Dimensional

SMAs: Quantifying the Tradeoffs Between Taxes and Diversification

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June 2021

We often hear that diversification is the only free lunch in investing. Indeed, broad diversification is a powerful tool to manage risk, to control costs, and to systematically pursue higher expected returns.

However, there may be situations that leave investors with wealth concentrated in relatively few holdings. Events such as stock awards, vesting of stock options, and public offerings of successful private equity endeavors may result in highly concentrated portfolios. Investors may also obtain large equity positions through inheritance, leading to concentration of their assets in a few securities.

Should holders of such portfolios sell concentrated positions, potentially incurring capital gains taxes, in order to pursue a well-diversified investment strategy? Herein, we consider the tradeoffs associated with such transitions. We show that, in many cases, a broadly diversified portfolio can lead to an increase in expected ending wealth over the long term compared to a concentrated portfolio, net of taxes incurred during the transition.

I. Benefits of Diversification

Benefit 1: Diversification provides reliable exposure to market returns.

Because equity returns are largely unpredictable, being broadly diversified reduces idiosyncratic risk and increases the likelihood of capturing market returns.

As investors, we often think about returns with respect to the overall market. For example, many recall that the S&P 500 Index enjoyed a strong performance in 2020, returning 18.4% for the year. It may, however, be easy to miss the wide dispersion in outcomes across stocks within the index: 194 stocks in the index had negative returns over 2020, with 50 down more than 25%. The disparity in fortune is visualized in **Exhibit 1**, which plots the return over 2020 of each S&P 500 constituent, ranging from best to worst.

For investors, missing the winning tail of this distribution can have a meaningful impact on investment outcomes, as demonstrated in **Exhibit 2**. The compound average annual return from 1994 through 2020 for all US stocks was 10.3%, as shown in Panel A. However, that return dropped to 6.3% after excluding just the top 10% of performers each year, and to −1.6% after excluding the top 25% of performers. Panel B shows a similar pattern in the global market: the compound average annual return of all stocks was 8.2%, but was cut by more than half to 3.6% after excluding just the top 10% of performers each year, and to −4.7% after excluding the top 25% of performers. By comparison, the average annual return to three-month Treasury Bills over the same period was 2.4%.[1]

Benefit 2: Transitioning to a more broadly diversified portfolio can improve expected returns.

A broadly diversified investment solution can enable investors not only to get a fair share of the market return, but also to systematically target sources of higher expected returns. This can improve the expected return of an investment relative to that of a highly concentrated portfolio that provides no consistent focus on return premiums.

Valuation theory provides a framework about the drivers of expected stock returns, linking expectations about a firm's future cash flows to its current value through a discount rate (or, equivalently, the expected return on the stock). Using the valuation framework, we can expect small cap stocks to outperform large cap stocks, low relative price stocks to outperform high relative price stocks, and stocks with higher profitability[2] to outperform low profitability stocks.

Consistent with valuation theory, the existence of these premiums has been documented in studies covering over 40 countries and nine decades of stock data.[3] **Exhibit 3** shows the historical annualized compound returns across size, relative price, and profitability groups in the US, developed ex US, and emerging markets.[4] The average size, value, and profitability premiums are positive and pervasive across different markets around the world.

EXHIBIT 1: Range of S&P 500 Constituent Returns, *2020*

Past performance is not a guarantee of future results. Indices are not available for direct investment; therefore, their performance does not reflect the expenses associated with the management of an actual portfolio.

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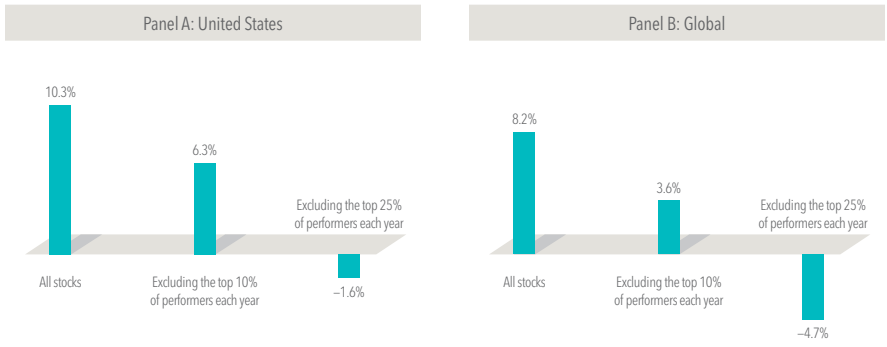
EXHIBIT 2: Compound Average Annual Returns Excluding Top-Performing Stocks, *1994–2020*



"All stocks" includes all eligible US stocks (Panel A) or all eligible developed and emerging markets stocks (Panel B) at their market cap weights. Eligible stocks are required to meet a minimum market capitalization requirement. REITs and investment companies are excluded. Compound average annual returns are computed as the compound returns of the value-weighted averages of the annual returns of the included securities. "Excluding the top 10%" and "Excluding the top 25%" are constructed similarly, but exclude the respective percentages of stocks with the highest annual returns by security count each year. Individual security data are obtained from Bloomberg, London Share Price Database, and Centre for Research in Finance. The eligible countries for Panel B: Australia, Austria, Belgium, Brazil, Canada, Chile, China, Colombia, Czech Republic, Denmark, Egypt, Finland, France, Germany, Greece, Hong Kong, Hungary, India, Indonesia, Ireland, Israel, Italy, Japan, Republic of Korea, Malaysia, Mexico, Netherlands, New Zealand, Norway, Peru, Philippines, Poland, Portugal, Russia, Singapore, South Africa, Spain, Sweden, Switzerland, Taiwan, Thailand, Turkey, the UK, and the US. Diversification does not eliminate the risk of market loss. Past performance, including hypothetical performance, is no guarantee of future results.

