

Momentum Screens

A Three-Year Study

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SIMULATED PRICE MOMENTUM STRATEGIES have been shown to produce significant and economically large profits. A number of academic researchers have reported, however, that the cost of implementing a momentum strategy is greater than the strategy's potential profit. This is due to the high turnover and high trading costs associated with such strategies. At Dimensional, during the daily rebalancing of each portfolio, we use a practical approach to help protect purchases against the adverse effect of negative momentum. We also avoid the opportunity costs of selling upward momentum securities too quickly. In this article, we study the performance of our small cap and value portfolios during the three-year period ending December 2008. We find, depending on the portfolio, that our momentum strategy enhanced cumulative returns between 2.3% and 16.3% over that period.

Overview

Momentum is the tendency of securities that have outperformed (or underperformed) the market, over a three- to twelve-month period, to continue to outperform (or underperform) the market. Stated simply, it is the tendency of past winners to keep winning and past losers to keep losing relative to their peers.¹

1. Narasimhan Jegadeesh and Sheridan Titman, "Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency," *Journal of Finance* 48 (1993): 65-91.

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Simulation studies measuring the average monthly profit of a strategy that buys winners and sells losers (not accounting for trading costs) yield monthly estimates anywhere from 0.5% to 1.5%. The turnover of a typical momentum strategy, however, can be on the order of 40% per month on the long side and 60% per month on the short side. Thus, the trading costs of implementing such a strategy can be greater than the strategy's potential profit.

A price decrease relative to the market is often what causes firms to become small cap or value. The reverse is true for companies leaving the small cap and value universe. This implies that, for a portfolio that overweights small cap or value companies, purchases (or sales) will have greater exposure to downward (or upward) momentum. Thus, the daily rebalancing of such portfolios is susceptible to the negative impact of downward momentum and the opportunity cost of selling upward momentum securities too quickly.

The lack of profitability of actual momentum strategies does not prevent Dimensional from exploiting the tendency of past losers to keep losing and past winners to keep winning. To enhance the performance of our portfolios, we delay purchasing (or selling) securities in downward (or upward) momentum. Dimensional evaluates security momentum characteristics on a daily basis to determine where each security ranks.

Our patient approach does not sacrifice asset class exposure. Rather, we seek to deliver diversified asset class exposure while minimizing the negative impact of momentum on our portfolios' returns.²

Dimensional Study

In 2005, Dimensional enhanced its security momentum strategies. The enhancements, combined with our proprietary trading-strategy algorithms, assist portfolio managers in determining what purchases to delay in securities with large downward momentum, and what sales to delay to avoid the opportunity cost of selling securities in upward momentum too quickly.

It is important to note that at Dimensional, we employ a diverse set of "value added" engineering strategies when running our portfolios. The current study focuses on one of these strategies, our momentum screens. These screens, however, are integrated with many additional complementary, value-enhancing portfolio management and trading strategies. As a result, it is not easy to isolate the precise effect that momentum screens have on portfolio returns. For example, our patient trading approach also helps protect against the adverse effects of momentum when reconstituting a portfolio.

To quantify the benefit of these screens, Dimensional studied the performance of small cap and value portfolios during the three-year period ending in December 2008. In

2. Diversification neither assures a profit nor guarantees against loss in a declining market.

the remainder of this paper, we describe the study's methodology and results. We use monthly data and begin by partitioning each portfolio into buy, hold, and sell ranges. Next, we construct a control portfolio—that is, a portfolio that does not employ momentum screens—to isolate the momentum-delayed buys and sells in the actual portfolio. Finally, we compare the returns of these delayed buys and sells to the returns of the control portfolio.

Portfolio Trichotomy

Table 1 shows monthly average portfolio allocations to buy, hold, and sell ranges.

Buy Range: Portfolio's targeted universe of securities.

Hold Range: Securities just outside the buy range.

Sell Range: Securities that have left the portfolio's targeted asset class.

In this study, the ranges are formed monthly. In practice, a portfolio manager does this daily for rebalancing purposes.

Using the US Micro Cap Portfolio as an example, Table 1 shows that, on average, 80% of the portfolio's weight was in the portfolio's buy range, 16% in the hold range, and 4% in the sell range.

