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COMBINING VALUE AND MOMENTUM

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This paper considers several popular portfolio implementation techniques that maximize exposure to value and/or momentum stocks while taking into account transaction costs. Our analysis of long-only strategies illustrates how a strategy that simultaneously incorporates both value and momentum outperforms a strategy that combines pure-play value and momentum portfolios that are formed independently. There are two advantages of the simultaneous strategy. The first is the reduction in transaction costs; the second is better utilization of unfavorable value and momentum information in a long-only portfolio. Our analysis also addresses the optimal way to combine the faster-moving momentum signal with the slower-moving value signal.

1 Introduction

Financial economists have identified a number of firm-level characteristics that are associated with excess returns. Two actively discussed characteristics include value and momentum. Fama and French (1992), Lakonishok *et al.* (1994), among others, find evidence of a value effect; i.e., high book-to-market stocks tend to have higher average returns when compared to low book-to-market stocks. Jegadeesh and Titman (1993, 2001) document a momentum effect; i.e., stocks with high past returns over the previous 6–12 months outperform stocks with low past returns. Subsequent work provides evidence of return premia associated with both value and momentum in different industries, countries, and time periods.

The asset management industry offers a number of investment vehicles that capture the return premia associated with these stock characteristics. These include both long-only and long/short strategies that combine the concepts in a single portfolio, as well as what we call pure-play momentum and

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value portfolios. This paper, which focuses on long-only strategies, describes the advantages of combining the concepts in an integrated portfolio. Our analysis explores two potential advantages of a combined approach. The first is that the combined approach can better utilize the unfavorable information that is conveyed by stock-level characteristics. For example, the fact that low book-to-market stocks tend to have poor returns is ignored in the long-only pure-play momentum portfolios. The second is that combined approaches can potentially reduce turnover and transaction costs. The advantage of the pure-play portfolios, which comes from the fact that individual asset management firms may have a comparative advantage in managing a particular focused strategy, is not addressed in this paper.

In our analysis of how to optimally combine these concepts we pay particular attention to differences between what we refer to as fast- and slow-moving characteristics. Momentum is a relatively fast-moving characteristic, since returns from year to year are relatively independent, while value is a relatively slow-moving characteristic, since it is based on levels rather than changes in market values. Clearly, the reduction in transaction costs from combining strategies is likely to be low if the characteristics in question are all very slow moving. However, when incorporating faster-moving characteristics like momentum, there is greater turnover and thus more potential to decrease transaction costs by optimally combining the signals. Moreover, as we show, the way in which the fast and slow characteristics are combined is especially important for the smaller capitalization stocks, since these stocks show greater value and momentum premiums and generate larger trading costs.

Our analysis starts by constructing pure-play long-only portfolios that select stocks based on either past returns or book-to-market rankings. We find that the pure-play value portfolio outperforms the overall market even after accounting for transaction costs that we estimate from Bid-Ask spreads. In contrast, the pure-play momentum portfolio, which exhibits high Sharpe ratios before transaction costs, in certain cases underperforms the market portfolio after transaction costs due to higher turnover. A 50–50 linear combination of pure-play value and momentum portfolios produces a modest improvement in Sharpe ratios after accounting for transaction costs for large capitalization portfolios due to the diversification benefits of combining value and momentum. The combination of small capitalization pure-play value and momentum portfolios, however, produces no improvement in after-transaction cost Sharpe ratios when compared to the small value pure-play portfolio due to the greater costs of trading momentum among small securities.

Combinations of pure-play value and momentum portfolios are then compared with portfolios that integrate value and momentum signals into a single portfolio. The integrated portfolios are formed using two approaches. Our first approach uses a technique that chooses the portfolio based on the average value and momentum rank of each stock. This approach outperforms the pure-play approach, but because of the trading generated by the momentum signal, the transaction costs associated with this approach are still quite high. Our second approach combines the momentum and value signals in a way that substantially reduces turnover. After the initial positions are chosen, this approach initiates new trades only when both value and momentum signals are sufficiently favorable.

With our second approach, the combination of momentum and value can reduce turnover relative to the turnover of the pure value portfolio. The reduction in turnover arises because a drop in the price of a stock, which might trigger a purchase in a pure value portfolio, may not trigger a purchase when the strategy also accounts for the stock's negative momentum. Although this second approach exhibits less exposure to momentum than the other approaches we consider, it generates much lower turnover, which leads to higher Sharpe ratios after transaction costs. As we show, the second approach is favored over the first approach when transaction costs are high, when the premium for the slow signal (value) is high relative to the fast signal (momentum), and when the signals are highly correlated.

We are, of course, not the first to consider how momentum and value signals can be combined. Asness (1997) and Daniel and Titman (1999) find that value strategies are strongest among low-momentum (loser) securities, and momentum strategies are strongest among growth (low book-to-market) securities. While we do not explore the benefits of tilting more towards momentum for the growth stocks, we acknowledge that this tilt would further increase the Sharpe ratio of our combined portfolio. More recently, Asness *et al.* (2013) show that within and across asset classes, momentum and value are negatively correlated and illustrate the gains associated with combining pure-play momentum and value portfolios. However, their analysis does not explore the issues associated with utilizing unfavorable information for long-only portfolios and they do not consider implementation in the presence of transaction costs.

There are also several papers which ask whether the momentum premium is exploitable after taking into account transaction costs. For example, Jegadeesh and Titman (1993) estimate that semi-annual turnover for a long/short momentum portfolio is 84.8%, which after incorporating a one-way transaction cost of 0.5% still results in 9.29% per year in trading profits. Grundy and Martin (2001) analyze the same strategy and find that net momentum profits remain statistically significant if round-trip trading costs are less than 1.5%. More recently, Frazzini *et al.* (2012) calculate the total transaction costs from the trades of a large institutional investor and also conclude that momentum profits are achievable after transaction costs.

