
Pursuing Multiple Premiums: Combination vs. Integration[†]

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Abstract

This paper compares two different approaches to pursue multiple premiums: a combination approach (market portfolio plus factor portfolios) and a fully integrated approach. We evaluate the two approaches via multiple lenses: pursuit of higher expected returns, distribution of over- and underweights, turnover, and costs. Our analysis shows the integrated approach can lead to greater reliability of outperformance, better risk control, and lower costs. These benefits are critical to an efficient pursuit of multiple premiums and cannot be replicated through combination approaches.

1. Introduction

Valuation theory and decades of empirical research suggest that price variables, such as market capitalization and relative price, and cash flow variables, such as profitability, contain reliable information about differences in expected stock returns.¹ These insights naturally lend themselves to the pursuit of multiple premiums—namely, the size, value, and profitability premiums—as a systematic way to increase expected returns. By incorporating multiple premiums, a strategy can more evenly distribute its over- and underweights across securities along multiple return drivers that do not move in lockstep. This, in turn, improves the reliability of expected outperformance compared to targeting a single premium.

How should investors go about pursuing multiple premiums? Size, value, and profitability premiums do not exist in a vacuum—a sort on one variable tends to produce simultaneous dispersion in the other characteristics. For example, smaller cap and deeper value firms tend to have lower profitability, so a sort on market capitalization or relative price also results in differences in profitability. Overlooking interactions between premiums may lead to an offsetting emphasis on the premiums and suboptimal portfolio construction. A well-thought-out approach should ensure robust risk control, while carefully balancing tradeoffs between competing premiums, costs, and diversification.

In this paper, we illustrate these considerations by comparing two different combination approaches, as well as a fully integrated approach, when applied to the US market. These three approaches are as follows:

- **Market-plus-single-factors combination:** 25% in the simulated market plus an equal mix of three simulated components (25% each): small cap, all cap value, and all cap high profitability.
- **Market-plus-satellite combination:** 75% in the simulated market plus 25% in a small cap value high profitability simulated component.

¹ See, for example, Fama and French (1992, 1993, 2006, 2015, 2017), Novy-Marx (2013), and O'Reilly and Rizova (2013).

- **Integrated core:** a marketwide simulation that simultaneously targets the size, value, and profitability premiums in a balanced manner.

These options are motivated by the fact that when pursuing higher expected returns, many investors place equal importance on different return premiums and hence seek to structure their portfolios to emphasize the different premiums equally. The market-plus-single-factors combination aims to reflect that approach to pursuing higher expected returns through combining the market with standalone strategies for each of the reliable premiums within equities (size, value, and profitability). The market-plus-satellite combination aims to reflect that approach by combining the market with a single strategy that focuses on the intersection of stocks with high expected returns across all three dimensions. These firms have lower market capitalization (smaller), lower relative price (deeper value), and higher profitability. Finally, the integrated core aims to reflect that approach through an integrated marketwide equity strategy that overweights stocks with higher expected returns and underweights stocks with lower expected returns across the entire market.

These three approaches to capturing the size, value, and profitability premiums are illustrated graphically in **Exhibit 1**. The weights to the different components in the first two allocations are chosen so that all three allocations have similar long-term performance, measured by average monthly returns over the sample covering July 1974 to December 2019.² For the two combination approaches, the underlying components hold firms in the relevant market segment in proportion to their market capitalizations and are rebalanced semiannually at the end of June and end of December. The allocations across components within these simulations are reset to their target weights monthly. The integrated core simulation also rebalances semiannually. At each rebalancing time, firms are independently sorted into groups based on their market capitalization, relative price, and profitability. The intersections of this three-way sort form groups of firms with similar characteristics. For example, mega cap firms with higher relative price, and higher profitability form one group, while mega cap firms with higher relative price but lower profitability form another group. Within each group, firms are held in proportion to their market capitalizations, but the integrated strategy overweights higher-expected-return groups, with the degree of emphasis gradually increasing in the directions of higher expected returns (smaller capitalization, lower relative price, and higher profitability).

