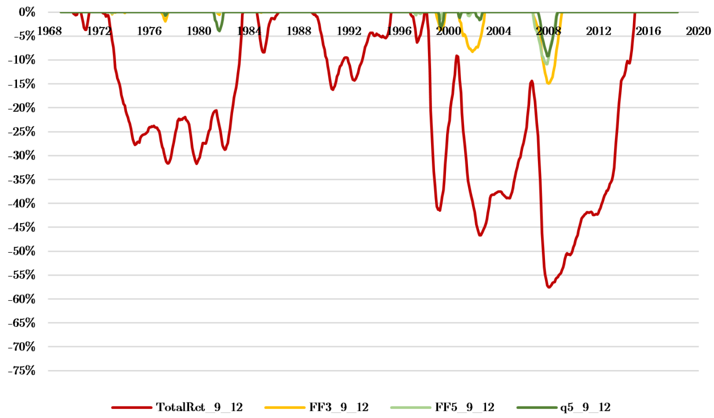

Figure 9.27: Drawdown 9-month/12-month

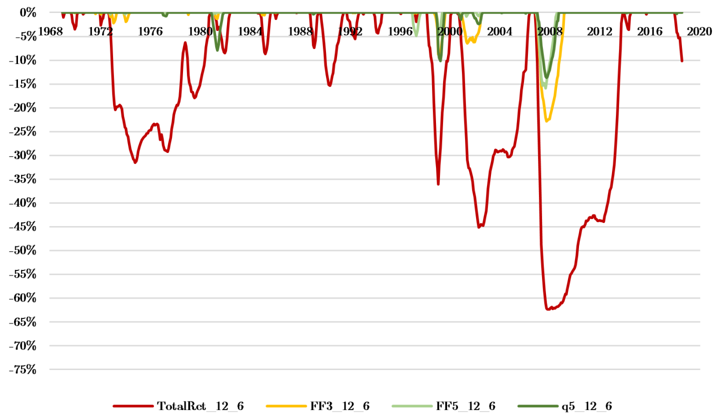

Figure 9.28: Drawdown 12-month/6-month

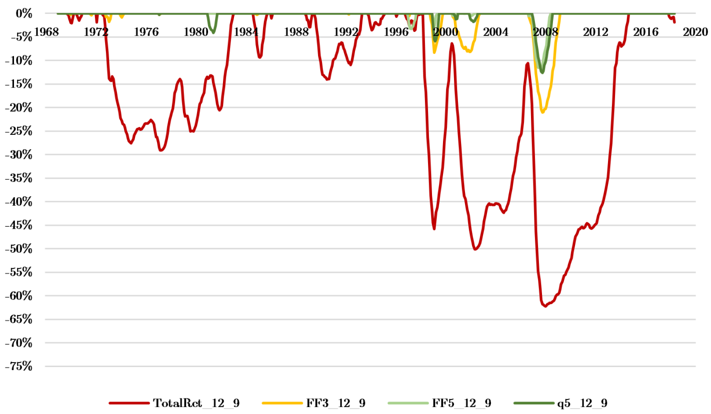

Figure 9.29: Drawdown 12-month/9-month

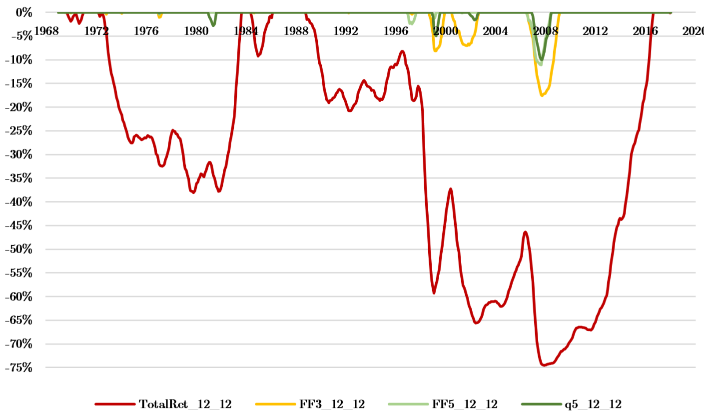

Figure 9.30: Drawdown 12-month/12-month

Table 9.1 Regression conditional up-factor model - FF3

J/K	Ret.	Vol.	Sharpe.	Alpha	MktRF	SMB	HML	$MktRF_{UP}$	SMB_{UP}	HML_{UP}	A.R^2
Panel A: J/K Total Return Momentum Portfolio's											
3/3	0.35	2.59	0.14	0.38**	-15.25**	-22.69**	-24.46**	10.63*	36.40**	29.32**	0.13
				(0.10)	(3.45)	(5.02)	(5.18)	(4.49)	(6.63)	(7.05)	
3/6	0.42	1.88	0.22	0.45**	-5.90*	-8.13*	-11.30**	5.50	15.45**	16.65**	0.04
				(0.08)	(2.62)	(3.81)	(3.94)	(3.41)	(5.04)	(5.36)	
3/9	0.35	1.61	0.22	0.36**	1.03	-6.30	-10.71**	-1.76	12.00**	15.66**	0.03
				(0.07)	(2.24)	(3.27)	(3.37)	(2.92)	(4.32)	(4.59)	
3/12	0.26	1.43	0.18	0.25**	2.72	-4.84	-8.38**	-2.86	9.98**	12.83**	0.03
				(0.06)	(1.98)	(2.88)	(2.97)	(2.58)	(3.80)	(4.04)	
6/3	0.78	3.22	0.24	0.86**	-22.77**	-29.31**	-39.53**	21.46**	31.18**	42.74**	0.14
				(0.13)	(4.19)	(6.75)	(6.85)	(5.51)	(8.44)	(8.83)	
6/6	0.78	2.21	0.35	0.81**	-8.61**	-10.99*	-24.15**	11.36**	9.62	33.67**	0.08
				(0.09)	(2.97)	(4.79)	(4.86)	(3.90)	(5.98)	(6.26)	
6/9	0.68	1.92	0.35	0.67**	-2.40	-7.86	-18.83**	5.02	8.91	28.9**	0.05
				(0.08)	(2.63)	(4.24)	(4.30)	(3.46)	(5.30)	(5.55)	
6/12	0.40	1.75	0.23	0.38**	0.59	-6.44	-15.75**	1.36	7.16	23.41**	0.03
				(0.07)	(2.40)	(3.87)	(3.92)	(3.15)	(4.84)	(5.06)	
9/3	0.95	3.43	0.28	1.05**	-25.68**	-24.74**	-36.83**	23.50**	22.85*	37.79**	0.13
				(0.13)	(4.67)	(7.05)	(6.98)	(6.02)	(8.96)	(9.57)	
9/6	0.94	2.41	0.39	1.00**	-10.6**	-4.54	-20.96**	10.77*	-0.84	21.97**	0.04
				(0.10)	(3.46)	(5.22)	(5.17)	(4.46)	(6.63)	(7.08)	
9/9	0.67	2.08	0.32	0.67**	-2.32	-4.63	-16.73**	3.57	2.71	20.42**	0.02
				(0.09)	(3.03)	(4.58)	(4.53)	(3.91)	(5.81)	(6.21)	
9/12	0.36	1.87	0.19	0.34**	-0.62	-2.62	-13.83**	2.65	1.49	17.71**	0.02
				(0.08)	(2.69)	(4.06)	(4.02)	(3.47)	(5.16)	(5.51)	
12/3	0.99	3.49	0.28	1.08**	-29.36**	-31.88**	-48.13**	26.8**	28.13**	51.48**	0.16
				(0.13)	(4.82)	(7.13)	(7.00)	(6.10)	(8.95)	(9.40)	
12/6	0.80	2.54	0.32	0.84**	-12.51**	-7.34	-32.5**	12.93**	0.52	41.71**	0.09
				(0.10)	(3.68)	(5.44)	(5.34)	(4.66)	(6.83)	(7.17)	
12/9	0.52	2.19	0.24	0.51**	-2.73	-6.74	-28.29**	3.40	3.56	38.56**	0.07
				(0.09)	(3.20)	(4.73)	(4.64)	(4.05)	(5.94)	(6.23)	
12/12	0.23	1.95	0.12	0.21**	0.40	-3.86	-23.47**	0.60	2.00	33.91**	0.06
				(0.08)	(2.83)	(4.18)	(4.10)	(3.58)	(5.25)	(5.51)	
Panel B: J/K Residual Return Momentum Portfolio's											
3/3	0.79	1.59	0.50	0.42**	-7.24**	-9.44**	-7.42**	6.88**	11.26**	5.78	0.03
				(0.07)	(2.33)	(3.39)	(3.50)	(3.04)	(4.48)	(4.76)	
3/6	0.76	1.14	0.67	0.41**	-3.68*	-4.14	-1.77	3.92	5.61	-1.34	0.01
				(0.05)	(1.74)	(2.53)	(2.62)	(2.27)	(3.35)	(3.56)	
3/9	0.69	0.92	0.75	0.33**	-1.14	-3.27	-2.65	0.86	4.46	4.00	0.00
				(0.04)	(1.45)	(2.12)	(2.19)	(1.89)	(2.80)	(2.97)	
3/12	0.60	0.85	0.71	0.23**	1.39	-3.04	-3.73**	-1.38	5.27*	1.52	0.01
				(0.04)	(1.36)	(1.98)	(2.04)	(1.77)	(2.61)	(2.78)	
6/3	1.41	1.98	0.71	1.04**	-8.13**	-15.97**	-13.71**	13.54**	10.22	13.67*	0.06
				(0.08)	(2.76)	(4.44)	(4.51)	(3.62)	(5.55)	(5.81)	
6/6	1.33	1.30	1.02	0.96**	-1.88	-5.26**	-8.71**	5.62*	1.69	9.23*	0.02
				(0.06)	(1.87)	(3.02)	(3.06)	(2.46)	(3.77)	(3.94)	
6/9	1.21	1.11	1.09	0.82**	0.67	-4.11	-5.52**	2.53	0.51	5.61	0.01
				(0.05)	(1.64)	(2.64)	(2.67)	(2.15)	(3.30)	(3.45)	
6/12	1.01	1.00	1.01	0.63**	2.19	-2.35	-5.62**	0.33	-0.59	4.14	0.01
				(0.05)	(1.52)	(2.45)	(2.49)	(2.00)	(3.06)	(3.20)	
9/3	1.72	2.11	0.81	1.36**	-8.92**	-16.93**	-11.25**	15.82**	10.00	9.59	0.06
				(0.09)	(3.04)	(4.60)	(4.55)	(3.93)	(5.84)	(6.24)	
9/6	1.61	1.47	1.09	1.24**	-3.10	-6.94**	-6.67**	7.24*	3.03	2.93	0.02
				(0.06)	(2.20)	(3.32)	(3.29)	(2.84)	(4.22)	(4.51)	
9/9	1.40	1.24	1.13	1.00**	0.13	-5.42**	-5.42**	4.41	1.45	3.65	0.02
				(0.05)	(1.89)	(2.86)	(2.83)	(2.44)	(3.64)	(3.88)	
9/12	1.16	1.08	1.08	0.77**	1.30	-3.92	-5.45**	2.79	0.58	3.41	0.02
				(0.05)	(1.69)	(2.55)	(2.52)	(2.18)	(3.24)	(3.46)	
12/3	1.83	2.20	0.83	1.45**	-10.85**	-17.19**	-14.15**	16.45**	8.47	14.86*	0.06
				(0.09)	(3.28)	(4.85)	(4.76)	(4.16)	(6.10)	(6.40)	
12/6	1.65	1.55	1.06	1.26**	-3.06	-6.3**	-11.07**	7.04*	-0.81	12.40**	0.03
				(0.07)	(2.40)	(3.54)	(3.48)	(3.03)	(4.45)	(4.67)	
12/9	1.41	1.30	1.08	1.01**	1.21	-4.10	-10.68**	2.56	-2.81	14.09**	0.03
				(0.06)	(2.04)	(3.01)	(2.95)	(2.58)	(3.78)	(3.97)	
12/12	1.21	1.15	1.05	0.81**	2.65	-4.03	-10.99**	0.67	-1.47	12.97**	0.04
				(0.05)	(1.85)	(2.73)	(2.68)	(2.34)	(3.43)	(3.60)	

Note. This table shows average monthly returns in excess of the risk-free rate, volatilities, Sharpe ratios, alphas and betas to the Fama and French (1993) (un)conditional factors $MktRF$, SMB, HML, $MktRF_{UP}$, SMB_{UP} and HML_{UP} and adjusted R^2 values for total- and residual return momentum portfolios. The conditional UP factors are not the same for each regression, as they are conditional on the sign of the returns over the formation period considered. The (residual) momentum strategy is defined as a zero-investment top-minus-bottom decile portfolio using the overlapping portfolios approach of Jegadeesh and Titman (1993). Here, residual returns are estimated using Equation (4). Alphas and betas are estimated using the conditional up-factor model as presented in Equation (8). $^*p < 0.05$ $^{**}p < 0.01$, standard errors are in parentheses. Values are in percentages, except for adjusted R^2.