Although we do not carefully examine the transaction costs associated with these strategies, it should be noted that our assumed transaction costs, which are based on observed Bid-Ask spreads, are somewhat higher than what is assumed in these earlier studies. However, it should also be noted that others, who explicitly consider market impact, assume trading costs that are considerably higher and have concluded that pure-play momentum portfolios are not profitable after transaction costs.[1]

The paper that is most closely related to ours is Israelov and Katz (2011), which examines a two-stage optimization technique, like ours, that combines fast and slow signals. The main difference is that they examine a long/short country selection model for trading 18 developed market country indices. Since this study examines indices, the assumed transaction costs are relatively low. It should also be noted that momentum is included as one of their slow signals (weekly reversals are the fast signal). In contrast, our focus is on trading less-liquid individual stocks, where momentum trades are a material contributor to transaction costs.

The rest of this paper is organized as follows. The first section describes the data sources and methodology behind how we construct portfolios and calculate turnover. The second section presents return sorts on various characteristics and pure-play portfolios formed on single characteristics constructed using the ranged approach. The third and fourth sections report results for portfolios that combine multiple characteristics and sub-sample analysis starting in January 2000. The final section concludes.

2 Data sources and methodology

The starting sample for this study includes all NYSE, AMEX, and NASDAQ stocks listed on the Center for Research in Security Prices (CRSP) return files during the period January 1975–December 2013. Information on stock returns, industry codes, market capitalizations, and prices are taken from the CRSP database. Market, size, value and momentum factor returns, and one-month Treasury rates are provided by Ken French. Information used to construct book equity is taken from the COMPUSTAT database. Consistent with previous studies, we exclude real estate investment trusts and utility stocks.[2]

Portfolios are constructed for both the large capitalization universe (similar to Russell 1000) and the small capitalization universe (similar to Russell 2000). Large capitalization stocks are the 1,000 largest firms based on market capitalization at the beginning of the month, with all other stocks classified as small capitalization stocks. Book equity is equal to shareholders' equity plus deferred taxes less preferred stock.[3] The book-to-market (B/M) ratio is defined as book equity divided by beginning-of-month market equity. Information on book equity and assets is taken from the most recent financial statement using a minimum lag of four months from portfolio formation. Momentum is defined as the past 12-month return, excluding the most recent month. To be included in the portfolios we analyze, a stock must have a valid market capitalization at the beginning of month $t - 12$ and a valid return in month $t - 12$. Portfolios are rebalanced once a month.

A stock's book-to-market ratio and momentum are the stock characteristics that define when the stocks are traded, and their market capitalizations determine how much of the stock we buy or sell. Specifically, stocks are assigned a characteristic score (F_{k}) each month based on the sum of the stocks with the same or lower characteristic values (F_{j}) divided by the total market capitalization of the eligible universe multiplied by 100. A stock's score captures the percentage of aggregate market capitalization of stocks that have lower or equal characteristic values. For example, a stock with a book-to-market ratio of 2 would have a score of 75 if 75% of the total capitalization of the stock market consisted of stocks with book-to-market ratios less than 2.

$$\textit{Characteristic score}_k = \frac{\sum_{j=1}^{k} Cap_j}{\sum_{i=1}^{N} Cap_i} \times 100\, \forall\, n,\ j\ \ where\ F_k \geq F_j$$

Take for example three stocks A, B, C that have book-to-market ratios of 0.5, 1.0, and 1.5 and capitalizations of \$200 MM, \$300 MM, and \$500 MM, respectively. The characteristic score for stock A is equal to $200/(200 + 300 + 500) \times 100 = 20$, and the score for security B is equal to $(200 + 300)/(200 + 300 + 500) \times 100 = 50$. The score of 50 for stock B indicates that 50% of the aggregate market capitalization (including stock B) has the same or a lower B/M ratio than stock B, while 50% of the market has a higher B/M ratio.

Portfolios are rebalanced using Buy-and-Sell thresholds. To avoid selling a stock soon after it is purchased, we define buy and sell ranges based on a *stock's value and momentum scores* relative to the scores of other stocks in the eligible universe.

At the beginning of each month, eligible stocks with characteristic scores that are higher than the Buy threshold and are not in the portfolio are purchased. Stocks that are in the portfolio but have characteristic scores that are lower than the Sell threshold are sold.[4] Portfolio Buy and

Sell thresholds are defined in this way to allow an investor to target a specific percentage of the universe's aggregate capitalization with high scores and thus high expected returns. Stocks within each portfolio are value-weighted and are placed into portfolios that are constructed to have roughly equal market capitalizations.

We estimate Sharpe ratios, the difference between the annualized monthly excess portfolio return less the risk-free rate divided by the standard deviation, with and without transaction costs. Turnover is calculated by tracking the total amount bought or sold each month relative to the portfolio size. We assume that the portfolio is initially seeded with capital in January 1975 and does not have any other capital flows thereafter.[5] We estimate trading costs for both small and large capitalization stocks as the sum of historical Bid/Ask spreads and trading commissions.

$$Spread = 1 - \frac{Bid}{Ask}$$

Figure 1 reports value-weighted average Bid/Ask spreads for small and large capitalization stocks over the period January 1993–December 2013.[6] The time-series average Bid/Ask spread for small stocks is 2.74% and 0.86% for large stocks for the period 1993–1999. Since 2000, the time-series average Bid/Ask spread has fallen to 0.61% for small stocks and 0.20% for large stocks. The second component of direct trading costs is commissions. Keim and Madhavan (1997) find an average broker commission rate of 0.20% for trades from January 1991 through March 1993. Jones and Lipson (2001) find average one-way commissions of 0.12% for NYSE trades in 1997.

