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RESEARCH MATTERS

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How Diversification Impacts Investment Outcomes: A Case Study on Global Large Caps

Research shows that a focus on small cap, low relative price, and high profitability stocks can increase expected returns.[1] While realized premiums may differ from expectations, robust strategy design can increase the likelihood of outperforming the market. The probability of outperformance is influenced by a few variables, including how much a strategy is focused on the premiums and the volatility of the premiums. A third important driver for the reliability of outperformance, and the focus of this column, is the level of diversification.

How does diversification impact the reliability of outperformance? To illustrate, consider a group of securities with similar characteristics that are expected to deliver a premium. While these securities may have similar expected returns, they are unlikely to contribute equally to the realization of that premium. Rather, research shows that premiums are often delivered by a subset of stocks.[2] The challenge for investors is that there is no reliable way to predict which securities will deliver the premium in a given period. Therefore, investment solutions forfeiting broad diversification may miss out on the very stocks that deliver the premiums.

As documented by Dai (2016), for a given level of expected outperformance, broader diversification has led to greater reliability of outperformance within US stocks. The purpose of this study is to expand the analysis to a global investment set.

To analyze the relation between diversification level and reliability of outperformance, we simulated global large cap portfolios with varying numbers of holdings. These portfolios pursue higher expected returns by overweighting stocks with lower market capitalization, lower relative price, and higher profitability.[3] The fully diversified portfolio, represented by the Dimensional All Country World Adjusted Large 1 Index, had 2,637 names on average. As shown in **Exhibit 1**, emphasizing the premiums led the Dimensional All Country World Adjusted Large 1 Index to outperform the MSCI All Country World Index by 80 basis points annualized (8.42% vs. 7.62%) from January 1994–December 2017. The average monthly return difference of six basis points was statistically reliable (with a t-stat of 3.36). We simulated less diversified portfolios through sampling from the global large cap universe.[4] These

1. Fama and French (1992, 1993, 2006), Novy-Marx (2013), and O'Reilly and Rizova (2013).
2. Fama and French (2007).
3. Profitability is measured as operating income before depreciation and amortization minus interest expense scaled by book.
4. The global large cap universe, as defined by Dimensional, is all stocks included in the Dimensional All Country World Adjusted Large 1 Index. See "Index Description" for description of Dimensional index data. See "Important Information about Simulations" for a description of the methodology used to simulate the sample portfolios.

Exhibit 1: Summary Statistics of Dimensional All Country World Adjusted Large 1 Index and MSCI All Country World Index (gross div.), *January 1994–December 2017*

	Annualized Return	Annualized Standard Deviation	Average Monthly Return	t-Stat of Return Differences	Annualized Tracking Error	Monthly Correlation
Dimensional All Country World Adjusted Large 1 Index	8.42%	14.82%	0.77%	3.36	1.07%	0.9974
MSCI All Country World Index (gross div.)	7.62%	14.90%	0.71%	—	—	—

Indices are not available for direct investment. See "Index Description" for description of Dimensional index data. MSCI data © MSCI 2018, all rights reserved.

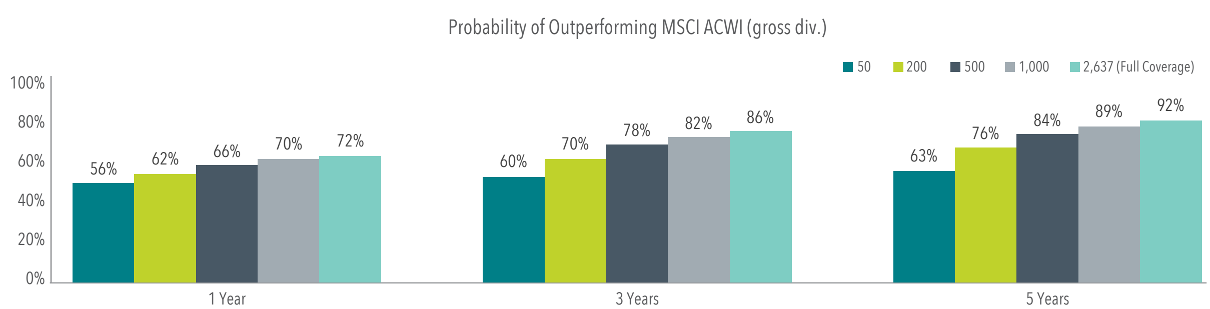
Past performance is not a guarantee of future results.

sampled portfolios on average hold 50, 200, 500, and 1,000 names and by construction have the same exposure to the premiums as the Dimensional All Country World Adjusted Large 1 Index. This helps isolate the effects of diversification on performance reliability.