Table 9.2 Regression conditional up-factor model - FF5

J/K	Ret	Vol	Sharpe	Alpha	MktRF	SMB	HML	RMW	CMA	$MktRF_{UP}$	SMB_{UP}	HML_{UP}	RMW_{UP}	CMA_{UP}	A.R^2
Panel A: Total Return Momentum Portfolio's															
3/3	0.35	2.59	0.14	0.28**	-8.39*	-18.75**	-21.66**	-5.17	0.59	4.48	16.79*	34.93**	36.33**	23.00*	0.17
				(0.10)	(3.58)	(4.98)	(6.03)	(6.28)	(9.30)	(4.55)	(7.56)	(6.77)	(9.22)	(11.21)	
3/6	0.42	1.88	0.22	0.42**	-3.56	-7.59*	-4.89	0.53	-16.45*	1.81	10.42	19.16**	12.00	18.19*	0.07
				(0.08)	(2.75)	(3.83)	(4.64)	(4.83)	(7.15)	(3.50)	(5.81)	(5.20)	(7.09)	(8.62)	
3/9	0.35	1.61	0.22	0.37**	0.85	-6.67*	-4.08	-4.46	-13.24*	-2.96	14.69**	13.56**	8.78	0.97	0.04
				(0.07)	(2.37)	(3.30)	(4.00)	(4.16)	(6.17)	(3.02)	(5.01)	(4.48)	(6.11)	(7.43)	
3/12	0.26	1.43	0.18	0.27**	2.22	-5.19	-2.80	-2.41	-13.31*	-3.75	12.25**	11.27**	2.99	3.28	0.03
				(0.06)	(2.09)	(2.91)	(3.53)	(3.67)	(5.44)	(2.66)	(4.42)	(3.95)	(5.39)	(6.55)	
6/3	0.78	3.22	0.24	0.77**	-17.34**	-22.99**	-44.16**	-3.29	12.26	17.02**	38.54**	22.25*	26.48*	11.93	0.15
				(0.13)	(4.45)	(6.70)	(8.49)	(9.32)	(13.15)	(5.64)	(9.69)	(8.69)	(11.94)	(14.44)	
6/6	0.78	2.21	0.35	0.77**	-7.1*	-7.22	-26.23**	12.70	2.18	10.2*	35.41**	8.94	-2.72	0.98	0.08
				(0.09)	(3.17)	(4.78)	(6.05)	(6.64)	(9.37)	(4.02)	(6.90)	(6.19)	(8.51)	(10.29)	
6/9	0.68	1.92	0.35	0.65**	-1.90	-4.71	-17.11**	2.59	-4.05	4.20	28.5**	6.19	5.70	1.34	0.05
				(0.08)	(2.82)	(4.25)	(5.38)	(5.90)	(8.33)	(3.57)	(6.14)	(5.51)	(7.56)	(9.15)	
6/12	0.40	1.75	0.23	0.37**	0.68	-5.02	-13.62**	1.88	-5.61	0.86	22.73**	6.46	2.38	3.20	0.03
				(0.07)	(2.57)	(3.87)	(4.91)	(5.39)	(7.60)	(3.26)	(5.60)	(5.02)	(6.90)	(8.34)	
9/3	0.95	3.43	0.28	0.96**	-20.02**	-26.04**	-30.84**	-4.85	-11.52	18.11**	26.73**	27.76**	36.07**	30.72*	0.16
				(0.14)	(4.89)	(7.11)	(8.47)	(9.02)	(14.13)	(6.09)	(10.00)	(9.23)	(12.37)	(15.10)	
9/6	0.94	2.41	0.39	0.95**	-7.83*	-5.08	-15.03*	-1.13	-10.00	8.01	15.85*	3.66	22.5*	13.49	0.06
				(0.10)	(3.65)	(5.31)	(6.32)	(6.74)	(10.55)	(4.55)	(7.47)	(6.89)	(9.24)	(11.28)	
9/9	0.67	2.08	0.32	0.64**	-1.05	-5.43	-9.07	-6.76	-11.07	1.93	15.01*	5.33	24.27**	7.32	0.04
				(0.09)	(3.20)	(4.65)	(5.54)	(5.90)	(9.24)	(3.98)	(6.54)	(6.04)	(8.09)	(9.88)	
9/12	0.36	1.87	0.19	0.33**	0.20	-3.72	-6.80	-7.92	-12.28	1.26	12.58*	3.27	19.92**	9.59	0.03
				(0.08)	(2.84)	(4.14)	(4.93)	(5.25)	(8.22)	(3.54)	(5.82)	(5.37)	(7.20)	(8.78)	
12/3	0.99	3.49	0.28	0.96**	-23.31**	-28.91**	-43.34**	-7.73	6.49	22.45**	41.45**	25.38**	42.44**	8.72	0.18
				(0.14)	(5.12)	(7.16)	(9.17)	(9.81)	(13.64)	(6.19)	(10.56)	(9.29)	(13.44)	(14.75)	
12/6	0.80	2.54	0.32	0.79**	-10.59**	-5.50	-24.07**	-2.57	-7.10	11.21*	36.4**	0.66	23.33*	0.21	0.10
				(0.11)	(3.93)	(5.50)	(7.04)	(7.53)	(10.48)	(4.75)	(8.11)	(7.14)	(10.33)	(11.33)	
12/9	0.52	2.19	0.24	0.49**	-2.33	-5.09	-20.36**	-4.59	-6.43	2.86	35.18**	2.11	17.87*	-4.95	0.08
				(0.09)	(3.43)	(4.79)	(6.14)	(6.56)	(9.13)	(4.14)	(7.07)	(6.22)	(9.00)	(9.87)	
12/12	0.23	1.95	0.12	0.21**	0.44	-2.83	-16.48**	-5.20	-10.07	0.10	30.01**	0.10	12.17	2.96	0.06
				(0.08)	(3.03)	(4.25)	(5.44)	(5.81)	(8.09)	(3.67)	(6.26)	(5.51)	(7.97)	(8.75)	
Panel B: Residual Return Momentum Portfolio's															
3/3	1.03	1.73	0.60	0.57**	-1.15	-3.99	-3.82	2.50	3.86	2.09	6.86	-0.99	25.81**	15.87	0.08
				(0.07)	(2.59)	(3.60)	(4.36)	(4.54)	(6.72)	(3.29)	(4.89)	(5.46)	(6.66)	(8.10)	
3/6	0.95	1.23	0.77	0.58**	-1.05	-1.15	1.88	1.36	-3.56	0.90	0.24	-3.98	9.10*	6.02	0.01
				(0.05)	(1.94)	(2.70)	(3.28)	(3.42)	(5.06)	(2.47)	(3.68)	(4.11)	(5.01)	(6.09)	
3/9	0.88	1.00	0.88	0.51**	1.35	-2.71	2.99	-1.88	-1.89	-1.40	1.70	-2.37	7.45	-1.34	0.00
				(0.05)	(1.61)	(2.23)	(2.71)	(2.82)	(4.17)	(2.04)	(3.04)	(3.39)	(4.13)	(5.03)	
3/12	0.78	0.91	0.86	0.41**	2.50	-3.47	0.03	-1.91	0.82	-2.39	2.70	0.56	5.33	-4.69	0.00
				(0.04)	(1.49)	(2.07)	(2.51)	(2.61)	(3.87)	(1.89)	(2.81)	(3.14)	(3.83)	(4.66)	
6/3	1.68	2.11	0.80	1.19**	-2.50	-6.85	-20.23**	12.08	16.07	10.47**	5.47	21.56**	11.52	-3.64	0.08
				(0.09)	(3.09)	(4.64)	(5.88)	(6.46)	(9.11)	(3.91)	(6.02)	(6.71)	(8.27)	(10.00)	
6/6	1.59	1.46	1.09	1.17**	-1.18	-2.41	-9.08*	6.47	3.76	5.66*	0.87	13.30**	2.14	-6.94	0.02
				(0.06)	(2.19)	(3.29)	(4.17)	(4.57)	(6.45)	(2.77)	(4.26)	(4.75)	(5.86)	(7.08)	
6/9	1.46	1.20	1.21	1.05**	1.58	-2.09	-1.10	-0.80	0.57	2.23	-0.38	5.87	8.24	-6.47	0.01
				(0.05)	(1.85)	(2.78)	(3.52)	(3.86)	(5.45)	(2.34)	(3.60)	(4.01)	(4.95)	(5.98)	
6/12	1.26	1.07	1.17	0.86**	2.49	-1.07	-3.01	-2.15	2.42	-0.03	-1.39	4.99	8.44	-6.81	0.00
				(0.05)	(1.68)	(2.54)	(3.21)	(3.53)	(4.97)	(2.13)	(3.29)	(3.66)	(4.52)	(5.46)	
9/3	2.01	2.23	0.90	1.53**	-5.91	-9.73*	-7.21	8.00	-0.30	15.19**	6.82	3.69	20.72*	17.11	0.09
				(0.09)	(3.34)	(4.86)	(5.78)	(6.16)	(9.64)	(4.16)	(6.30)	(6.83)	(8.44)	(10.31)	
9/6	1.87	1.53	1.22	1.47**	-3.40	-3.91	0.02	0.08	-6.77	8.11**	0.08	-1.04	15.57**	5.34	0.04
				(0.07)	(2.36)	(3.43)	(4.09)	(4.36)	(6.82)	(2.94)	(4.46)	(4.83)	(5.97)	(7.29)	
9/9	1.67	1.28	1.31	1.25**	0.12	-4.44	3.11	-4.06	-6.14	5.13*	0.90	-1.25	16.13**	2.14	0.03
				(0.06)	(2.01)	(2.93)	(3.49)	(3.72)	(5.82)	(2.51)	(3.80)	(4.12)	(5.09)	(6.22)	
9/12	1.44	1.11	1.29	1.04**	0.92	-2.75	-1.03	-4.71	-2.87	3.04	-1.08	1.43	13.46**	0.83	0.02
				(0.05)	(1.80)	(2.62)	(3.11)	(3.32)	(5.19)	(2.24)	(3.39)	(3.68)	(4.55)	(5.55)	
12/3	2.17	2.28	0.95	1.64**	-6.02	-12.02*	-16.26*	10.64	19.85*	14.47**	9.84	12.84	20.33*	-3.06	0.10
				(0.10)	(3.56)	(4.97)	(6.37)	(6.81)	(9.48)	(4.30)	(6.45)	(7.33)	(9.34)	(10.25)	
12/6	1.97	1.58	1.25	1.51**	-1.47	-2.84	-6.61	6.16	2.79	6.17*	-0.93	9.95	10.62	-3.71	0.04
				(0.07)	(2.57)	(3.59)	(4.60)	(4.92)	(6.84)	(3.10)	(4.66)	(5.30)	(6.74)	(7.40)	
12/9	1.73	1.31	1.32	1.29**	3.00	-2.50	-4.23	0.86	2.54	1.70	-2.18	9.79*	10.58	-5.72	0.03
				(0.06)	(2.16)	(3.03)	(3.88)	(4.15)	(5.77)	(2.62)	(3.93)	(4.46)	(5.68)	(6.24)	
12/12	1.53	1.15	1.33	1.11**	3.27	-3.06	-6.22	-0.27	0.85	0.28	-0.52	9.76*	7.87	-2.30	0.03
				(0.05)	(1.95)	(2.73)	(3.50)	(3.74)	(5.21)	(2.36)	(3.55)	(4.03)	(5.13)	(5.63)	

