

The case for low-cost index fund investing

- Because of governmental regulatory changes, the introduction of exchange-traded funds (ETFs), and a growing awareness of the benefits of low-cost investing, index investing has become a global trend over the last several years, with a large and growing investor base.
- This paper discusses why we expect index investing to remain successful over the long term—a rationale grounded in the zero-sum game, the effect of costs, and the challenge of obtaining persistent outperformance.
- We examine how indexing performs in a variety of circumstances, including diverse time periods and market cycles, and we provide investors with points to consider when evaluating different investment strategies.

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Index investing first became broadly available to U.S. investors with the launch of the first indexed mutual fund in 1976.¹ Since then, low-cost index investing has proven to be a successful strategy over the long term, outperforming the majority of active managers across markets and asset styles (S&P Dow Jones Indices, 2015). In part because of this long-term outperformance, index investing has grown exponentially, particularly in the United States, and especially since the global financial crisis of 2007–2009. In recent years, governmental regulatory changes, the introduction of indexed ETFs, and a growing awareness of the benefits of low-cost investing in many world markets have made index investing a global trend. This paper reviews the conceptual and theoretical underpinnings of index investing's ascendancy (along with supporting quantitative data) and discusses why we expect it to remain successful and increase in popularity.

A market-capitalization-weighted indexed investment strategy—through a mutual fund or an ETF, for example—seeks to track the returns of a market or market segment with minimal expected deviations (and, by extension, no positive excess return) before costs by assembling a portfolio that invests in the securities, or a sampling of them, that make up the market. In contrast, actively managed funds seek to achieve a return or risk level that differs from that of a market-cap-weighted benchmark. Any strategy, in fact, that aims to differentiate itself from a market-cap-weighted benchmark (such as alternative indexing, smart beta, or factor strategies) is, in our view, active management, and should be evaluated based on the success of the differentiation.²

Notes about risk and performance data

Investments are subject to market risk, including the possible loss of the money you invest. Bond funds are subject to the risk that an issuer will fail to make payments on time, and that bond prices will decline because of rising interest rates or negative perceptions of an issuer's ability to make payments. Investments in stocks issued by non-U.S. companies are subject to risks including country/regional risk, which is the chance that political upheaval, financial troubles, or natural disasters will adversely affect the value of securities issued by companies in foreign countries or regions, and currency risk, which is the chance that the value of a foreign investment, measured in U.S. dollars, will decrease because of unfavorable changes in currency exchange rates. Stocks of companies based in emerging markets are subject to national and regional political and economic risks and to the risk of currency fluctuations. These risks are especially high in emerging markets. Funds that concentrate on a relatively narrow market sector face the risk of higher share-price volatility. Prices of mid- and small-cap stocks often fluctuate more than those of large-company stocks. U.S. government backing of Treasury or agency securities applies only to the underlying securities and does not prevent share-price fluctuations. Unlike stocks and bonds, U.S. Treasury bills are guaranteed as to the timely payment of principal and interest. High-yield bonds generally have medium- and lower-range credit quality ratings and are therefore subject to a higher level of credit risk than bonds with higher credit quality ratings. Diversification does not ensure a profit or protect against a loss. *Performance data shown represent past performance, which is not a guarantee of future results. Note that hypothetical illustrations are not exact representations of any particular investment, as you cannot invest directly in an index or fund-group average.*

- ¹ Throughout this paper, we use the term *index investing* to refer to a passive, broadly diversified, market-capitalization-weighted strategy. For purposes of this discussion, we consider any strategy that is not market-cap-weighted to be active.
- ² Pappas and Dickson (2015) give an introduction to factor strategies. Chow et al. (2011) explain how various alternatively weighted index strategies outperformed market-capitalization-weighted strategies largely on the basis of factors.

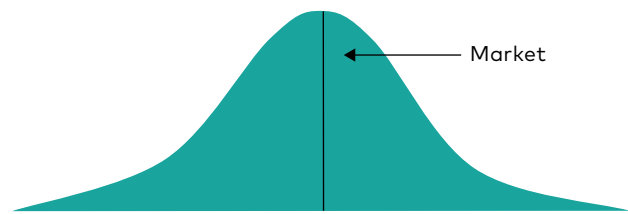
This paper presents the case for low-cost index fund investing by reviewing the main drivers of its efficacy. These include zero-sum game theory, the effect of costs, and the difficulty of finding persistent outperformance among active managers. In addition, we review circumstances under which this case may appear less or more compelling than theory would suggest and provide suggestions for selecting an active manager for investors who still prefer active management or for whom no viable low-cost indexed option is available.