We examine the holdings and performance of these simulated strategies through multiple lenses. Our analysis shows that the integrated approach is preferable to both combination approaches, yielding a more balanced emphasis on the premiums, more controlled deviations from the market, and lower implementation costs.

² Please see the appendix for more details on the construction of the simulated strategies.

2. Strategy at First Glance

While the simulations are constructed to have similar historical outperformance driven by exposures to the same three premiums, differences in their construction lead to differences in their holdings, as well as their tilts to the individual premiums. **Exhibit 2** summarizes the aggregate characteristics of the simulated strategies as of the end of 2019. The weighted average market capitalizations are similar across the three simulations at around \$200 billion, lower than that of the market at \$257 billion. The aggregate price-to-book ratios range from 2.7 for market-plus-single-factors and 2.5 for market-plus-satellite to 3.0 for integrated core, all lower than the aggregate price-to-book of 3.6 for the market. In terms of weighted average profitability, it is slightly lower for the market-plus-satellite combination and slightly higher for the market-plus-single-factors combination and the integrated core, although the levels are quite similar at around 0.4.

Judging from the aggregate characteristics alone, it might appear that all three simulations emphasize smaller cap firms and those with lower relative prices, without overweighting higher profitability firms. While examining aggregate characteristics is a useful first step to assessing differences across strategies, this high-level view can mask a strategy's true exposure to the underlying premiums because of interactions between the premiums. For example, smaller cap and deeper value firms tend to have lower profitability, so a strategy focused on the size and value premiums can have lower weighted average profitability than the market. The incorporation of profitability in the strategy increases the weighted average profitability of the strategy relative to where it would have been without a profitability tilt, despite the fact that the level might still be below the market average. As a result, one needs to dig deeper into the holdings to better understand how each strategy is constructed and the exposure it provides.

3. A Closer Look at Holdings

Exhibit 3 shows the positioning of each simulation relative to the market across different size, relative price, and profitability segments as of the end of 2019. The allocation to large versus small caps reveals interesting differences between the simulations despite their similar weighted average market capitalization. Both combination simulations have sizable allocations to small caps. The market-plus-single-factors and the market-plus-satellite simulations allocate 30.2% and 32.3% to small caps, or 3.86 and 4.12 times the market's weight of 7.8% in small caps, respectively. In comparison, the integrated core simulation has a more moderate small cap allocation of 14.5%, yielding a strategy-to-market weight ratio of 1.85.

Within each size group, the integrated core simulation's allocation across the relative price and profitability segments illustrates a balanced emphasis on the value and profitability premiums. For example, within the large cap group, the value high profitability segment has the most overweight (1.42 times the market's weight) and the growth low profitability segment has the most underweight (0.61 times the market's weight), while the growth high profitability and value low profitability segments have similar strategy-to-market weight ratios of 0.89 and 0.94, respectively.

The market-plus-single-factors simulation, on the other hand, does not exhibit the same balanced emphasis on the premiums. For example, although the value high profitability segment has a higher expected return than the growth high profitability segment, within large caps the former has less emphasis than the latter with strategy-to-market weight ratios of 0.82 vs. 0.89, respectively. This suggests that simply combining single factor portfolios may lead to offsetting tilts towards different premiums or unintended emphasis on certain premiums, resulting in a strategy that is not effectively focused on firms with higher expected returns.

The market-plus-satellite simulation targets higher expected returns than the market only through its allocation to the satellite component, consisting of small cap value high profitability firms. As a result, firms within its large cap allocation are simply market cap weighted, as evident from the identical strategy-to-market ratios within large caps. Within small caps, the weight ratios range from 0.73 for the growth low profitability segment to 7.49 for the value high profitability segment. Compared to the other two simulations, the overweight to small value high profitability firms is greater. In fact, the weight the market-plus-satellite approach places on small value high profitability firms is similar to the weight that the integrated core approach places on all small cap firms (13.2% versus 14.5%). This is because the market-plus-satellite simulation gives up its pursuit of higher expected returns within large caps, so it has to concentrate more weights on the satellite component to achieve similar outperformance.