Note. This table shows average monthly returns in excess of the risk-free rate, volatilities, Sharpe ratios, alphas and betas to the Fama and French (2015) (un)conditional factors $MktRF$, SMB, HML, RMW, CMA, $MktRF_{UP}$, SMB_{UP}, HML_{UP}, RMW_{UP} and CMA_{UP} and adjusted R^2 values for total- and residual return momentum portfolios. The conditional UP factors are not the same for each regression, as they are conditional on the sign of the returns over the formation period considered. The (residual) momentum strategy is defined as a zero-investment top-minus-bottom decile portfolio using the overlapping portfolios approach of Jegadeesh and Titman (1993). Here, residual returns are estimated using Equation (5). Alphas and betas are estimated using the conditional up-factor model as presented in Equation (9). $^*p < 0.05$ $^{**}p < 0.01$, standard errors are in parentheses. Values are in percentages, except for adjusted R^2.

Table 9.3 Regression conditional up-factor model - q5

J/K	Ret.	Vol.	Sharpe.	Alpha	R_{MKT}	R_{ME}	R_{IA}	R_{ROE}	R_{EG}	$R_{MKT_{UP}}$	$R_{ME_{UP}}$	$R_{IA_{UP}}$	$R_{ROE_{UP}}$	$R_{EG_{UP}}$	A.R^2
Panel A: J/K Total Return Momentum Portfolio's															
3/3	0.35	2.59	0.14	0.11	-6.85	-11.2*	-19.97*	-7.12	-6.24	4.45	25.39	35.25**	30.90**	30.47**	0.18
				(0.11)	(3.58)	(5.11)	(8.48)	(7.92)	(11.20)	(4.45)	(6.56)	(11.14)	(8.66)	(11.78)	
3/6	0.42	1.88	0.22	0.38**	-3.63	-2.52	-19.03**	-1.33	-12.55	2.47	10.60*	24.13**	15.65*	19.28*	0.08
				(0.09)	(2.75)	(3.92)	(6.51)	(6.08)	(8.59)	(3.41)	(5.03)	(8.55)	(6.65)	(9.04)	
3/9	0.35	1.61	0.22	0.38**	1.30	-6.63	-18.86**	-10.01	-7.74	-3.03	10.74*	20.71**	16.53**	9.12	0.05
				(0.07)	(2.37)	(3.39)	(5.62)	(5.25)	(7.43)	(2.95)	(4.35)	(7.38)	(5.74)	(7.81)	
3/12	0.26	1.43	0.18	0.28**	2.67	-5.75	-16.6**	-7.07	-7.03	-3.63	8.55*	18.82**	9.11	8.47	0.03
				(0.07)	(2.10)	(3.00)	(4.98)	(4.65)	(6.57)	(2.61)	(3.85)	(6.54)	(5.08)	(6.92)	
6/3	0.78	3.22	0.24	0.67**	-14.76**	-14.85*	-49.67**	-17.58	27.64	12.4*	16.58	67.46**	52.43**	-17.64	0.17
				(0.14)	(4.46)	(7.19)	(11.89)	(10.49)	(18.53)	(5.62)	(8.58)	(14.45)	(11.18)	(19.13)	
6/6	0.78	2.21	0.35	0.81**	-7.46*	-5.37	-30.7**	5.25	-1.83	7.56	7.69	38.19**	16.82*	-4.05	0.08
				(0.10)	(3.22)	(5.19)	(8.57)	(7.56)	(13.36)	(4.05)	(6.18)	(10.42)	(8.06)	(13.79)	
6/9	0.68	1.92	0.35	0.71**	-2.63	-6.17	-25.04**	-2.72	-2.82	3.11	7.66	31.62**	14.94*	-1.91	0.03
				(0.09)	(2.88)	(4.65)	(7.69)	(6.78)	(11.98)	(3.63)	(5.54)	(9.34)	(7.23)	(12.36)	
6/12	0.40	1.75	0.23	0.43**	0.01	-6.14	-23.64**	-1.95	-6.23	0.11	6.64	27.54**	9.60	2.74	0.02
				(0.08)	(2.63)	(4.23)	(7.00)	(6.17)	(10.91)	(3.31)	(5.05)	(8.50)	(6.58)	(11.26)	
9/3	0.95	3.43	0.28	0.82**	-17.9**	-26.91**	-30.01*	17.71	9.00	16.04**	43.39**	31.73*	20.66	-3.43	0.18
				(0.15)	(4.80)	(7.20)	(13.76)	(11.87)	(22.63)	(6.01)	(9.05)	(15.83)	(12.64)	(23.55)	
9/6	0.94	2.41	0.39	0.92**	-7.49*	-7.18	-23.62*	11.90	2.22	6.49	14.1*	21.27	16.21	-6.30	0.09
				(0.11)	(3.58)	(5.37)	(10.25)	(8.85)	(16.87)	(4.48)	(6.75)	(11.80)	(9.42)	(17.55)	
9/9	0.67	2.08	0.32	0.67**	-1.60	-10.82*	-21.43*	1.93	0.22	1.94	15.38*	20.98*	14.07	-5.60	0.04
				(0.10)	(3.18)	(4.78)	(9.12)	(7.87)	(15.00)	(3.99)	(6.00)	(10.49)	(8.38)	(15.61)	
9/12	0.36	1.87	0.19	0.38**	-1.33	-8.24	-20.43*	-4.58	4.29	2.46	10.33	19.33*	15.02*	-10.08	0.03
				(0.09)	(2.84)	(4.26)	(8.14)	(7.02)	(13.38)	(3.56)	(5.35)	(9.36)	(7.47)	(13.93)	
12/3	0.99	3.49	0.28	0.77**	-20.46**	-23.17**	-48.65**	-1.04	31.82	20.67**	26.39**	59.3**	44.88**	-24.92	0.19
				(0.15)	(5.15)	(7.72)	(14.27)	(13.09)	(27.71)	(6.22)	(9.21)	(16.74)	(13.59)	(28.18)	
12/6	0.80	2.54	0.32	0.78**	-10.98**	-6.26	-44.44**	4.33	8.96	10.42*	6.09	49.19**	26.76*	-18.79	0.12
				(0.12)	(3.94)	(5.91)	(10.92)	(10.02)	(21.20)	(4.76)	(7.04)	(12.81)	(10.39)	(21.56)	
12/9	0.52	2.19	0.24	0.54**	-4.09	-10.35*	-37.96**	-0.84	11.09	4.31	9.19	42.13**	18.51*	-22.59	0.06
				(0.10)	(3.50)	(5.24)	(9.68)	(8.88)	(18.80)	(4.22)	(6.25)	(11.36)	(9.22)	(19.12)	
12/12	0.23	1.95	0.12	0.27**	-1.68	-7.41	-34.87**	-7.58	10.03	1.96	5.04	38.68**	19.09*	-19.89	0.05
				(0.09)	(3.09)	(4.63)	(8.56)	(7.85)	(16.61)	(3.73)	(5.52)	(10.04)	(8.14)	(16.90)	
Panel B: J/K Residual Return Momentum Portfolio's															
3/3	1.45	1.82	0.80	0.76**	2.06	5.95	7.60	5.68	12.44	0.61	1.04	-9.39	5.81	21.69*	0.11
				(0.08)	(2.66)	(3.79)	(6.30)	(5.89)	(8.32)	(3.30)	(4.87)	(8.27)	(6.44)	(8.75)	
3/6	1.33	1.31	1.01	0.82**	1.54	1.22	4.69	5.14	0.84	0.02	1.78	-11.44	-0.94	19.04**	0.05
				(0.06)	(1.99)	(2.84)	(4.72)	(4.41)	(6.23)	(2.47)	(3.65)	(6.19)	(4.82)	(6.55)	
3/9	1.22	1.06	1.15	0.76**	1.42	-0.21	4.17	3.36	2.99	0.21	0.83	-11.66*	-2.29	9.96	0.02
				(0.05)	(1.65)	(2.35)	(3.90)	(3.64)	(5.15)	(2.04)	(3.01)	(5.12)	(3.98)	(5.42)	
3/12	1.10	0.96	1.15	0.67**	2.88	-1.08	-0.26	-2.09	2.16	-1.61	1.85	-6.46	2.03	7.29	0.01
				(0.05)	(1.52)	(2.16)	(3.59)	(3.36)	(4.74)	(1.88)	(2.78)	(4.72)	(3.67)	(4.99)	
6/3	2.19	2.25	0.97	1.47**	4.12	1.99	-8.75	-2.33	34.05*	1.48	3.59	7.76	17.23*	2.44	0.11
				(0.10)	(3.22)	(5.19)	(8.58)	(7.56)	(13.36)	(4.06)	(6.18)	(10.42)	(8.06)	(13.79)	
6/6	2.04	1.60	1.28	1.53**	2.75	-1.39	-8.43	-5.01	21.63*	1.56	4.32	1.47	9.79	-3.54	0.04
				(0.08)	(2.37)	(3.81)	(6.31)	(5.56)	(9.83)	(2.98)	(4.55)	(7.66)	(5.93)	(10.14)	
6/9	1.87	1.33	1.40	1.37**	3.09	0.00	-4.78	-1.84	26.27**	0.36	0.95	0.21	3.15	-12.43	0.03
				(0.06)	(1.99)	(3.20)	(5.30)	(4.67)	(8.25)	(2.51)	(3.82)	(6.44)	(4.98)	(8.52)	
6/12	1.63	1.17	1.40	1.19**	3.35	0.14	-8.18	-4.49	23.28**	-0.74	0.10	0.45	3.57	-13.31	0.03
				(0.06)	(1.76)	(2.84)	(4.70)	(4.15)	(7.33)	(2.22)	(3.39)	(5.71)	(4.42)	(7.56)	
9/3	2.54	2.45	1.04	1.75**	2.67	-4.30	3.13	21.67*	41.00*	5.91	18.18**	-2.01	-6.07	-6.26	0.13
				(0.11)	(3.53)	(5.30)	(10.12)	(8.73)	(16.65)	(4.43)	(6.66)	(11.65)	(9.30)	(17.33)	
9/6	2.34	1.77	1.32	1.79**	1.90	-3.37	-1.33	6.02	25.12*	3.04	8.34	-5.02	0.50	-7.47	0.05
				(0.08)	(2.68)	(4.02)	(7.68)	(6.62)	(12.63)	(3.36)	(5.05)	(8.84)	(7.06)	(13.15)	
9/9	2.09	1.45	1.44	1.59**	1.38	-1.15	-0.14	2.41	13.61	3.15	1.68	-5.64	0.46	-0.04	0.03
				(0.07)	(2.23)	(3.35)	(6.39)	(5.51)	(10.51)	(2.79)	(4.20)	(7.35)	(5.87)	(10.94)	
9/12	1.83	1.23	1.49	1.39**	0.88	-0.96	-2.34	-4.29	13.33	2.96	0.28	-6.15	5.17	-4.16	0.02
				(0.06)	(1.92)	(2.87)	(5.49)	(4.73)	(9.03)	(2.40)	(3.61)	(6.32)	(5.04)	(9.39)	
12/3	2.63	2.57	1.02	1.78**	0.96	0.51	11.02	14.30	42.44*	8.01	9.10	-11.36	4.23	-2.22	0.14
				(0.12)	(3.92)	(5.88)	(10.86)	(9.97)	(21.09)	(4.74)	(7.01)	(12.74)	(10.34)	(21.45)	
12/6	2.38	1.82	1.31	1.80**	-0.02	-0.71	-7.39	4.11	21.30	4.92	2.61	2.19	3.97	-1.34	0.06
				(0.09)	(2.93)	(4.39)	(8.12)	(7.45)	(15.77)	(3.54)	(5.24)	(9.52)	(7.73)	(16.03)	
12/9	2.11	1.45	1.46	1.61**	0.90	0.57	-7.41	3.83	17.53	3.50	-1.65	4.75	-0.42	-5.16	0.03
				(0.07)	(2.38)	(3.56)	(6.58)	(6.04)	(12.78)	(2.87)	(4.25)	(7.72)	(6.27)	(13.00)	
12/12	1.87	1.24	1.50	1.42**	1.09	-0.88	-8.83	-3.35	20.65	2.43	-0.68	3.44	4.87	-11.96	0.02
				(0.06)	(2.07)	(3.11)	(5.74)	(5.27)	(11.15)	(2.50)	(3.70)	(6.73)	(5.46)	(11.33)	