Table 1

Average Portfolio Buy, Hold, and Sell Range Weights January 2006-December 2008

Portfolio	Buy Range	Hold Range	Sell Range	Total
US Micro Cap	80%	16%	4%	100%
US Small Cap	82%	15%	3%	100%
Tax-Managed US Small Cap	75%	11%	14%	100%
US Small Cap Value	54%	22%	24%	100%
Tax-Managed US Targeted Value	64%	10%	26%	100%
US Large Cap Value	66%	24%	10%	100%
Tax-Managed US Marketwide Value	60%	21%	18%	100%
Asia Pacific Small Company	80%	9%	12%	100%
Continental Small Company	80%	9%	11%	100%
United Kingdom Small Company	81%	11%	8%	100%
International Small Cap Value	52%	26%	22%	100%
International Value	61%	32%	8%	100%
Emerging Markets Small Cap	77%	10%	13%	100%
Emerging Markets Value	56%	35%	9%	100%

To sort portfolios into down, neutral, and up momentum bins, we order securities in each country on a monthly basis by their momentum ranking. We categorize the lowest-ranking quartile as securities with downward momentum, the highest-ranking quartile as securities with upward momentum, and the middle 50% as neutral.

For each portfolio, we form the target buy range monthly and define it as a market-cap weighted portfolio of all securities eligible for purchase at the time of formation. In Table 2 we show the average allocation of the portfolio's buy and sell ranges and the target buy range across the down, neutral, and up momentum bins. The portfolio's buy and sell ranges are scaled to sum to 100%.

Table 2 shows that each portfolio's buy range has exposure to downward momentum securities. Our momentum strategy delays the purchase of downward momentum securities. After a security is purchased, it may exhibit downward momentum. We believe the trading cost and increased turnover associated with selling such securities, on average, does not add value.

The target buy range does not equal the portfolio's buy range. In practice, our momentum screens imply that we buy securities slowly when they become eligible for purchase. Table 2 shows that our portfolio's buy ranges have less exposure to down-

Table 2

Target Buy Range, Portfolio's Buy Range, and Portfolio's Sell Range
Allocations across Momentum Bins
January 2006-December 2008

Portfolio	Target Buy Range			Portfolio Buy Range			Portfolio Sell Range		
	Down	Neutral	Up	Down	Neutral	Up	Down	Neutral	Up
US Micro Cap	25%	48%	27%	21%	49%	31%	2%	15%	83%
US Small Cap	21%	50%	29%	18%	51%	31%	1%	21%	78%
Tax-Managed US Small Cap	21%	50%	29%	17%	50%	33%	8%	35%	57%
US Small Cap Value	35%	53%	12%	24%	59%	17%	4%	31%	64%
Tax-Managed US Targeted Value	28%	56%	16%	19%	58%	23%	5%	33%	61%
US Large Cap Value	17%	67%	16%	9%	70%	20%	9%	44%	47%
Tax-Managed US Marketwide Value	19%	66%	15%	12%	70%	18%	4%	45%	50%
Asia Pacific Small Company	17%	54%	29%	16%	55%	29%	2%	40%	58%
Continental Small Company	24%	51%	25%	21%	51%	28%	8%	41%	51%
United Kingdom Small Company	21%	51%	28%	19%	51%	30%	4%	42%	53%
International Small Cap Value	34%	53%	13%	25%	58%	17%	6%	39%	55%
International Value	18%	66%	16%	14%	69%	16%	11%	38%	50%
Emerging Markets Small Cap	24%	50%	26%	22%	50%	28%	7%	39%	54%
Emerging Markets Value	27%	53%	20%	23%	53%	24%	5%	37%	58%

ward momentum than their target buy ranges. Because small value strategies usually have higher turnover than small or large value strategies, this phenomenon is more pronounced for our small value strategies. Further, we sell securities with upward momentum slowly after they become eligible for sale. Generally, our portfolio's sell range securities will be heavily tilted toward upward momentum.

Referring again to the US Micro Cap Portfolio example, 25% of the portfolio's target buy range weight is composed of downward momentum stocks, while only 21% of the portfolio's actual buy range weight is characterized as having downward momentum. Meanwhile, 83% of the sell range weight is characterized as having upward momentum. Recall that we defined our momentum categories based on the percentage of all eligible securities in each country, not as a percentage of aggregate market capitalization. On average, over this time period, the 25% of securities categorized as downward momentum in a country constituted less than 25% of that country's market capitalization.