In addition to strategies' positioning across market segments, we examine strategies' weighting across individual holdings to provide further insights into how the over- and underweights are distributed. **Exhibit 4** shows the distribution of firm-level weight ratios relative to the market as of the end of 2019. Hypothetically, if a firm made up 0.15% of the strategy and 0.10% of the market, its weight ratio would be 1.5, and its weight in the strategy would be added to the bar representing weight ratios between one and two. For the integrated core simulation, its moderate and measured weighting scheme results in weight ratios below one (underweight relative to the market) for 40% of the strategy, between one and two for 45% of the strategy, and between two and three for the remaining 15% of the strategy. In contrast, the distribution of weight ratios extends beyond three times market weight for the two combination simulations. For the market-plus-single-factors simulation, the weight ratios are above three for more than 30% of the strategy. The market-plus-satellite simulation, on the other hand, has a barbell distribution: 72% of the strategy has weight ratios below one, while 28% are above seven.

Overall, the holdings analyses in this section show that the integrated core simulation has a more balanced emphasis on the premiums and is better positioned to capture the premiums. This obviously reduces the solution's tracking error relative to the market. Furthermore, the integrated approach distributes the over- and underweights more evenly and gradually across the strategy, leading to more measured deviations from the market and robust risk control. This also means that, as companies' share prices and fundamentals change, the change in their desired over- or underweight is likely moderate, which may contribute to lower turnover and costs.

4. Evaluating Historical Performance

Examining historical performance can help inform expectations about the behavior of different asset allocations over time and about relative returns versus the market. As shown in **Exhibit 5**, the integrated core simulation has an average monthly return of 1.1% over the sample period from July 1974 to December 2019, outperforming the market by 0.1% per month. On an annualized compound basis, the integrated core delivers 13.0% per year compared to 11.8% for the market. The two combination simulations achieve similar average monthly returns by construction. The t-statistics of the average monthly return differences relative to the market are all above two, indicating the outperformance is reliably different from zero. The annualized volatility of the integrated core simulation is 15.7%, similar to that of the market at 15.5%. The combination simulations have slightly higher volatility: 16.3% for the market-plus-single-factors combination and 15.9% for the market-plus-satellite combination. These results suggest that the pursuit of multiple premiums, especially through an integrated approach, does not have to come with materially higher volatility.

Turning to the tracking error against the market in the last row, we see sizable differences across simulations. The holdings analysis above shows that the simulations have meaningful differences in their security concentration. Tracking error is one way to measure the impact of those differences on the simulated strategies' returns relative to the market. Consistent with the observations from the holdings analysis, the integrated core simulation has the lowest tracking error of 2.1% annualized, compared to 3.0% and 2.6% for the market-plus-single-factors and market-plus-satellite simulations, respectively.

These results illustrate that not all deviations from the market, even when resulting from tilts to the same premiums, are created equal. Controlling for the level of average outperformance (as we do in our analysis), a lower tracking error implies less uncertainty around the expected excess return, which translates into greater reliability of outperformance. Indeed, among the three simulations, the integrated core has the highest t-statistic associated with its excess return due to its lowest tracking error against the market. It also has, as shown in **Exhibit 6**, the highest estimated probability of outperforming the market across all investment horizons. For example, over a five-year horizon, the estimated probability increases from 79% for the market-plus-single-factors simulation to 82% for the market-plus-satellite simulation and to 84% for the integrated core simulation. Realized premiums are volatile, and prolonged periods of underperformance can occur. Although there is no guarantee that a strategy pursuing multiple premiums will be positive in any given period, we believe an integrated approach puts investors in the best position to capture the premiums in a reliable way.