We use two rough estimates of trading costs to provide some insight into how the performance of different strategies is affected by turnover. For our first estimate of round-trip trading costs, TC_{High}, we assume 2.94% and 1.06% for small and large capitalization stocks, respectively. These numbers are equal to the average Bid/Ask spreads from 1993 to 1999, plus 0.20% for broker commissions. For our second estimate, TC_{Low}, we assume 0.82% for small stocks and 0.41% for large stocks, using estimates of Bid/Ask spreads from 2000 to 2013, plus 0.20% for broker commissions.[7]

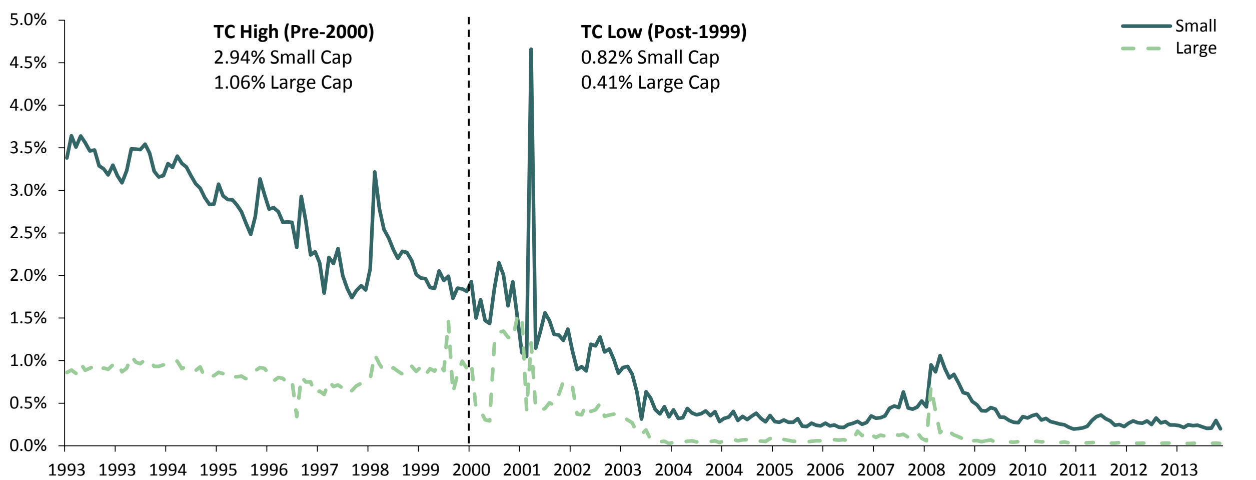

Figure 1 Weighted average Bid/Ask spreads from January 1993 to December 2013 for stocks with different market capitalizations.

Bid/Ask spread is equal to 1 – Ask/Bid. Small refers to stocks that are not in the largest 1,000 by market capitalization. Large refers to stocks that are in the largest 1,000 by market capitalization.

3 Single factor portfolios

Table 1 displays value-weighted returns for portfolios formed on book-to-market and momentum over the period January 1975 to December 2013. Each month, small and large stocks are sorted into four portfolios with roughly equal capitalizations. High book-to-market stocks outperform low book-to-market stocks by 0.61% per month for small stock portfolios and 0.30% for large stock portfolios. The difference between value and growth for large stocks is not significantly different from zero ($t = 1.57$). The highest quartile momentum portfolio has 0.98% higher average returns when compared to the lowest quartile momentum portfolio for small stocks; for large stocks, the difference is 0.52%. Momentum average return differences are more robust than value average return differences, indicated by higher t-statistics. Similar to previous studies (e.g., Jegadeesh and Titman (1993) and Fama and French (1992)), we find stronger results for momentum and value among small stocks.

We start our main analysis by examining pure-play momentum and value portfolios. Table 2 presents results for value-weighted, long-only small stock (Panel A) and large stock (Panel B) portfolios formed on momentum and value characteristics using different Buy-and-Sell thresholds. The first row of each panel displays the market portfolio formed by capitalization-weighting all securities in the eligible universe for large (top 1,000 stocks) and small (all but the top 1,000 stocks).

The table describes the returns of long-only portfolios that are seeded at the beginning of 1975 as a value-weighted portfolio of stocks that have characteristic scores greater than the average of the Buy and Sell thresholds. Each month, portfolios are rebalanced by adding new stocks that have characteristic scores that exceed a Buy threshold, and selling stocks that have characteristic scores that are less than the Sell threshold. For example, the 90 Buy, 70 Sell Portfolio adds stocks with scores higher than 90 that are not in the portfolio and sells stocks in the portfolio with scores less than 70. We re-weight, so that the portfolio continues to be value-weighted. It should be noted that this procedure induces some path dependence. A stock that is not in the original portfolio and has a score of 89 will never be purchased. Similarly,

Table 1 Book-to-market and momentum portfolio return sorts over January 1975–December 2013.

	Low	2	3	High	High–Low	*T*-Stat
Panel A: *Small capitalization stocks*						
B/M	1.07%	1.28%	1.54%	1.68%	0.61%	2.68
Momentum	0.84%	1.23%	1.57%	1.82%	0.98%	4.72
Panel B: *Large capitalization stocks*						
B/M	0.99%	0.96%	1.11%	1.29%	0.30%	1.57
Momentum	0.90%	0.94%	1.09%	1.42%	0.52%	2.41

Panel A reports value-weighted portfolio returns for small stocks that are not in the largest 1,000 by market capitalization. Panel B reports value-weighted portfolio returns for large stocks that are in the largest 1,000 by market capitalization. B/M is book equity divided by market equity. Momentum is the past year's buy-and-hold return excluding the most recent month. Each month, stocks are sorted into five portfolios with roughly equal market capitalization using either B/M or momentum stock characteristics. High–Low is the long/short return equal to going long stocks with high B/M or momentum and short stocks with low B/M or momentum, respectively. All returns are reported on a monthly basis.

Table 2 Single factor portfolios formed on different breakpoints from January 1975 to December 2013.