EXHIBIT 3: Return Dimensions Around the World, *Illustrative Index Performance (%)*

Past performance is not a guarantee of future results. 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.

Annualized compound returns (%) in US dollars. MSCI indices are gross div. The Dimensional and Fama/French Indices represent academic concepts that may be used in portfolio construction and are not available for direct investment or for use as a benchmark. See Index Descriptions in the appendix for descriptions of Dimensional and Fama/French index data. S&P data © 2021 S&P Dow Jones Indices LLC, a division of S&P Global. All rights reserved. MSCI data © MSCI 2021, all rights reserved.

Benefit 3: Diversification allows investors to pursue higher expected returns more reliably.

Diversification is an integral part of robust portfolio design and increases the probability of capturing the premiums and outperforming the market. To illustrate, consider a group of securities with similar characteristics (market capitalization, relative price, and profitability) 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 the size, relative price, and profitability premiums. Rather, research shows that premiums are often delivered by a subset of stocks.[5] However, there is no reliable way to predict which securities will deliver the premium in a given period. Therefore, concentrated investment solutions may miss out on the very stocks that deliver the premiums. In contrast, broader diversification has led to greater reliability of outperformance within equities for a given level of expected outperformance, as documented by Dai (2016) and Dai and Wicker (2018).[6]

This impact of diversification on the reliability of outcomes is illustrated in Exhibit 4, which examines the performance of simulated global large cap portfolios with varying numbers of holdings. Each portfolio pursues higher expected returns within global large cap stocks by overweighting stocks with smaller market capitalization, lower relative price, and higher profitability. The difference between portfolios is the level of diversification: the fully diversified simulation consists of 2,637 stocks on average, while the various sampled portfolios hold on average 50, 200, 500, and 1,000 stocks. Exhibit 4 shows the probability that each simulated portfolio outperforms the market, as proxied by the MSCI All Country World Index, over investment horizons of one, three, and five years. Within each period, the portfolios with more stocks have a higher probability of beating the market. At five years, for example, the fully diversified portfolio beats the market 92% of the time, compared with 63% for a portfolio that has the same exposure to known drivers of higher expected returns but holds only 50 stocks on average.[7]

Benefit 4: Well-diversified portfolios provide for more robust implementation.

A broadly diversified portfolio enhances opportunities for tax-efficient rebalancing without materially impacting the ability to pursue equity premiums.

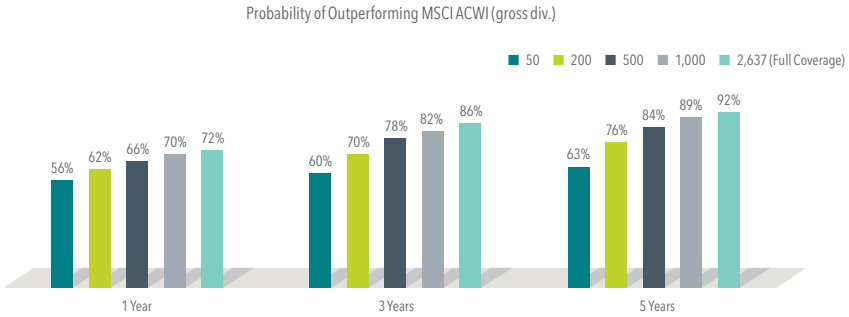
Simply put, portfolio managers have more choices. When evaluating portfolio characteristics and generating buy and sell orders, a portfolio with more positions, all else equal, allows portfolio managers to more efficiently balance the tradeoffs between pursuing higher expected returns and taxes.

Because many stocks have similar characteristics and may provide the portfolio similar benefits in terms of expected returns, diversification enables portfolio managers to efficiently incorporate additional information related to capital gains and losses as well as dividend income, among other factors, into their buy and sell orders.

Diversification can improve not only the tax efficiency but also the cost efficiency of portfolio rebalancing. To generate meaningful portfolio turnover, we need to balance the expected tax benefits from potential sell orders with their expected trading costs. All else equal, a portfolio with more positions allows portfolio managers to more efficiently balance these tradeoffs because there is a wider set of options to choose from when generating orders.

Finally, diversification enhances the ability of portfolio managers to robustly manage risks and costs. Holding on to a few legacy stocks typically leads to one of two outcomes over the long term: (1) one or more of the stocks delist due to bankruptcy or poor performance, or (2) one or more of the stocks get acquired, and as a result, an investor can face taxable gains with no control over the timing of their realization. Broad diversification can minimize the impact of delisting events on the portfolio and mitigate the impact of unexpected and hard-to-control cash flows from M&A events.

EXHIBIT 4: Estimated Probability of Outperforming the MSCI ACWI (gross div.) over Various Investment Horizons for Simulated Global Large Cap Core Equity Portfolios with Different Diversification Levels



Past performance, including simulated performance, is not a guarantee of future results.