Note. This table shows average monthly returns in excess of the risk-free rate, volatilities, Sharpe ratios, alphas and betas to the Hou et al (2021) (un)conditional factors R_{MKT}, R_{ME}, R_{IA}, R_{ROE}, R_{EG}, $R_{MKT_{UP}}$, $R_{ME_{UP}}$, $R_{IA_{UP}}$, $R_{ROE_{UP}}$ and $R_{EG_{UP}}$ and adjusted R^2 values for total- and residual return momentum portfolios. The conditional UP factors are not the same for each regression, as they are conditional on the sign of the returns over the formation period considered. The (residual) momentum strategy is defined as a zero-investment top-minus-bottom decile portfolio using the overlapping portfolios approach of Jegadeesh and Titman (1993). Here, residual returns are estimated using Equation (6). Alphas and betas are estimated using the conditional up-factor model as presented in Equation (10). $*p < 0.05$ $**p < 0.01$, standard errors are in parentheses. Values are in percentages, except for adjusted R^2.

Table 9.4 Survivorship bias - FF3

J/K	Ret.	Vol.	Sharpe.	Alpha	MktRF	SMB	HML	MktRF_{UP}	SMB_{UP}	HML_{UP}	A.R^2
3/3	0.08	2.89	0.03	0.09	-18.12*	-17.27**	-16.29	15.07**	24.95**	16.95*	0.07
				(0.12)	(3.95)	(5.77)	(6.12)	(5.17)	(7.56)	(8.21)	
3/6	0.08	2.05	0.04	0.02	-8.56**	-9.13*	-7.02	8.4*	13.13*	11.25	0.03
				(0.12)	(2.83)	(4.13)	(4.38)	(3.70)	(5.41)	(5.87)	
3/9	0.11	1.69	0.07	0.05	-2.66	-4.24	-5.68	2.63	7.87	9.04	0.01
				(0.12)	(2.40)	(3.51)	(3.72)	(3.14)	(4.60)	(4.99)	
3/12	0.09	1.47	0.06	0.04	0.30	-2.24	-4.62	0.20	7.44	8.16	0.01
				(0.12)	(2.08)	(3.04)	(3.22)	(2.72)	(3.98)	(4.32)	
6/3	0.37	3.46	0.11	0.33*	-19.44**	-32.78**	-36.24**	19.13**	33.43**	39.88**	0.11
				(0.12)	(4.36)	(7.18)	(7.46)	(5.85)	(8.91)	(9.46)	
6/6	0.43	2.29	0.19	0.34**	-7.15*	-18.1**	-18.4**	11.02**	18.45**	25.27**	0.06
				(0.12)	(2.97)	(4.89)	(5.09)	(3.99)	(6.08)	(6.45)	
6/9	0.45	1.91	0.24	0.36**	-0.53	-11.68**	-13.25**	3.72	13.07*	23.51**	0.04
				(0.12)	(2.57)	(4.23)	(4.39)	(3.44)	(5.25)	(5.57)	
6/12	0.29	1.64	0.18	0.22**	1.32	-9.4*	-11.35**	0.48	12.86**	18.2**	0.03
				(0.12)	(2.22)	(3.65)	(3.79)	(2.97)	(4.53)	(4.81)	
9/3	0.54	3.65	0.15	0.55**	-21.67**	-26.64**	-29.54**	21.65**	22.91*	28.01**	0.09
				(0.12)	(4.78)	(7.33)	(7.44)	(6.30)	(9.30)	(10.05)	
9/6	0.64	2.38	0.27	0.61**	-8.28*	-11.12*	-16.53**	10.58*	6.29	18.67**	0.04
				(0.12)	(3.28)	(5.02)	(5.10)	(4.32)	(6.37)	(6.89)	
9/9	0.50	1.92	0.26	0.45**	-2.43	-8.23*	-10.91**	5.06	7.46	13.87*	0.02
				(0.12)	(2.70)	(4.14)	(4.21)	(3.56)	(5.26)	(5.68)	
9/12	0.31	1.64	0.19	0.25**	0.03	-4.84	-9.92**	2.84	5.75	12.3*	0.01
				(0.12)	(2.32)	(3.55)	(3.61)	(3.05)	(4.51)	(4.87)	
12/3	0.70	3.60	0.19	0.74**	-32.41**	-27.01**	-32.31**	35.38**	22.77*	27.42**	0.13
				(0.12)	(4.77)	(7.24)	(7.38)	(6.18)	(9.11)	(9.71)	
12/6	0.63	2.39	0.26	0.61**	-14.93**	-8.78	-21.23**	17.59**	3.74	23.3**	0.07
				(0.12)	(3.29)	(5.00)	(5.09)	(4.27)	(6.29)	(6.71)	
12/9	0.45	1.93	0.23	0.4**	-6.2*	-5.69	-18.02**	9.27**	1.95	24.05**	0.05
				(0.12)	(2.72)	(4.13)	(4.21)	(3.53)	(5.21)	(5.55)	
12/12	0.24	1.64	0.15	0.18**	-3.02	-1.59	-15.95**	5.70	0.13	19.72**	0.04
				(0.12)	(2.32)	(3.52)	(3.59)	(3.00)	(4.43)	(4.72)	

Note. This table shows average monthly returns in excess of the risk-free rate, volatilities, Sharpe ratios, alphas and betas to the Fama and French (1993) (un)conditional factors $MktRF$, SMB, HML, $MktRF_{UP}$, SMB_{UP} and HML_{UP} and adjusted R^2 values for total return momentum portfolios when the first 36 observations per stock are not omitted from the data set. The conditional UP factors are not the same for each regression, as they are conditional on the sign of the returns over the formation period considered. The (residual) momentum strategy is defined as a zero-investment top-minus-bottom decile portfolio using the overlapping portfolios approach of Jegadeesh and Titman (1993). Here, residual returns are estimated using Equation (4). Alphas and betas are estimated using the conditional up-factor model as presented in Equation (8). $*p < 0.05$ $*p < 0.01$, standard errors are in parentheses. Values are in percentages, except for adjusted R^2.

Table 9.5 Survivorship bias - FF5

J/K	Ret	Vol	Sharpe	Alpha	MktRF	SMB	HML	RMW	CMA	MktRF_{UP}	SMB_{UP}	HML_{UP}	RMW_{UP}	CMA_{UP}	A.R^2
3/3	0.08	2.89	0.03	0.04	-14.61**	-19.47**	-15.24*	-6.17	7.75	12.71*	29.41**	10.48	19.27	3.94	0.08
				(0.12)	(4.17)	(5.80)	(7.36)	(7.40)	(10.98)	(5.29)	(7.77)	(9.09)	(10.89)	(13.00)	
3/6	0.08	2.05	0.04	-0.01	-6.82*	-11.9**	-3.94	2.36	-3.26	6.72	21.25**	7.89	6.03	4.20	0.05
				(0.09)	(2.98)	(4.15)	(5.26)	(5.29)	(7.85)	(3.78)	(5.55)	(6.50)	(7.79)	(9.30)	
3/9	0.11	1.69	0.07	0.08	-3.32	-7.2*	-0.91	-5.22	-6.99	2.50	12.16*	8.92	5.23	-3.87	0.01
				(0.07)	(2.54)	(3.54)	(4.48)	(4.51)	(6.70)	(3.22)	(4.73)	(5.54)	(6.64)	(7.93)	
3/12	0.09	1.47	0.06	0.06	-0.48	-4.50	-0.92	-2.79	-7.16	0.15	11.24**	8.47	1.02	-2.24	0.01
				(0.06)	(2.20)	(3.06)	(3.89)	(3.91)	(5.80)	(2.79)	(4.10)	(4.80)	(5.75)	(6.87)	
6/3	0.37	3.46	0.11	0.26	-15.56**	-29.44**	-40.98**	7.13	8.55	15.93**	31.82**	38.47**	7.58	12.38	0.12
				(0.14)	(4.66)	(7.09)	(9.47)	(9.89)	(14.25)	(6.02)	(9.14)	(10.54)	(12.82)	(15.26)	
6/6	0.43	2.29	0.19	0.31**	-6.75*	-14.99**	-20.92**	17.31*	1.30	10.82**	19.69**	29.23**	-12.32	0.49	0.07
				(0.10)	(3.18)	(4.84)	(6.46)	(6.75)	(9.72)	(4.11)	(6.24)	(7.19)	(8.75)	(10.41)	
6/9	0.45	1.91	0.24	0.37**	-1.61	-10.52*	-11.24*	3.08	-2.66	4.46	12.73*	25.96**	-1.02	-6.20	0.03
				(0.08)	(2.76)	(4.19)	(5.60)	(5.85)	(8.43)	(3.56)	(5.41)	(6.23)	(7.58)	(9.02)	
6/12	0.29	1.64	0.18	0.22**	0.44	-8.35*	-8.54	-0.71	-2.53	0.95	12.07**	19.6**	5.36	-7.62	0.03
				(0.07)	(2.38)	(3.61)	(4.83)	(5.04)	(7.26)	(3.07)	(4.66)	(5.37)	(6.53)	(7.78)	
9/3	0.54	3.65	0.15	0.52**	-18.37**	-25.39**	-27.19**	15.83	-21.66	17.68**	27.23**	21.78*	-6.56	39.61*	
				(0.15)	(5.08)	(7.44)	(9.31)	(9.61)	(15.10)	(6.46)	(9.68)	(10.75)	(13.34)	(15.89)	0.10
9/6	0.64	2.38	0.27	0.58**	-6.64	-9.59	-13.73*	9.75	-10.64	8.79*	8.66	15.36*	0.41	15.79	0.04
				(0.10)	(3.49)	(5.12)	(6.40)	(6.60)	(10.38)	(4.44)	(6.66)	(7.39)	(9.17)	(10.92)	
9/9	0.50	1.92	0.26	0.45**	-2.25	-7.86	-3.21	-3.30	-15.84	4.02	7.80	9.08	12.50	11.65	0.02
				(0.08)	(2.88)	(4.22)	(5.28)	(5.45)	(8.56)	(3.66)	(5.49)	(6.09)	(7.57)	(9.01)	
9/12	0.31	1.64	0.19	0.26**	0.06	-4.39	-2.38	-7.74	-15.03*	1.84	4.53	7.02	15.18*	11.61	0.02
				(0.07)	(2.46)	(3.61)	(4.52)	(4.66)	(7.32)	(3.13)	(4.70)	(5.21)	(6.47)	(7.71)	
12/3	0.70	3.60	0.19	0.67**	-30**	-28.07**	-33.12**	10.33	-0.93	33.59**	28.62**	25.04*	5.40	13.33	0.14
				(0.14)	(5.10)	(7.30)	(10.01)	(10.12)	(14.44)	(6.27)	(9.53)	(11.34)	(14.15)	(15.25)	
12/6	0.63	2.39	0.26	0.56**	-13.66**	-8.99	-19.94**	8.71	0.11	16.82**	8.19	23.61**	5.46	-1.96	0.08
				(0.10)	(3.52)	(5.04)	(6.92)	(6.99)	(9.97)	(4.33)	(6.59)	(7.84)	(9.77)	(10.54)	
12/9	0.45	1.93	0.23	0.38**	-6.39*	-6.26	-15.1**	2.68	-0.41	9.52**	4.31	25.3**	4.44	-8.83	0.05
				(0.08)	(2.92)	(4.18)	(5.74)	(5.80)	(8.27)	(3.59)	(5.46)	(6.50)	(8.11)	(8.74)	
12/12	0.24	1.64	0.15	0.18*	-3.28	-2.69	-10.77*	-5.00	-3.56	5.73	1.09	17.58**	9.55	-4.41	0.04
				(0.07)	(2.49)	(3.56)	(4.89)	(4.94)	(7.04)	(3.06)	(4.65)	(5.53)	(6.90)	(7.44)	