Style	Buy	Sell	Compound Return	Standard Deviation	Sharpe Ratio	Turnover	Sharpe after TC_{High}	Sharpe after TC_{Low}	N	HML	MOM
Panel A. Small capitalization stocks											
Small Market	—	—	15.0%	21.4%	0.53				2,514	0.15	−0.12
Value	90	70	18.3%	20.3%	0.69	31%	0.65	0.68	1,164	0.69	−0.21
Value	95	65	18.4%	20.6%	0.69	25%	0.65	0.68	923	0.70	−0.18
Momentum	90	70	19.1%	26.4%	0.61	118%	0.48	0.58	580	−0.19	0.43
Momentum	95	65	17.1%	27.8%	0.54	104%	0.43	0.51	390	−0.27	0.42
$0.5V + 0.5M$	90	70	19.2%	21.7%	0.70	75%	0.59	0.67	872	0.25	0.11
$0.5V + 0.5M$	95	65	18.3%	22.5%	0.65	64%	0.56	0.62	657	0.22	0.12
Panel B. Large capitalization stocks											
Large Market	—	—	12.4%	15.9%	0.51				1,000	−0.03	0.00
Value	90	70	13.9%	18.5%	0.53	26%	0.52	0.53	290	0.54	−0.19
Value	95	65	14.2%	18.8%	0.54	20%	0.53	0.54	239	0.57	−0.16
Momentum	90	70	16.7%	21.1%	0.61	157%	0.53	0.58	233	−0.20	0.52
Momentum	95	65	16.7%	22.4%	0.58	133%	0.52	0.56	179	−0.31	0.50
$0.5V + 0.5M$	90	70	15.7%	18.1%	0.63	91%	0.57	0.61	262	0.17	0.17
$0.5V + 0.5M$	95	65	15.9%	18.7%	0.62	76%	0.58	0.60	209	0.13	0.17

Small Market is a value-weighted portfolio of all stocks that are not in the top 1,000 by market capitalization. Large Market is a value-weighted portfolio of all stocks that are in the top 1,000 by market capitalization. At the start of January 1975, portfolios consist of the top (Buy–Sell)/2 % of aggregate market capitalization with highest book-to-market ratios (Value) or past one year returns skipping the most recent month (momentum). At the beginning of each month, securities with capitalization ranks that are higher than Buy/100 and are not owned by the portfolio are purchased; securities with capitalization ranks that are lower than Sell/100 and are owned by the portfolio are sold. The last two rows of each panel display results for a 50/50 linear combination of value and momentum portfolios (with specific breakpoints). Annualized compound returns, standard deviation, Sharpe ratios, and turnover are reported. Sharpe after TC_{High} displays the Sharpe ratio over the entire sample period after assuming round-trip transactions cost of 2.94% and 1.06% for small and large capitalization style portfolios. Sharpe after TC_{Low} displays the Sharpe ratio over the entire sample period after assuming round-trip transactions cost of 0.82% and 0.41% for small and large capitalization style portfolios. N is the average number of stocks per portfolio. HML and MOM reflect value, and momentum factor exposures from 4-factor regression of portfolio returns on the market, size, value, and momentum factors. Panel A reports results for small capitalization stock portfolios; Panel B reports results for large capitalization stock portfolios.

a stock that is in the original portfolio and has a score of 71 will never be sold.

Higher Buy and Sell thresholds usually result in higher average returns and higher turnover, as a smaller percentage of aggregate capitalization is targeted. Higher Buy–Sell ranges usually result in slightly lower average returns and lower turnover, as portfolios are less focused on high expected return stocks and the characteristics of stocks have to change more to exit the portfolio.[8]

Small value portfolios have average annualized compound returns that range from 18.3% to 18.4% per year, with volatility between 20.3% and 20.6%. The Sharpe ratios (before transaction costs) are 0.16 higher than for the small market portfolio (the value-weighted portfolio of all small cap stocks). The turnover for the small value portfolios is relatively low, ranging from 25% to 31%, indicating average security holding periods of 3 – 4 years.

The average small momentum portfolio outperforms the small market portfolio by 3.1% per year on a compound basis with 5.8% in additional volatility. These portfolios have positive momentum and negative value factor exposure and turnover is very high, exceeding 100% per year. For the momentum portfolio with wider breakpoints [Buy 95, Sell 65], the compound returns are 2% less than the portfolio with more narrow breakpoints [Buy 90, Sell 70] due to more negative value factor exposure and higher volatility. Despite the high return premium of momentum relative to value among small capitalization stocks, the high volatility of the small momentum portfolio causes gross Sharpe ratios to be lower than those of the small value portfolio.

Because small value generates relatively low turnover, transaction costs reduce their Sharpe ratios on average by only 5.8% using the high estimate of transaction cost (TC_{High}), and 1.6% using the low estimate of transaction cost (TC_{Low}). In contrast, the high turnover of small momentum portfolios reduces their after T-cost Sharpe ratios by close to 21.0% and 5.8% using the high and low transaction costs, respectively. None of the small momentum portfolios' Sharpe ratios after TC_{High} is higher than the Sharpe ratio of the small market portfolio, casting doubt on the usefulness of small momentum as an implementable investment strategy.

One of the appeals of combining value and momentum is the natural negative correlation of these two factors. Since negative returns reduce market equity, low momentum stocks tend to have high book-to-market ratios, and since positive returns increase market equity, high momentum stocks tend to have low book-to-market ratios. Because of this, value and momentum pure-play portfolio excess returns relative to the market tend to be negatively correlated. Additionally, even though the percentage of aggregate market capitalization is similar for the small value and momentum portfolios, the small value portfolio tends to hold close to twice as many securities as the small momentum portfolio due to holding many stocks with small market capitalizations.

The last two rows of Table 2 Panel A invest equally between the small capitalization value and momentum portfolios. From a practical perspective, this portfolio can be viewed as investing in one manager to obtain value exposure and another manager to obtain momentum exposure. While the Sharpe ratios after accounting for transaction costs are higher than the Sharpe ratio of the small market portfolio, these portfolios underperform the pure-play value portfolio due to the higher turnover of momentum.