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."

II. Transitioning to a Well-Diversified Portfolio

While diversification has many important benefits, some investors with concentrated holdings may still prefer to stay put in their portfolios. Besides personal attachment to a particular investment and legal restrictions such as lock-up periods, capital gains taxes associated with the sale of appreciated investments can be an important consideration. Investors may seek to defer or avoid the tax bill, potentially waiting for a step-up in basis upon bequeathing assets to the next generation.

Indeed, the incurrence of capital gains taxes may deter some investors from transitioning to a well-diversified portfolio. Consider a hypothetical investor who invests $1 million in a portfolio of five stocks and holds this portfolio for 10 years. At the end of the 10-year period, the portfolio is worth $1.5 million, a gain of $500,000 or 50%. This investor is likely happy with the investment outcome, but perhaps is reconsidering her concentrated portfolio of five stocks. How should such an investor proceed?

The cost of diversifying comes from paying the tax bill today. If the investor decides to transition out of her current holdings, the incurred tax will be equal to the current long-term capital gains tax rate times the gain of $500,000. In this example, suppose the long-term capital gains tax rate is 25%, resulting in capital gains tax of $125,000. The actual cost might be smaller than the full tax bill, however, if the investor is just planning to defer the realization of the capital gains for a few years instead of eventually getting a step-up in basis upon inheritance. In that case, the tax cost of diversifying now rather than say, five years from now, is just the interest rate on the tax bill.

The cost of not diversifying, which may be more difficult to quantify, lies in what an investor must give up: for example, reduction in idiosyncratic risk, participation in market returns, and the potential to systematically and efficiently target higher expected returns. As illustrated above, the potential for underperformance in a highly concentrated portfolio can be significant.

What's more, tax rates may go up in the future and considerations based on tax rules today, such as step-up in cost basis at the time of inheritance, may become moot if tax rules change. Contrast the risks of holding a highly concentrated portfolio with the marginal, and uncertain, benefit of tax deferral, and the realization of tax today starts to appear a more advantageous tradeoff.

Continuing the example above, we examine the outcome if this investor

maintains the same concentrated portfolio or transitions to a well-diversified portfolio. In both cases, the investor holds a $1.5 million portfolio with a cost basis of $1 million and faces capital gains tax of $125,000 if she liquidates her current holdings. If the investor transitions to a well-diversified portfolio, the annualized volatility of her portfolio falls. All else equal, lower volatility leads to a higher compound return.

We consider two broadly diversified alternative portfolios: the first, call it "Transition A," maintains the same expected return as the existing portfolio, just with more holdings; the second, "Transition B," represents a portfolio that also has a systematic emphasis on stocks with higher expected returns and therefore a slightly higher expected return. The existing portfolio and the two alternative strategies are illustrated in **Exhibit 5**.

We assume an expected return of 9% for the existing portfolio and for Transition A, and an expected return of 10% for Transition B. The expected annual returns are informed by the historical realization of global stock market returns. For example, the Russell 3000 returned 12.1%, annualized, from index inception in January 1979 through December 2020. By way of global comparison, the MSCI World ex USA Index (gross div.) returned 9.0% over the same period and the MSCI Emerging Markets Index (gross div.) returned 10.9% from its earliest available date in January 1988 through December 2020.[8]

The pickup of 100 basis points (bps) from Transition A to Transition B is informed by the historical outperformance range for a core equity strategy relative to that of the market. The Dimensional US Adjusted Market 1 Index, with a systematic emphasis on drivers of higher expected returns, returned 13.2%, annualized, from January 1979 through December 2020, compared to 12.1% for the Russell 3000 Index. The Dimensional US Adjusted Market 2 Index, with a heavier emphasis on known drivers of higher expected returns, returned 13.4% over the same period. Results outside the US are similar.

EXHIBIT 5: Existing vs. Alternative Portfolios

We assume the annual volatility, as measured by standard deviation, of the existing concentrated portfolio to be 30% and the volatility of the well-diversified transition portfolios to be 20%. To arrive at these assumptions, we computed the annualized volatility over a 30-year investment horizon for 100 hypothetical portfolios of five, 10, 25, and 50 US stocks over the period from January 1991 through December 2020. At the beginning of the investment horizon, each hypothetical portfolio holds the designated number of stocks, selected at random, at market capitalization weight. If a stock is delisted for any reason, the portfolio redeploys the cash into a randomly selected replacement stock to maintain the same number of holdings. Across the hundred simulated five-stock portfolios, the average annualized volatility is 35.5%. Similarly, across the 100 simulated 10-stock portfolios, the average annualized volatility is 31.2%. In contrast, a portfolio of 25 or 50 stocks exhibits an average annualized volatility of 23.7% or 20.9%, respectively.[9] For comparison, the annualized volatility of the Russell 3000 Index and S&P 500 Index over the 1991–2020 period was 14.9% and 19.3%, respectively.

Finally, we assume a lognormal distribution for portfolio returns given the parameters set forth above and derive a distribution of outcomes. We then plot the growth of wealth at the 25th, 50th, and 75th percentiles over 25 years for each portfolio in **Exhibit 6**.

