Combining value and momentum: evidence from the United Kingdom

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Abstract

I investigate whether combining momentum and value in a double-sorted long-short strategy with a sample of large UK firms outperforms single-factor portfolios and relevant benchmarks. The paper fully focuses on the performance of the strategy and does not try to provide explanations for either the value, momentum or the combined premiums.

There is one strategy that outperforms the single-factor portfolios, benchmarks, and other strategies created in this paper, which is investing in a winner strong value portfolio and shorting the loser growth portfolio. The profitability of this strategy is not explained by the factors in existing research. In addition, I find that solely investing in the winner strong value portfolio outperforms all possible strategies in this paper. This dissertation adds to the recently popular double-sorted strategy literature as UK evidence using specific construction techniques.

Keywords: long-short strategy, double-sorted strategy, value, momentum, investing, UK

Combinando value e momentum: prova no Reino Unido

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Resumo

A minha investigação incide sobre se combinar *momentum* e *value* numa estratégia de dupla classificação *long-short* com uma amostra de grandes empresas do RU tem melhor prestação que carteiras de um só factor e outras *benchmarks* relevantes. A dissertação foca-se apenas na prestação da estratégia, não tecendo explicações relativamente ao *value*, *momentum* ou aos prémios combinados.

Há uma estratégia que tem melhor performance que carteiras dum só factor, *benchmarks* e outras estratégias teóricas, que é investir numa carteira *winner* com forte *value*, enquanto se faz uma venda a descoberto duma carteira *loser growth*. A rentabilidade desta estratégia não é explicada pelos factores discutidos na literatura existente. Adicionalmente, proponho que apenas investir na carteira *winner* com forte *value* tem uma melhor prestação que todas as outras estratégias abordadas nesta dissertação. Esta dissertação contribui para a literatura da recém-popular estratégia de dupla classificação com evidência do RU usando técnicas de construção específicas.

Palavras chave: estratégia *long-short*, estratégia de dupla classificação, *value*, *momentum*, investimento, RU

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List of Abbreviations

3FF	The Three-Factor Model by Fama and French
4FF	The Carhart model
AR	Autocorrelation
AQR	Applied Quantitative Research
B/M	Book to Market Ratio
CAPM	Capital Asset Pricing Model
E/P	Earnings to Price Ratio
GRS	Gibbons, Ross, and Shanken Test
JB	Jarque Bera Test
OLS	Ordinary Least Squares
P/E	Price to Earnings Ratio
RF	The Risk-Free Rate
UK	The United Kingdom
WSV-LG	Winner Strong Value minus Loser Growth
WSV-LSG	Winner Strong Value minus Loser Strong Growth

To the memory of my mother

Acknowledgments

I would like to dedicate this dissertation to my mother, who passed away during the first semester of the Master. She is a great inspiration and the source of motivation that pushes me to excel to this day.

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1. Introduction

Achieving alpha is the goal of any active investor. Over the past decades, many papers on investment strategies incorporating anomalies and research on the motivation behind the existence of anomalies have been published. Many factors and investment vehicles are created to capitalize on these anomalies. These anomalies are often contradicting the efficient market hypothesis and could at any moment become unprofitable. Many anomalies currently exist, like short-term reversals, value stocks, the January effect, and momentum, just to name a few. In this study, I focus on possible ways to combine two very popular anomalies; value and momentum.

The purpose of this dissertation is to analyze the performance of a double-sorted long-short strategy that combines momentum with value in the UK market compared against single-factor portfolios. The research analyses the period of 01-1991 till 06-2021 and only incorporates the largest and most liquid firms. All data is retrieved from DataStream and the AQR data library. The double-sorted long-short strategy is created with a bottom-up approach by creating two single-factor portfolios for value and momentum and ultimately combining them. The results of the single-factor portfolios are continuously compared against the results of the double-sorted long-short strategy. This continuous analysis is to study the effect of double-sorting on the value and momentum anomalies. Double-sorting the value and momentum anomalies provides 210 possible double-sorted long-short strategies, of which all are analyzed to determine the optimal combination of long-short portfolios. The findings of this paper can be of value for several types of investors and especially investors who already invest in either momentum or value to further enhance their alpha. The main research question of this paper is:

"Do portfolios with combined value and momentum characteristics outperform the single-factor portfolios of value and momentum in the UK market?"

The main research question is supported by five sub-hypotheses. Of which, the first hypothesis is that the single factor portfolios are improved by combining them in a double-sorted long-short strategy. The construction methods of the AQR factors are followed, where possible, so the correlation between the single factor portfolios is an important indicator of whether there might be differences in the construction of the momentum and value long-short strategies. Further, the long and short legs of the value and momentum long-short strategies are analyzed, whether it might be better to just invest in either of the legs rather than in the single factor portfolio, the AQR benchmark, or the double-sorted long-short strategy.

Secondly, the profitability of the double-sorted long-short strategy is tested after the implementation of turnover and transaction costs. At this point, 210 possible double-sorted long-short strategies are created out of the 15 different long possibilities and 14 different short possibilities. The profitable combinations are further analyzed and compared against the relevant AQR benchmark to determine possible profitability after transaction costs. It is expected that some combinations outperform the AQR benchmark and the single-factor strategies, but the expected increase in turnover limits the outperforming combinations to only a few.

The third sub-hypothesis is that the Carhart model can explain most of the returns of the strategy. After all, the proposed double-sorted long-short strategy consists of the value and momentum factor of which the Carhart model is the closest model including both value and momentum, while also including the market factor and the size factor. The non-linear combination of value and momentum as proposed is tested against the linear Carhart model and whether this non-linear combination holds abnormal returns against the model. The GRS test further examines if the Carhart model explains the returns achieved by the double-sorted long-short strategy.

The fourth sub-hypothesis and the fifth sub-hypothesis are created as a robustness check of the returns of the strategy. The fourth sub-hypothesis is that the investor is able, at any time in the sample period, to pick out the outperforming strategies. This is tested through a selection exercise and is of importance to determine whether an investor would be able to spot outperforming strategies and stay with the outperforming strategies throughout time. The fifth sub-hypothesis centers also around a robustness test and tests whether different construction methods point towards the same outperforming strategies. All these sub-hypotheses support the answer to the main research question.

The paper is constructed as follows. Firstly, the literature that is used to support and contradict findings in the empirical results is outlined. Secondly, the methodology including the construction method and test descriptions is provided. Thirdly, the empirical results are divided among sub-chapters; single-factor portfolios, double-sorted strategy, neutralized strategies, growth and value stocks, Carhart model and the GRS test, and the robustness checks. Afterward, the conclusion with the limitations and options for future research is discussed. Lastly, the references and appendices can be found.

2. Literature review

The literature concerning investment strategies is vast and ever-growing. Momentum and value among these strategies are often well documented as long-short strategies and several factor portfolios are available on sites from Applied Quantitative Research (AQR) and Fama and French. The combination of value and momentum is also well researched, but the construction of the combined strategy often heavily differs. In this literature review, I start by outlining the momentum literature. Then the value literature and the combination of value and momentum in research. Ultimately, the section finishes with the research on the Carhart model and the GRS test.

Momentum is an anomaly that follows the empirical regularity that if asset returns are positive in the past, then it is expected that the asset returns persist to perform well in the future. This is often combined with a long-short strategy, whereby the winner portfolio, which had great past returns, is invested in, while the loser portfolio with bad past returns is sold or shorted. Jegadeesh & Titman (1993) have set the foundation for much of the momentum literature by documenting the momentum effect in the US by following up on the existing research at that time on successive price changes (Levy, 1967). They researched different amounts of lag in the past returns and different holding periods. They concluded that longer holding periods enhance the momentum premium (Jegadeesh & Titman, 1993). This premium is further found in international markets (C. S. Asness et al., 2013; Fama & French, 2012), European markets (Doukas & McKnight, 2005; Rouwenhorst, 1998), and in particular in the United Kingdom. However, the premium has been absent between 1955 and 1977 in the UK market (Hon & Tonks, 2003) and has since then resurfaced as a profitable investment strategy (Agyei-Ampomah, 2007). A major downside of the momentum strategy is the high level of turnover, which increases the transaction costs and drives down the average returns. Agyei-Ampomah (2007) found that the average annualized turnover in the UK is 297.6% for momentum for a 12 month formation period and a 1-month holding period. These periods are also used in this research. Moreover, he found that these transaction costs can be reduced by extending the holding periods to, i.e. 9 or 12 months, but regardless of that momentum is still profitable in the UK after transaction costs.

In addition, a lot of momentum research has also been dedicated to figuring out the underlying reason why the momentum phenomenon exists. In general, research seems to agree that there is a common factor that instigates the momentum premium across markets (Fama & French, 2012; Nijman et al., 2004; Rouwenhorst, 1998). Furthermore, industries do not seem to explain this momentum effect according to the research by Nijman et al. (2004). Other research points towards underreaction by investors, due to a conservatism bias. This states that the investor behaves inflexibly to new information presented in the market (Doukas & McKnight, 2005). Other possible reasons include higher levels of volatility (Hon & Tonks, 2003), short-selling constraints (Agyei-Ampomah, 2007), or a positive correlation to the liquidity risk premium (C. S. Asness et al., 2013).

Value is another anomaly that has been present for a long time. Value can be proxied by different formulas from price-to-earnings (P/E) ratio, dividend-to-price ratio to book-to-market (B/M) ratios. Of which the latter is most popular in value literature. Many famous investors from Benjamin Graham to Warren Buffet have allegedly embraced this style of investing. Several researchers have found there to be significant returns in investing in long-only strategies with lowly valued stock (C. S. Asness et al., 2013; Basu, 1977; Chan & Lakonishok, 2004; Fama & French, 1998, 2012; Lakonishok et al., 1993). Specifically, Basu (1977) researched the profitability of investing in low P/E ratios, which have earned higher absolute returns than high P/E ratios in the period of 07/1956 to 06/1971. Again there are many possible explanations for the existence of the value premium. Multiple papers research value in connection with economic variables and evidence is found for value's ability to forecast GDP growth (Barroso, Boons, et al., 2021; Liew & Vassalou, 2000) and that value is affected by business cycles (Boons, 2016). Other reasons include again underreaction or slow reaction to the news by investors (Basu, 1977), investors overestimating the future growth rate of growth stocks, and the short time horizon of investors is not favorable to value investing (Lakonishok et al., 1993).

More recent literature has focused on combining two anomalies. The common combination of size and either value or momentum shows that larger firms have lower returns on either value or momentum strategies(Fama & French, 2012). Asness (1997) finds that the value anomaly is statistically stronger among loser portfolios of the momentum strategy, while momentum is statistically stronger among the growth firms. In addition, concluding that buying winner portfolios is pursuing a poor-value strategy. The momentum effect is arguably strongest in stocks that require the investor to predict future growth (Daniel & Titman, 1999). This indicates that there is a relation between growth stocks and momentum. This is further supported by the finding of a negative correlation between value and momentum (C. S. Asness et al., 2013; Fisher et al., 2014; Nijman et al., 2004). The common lining between value and momentum originates from funding risk (C. S. Asness et al., 2013). The combination of value and momentum could be exploited due to that negative correlation. Momentum is considered to be a quickly moving signal with high turnover, while value is considered the opposite. Combining these two anomalies has the possibility to lower the transaction costs and be more profitable than the single factor portfolios (Fisher et al., 2014). Different combination methods are proposed in the literature that could potentially outperform the single-factor portfolios, like a 50/50 pure-play combination (C. S. Asness et al., 2013; Fisher et al., 2014) or a 130/30 long-short strategy (Leivo & Pätäri, 2011). These combinations seem to have the ability to outperform the markets' cumulative returns while increasing the average returns and decreasing volatility (Grobys & Huhta-Halkola, 2019; Leivo & Pätäri, 2011). In addition, research contradicts itself on the best performing portfolios among double-sorted strategies. Some research indicates that winner-value portfolios perform the best, while loser-growth portfolios underperform (Bird & Casavecchia, 2007; Grobys & Huhta-Halkola, 2019). Other research suggests that the best long-only portfolio is the loser-value portfolio (Bird & Whitaker, 2004). I hope that my research shines more light on the better-performing portfolios and the profitability of a double-sorted value and momentum strategy in the UK market. This adds to existing, mainly Scandinavian, literature.

The model that is used to explain the results of the double-sorted strategy is the Carhart model. This model contains the momentum, value, size, and market factors (Carhart, 1997) and is the closest model to the strategy. This is supported by a GRS test which examines whether the model explains the strategy (Gibbons et al., 1989). Fama and French (2012) have found that adding the momentum factor, so moving from the 3FF-model to the Carhart model, lowers the GRS F-statistic, which is good, yet they still reject the Carhart model with similar intercepts as the 3FF model. However, the global four-factor model seems to explain the average results on the size-value and size-momentum portfolios relatively well unless they are tilted towards specific regions or firms with a very low market capitalization (Fama & French, 2012). Furthermore, the UK returns are well explained by the momentum and size factor, while insignificant to the value factor (Gregory et al., 2013; Nijman et al., 2004). Gregory et al (2013) does find that a specifically constructed four-factor model can explain the returns in large firms in the UK. This bodes well for the strategy proposed in this research.

3. Methodology

This chapter is utilized to illustrate the construction of the proposed double-sorted long-short strategy and all applicable formulas and tests that are used to further test the results of the proposed strategy.