Testing Our Approach: Constructing a Control Portfolio

During periods when the momentum factor (up minus down, or UMD) is positive, we expect that overweighting upward momentum securities in the sell range, and underweighting downward momentum securities in the buy range (relative to the target buy range), may add value. For example, over the three-year period evaluated in this study, the Fama/French US UMD factor averaged 0.92% per month and was positive for 21 of the 36 months.³ We would expect our momentum screens to have added value in our US portfolios during such a period.

To quantify the benefit of our momentum screens, we construct a control portfolio and compare its return to the return of the actual portfolio. The control portfolio will not hold sell range securities. Rather, these securities are sold and the proceeds reinvested in the target buy range. Additionally, the control portfolio does not delay buys of downward momentum securities as they become eligible for purchase; the control buy range will equal the target buy range. The control portfolio's hold range will be constructed in the same fashion as the actual portfolio's hold range. Thus, the actual and control portfolios have different buy and sell ranges only.

Our momentum screens imply we sell securities in upward momentum slowly after they become eligible for sale. To identify these securities, we assume that the sell range securities in the upward momentum bin are held only as a result of the screens.

Generally, our strategies delay the purchase of downward momentum securities. In this study, we use a conservative approach to identify buy range securities that are underweighted as a result. We assume that only extremely underweighted buy range

3. Fama/French data provided by Fama/French.

Table 3

Average Buy Range Allocation
Actual and Control Portfolios
January 2006-December 2008

Portfolio	Underweighted Buy Range Securities	
	Actual	Control
US Micro Cap	2%	19%
US Small Cap	2%	13%
Tax-Managed US Small Cap	3%	17%
US Small Cap Value	2%	30%
Tax-Managed US Targeted Value	3%	37%
US Large Cap Value	3%	24%
Tax-Managed US Marketwide Value	2%	17%
Asia Pacific Small Company	2%	13%
Continental Small Company	2%	11%
United Kingdom Small Company	2%	10%
International Small Cap Value	2%	25%
International Value	1%	15%
Emerging Markets Small Cap	2%	18%
Emerging Markets Value	2%	21%

securities in the downward momentum bin are underweighted because of our momentum strategy. This is accomplished by classifying securities that are held at less than one-half times target weight as underweighted. In practice, a security may be underweighted because of our momentum screens or because we trade positions patiently over time using natural portfolio turnover.

Table 3 shows the average allocation of each portfolio's buy range to underweighted securities, and the average allocation of the control portfolio to these securities. For example, in the US Micro Cap Portfolio, 2% of the portfolio is allocated to underweighted stocks in the buy range, versus 19% of the control portfolio.

Table 4 shows the average allocations of the actual and control portfolios to delayed upward momentum sell bins and underweighted downward momentum buy bins. Using the same US Micro Cap example, an average of 3% of the actual portfolio was allocated to upward momentum securities eligible for sale, and 1% of the actual portfolio was allocated to underweighted downward momentum securities.

Comparing the weights from Tables 3 and 4, it is clear that not all underweighted securities are in downward momentum. For example, the US Micro Cap Portfolio had an average allocation of 2% to underweighted securities. Of this allocation, using the definition of downward momentum described above, 1% was in downward momentum

Table 4

Delayed Momentum Sell and Buy Range Weights
Actual and Control Portfolios
January 2006-December 2008

Portfolio	Delayed Upward Momentum Sells		Delayed Downward Momentum Buys		Sell Range ¹ + Hold Range + Buy Range ²	
	Actual	Control	Actual	Control	Actual	Control
US Micro Cap	3%	0%	1%	7%	96%	93%
US Small Cap	2%	0%	0%	4%	97%	96%
Tax-Managed US Small Cap	8%	0%	1%	5%	91%	95%
US Small Cap Value	15%	0%	1%	15%	84%	85%
Tax-Managed US Targeted Value	16%	0%	1%	14%	83%	86%
US Large Cap Value	5%	0%	1%	7%	95%	93%
Tax-Managed US Marketwide Value	9%	0%	1%	7%	90%	93%
Asia Pacific Small Company	7%	0%	0%	3%	93%	97%
Continental Small Company	6%	0%	1%	4%	94%	96%
United Kingdom Small Company	4%	0%	0%	4%	95%	96%
International Small Cap Value	12%	0%	1%	12%	87%	88%
International Value	4%	0%	0%	5%	96%	95%
Emerging Markets Small Cap	7%	0%	1%	6%	92%	94%
Emerging Markets Value	5%	0%	1%	7%	94%	93%