Note. This table shows average monthly returns in excess of the risk-free rate, volatilities, Sharpe ratios, alphas and betas to the Fama and French (2015) (un)conditional factors $MktRF$, SMB, HML, RMW, CMA, $MktRF_{UP}$, SMB_{UP}, HML_{UP}, RMW_{UP} and CMA_{UP} and adjusted R^2 values for total return momentum portfolios when the first 36 observations per stock are not omitted from the data set. The conditional UP factors are not the same for each regression, as they are conditional on the sign of the returns over the formation period considered. The (residual) momentum strategy is defined as a zero-investment top-minus-bottom decile portfolio using the overlapping portfolios approach of Jegadeesh and Titman (1993). Here, residual returns are estimated using Equation (5). Alphas and betas are estimated using the conditional up-factor model as presented in Equation (9). $^*p < 0.05$ $^*p < 0.01$, standard errors are in parentheses. Values are in percentages, except for adjusted R^2.

Table 9.6 Survivorship bias - q5

J/K	Ret.	Vol.	Sharpe.	Alpha	R$_{MKT}$	R$_{ME}$	R$_{IA}$	R$_{ROE}$	R$_{EG}$	R$_{MKT_{UP}}$	R$_{ME_{UP}}$	R$_{IA_{UP}}$	R$_{ROE_{UP}}$	R$_{EG_{UP}}$	A.R^2
3/3	0.08	2.89	0.03	-0.13	-11.38**	-13.77*	-3.87	2.04	-10.95	10.8*	25.91**	9.69	19.14	27.72*	0.10
				(0.13)	(4.17)	(5.98)	(10.19)	(9.12)	(13.02)	(5.16)	(7.60)	(12.86)	(10.03)	(13.55)	
3/6	0.08	2.05	0.04	-0.06	-6.07*	-8.15	-3.68	3.33	-6.44	6.33	16.74**	7.27	11.89	10.52	0.06
				(0.10)	(3.00)	(4.30)	(7.33)	(6.56)	(9.36)	(3.71)	(5.46)	(9.24)	(7.21)	(9.74)	
3/9	0.11	1.69	0.07	0.07	-2.57	-6.28	-4.94	-1.59	-11.99	2.01	10.62*	5.29	9.52	10.44	0.02
				(0.08)	(2.57)	(3.69)	(6.28)	(5.62)	(8.02)	(3.18)	(4.68)	(7.92)	(6.18)	(8.35)	
3/12	0.09	1.47	0.06	0.05	0.32	-3.74	-5.11	0.10	-8.14	-0.20	9.50	6.03	5.00	7.10	0.01
				(0.07)	(2.23)	(3.21)	(5.46)	(4.89)	(6.98)	(2.76)	(4.07)	(6.89)	(5.38)	(7.26)	
6/3	0.37	3.46	0.11	0.18	-11.62*	-20.64**	-55**	1.98	-10.74	8.64	24**	73.94**	35.07**	15.39	0.15
				(0.15)	(4.69)	(7.60)	(13.31)	(11.09)	(19.94)	(5.98)	(9.06)	(15.44)	(11.81)	(20.61)	
6/6	0.43	2.29	0.19	0.33**	-6.13	-9.70	-19.81*	8.41	-13.15	7.33	12.48*	23.97*	14.65	7.99	0.07
				(0.11)	(3.26)	(5.28)	(9.25)	(7.71)	(13.87)	(4.16)	(6.30)	(10.74)	(8.21)	(14.34)	
6/9	0.45	1.91	0.24	0.43**	-1.33	-8.83	-14.83	0.90	-20.81	1.72	10.66	20.32*	13.71	13.20	0.03
				(0.09)	(2.84)	(4.60)	(8.05)	(6.71)	(12.07)	(3.62)	(5.48)	(9.34)	(7.15)	(12.47)	
6/12	0.29	1.64	0.18	0.26**	0.77	-5.80	-13.78*	-3.44	-12.43	-1.25	9.04	14.01	15.7*	9.23	0.03
				(0.08)	(2.45)	(3.96)	(6.94)	(5.78)	(10.40)	(3.12)	(4.72)	(8.05)	(6.16)	(10.75)	
9/3	0.54	3.65	0.15	0.36*	-15.39**	-27.72**	-37.02*	40.53**	27.55	15.73*	42.62**	42.45*	-2.14	-33.29	0.16
				(0.16)	(5.01)	(7.49)	(15.39)	(12.30)	(24.26)	(6.33)	(9.36)	(16.91)	(13.16)	(25.34)	
9/6	0.64	2.38	0.27	0.51**	-5.62	-11.62*	-21.31*	23.21**	11.13	7.26	18.69**	21.97	2.18	-15.88	0.09
				(0.11)	(3.46)	(5.18)	(10.63)	(8.50)	(16.77)	(4.38)	(6.47)	(11.69)	(9.09)	(17.51)	
9/9	0.50	1.92	0.26	0.46**	-2.13	-12.5**	-17.45*	12.23	0.90	3.78	18.03**	18.34	3.78	-9.79	0.05
				(0.09)	(2.89)	(4.32)	(8.87)	(7.09)	(13.98)	(3.65)	(5.39)	(9.75)	(7.58)	(14.61)	
9/12	0.31	1.64	0.19	0.27**	-0.34	-8.13*	-13.43	3.36	2.97	2.46	12.59**	11.38	7.22	-8.79	0.03
				(0.08)	(2.50)	(3.74)	(7.68)	(6.14)	(12.11)	(3.16)	(4.67)	(8.44)	(6.57)	(12.65)	
12/3	0.70	3.60	0.19	0.48**	-24.02**	-20.7**	-53.86**	33.87**	27.95	28.5**	27.24**	61.47**	5.62	-27.89	0.18
				(0.16)	(5.14)	(7.78)	(15.99)	(13.07)	(27.85)	(6.30)	(9.30)	(17.86)	(13.70)	(28.48)	
12/6	0.63	2.39	0.26	0.53**	-12.01**	-7.15	-38.97**	16.70	2.73	13.58**	8.69	41.8**	10.64	-10.02	0.12
				(0.11)	(3.56)	(5.39)	(11.07)	(9.05)	(19.28)	(4.36)	(6.44)	(12.37)	(9.49)	(19.72)	
12/9	0.45	1.93	0.23	0.41**	-6.25*	-6.49	-29.7**	9.05	3.04	8.43*	5.78	32.65**	7.93	-12.80	0.06
				(0.09)	(3.00)	(4.55)	(9.34)	(7.63)	(16.27)	(3.68)	(5.43)	(10.44)	(8.00)	(16.64)	
12/12	0.24	1.64	0.15	0.2**	-3.42	-3.99	-29.02**	-2.34	7.64	5.16	3.41	28.7**	14.05*	-14.58	0.06
				(0.08)	(2.55)	(3.86)	(7.93)	(6.49)	(13.82)	(3.13)	(4.62)	(8.87)	(6.80)	(14.14)	

Note. This table shows average monthly returns in excess of the risk-free rate, volatilities, Sharpe ratios, alphas and betas to the Hou et al (2021) (un)conditional factors R_{MKT}, R_{ME}, R_{IA}, R_{ROE}, R_{EG}, $R_{MKT_{UP}}$, $R_{ME_{UP}}$, $R_{IA_{UP}}$, $R_{ROE_{UP}}$ and $R_{EG_{UP}}$ and adjusted R^2 values for total return momentum portfolios when the first 36 observations per stock are not omitted from the data set. The conditional UP factors are not the same for each regression, as they are conditional on the sign of the returns over the formation period considered. The (residual) momentum strategy is defined as a zero-investment top-minus-bottom decile portfolio using the overlapping portfolios approach of Jegadeesh and Titman (1993). Here, residual returns are estimated using Equation (6). Alphas and betas are estimated using the conditional up-factor model as presented in Equation (10). $*p < 0.05$ $*p < 0.01$, standard errors are in parentheses. Values are in percentages, except for adjusted R^2.