3.1 Data source and filter

First, the UK data used within this research is derived from several sources. The return indices, market capitalizations, total earnings, exchange rates, and the risk-free rate are retrieved from Refinitiv Eikon DataStream using the WSCOPEUK code for the period of 01-01-1990 to 01-06-2021. This period was taken to minimally have a sample of 30 years and to ensure that software/internet/digital firms are well presented in the sample. Further, the factor data are retrieved from the AQR database and converted to Pounds. The risk-free rate, the base rate of the Bank of England, is used to reduce the returns in long-only portfolios. The total amount of stocks was 5,895 stocks in the United Kingdom. It is important to state that stocks that have defaulted or delisted are not excluded to counter survivorship bias.

To further clean up the data and to achieve a similar correlation to the AQR UK Momentum factor, some of the filters proposed by the paper "Value and Momentum Everywhere" (C. S. Asness et al., 2013) were followed. The following factors were reasons to include certain stocks; a share with a price of more than $1 and stocks that cumulatively amount to 90% of the total market capitalization (C. S. Asness et al., 2013) of the United Kingdom in that month. The filter on excluding ADRs, REITs, financials, closed-end funds, and foreign shares was not included, due to a lack of access to this type of data.

Stocks are further excluded based on the additional filters set by AQR on the previously mentioned paper. The sample is reduced by only including stocks that cumulatively amount to 20% of the total market cap of the United Kingdom of that month. In addition, all data that would result in a negative P/E ratio are excluded as well. This is done to follow Kenneth and French's data library's approach for the reversed earnings-to-price (E/P) ratio. This library does not state to exclude negative P/E ratios, but rather to isolate them in a separate portfolio. If these types of stocks would be isolated, the sample in these portfolios would be too small. The result of all the applied filters was a sample with highly liquid stocks and free of small-firm bias. This is a sample that would be well suited for institutional investors. In Table 1, the overall sample and the sample divided over the 15 proposed portfolios are shown.

	Total Stocks in Sample				Stocks per Portfolio			
Year	Max	Min	Median	Average	Max	Min	Median	Average
1991-1995	206	153	162	171	14	10	11	11
1996-2000	221	167	162	171	15	11	11	11
2001-2005	228	143	162	172	15	10	11	11
2006-2010	261	134	162	173	17	9	11	12
2011-2015	182	140	163	173	12	9	11	12
2016-2021	175	123	163	174	12	8	11	12

Table 1 portrays an overview of the size of the sample and the portfolios per 5 years or 6 years in the last row.

3.2 Construction of the long-short strategy

The double-sorted long-short strategy consists of two components; price momentum and a value proxy. These components are conditionally sorted and the returns are value-weighted. The long-short and the momentum methodology of the paper "Returns to Buying Winners and Selling Losers" (Jegadeesh & Titman, 1993) is followed, except that the holding period is held at only 1 month, while the research has several sizes of holding periods.

Price momentum is calculated using the cumulative performance of the return indices of the past 12 months while skipping the most recent month (Jegadeesh & Titman, 1993). The exclusion of the most recent month is common among the momentum literature to circumvent the phenomenon of the 1-month reversal. The momentum component is divided among 3 portfolios; winner, neutral, and loser and are combined with a portfolio of the value proxy.

The value proxy chosen for this strategy is the P/E ratio. This ratio is chosen over the popular B/M ratio because the P/E ratio focuses on future earnings growth rather than future book value growth (Penman, 1996). As the United Kingdom has a very developed economy, I felt that using the P/E ratio would better capture the value within IT and service-related firms. These types of firms have a generally lower book value, due to less tangible assets, than firms in the more traditional industries like oil and gas. As previously mentioned, the P/E ratio follows the method of the Kenneth and French data library, which is shown in Equation 1 below.

$$P/E\ ratio_{\ June\ of\ year\ t} = \frac{Market\ value_{\ End\ of\ December\ year\ t-1}}{Total\ earnings_{\ last\ fiscal\ year\ t-1}} \quad (1)$$

The equation takes the market value of the firm in December of the past year and divides this by the total full-year earnings of the last fiscal year that ended the past year. The delayed periods for the market value and total earnings are taken to avoid any look-ahead bias and to ensure that an investor would have access to the same information in the past. The value proxy is further divided into 5 portfolios; strong growth, growth, neutral, value, and strong value. These portfolios can be combined with any of the momentum portfolios. Consequently, this creates a total of 15 possible combinations. Of these 15 combinations, each can be shorted against a total of 14 other combinations, thus, forming a total of 210 double-sorted long-short strategies. An example of a combination can be a long winner – strong growth and short loser – strong value.

3.3 Turnover and adjusted Mean

These 210 portfolios are analyzed on core statistics; mean, standard deviation, Sharpe ratio, monthly turnover, adjusted mean, and adjusted Sharpe ratio. The adjusted statistics are adjusted for the transaction costs. The mean and Sharpe ratio statistics also contain OLS t-statistics and p-values to test for significance. All of these statistics except for turnover are annualized in the matrices, which were used as a quick overview for myself and can be found in Appendix II and III. The adjusted statistics include the level of turnover of the portfolio combination and a standard conservative 0.5% transaction costs. The monthly turnover is calculated as follows (Agyei-Ampomah, 2007):

$$Turnover\ (\%) = 0.5 * \big(Dropouts\ (\%) + New\ (\%)\big)\ (2)$$

A steep increase in turnover can potentially make attractive-looking combinations turn unprofitable. An important limitation of the turnover formula is that it is not value-weighted. Research has shown that the combination of value and momentum could in certain instances decrease the turnover but also finds that the faster moving signal of momentum can cause higher transaction costs when combined with value (Fisher et al., 2014). The average monthly turnover within this strategy increased heavily compared to their single factor portfolios' turnover. The average monthly turnover of all the combinations possible of the proposed strategy is 37.62%, while the monthly turnover of momentum and value separately is 24.71% and 6.14% respectively. The low level of turnover of the value portfolio is due to the persistence of the value factor among the stocks and the semi-annual rebalancing. The turnover could potentially be further reduced by aligning the momentum rebalancing exactly when the value proxy rebalances. This would be a suggestion for future research. Then the turnover is used to compute the annualized adjusted mean in the following way:

$$Adjusted\ mean = Mean - \Big(\big(Turnover\ (\%) * Transaction\ costs\ (\%)\big) * 12\Big)\ (3)$$

All means in the above equation are annualized. The adjusted Sharpe ratio is the result of the adjusted annualized mean divided by the annualized standard deviation, which is the regular formula for the Sharpe ratio. A few outperforming portfolio combinations are deeper investigated with more extensive statistics, like the skewness, kurtosis, JB-statistic, and the correlation to the benchmark.

3.4 Benchmarks and the GRS test

The benchmarks used are the AQR UK market, size, momentum, and value factors. These are converted to Pounds and compiled together into the UK Carhart (4FF) model (Carhart, 1997). The correlations used in the tables are either the AQR UK value or the UK momentum factor. The Carhart model is the closest model that combines value and momentum, just like the double-sorted long-short strategy, and is shown below:

$$r_i - r_f = \alpha_i + \beta_{i,m}\left(r_m - r_f\right) + \beta_{i,SMB}SMB + \beta_{i,HML}HML + \beta_{i,WML}WML + \varepsilon_i \quad (4)$$

The size factor within the Carhart model is biased due to the data filter set on the sample, which only allows large firms. The proposed strategy is regressed against the model to determine the alphas and the betas. The standard errors used for the t-statistics of the alphas and the betas account for heteroscedasticity (White, 1980). This is all executed through Python. The Gibbons Ross and Shanken (GRS) test then uses the UK Carhart model to test how much of the returns of the proposed strategy are explained through this model (Gibbons et al., 1989). This exercise is done through Stata. The F-statistics needs to be higher than the critical F-value to reject the null hypothesis in the GRS test. The formula of the GRS F-statistic is as follows (Gibbons et al., 1989):

$$GRS\ F - Statistic = \frac{T(T-N-K)}{N\ (T-K-1)} * \frac{\hat{\alpha}\sum^{-1}\hat{\alpha}}{1+\bar{\mu}\,\hat{\Omega}^{-1}\bar{\mu}} \quad (5)$$

T = Number of observations

N = Number of factor portfolios

$\hat{\alpha}$ = N-times-one vector of the estimate of the error covariance matrix

K = Number of risk factors

$\sum$ = N-times-N unbiased estimates of the error covariance matrix

Ω = K-times-K risk factor covariance matrix

μ = K-times-one vector of average monthly excess returns of the factor portfolios

The critical F value is calculated using F tables. The following values are needed to determine the critical F value; the level of significance, the numerator degrees of freedom, and the denominator degrees of freedom. There are several F tables with different levels of significance. For this research, the levels of significance of 90%, 95%, 97.5%, 99%, and 99.9% are taken. The numerator degrees of freedom and the denominator degrees of freedom are calculated, as follows:

$$numerator_{df} = K - 1 \ (6)$$

$$denominator_{df} = N - K \ (7)$$

K = the number of different portfolios

N = the number of observations

These two degrees of freedom are then used within the F-tables to find the critical F-values. In this study, K amounts to 15 and N amounts to 366. The relevant critical F-values to the levels of significance in percentages are as follows; 90%: 1.52, 95%: 1.72, 97.5%: 1.90, 99%: 2.13, and 99.9%: 2.67.

In the next chapter, the empirical results are presented. Beginning with the analyses of the single factor long-short strategies, then continuing towards the results of the double-sorted long-short strategy, the regressions against the Carhart model and the GRS test and ending with the robustness checks, which contain a selection exercise and the analyses of different construction techniques.

4. Empirical Results

4.1 Single-factor portfolios

Before the description of the performance of the long-short strategy double-sorted with momentum and value, the individual components are analyzed and outlined. To ensure the accuracy of the double-sorted strategy, the single factor long-short strategies must have high correlations to their related benchmarks. Further, it is of interest to know whether the double-sorted strategy outperforms the single-factor portfolios. The correlation of 79.42% of the momentum portfolio compared to the AQR momentum factor is relatively high considering the limitations as expressed in the methodology.

	Momentum		Value		Market	
	AQR Momentum	Momentum	AQR Value	Value	AQR Market	FTSE 100 - RF
Mean (%)	10.80	4.61	1.53	5.38	6.28	4.96
t-statistic	*3.00*	*1.28*	*0.48*	*2.11*	*2.45*	*1.87*
p-value	*0.003*	*0.201*	*0.630*	*0.035*	*0.014*	*0.062*
Standard deviation (%)	19.90	19.89	17.51	14.12	14.14	14.67
Sharpe ratio	0.54	0.23	0.09	0.38	0.44	0.34
t-statistic	*2.98*	*1.28*	*0.48*	*2.10*	*2.44*	*1.86*
p-value	*0.003*	*0.201*	*0.630*	*0.036*	*0.015*	*0.063*
Correlation to AQR (%)		79.42		19.13		88.48

Table 2 displays the performance of the single factor portfolios against the AQR benchmarks and the performance of the market. The sample period is 01-1991 until 06-2021 and the values are before transaction costs. The mean and the standard deviation are annualized. The t-statistics are calculated using the OLS computation. The momentum portfolio lacks the exclusion of certain types of stocks; ADRs, financials, REITs, and foreign shares. This momentum portfolio is compared to the AQR momentum factor. The value portfolio, which uses the P/E ratio, is compared against the AQR value factor, which uses the B/M ratio. The AQR market factor consists of all the value-weighted returns of all available stocks of the UK reduced with the one-month treasury bill rate. The FTSE 100 – rf is the FTSE 100 index reduced with the risk-free rate, which is the base rate of the Bank of England.

Table 2 represents the performance of the single factor strategies compared against the related AQR benchmarks. The AQR momentum factor is the best performing strategy among all the single-factor strategies and AQR benchmarks in terms of annualized mean and Sharpe ratio. The AQR market factor is a close second and outperforms the FTSE 100 because the AQR market factor includes smaller-sized firms. Research has shown that smaller firms have a higher probability of higher returns (Rouwenhorst, 1998). The good performance of the AQR momentum factor indicates that the momentum anomaly is present within the UK market, contrary to the beliefs concerning the momentum anomaly in the period of 1955 to 1977 (Hon & Tonks, 2003). However, my construction of the momentum strategy underperforms the AQR market factor, FTSE 100, my value strategy, and the AQR momentum factor. This is possibly due to the sole inclusion of highly liquid and large firms. The premiums for momentum and value show a decrease in return from small-sized to large-sized stocks (Fama & French, 2012; Rouwenhorst, 1998).

The value component within this strategy is dissimilar in creation to the AQR value factor. This is portrayed in the lower level of correlation (19.13%). The AQR value factor makes use of the B/M ratio and this ratio underperforms in terms of annualized average return and volatility compared to the P/E ratio. Unlike what I found, during 1975 and 1995 the E/P ratio was inferior to the B/M ratio in the UK market while being of nearly similar annualized mean in the US market (Fama & French, 1998). However, the long-short strategies of the E/P ratio and the B/M ratio of our sample period 01-1991 till 06-2021 show that the E/P ratio performs better than the B/M in the US. The portfolios for this calculation are retrieved from the Kenneth R. French data library. This library does not contain UK-specific portfolios. Thus the P/E ratio is found to be a more profitable proxy for value than the B/M ratio.

	Momentum		Value	
	Long Leg	Short Leg	Long Leg	Short Leg
Mean (%)	11.55	-14.77	15.87	-17.90
t-statistic	*3.99*	*-3.98*	*4.77*	*-6.24*
p-value	*0.000*	*2.000*	*0.000*	*2.000*
Standard deviation (%)	15.99	20.47	18.36	15.84
Sharpe ratio	0.72	-0.72	0.86	-1.13
t-statistic	*3.95*	*-3.94*	*4.70*	*-6.08*
p-value	*0.000*	*2.000*	*0.000*	*2.000*
Monthly turnover (%)	*19.91*	*17.98*	*3.72*	*4.26*

Table 3 displays the long and short legs of the created momentum and value strategy. Each leg is reduced with the risk-free rate, which is the base rate of the Bank of England. The sample period is 01-1991 until 06-2021 and the values are before transaction costs. The long legs are bought and the short legs are sold. The mean and the standard deviation are annualized. The t-statistics are calculated following the OLS method.