1. Sell range excludes securities in upward momentum.

2. Buy range excludes underweighted securities in downward momentum.

securities. Its control portfolio had an allocation of 19% to underweighted securities, 7% of which were in downward momentum.

Now that we have identified the extent to which our momentum screens have impacted relative weightings, we approximate the benefit of these screens to the funds as the relative return difference between the actual and control portfolios due to allocation and composition differences from securities in the delayed upward momentum sell and downward momentum buy bins.

Results

Panels A and B of Table 5 show the compound return differences of the delayed sell and buy bins, along with the compound return of each portfolio. In general, over this time period, the delayed upward momentum sells outperformed the other bins. The underweighted downward momentum buys were generally the worst-performing securities. For securities not in these bins, the actual and control portfolio's returns were similar.

Table 5

Panel A: Delayed Upward Momentum Sells vs. Actual Portfolio**Compound Returns**

January 2006-December 2008

Portfolio	Actual Portfolio	Delayed Upward Momentum Sells	Delayed Upward Momentum Sells minus Actual Portfolio	
			Actual	Control
US Micro Cap	-30.3%	-19.7%	10.6%	
US Small Cap	-27.7%	-14.6%	13.0%	
Tax-Managed US Small Cap	-30.1%	-17.5%	12.6%	
US Small Cap Value	-31.4%	-9.8%	21.6%	
Tax-Managed US Targeted Value	-32.3%	-12.1%	20.3%	
US Large Cap Value	-30.8%	-12.1%	18.7%	
Tax-Managed US Marketwide Value	-31.6%	-25.4%	6.3%	
Asia Pacific Small Company	-16.2%	25.9%	42.1%	
Continental Small Company	-16.9%	-24.0%	-7.1%	
United Kingdom Small Company	-37.4%	-23.5%	13.8%	
International Small Cap Value	-22.9%	11.3%	34.2%	
International Value	-20.6%	19.3%	39.9%	
Emerging Markets Small Cap	-13.8%	-12.4%	1.4%	
Emerging Markets Value	-7.5%	1.7%	9.2%	

Panel B: Delayed Downward Momentum Buys vs. Actual Portfolio**Compound Returns**

January 2006-December 2008

Portfolio	Actual Portfolio	Delayed Downward Momentum Buys		Delayed Downward Momentum Buys minus Actual Portfolio	
		Actual	Control	Actual	Control
US Micro Cap	-30.3%	-51.5%	-53.3%	-21.2%	-23.0%
US Small Cap	-27.7%	-54.6%	-44.2%	-27.0%	-16.5%
Tax-Managed US Small Cap	-30.1%	-55.9%	-52.5%	-25.8%	-22.5%
US Small Cap Value	-31.4%	-63.9%	-53.0%	-32.5%	-21.6%
Tax-Managed US Targeted Value	-32.3%	-50.8%	-50.0%	-18.4%	-17.7%
US Large Cap Value	-30.8%	-87.4%	-74.1%	-56.6%	-43.3%
Tax-Managed US Marketwide Value	-31.6%	-62.3%	-55.3%	-30.7%	-23.7%
Asia Pacific Small Company	-16.2%	-78.7%	-80.7%	-62.5%	-64.5%
Continental Small Company	-16.9%	-37.2%	-35.2%	-20.2%	-18.3%
United Kingdom Small Company	-37.4%	-78.3%	-73.1%	-40.9%	-35.7%
International Small Cap Value	-22.9%	-47.0%	-56.6%	-24.1%	-33.7%
International Value	-20.6%	-51.4%	-56.0%	-30.8%	-35.3%
Emerging Markets Small Cap	-13.8%	-41.5%	-37.4%	-27.7%	-23.5%
Emerging Markets Value	-7.5%	-23.8%	-18.4%	-16.4%	-10.9%

A general rule of thumb when diagnosing performance differences between a portfolio and its benchmark is as follows: If a portfolio has more (or less) exposure than its benchmark to stocks that have high (or low) compound returns, then this allocation decision adds to the portfolio's relative performance. Thus, by studying the weighting differences in Table 4 and the return differences in Table 5, we can begin to calculate the performance impact of our momentum screens.