5. Real-World Considerations

Translating the pursuit of higher expected returns into real-world value-adds depends crucially on practical considerations, such as turnover and costs. After all, it is the return after costs and expenses that matters to investors. From that perspective, an all-in integrated portfolio has distinct advantages over a mix of portfolios. Not having to hold and trade securities across multiple underlying portfolios results in fewer ticket charges and safekeeping charges. Having fewer moving parts also helps reduce the unnecessary turnover associated with buying and selling the same securities for different portfolios. Furthermore, as discussed earlier, the integrated approach tends to distribute the over- and underweights more evenly across holdings, requiring less turnover as the desired emphasis on the securities changes due to changes in their expected return potential.

Exhibit 7 shows the estimated turnover for the integrated and combination simulations over the sample period. The first row shows the weighted average turnover across the underlying components, where the weights are the target component weights (for example, 25% each for the market-plus-single-factors simulation). It is effectively the turnover of the overall strategy in the case of the integrated core simulation. The average one-way turnover is 18% per year for the integrated simulation. In comparison, the weighted average annual one-way turnover across the underlying portfolios is 26% and 21% for market-plus-single-factors and market-plus-satellite simulations, respectively. These combination simulations not only incur higher overall turnover but also have a bigger portion of the turnover within the small cap universe, which tends to be more costly to trade. For example, the small cap component has an average annual one-way turnover of 31%, making up 30% of the weighted average turnover of the market-plus-single-factors simulation. In the case of the market-plus-satellite simulation, more than three quarters of the turnover is contributed by the small cap value high profitability component, which has an average annual one-way turnover of 64%. On top of that, rebalancing the underlying portfolios to their target allocations every month incurs turnover, adding another 5–7% on average per year. We believe these results confirm that the integrated approach has lower turnover and, thus, offers a more efficient pursuit of multiple premiums.³

4. Conclusion

There are many considerations when it comes to pursuing multiple premiums, including the emphasis on competing premiums, the distribution of over- and underweights, turnover, and costs. Striking the right balance, as we believe the integrated approach in our case study does, may lead to greater reliability of outperformance, better risk control, and lower costs. These benefits are critical to a good investment experience and cannot be replicated through the combination approaches. This is not to suggest that investors should not build an asset allocation using multiple strategies. Rather, while investors can use a variety of marketwide and component strategies together to customize

³ While not considered in this study, the efficient use of cash flows, a flexible trading approach that spreads turnover over time and avoids demanding immediacy, and other transaction cost mitigation techniques can further reduce turnover and costs. See, for example, Twardowski and Wiley (2014) and Novy-Marx and Velikov (2016).

their desired emphasis on different segments of the markets based on their investment goals and constraints, each of the strategies used should be designed to thoughtfully integrate multiple premiums within its eligible universe. More broadly, our study underpins the importance of understanding what a portfolio holds and what to expect from those holdings. A careful evaluation through multiple lenses can help investors make more informed decisions.