Table 3 takes a deeper dive into the momentum and value strategy and displays the performance of each leg of the strategy. Buying simply the winners portfolio or the value portfolio outperforms all the strategies shown in Table 2 based on annualized mean and Sharpe ratio. These strategies were my created momentum, value, and market strategies and the relevant AQR factors. The loser portfolio and the value stocks have comparatively higher volatility, while the winner portfolio and the growth stocks have a similar level of volatility. Research has shown that the momentum effect is stronger with growth stocks, while value stocks are stronger with little momentum exposure (C. S. Asness, 1997; Daniel & Titman, 1999; Fisher et al., 2014). Both the long legs of the strategy are responsible for the majority of the profits of each strategy. This is contrary to the findings of Agyei-Ampomah, who argues that the profits of the UK momentum strategy rely on the short leg (Agyei-Ampomah, 2007).

The created momentum strategy is conservative compared to the AQR momentum factor, while the value strategy is more profitable compared to the AQR value factor. The long-short strategies have been shown to underperform buying the long legs of each strategy reduced with the risk-free rate. This sub-chapter is the basis for the following double-sorted long-short strategy and the next chapter shows whether the double-sorted strategy outperforms the single-factor portfolios, and ultimately the long-only long or short legs of the single-factor portfolios.

4.2 Double-sorted strategy

The proposed strategy for this research, as previously mentioned, is a conditional double-sorted long-short strategy with value weights that combines price momentum with a value proxy. This research creates a total of 15 portfolios and a total of 210 possible long-short strategies. All long-short combinations are analyzed and detailed statistics are provided in Appendix II and III. The AQR momentum and value factors are continuously used as a benchmark against the long-short combinations.

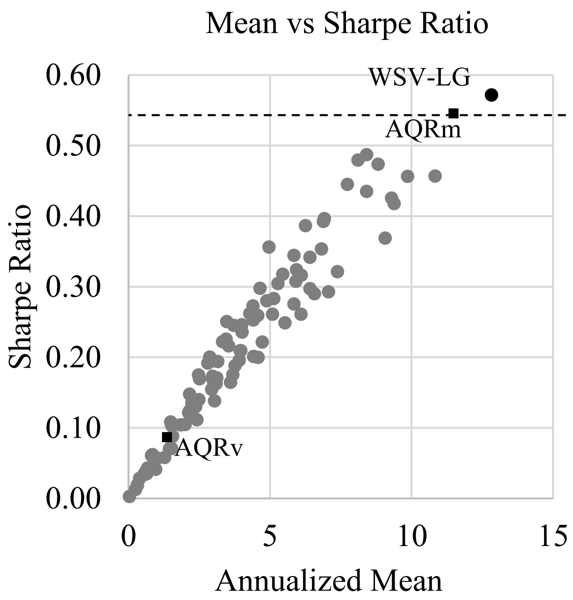

Figure 1 displays the relation between the annualized mean and the Sharpe ratio for 105 of the portfolio combinations. AQRm stands for the AQR momentum factor and AQRv stands for the AQR value factor. WSV-LG stands for the combination winner strong value – loser growth. The period is 01-1991 till 06-2021 and the values are not reduced with the transaction costs.

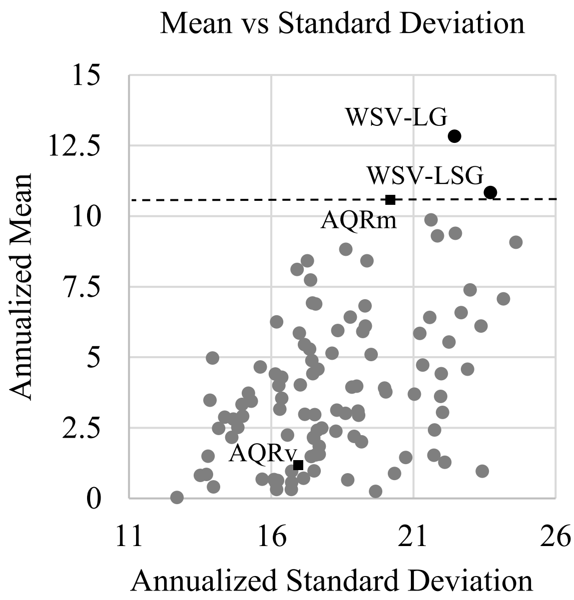

Figure 2 displays the relation between the annualized mean and the annualized standard deviation for 105 of the portfolio combinations. AQRm stands for the AQR momentum factor and AQRv stands for the AQR value factor. WSV-LG stands for the combination winner strong value – loser growth and WSV-LSG stands for the combination winner strong value – loser strong growth. The period is 01-1991 till 06-2021 and the values are not reduced with the transaction costs.

The two scatterplots (Figures 1 and 2) provide a quick overview of the combinations that outperform both the AQR momentum and AQR value benchmarks on either the Sharpe ratio or the annualized mean. The AQR momentum benchmark outperforms the AQR value benchmark on both annualized mean and Sharpe ratio. The winner strong value – loser growth (WSV-LG) combination outperforms based on the annualized mean (12.83%) and on the Sharpe ratio (0.57), while the winner strong value – loser strong growth (WSV-LSG) only outperforms based on the annualized mean (10.83%). The values of the WSV-LG combination are significant to a p-value of 0.002, while the values of the WSV-LSG are less significant than the WSV-LG combination with a p-value of 0.012. These strategies both outperform, in terms of annualized mean, any of the single factor long-short portfolios, AQR benchmarks, and the market. The Sharpe ratio is also improved compared against the single factor long-short portfolios, which supports the findings that combining value and momentum improves the Sharpe ratio (C. S. Asness et al., 2013; Fisher et al., 2014).

Ultimately, this shows that investing in winning strong value stocks, while shorting losing (strong) growth stocks is a profitable combination. This contradicts previous findings, since winning momentum portfolios seem to work well with growth stocks, while value stocks work well with losing momentum portfolios strategy (C. S. Asness, 1997; Daniel & Titman, 1999; Fisher et al., 2014; Nijman et al., 2004). Thus, the expectation would be that winner strong growth – loser strong value would be the outperforming combination based on the previously mentioned research. Other research contrarily notes that the best long-only portfolio is the loser-value portfolio (Bird & Whitaker, 2004). Several papers on the combination of value and momentum have shown that the WSV-LSG / WSV-LG combinations are the most profitable combinations among their findings (Bird & Casavecchia, 2007; Grobys & Huhta-Halkola, 2019; Leivo & Pätäri, 2011). Generally, I find next to the profitability of WSV-LG/WSV-LSG that solely shorting the loser (strong) growth portfolios in combination with investing in either a winner or value portfolio is comparatively profitable among the other combinations. In addition, investing in the winner strong value portfolio, while shorting any of the other portfolios is a comparatively profitable exercise as well. Appendix II and III show the relevant statistics to support these statements.

	WSV-LG	WSV-LSG	AQR Momentum	AQR Value
Mean (%)	12.83	10.83	10.80	1.53
t-statistic	*3.16*	*2.52*	*3.00*	*0.48*
p-value	*0.002*	*0.012*	*0.003*	*0.630*
Standard deviation (%)	22.45	23.71	19.90	17.51
Sharpe ratio	0.57	0.46	0.54	0.09
t-statistic	*3.14*	*2.51*	*2.98*	*0.48*
p-value	*0.002*	*0.012*	*0.003*	*0.630*
Skewness	-0.24	-0.04	-0.24	0.21
Kurtosis	1.59	1.82	2.50	4.60
JB test statistic	*22.65*	*20.70*	*27.76*	*35.39*
p-value	*0.000*	*0.000*	*0.000*	*0.000*
Minimum (%)	-29.29	-31.18	-25.23	-25.77
Percentile 25%	-2.50	-2.83	-2.12	-2.40
Median (%)	1.01	0.73	0.46	0.00
Percentile 75%	5.06	4.64	4.13	2.35
Maximum (%)	23.75	23.91	21.39	24.39

AR (1) (%)	-5.27	-0.47	23.85	23.16
p-value	*0.313*	*0.929*	*0.000*	*0.000*
Correlation to AQRm	51.28	43.88		
Correlation to AQRv	-22.90	-13.99		

Table 4 displays the descriptive statistics of the WSV-LG and the WSV-LSG combinations, and the AQR value and momentum benchmarks. The mean and the standard deviation are annualized. The t-statistics are calculated using the OLS computation. WSV-LG stands for winner strong value – loser growth and WSV-LSG stands for winner strong value – loser strong growth. AQRm stands for the AQR momentum factor and AQRv stands for the AQR value factor. The sample period is 01-1991 until 06-2021 and the values are excluding transaction costs.

A more extensive look into the WSV-LSG / WSV-LG statistics is performed in Table 4. The two strategies tend to have more extreme values, especially looking at the minimum returns compared to the AQR benchmarks. This is not supported by the lower kurtosis of my two strategies, which indicates that these strategies have relatively lighter tails than the AQR benchmarks. The negative autocorrelation of my two strategies suggests that the next value will be negative and this can point towards a decrease in profitability of my two strategies in the future. The inclusion of the value factor to the single factor momentum strategy reduced the correlation to the AQR momentum factor from 79.42% to 51.28% (WSV-LG) and 43.88% (WSV-LSG) in the double-sorted strategies. The correlation to the AQR value factor is also reduced with the addition of the momentum factor to the single factor value strategy from an already low 19.13% to -22.90% (WSV-LG) and -13.99% (WSV-LSG) in the double-sorted strategies. This is a logical consequence since good momentum strategies are associated with growth stocks and good value strategies are associated with low momentum stocks (C. S. Asness, 1997).

The cumulative returns of the WSV-LSG and the WSV-LG combinations are displayed against the AQR momentum and value factors and the FTSE 100 in Figure 3. The performance of the WSV-LSG is especially strong in the years between 2001 and 2009 and seems to perform well during major crises like the financial crises. The WSV-LG combination outperforms especially during the more recent years from 2015 up until 2021/06. More data is needed to determine, whether the performance was good during the Covid-19 crisis as well.

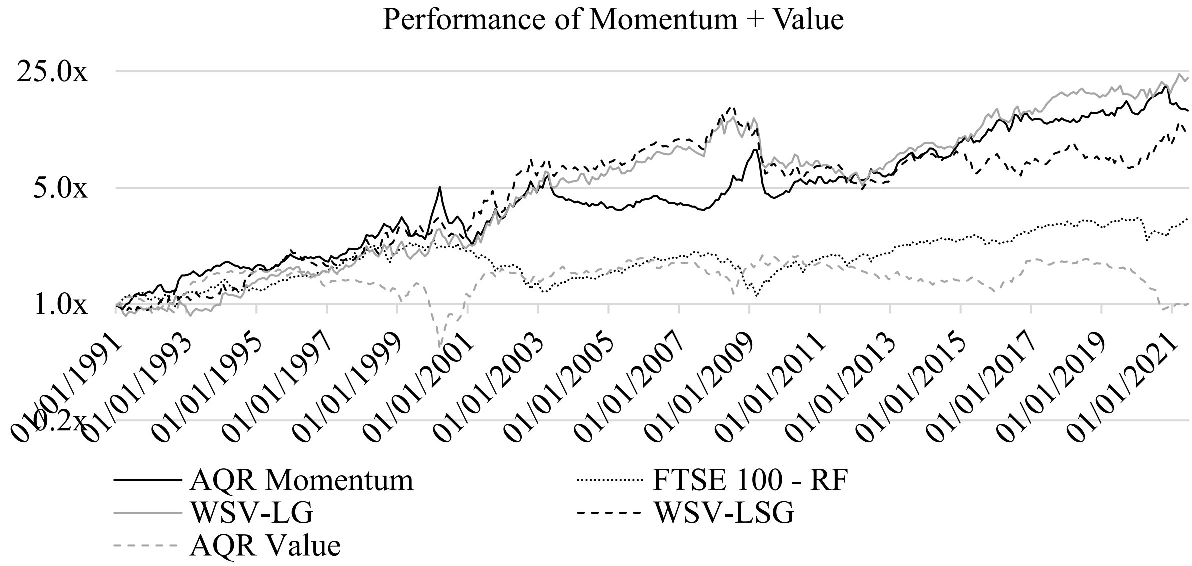

Figure 1 displays the cumulative returns of the WSV-LG and the WSV-LSG combinations against the AQR momentum factor and the FTSE 100 from 01-1991 till 06-2021 on a logarithmic scale. The FTSE 100 is reduced with the risk-free rate, which is the base rate of the Bank of England. The cumulative returns do not include transaction costs.

The performance after transaction costs, as shown in Table 5, paints a less pretty picture where the WSV-LSG combination underperforms the AQR momentum benchmark. The WSV-LG still outperforms based on the annualized mean but performs similarly on the Sharpe ratio. The reason for the worsening results of the two double-sorted strategies relies heavily on the high turnover, which reduces the mean strongly. The high turnover is caused by the faster-moving momentum signals and this could potentially be slowed down by implementing a semiannual/annual rebalancing rather than a monthly rebalancing (Agyei-Ampomah, 2007; Fisher et al., 2014; Jegadeesh & Titman, 1993) as is proposed right now. This is however not included in the scope of this research.