Zero-sum game theory

The central concept underlying the case for index fund investing is the zero-sum game. This theory states that, at any given time, the market consists of the cumulative holdings of all investors, and that the aggregate market return is equal to the asset-weighted return of all market participants. Since the market return represents the average return of all investors, for each position that outperforms the market, there must be one that underperforms the market by the same amount such that, in aggregate, the excess return of all invested assets equals zero.³ This concept does not depend on any degree of market efficiency; the zero-sum game applies to markets thought to be less efficient (such as small-capitalization and emerging-market equities) as readily as to those widely regarded as efficient (Waring and Siegel, 2005).

Figure 1 illustrates the concept of the zero-sum game. The returns of the holdings in a market form a bell curve with a distribution of returns around the mean, which is the market return.

FIGURE 1.
Participants' asset-weighted returns form a bell curve around the market's return



Source: Vanguard.

It may seem counterintuitive that the zero-sum game would apply in inefficient markets, because, by definition, an inefficient market will have more price and informational inefficiencies and, therefore, more opportunities for outperformance. Although this may be true to a certain extent, it is important to remember that for every profitable trade an investor makes, (an)other investor(s) must take the opposite side of that trade and incur an equal loss. This holds true regardless of whether the security in question is mispriced or not. For the same reason, the zero-sum game must apply regardless of market direction, including bear markets, where active management is often thought to have an advantage. In a bear market, if a manager is selling out of an investment to position the portfolio more defensively, another or others must take the other side of that trade, and the zero-sum game still applies. The same logic applies in any other market, as well.

Some investors may still find active management appealing as it seemingly would provide an even-odds chance of outperforming. As we discuss in the next section, though, the costs of investing make outperforming the market significantly more difficult than the gross-return distribution would imply.

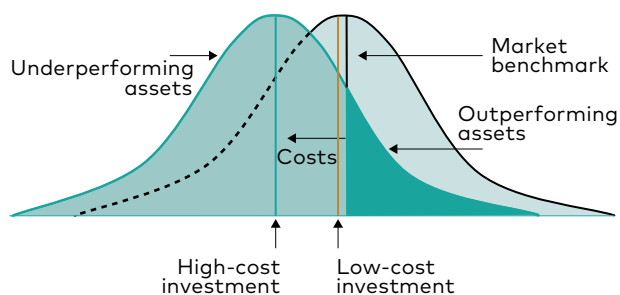
³ See Sharpe (1991) for a discussion of the zero-sum game.

Effect of costs

The zero-sum game discussed here describes a theoretical cost-free market. In reality, however, investors are subject to costs including management fees, bid-ask spreads, administrative costs, commissions, market impact, and, where applicable, taxes—all of which can be significant and reduce net returns over time. The aggregate result shifts the return distribution to the left.

Figure 2 shows two different investments compared to the market. The first has low costs, represented by the line to the right. The second has high costs, represented by the line to the left. As the figure shows, although both move the return curve to the left—meaning fewer assets outperform—the high-cost investment moves it much further, making outperformance relative to both the market and the low-cost investment much less likely. In other words, after accounting for costs, the aggregate performance of investors is less than zero sum, and as costs increase, the performance deficit becomes larger.

FIGURE 2.
Market participant returns after adjusting for costs



Source: Vanguard.

This performance deficit also changes the risk-return calculus of those seeking to outperform the market. We previously noted that an investor may find active management attractive because it theoretically provides an even chance of outperforming the market. Once we account for costs, however, underperformance becomes more likely than outperformance. As costs increase, both

the odds and magnitude of underperformance rise until significant underperformance becomes as likely as, or more likely than, even minor outperformance.