The excess returns of large capitalization portfolios tend to be smaller than the excess returns of small capitalization portfolios. Similar to Table 1, a weak value premium among large capitalization stocks leads to relatively smaller improvements in the Sharpe ratio over the large market portfolio. However, the large stock momentum portfolio has a higher Sharpe ratio than the large value portfolio and the large market portfolio. Due to differences in portfolio design, the turnover for these long-only momentum portfolios is far lower than that of the six-month overlapping portfolio strategy proposed in Jegadeesh and Titman (1993). Nevertheless, transaction costs negate much of the difference in the Sharpe ratios between large value and large momentum portfolios. Using larger estimates of Bid/Ask spreads from pre-2000 (TC_{High}), Sharpe ratios of large value and large momentum portfolios are very similar. Analysis of Sharpe ratios after transaction costs using data on Bid/Ask spreads post-1999 (TC_{Low}) shows large momentum portfolios having higher Sharpe ratios than large value portfolios. Largely due to the similarities in Sharpe ratios and the negative correlation of large value and large momentum excess returns, the 50–50 combination of pure-play value and momentum generates higher Sharpe ratios even after transaction costs when compared to either of the individual portfolios.

4 Combining value and momentum

The next step of our analysis examines other ways to combine value and momentum. We consider two alternative implementation strategies that utilize information in value and momentum characteristics jointly. As we show, both approaches improve on comparable combinations of pure-play single-factor long-only constrained portfolios by incorporating unfavorable information from the other characteristic.

The first strategy (denoted Avg. V/M) ranks firms by Momentum and Value separately,[9] and then computes the average rank (R_j) to calculate the stock's Avg. V/M score.

$$Avg\ V/M\ Score_k = \frac{\sum_{j=1}^{k} Cap_j}{\sum_{i=1}^{N} Cap_i} \times 100\ \forall n,\ j\ \ where\ R_k \geq R_j$$

The Avg. *V/M* score reflects the percentage of aggregate market capitalization that has the same or lower average momentum and value rank. This score dictates when stocks enter and exit the portfolio in the same way that the book-to-market and momentum scores determine the portfolio choice in our preceding analysis.

The first two rows of each panel on Table 3 report average returns, volatilities, Sharpe ratios, and value and momentum factor exposures for portfolios formed using this strategy. We then compare these portfolios with a 70% Value/30% momentum (denoted 0.7V + 0.3M) linear combination of single-factor portfolios from Table 2 that provide similar levels of value (HML) and momentum (MOM) exposure to the two approaches we consider.

When compared to the small 0.7V + 0.3M portfolio, small Avg. *V/M* portfolios have on average 3.0% higher compound returns and 1.3% lower standard deviations, resulting in meaningful increases in Sharpe ratios. For the small-capitalization portfolios, Sharpe ratios after accounting for transactions cost increase by 21% on average. Corresponding risk-adjusted performance improves for large capitalization portfolios as well — Sharpe ratios after transaction costs increase by 10%.

There are two main benefits of using this approach over combining single-factor portfolios. First, this approach increases average returns by taking into account unfavorable information on both characteristics by avoiding value stocks that have negative momentum and positive momentum stocks that are growth-oriented. As a result,

Table 3 Combined momentum and value portfolio and value portfolio using momentum to motivate trades formed on different breakpoints from January 1975 to December 2013.

Style	Buy	Sell	Compound Return	Standard Deviation	Sharpe Ratio	Turnover	Sharpe after TC_{High}	Sharpe after TC_{Low}	N	HML	MOM
Panel A. Small capitalization stocks											
Small Market	—	—	15.0%	21.4%	0.53				2,514	0.15	−0.12
Avg. *V/M*	90	70	22.0%	19.6%	0.87	89%	0.74	0.84	847	0.61	0.13
Avg. *V/M*	95	65	21.4%	19.7%	0.84	62%	0.75	0.82	685	0.64	0.11
Value $\mid m > 50\%$	90	70	20.4%	20.5%	0.77	20%	0.74	0.76	881	0.73	−0.06
Value $\mid m > 50\%$	95	65	20.3%	20.9%	0.76	16%	0.74	0.75	638	0.76	−0.06
$0.7V + 0.3M$	90	70	19.0%	20.7%	0.71	57%	0.63	0.69	989	0.42	−0.01
$0.7V + 0.3M$	95	65	18.5%	21.2%	0.68	48%	0.61	0.66	763	0.41	0.00
Panel B. Large capitalization stocks											
Large Market	—	—	12.4%	15.9%	0.51				1,000	−0.03	0.00
Avg. *V/M*	90	70	16.4%	17.3%	0.68	103%	0.62	0.66	234	0.36	0.18
Avg. *V/M*	95	65	16.1%	17.6%	0.66	75%	0.62	0.65	191	0.37	0.17
Value $\mid m > 50\%$	90	70	14.8%	18.1%	0.58	17%	0.57	0.58	247	0.45	−0.01
Value $\mid m > 50\%$	95	65	14.6%	17.8%	0.58	12%	0.57	0.58	192	0.44	−0.02
$0.7V + 0.3M$	90	70	15.1%	17.8%	0.60	65%	0.57	0.59	273	0.32	0.02
$0.7V + 0.3M$	95	65	15.3%	18.3%	0.60	54%	0.57	0.59	221	0.30	0.04