	WSV-LG	WSV-LSG	AQR Momentum	AQR Value
Mean (%)	11.00	9.25	9.31	1.16
t-statistic	*2.70*	*2.15*	*2.58*	*0.36*
p-value	*0.007*	*0.032*	*0.010*	*0.715*
Standard deviation (%)	22.45	23.71	19.90	17.51
Sharpe ratio	0.49	0.39	0.47	0.07
t-statistic	*2.68*	*2.14*	*2.57*	*0.36*
p-value	*0.007*	*0.032*	*0.010*	*0.715*
Monthly Turnover (%)	31.23	26.83	24.71	6.14

Table 5 displays the annualized mean, the annualized standard deviation after transaction costs plus the monthly turnover of each strategy, and the AQR momentum and value factors. The t-statistics are calculated using the OLS computation. The sample period is 01-1991 until 06-2021.

Table 6 shows that the long leg or the winner strong value portfolio is the main driver of the returns of the double-sorted strategy. The returns which are reduced with the risk-free rate and the Sharpe ratio are highly significant with a p-value below 0.000 and outperforms both WSV-

LG and WSV-LSG strategies. Not only does it outperform my double-sorted strategies, but also the market, the AQR benchmarks, the single factor strategies, and the legs of the single-factor strategies. Shorting the short legs exposes the investor to more volatility and a lower annualized mean. The annualized mean excludes any costs that are related to shorting a security. Similar to the single factor portfolios, it is relatively more profitable to invest in the long leg of a long-short strategy than investing in the long-short strategy itself. Ultimately, the winner strong value portfolio outperforms all previously presented strategies and benchmarks.

	WSV-LG		WSV-LSG	
	Long Leg	Short Leg	Long Leg	Short Leg
Mean (%)	17.73	12.31	17.73	14.31
t-statistic	4.95	-2.90	4.95	-3.43
p-value	0.000	1.996	0.000	1.999
Standard deviation (%)	19.77	23.40	19.77	23.07
Sharpe ratio	0.90	0.53	0.90	0.62
t-statistic	4.87	-2.89	4.87	-3.40
p-value	0.000	1.996	0.000	1.999

Table 6 displays the long and short leg of each strategy for the period of 01-1991 till 06-2021. Transaction costs are not included. The long leg for both strategies is the winner strong value portfolio and the short leg is the loser growth portfolio and for WSV-LSG is the loser strong growth portfolio. The long and short legs are reduced with the risk-free rate, which is the base rate of the Bank of England. The long leg is invested in and the short leg is shorted.

4.3 Neutralized strategies

To illustrate the potential impact of either the momentum premium or the value premium on the double-sorted strategy, neutralized double-sorted strategies are proposed. Neutralizing one anomaly or component, while performing a long-short on the other component or anomaly is an exercise done in other research as well (C. Asness et al., 2020; Barroso, Detzel, et al., 2021). The two strategies neutralized are; a long-short strategy on momentum while value is neutralized and a long-short strategy on value with momentum neutralized. The long leg of the long-short momentum strategy with neutralized value consists of the average returns of the five winner portfolios and the short leg consists of the average returns of the five loser portfolios. The long-short strategy on value with momentum neutralized has a long leg that consists of the average of all the value and strong value portfolios and is reduced with the short leg, which consists of the average of all the growth and strong growth portfolios. Table 7 shows the statistics of these neutralized strategies compared to the AQR benchmarks,

	Momentum + Neutral Value	Momentum	AQR Momentum	Value + Neutral Momentum	Value	AQR Value
Mean (%)	5.13	4.61	10.80	2.81	5.38	1.53
t-statistic	*1.74*	*1.28*	*3.00*	*2.08*	*2.11*	*0.48*
p-value	*0.082*	*0.201*	*0.003*	*0.038*	*0.035*	*0.630*
Standard deviation (%)	16.30	19.89	19.90	7.45	14.12	17.51
Sharpe ratio	0.31	0.23	0.54	0.38	0.38	0.09
t-statistic	*1.73*	*1.28*	*2.98*	*2.07*	*2.10*	*0.48*
p-value	*0.083*	*0.201*	*0.003*	*0.038*	*0.036*	*0.630*
Monthly turnover (%)	32.74	24.71	24.71	36.27	6.14	6.14
Correlation to AQR (%)	76.57	79.42		21.62	19.13	

Table 7 displays the descriptive statistics of the neutralized strategies before transaction costs against the single-factor strategies and the AQR benchmarks over the period 01-1991 till 06-2021. The mean and the standard deviation are annualized and the t-statistics are calculated using the OLS computation. The turnover of my computed value and momentum strategies is used as an assumption for the relevant AQR factors. The correlation to the AQR factor is from momentum + neutral value and momentum against the AQR Momentum factor and for value + neutral momentum and value against the AQR value factor. The AQR value factor utilizes the B/M ratio as a proxy for value, while the other two strategies use the P/E ratio as a value proxy. The momentum + neutral value strategy is computed using the five winner portfolios in the long leg and the five loser portfolios in the short leg. The value + neutral momentum strategy is computed using the three value and three strong value in the long leg and shorting the three growth and three strong growth portfolios.

and my momentum and value strategies. Initially, the momentum with neutralized value strategy outperforms my single factor momentum strategy on annualized mean, annualized standard deviation, and Sharpe ratio, while the value with neutralized momentum strategy outperforms the single factor value strategy on annualized standard deviation. This indicates that value or momentum are adding certain values to each other by increasing some of the descriptive statistics favorably. This partially confirms prior research that expects value to perform better if momentum is held constant and vice versa, due to the negative correlation between value and momentum (C. S. Asness, 1997). Nevertheless, the neutralized strategies do experience higher turnover, which results in underperformance once transaction costs are factored in. The transaction costs used are 0.5%. The adjusted annualized mean for the momentum with neutralized value strategy is 3.17%, while my single factor momentum strategy has an annualized mean of 3.47%. However, the Sharpe ratio of the momentum with neutralized value strategy is better at 0.19 than the 0.17 Sharpe ratio of my single factor momentum strategy. Conclusively, the neutralized strategies are not improved in terms of profitability to my single factor strategies but do tend to have less volatility than the single-factor strategies.

4.4 Growth and value stocks

To investigate the finding that the momentum premium is higher with growth stocks than with value stocks, two double-sorted strategies are proposed that include momentum that is either exposed to stocks with high P/E ratios (growth stocks) or to stocks with low P/E ratios (value stocks). The growth stocks strategy combined with momentum invests in both the winner strong growth and winner growth portfolio and shorts the loser strong growth and loser growth portfolio. This is equal-weighted and the same method is used for value. These strategies are then compared against my single factor value strategy and the AQR value factor. Table 8 does demonstrate that growth stocks combined with momentum perform better than the value stocks strategy combined with momentum, my value strategy, and the AQR value factor. It is again confirmed that combining momentum with value does increase the turnover significantly as shown in Table 8.

	Growth Stocks	Value Stocks	Value	AQR Value
Mean (%)	8.22	3.88	5.38	1.53
t-statistic	*2.28*	*1.18*	*2.11*	*0.48*
p-value	*0.023*	*0.237*	*0.035*	*0.630*
Standard deviation (%)	19.96	18.14	14.12	17.51
Sharpe ratio	0.41	0.21	0.38	0.09
t-statistic	*2.27*	*1.18*	*2.10*	*0.48*
p-value	*0.023*	*0.238*	*0.036*	*0.630*
Monthly turnover (%)	31.19	31.52	6.14	6.14
Correlation to AQR (%)	-40.47	-22.01	19.13	

Table 8 displays the performance of the growth stocks and the value stocks combined with momentum relative to the single-factor value strategy and the AQR value factor. The mean and the standard deviation are annualized. The t-statistics are calculated using the OLS method. The sample period is 01-1991 until 06-2021 and values do not include transaction costs.

Table 9 shows the strategies after transaction costs and confirms that the growth stocks strategy combined with momentum is still performing better than the other strategy after transaction costs. The transaction costs used are 0.5%. Prior research shows that buying winners is pursuing a bad value strategy and that momentum has stronger premia among growth stocks (C. S. Asness, 1997; Daniel & Titman, 1999; Fisher et al., 2014). This is confirmed by the overall better performance of the growth stocks combined with momentum and the negative correlation to the AQR value factor of both the value and growth stocks strategies combined with momentum.

	Growth Stocks	Value Stocks	Value	AQR Value
Mean (%)	6.35	1.99	5.14	1.29
t-statistic	*1.76*	*0.61*	*2.0117*	*0.41*
p-value	*0.079*	*0.544*	*0.044*	*0.685*
Standard deviation (%)	19.96	18.14	14.12	17.51
Sharpe ratio	0.32	0.11	0.36	0.07
t-statistic	*1.75*	*0.59*	*1.97*	*0.40*
p-value	*0.079*	*0.553*	*0.048*	*0.690*

Table 9 shows the performance of the strategies after transaction costs over the period 01-1991 till 06-2021. The growth and value stocks strategies are combined with momentum. The mean and the standard deviation are annualized. The transaction costs used are 0.5% and the turnover of Table 8 is used per strategy. The t-statistics are calculated using the OLS computation.

4.5 Carhart model and the GRS test

To determine whether the results of the winner strong value – loser strong growth (WSV-LSG) and the winner strong value – loser growth (WSV-LG) are explained through the Carhart model, the alphas, betas, r-squared and relevant p-values are analyzed among the interesting combinations in Table 10. For more detailed information on every combination, please see Appendix IV.

The p-value is calculated using HC3 standard errors, also known as robust standard errors, to counter the assumption in the basic standard errors of constant variance. HC3 standard errors are heteroskedasticity-consistent, allow for variance over time, and are more accurate in this exercise than the OLS standard errors (White, 1980). The Carhart model is chosen since it incorporates both the momentum and value factor. Next to these factors it also includes the size and the market factor (Carhart, 1997). The size factor is biased, due to the filters set on the dataset, which causes only large companies to be included in the sample.

WSV-LSG and WSV-LG display an annualized alpha of 4.48% and 5.57% respectively and both have a significant relation to the beta of the momentum factor. In general, the Carhart model should be able to explain the cross-section of 'normal' UK returns pretty well (Gregory et al., 2013). In addition, AQR, following Fama and French, builds factors with a double sorted procedure that puts half the weight on small stocks. Typically predictability is stronger in this subset, the setting should bias against finding positive alphas in these spanning regressions for strategies in the large caps universe. In this instance, the Carhart model seems poorly equipped to explain the excess annual returns, due to the insignificant p-values of the alphas of these two strategies. In retrospect, most portfolios that are significantly impacted by the model are the strong value portfolios, in combination with any momentum level, and especially the winner-neutral portfolio. These portfolios all have a comparatively large alpha and a high level of statistical significance. Furthermore, the winner-strong growth and some winner-growth portfolios are the only portfolios that are well justified by the value factor with high levels of significance. The value factor is expected to heavily differ from the model, since AQR utilizes the B/M ratio, while the P/E ratio is used in this research. The momentum factor interprets the results of any portfolio, which is not shorted, sufficiently and is either of neutral or a winner level of momentum. AQR's method for calculating momentum was followed and the relation with the momentum factor is expected, however, the low significance to the Loser portfolios might be influenced by the inability to exclude certain stocks. Another interesting finding is that the two portfolio combinations with the highest alphas have a negative beta to the momentum factor and are insignificant. No relation based on Table 10 can be made regarding negative betas to the momentum factor and high alphas since the lowest alphas also have a negative beta to the momentum factor.

Long	Short	Annualized α	Market β	Size β	Value β	Momentum β	R² (%)
Two outperforming strategies							
Winner - Strong Value	Loser - Strong Growth	4.48	0.09	-0.13	-0.02	0.56 ***	19.98
		(1.14)	*(0.75)*	*(-1.00)*	*(-0.11)*	*(6.08)*	
Winner - Strong Value	Loser - Growth	5.57	0.08	-0.31	0.03	0.65 ***	29.70
		(1.54)	*(0.82)*	*(-3.54)*	*(0.34)*	*(10.17)*	
Interesting combinations							
Winner - Strong Value	Loser - Strong Value	-1.93	0.17 *	-0.14	-0.07	0.57 ***	25.00
		(-0.53)	*(1.75)*	*(-1.73)*	*(-0.69)*	*(7.51)*	
Winner - Strong Growth	Loser - Strong Growth	1.01	0.03	-0.01	-0.36	0.73 ***	38.62
		(0.28)	*(0.38)*	*(-0.08)*	*(-2.87)*	*(9.07)*	
Winner – Neutral	Loser - Neutral	-5.85	0.13	-0.19	-0.10	0.67 ***	37.25
		(-1.77)	*(1.59)*	*(-2.41)*	*(-0.93)*	*(9.58)*	
Neutral - Strong Value	Neutral - Strong Growth	5.48 *	-0.08	0.06	-0.04	-0.10	1.95
		(1.91)	*(-1.10)*	*(0.98)*	*(-0.43)*	*(-1.64)*	
2 highest and 2 lowest annualized alphas							
Loser - Strong Value	Winner - Neutral	10.61 **	-0.13	0.13 *	0.13 *	-0.65	34.16
		(3.01)	*(-1.60)*	*(1.83)*	*(1.71)*	*(-9.62)*	
Loser - Strong Value	Winner - Value	9.24 **	-0.11	0.23 **	-0.04	-0.65	31.83
		(2.58)	*(-1.23)*	*(2.87)*	*(-0.36)*	*(-8.53)*	
Neutral – Growth	Loser - Growth	0.05	0.07	0.31 ***	-0.08	-0.59	36.91
		(0.02)	*(0.91)*	*(3.88)*	*(-0.93)*	*(-8.03)*	
Winner - Growth	Loser - Value	0.07	0.02	0.14 *	0.18	-0.67	38.85
		(0.02)	*(0.29)*	*(1.86)*	*(1.64)*	*(-8.30)*	

Table 10 displays the results of the regressions against the Carhart model over the period of 01-1991 till 06-2021. The value-weighted returns used do not include transaction costs. This table contains the annualized alphas, market beta, size beta, value beta, momentum beta, and r-squared. The t-statistics are in brackets and the stars indicate the level of significance according to the p-value; *** <0.001 , ** < 0.01 and * < 0.05. Robust standard errors are used in the calculation of the t-statistics and ultimately the p-value.