Table 9.7 24-month estimation window - FF3

J/K	Ret.	Vol.	Sharpe.	Alpha	MktRF	SMB	HML	MktRF_{UP}	SMB_{UP}	HML_{UP}	A.R^2
3/3	1.08	1.79	0.60	1.08**	-7.23**	-9.39	-7.59	6.66	10.06	10.16	0.03
				(0.07)	(2.52)	(3.67)	(3.91)	(3.31)	(4.84)	(5.25)	
3/6	0.99	1.28	0.77	0.98**	-3.47	-4.92	0.88	3.21	6.13	-1.54	0.00
				(0.05)	(1.84)	(2.67)	(2.85)	(2.41)	(3.52)	(3.82)	
3/9	0.92	1.01	0.91	0.91**	-0.91	-3.16	0.22	0.59	3.5	-0.54	0.00
				(0.04)	(1.44)	(2.10)	(2.24)	(1.89)	(2.77)	(3.00)	
3/12	0.81	0.92	0.89	0.8**	1.43	-3.01	-0.94	-1.5	4.2	0.48	0.00
				(0.04)	(1.31)	(1.91)	(2.03)	(1.72)	(2.51)	(2.72)	
6/3	1.76	2.25	0.78	1.73**	-9.05**	-14.61**	-11.95	15.04**	7.75	16.34	0.05
				(0.09)	(2.99)	(4.82)	(5.07)	(4.01)	(6.07)	(6.45)	
6/6	1.66	1.47	1.13	1.62**	-2.99	-4.34	-5.73	7.42**	1.04	8.19	0.02
				(0.06)	(1.99)	(3.21)	(3.37)	(2.66)	(4.04)	(4.29)	
6/9	1.53	1.19	1.29	1.5**	-0.7	-3.1	-3.66	4.08	-0.4	5.6	0.01
				(0.05)	(1.63)	(2.62)	(2.75)	(2.18)	(3.30)	(3.50)	
6/12	1.32	1.08	1.22	1.29**	0.81	-2.76	-3.38	1.69	-0.4	2.93	0.00
				(0.05)	(1.48)	(2.38)	(2.51)	(1.98)	(3.00)	(3.19)	
9/3	2.12	2.38	0.89	2.09**	-10.62**	-13.48**	-11.02	19.15**	6.15	16.89	0.06
				(0.10)	(3.23)	(4.88)	(5.02)	(4.26)	(6.27)	(6.78)	
9/6	1.98	1.58	1.25	1.94**	-4.36	-4.73	-3.82	9.84**	0.99	5.17	0.02
				(0.07)	(2.22)	(3.36)	(3.46)	(2.93)	(4.32)	(4.66)	
9/9	1.76	1.32	1.33	1.71**	-1.47	-2.92	-3.12	6.69**	-2.17	6.01	0.02
				(0.05)	(1.84)	(2.78)	(2.86)	(2.43)	(3.58)	(3.86)	
9/12	1.52	1.18	1.28	1.48**	0.11	-3.42	-3.53	4.27	-0.83	4.7	0.01
				(0.05)	(1.66)	(2.51)	(2.58)	(2.19)	(3.23)	(3.49)	
12/3	2.27	2.43	0.94	2.23**	-15.23**	-19.3**	-13.87**	22.78**	11.82	20.95**	0.09
				(0.10)	(3.34)	(4.98)	(5.12)	(4.33)	(6.33)	(6.77)	
12/6	2.05	1.67	1.22	1.99**	-6.03	-7.65	-9.4**	11.34**	2	14**	0.05
				(0.07)	(2.36)	(3.52)	(3.62)	(3.06)	(4.48)	(4.79)	
12/9	1.80	1.40	1.29	1.74**	-1.26	-5.48	-9.86**	5.68	-1.54	16.47**	0.05
				(0.06)	(1.96)	(2.92)	(3.01)	(2.55)	(3.72)	(3.98)	
12/12	1.58	1.26	1.25	1.54**	1.26	-6.86	-9.88**	2.48	0.76	13.55**	0.04
				(0.05)	(1.78)	(2.66)	(2.74)	(2.31)	(3.38)	(3.62)	

Note. This table shows average monthly returns in excess of the risk-free rate, volatilities, Sharpe ratios, alphas and betas to the Fama and French (1993) (un)conditional factors $MktRF$, SMB, HML, $MktRF_{UP}$, SMB_{UP} and HML_{UP} and adjusted R^2 values for residual return momentum portfolios. The conditional UP factors are not the same for each regression, as they are conditional on the sign of the returns over the formation period considered. The (residual) momentum strategy is defined as a zero-investment top-minus-bottom decile portfolio using the overlapping portfolios approach of Jegadeesh and Titman (1993). Here, residual returns are estimated using Equation (4). Alphas and betas are estimated using the conditional up-factor model as presented in Equation (8) using a 24-month period. $*p < 0.05$ $*p < 0.01$, standard errors are in parentheses. Values are in percentages, except for adjusted R^2.

Table 9.8 24-month estimation window - FF5

J/K	Ret	Vol	Sharpe	Alpha	MktRF	SMB	HML	RMW	CMA	MktRF$_{UP}$	SMB$_{UP}$	HML$_{UP}$	RMW$_{UP}$	CMA$_{UP}$	A.R^2
3/3	1.84	2.20	0.84	1.73**	-0.12	-3.91	-11.37*	4.38	10.74	1.08	2.2	11.3	25.08**	7.39	0.06
				(0.09)	(3.26)	(4.54)	(5.71)	(5.80)	(8.63)	(4.17)	(6.14)	(7.07)	(8.52)	(10.24)	
3/6	1.63	1.70	0.96	1.59**	0.82	-2.02	-1.86	2.73	1.87	-2.16	-1.58	1.22	9.45	2.6	0.00
				(0.07)	(2.60)	(3.62)	(4.56)	(4.63)	(6.89)	(3.33)	(4.90)	(5.65)	(6.81)	(8.17)	
3/9	1.46	1.40	1.04	1.44**	2.72	-3.03	2.43	0.15	0.98	-3.23	-0.58	1.28	7.13	-4.12	0.00
				(0.06)	(2.14)	(2.98)	(3.75)	(3.82)	(5.68)	(2.74)	(4.03)	(4.65)	(5.60)	(6.73)	
3/12	1.26	1.28	0.99	1.25**	3.82	-4.41	0.31	0.53	1.65	-3.83	1.6	3.66	4.04	-6.6	0.00
				(0.06)	(1.95)	(2.71)	(3.41)	(3.47)	(5.16)	(2.49)	(3.67)	(4.23)	(5.09)	(6.12)	
6/3	2.62	2.68	0.98	2.46**	-2.98	-4.35	-26.05**	3.09	29.13*	14.48**	-6.07	28.39**	23.68	-12.52	0.07
				(0.11)	(3.80)	(5.69)	(7.58)	(8.15)	(11.41)	(4.91)	(7.49)	(8.51)	(10.47)	(12.41)	
6/6	2.40	1.90	1.26	2.32**	-2.67	-0.61	-10.21	4.03	6.42	8.81*	-5.2	14.1*	8.97	-7.57	0.03
				(0.08)	(2.77)	(4.15)	(5.53)	(5.94)	(8.32)	(3.58)	(5.46)	(6.20)	(7.64)	(9.05)	
6/9	2.13	1.56	1.37	2.07**	-0.31	-1.29	-0.32	-4.09	1.02	5.62	-4.8	6.16	15.9*	-6.59	0.02
				(0.07)	(2.29)	(3.42)	(4.56)	(4.90)	(6.86)	(2.95)	(4.50)	(5.11)	(6.30)	(7.46)	
6/12	1.85	1.37	1.35	1.81**	0.16	-1.22	-2.82	-3.89	4.04	3.68	-5.39	6.75	12.7*	-10.31	0.02
				(0.06)	(2.01)	(3.01)	(4.00)	(4.30)	(6.02)	(2.59)	(3.95)	(4.49)	(5.53)	(6.55)	
9/3	2.95	2.72	1.09	2.79**	-5.22	-5.74	-11.84	0.96	8.5	18.18**	-4.55	12.9	31.49**	13.59	
				(0.11)	(3.90)	(5.67)	(7.11)	(7.44)	(11.53)	(4.97)	(7.48)	(8.22)	(10.26)	(12.25)	0.09
9/6	2.65	1.92	1.38	2.58**	-3.99	-0.47	0.4	0.14	-2.94	10.4**	-7.46	0.52	19.57**	2.57	0.04
				(0.08)	(2.85)	(4.14)	(5.20)	(5.43)	(8.42)	(3.63)	(5.47)	(6.01)	(7.50)	(8.95)	
9/9	2.32	1.59	1.46	2.26**	-1.23	-2.51	4.54	-4.44	-5.25	7.17*	-5.08	0.04	19.22**	2.07	0.03
				(0.07)	(2.36)	(3.43)	(4.30)	(4.49)	(6.97)	(3.01)	(4.52)	(4.97)	(6.20)	(7.40)	
9/12	2.03	1.38	1.47	1.99**	-0.56	-3.16	0.93	-4.76	-1.98	4.77	-4.94	2.38	14.04**	-1.36	0.02
				(0.06)	(2.06)	(2.99)	(3.76)	(3.93)	(6.09)	(2.63)	(3.95)	(4.34)	(5.42)	(6.47)	
12/3	2.99	2.72	1.10	2.8**	-10.05*	-12.81*	-11.08	0.43	14.43	22.55**	6.52	14.31	35.28**	2.06	0.12
				(0.11)	(3.97)	(5.59)	(7.70)	(7.97)	(10.94)	(4.89)	(7.40)	(8.74)	(11.00)	(11.72)	
12/6	2.65	1.89	1.40	2.55**	-4.64	-3.21	-1.09	-0.24	-0.52	10.76**	-4.32	7.48	21.36**	-1.99	0.06
				(0.08)	(2.86)	(4.02)	(5.54)	(5.73)	(7.88)	(3.52)	(5.32)	(6.29)	(7.92)	(8.43)	
12/9	2.34	1.56	1.50	2.25**	-0.36	-4.34	1.05	-4.6	-1.24	5.16	-4.05	9.25	19.34**	-3.82	0.05
				(0.07)	(2.35)	(3.31)	(4.56)	(4.72)	(6.49)	(2.90)	(4.38)	(5.18)	(6.52)	(6.94)	
12/12	2.07	1.37	1.52	2.02**	0.24	-6.17*	-1.47	-4.81	-0.3	3.29	-1.54	9.63*	13.11*	-5.42	0.04
				(0.06)	(2.09)	(2.94)	(4.05)	(4.19)	(5.76)	(2.57)	(3.89)	(4.60)	(5.79)	(6.16)	

Note. This table shows average monthly returns in excess of the risk-free rate, volatilities, Sharpe ratios, alphas and betas to the Fama and French (2015) (un)conditional factors $MktRF$, SMB, HML, RMW, CMA, $MktRF_{UP}$, SMB_{UP}, HML_{UP}, RMW_{UP} and CMA_{UP} and adjusted R^2 values for residual return momentum portfolios. The conditional UP factors are not the same for each regression, as they are conditional on the sign of the returns over the formation period considered. The (residual) momentum strategy is defined as a zero-investment top-minus-bottom decile portfolio using the overlapping portfolios approach of Jegadeesh and Titman (1993). Here, residual returns are estimated using Equation (5). Alphas and betas are estimated using the conditional up-factor model as presented in Equation (9) using a 24-month period. $*p < 0.05$ $*p < 0.01$, standard errors are in parentheses. Values are in percentages, except for adjusted R^2.