Exhibit 6 presents the results for six different scenarios: 1) a full transition (base case), 2) transitioning only 50% of the portfolio, 3) a smaller reduction in portfolio volatility, 4) a higher capital gains tax rate, 5) a lower cost basis for the starting portfolio, and 6) the after-tax pre-liquidation of the base case. The ending wealth values for scenarios 1–5 are after-tax post-liquidation, meaning the value reflects taxes incurred in the portfolio transition and upon the final liquidation of the investment. After-tax pre-liquidation reflects the value of a portfolio for which the investor has incurred taxes in the portfolio transition but has not liquidated the portfolio yet and therefore has not turned all unrealized gains into taxable realized gains.

In all scenarios, the end wealth of both diversified portfolios exceeds that of a highly concentrated portfolio. Compared to the existing portfolio, Transition A has lower volatility, which improves compound returns over time. Transition B, with a higher expected return through the systematic and efficient pursuit of equity premiums, further improves the investment outcome over the long run.

That is, across different portfolio and tax assumptions, an investor can expect to have higher wealth in the long term, despite incurring capital gains today, by holding a well-diversified portfolio that efficiently pursues even moderately higher expected returns.

EXHIBIT 6: Ending Wealth Distributions Under Alternative Portfolio Transitions

SCENARIO 1:
Full Transition (Base Case)

The investor transitions from her existing $1.5 million portfolio to a well-diversified portfolio with the same expected return in Transition A, and with a moderately higher expected return in Transition B. Facing a 25% capital gains tax rate and with a gain of $500,000, she incurs tax of $125,000 in the transition. Increasing portfolio diverisifcation results in a lower portfolio volatility: 20% for Transition A and B vs. 30% for the existing portfolio.

After just one year, the 50th percentile outcome for Transition B exceeds the 50th percentile outcome for the existing portfolio. At the 10-year mark, Transition A and Transition B have grown to $2.4 million and $2.6 million, respectively, at the 50th percentile, compared to $2.1 million for the existing portfolio. The benefits of broad diversification and systematic pursuit of premiums continue to accrue over time: after 25 years, the median end wealth is $7.8 million for Transition B, followed by $6.2 million for Transition A, both meaningfully higher than the $4.1 million for the existing portfolio. Actually, the exhibit shows that after 25 years, Transition B has higher ending wealth at the 25th, 50th, and 75th percentile outcomes than Transition A, which in turn has higher ending wealth at each of those percentiles than the existing portfolio.

	Existing	Transition A	Transition B
Initial Portfolio Value	$1,500,000	$1,375,000	$1,375,000
Cost Basis	$1,000,000	$1,375,000	$1,375,000
Tax Rate	25%	25%	25%
Expected Return	9%	9%	10%
Volatility	30%	20%	20%
50th Percentile Ending Wealth (After-Tax, Post-Liquidation) at 25 Years	$4,144,189	$6,222,259	$7,784,609

After-tax post-liquidation value reflects taxes incurred in portfolio transition and upon the final liquidation of the investment.

SCENARIO 2:
Transition 50% of Portfolio

In this scenario, the investor transitions just half of her $1.5 million portfolio and realizes a gain of $250,000 in the process. Assuming a 25% capital gains tax rate, she incurs tax of $62,500 (half of the gain of Scenario 1) in the transition, and thus Transition A and Transition B have higher initial portfolio values in Scenario 2 than Scenario 1. Because the investor only transitions half of her existing portfolio, we assume a smaller reduction in portfolio volatility from 30% to 22% in both transition portfolios and an expected return of 9.5% for Transition B instead of 10%, reflecting an assumed correlation of 0.5 between the existing and transition portfolios.

As in Scenario 1, Transition B has higher ending wealth at the 25th, 50th, and 75th percentile outcomes than Transition A, which in turn has higher ending wealth at each percentile than the existing portfolio after 25 years. It takes just one year for the 50th percentile outcome for Transition B to exceed the 50th percentile outcome for the existing portfolio.

	Existing	Transition A	Transition B
Initial Portfolio Value	$1,500,000	$1,437,500	$1,437,500
Cost Basis	$1,000,000	$1,187,500	$1,187,500
Tax Rate	25%	25%	25%
Expected Return	9%	9%	9.5%
Volatility	30%	22%	22%
50th Percentile Ending Wealth (After-Tax, Post-Liquidation) at 25 Years	$4,144,189	$5,940,622	$6,653,031

After-tax post-liquidation value reflects taxes incurred in portfolio transition and upon the final liquidation of the investment.

EXHIBIT 6: Ending Wealth Distributions Under Alternative Portfolio Transitions *(continued)*

SCENARIO 3:
Full Transition with Lower Starting Volatility

The investor fully transitions her $1.5 million portfolio in this scenario, but we assume that the initial portfolio volatility is lower than in Scenarios 1 and 2. We assume the volatility of the initial portfolio is 25%, falling to 20% with a transition to a well-diverisifed portfolio.

Even with half the reduction in portfolio volatility, the scenario achieves the same relative outcome over 25 years: Transition B has higher ending wealth than both Transition A and the existing portfolio at each percentile. After just one year, the 50th percentile outcome for Transition B exceeds the 50th percentile outcome for the existing portfolio.