Exhibit 2 illustrates the impact of diversification on the probability of outperforming the market benchmark (MSCI ACWI) over differing investment horizons.[5] By construction, the sampled portfolios have the same average excess return as the fully diversified portfolio across all diversification levels. However, the probability of outperformance increases substantially across all investment horizons as the coverage grows from 50 stocks to full coverage. Over a one-year horizon, a portfolio with 50 stocks has a 56.2% probability of outperforming. For the full coverage portfolio, the probability increases to 71.9%. The difference in reliability was even more pronounced for longer investment horizons. For the same change in diversification level over a five-year horizon, the probability of outperformance increases from 63.5% to 91.9%.

Examining the lower tail of the distribution of excess returns is another way to see how the reliability of investment outcomes improves with increasing diversification. As shown in **Exhibit 3**, as the portfolios become more diversified, the 25th percentile of excess returns becomes less negative. For example, the 25th percentile of excess returns for the one-year investment horizon increases markedly from –2.19% to –0.06% as diversification increases from 50-stock sampled portfolios to the full coverage index. Hence, diversification may meaningfully mitigate the underperformance that investors might experience relative to the benchmark.

Exhibit 2: Estimated Probability of Outperforming the MSCI ACWI (gross div.) over Various Investment Horizons for Simulated Global Large Cap Portfolios with Different Diversification Levels

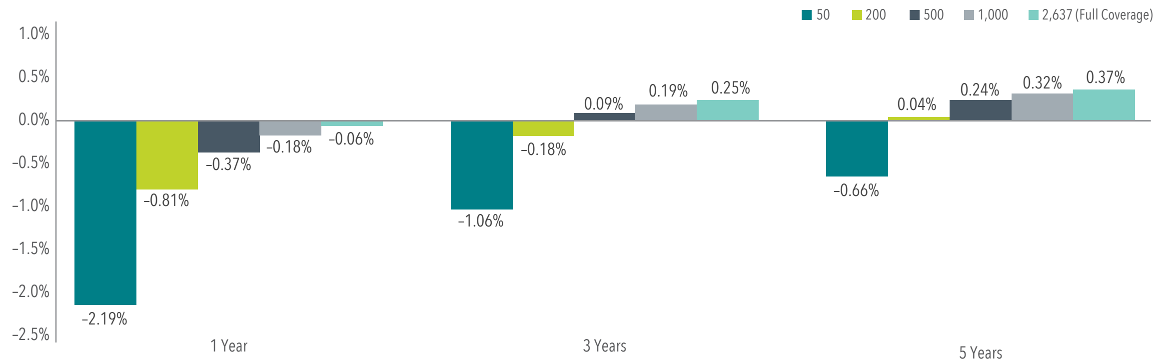


Sample portfolios (50, 200, 500, and 1,000) constructed using simulated data and do not represent live strategies managed by Dimensional Fund Advisors LP or any of its affiliates. "2,637 (Full Coverage)" represented by the Dimensional All Country World Adjusted Large 1 Index. See "Index Descriptions" for description of Dimensional index data. See also "Important Information about Estimated Probability and Simulations".

Past performance, including simulated performance, is not a guarantee of future results. The projections or other information generated by bootstrapped samples regarding the likelihood of various investment outcomes are hypothetical in nature, do not reflect actual investment results, and are not guarantees of future results. Results will vary with each use and over time.

5. See "Important Information about Simulations" for description of simulation methodology.

Exhibit 3: 25th Percentile of the Return Distribution in Excess of the MSCI ACWI (gross div.) over Various Investment Horizons for Simulated Global Large Cap Portfolios with Different Diversification Levels



Sample portfolios (50, 200, 500, and 1,000) constructed using simulated data and do not represent live strategies managed by Dimensional Fund Advisors LP or any of its affiliates. See "Important Information about Simulations." "2,637 (Full Coverage)" represented by the Dimensional All Country World Adjusted Large 1 Index. See "Index Description" for description of Dimensional index data. MSCI data © MSCI 2018, all rights reserved. Indices are not available for direct investment.

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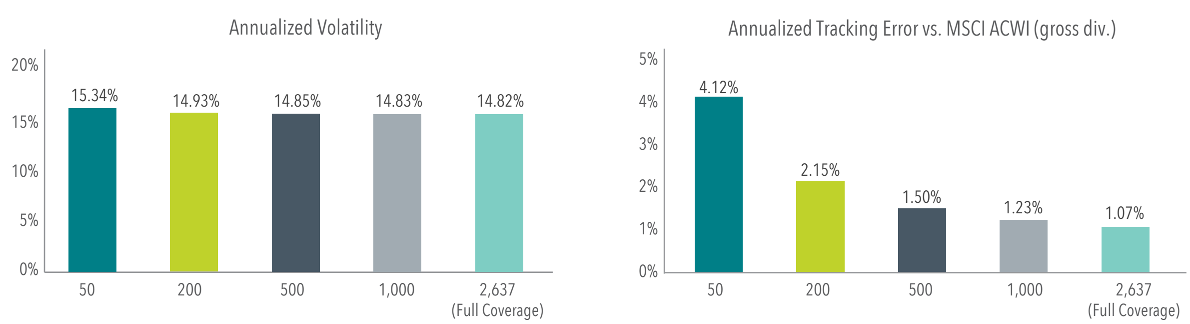
Exhibit 4 sheds light on the driving force behind the changes in performance reliability. While there is a slight reduction in volatility as the number of securities held in portfolios increases, the reduction in tracking error vs. the benchmark is much more pronounced. Annualized tracking error falls from 4.12% for 50-stock portfolios to 1.07% when holding the full universe.