Figure 3 illustrates the zero-sum game on an after-cost basis by showing the distribution of excess returns of domestic equity funds (Figure 3a) and fixed income funds (Figure 3b), net of fees. Note that for both asset classes, a significant number of funds' returns lie to the left of the prospectus benchmark, which represents zero excess returns. Once merged and liquidated funds are considered, a clear majority of funds fail to outperform their benchmarks, meaning that negative excess returns tend to be more common than positive excess returns.⁴ Thus, as predicted by the zero-sum game theory, outperformance tends to be less likely than underperformance once costs are considered.

This raises the question of how investors can reduce the chances of underperforming their benchmark. Considerable evidence supports the view that the odds of outperforming a majority of similar investors increase if investors simply seek the lowest possible cost for a given strategy. For example, Financial Research Corporation (2002) evaluated the predictive value of different fund metrics, including a fund's past performance, Morningstar rating, alpha, and beta. In the study, a fund's expense ratio was the most reliable predictor of its future performance, with low-cost funds delivering above-average performance relative to the funds in their peer group in all of the periods examined. Morningstar performed a similar analysis and found that, regardless of fund type, low expense ratios were the best predictors of future relative outperformance (Kinnel, 2010).

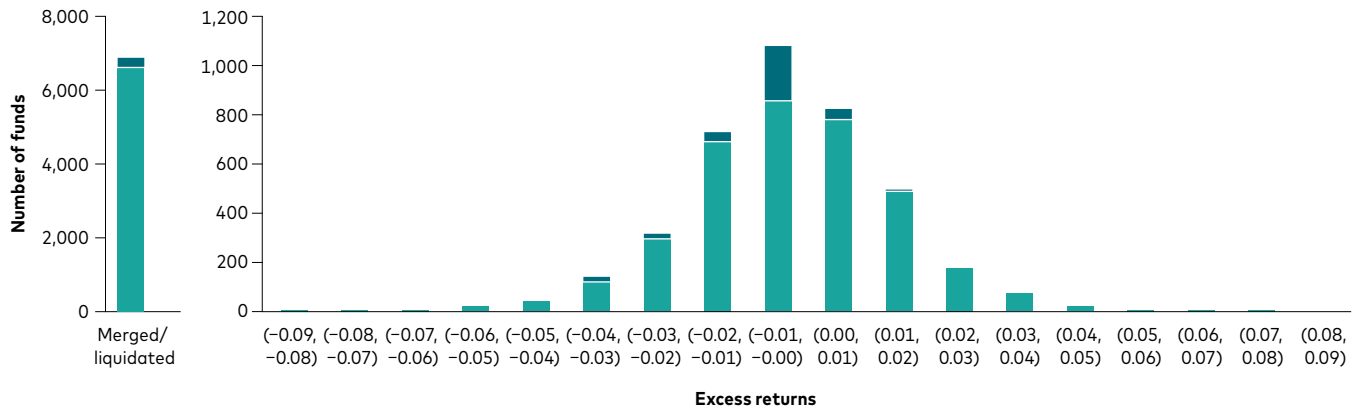
This negative correlation between costs and excess return is not unique to active managers. Rowley and Kwon (2015) looked at several variables among index funds and ETFs, including expense ratio, turnover, tracking error, assets under management, weighting methodology, and active share, and found that expense ratio was the most dominant in explaining an index fund's excess return.

⁴ Survivorship bias and the effect of merged and closed funds on performance are discussed in more detail later in this paper.