To further illustrate the ability of the Carhart model to explain the average excess returns of the double-sorted long-short strategies, the GRS test is performed in Table 11. As previously mentioned in the methodology, the GRS test inspects whether all alphas are jointly equal to zero or alternatively whether one or more alphas are different from zero. The GRS test needs to be greater than the critical F-value to reject the null hypothesis (Gibbons et al., 1989). The five-factor and six-factor models by Fama and French cannot be used, since AQR does not provide the UK factors for profitability (robust minus weak) and investment (conservative minus aggressive).

	GRS F-Statistic	*p-value*	Mean absolute α (%)	Mean adjusted R^2 (%)
Carhart Model	5.16	*0.000*	0.81	53.72
3FF Model	5.66	*0.000*	0.74	47.63
CAPM Model	5.43	*0.000*	0.74	46.42

Table 11 shows the summary statistics of the GRS test against the Carhart model, 3FF model, and the CAPM model over the period 01-1991 to 06-2021 with the monthly excess returns used from my value-weighted double-sorted long-short strategy. The returns do not include transaction costs. The CAPM model consists of the market factor, the 3FF model of the market, the size and value factor, and the Carhart model of the market, size, value, and momentum factor. The critical F-values are: 90%: 1.52, 95%: 1.72, 97.5%: 1.90, 99%: 2.13 and 99.9%: 2.67 with a numerator of 14 and a denominator of 351.

In previous research, the GRS test rejected the Carhart model when asked to explain double-sorted strategies based on size-value and size-momentum. It was further found that the Carhart model is less likely to be rejected by the GRS test if a global model is used and if the strategy does not tilt towards small-sized firms (Fama & French, 2012). This indicates that performing a GRS test on the Carhart model of a single country would be not diversified enough for the model and would indicate a rejection by the GRS test. My findings support previous research and I can confidently state that the GRS test rejects the Carhart model when asked to explain the returns of the double-sorted long-short strategy. The rejection is based on the highly statistically significant p-value of less than 0.000 and a GRS test statistic of 5.16, which is higher than the critical F-value of 2.67 at a level of significance of 99.9%. Further, I find that adding the momentum factor to the 3FF model lowers the GRS F-statistic, which is another finding that is supported by research (Fama & French, 2012).

The mean absolute alpha shows that there is a 0.81% unexplained excess return per month, which is relatively higher than in the 3FF model and the CAPM model. Further, the mean adjusted r-squared values show that the cross-section of the returns of the factor portfolios is explained for 53.72%, which is an improvement from the 3FF (47.63%) and the CAPM (46.42%) model.

To conclude this sub-chapter, the insignificant p-values of the WSV-LSG and WSV-LG strategies from the regressions on the Carhart model and the high GRS test statistic plus the highly significant p-values demonstrate that the Carhart model is not suitable to explain the returns of my double-sorted long-short strategies.

4.6 Robustness checks

In light of the comparative overperformance of the winner strong value – loser growth (WSV-LG) and the winner strong value – loser strong growth (WSV-LSG) portfolios, two robustness checks are conducted. The first robustness test is a selection exercise and tests whether an investor can pick either WSV-LG or WSV-LSG using different sub-samples of past data. The second robustness test analyses whether different construction techniques point towards similar results.

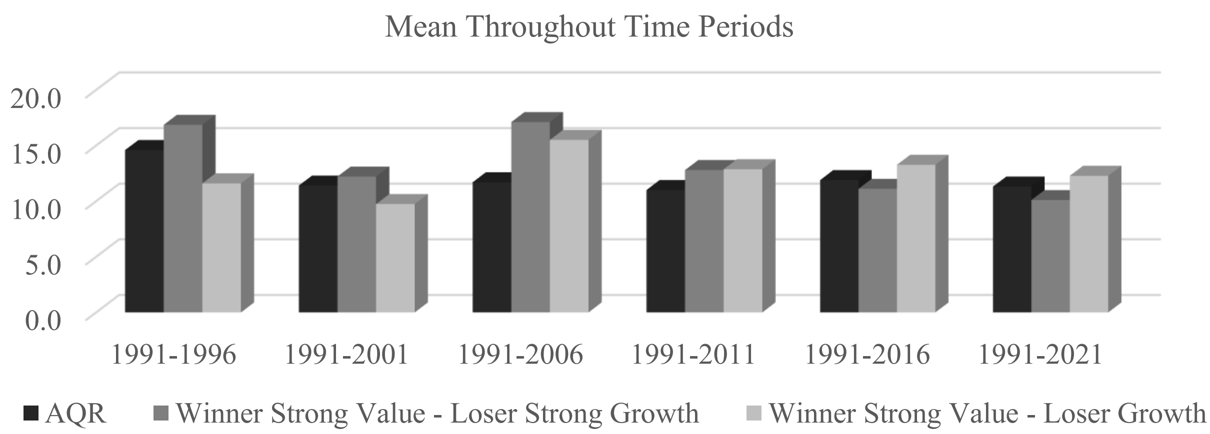

Figure 2 displays the annualized mean from 01-1991 to 06-2021 with 1991 as a fixed starting year and an expanding window of 5 years. The annualized mean does not include transaction costs.

Firstly, the time period starts in 1991 and each period is further extended by 5 years while keeping the starting year constant. Figure 4, confirms what was previously been stated in the results that the WSV-LSG portfolio is performing better, in terms of annualized mean, against the benchmark in the more recent years. The WSV-LSG portfolio shows better performance on average within the first four periods in the bar chart. A worrying down-trend of the annualized mean of the WSV-LSG strategy does not fare well for the future performance of this strategy, which was also shown through the previously mentioned negative autocorrelation. Based on the annualized mean alone, the investor would not continuously pick the same strategy in each period, but would always pick one of the two strategies if the decision solely relies on the annualized mean.

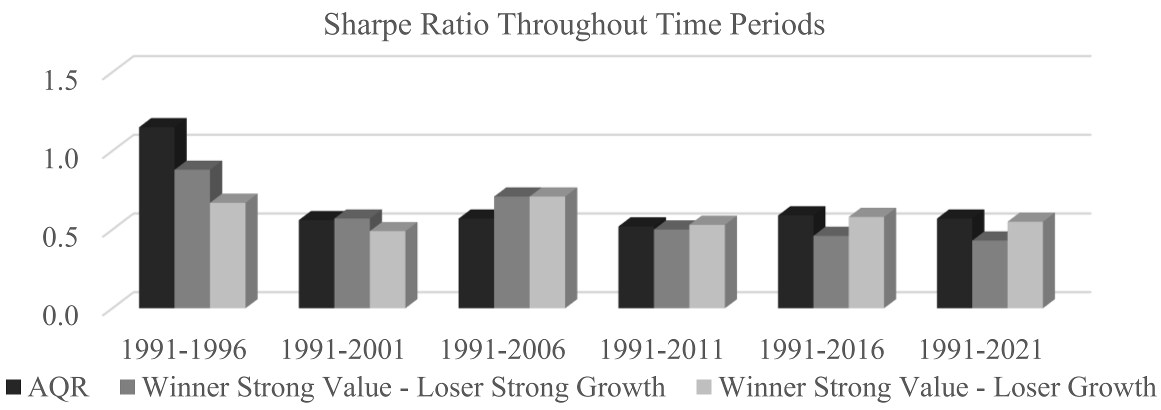

Figure 3 displays the Sharpe ratio from 01-1991 to 06-2021 with 1991 as a fixed starting year and an expanding window of 5 years. The annualized mean used for the Sharpe ratio does not include transaction costs.

The Sharpe ratio throughout the time periods paints another picture. As shown in Figure 5, the AQR momentum factor was exceptionally strong in terms of Sharpe ratio in the earliest period, this was researched to be a strong momentum period within the UK (Agyei-Ampomah, 2007). Only in the periods of 1991-2001 and 1991-2006 would the investor choose one of the proposed strategies rather than investing in the benchmark. I, therefore, cannot with full confidence state that the investor will always pick the proposed strategies based on the Sharpe ratio. In general, if the investor solely cares about the average mean of a strategy, then the investor will pick one of the proposed strategies. However, if the investor also incorporates volatility in his decision then it is less likely that one of the proposed strategies will be chosen.

Secondly, other construction methods were implemented to spot whether similar combinations would point towards the same portfolio and possibly outperform the initially proposed strategies. The following alternative methods were used: equal-weighted results, unconditional sorting, and starting with the value proxy instead of momentum. This resulted in seven additionally assembled strategies. Generally, the winner-strong value and loser-growth combinations remained the strong portfolio combination regardless of the construction method. Yet, no serious difference in terms of mean, standard deviation, or Sharpe ratio could be found. Ultimately, the initial two strategies remained the best performing strategies compared to the alternative strategies.

5. Conclusion and limitations

In this research, findings are presented whether UK stocks that are combined based on value and momentum indicators in a double-sorted long-short strategy would be more profitable than a single factor long-short strategy. Several strategies were proposed and compared against the initial long-short strategy before and after transaction costs. Out of all the 210 possible long-short combinations of portfolios, one clear outperforming strategy is found.

The key finding in this research is that investing in the winner strong value portfolio while shorting the loser growth portfolio would outperform the relevant AQR momentum factor before and after transaction costs. In addition, it would also outperform the single-factor strategies, the neutralized strategies, and the growth and value stock strategies. This result is in line with the findings of Scandinavian research using a double-sorted long-short strategy with value and momentum (Grobys & Huhta-Halkola, 2019; Leivo & Pätäri, 2011) and would add as UK evidence to the total literature available. However, there are questions about whether an investor would be able to pick this strategy with different subsamples since it did not confidently pass the selection exercise.

Surprisingly, this research did find that creating a long-only strategy of the winner strong value portfolio trumps all other long-short strategies and long-only strategies presented in this research. It could be expected that the winner strong value portfolio would be an improvement in terms of Sharpe ratio, due to the exposure to the market, value, and momentum factors. However, the exceptional performance was not expected. The results for the long-only strategy of the winner strong value portfolio were highly significant and would therefore require more research since the scope of this study excluded in-depth research on long-only strategies based on the long or short legs of the double-sorted strategies.

This study could be further extended by utilizing a different value proxy, like book-to-market ratio, dividend-to-price ratio (C. S. Asness, 1997), or sales-to-price ratio (Bird & Casavecchia, 2007). Other improvements could be focused on like slowing down the signal of momentum to reduce turnover (Fisher et al., 2014), increasing the holding period to 6 or 12 months (Jegadeesh & Titman, 1993), or by improving the momentum construction by managing the risk to reduce crashes (Barroso & Santa-Clara, 2015). Additionally, the sample could be of another country or could have a different filter to include small firms, since small firms are proven to have higher momentum and value premia than large firms (Fama & French, 2012; Rouwenhorst, 1998).

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Appendices

Appendix I - Single-factor portfolios before and after transaction costs

Panel A: Descriptive statistics of the single components pre-transaction costs

	Momentum		Value		Market	
	AQR Momentum	Momentum	AQR Value	Value	AQR Market	FTSE 100 - RF
Mean (%)	10.80	4.61	1.53	5.38	6.28	4.96
t-statistic	*3.00*	*1.28*	*0.48*	*2.11*	*2.45*	*1.87*
p-value	*0.003*	*0.201*	*0.630*	*0.035*	*0.014*	*0.062*
Standard deviation (%)	19.90	19.89	17.51	14.12	14.14	14.67
Sharpe ratio	0.54	0.23	0.09	0.38	0.44	0.34
t-statistic	*2.98*	*1.28*	*0.48*	*2.10*	*2.44*	*1.86*
p-value	*0.003*	*0.201*	*0.630*	*0.036*	*0.015*	*0.063*
Correlation to AQR (%)		79.42		19.13		88.48

Panel B: Descriptive statistics of the value and momentum components after transaction costs

	Momentum		Value	
	AQR Momentum	Momentum	AQR Value	Value
Mean (%)	9.66	3.47	1.29	5.14
t-statistic	*2.68*	*0.96*	*0.41*	*2.01*
p-value	*0.007*	*0.336*	*0.685*	*0.044*
Standard deviation (%)	19.90	19.89	17.51	14.12
Sharpe ratio	0.49	0.17	0.07	0.36
t-statistic	*2.62*	*0.95*	*0.40*	*1.97*
p-value	*0.009*	*0.344*	*0.690*	*0.048*

Table 12 shows two panels. Panel A shows my created single-factor portfolios, the AQR benchmarks, and the FTSE 100 before transaction costs. Panel B shows the value and momentum strategies and the related AQR benchmarks after transaction costs. The transaction costs are 0.5%. The mean and standard deviation are annualized and the t-statistic is calculated using the OLS computation. The risk-free rate used to reduce the FTSE 100 is the Bank of England base rate. AQR market and FTSE 100 are not shown after transaction costs, since none of these strategies are created in this thesis.