These results suggest that while a portfolio must deviate from the market to outperform, not all deviations provide higher expected returns. In this study, the tracking error due to the pursuit of premiums is associated with higher expected return (as in the case of the Dimensional All Country World Adjusted Large 1 Index), but the additional tracking error due to sampling is not. In other words, reducing unnecessary tracking error through broad diversification may meaningfully improve the reliability of capturing the premiums.

Empirical results for the global equity universe paint a clear picture of the benefits of diversification. While the appropriate level of diversification should always be considered within the context of a strategy's goal, broad diversification combined with long-term investing

Exhibit 4: Average Annualized Volatility and Tracking Error of Simulated Global Large Cap Portfolios with Different Diversification Levels



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plays a key role in improving the reliability of investment outcomes. Diversification also provides the benefit of increased portfolio flexibility. These are all critical contributors to the success of an investment strategy.

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INDEX DESCRIPTION

Dimensional All Country World Adjusted Large 1 Index

Targets large cap securities in the eligible markets with an emphasis on companies with smaller capitalization, lower relative price, and higher profitability. Profitability is measured as operating income before depreciation and amortization minus interest expense scaled by book. The index is rebalanced semi-annually. Countries currently included are Australia, Austria, Belgium, Brazil, Canada, Chile, China, Colombia, Czech Republic, Denmark, Finland, France, Germany, Greece, Hong Kong, Hungary, India, Indonesia, Ireland, Israel, Italy, Japan, Malaysia, Mexico, New Zealand, Norway, Philippines, Poland, Portugal, Russia, Singapore, South Africa, South Korea, Spain, Sweden, Switzerland, Taiwan, Thailand, The Netherlands, Turkey, United Kingdom, United States. Exclusions: REITs and investment companies. Source: Bloomberg.

The Dimensional indices have been retrospectively calculated by Dimensional Fund Advisors LP and did not exist prior to their index inceptions dates. Accordingly, results shown during the periods prior to each index's index inception date do not represent actual returns of the index. Other periods selected may have different results, including losses. Backtested index performance is hypothetical and is provided for informational purposes only to indicate historical performance had the index been calculated over the relevant time periods. Backtested performance results assume the reinvestment of dividends and capital gains.

The Dimensional and Fama/French Indices reflected above are not "financial indices" for the purpose of the EU Markets in Financial Instruments Directive (MiFID). Rather, they represent academic concepts that may be relevant or informative about portfolio construction and are not available for direct investment or for use as a benchmark. Their performance does not reflect the expenses associated with the management of an actual portfolio. Index returns are not representative of actual portfolios and do not reflect costs and fees associated with an actual investment. Actual returns may be lower.

IMPORTANT INFORMATION ABOUT SIMULATIONS

Methodology: The 50, 200, 500, and 1,000 sample portfolios were constructed by bootstrapping stocks from the global large cap universe—the greater the number of draws, the more diversified the resulting portfolios are in terms of the average number of unique names. The portfolios are rebalanced semi-annually and maintain the same tilts toward the size, value, and profitability premiums as the Dimensional All Country World Adjusted Large 1 Index, on average. Hypothetical performance is measured by annualized compound returns relative to the MSCI All Country World Index (gross div.).

Simulations are based on model/backtested performance achieved with benefit of hindsight. These results are hypothetical, are not representative of indices, actual investments, or actual strategies managed by Dimensional, and do not reflect costs and fees associated with an actual investment. The securities in the model may differ significantly from those in client accounts. Model performance may not reflect the impact that economic and market factors might have had on the advisor's decision making if the advisor had been actually managing client money. Past performance, including simulated performance, is no guarantee of future results. 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.

IMPORTANT INFORMATION ABOUT ESTIMATED PROBABILITY

The probability of outperforming the MSCI All Country World Index (gross div.) for sampled global large cap portfolios with different diversification levels and over various investment horizons based on 50,000 bootstraps. The sample period was from January 1994–December 2017. The sampled portfolios were formed by bootstrapping stocks from the global large cap universe—the greater the number of draws, the more diversified the resulting portfolios are in terms of the average number of unique names. Indices are not available for direct investment.

The following persons listed as references are employees of Dimensional Investment LLC, a subsidiary of Dimensional Fund Advisors LP: Gerard O'Reilly, Savina Rizova, and Wei Dai.