Small Market is a value-weighted portfolio of all stocks that are not in the top 1,000 by market capitalization. Large Market is a value-weighted portfolio of all stocks that are in the top 1,000 by market capitalization. At the start of January 1975, portfolios consist of the top (Buy–Sell)/2% of aggregate market capitalization with average value/momentum rank (Avg. *V/M*) or highest book-to-market ratios (value $\mid m > 50\%$). At the beginning of each month, securities with characteristic scores that are higher than Buy/100 and are not owned by the portfolio are purchased; securities with characteristic scores that are lower than Sell/100 and are owned by the portfolio are sold. The last four rows of each panel display portfolios formed on value that use momentum to motivate trading that yield the highest Sharpe ratio. Value $\mid m > 50\%$ reflects a value portfolio (as defined above) that does not buy securities with momentum characteristic scores that are less than 50%, and sell securities with momentum characteristic scores that are greater than 50%. The last two rows of each panel display results for a 70/30 linear combination of value and momentum portfolios (with specific breakpoints). Annualized compound returns, standard deviation, Sharpe ratios, and turnover are reported. Sharpe after TC_{High} displays the Sharpe ratio over the entire sample period after assuming round-trip transaction costs of 2.94% and 1.06% for small and large capitalization style portfolios. Sharpe after TC_{Low} displays the Sharpe ratio over the entire sample period after assuming round-trip transaction costs of 0.82% and 0.41% for small and large capitalization style portfolios. N is the average number of stocks per portfolio. HML and MOM reflect value and momentum factor exposures from a 4-factor regression of portfolio returns on the market, size, value, and momentum factors. Panel A reports results for small capitalization stock portfolios; Panel B reports results for large capitalization stock portfolios.

both the value and momentum factor exposures are higher than the linear combination of single-factor value and momentum portfolios. Second, portfolio volatility drops, as value and momentum premiums are negatively correlated. The limitation of this approach is an increase in turnover, as the faster signal drives much of the trading.

The second implementation strategy differs in two relevant ways. First, rather than selecting stocks based on a combined signal, after the initial portfolio is formed (based only on value scores as in the previous section), this strategy buys stocks only when both characteristics are favorable and sells stocks only when both characteristics are unfavorable. Second, the strategy does not equally weight the signals. Because the momentum signal decays much more quickly, the strategy puts greater weight on value.

To be more specific, the portfolio is initially formed in the same way as the value portfolios in Table 2, but for each trade, value and momentum together play a role when a security is purchased or sold. Purchases require a security to simultaneously have a value score that is higher than a Buy threshold, e.g., 90, and a momentum score that is higher than 50. Sales require a security to have a value score that is lower than the Sell threshold, e.g., 70, and a momentum score that is less than 50.[10]

To understand the mechanics of this approach, suppose a stock returns 25% in the past 12 months (actually, over the time period $t - 13$ to $t - 2$) and the market return over this same period is 5%. If this stock, which has favorable momentum, is already in the portfolio, it will not be sold even if it has migrated to growth. Similarly, a stock that falls 15% and thus has negative momentum, will not be added to the portfolio even if its book-to-market ratio has moved it into the value category. Since momentum is required to initiate trades but will never by itself trigger a trade, this approach for adding momentum exposure to a portfolio reduces rather than increases portfolio turnover.

The fourth and fifth rows of each panel in Table 3 (denoted Value $| m > 50\%$) display average returns, volatilities, Sharpe ratios, and value and momentum factor exposures for portfolios that use this second implementation strategy. As we show, the process generates similar or higher Sharpe ratios and reduces turnover by roughly one-third when compared to pure-play value portfolios for both small and large capitalization portfolios. These portfolios have higher average returns relative to pure-play value portfolios due to greater momentum exposure and lower turnover. When compared to the benchmark $0.7\text{V} + 0.3\text{M}$ small portfolios, small Value $| m > 50\%$ portfolios' Sharpe ratios after transaction costs increase on average by 19% using the larger estimate of transaction costs (TC_{High}) and 13% using the lower estimate of transaction costs (TC_{Low}). For large capitalization Value $| m > 50\%$ portfolios, Sharpe ratios are similar when compared to the 70/30 linear combination of large value and momentum portfolios. Among large capitalization stocks, we find the benefits of greater momentum factor exposure associated with linear combination of single-factor long-only portfolios are largely cancelled out by the lower exposure to value and the higher turnover.

The two different approaches use information in value and momentum differently. The first approach may buy a stock that has negative momentum, as long as the B/M ratio is high enough. One signal has the ability to outweigh the other. For the second approach, a stock may be bought if it has a moderately high B/M ratio and slightly positive momentum. Neither signal is required to be extreme, but both are required to be favorable for a purchase to occur.

These differences create the following trade-off when comparing the two approaches presented in Table 3. The first approach takes into account information in momentum and value by trading off exposure to both signals equally. The disadvantage of this approach, however, is much higher trading costs, as changes in momentum scores have a large influence on trading. The second approach does not fully take into account either signal, but incurs far less trading.

From our analysis in Table 3, both approaches that incorporate negative characteristic information by avoiding growth and negative momentum stocks improve risk-adjusted performance over single-factor portfolios that fail to incorporate this information due to the long-only constraint. Indeed, one can see that combining momentum and value with these approaches can lead to higher rates of return as well as lower standard deviations. What is not clear-cut from the analysis is which portfolio design is preferred. The optimal procedure for implementing value and momentum will depend on expectations of trading costs as well as return premia. The first approach (Avg. *V/M*) generates higher momentum and lower value exposure when compared to the second approach (Value | $m > 50\%$), but with significantly more turnover. Over our sample period, which starts in 1975, the first approach generally generates higher Sharpe ratios after transaction costs, as the benefits of greater momentum exposure outweigh the increase in turnover and the reduction in value exposure.

The optimal weight placed on the two signals examined in this study, and thus the implementation strategy, depends on a combination of the difference in signal speed, which has a direct impact on turnover, and the risk premium associated with the signals. The first approach, which generates more turnover, has a larger adverse impact on risk-adjusted performance if trading costs are high. The second approach, which has greater exposure to the slow factor (HML) and less exposure to the fast factor (MOM), yields better performance if the return premium associated with the slow signal is large relative to the fast