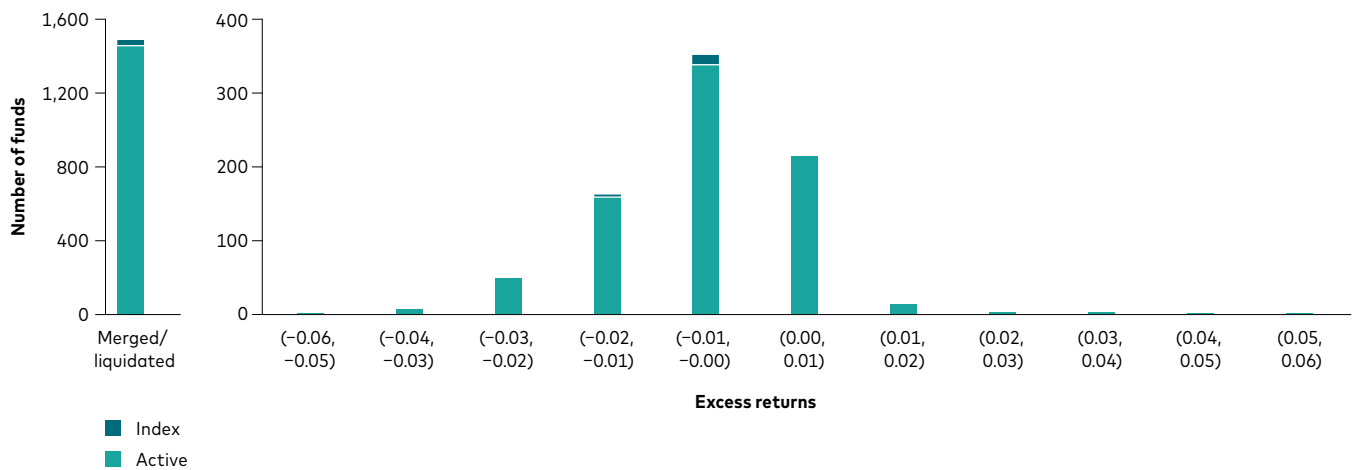
FIGURE 3.

Distribution of equity and fixed income funds' excess return

a. Distribution of equity funds' excess return



b. Distribution of fixed income funds' excess return



Past performance is not a guarantee of future results.

Notes: Charts a and b display the distribution of funds' excess returns relative to their prospectus benchmarks for the 15 years ended December 31, 2021.

Performance is shown in USD, net of fees, gross of tax, with income reinvested. The funds underlying the analyses shown in this paper are those available for sale in the U.S. Please refer to Appendix Figure A-1 for a list of Morningstar fund categories considered.

Sources: Vanguard calculations, using data from Morningstar, Inc.

To quantify the impact of costs on net returns, we charted managers' excess returns as a function of their expense ratios in various fund categories over a ten-year period. **Figure 4** shows that higher expense ratios are generally associated with lower excess returns. The slanted line in each category

represents the simple regression line and signifies the trend across all funds for each category. For investors, the clear implication is that by focusing on low-cost funds (both active and passive), the probability of outperforming higher-cost portfolios increases.

FIGURE 4.
Higher expense ratios were associated with lower excess returns for U.S. funds