	Existing	Transition A	Transition B
Initial Portfolio Value	$1,500,000	$1,375,000	$1,375,000
Cost Basis	$1,000,000	$1,375,000	$1,375,000
Tax Rate	25%	25%	25%
Expected Return	9%	9%	10%
Volatility	25%	20%	20%
50th Percentile Ending Wealth (After-Tax, Post-Liquidation) at 25 Years	$5,360,897	$6,222,259	$7,784,609

After-tax post-liquidation value reflects taxes incurred in portfolio transition and upon the final liquidation of the investment.

SCENARIO 4:
Full Transition with a Higher Tax Rate

In this scenario, the investor fully transitions her $1.5 million portfolio but faces a higher capital gains tax rate of 40%. The result is a lower initial portfolio value following a transition after facing $200,000 in capital gains tax instead of $125,000 in the above full-transition scenarios.

At each percentile shown, the ending wealth of Transition B at the 25-year mark exceeds that of Transition A, which in turn exceeds that of the existing portfolio. It takes just one year for the 50th percentile outcome for Transition B to exceed the 50th percentile outcome for the existing portfolio.

	Existing	Transition A	Transition B
Initial Portfolio Value	$1,500,000	$1,300,000	$1,300,000
Cost Basis	$1,000,000	$1,300,000	$1,300,000
Tax Rate	40%	40%	40%
Expected Return	9%	9%	10%
Volatility	30%	20%	20%
50th Percentile Ending Wealth (After-Tax, Post-Liquidation) at 25 Years	$3,515,351	$4,966,291	$6,147,995

After-tax post-liquidation value reflects taxes incurred in portfolio transition and upon the final liquidation of the investment.

EXHIBIT 6: Ending Wealth Distributions Under Alternative Portfolio Transitions *(continued)*

SCENARIO 5:
Full Transition with Lower Cost Basis

Now the investor faces a lower cost basis when fully transitioniong her $1.5 million portfolio. Again facing a 25% capital gains tax rate, she incurs higher capital gains tax than in the above scenarios and her initial portfolio value following a transition is $1.25 million.

Over 25 years, again Transition B has higher ending wealth at the 25th, 50th, and 75th percentile outcomes than Transition A, which in turn has higher ending wealth than the existing portfolio. At the one-year mark, the 50th percentile outcome for Transition B exceeds the 50th percentile outcome for the existing portfolio.

	Existing	Transition A	Transition B
Initial Portfolio Value	$1,500,000	$1,250,000	$1,250,000
Cost Basis	$500,000	$1,250,000	$1,250,000
Tax Rate	25%	25%	25%
Expected Return	9%	9%	10%
Volatility	30%	20%	20%
50th Percentile Ending Wealth (After-Tax, Post-Liquidation) at 25 Years	$4,019,189	$5,656,599	$7,076,917

After-tax post-liquidation value reflects taxes incurred in portfolio transition and upon the final liquidation of the investment.

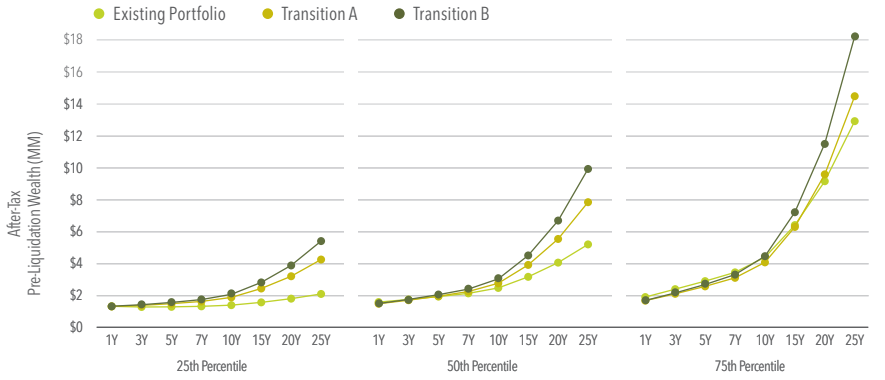
SCENARIO 6:
After-Tax Pre-Liquidation Base Case

Again, the investor fully transitions from her existing $1.5 million portfolio to a well-diversified portfolio with the same expected return in Transition A, and with a moderately higher expected return in Transition B. In this scenario, we examine the pre-liquidation ending wealth for each portfolio.

The after-tax pre-liquidation value after 25 years is higher for Transition B than Transition A, which is in turn higher than that of the existing portfolio. Within three years from the portfolio transition, the 50th percentile outcome for Transition B exceeds the 50th percentile outcome for the existing portfolio.

Even in the case of a step-up in basis at the end of the investment horizon, diversifying one's portfolio can be beneficial due to the lower volatility and higher, more reliable expected returns of a systematic, broadly diversified strategy.

	Existing	Transition A	Transition B
Initial Portfolio Value	$1,500,000	$1,375,000	$1,375,000
Cost Basis	$1,000,000	$1,375,000	$1,375,000
Tax Rate	25%	25%	25%
Expected Return	9%	9%	10%
Volatility	30%	20%	20%
50th Percentile Ending Wealth (After-Tax, Pre-Liquidation) at 25 Years	$5,192,252	$7,838,013	$9,921,145



After-tax pre-liquidation value reflects taxes paid in the portfolio transition, but not taxes that would be incurred on any gains (or losses) that would be realized upon liquidation.