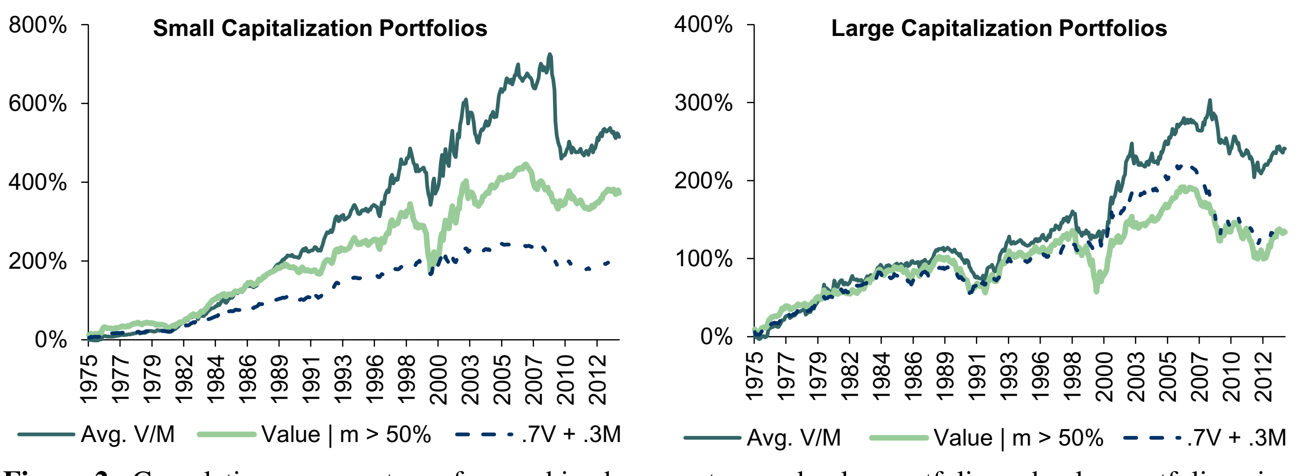

Figure 2 Cumulative excess returns for combined momentum and value portfolio and value portfolio using momentum to motivate trades formed on 90% Buy and 70% Sell breakpoint from January 1974 to December 2013.

The cumulative excess return is equal to the buy-and-hold return of a portfolio that is rebalanced once a month and is long a particular momentum or value portfolio less transactions cost (TC_{Low}) and short the respective market portfolio. The left-most figure displays cumulative returns for small capitalization portfolios, the right-most figure displays cumulative returns for large capitalization portfolios.

Table 4 Various momentum and value portfolio returns formed on 90% Buy and 70% Sell breakpoints from January 2000 to December 2013.

Style	Buy	Sell	Compound Return	Standard Deviation	Sharpe Ratio	Turnover	Sharpe after TC_{High}	Sharpe after TC_{Low}	N	HML	MOM
Panel A. Small capitalization stocks											
Small Market	—	—	9.1%	23.4%	0.41				2,514	0.18	−0.14
Value	90	70	12.2%	23.2%	0.53	30%	0.49	0.52	1,175	0.77	−0.29
Momentum	90	70	6.0%	27.6%	0.28	123%	0.15	0.24	576	−0.08	0.47
$0.7V + 0.3M$	90	70	10.8%	22.5%	0.48	58%	0.41	0.46	995	0.51	−0.06
Avg. V/M	90	70	13.8%	19.9%	0.66	91%	0.52	0.62	854	0.62	0.13
Value $\| m > 50\%$	90	70	13.3%	20.9%	0.61	18%	0.59	0.61	884	0.79	−0.09
Panel B. Large capitalization stocks											
Large Market	—	—	3.7%	16.1%	0.19				1,000	−0.02	0.00
Value	90	70	4.7%	20.6%	0.23	22%	0.22	0.23	299	0.60	−0.20
Momentum	90	70	2.8%	21.5%	0.15	163%	0.07	0.12	232	−0.19	0.52
$0.7V + 0.3M$	90	70	4.6%	18.6%	0.23	64%	0.19	0.21	279	0.37	0.01
Avg. V/M	90	70	7.3%	17.3%	0.38	97%	0.32	0.36	262	0.37	0.15
Value $\| m > 50\%$	90	70	6.6%	18.3%	0.34	13%	0.33	0.33	252	0.58	−0.04

Small Market is a value-weighted portfolio of all stocks that are not in the top 1,000 by market capitalization. Large Market is a value-weighted portfolio of all stocks that are in the top 1,000 by market capitalization. At the start of January 2000, portfolios consist of the top (Buy–Sell)/2% of aggregate market capitalization with value, momentum, and average value/momentum score (Avg. V/M) or highest book-to-market ratios (Value $|m > 50\%$). $0.7V + 0.3M$ display results for 70/30 linear combinations of value and momentum portfolios (with specific breakpoints). At the beginning of each month, securities with characteristic scores that are higher than 90 and are not owned by the portfolio are purchased; securities with characteristic scores that are lower than 70 and are owned by the portfolio are sold. The last four rows of each panel display portfolios formed on value that use momentum to motivate trading that yields the highest Sharpe ratio. Value $| m > 50\%$ reflects a value portfolio (as defined above) that does not buy securities with momentum characteristic scores that are less than 50%, and does not sell securities with momentum characteristic scores that are greater than 50%. Annualized compound returns, standard deviation, Sharpe ratios and turnover are reported. Sharpe after TC_{High} displays the Sharpe ratio over the entire sample period after assuming round-trip transaction costs of 2.94% and 1.06% for small and large capitalization style portfolios, respectively. Sharpe after TC_{Low} displays the Sharpe ratio over the entire sample period after assuming round-trip transaction costs of 0.82% and 0.41% for small and large capitalization style portfolios, respectively. N is the average number of stocks per portfolio. HML and MOM reflect value and momentum factor exposures from a 4-factor regression of portfolio returns on the market, size, value and momentum factors. Panel A reports results for small capitalization stock portfolios; Panel B reports results for large capitalization stock portfolios.

signal. If the signals used to construct portfolios have high correlations to one another, the second approach is preferred, as the fast signal does not add much to performance but increases turnover. If the signals have negative or low correlations, the first approach is preferred, as there are diversification benefits associated with a more-equal loading on the two signals.