a. U.S. equity funds

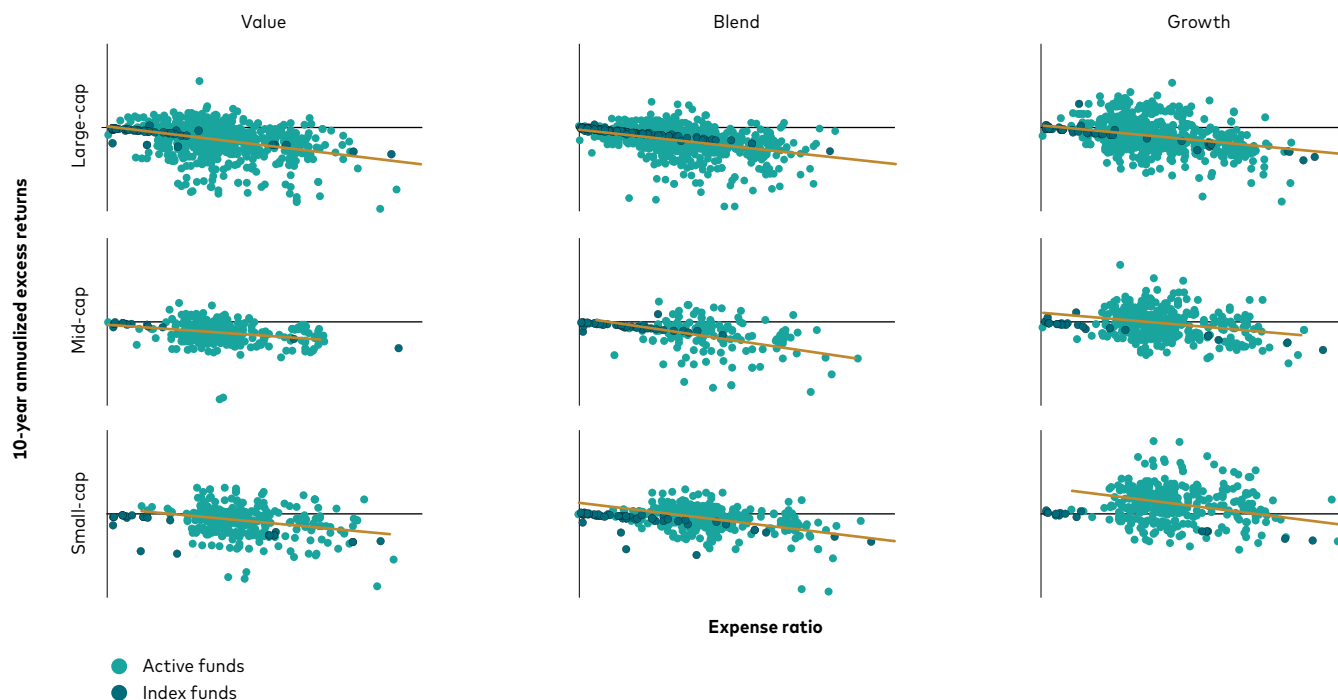
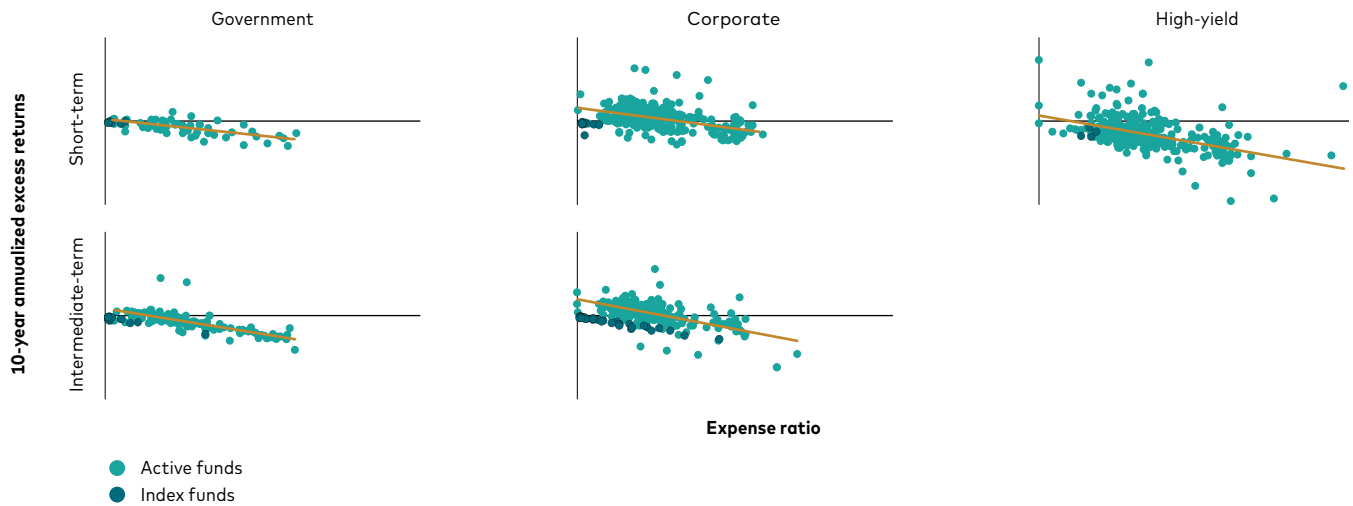


FIGURE 4 (CONTINUED).

Higher expense ratios were associated with lower excess returns for U.S. funds

b. U.S. bond funds



Past performance is not a guarantee of future results.

Notes: Each plotted point represents a U.S. equity or bond mutual fund or ETF in the specific size, style, and asset group. Each fund is plotted to represent the relationship of its expense ratio (x-axis) to its ten-year annualized excess return relative to its stated benchmark (y-axis). The straight line represents the linear regression, or the best-fit trend line—that is, the general relationship of expenses to returns in each asset group. The scales are standardized to show the slopes' relationships to each other, with expenses ranging from 0% to 3% and returns ranging from -15% to 15% for equities and from -5% to 5% for fixed income. Some funds' expense ratios and returns go beyond the scales and are not shown. Performance is NAV-based, and returns are calculated in USD, net of fees with income reinvested. Please refer to Appendix Figure A-1 for a list of fund categories considered.