For readers interested in more detail on the outcomes under different scenarios, we offer additional information in the appendix.

III. Investment Decisions

We believe holding a well-diversified portfolio that systematically pursues higher expected returns through an efficient investment approach better positions investors for a positive investment outcome, compared to holding a concentrated portfolio with few stocks.

A well-diversified portfolio not only reduces risk, but also enables investors to systematically and reliably target equity premiums. With an efficient focus on higher expected returns and with lower volatility, diversifying can improve investment outcomes even for investors who anticipate a future step-up in basis. Diversification also allows for a flexible trading approach that can help reduce implementation costs.

For investors concerned with after-tax returns, diversification can also contribute to tax management, as holding more positions increases the opportunity, for example, to capture benefits associated with tax loss harvesting.

Incurring capital gains tax is a tangible cost investors face in transitioning to a well-diversified portfolio. However, as our analysis suggests, the less tangible costs of not transitioning, in terms of what an investor may be giving up in the future, may be greater.

There may be client-specific situations that compel investors to postpone the liquidation of a concentrated position.

Investment solutions that provide alternatives to immediate liquidation can help clients meet their investment goals. For example, efficient incorporation of charitable gifting that focuses on low cost basis positions can help investors reposition concentrated holdings without adding to the tax bill.

In times of frequently changing tax rules, holding a well-diversified portfolio is one important tool available to investors to manage uncertainty and help achieve their investment goals.

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1. US Treasury bill data provided by Ibbotson Associates via Morningstar Direct.
2. Profitability is measured as operating income before depreciation and amortization minus interest expense scaled by book equity.
3. For example, see: Eugene F. Fama and Kenneth R. French, "The Cross-Section of Expected Stock Returns," *Journal of Finance* 47, no. 2, (June 1992); Eugene F. Fama and Kenneth R. French, "Common Risk Factors in the Returns on Stocks and Bonds," *Journal of Financial Economics* 33, no. 1, (February 1993); Eugene F. Fama and Kenneth R. French, "Profitability, Investment and Average Returns," *Journal of Financial Economics* 82, no. 3 (December 2006); Eugene F. Fama and Kenneth R. French, "A Five-Factor Asset Pricing Model," *Journal of Financial Economics* 116, no. 1 (April 2015); Eugene F. Fama and Kenneth R. French, "International Tests of a Five-Factor Asset Pricing Model," *Journal of Financial Economics* 123, no. 3 (March 2017); Robert Novy-Marx, "The Other Side of Value: The Gross Profitability Premium," *Journal of Financial Economics* 108, no. 1 (April 2013); and Gerard O'Reilly and Savina Rizova, "Expected Profitability: A New Dimension of Expected Returns" (white paper, Dimensional Fund Advisors, June 2013).
4. Note that the time periods reported in the exhibit differ depending on the region and the dimension, based on data availability.
5. For example, see Eugene F. Fama and and Kenneth R. French, "Migration," *Financial Analysts Journal* 63, no. 3 (2007): 48–58.
6. Wei Dai, "How Diversification Impacts the Reliability of Outcomes," (white paper, Dimensional Fund Advisors, 2016); Wei Dai and Matt Wicker, "How Diversification Impacts Investment Outcomes: A Case Study on Global Large Caps" (white paper, Dimensional Fund Advisors, April 2018).
7. See Dai (2016) for further discussion.
8. For comparison, over the same period from January 1988 through December 2020, the Russell 3000 Index and the MSCI World ex USA Index (gross div.) returned an annualized 11.1% and 6.0%, respectively. MSCI data © MSCI 2021, all rights reserved. Frank Russell Company is the source and owner of the trademarks, service marks, and copyrights related to the Russell Indexes.
9. We conducted similar analyses over 10-year and 20-year investment horizons and results are similar. For additional detail, see Estimated Volatility Analyses methodology in the appendix.

Appendix

Appendix A: After-tax post-liquidation multiples of existing portfolio value ($1.5 million) are presented for different percentile outcomes (**Exhibit A1**) and under alternative capital gains rates for the portfolio transition and liquidation at the end of the period (**Exhibit A2**). **Exhibit A3** presents after-tax pre-liquidation multiples of existing portfolio value after 25 years under alternative tax rates for the portfolio transition.

Remaining parameters for Exhibits A1, A2, and A3 are consistent with **Exhibit 6, Scenario 1**: cost basis is two-thirds of the initial portfolio value (embedded gains are one-third); annualized volatility is 30% for the existing portfolio and 20% for Transition A and Transition B; expected return is 9%, annualized, for the existing portfolio and Transition A and 10% for Transition B.