Table 9.9 24-month estimation window - q5

J/K	Ret.	Vol.	Sharpe.	Alpha	R_{MKT}	R_{ME}	R_{IA}	R_{ROE}	R_{EG}	$R_{MKT_{UP}}$	$R_{ME_{UP}}$	$R_{IA_{UP}}$	$R_{ROE_{UP}}$	$R_{EG_{UP}}$	A.R^2
3/3	2.24	2.38	0.94	1.73**	4.94	6.74	24.59**	6.43	24.15*	1.49	0.58	-30.56**	8.01	29.85**	0.15
				(0.11)	(3.37)	(4.87)	(8.16)	(7.51)	(10.65)	(4.21)	(6.22)	(10.52)	(8.22)	(11.16)	
3/6	2.00	1.84	1.09	1.69**	4.1	1.96	16.09*	6.99	8.83	0.64	1.57	-25.24**	-1.3	26.81**	0.09
				(0.09)	(2.72)	(3.94)	(6.59)	(6.07)	(8.61)	(3.40)	(5.02)	(8.50)	(6.64)	(9.02)	
3/9	1.79	1.52	1.18	1.57**	4.12	1.47	11.36*	4.08	10.03	1.09	-0.32	-21.07**	-0.68	16.1*	0.06
				(0.07)	(2.28)	(3.29)	(5.51)	(5.07)	(7.20)	(2.84)	(4.20)	(7.11)	(5.55)	(7.54)	
3/12	1.56	1.37	1.14	1.39**	5.78**	0.74	4.00	-0.16	11.18	-1.98	1.57	-12.53	1.33	10.55	0.04
				(0.07)	(2.08)	(3.00)	(5.02)	(4.62)	(6.56)	(2.59)	(3.83)	(6.48)	(5.06)	(6.87)	
6/3	3.08	2.90	1.06	2.49**	5.49	7.3	14.15	1.78	45.73**	2.4	1.22	-13.95	16.91	10.77	0.14
				(0.13)	(4.08)	(6.57)	(11.11)	(9.59)	(17.13)	(5.21)	(7.88)	(13.32)	(10.24)	(17.73)	
6/6	2.79	2.12	1.31	2.49**	3.83	1.01	1.36	-4.36	25.26	0.84	3.2	-8.99	13.46	6.79	0.06
				(0.10)	(3.14)	(5.06)	(8.55)	(7.38)	(13.19)	(4.01)	(6.07)	(10.26)	(7.88)	(13.65)	
6/9	2.47	1.78	1.39	2.25**	3.96	2.24	-0.63	-2.76	34.29**	-0.52	0.24	-5.95	7.79	-9.65	0.05
				(0.09)	(2.65)	(4.26)	(7.21)	(6.22)	(11.12)	(3.38)	(5.11)	(8.65)	(6.65)	(11.51)	
6/12	2.12	1.57	1.35	1.95**	4.53	1.22	-5.73	-4.42	32.19**	-1.9	-0.12	-2.63	5.62	-11.22	0.04
				(0.08)	(2.34)	(3.77)	(6.37)	(5.50)	(9.82)	(2.99)	(4.52)	(7.64)	(5.87)	(10.16)	
9/3	3.41	3.00	1.13	2.82**	2.63	-0.37	24.05	13.92	41.31*	10.37	11.59	-20.19	2.68	10.54	0.15
				(0.14)	(4.27)	(6.39)	(12.53)	(10.53)	(20.81)	(5.45)	(8.06)	(14.27)	(11.23)	(21.64)	
9/6	3.04	2.22	1.37	2.75**	1.87	-1.02	10.95	-2.21	23.69	4.85	3.94	-18.08	10.39	7.09	0.06
				(0.11)	(3.34)	(5.00)	(9.81)	(8.24)	(16.29)	(4.26)	(6.31)	(11.17)	(8.79)	(16.94)	
9/9	2.64	1.84	1.43	2.43**	2.16	1.07	5.35	-3.76	16.67	3.55	-1.53	-12.01	7.77	7.49	0.04
				(0.09)	(2.79)	(4.18)	(8.19)	(6.89)	(13.61)	(3.56)	(5.27)	(9.33)	(7.35)	(14.15)	
9/12	2.25	1.58	1.42	2.1**	2.38	0.01	2.73	-9.65	18.23	2.63	-1.41	-10.7	11.65	1.68	0.04
				(0.08)	(2.40)	(3.59)	(7.04)	(5.92)	(11.70)	(3.06)	(4.53)	(8.02)	(6.32)	(12.16)	
12/3	3.38	3.04	1.11	2.76**	0.11	-1.62	31.35*	-2.76	60.46*	14.28*	10.56	-26.34	19.95	-6.12	0.16
				(0.14)	(4.51)	(6.83)	(13.12)	(11.56)	(24.91)	(5.54)	(8.18)	(15.16)	(12.03)	(25.40)	
12/6	2.97	2.24	1.33	2.65**	1.47	-1.12	0.98	-5.63	30.99	5.49	3.15	-1.84	13.98	0.99	0.07
				(0.11)	(3.52)	(5.33)	(10.23)	(9.01)	(19.43)	(4.32)	(6.38)	(11.83)	(9.38)	(19.81)	
12/9	2.55	1.79	1.42	2.34**	2.99	-0.03	-4.76	-7.56	29.69	2.9	-1.95	4.48	12.18	-7.34	0.05
				(0.09)	(2.85)	(4.31)	(8.28)	(7.29)	(15.72)	(3.50)	(5.16)	(9.57)	(7.59)	(16.03)	
12/12	2.18	1.54	1.41	2.02**	3.57	-1.53	-7.12	-13.58*	34.85	1.37	-0.65	5.39	15.49*	-16.54	0.04
				(0.07)	(2.45)	(3.71)	(7.13)	(6.28)	(13.55)	(3.01)	(4.45)	(8.25)	(6.54)	(13.81)	

Note. This table shows average monthly returns in excess of the risk-free rate, volatilities, Sharpe ratios, alphas and betas to the Hou et al (2021) (un)conditional factors R_{MKT}, R_{ME}, R_{IA}, R_{ROE}, R_{EG}, $R_{MKT_{UP}}$, $R_{ME_{UP}}$, $R_{IA_{UP}}$, $R_{ROE_{UP}}$ and $R_{EG_{UP}}$ and adjusted R^2 values for residual return momentum portfolios. The conditional UP factors are not the same for each regression, as they are conditional on the sign of the returns over the formation period considered. The (residual) momentum strategy is defined as a zero-investment top-minus-bottom decile portfolio using the overlapping portfolios approach of Jegadeesh and Titman (1993). Here, residual returns are estimated using Equation (6). Alphas and betas are estimated using the conditional up-factor model as presented in Equation (10) using a 24-month period. $*p < 0.05$ $*p < 0.01$, standard errors are in parentheses. Values are in percentages, except for adjusted R^2.

Table 9.10 60-month estimation window - FF3

J/K	Ret.	Vol.	Sharpe.	Alpha	MktRF	SMB	HML	MktRF$_{UP}$	SMB$_{UP}$	HML$_{UP}$	A.R^2
3/3	0.54	1.51	0.36	0.56**	-6.64**	-9.08**	-6.66*	5.6*	11**	6.09	0.04
				(0.06)	(2.14)	(3.20)	(3.05)	(2.77)	(4.21)	(4.31)	
3/6	0.54	1.11	0.49	0.55**	-3.09	-4.32	-2.53	2.72	6.67*	1.30	0.01
				(0.05)	(1.59)	(2.39)	(2.28)	(2.06)	(3.13)	(3.21)	
3/9	0.50	0.89	0.56	0.51**	-0.86	-3.15	-3.31	0.46	4.29	1.73	0.00
				(0.04)	(1.29)	(1.93)	(1.85)	(1.66)	(2.53)	(2.59)	
3/12	0.43	0.81	0.53	0.43**	0.89	-2.09	-4.31*	-1.05	4.07	2.63	0.01
				(0.03)	(1.18)	(1.75)	(1.77)	(1.54)	(2.29)	(2.40)	
6/3	1.07	1.89	0.57	1.08**	-7.83**	-17.1**	-11.74**	12.51**	15.58**	12.48*	0.06
				(0.08)	(2.55)	(4.22)	(4.00)	(3.35)	(5.29)	(5.31)	
6/6	1.04	1.27	0.82	1.04**	-2.52	-4.87	-8.18**	5.59*	4.52	8.38*	0.02
				(0.05)	(1.75)	(2.89)	(2.76)	(2.30)	(3.62)	(3.65)	
6/9	0.95	1.07	0.89	0.94**	0.13	-3.50	-6.67**	2.05	2.12	6.85*	0.01
				(0.05)	(1.49)	(2.47)	(2.36)	(1.96)	(3.09)	(3.12)	
6/12	0.77	0.95	0.81	0.77**	1.34	-1.98	-6.21**	0.09	1.47	4.83	0.01
				(0.04)	(1.35)	(2.20)	(2.22)	(1.77)	(2.75)	(2.84)	
9/3	1.37	2.02	0.68	1.37**	-7.51**	-18.7**	-8.74*	12.57**	14.97**	7.22	0.06
				(0.08)	(2.85)	(4.39)	(4.08)	(3.65)	(5.59)	(5.75)	
9/6	1.29	1.40	0.92	1.29**	-2.28	-6.57*	-5.71	4.57	5.21	3.22	0.01
				(0.06)	(2.02)	(3.13)	(2.91)	(2.60)	(3.97)	(4.10)	
9/9	1.11	1.17	0.95	1.1**	0.84	-5.54*	-5.8*	1.88	3.63	4.71	0.01
				(0.05)	(1.70)	(2.63)	(2.46)	(2.18)	(3.34)	(3.45)	
9/12	0.91	1.00	0.91	0.91**	1.26	-3.54	-5.74*	1.36	2.56	4.02	0.02
				(0.04)	(1.48)	(2.26)	(2.22)	(1.91)	(2.86)	(3.03)	
12/3	1.45	2.10	0.69	1.45**	-11.21**	-16.9**	-8.42*	15.87**	10.15	6.81	0.06
				(0.09)	(3.10)	(4.58)	(4.26)	(3.87)	(5.81)	(5.91)	
12/6	1.31	1.48	0.88	1.3**	-3.96	-3.66	-7.67*	6.56*	-0.77	7.57	0.02
				(0.06)	(2.23)	(3.32)	(3.09)	(2.79)	(4.20)	(4.27)	
12/9	1.12	1.24	0.90	1.11**	0.30	-3.03	-9.11**	2.18	-1.52	10.24**	0.02
				(0.05)	(1.87)	(2.79)	(2.60)	(2.34)	(3.52)	(3.59)	
12/12	0.94	1.08	0.87	0.93**	1.66	-1.85	-10.31**	0.01	-1.55	11.18**	0.03
				(0.05)	(1.61)	(2.42)	(2.38)	(2.06)	(3.05)	(3.18)	

Note. This table shows average monthly returns in excess of the risk-free rate, volatilities, Sharpe ratios, alphas and betas to the Fama and French (1993) (un)conditional factors $MktRF$, SMB, HML, $MktRF_{UP}$, SMB_{UP} and HML_{UP} and adjusted R^2 values for residual return momentum portfolios. The conditional UP factors are not the same for each regression, as they are conditional on the sign of the returns over the formation period considered. The (residual) momentum strategy is defined as a zero-investment top-minus-bottom decile portfolio using the overlapping portfolios approach of Jegadeesh and Titman (1993). Here, residual returns are estimated using Equation (4). Alphas and betas are estimated using the conditional up-factor model as presented in Equation (8) using a 60-month period. $*p < 0.05$ $*p < 0.01$, standard errors are in parentheses. Values are in percentages, except for adjusted R^2.