Exhibits

EXHIBIT 1

Illustration of Simulated Strategies

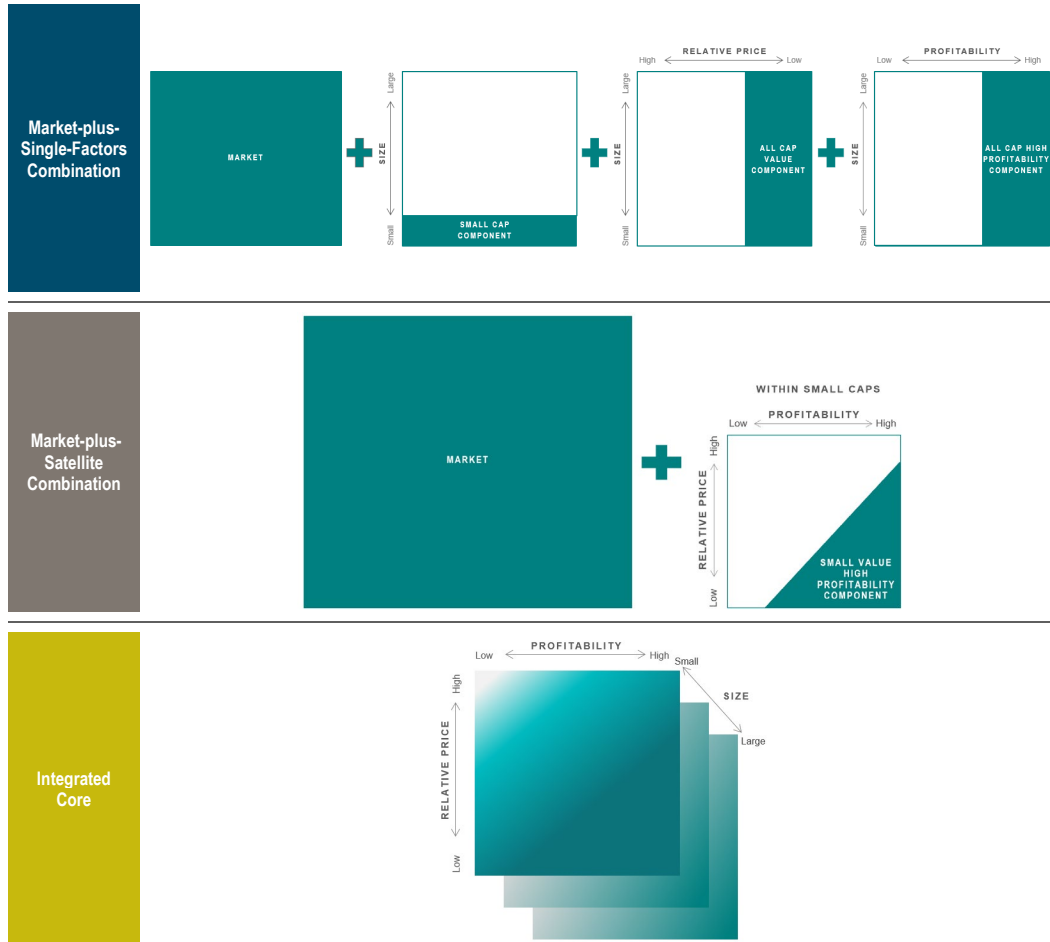


EXHIBIT 2

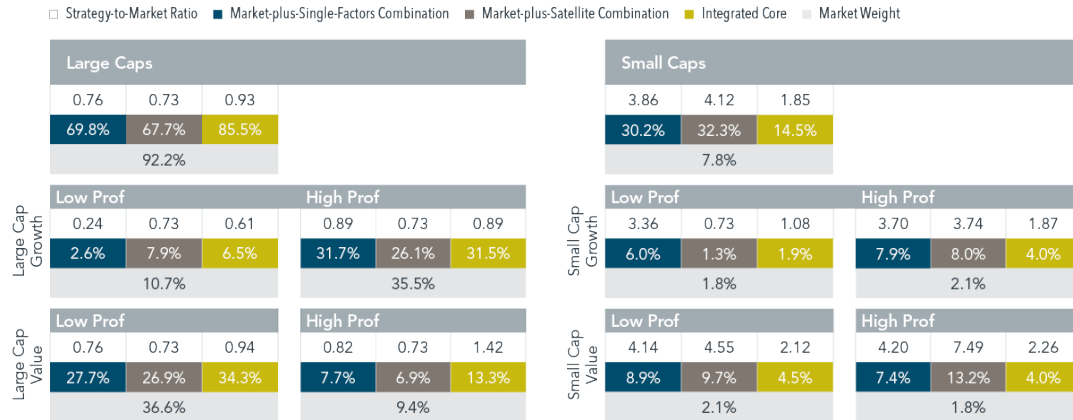
**Aggregate Characteristics
As of December 31, 2019**

	Market	Market-plus-Single-Factors Combination	Market-plus-Satellite Combination	Integrated Core
Weighted Average Market Capitalization (million USD)	\$256,741	\$226,804	\$193,127	\$193,675
Aggregate Price-to-Book	3.6	2.7	2.5	3.0
Weighted Average Profitability	0.42	0.41	0.39	0.41

Source: Dimensional using CRSP and Compustat data. See Appendix for more information on the simulated strategies.