Exhibit A4 presents after-tax post-liquidation multiples of starting portfolio value for alternative tax rates under the same assumptions as above with one change: the cost basis is one-third of the initial portfolio value, reflecting greater unrealized embedded gains in the existing portfolio (two-thirds of the portfolio value are embedded gains). (This is similar to **Exhibit 6, Scenario 5.**)

EXHIBIT A1: After-Tax Post-Liquidation Wealth: Multiple of Starting Portfolio Value at Different Percentile Outcomes, with Capital Gains Tax of 25%

Panel A: 25th Percentile of Outcomes

	Existing Portfolio	Transition A	Transition B
Year 1	0.82	0.88	0.89
Year 5	0.81	0.97	1.01
Year 10	0.86	1.16	1.26
Year 15	0.95	1.44	1.63
Year 20	1.06	1.83	2.17
Year 25	1.21	2.35	2.93

Panel B: 50th Percentile of Outcomes

	Existing Portfolio	Transition A	Transition B
Year 1	0.95	0.97	0.97
Year 5	1.13	1.20	1.25
Year 10	1.40	1.61	1.74
Year 15	1.75	2.18	2.48
Year 20	2.19	3.00	3.57
Year 25	2.76	4.15	5.19

Panel C: 75th Percentile of Outcomes

	Existing Portfolio	Transition A	Transition B
Year 1	1.11	1.06	1.07
Year 5	1.61	1.51	1.57
Year 10	2.36	2.26	2.46
Year 15	3.37	3.37	3.83
Year 20	4.74	5.02	5.99
Year 25	6.62	7.47	9.34

EXHIBIT A2: After-Tax Post-Liquidation Wealth: Multiple of Existing Portfolio Value Under Different Tax Rates, 50th Percentile Outcomes

Panel A: 25% Capital Gains Tax

	Existing Portfolio	Transition A	Transition B
Year 1	0.95	0.97	0.97
Year 5	1.13	1.20	1.25
Year 10	1.40	1.61	1.74
Year 15	1.75	2.18	2.48
Year 20	2.19	3.00	3.57
Year 25	2.76	4.15	5.19

Panel B: 35% Capital Gains Tax

	Existing Portfolio	Transition A	Transition B
Year 1	0.92	0.92	0.93
Year 5	1.07	1.12	1.16
Year 10	1.30	1.46	1.57
Year 15	1.60	1.94	2.19
Year 20	1.99	2.62	3.10
Year 25	2.48	3.58	4.45

Panel C: 45% Capital Gains Tax

	Existing Portfolio	Transition A	Transition B
Year 1	0.88	0.88	0.89
Year 5	1.01	1.04	1.08
Year 10	1.20	1.32	1.41
Year 15	1.46	1.71	1.91
Year 20	1.79	2.26	2.65
Year 25	2.20	3.05	3.76

EXHIBIT A3: After-Tax Pre-Liquidation Wealth: Multiple of Existing Portfolio Value Under Different Tax Rates at Portfolio Transition, 50th Percentile Outcomes

Panel A: 25% Capital Gains Tax

	Existing Portfolio	Transition A	Transition B
Year 1	1.05	0.98	0.99
Year 5	1.28	1.30	1.36
Year 10	1.64	1.84	2.02
Year 15	2.11	2.60	3.00
Year 20	2.70	3.69	4.45
Year 25	3.46	5.23	6.61

Panel B: 35% Capital Gains Tax

	Existing Portfolio	Transition A	Transition B
Year 1	1.05	0.95	0.96
Year 5	1.28	1.25	1.31
Year 10	1.64	1.77	1.95
Year 15	2.11	2.51	2.89
Year 20	2.70	3.56	4.29
Year 25	3.46	5.04	6.37

Panel C: 45% Capital Gains Tax

	Existing Portfolio	Transition A	Transition B
Year 1	1.05	0.91	0.92
Year 5	1.28	1.20	1.26
Year 10	1.64	1.71	1.87
Year 15	2.11	2.42	2.78
Year 20	2.70	3.42	4.13
Year 25	3.46	4.85	6.13

EXHIBIT A4: After-Tax Post-Liquidation Wealth: Multiple of Existing Portfolio Value Under Different Tax Rates at Portfolio Transition with Lower Cost Basis, 50th Percentile Outcomes

Panel A: 25% Capital Gains Tax

	Existing Portfolio	Transition A	Transition B
Year 1	0.87	0.88	0.88
Year 5	1.04	1.09	1.14
Year 10	1.32	1.46	1.59
Year 15	1.66	1.98	2.25
Year 20	2.11	2.72	3.25
Year 25	2.68	3.77	4.72

Panel B: 35% Capital Gains Tax

	Existing Portfolio	Transition A	Transition B
Year 1	0.80	0.80	0.81
Year 5	0.95	0.97	1.01
Year 10	1.18	1.27	1.37
Year 15	1.49	1.68	1.90
Year 20	1.87	2.27	2.69
Year 25	2.37	3.11	3.86

Panel C: 45% Capital Gains Tax

	Existing Portfolio	Transition A	Transition B
Year 1	0.73	0.73	0.73
Year 5	0.86	0.86	0.89
Year 10	1.05	1.09	1.16
Year 15	1.31	1.41	1.58
Year 20	1.64	1.86	2.19
Year 25	2.05	2.51	3.09

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 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. MSCI data © MSCI 2021, all rights reserved. Indices are not available for direct investment.

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.

ESTIMATED VOLATILITY ANALYSES

Methodology: Portfolios are constructed at the end of December 1990 and held for the next 30 years. Stocks are selected randomly across all common stocks in the CRSP universe with share code 10 or 11 and are initially weighted based on their market capitalization at the time of portfolio formation. Every month available cash is reinvested in the same set of stocks, unless one or more of the stocks has disappeared from the eligible universe (due to delisting or merger, for example). In that case, the available cash (including cash from the liquidation of the position in the disappearing security) is invested in a randomly selected stock with the goal to keep the name count the same.