For example, the US Micro Cap Portfolio had an average allocation of 3% to delayed upward momentum sell candidates versus 0% for the control portfolio, and an average allocation of 1% to the delayed downward momentum underweighted buy candidates versus 7% for the control portfolio. For this portfolio, the delayed sell candidates returned -19.7% and the underweighted downward momentum buy candidates returned -51.5%. Thus, we expect this allocation decision to have added to the portfolio's relative performance.

We quantify the benefit of avoiding the opportunity cost of selling upward momentum securities too early as the contribution of the momentum delayed sells to each portfolio's compound return. Similarly, the benefit of protecting against the negative impact of purchasing downward momentum securities is defined as the contribution of the momentum delayed buys to each portfolio's compound return. The results of this are shown in Table 6. Appendix A contains additional details on how these numbers are computed.

Table 6

Performance Impact of Momentum Screens
January 2006-December 2008

Portfolio	Momentum Delay Sells	Momentum Delay Buys	Total Momentum
US Micro Cap	0.9%	4.3%	5.2%
US Small Cap	0.1%	2.1%	2.3%
Tax-Managed US Small Cap	2.2%	2.9%	5.1%
US Small Cap Value	5.6%	5.3%	10.9%
Tax-Managed Targeted Value	2.4%	7.2%	9.6%
US Large Cap Value	0.4%	8.1%	8.5%
Tax-Managed US Marketwide Value	1.0%	5.1%	6.2%
Asia Pacific Small Company	5.3%	4.9%	10.2%
Continental Small Company	-0.6%	5.7%	5.2%
United Kingdom Small Company	0.9%	5.1%	6.0%
International Small Cap Value	7.8%	8.5%	16.3%
International Value	2.0%	1.9%	3.9%
Emerging Markets Small Cap	0.2%	4.8%	5.0%
Emerging Markets Value	2.5%	0.0%	2.4%

Table 6 shows that, from January 2006 to December 2008, there has been an economically significant positive premium from our momentum screens. The impact of these screens was largest for the small cap value portfolios. The reason for this is twofold. Small cap value portfolios usually have higher turnover than small cap or large cap value portfolios. Also, the continuous rebalancing of these portfolios creates the potential for more exposure to the adverse impact of momentum than that of small cap or large cap value portfolios.

The results presented herein show that our momentum screens have had the desired effect on our portfolios. During the three-year period included in our study, the momentum factor was positive on average in many of the countries where Dimensional invests. We expect our momentum screens to add value during periods when this factor is positive. The results of our study show that this was the case over the time period studied.

Appendix A:

The contribution of the momentum strategy to performance is twofold:

- (a) Delay the sale of upward momentum securities. Without the momentum screens the proceeds of these sales would be allocated to the target buy range. We expect the upward momentum sell range securities to realize a momentum premium while those in the target buy range will not.
- (b) Delay the purchases of downward momentum securities. Proceeds from security sales and cash inflows are invested in a buy range that is tilted away from downward momentum. We expect this tilted buy range will realize a momentum premium relative to the target buy range.

The value added by the strategy is computed by comparing the performance of the actual portfolio with a portfolio that would have sold securities and invested the proceeds without considering momentum—the control portfolio.

The following formula computes the compound return difference between the actual and control portfolio that is due to the momentum strategy:

$$\left(\sum_{i=1, N} w_i^t r_i^t G^{t-1} \right)_{\text{Actual}} - \left(\sum_{i=1, N} w_i^t r_i^t G^{t-1} \right)_{\text{Control}}$$

Here, N represents the number of periods (in this case 36 for the number of months); w_i^t and r_i^t are the weight and return of bin i in the actual or control portfolio for period t ; and G^{t-1} is the growth of wealth of the actual or control portfolio until time $t - 1$. This formula also accounts for performance differences due to the growth of wealth.