Figure 2, which illustrates the after-transaction costs (using TC_{Low}) cumulative excess returns of our strategies over the entire sample period, shows that each of the different approaches we consider improves on the market index. The return time series provides additional insight into how each portfolio performed during different market environments. For both small and large capitalization portfolios, Avg. *V/M* generates the largest outperformance, improving on the respective market index by 514% and 241% for small and large capitalization stocks, respectively. The performance of all three strategies is poor during the tech-boom in the late 1990s (due to value) and during the market rebound after March 2009 (due to momentum).

5 Post-2000 value and momentum portfolio performance

Starting in the early 1990s, a number of changes in the financial markets took place that likely influenced the profitability of both momentum and value strategies. The first was the documentation of these return patterns in the academic literature and the emergence of quantitative equity strategies that exploited them. The second was various financial market innovations that reduced transaction costs. In this section, we examine our portfolio strategies starting in January 2000, eight years after the Fama and French (1992) paper on the book-to-market effect and seven years after the Jegadeesh and Titman (1993) paper on the momentum effect were published. Table 4 reports the results.

One caveat for the analysis of this more recent period: The starting period is right after a period (1998–1999) when the value strategy generated very negative returns and before a period (2000–2003) when the value strategy generated very high returns. For momentum, one of the worst periods, March 2009–August 2009, is included, which has a relatively large effect on momentum returns over this sub-period.[11]

For both small and large stock portfolios, 70/30 linear combinations of pure-play value and momentum portfolios underperform corresponding value portfolios due to the low momentum premium. However, despite the poor performance of momentum over this period, both implementation techniques that jointly take into account both momentum and value characteristics have higher Sharpe ratios than the market, the pure-play value portfolio or the 70/30 linear combination of value and momentum. In other words, even in a period where momentum does relatively poorly, there can be a benefit from combining momentum with value in an integrated portfolio.

The Sharpe ratios using these two approaches are similar during this period. The first approach is preferred if transaction costs are high; the second approach is preferred if transaction costs are low. The improvement in performance, again, is due to taking into account negative characteristic information in the same portfolio, instead of ignoring this information using single-factor long-only portfolios.

6 Conclusion

The academic literature has identified a number of stock characteristics that are associated with significant excess returns. In this paper, we explore how these firm-level characteristics should be optimally combined to form portfolios, with a particular focus on momentum and value.

The potential advantage associated with combining multiple characteristics into a single long-only portfolio comes from two sources. The first is that it lowers turnover and transaction costs. While the transaction cost consideration can potentially be particularly important for portfolios with smaller capitalization stocks, our evidence suggests that transaction costs play only a modest role in determining the optimal way to combine value and momentum for large capitalization stocks. Looking forward, if we expect transaction costs to continue to decline, the advantage of portfolios that combine characteristics over single characteristic portfolios may decline. However, transaction costs are likely to always be relevant for small capitalization stocks and we find that one can still gain from incorporating a fast signal like momentum in a portfolio that targets a slow signal like value even when one is constrained to have a portfolio with very low turnover. As we show, one can use the fast signal to slow down trading and use unfavorable characteristic information in a long-only portfolio to improve the timing of the trades.

The second advantage of combining signals is that it allows one to better utilize the negative information from signals in long-only portfolios. Our evidence suggests that this advantage is also especially important for small capitalization stocks, where because of the higher costs of short-selling, it is more difficult for investors to express negative sentiment.

In this paper, we limit our analysis to combining value and momentum signals. Addressing how value and momentum strategies can be enhanced by incorporating other firm characteristics such as profitability, asset growth or analysts' revisions would be a straightforward extension of this analysis.

Notes

1 Lesmond *et al.* (2004) estimate trading costs of close to 7%, which reduces the average strategy returns to close to zero. This paper estimates trading costs using an LDV model explained by Lesmond *et al.* (1999). Korajczyk and Sadka (2004), who also consider the price impact of momentum trading, estimate the capacity for value-weighted momentum strategies in US markets to be between two and five billion before momentum profits are reduced to zero.

2 Real estate investment trusts have an SIC code equal to 6798. Utilities have SIC codes between 4900 and 4949.

3 If shareholders' equity is missing, we substitute common equity. If common equity and shareholders' equity are both missing, the difference between assets and liabilities less minority interest is selected. We set to zero the following balance sheet items, if missing: preferred stock, minority interest, and deferred taxes.

4 Eligible stocks are those stocks that are in the eligible universe. If a stock migrates from small to large, or vice versa, it is not sold immediately. Instead, the stock is allowed to remain in the portfolio and is sold as long as the characteristic score is below the Sell threshold.

5 Purchases when the portfolio is seeded in January 1975 are not included in the turnover calculation.

6 Reliable Bid/Ask spread data begin in 1993.

7 There are certain limitations to our estimates of trading costs. First, we assume that trading costs are solely determined by market capitalization, ignoring the possibility that value and momentum scores affect trading costs. Second, we analyze portfolios over the period 1975–2013 using estimates of trading costs based on Bid/Ask spread data that start in 1993, a little less than half-way through our sample period. Last, we do not directly consider price impact, which is likely to be larger for portfolios that have higher turnover and portfolios that invest in small stocks. Our estimates of trading costs are generally much larger than those reported in Frazzini *et al.* (2012), and somewhat smaller than those described by Lesmond *et al.* (2004) and Korajczyk and Sadka (2004).

8 The results of this paper are generalizable to a variety of Buy and Sell thresholds.

9 We use a simple percentile rank based on number of firms, not percentage of capitalization. Results using

percentage of capitalization are not materially different from those presented in this paper using a simple rank approach.

[10] We also examined different momentum Buy and Sell thresholds. When we constrained more trades by requiring momentum scores to be higher than 70 for a security to be purchased, and momentum scores to be less than 30 for a security to be sold, turnover decreased slightly. After transaction costs, this analysis produced very similar Sharpe ratios as the simpler version presented in this paper. Changes in the slower signal, value, generally had a larger impact on average returns and volatilities.

[11] Daniel and Moskowitz (2014) discuss the poor performance of momentum portfolios following the 2008–2009 financial crisis.

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