INDEX DESCRIPTIONS

Dimensional US Adjusted Market 2 Index: January 1975–present: Compiled by Dimensional from CRSP and Compustat data. Targets all securities of US companies traded on the NYSE, NYSE MKT (formerly AMEX), and Nasdaq Global Market with an emphasis on companies with smaller capitalization, lower relative price, and higher profitability, excluding those with the lowest profitability and highest relative price within the small cap universe. The index also excludes those companies with the highest asset growth within the small cap universe. Profitability is defined as operating income before depreciation and amortization minus interest expense divided by book equity. Asset growth is defined as change in total assets from the prior fiscal year to current fiscal year. The index overweights securities of companies with smaller capitalization and lower relative price to a greater degree than the Dimensional US Adjusted Market 1 Index. Exclusions: non-US companies, REITs, UITs, and investment companies. The index has been retroactively calculated by Dimensional and did not exist prior to March 2007. The calculation methodology was amended in January 2014 to include profitability as a factor in selecting securities for inclusion in the index. The calculation methodology was amended in December 2019 to include asset growth as a factor in selecting securities for inclusion in the index. Prior to January 1975: Targets all securities of US companies traded on the NYSE, NYSE MKT (formerly AMEX), and Nasdaq Global Market with an emphasis on companies with smaller capitalization and lower relative price.

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.

Fama/French Total US Market Research Index: July 1926–present: Fama/French Total US Market Research Factor + One-Month US Treasury Bills. Source: Ken French Website.

Fama/French US Value Research Index: Provided by Fama/French from CRSP securities data. Includes the lower 30% in price-to-book of NYSE securities (plus NYSE Amex equivalents since July 1962 and Nasdaq equivalents since 1973).

Fama/French US Growth Research Index: Provided by Fama/French from CRSP securities data. Includes the higher 30% in price-to-book of NYSE securities (plus NYSE Amex equivalents since July 1962 and Nasdaq equivalents since 1973).

Fama/French US Small Value Research Index: Provided by Fama/French from CRSP securities data. Includes the lower 30% in price-to-book of NYSE securities (plus NYSE Amex equivalents since July 1962 and Nasdaq equivalents since 1973) that have smaller market capitalization than the median NYSE company.

Fama/French US Large Growth Research Index: Provided by Fama/French from CRSP securities data. Includes the higher 30% in price-to-book of NYSE securities (plus NYSE Amex equivalents since July 1962 and Nasdaq equivalents since 1973) that have larger market capitalization than the median NYSE company.

Fama/French US High Profitability Index: July 1963–present: Fama/French US High Profitability Index. Courtesy of Fama/French from CRSP and Compustat securities data. Includes all stocks in the upper 30% operating profitability range of NYSE eligible firms; rebalanced annually in June. OP for June of year t is annual revenues minus cost of goods sold, interest expense, and selling, general, and administrative expenses divided by book equity for the last fiscal year end in t−1. Fama/French and multifactor data provided by Fama/French.

Fama/French US Low Profitability Index: July 1963–present: Fama/French US Low Profitability Index. Courtesy of Fama/French from CRSP and Compustat securities data. Includes all stocks in the lower 30% operating profitability range of NYSE eligible firms; rebalanced annually in June. OP for June of year t is annual revenues minus cost of goods sold, interest expense, and selling, general, and administrative expenses divided by book equity for the last fiscal year end in t−1. Fama/French and multifactor data provided by Fama/French.

Fama/French International Market Index: January 1975–present: Fama/French International Market Index. Source: Ken French website. Simulated from MSCI and Bloomberg data.

Fama/French International Value Index: January 1975–present: Fama/French International Value Index. Simulated strategy of international developed countries with securities in the lower 30% price-to-book range. Source: Ken French website. Simulated from MSCI and Bloomberg data.

Fama/French International Growth Index: January 1975–present: Fama/French International Growth Index. Simulated strategy of international developed countries with securities in the higher 30% price-to-book range. Source: Ken French website. Simulated from MSCI and Bloomberg data.

Fama/French International High Profitability Index: July 1990–present: Fama/French International High Profitability Index. Courtesy of Fama/French from Bloomberg securities data. Includes stocks in the upper 30% operating profitability range in each region; companies weighted by float-adjusted market cap; rebalanced annually in June. OP for June of year t is annual revenues minus cost of goods sold, interest expense, and selling, general, and administrative expenses divided by book equity for the last fiscal year end in t−1. Fama/French and multifactor data provided by Fama/French.

Fama/French International Low Profitability Index: July 1990–present: Courtesy of Fama/French from Bloomberg securities data. Includes stocks in the lower 30% operating profitability range in each region; companies weighted by float-adjusted market cap; rebalanced annually in June. OP for June of year t is annual revenues minus cost of goods sold, interest expense, and selling, general, and administrative expenses divided by book equity for the last fiscal year end in t−1. Fama/French and multifactor data provided by Fama/French.

The Dimensional Indices have been retrospectively calculated by Dimensional Fund Advisors LP and did not exist prior to their index inception 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.

Eugene Fama and Ken French are members of the Board of Directors of the general partner of, and provide consulting services to, Dimensional Fund Advisors LP.