Appendix II – Annualized mean, standard deviation, Sharpe ratio, and monthly turnover per possible portfolio combination

Annualized Mean per Portfolio Combination with p-values in stars

Long \ Short	Loser Strong Growth	Loser Growth	Loser Neutral	Loser Value	Loser Strong Value	Neutral Strong Growth	Neutral Growth	Neutral Neutral	Neutral Value	Neutral Strong Value	Winner Strong Growth	Winner Growth	Winner Neutral	Winner Value	Winner Strong Value
Loser Strong Growth		2.00	-0.97	-1.54	-6.11	-3.09	-3.91	-3.94	-6.42	-6.82	-7.07	-7.38	-2.42	-4.58	-10.83
Loser Growth	-2.00		-2.97	-3.54	-8.11	-5.09	-5.91	-5.94	-8.42	-8.82	-9.07	-9.38	-4.42	-6.58	-12.83
Loser Neutral	0.97	2.97		-0.57	-5.14	-2.12	-2.94	-2.97	-5.45	-5.85	-6.10	-6.41	-1.45	-3.61	-9.86
Loser Value	1.54	3.54	0.57		-4.57	-1.56	-2.37	-2.41	-4.88	-5.28	-5.53	-5.85	-0.88	-3.04	-9.29
Loser Strong Value	6.11	8.11 **	5.14	4.57		3.01	2.20	2.16	-0.31	-0.71	-0.96	-1.28	3.69	1.53	-4.72
Neutral Strong Growth	3.09	5.09	2.12	1.56	-3.01		-0.82	-0.85	-3.32	-3.72	-3.97	-4.29	0.68	-1.48	-7.74
Neutral Growth	3.91	5.91	2.94	2.37	-2.20	0.82		-0.03	-2.51	-2.91	-3.16	-3.47	1.49	-0.67	-6.92
Neutral Neutral	3.94	5.94	2.97	2.41	-2.16	0.85	0.03		-2.48	-2.88	-3.12	-3.44	1.52	-0.63	-6.89
Neutral Value	6.42	8.42 *	5.45	4.88	0.31	3.32	2.51	2.48		-0.40	-0.65	-0.96	4.00	1.84	-4.41
Neutral Strong Value	6.82	8.82 **	5.85	5.28	0.71	3.72	2.91	2.88	0.40		-0.25	-0.56	4.40	2.24	-4.01
Winner Strong Growth	7.07	9.07 *	6.10	5.53	0.96	3.97	3.16	3.12	0.65	0.25		-0.31	4.65	2.49	-3.76
Winner Growth	7.38	9.38 *	6.41	5.85	1.28	4.29	3.47	3.44	0.96	0.56	0.31		4.96 *	2.81	-3.45
Winner Neutral	2.42	4.42	1.45	0.88	-3.69	-0.68	-1.49	-1.52	-4.00	-4.40	-4.65	-4.96		-2.16	-8.41
Winner Value	4.58	6.58	3.61	3.04	-1.53	1.48	0.67	0.63	-1.84	-2.24	-2.49	-2.81	2.16		-6.26
Winner Strong Value	10.83 *	12.83 **	9.86 *	9.29 *	4.72	7.74 *	6.92 *	6.89 *	4.41	4.01	3.76	3.45	8.41 **	6.26 *	

Table 13 displays a matrix of the annualized mean with p-values in stars of all the 210 possible combinations. The stars indicate the level of significance according to the p-value; *** <0.001, ** <0.01 and *<0.05. The t-statistics used for the p-value are calculated using the OLS method. The vertical axis is invested in (long) and the horizontal axis is shorted.

Annualized Standard Deviation per Portfolio Combination

Long \ Short	Loser Strong Growth	Loser Growth	Loser Neutral	Loser Value	Loser Strong Value	Neutral Strong Growth	Neutral Growth	Neutral Neutral	Neutral Value	Neutral Strong Value	Winner Strong Growth	Winner Growth	Winner Neutral	Winner Value	Winner Strong Value
Loser Strong Growth		19.18	17.51	17.57	19.32	19.05	19.99	18.85	18.78	19.30	24.17	23.00	21.75	22.91	23.71
Loser Growth	19.18		17.53	16.38	16.92	19.52	19.22	18.35	19.37	18.63	24.61	22.47	21.98	22.69	22.45
Loser Neutral	17.51	17.53		16.17	18.14	17.50	19.08	17.19	17.17	17.00	23.38	21.58	20.73	21.96	21.63
Loser Value	17.57	16.38	16.17		17.65	17.69	18.28	17.63	17.43	17.35	22.25	21.23	20.34	22.03	21.85
Loser Strong Value	19.32	16.92	18.14	17.65		18.61	18.92	17.48	16.71	17.15	23.43	22.11	21.04	21.72	21.33
Neutral Strong Growth	19.05	19.52	17.50	17.69	18.61		13.52	13.73	14.98	15.21	19.01	16.37	15.68	17.41	17.39
Neutral Growth	19.99	19.22	19.08	18.28	18.92	13.52		12.69	14.83	15.00	16.30	13.86	13.78	16.10	17.46
Neutral Neutral	18.85	18.35	17.19	17.63	17.48	13.73	12.69		14.15	14.37	18.32	15.30	14.78	16.22	17.57
Neutral Value	18.78	19.37	17.17	17.43	16.71	14.98	14.83	14.15		13.97	18.69	16.72	16.28	17.69	17.46
Neutral Strong Value	19.30	18.63	17.00	17.35	17.15	15.21	15.00	14.37	13.97		19.67	16.72	16.15	16.58	17.03
Winner Strong Growth	24.17	24.61	23.38	22.25	23.43	19.01	16.30	18.32	18.69	19.67		16.20	15.61	17.79	20.04
Winner Growth	23.00	22.47	21.58	21.23	22.11	16.37	13.86	15.30	16.72	16.72	16.20		13.94	14.67	15.28
Winner Neutral	21.75	21.98	20.73	20.34	21.04	15.68	13.78	14.78	16.28	16.15	15.61	13.94		14.61	17.27
Winner Value	22.91	22.69	21.96	22.03	21.72	17.41	16.10	16.22	17.69	16.58	17.79	14.67	14.61		16.19
Winner Strong Value	23.71	22.45	21.63	21.85	21.33	17.39	17.46	17.57	17.46	17.03	20.04	15.28	17.27	16.19	

Table 14 displays a matrix of the annualized standard deviation of all the 210 possible combinations. The vertical axis is invested in (long) and the horizontal axis is shorted.

Annualized Sharpe ratio per Portfolio Combination with p-values in stars

Long \ Short		Loser Strong Growth	Loser Growth	Loser Neutral	Loser Value	Loser Strong Value	Neutral Strong Growth	Neutral Growth	Neutral Neutral	Neutral Value	Neutral Strong Value	Winner Strong Growth	Winner Growth	Winner Neutral	Winner Value	Winner Strong Value
Loser	Strong Growth		0.10	-0.06	-0.09	-0.32	-0.16	-0.20	-0.21	-0.34	-0.35	-0.29	-0.32	-0.11	-0.20	-0.46
Loser	Growth	-0.10		-0.17	-0.22	-0.48	-0.26	-0.31	-0.32	-0.43	-0.47	-0.37	-0.42	-0.20	-0.29	-0.57
Loser	Neutral	0.06	0.17		-0.04	-0.28	-0.12	-0.15	-0.17	-0.32	-0.34	-0.26	-0.30	-0.07	-0.16	-0.46
Loser	Value	0.09	0.22	0.04		-0.26	-0.09	-0.13	-0.14	-0.28	-0.30	-0.25	-0.28	-0.04	-0.14	-0.43
Loser	Strong Value	0.32	0.48 **	0.28	0.26		0.16	0.12	0.12	-0.02	-0.04	-0.04	-0.06	0.18	0.07	-0.22
Neutral	Strong Growth	0.16	0.26	0.12	0.09	-0.16		-0.06	-0.06	-0.22	-0.24	-0.21	-0.26	0.04	-0.09	-0.44
Neutral	Growth	0.20	0.31	0.15	0.13	-0.12	0.06		0.00	-0.17	-0.19	-0.19	-0.25	0.11	-0.04	-0.40
Neutral	Neutral	0.21	0.32	0.17	0.14	-0.12	0.06	0.00		-0.17	-0.20	-0.17	-0.22	0.10	-0.04	-0.39
Neutral	Value	0.34	0.43 *	0.32	0.28	0.02	0.22	0.17	0.17		-0.03	-0.03	-0.06	0.25	0.10	-0.25
Neutral	Strong Value	0.35	0.47 **	0.34	0.30	0.04	0.24	0.19	0.20	0.03		-0.01	-0.03	0.27	0.14	-0.24
Winner	Strong Growth	0.29	0.37 *	0.26	0.25	0.04	0.21	0.19	0.17	0.03	0.01		-0.02	0.30	0.14	-0.19
Winner	Growth	0.32	0.42 *	0.30	0.28	0.06	0.26	0.25	0.22	0.06	0.03	0.02		0.36 *	0.19	-0.23
Winner	Neutral	0.11	0.20	0.07	0.04	-0.18	-0.04	-0.11	-0.10	-0.25	-0.27	-0.30	-0.36		-0.15	-0.49
Winner	Value	0.20	0.29	0.16	0.14	-0.07	0.09	0.04	0.04	-0.10	-0.14	-0.14	-0.19	0.15		-0.39
Winner	Strong Value	0.46 *	0.57 **	0.46 *	0.43 *	0.22	0.44 *	0.40 *	0.39 *	0.25	0.24	0.19	0.23	0.49 **	0.39 *	

Table 15 displays a matrix of the Sharpe ratio with p-values in stars of all the 210 possible combinations. The stars indicate the level of significance according to the p-value; *** <0.001, ** <0.01 and *<0.05. The t-statistics used for the p-value are calculated using the OLS method. The vertical axis is invested in (long) and the horizontal axis is shorted.

Monthly Turnover (%) per Portfolio Combination

Long \ Short		Loser Strong Growth	Loser Growth	Loser Neutral	Loser Value	Loser Strong Value	Neutral Strong Growth	Neutral Growth	Neutral Neutral	Neutral Value	Neutral Strong Value	Winner Strong Growth	Winner Growth	Winner Neutral	Winner Value	Winner Strong Value
Loser	Strong Growth		30.34	31.08	30.26	26.31	33.09	37.77	39.12	38.26	34.73	26.71	31.27	33.02	31.57	26.83
Loser	Growth	30.34		35.72	34.86	30.74	37.57	42.50	43.89	43.00	39.30	31.09	35.89	37.68	36.20	31.23
Loser	Neutral	31.08	35.72		35.65	31.49	38.26	43.24	44.62	43.73	39.98	31.76	36.59	38.37	36.90	31.91
Loser	Value	30.26	34.86	35.65		30.67	37.45	42.38	43.76	42.88	39.17	30.93	35.74	37.50	36.05	31.07
Loser	Strong Value	26.31	30.74	31.49	30.67		33.45	38.20	39.57	38.69	35.11	27.02	31.64	33.38	31.95	27.13
Neutral	Strong Growth	33.09	37.57	38.26	37.45	33.45		44.69	46.02	45.17	41.57	33.70	38.36	40.07	38.66	33.87
Neutral	Growth	37.77	42.50	43.24	42.38	38.20	44.69		51.12	50.25	46.48	38.39	43.28	45.08	43.60	38.60
Neutral	Neutral	39.12	43.89	44.62	43.76	39.57	46.02	51.12		51.62	47.81	39.74	44.69	46.43	45.00	39.96
Neutral	Value	38.26	43.00	43.73	42.88	38.69	45.17	50.25	51.62		46.97	38.86	43.79	45.57	44.11	39.08
Neutral	Strong Value	34.73	39.30	39.98	39.17	35.11	41.57	46.48	47.81	46.97		35.38	40.12	41.86	40.43	35.57
Winner	Strong Growth	26.71	31.09	31.76	30.93	27.02	33.70	38.39	39.74	38.86	35.38		31.94	33.66	32.23	27.48
Winner	Growth	31.27	35.89	36.59	35.74	31.64	38.36	43.28	44.69	43.79	40.12	31.94		38.54	37.04	32.10
Winner	Neutral	33.02	37.68	38.37	37.50	33.38	40.07	45.08	46.43	45.57	41.86	33.66	38.54		38.84	33.82
Winner	Value	31.57	36.20	36.90	36.05	31.95	38.66	43.60	45.00	44.11	40.43	32.23	37.04	38.84		32.40
Winner	Strong Value	26.83	31.23	31.91	31.07	27.13	33.87	38.60	39.96	39.08	35.57	27.48	32.10	33.82	32.40	

Table 16 displays a matrix of the monthly turnover of all the 210 possible combinations. The vertical axis is invested in (long) and the horizontal axis is shorted.