Table 9.11 60-month estimation window - FF5

J/K	Ret	Vol	Sharpe	Alpha	MktRF	SMB	HML	RMW	CMA	$MktRF_{UP}$	SMB_{UP}	HML_{UP}	RMW_{UP}	CMA_{UP}	A.R^2
3/3	0.61	1.47	0.42	0.57**	-0.37	-5.39	-1.8	-0.5	-3.07	-0.37	7.75	2.12	19.35**	12.34	0.06
				(0.06)	(2.18)	(3.11)	(3.48)	(3.86)	(5.68)	(2.76)	(4.20)	(4.53)	(5.67)	(6.88)	
3/6	0.61	1.09	0.55	0.6**	-0.1	-1.45	0.27	0.7	-6.43	-1.68	3.55	0.26	6.31	5.79	0.00
				(0.05)	(1.67)	(2.39)	(2.68)	(2.96)	(4.36)	(2.12)	(3.22)	(3.48)	(4.36)	(5.28)	
3/9	0.57	0.89	0.63	0.58**	1.17	-1.56	1.75	-2.2	-6.71	-2.76	1.23	0.79	6.33	-0.08	0.00
				(0.04)	(1.36)	(1.95)	(2.20)	(2.41)	(3.58)	(1.74)	(2.63)	(2.85)	(3.56)	(4.32)	
3/12	0.49	0.81	0.61	0.5**	1.7	-2.11	0.96	-1.36	-4.65	-2.46	1.64	1.04	3.7	-1.98	0.00
				(0.04)	(1.26)	(1.78)	(2.11)	(2.19)	(3.27)	(1.60)	(2.39)	(2.63)	(3.22)	(3.92)	
6/3	1.19	1.79	0.66	1.12**	-2.68	-9.1*	-11.73*	5.42	6.69	7.61*	9.55	11.48*	9.91	3.16	0.05
				(0.08)	(2.56)	(3.98)	(4.68)	(5.50)	(7.80)	(3.28)	(5.19)	(5.55)	(7.07)	(8.62)	
6/6	1.14	1.22	0.94	1.13**	-1.53	-2.13	-6.85*	2.96	-2.78	3.92	2.83	8.34*	1.56	1.28	0.01
				(0.05)	(1.80)	(2.76)	(3.28)	(3.82)	(5.46)	(2.29)	(3.62)	(3.87)	(4.92)	(6.01)	
6/9	1.06	1.03	1.03	1.05**	1.27	-2.46	-2.96	-1.9	-2.41	0.61	1.33	6.84*	6.23	-4.14	0.01
				(0.05)	(1.53)	(2.35)	(2.79)	(3.23)	(4.64)	(1.95)	(3.06)	(3.29)	(4.16)	(5.10)	
6/12	0.89	0.92	0.97	0.9**	1.36	-1.65	-2.97	-1.73	-1.47	-0.37	1.06	5.41	4.89	-6.3	0.01
				(0.04)	(1.39)	(2.11)	(2.65)	(2.89)	(4.17)	(1.77)	(2.73)	(3.01)	(3.71)	(4.55)	
9/3	1.48	1.93	0.77	1.41**	-3.27	-13.23**	-7.17	8.74	-4.85	9.13*	11.87*	4.52	10.61	16.89	0.07
				(0.08)	(2.86)	(4.24)	(4.65)	(5.29)	(8.40)	(3.58)	(5.53)	(5.74)	(7.27)	(9.05)	
9/6	1.38	1.35	1.02	1.37**	-1.62	-4.05	-1.7	2.65	-9.84	3.35	3.02	0.14	8.65	9.2	0.02
				(0.06)	(2.06)	(3.06)	(3.37)	(3.84)	(6.07)	(2.58)	(3.98)	(4.14)	(5.25)	(6.51)	
9/9	1.23	1.12	1.09	1.22**	1.04	-4.14	0.22	-0.89	-8.45	1.23	2.23	1.19	8.53	4.25	0.02
				(0.05)	(1.72)	(2.55)	(2.82)	(3.20)	(5.08)	(2.15)	(3.32)	(3.45)	(4.37)	(5.45)	
9/12	1.04	0.97	1.08	1.04**	0.68	-2.77	-0.33	-2.69	-6.3	1.22	0.97	0.76	8.83*	1.78	0.02
				(0.04)	(1.52)	(2.23)	(2.62)	(2.78)	(4.45)	(1.90)	(2.88)	(3.08)	(3.81)	(4.73)	
12/3	1.60	2.04	0.79	1.51**	-5.72	-12.43**	-12.29*	10.58	11.72	10.73**	11.95*	7.94	8.5	-0.73	0.06
				(0.09)	(3.22)	(4.47)	(5.23)	(6.05)	(8.53)	(3.87)	(5.87)	(6.33)	(8.23)	(9.32)	
12/6	1.46	1.44	1.02	1.42**	-1.95	-1.73	-7.13	6.91	-1.15	4.11	1.21	8.39	4.11	0.22	0.02
				(0.06)	(2.32)	(3.24)	(3.82)	(4.43)	(6.19)	(2.80)	(4.25)	(4.59)	(5.99)	(6.74)	
12/9	1.28	1.18	1.09	1.26**	1.22	-2.16	-4.98	3.24	-2.1	1.17	0.53	8.22*	2.18	-0.05	0.01
				(0.05)	(1.92)	(2.68)	(3.17)	(3.65)	(5.12)	(2.31)	(3.51)	(3.80)	(4.94)	(5.57)	
12/12	1.12	1.01	1.11	1.11**	0.87	-1.54	-6.13*	1.72	-1.84	0.51	0.23	8.5*	1.08	-1.16	0.01
				(0.04)	(1.64)	(2.32)	(2.96)	(3.16)	(4.48)	(2.01)	(3.03)	(3.39)	(4.31)	(4.80)	

Note. This table shows average monthly returns in excess of the risk-free rate, volatilities, Sharpe ratios, alphas and betas to the Fama and French (2015) (un)conditional factors $MktRF$, SMB, HML, RMW, CMA, $MktRF_{UP}$, SMB_{UP}, HML_{UP}, RMW_{UP} and CMA_{UP} and adjusted R^2 values for residual return momentum portfolios. The conditional UP factors are not the same for each regression, as they are conditional on the sign of the returns over the formation period considered. The (residual) momentum strategy is defined as a zero-investment top-minus-bottom decile portfolio using the overlapping portfolios approach of Jegadeesh and Titman (1993). Here, residual returns are estimated using Equation (5). Alphas and betas are estimated using the conditional up-factor model as presented in Equation (9) using a 60-month period. $*p < 0.05$ $*p < 0.01$, standard errors are in parentheses. Values are in percentages, except for adjusted R^2.

Table 9.12 60-month estimation window - q5

J/K	Ret.	Vol.	Sharpe.	Alpha	R_{MKT}	R_{ME}	R_{IA}	R_{ROE}	R_{EG}	$R_{MKT_{UP}}$	$R_{ME_{UP}}$	$R_{IA_{UP}}$	$R_{ROE_{UP}}$	$R_{EG_{UP}}$	A.R^2
3/3	0.85	1.56	0.54	1.73**	4.94	6.74	24.59**	6.43	24.15	1.49	0.58	-30.56**	8.01	29.85**	0.15
				(0.11)	(3.37)	(4.87)	(8.16)	(7.51)	(10.65)	(4.21)	(6.22)	(10.52)	(8.22)	(11.16)	
3/6	0.81	1.10	0.73	1.69**	4.1	1.96	16.09*	6.99	8.83	0.64	1.57	-25.24**	-1.3	26.81**	0.09
				(0.09)	(2.72)	(3.94)	(6.59)	(6.07)	(8.61)	(3.40)	(5.02)	(8.50)	(6.64)	(9.02)	
3/9	0.75	0.91	0.83	1.57**	4.12	1.47	11.36*	4.08	10.03	1.09	-0.32	-21.07**	-0.68	16.1	0.06
				(0.07)	(2.28)	(3.29)	(5.51)	(5.07)	(7.20)	(2.84)	(4.20)	(7.11)	(5.55)	(7.54)	
3/12	0.66	0.84	0.79	1.39**	5.78**	0.74	4	-0.16	11.18	-1.98	1.57	-12.53	1.33	10.55	0.04
				(0.07)	(2.08)	(3.00)	(5.02)	(4.62)	(6.56)	(2.59)	(3.83)	(6.48)	(5.06)	(6.87)	
6/3	1.48	1.98	0.75	2.49**	5.49	7.3	14.15	1.78	45.73**	2.4	1.22	-13.95	16.91	10.77	0.14
				(0.13)	(4.08)	(6.57)	(11.11)	(9.59)	(17.13)	(5.21)	(7.88)	(13.32)	(10.24)	(17.73)	
6/6	1.40	1.39	1.01	2.49**	3.83	1.01	1.36	-4.36	25.26	0.84	3.2	-8.99	13.46	6.79	0.06
				(0.10)	(3.14)	(5.06)	(8.55)	(7.38)	(13.19)	(4.01)	(6.07)	(10.26)	(7.88)	(13.65)	
6/9	1.28	1.17	1.09	2.25**	3.96	2.24	-0.63	-2.76	34.29**	-0.52	0.24	-5.95	7.79	-9.65	0.05
				(0.09)	(2.65)	(4.26)	(7.21)	(6.22)	(11.12)	(3.38)	(5.11)	(8.65)	(6.65)	(11.51)	
6/12	1.09	1.03	1.06	1.95**	4.53	1.22	-5.73	-4.42	32.19**	-1.9	-0.12	-2.63	5.62	-11.22	0.04
				(0.08)	(2.34)	(3.77)	(6.37)	(5.50)	(9.82)	(2.99)	(4.52)	(7.64)	(5.87)	(10.16)	
9/3	1.75	2.14	0.82	2.82**	2.63	-0.37	24.05	13.92	41.31	10.37	11.59	-20.19	2.68	10.54	0.15
				(0.14)	(4.27)	(6.39)	(12.53)	(10.53)	(20.81)	(5.45)	(8.06)	(14.27)	(11.23)	(21.64)	
9/6	1.62	1.53	1.06	2.75**	1.87	-1.02	10.95	-2.21	23.69	4.85	3.94	-18.08	10.39	7.09	0.06
				(0.11)	(3.34)	(5.00)	(9.81)	(8.24)	(16.29)	(4.26)	(6.31)	(11.17)	(8.79)	(16.94)	
9/9	1.43	1.25	1.14	2.43**	2.16	1.07	5.35	-3.76	16.67	3.55	-1.53	-12.01	7.77	7.49	0.04
				(0.09)	(2.79)	(4.18)	(8.19)	(6.89)	(13.61)	(3.56)	(5.27)	(9.33)	(7.35)	(14.15)	
9/12	1.24	1.05	1.18	2.1**	2.38	0.01	2.73	-9.65	18.23	2.63	-1.41	-10.7	11.65	1.68	0.04
				(0.08)	(2.40)	(3.59)	(7.04)	(5.92)	(11.70)	(3.06)	(4.53)	(8.02)	(6.32)	(12.16)	
12/3	1.84	2.24	0.82	2.76**	0.11	-1.62	31.35*	-2.76	60.46	14.28	10.56	-26.34	19.95	-6.12	0.16
				(0.14)	(4.51)	(6.83)	(13.12)	(11.56)	(24.91)	(5.54)	(8.18)	(15.16)	(12.03)	(25.40)	
12/6	1.66	1.59	1.05	2.65**	1.47	-1.12	0.98	-5.63	30.99	5.49	3.15	-1.84	13.98	0.99	0.07
				(0.11)	(3.52)	(5.33)	(10.23)	(9.01)	(19.43)	(4.32)	(6.38)	(11.83)	(9.38)	(19.81)	
12/9	1.48	1.28	1.15	2.34**	2.99	-0.03	-4.76	-7.56	29.69	2.9	-1.95	4.48	12.18	-7.34	0.05
				(0.09)	(2.85)	(4.31)	(8.28)	(7.29)	(15.72)	(3.50)	(5.16)	(9.57)	(7.59)	(16.03)	
12/12	1.30	1.08	1.20	2.02**	3.57	-1.53	-7.12	-13.58	34.85	1.37	-0.65	5.39	15.49	-16.54	0.04
				(0.07)	(2.45)	(3.71)	(7.13)	(6.28)	(13.55)	(3.01)	(4.45)	(8.25)	(6.54)	(13.81)	

Note. This table shows average monthly returns in excess of the risk-free rate, volatilities, Sharpe ratios, alphas and betas to the Hou et al (2021) (un)conditional factors R_{MKT}, R_{ME}, R_{IA}, R_{ROE}, R_{EG}, $R_{MKT_{UP}}$, $R_{ME_{UP}}$, $R_{IA_{UP}}$, $R_{ROE_{UP}}$ and $R_{EG_{UP}}$ and adjusted R^2 values for residual return momentum portfolios. The conditional UP factors are not the same for each regression, as they are conditional on the sign of the returns over the formation period considered. The (residual) momentum strategy is defined as a zero-investment top-minus-bottom decile portfolio using the overlapping portfolios approach of Jegadeesh and Titman (1993). Here, residual returns are estimated using Equation (6). Alphas and betas are estimated using the conditional up-factor model as presented in Equation (10) using a 60-month period. $*p < 0.05$ $*p < 0.01$, standard errors are in parentheses. Values are in percentages, except for adjusted R^2.