EXHIBIT 3

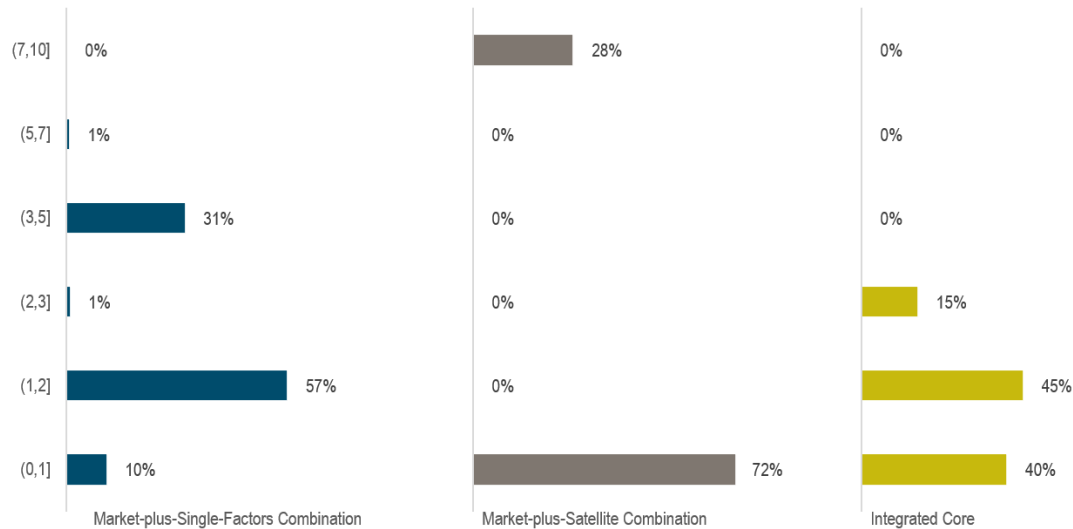
**Strategy Weights by Market Segment
As of December 31, 2019**



Source: Dimensional using CRSP and Compustat data. Large cap is defined as approximately the top 92% of market capitalization and small cap as approximately the bottom 8%. Value is defined as the 50% of the market capitalization within each size group with the lowest price-to-book ratios, and growth is the top 50%. High profitability is defined as the 50% of the market capitalization within each size group with the highest profitability, and low profitability as the lowest 50%. Utilities and firms without relative price and profitability data are excluded from this analysis. See Appendix for more information on the simulated strategies.

EXHIBIT 4

**Distribution of Firm-Level Weight Ratios Relative to the Market
As of December 31, 2019**



Source: Dimensional using CRSP and Compustat data. For each firm held in each simulated strategy, its firm-level weight ratio is computed as its weight in the strategy relative to that in the market. The exhibit shows the distributions of the simulated strategies' firm-level weight ratios, with the bars representing the total strategy weights of firms that fall within each weight ratio range. Firms that are not held by the simulated strategies have a weight ratio of zero and are excluded from the exhibit. See Appendix for more information on the simulated strategies.