Sources: Vanguard calculations, using data from Morningstar, Inc. All data are as of December 31, 2021.

Costs play a crucial role in investor success. In either an actively managed fund or an index fund, each basis point an investor pays in costs is a basis point less an investor receives in returns. Since excess returns are a zero-sum game, as cost drag increases, the likelihood that the manager will be able to overcome this drag

diminishes. Most investors' best chance at maximizing net returns over the long term lies in minimizing these costs. In most markets, low-cost index funds have a significant cost advantage over actively managed funds. Therefore, we believe that most investors are best served by low-cost index funds.

Persistent outperformance is scarce

For those investors pursuing an actively managed strategy, the critical question becomes, which fund will outperform? Most approach this question by selecting a winner from the past. Investors cannot profit from a manager's past success, however, so it is important to ask, does a winning manager's past performance persist into the future? Academics have long studied whether past performance can accurately predict future performance. More than 50 years ago, Sharpe (1966) and Jensen (1968) found limited to no persistence. Three decades later, Carhart (1997) reported no evidence of persistence in fund outperformance after adjusting for both the well-known Fama-French (1993) three-factor model and momentum. More recently, Fama and French (2010) reported results of a separate 22-year study suggesting that it is extremely difficult for an actively managed investment fund to outperform its benchmark regularly.

To test if active managers' performance has persisted, we looked at two separate, sequential, nonoverlapping five-year periods. First, we ranked the funds by performance quintile in the first five-year period, with the top 20% of funds going

into the first quintile, the second 20% into the second quintile, and so on. Second, we sorted those funds by quintile according to their performance in the second five-year period. To the second five-year period, however, we added a sixth category: funds that were either liquidated or merged during that period. We then compared the results. If managers were able to provide consistently high performance, we would expect to see the majority of first-quintile funds remaining in the first quintile. **Figure 5**, however, shows that most managers failed to do so.⁵

Once we accounted for closed and merged funds, persistence was actually stronger among the low-performing managers than among the high-performing managers. These findings were consistent for all asset classes and all markets we studied globally. From this, we concluded that consistent outperformance is very difficult to achieve. This is not to say that there are not periods when active management outperforms, or that no active managers do so regularly. Only that, on average and over time, active managers as a group fail to outperform; though some may be able to generate consistent outperformance, they are extremely rare.

FIGURE 5.
Actively managed domestic funds failed to show persistent outperformance

Initial excess return quintile, five years ended December 2016	Number of funds	Subsequent nonoverlapping five-year period (percentage of funds) ending December 2021					
		Highest quintile	2nd quintile	3rd quintile	4th quintile	Lowest quintile	Merged/liquidated
Highest quintile	956	18.31%	18.20%	17.89%	17.15%	15.90%	12.55%
2nd quintile	956	12.45%	18.51%	21.34%	16.00%	15.06%	16.63%
3rd quintile	956	15.90%	15.90%	14.75%	18.83%	13.60%	21.03%
4th quintile	956	15.48%	15.17%	14.02%	15.17%	13.60%	26.57%
Lowest quintile	957	14.63%	8.88%	8.78%	9.51%	18.60%	39.60%

Past performance is not a guarantee of future results.

Notes: The far-left column ranks all active U.S. equity funds as they fall into Morningstar's nine style categories for U.S. equity based on their excess returns relative to their stated benchmark during the five-year period as of the date listed. The remaining columns show how funds in each quintile performed over the next five years. Performance is NAV-based, and returns are calculated in USD, net of fees with income reinvested.

Sources: Vanguard and Morningstar, Inc.

⁵ We define consistently high performance persistence as maintaining top-quintile excess return performance. However, a manager may fall below the top quintile when measured against peers but still generate positive outperformance versus a benchmark. Of course, a manager could also remain in the top quintile without generating outperformance versus a benchmark.

When the case for low-cost index fund investing can seem less or more compelling

For the reasons already discussed, we expect the case for low-cost index fund investing to hold over the long term. Like any investment strategy, however, the real-world application can be more complex than the theory would suggest. This is especially true when attempting to measure indexing's track record versus that of active management. Various circumstances, which we discuss below, can result in data that at times show active management outperforming indexing and, at other times, show indexing outperforming active management by more than expected. As a result, the case for low-cost index fund investing can appear either less or more compelling than the theory would indicate. The following subsections address some of these circumstances.