Appendix III – The annualized mean and Sharpe ratio after transaction costs per every possible combination

Adjusted Annualized Mean per Portfolio Combination with p-values in stars

Transaction costs of 0.50%

Long \ Short		Loser Strong Growth	Loser Growth	Loser Neutral	Loser Value	Loser Strong Value	Neutral Strong Growth	Neutral Growth	Neutral Neutral	Neutral Value	Neutral Strong Value	Winner Strong Growth	Winner Growth	Winner Neutral	Winner Value	Winner Strong Value
Loser	Strong Growth		0.18	-2.83	-3.35	-7.68	-5.08	-6.18	-6.29	-8.71	-8.90	-8.67	-9.26	-4.40	-6.47	-12.44
Loser	Growth	-3.82		-5.11	-5.63	-9.95	-7.35	-8.46	-8.58	-11.00	-11.18	-10.93	-11.54	-6.68	-8.75	-14.71
Loser	Neutral	-0.90	0.83		-2.71	-7.03	-4.42	-5.54	-5.65	-8.07	-8.25	-8.00	-8.61	-3.75	-5.82	-11.78
Loser	Value	-0.28	1.45	-1.57		-6.41	-3.80	-4.92	-5.03	-7.45	-7.63	-7.39	-7.99	-3.13	-5.20	-11.16
Loser	Strong Value	4.53	6.26 *	3.25	2.73		1.01	-0.10	-0.21	-2.63	-2.82	-2.58	-3.17	1.69	-0.39	-6.35
Neutral	Strong Growth	1.11	2.84	-0.17	-0.69	-5.02		-3.50	-3.61	-6.04	-6.22	-6.00	-6.59	-1.73	-3.80	-9.77
Neutral	Growth	1.64	3.36	0.35	-0.17	-4.49	-1.86		-3.10	-5.52	-5.70	-5.46	-6.07	-1.21	-3.28	-9.24
Neutral	Neutral	1.59	3.31	0.30	-0.22	-4.54	-1.91	-3.03		-5.57	-5.74	-5.51	-6.12	-1.26	-3.33	-9.29
Neutral	Value	4.12	5.84	2.83	2.31	-2.01	0.61	-0.51	-0.62		-3.22	-2.98	-3.59	1.27	-0.80	-6.76
Neutral	Strong Value	4.73	6.46	3.45	2.93	-1.40	1.23	0.12	0.01	-2.42		-2.37	-2.97	1.89	-0.18	-6.15
Winner	Strong Growth	5.46	7.20	4.19	3.67	-0.66	1.95	0.85	0.74	-1.68	-1.87		-2.23	2.63	0.56	-5.41
Winner	Growth	5.51	7.23	4.22	3.70	-0.62	1.99	0.88	0.76	-1.66	-1.84	-1.60		2.65	0.58	-5.37
Winner	Neutral	0.44	2.16	-0.85	-1.37	-5.69	-3.08	-4.20	-4.31	-6.73	-6.91	-6.67	-7.28		-4.49	-10.44
Winner	Value	2.68	4.40	1.39	0.88	-3.45	-0.84	-1.95	-2.07	-4.49	-4.67	-4.43	-5.03	-0.17		-8.20
Winner	Strong Value	9.22 *	10.96 **	7.95 *	7.43	3.10	5.71	4.61	4.49	2.07	1.88	2.11	1.52	6.38 *	4.31	

Table 17 displays a matrix of the annualized adjusted mean with p-values in stars of all the 210 possible combinations. The stars indicate the level of significance according to the p-value; *** <0.001, ** <0.01 and *<0.05. The t-statistics used for the p-value are calculated using the OLS method. The transaction costs are 0.5% and the turnover of Table 16 is used. The vertical axis is invested in (long) and the horizontal axis is shorted.

Adjusted Annualized Sharpe Ratio per Portfolio Combination with p-values in stars

Transaction costs of 0.50%

Long \ Short		Loser Strong Growth	Loser Growth	Loser Neutral	Loser Value	Loser Strong Value	Neutral Strong Growth	Neutral Growth	Neutral Neutral	Neutral Value	Neutral Strong Value	Winner Strong Growth	Winner Growth	Winner Neutral	Winner Value	Winner Strong Value
Loser	Strong Growth		0.01	-0.16	-0.19	-0.40	-0.27	-0.31	-0.33	-0.46	-0.46	-0.36	-0.40	-0.20	-0.28	-0.52
Loser	Growth	-0.20		-0.29	-0.34	-0.59	-0.38	-0.44	-0.47	-0.57	-0.60	-0.44	-0.51	-0.30	-0.39	-0.66
Loser	Neutral	-0.05	0.05		-0.17	-0.39	-0.25	-0.29	-0.33	-0.47	-0.49	-0.34	-0.40	-0.18	-0.27	-0.54
Loser	Value	-0.02	0.09	-0.10		-0.36	-0.21	-0.27	-0.29	-0.43	-0.44	-0.33	-0.38	-0.15	-0.24	-0.51
Loser	Strong Value	0.23	0.37 *	0.18	0.15		0.05	-0.01	-0.01	-0.16	-0.16	-0.11	-0.14	0.08	-0.02	-0.30
Neutral	Strong Growth	0.06	0.15	-0.01	-0.04	-0.27		-0.26	-0.26	-0.40	-0.41	-0.32	-0.40	-0.11	-0.22	-0.56
Neutral	Growth	0.08	0.17	0.02	-0.01	-0.24	-0.14		-0.24	-0.37	-0.38	-0.33	-0.44	-0.09	-0.20	-0.53
Neutral	Neutral	0.08	0.18	0.02	-0.01	-0.26	-0.14	-0.24		-0.39	-0.40	-0.30	-0.40	-0.09	-0.21	-0.53
Neutral	Value	0.22	0.30	0.16	0.13	-0.12	0.04	-0.03	-0.04		-0.23	-0.16	-0.21	0.08	-0.05	-0.39
Neutral	Strong Value	0.25	0.35	0.20	0.17	-0.08	0.08	0.01	0.00	-0.17		-0.12	-0.18	0.12	-0.01	-0.36
Winner	Strong Growth	0.23	0.29	0.18	0.16	-0.03	0.10	0.05	0.04	-0.09	-0.10		-0.14	0.17	0.03	-0.27
Winner	Growth	0.24	0.32	0.20	0.17	-0.03	0.12	0.06	0.05	-0.10	-0.11	-0.10		0.19	0.04	-0.35
Winner	Neutral	0.02	0.10	-0.04	-0.07	-0.27	-0.20	-0.30	-0.29	-0.41	-0.43	-0.43	-0.52		-0.31	-0.60
Winner	Value	0.12	0.19	0.06	0.04	-0.16	-0.05	-0.12	-0.13	-0.25	-0.28	-0.25	-0.34	-0.01		-0.51
Winner	Strong Value	0.39 *	0.49 **	0.37 *	0.34	0.15	0.33	0.26	0.26	0.12	0.11	0.11	0.10	0.37 *	0.27	

Table 18 displays a matrix of the adjusted Sharpe ratio with p-values in stars of all the 210 possible combinations. The stars indicate the level of significance according to the p-value; *** <0.001, ** <0.01 and *<0.05. The t-statistics used for the p-value are calculated using the OLS method. The transaction costs are 0.5% and the turnover of Table 16 is used. The vertical axis is invested in (long) and the horizontal axis is shorted.

Appendix IV – All results from the regressions on the Carhart model per every possible combination

Annualized Alphas per Portfolio Combination with p-values in stars using HC3 s.e.

Long \ Short		Loser Strong Growth	Loser Growth	Loser Neutral	Loser Value	Loser Strong Value	Neutral Strong Growth	Neutral Growth	Neutral Neutral	Neutral Value	Neutral Strong Value	Winner Strong Growth	Winner Growth	Winner Neutral	Winner Value	Winner Strong Value
Loser	Strong Growth		1.09	-1.65	-0.63	-6.41	1.24	1.14	-0.43	-3.34	-4.24	-1.01	-0.56	4.20	2.83	-4.48
Loser	Growth	-1.09		-2.74	-1.73	-7.51	0.15	0.05	-1.52	-4.43	-5.33	-2.10	-1.66	3.11	1.74	-5.57
Loser	Neutral	1.65	2.74		1.01	-4.77	2.89	2.79	1.22	-1.70	-2.59	0.64	1.08	5.85 *	4.48	-2.83
Loser	Value	0.63	1.73	-1.01		-5.78	1.88	1.78	0.21	-2.71	-3.60	-0.37	0.07	4.84	3.46	-3.84
Loser	Strong Value	6.41 *	7.51 *	4.77	5.78		7.65 *	7.56 **	5.98 *	3.07	2.17	5.41	5.85 *	10.61 **	9.24 **	1.93
Neutral	Strong Growth	-1.24	-0.15	-2.89	-1.88	-7.65		-0.10	-1.67	-4.58	-5.48	-2.25	-1.81	2.96	1.59	-5.72
Neutral	Growth	-1.14	-0.05	-2.79	-1.78	-7.56	0.10		-1.57	-4.49	-5.38	-2.15	-1.71	3.06	1.69	-5.62
Neutral	Neutral	0.43	1.52	-1.22	-0.21	-5.98	1.67	1.57		-2.91	-3.81	-0.58	-0.14	4.63 *	3.26	-4.05
Neutral	Value	3.34	4.43	1.70	2.71	-3.07	4.58	4.49	2.91		-0.90	2.34	2.78	7.54 **	6.17 *	-1.14
Neutral	Strong Value	4.24	5.33	2.59	3.60	-2.17	5.48 *	5.38 *	3.81	0.90		3.23	3.68	8.44 **	7.07 **	-0.24
Winner	Strong Growth	1.01	2.10	-0.64	0.37	-5.41	2.25	2.15	0.58	-2.34	-3.23		0.44	5.21 *	3.84	-3.47
Winner	Growth	0.56	1.66	-1.08	-0.07	-5.85	1.81	1.71	0.14	-2.78	-3.68	-0.44		4.77 *	3.39	-3.91
Winner	Neutral	-4.20	-3.11	-5.85	-4.84	-10.61	-2.96	-3.06	-4.63	-7.54	-8.44	-5.21	-4.77		-1.37	-8.68
Winner	Value	-2.83	-1.74	-4.48	-3.46	-9.24	-1.59	-1.69	-3.26	-6.17	-7.07	-3.84	-3.39	1.37		-7.31
Winner	Strong Value	4.48	5.57	2.83	3.84	-1.93	5.72 *	5.62 *	4.05	1.14	0.24	3.47	3.91	8.68 **	7.31 **	

Table 19 displays a matrix of the annualized alphas with p-values in stars of all the 210 possible combinations. The stars indicate the level of significance according to the p-value; *** <0.001, ** <0.01 and *<0.05. The t-statistics used for the p-value are calculated using HC3 standard errors. The alphas are derived from OLS regressions against the Carhart model. The vertical axis is invested in (long) and the horizontal axis is shorted.

Market Beta per Portfolio Combination of Carhart (4FF) Model with p-values in stars

Long \ Short		Loser Strong Growth	Loser Growth	Loser Neutral	Loser Value	Loser Strong Value	Neutral Strong Growth	Neutral Growth	Neutral Neutral	Neutral Value	Neutral Strong Value	Winner Strong Growth	Winner Growth	Winner Neutral	Winner Value	Winner Strong Value
Loser	Strong Growth		-0.01	0.09	-0.05	0.09	0.02	0.07	0.07	0.11	0.10	-0.03	-0.03	-0.05	-0.03	-0.09
Loser	Growth	0.01		0.10	-0.05	0.10	0.03	0.07	0.07	0.12	0.11	-0.02	-0.02	-0.04	-0.02	-0.08
Loser	Neutral	-0.09	-0.10		-0.14	0.00	-0.06	-0.02	-0.02	0.02	0.02	-0.12	-0.12	-0.13	-0.11	-0.17
Loser	Value	0.05	0.05	0.14 *		0.14 *	0.08	0.12	0.12	0.16 *	0.16 *	0.02	0.02	0.01	0.03	-0.03
Loser	Strong Value	-0.09	-0.10	0.00	-0.14		-0.06	-0.02	-0.02	0.02	0.02	-0.12	-0.12	-0.13	-0.11	-0.17
Neutral	Strong Growth	-0.02	-0.03	0.06	-0.08	0.06		0.04	0.04	0.08	0.08	-0.06	-0.06	-0.07	-0.05	-0.11
Neutral	Growth	-0.07	-0.07	0.02	-0.12	0.02	-0.04		0.00	0.04	0.04	-0.10	-0.10	-0.11	-0.09	-0.15
Neutral	Neutral	-0.07	-0.07	0.02	-0.12	0.02	-0.04	0.00		0.04	0.04	-0.10	-0.10	-0.11	-0.09	-0.15
Neutral	Value	-0.11	-0.12	-0.02	-0.16	-0.02	-0.08	-0.04	-0.04		-0.01	-0.14	-0.14	-0.16	-0.14	-0.20
Neutral	Strong Value	-0.10	-0.11	-0.02	-0.16	-0.02	-0.08	-0.04	-0.04	0.01		-0.14	-0.14	-0.15	-0.13	-0.19
Winner	Strong Growth	0.03	0.02	0.12	-0.02	0.12	0.06	0.10	0.10	0.14 *	0.14 *		0.00	-0.01	0.01	-0.05
Winner	Growth	0.03	0.02	0.12	-0.02	0.12	0.06	0.10	0.10	0.14 *	0.14 *	0.00		-0.01	0.00	-0.05
Winner	Neutral	0.05	0.04	0.13	-0.01	0.13	0.07	0.11 *	0.11 *	0.16 *	0.15 *	0.01	0.01		0.02	-0.04
Winner	Value	0.03	0.02	0.11	-0.03	0.11	0.05	0.09	0.09	0.14	0.13	-0.01	0.00	-0.02		-0.06
Winner	Strong Value	0.09	0.08	0.17 *	0.03	0.17 *	0.11	0.15	0.15 *	0.20 *	0.19 *	0.05	0.05	0.04	0.06	

Table 20 displays a matrix of the market betas with p-values in stars of all the 210 possible combinations. The stars indicate the level of significance according to the p-value; *** <0.001, ** <0.01 and *<0.05. The t-statistics used for the p-value are calculated using HC3 standard errors. The market betas are derived from OLS regressions against the Carhart model. The vertical axis is invested in (long) and the horizontal axis is shorted.