EXHIBIT 5

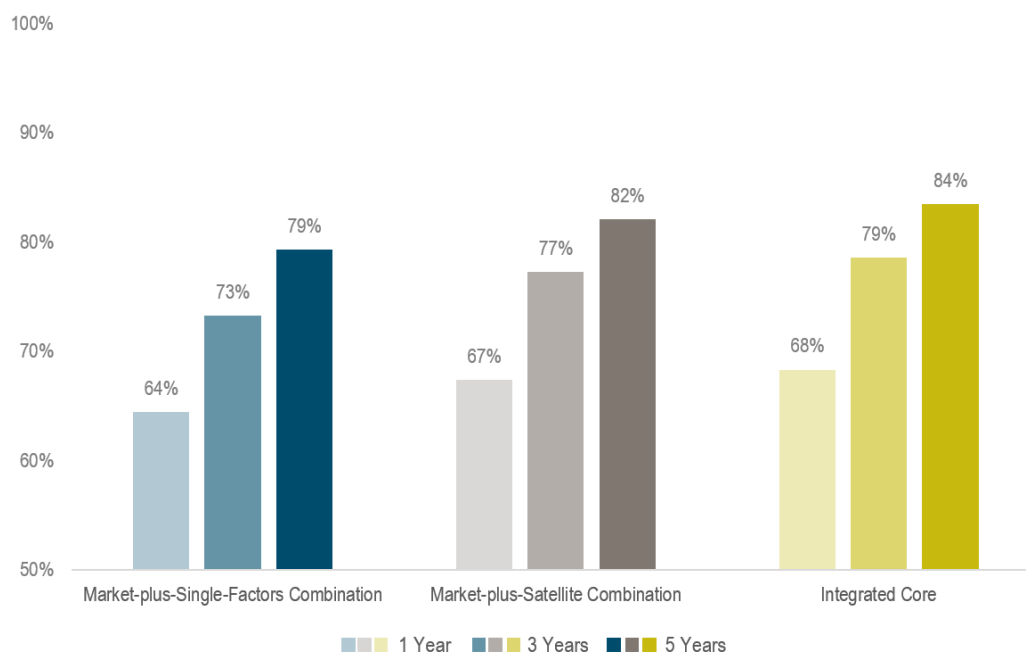
**Performance Summary
July 1974–December 2019**

	Market	Market-plus-Single-Factors Combination	Market-plus-Satellite Combination	Integrated Core
Annualized Compound Return (%)	11.8	12.9	13.2	13.0
Annualized Standard Deviation (%)	15.5	16.3	15.9	15.7
Average Monthly Return (%)	1.0	1.1	1.1	1.1
t-Statistic vs. Market	—	2.5	3.3	3.5
Annualized Tracking Error vs. Market (%)	—	3.0	2.6	2.1

Past performance, including hypothetical performance, is no guarantee of future results.

Source: Dimensional, using CRSP and Compustat data. See Appendix for more information on the simulated strategies.

EXHIBIT 6

Estimated Probability of Outperforming the Market

Source: Dimensional using CRSP and Compustat data. Estimated probability of outperformance is computed by performing 10,000 bootstrapped runs of monthly returns from July 1974 to December 2019. For each simulated strategy, returns are bootstrapped jointly for the simulated strategy and the market, and the probability of outperformance is calculated as the percentage of sample return trajectories in which the annualized compound return of the simulated strategy is greater than that of the market. The bootstrap simulations account for the impact of unknown expected returns following the methodology of Fama and French (2018). See Appendix for more information on the simulated strategies.

EXHIBIT 7

**Average Annual One-Way Turnover by Strategy Weight
July 1974–December 2019**

	Market-plus-Single-Factors Combination	Market-plus-Satellite Combination	Integrated Core
Weighted Average Turnover across Underlying Components	26%	21%	18%
Turnover between Underlying Components	7%	5%	--

Source: Dimensional using CRSP and Compustat data. See Appendix for more information on the simulated strategies.

Appendix

The eligible universe is the US market, which includes all US firms excluding REITs, tracking stocks, and investment companies. Unless otherwise specified, we use the following definitions and methodologies.

Market-plus-single-factors combination simulation comprises four underlying simulated components: 25% all cap market simulation plus an equal mix (25% each) of small cap market, all cap value, and all cap high profitability simulations. The small cap component includes small cap firms, defined as the bottom 8% of market capitalization, at the market cap weights. The value component includes value firms, defined as the bottom 30% of market capitalization based on relative price, at the market cap weights. The profitability component includes high profitability firms, defined as the top 30% of market capitalization based on operating profitability, at the market cap weights.

Market-plus-satellite combination simulation comprises two underlying simulated components: 75% all cap market simulation plus 25% small cap value high profitability simulation. The small cap value high profitability component is constructed as follows: Small cap firms are sorted into quintiles (each representing 20% of the market capitalization) based on relative price and profitability independently. From the intersections of these two independent sorts, we form 25 subgroups and arrange them in a 5-by-5 grid with decreasing relative price from top to bottom and increasing profitability from left to right. The component includes firms in the 10 subgroups that lie in the lower triangular region below the diagonal with lower relative price and higher profitability at the market cap weights.

Integrated core simulation includes eligible stocks of all market capitalization and emphasizes firms with lower market capitalization, lower relative price, and higher profitability.

Relative price is measured by price-to-book equity. Profitability is measured as operating income before depreciation and amortization minus interest expense scaled by book equity. The integrated core simulation and the underlying simulated components for market-plus-single-factors combination and market-plus-satellite combination are rebalanced semiannually at the end of June and end of December. The allocations across the components within market-plus-single-factors combination simulation and market-plus-satellite combination simulation are rebalanced monthly.

Simulated returns are based on model/backtested performance for research purposes. Hypothetical performance was achieved with the retroactive application of a model designed with the benefit of hindsight. Back-tested results are hypothetical and for informational purposes only. The results are not representative of indices, actual investments, or actual strategies managed by Dimensional. Assumes reinvestment of dividends and capital gains. Results do not reflect any costs or fees associated with actual investing. Actual investment returns may be lower or may differ significantly. Data is subject to numerous limitations. Results for different time periods could differ, perhaps significantly, from the results shown. Premiums can be calculated using different methodology. Results could differ, perhaps significantly, when using different methodology. The simulated

performance is “gross performance,” which includes the reinvestment of dividends and other earnings but does not reflect the deduction of investment advisory fees and other expenses. A client’s investment returns will be reduced by the advisory fees and other expenses that may be incurred in the management of the advisory account. For example, if a 1% annual advisory fee were deducted quarterly and a client’s annual return were 10% (based on quarterly returns of approximately 2.41% each) before deduction of advisory fees, the deduction of advisory fees would result in an annual return of approximately 8.91% due, in part, to the compound effect of such fees. Dimensional’s advisory fees are described in Part 2A of Dimensional’s Form ADV Part 2A. Past performance, including simulated performance, is no guarantee of future results.

References

- Fama, Eugene F., and Kenneth R. French. 1992. “The Cross-Section of Expected Stock Returns.” *The Journal of Finance* 47, no. 2: 427–65.
- Fama, Eugene F., and Kenneth R. French. 1993. “Common Risk Factors in the Returns on Stocks and Bonds.” *Journal of Financial Economics* 33, no. 1: 3–56.
- Fama, Eugene F., and Kenneth R. French. 2006. “Profitability, Investment and Average Returns.” *Journal of Financial Economics* 82, no. 3: 491-518.
- Fama, Eugene F., and Kenneth R. French. 2015. “A Five-Factor Asset Pricing Model.” *Journal of Financial Economics* 116, no. 1: 1–22.
- Fama, Eugene F., and Kenneth R. French. 2017. “International Tests of a Five-Factor Asset Pricing Model.” *Journal of Financial Economics* 123, no. 3: 441-463.
- Novy-Marx, Robert. 2013. “The Other Side of Value: The Gross Profitability Premium.” *Journal of Financial Economics* 108, no. 1: 1-28.
- Novy-Marx, Robert, and Mihail Velikov. 2016. "A Taxonomy of Anomalies and Their Trading Costs." *The Review of Financial Studies* 29.1: 104-147.
- O’Reilly, Gerard and Savina Rizova. 2013. “Expected Profitability: A New Dimension of Expected Returns,” Dimensional Fund Advisors’ *Quarterly Institutional Review* 9, no. 1: 4–7.
- Twardowski, Dave and Ryan J. Wiley. 2014. “Global Trading Advantages of Flexible Equity Portfolios.” (white paper, Dimensional Fund Advisors).

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