Size Beta per Portfolio Combination of Carhart (4FF) Model with p-values in stars

Long \ Short		Loser Strong Growth	Loser Growth	Loser Neutral	Loser Value	Loser Strong Value	Neutral Strong Growth	Neutral Growth	Neutral Neutral	Neutral Value	Neutral Strong Value	Winner Strong Growth	Winner Growth	Winner Neutral	Winner Value	Winner Strong Value
Loser	Strong Growth		-0.18	-0.07	0.01	-0.01	0.13	0.13	0.05	0.09	0.07	0.01	0.15	0.12	0.22	0.13
Loser	Growth	0.18		0.11	0.19 *	0.17 **	0.31 ***	0.31 ***	0.23 **	0.27 **	0.25 ***	0.19 *	0.33 ***	0.30 ***	0.40 ***	0.31 ***
Loser	Neutral	0.07	-0.11		0.08	0.06	0.20 **	0.20 *	0.12 *	0.16 *	0.14 *	0.08	0.22 **	0.19 **	0.28 ***	0.20 *
Loser	Value	-0.01	-0.19	-0.08		-0.02	0.12	0.12 *	0.04	0.08	0.06	0.00	0.14 *	0.11	0.20 *	0.12
Loser	Strong Value	0.01	-0.17	-0.06	0.02		0.14 *	0.14 *	0.07	0.10	0.08	0.02	0.16 *	0.13 *	0.23 **	0.14 *
Neutral	Strong Growth	-0.13	-0.31	-0.20	-0.12	-0.14		0.00	-0.08	-0.04	-0.06	-0.12	0.02	-0.01	0.09	0.00
Neutral	Growth	-0.13	-0.31	-0.20	-0.12	-0.14	0.00		-0.07	-0.04	-0.06	-0.12	0.02	-0.01	0.09	0.00
Neutral	Neutral	-0.05	-0.23	-0.12	-0.04	-0.07	0.08	0.07		0.04	0.02	-0.04	0.10	0.07	0.16 *	0.08
Neutral	Value	-0.09	-0.27	-0.16	-0.08	-0.10	0.04	0.04	-0.04		-0.02	-0.08	0.06	0.03	0.12	0.04
Neutral	Strong Value	-0.07	-0.25	-0.14	-0.06	-0.08	0.06	0.06	-0.02	0.02		-0.06	0.08	0.05	0.15 *	0.06
Winner	Strong Growth	-0.01	-0.19	-0.08	0.00	-0.02	0.12	0.12	0.04	0.08	0.06		0.14	0.11	0.21 *	0.12
Winner	Growth	-0.15	-0.33	-0.22	-0.14	-0.16	-0.02	-0.02	-0.10	-0.06	-0.08	-0.14		-0.03	0.06	-0.02
Winner	Neutral	-0.12	-0.30	-0.19	-0.11	-0.13	0.01	0.01	-0.07	-0.03	-0.05	-0.11	0.03		0.10	0.01
Winner	Value	-0.22	-0.40	-0.28	-0.20	-0.23	-0.09	-0.09	-0.16	-0.12	-0.15	-0.21	-0.06	-0.10		-0.08
Winner	Strong Value	-0.13	-0.31	-0.20	-0.12	-0.14	0.00	0.00	-0.08	-0.04	-0.06	-0.12	0.02	-0.01	0.08	

Table 21 displays a matrix of the size betas with p-values in stars of all the 210 possible combinations. The stars indicate the level of significance according to the p-value; *** <0.001, ** <0.01 and *<0.05. The t-statistics used for the p-value are calculated using HC3 standard errors. The size betas are derived from OLS regressions against the Carhart model. The vertical axis is invested in (long) and the horizontal axis is shorted.

Value Beta per Portfolio Combination of Carhart (4FF) Model with p-values in stars

Long \ Short		Loser Strong Growth	Loser Growth	Loser Neutral	Loser Value	Loser Strong Value	Neutral Strong Growth	Neutral Growth	Neutral Neutral	Neutral Value	Neutral Strong Value	Winner Strong Growth	Winner Growth	Winner Neutral	Winner Value	Winner Strong Value
Loser	Strong Growth		0.04	-0.02	-0.02	-0.06	-0.09	-0.03	0.00	-0.03	-0.06	0.36 **	0.16	0.08	-0.09	0.02
Loser	Growth	-0.04		-0.07	-0.06	-0.10	-0.14	-0.08	-0.04	-0.08	-0.10	0.32 **	0.12	0.03	-0.14	-0.03
Loser	Neutral	0.02	0.07		0.01	-0.03	-0.07	-0.01	0.03	-0.01	-0.03	0.39 **	0.18 *	0.10	-0.07	0.04
Loser	Value	0.02	0.06	-0.01		-0.04	-0.07	-0.02	0.02	-0.01	-0.04	0.38 ***	0.18	0.10	-0.08	0.03
Loser	Strong Value	0.06	0.10	0.03	0.04		-0.04	0.02	0.06	0.02	0.00	0.42 ***	0.22 *	0.13 *	-0.04	0.07
Neutral	Strong Growth	0.09	0.14	0.07	0.07	0.04		0.06	0.10	0.06	0.04	0.46 ***	0.25 **	0.17	0.00	0.11
Neutral	Growth	0.03	0.08	0.01	0.02	-0.02	-0.06		0.04	0.00	-0.02	0.40 ***	0.20 **	0.11	-0.06	0.05
Neutral	Neutral	0.00	0.04	-0.03	-0.02	-0.06	-0.10	-0.04		-0.04	-0.06	0.36 ***	0.16 *	0.07	-0.10	0.01
Neutral	Value	0.03	0.08	0.01	0.01	-0.02	-0.06	0.00	0.04		-0.02	0.39 ***	0.19 *	0.11	-0.06	0.05
Neutral	Strong Value	0.06	0.10	0.03	0.04	0.00	-0.04	0.02	0.06	0.02		0.42 ***	0.22 **	0.13 *	-0.04	0.07
Winner	Strong Growth	-0.36	-0.32	-0.39	-0.38	-0.42	-0.46	-0.40	-0.36	-0.39	-0.42		-0.20	-0.28	-0.46	-0.35
Winner	Growth	-0.16	-0.12	-0.18	-0.18	-0.22	-0.25	-0.20	-0.16	-0.19	-0.22	0.20 *		-0.08	-0.25	-0.15
Winner	Neutral	-0.08	-0.03	-0.10	-0.10	-0.13	-0.17	-0.11	-0.07	-0.11	-0.13	0.28 ***	0.08		-0.17	-0.06
Winner	Value	0.09	0.14	0.07	0.08	0.04	0.00	0.06	0.10	0.06	0.04	0.46 ***	0.25 ***	0.17 *		0.11
Winner	Strong Value	-0.02	0.03	-0.04	-0.03	-0.07	-0.11	-0.05	-0.01	-0.05	-0.07	0.35 **	0.15 *	0.06	-0.11	

Table 22 displays a matrix of the value betas with p-values in stars of all the 210 possible combinations. The stars indicate the level of significance according to the p-value; *** <0.001, ** <0.01 and *<0.05. The t-statistics used for the p-value are calculated using HC3 standard errors. The value betas are derived from OLS regressions against the Carhart model. The vertical axis is invested in (long) and the horizontal axis is shorted.

Momentum Beta per Portfolio Combination of Carhart (4FF) Model with p-values in stars

Long \ Short		Loser Strong Growth	Loser Growth	Loser Neutral	Loser Value	Loser Strong Value	Neutral Strong Growth	Neutral Growth	Neutral Neutral	Neutral Value	Neutral Strong Value	Winner Strong Growth	Winner Growth	Winner Neutral	Winner Value	Winner Strong Value
Loser	Strong Growth		0.09	0.03	-0.04	0.01	-0.38	-0.50	-0.37	-0.34	-0.28	-0.73	-0.71	-0.64	-0.65	-0.56
Loser	Growth	-0.09		-0.05	-0.13	-0.08	-0.47	-0.59	-0.46	-0.43	-0.37	-0.81	-0.80	-0.73	-0.73	-0.65
Loser	Neutral	-0.03	0.05		-0.08	-0.02	-0.41	-0.53	-0.40	-0.37	-0.31	-0.76	-0.74	-0.67	-0.68	-0.59
Loser	Value	0.04	0.13 *	0.08		0.05	-0.34	-0.46	-0.33	-0.30	-0.24	-0.68	-0.67	-0.60	-0.60	-0.52
Loser	Strong Value	-0.01	0.08	0.02	-0.05		-0.39	-0.51	-0.38	-0.35	-0.29	-0.74	-0.72	-0.65	-0.65	-0.57
Neutral	Strong Growth	0.38 ***	0.47 ***	0.41 ***	0.34 ***	0.39 ***		-0.12	0.01	0.04	0.10	-0.35	-0.33	-0.26	-0.26	-0.18
Neutral	Growth	0.50 ***	0.59 ***	0.53 ***	0.46 ***	0.51 ***	0.12 *		0.13 **	0.16 **	0.22 ***	-0.23	-0.21	-0.14	-0.14	-0.06
Neutral	Neutral	0.37 ***	0.46 ***	0.40 ***	0.33 ***	0.38 ***	-0.01	-0.13		0.03	0.09 *	-0.36	-0.34	-0.27	-0.27	-0.19
Neutral	Value	0.34 ***	0.43 ***	0.37 ***	0.30 ***	0.35 ***	-0.04	-0.16	-0.03		0.06	-0.39	-0.37	-0.30	-0.30	-0.22
Neutral	Strong Value	0.28 ***	0.37 ***	0.31 ***	0.24 ***	0.29 ***	-0.10	-0.22	-0.09	-0.06		-0.45	-0.43	-0.36	-0.37	-0.28
Winner	Strong Growth	0.73 ***	0.81 ***	0.76 ***	0.68 ***	0.74 ***	0.35 ***	0.23 ***	0.36 ***	0.39 ***	0.45 ***		0.02	0.09 *	0.08	0.17 *
Winner	Growth	0.71 ***	0.80 ***	0.74 ***	0.67 ***	0.72 ***	0.33 ***	0.21 ***	0.34 ***	0.37 ***	0.43 ***	-0.02		0.07	0.07	0.15 **
Winner	Neutral	0.64 ***	0.73 ***	0.67 ***	0.60 ***	0.65 ***	0.26 ***	0.14 **	0.27 ***	0.30 ***	0.36 ***	-0.09	-0.07		-0.01	0.08
Winner	Value	0.65 ***	0.73 ***	0.68 ***	0.60 ***	0.65 ***	0.26 ***	0.14 *	0.27 ***	0.30 ***	0.37 ***	-0.08	-0.07	0.01		0.08
Winner	Strong Value	0.56 ***	0.65 ***	0.59 ***	0.52 ***	0.57 ***	0.18 **	0.06	0.19 **	0.22 ***	0.28 ***	-0.17	-0.15	-0.08	-0.08	

Table 23 displays a matrix of the momentum betas with p-values in stars of all the 210 possible combinations. The stars indicate the level of significance according to the p-value; *** <0.001, ** <0.01 and *<0.05. The t-statistics used for the p-value are calculated using HC3 standard errors. The momentum betas are derived from OLS regressions against the Carhart model. The vertical axis is invested in (long) and the horizontal axis is shorted.

R-Squared (%) per Portfolio Combination of Carhart (4FF) Model

Long \ Short		Loser Strong Growth	Loser Growth	Loser Neutral	Loser Value	Loser Strong Value	Neutral Strong Growth	Neutral Growth	Neutral Neutral	Neutral Value	Neutral Strong Value	Winner Strong Growth	Winner Growth	Winner Neutral	Winner Value	Winner Strong Value
Loser	Strong Growth		1.89	0.69	0.36	0.47	15.56	24.77	15.84	14.35	9.36	38.62	36.10	31.84	29.08	19.98
Loser	Growth	1.89		1.76	3.60	3.27	23.09	36.91	24.87	21.24	17.23	43.58	46.87	39.60	38.75	29.70
Loser	Neutral	0.69	1.76		1.89	0.22	20.08	28.58	20.12	17.97	12.60	43.08	43.32	37.25	33.60	26.12
Loser	Value	0.36	3.60	1.89		1.27	15.22	26.44	15.77	14.73	10.04	42.55	38.85	32.74	28.10	20.52
Loser	Strong Value	0.47	3.27	0.22	1.27		15.57	26.66	17.61	16.72	10.56	41.82	39.33	34.16	31.83	25.00
Neutral	Strong Growth	15.56	23.09	20.08	15.22	15.57		4.02	1.41	1.12	1.95	23.54	18.89	11.85	7.98	4.55
Neutral	Growth	24.77	36.91	28.58	26.44	26.66	4.02		4.09	4.13	7.95	18.25	11.38	5.02	3.20	1.58
Neutral	Neutral	15.84	24.87	20.12	15.77	17.61	1.41	4.09		0.54	1.90	20.69	18.97	11.80	10.62	4.49
Neutral	Value	14.35	21.24	17.97	14.73	16.72	1.12	4.13	0.54		0.87	23.82	19.27	12.74	10.53	6.54
Neutral	Strong Value	9.36	17.23	12.60	10.04	10.56	1.95	7.95	1.90	0.87		27.22	26.26	18.72	17.08	10.40
Winner	Strong Growth	38.62	43.58	43.08	42.55	41.82	23.54	18.25	20.69	23.82	27.22		3.69	8.06	14.07	9.40
Winner	Growth	36.10	46.87	43.32	38.85	39.33	18.89	11.38	18.97	19.27	26.26	3.69		1.88	6.44	6.25
Winner	Neutral	31.84	39.60	37.25	32.74	34.16	11.85	5.02	11.80	12.74	18.72	8.06	1.88		2.78	1.33
Winner	Value	29.08	38.75	33.60	28.10	31.83	7.98	3.20	10.62	10.53	17.08	14.07	6.44	2.78		2.25
Winner	Strong Value	19.98	29.70	26.12	20.52	25.00	4.55	1.58	4.49	6.54	10.40	9.40	6.25	1.33	2.25	

Table 24 displays a matrix of the r-squared values of all the 210 possible combinations. The r-squared values are derived from OLS regressions against the Carhart model. The vertical axis is invested in (long) and the horizontal axis is shorted.