Survivorship bias can skew results

Survivorship bias is introduced when funds are merged into other funds or liquidated and so are not represented throughout the full time period examined. Because such funds tend to be

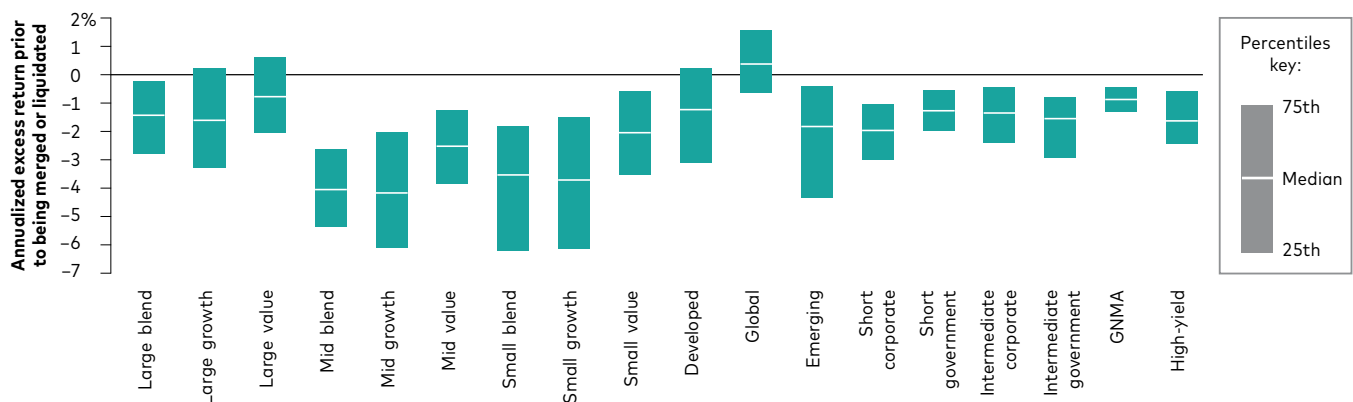
underperformers (see **Figure 6**), this skews the average results upward for the surviving funds, causing them to appear to perform better relative to a benchmark.⁶

Merged and liquidated funds have tended to be underperformers

To test the assumption that closed funds underperformed, we evaluated the performance of all domestic funds identified by Morningstar as being either liquidated or merged into another fund. Figure 6 shows that funds tend to trail their benchmark before being closed. We found the assumption that merged and liquidated funds underperformed to be reasonable.

In either case, we found that the share of active funds that underperformed tends to become more pronounced as the time period lengthens and survivorship bias is accounted for. Thus, it is critical to adjust for survivorship bias when comparing the performance of active funds to their benchmarks, especially over longer periods.⁷

FIGURE 6.
Dead funds showed underperformance versus style benchmarks prior to closing date



Past performance is not a guarantee of future results.

Notes: This chart displays the cumulative annualized performance of those funds that were merged or liquidated in this study's sample, relative to a benchmark representative of each fund's Morningstar category. See Appendix Figure A-1 for a list of benchmarks used. We measured each fund's performance from January 1, 2007, through the month-end prior to its merger or liquidation. For each category shown on the x-axis, the figure displays the middle 50% distribution of these funds' returns before their closure. Performance is NAV-based, and returns are calculated in USD, net of fees with income reinvested.

Sources: Vanguard calculations, based on data from Morningstar, Inc., CRSP, MSCI, and Bloomberg.

⁶ Schlanger and Philips (2013).

⁷ Another way to evaluate the relative success of investors is to view performance results in terms of asset-weighted performance. Please see Appendix Figure A-2 for a discussion of asset-weighted performance.

However, the average experience of investors—some of whom invested in the underperforming fund before it was liquidated or merged—may be much different. **Figure 7** shows the impact of

survivorship bias on the apparent relative performance of actively managed funds versus both their prospectus and style benchmarks.

FIGURE 7.

Percentage of actively managed mutual funds that underperformed versus their benchmarks

a. Versus fund prospectus

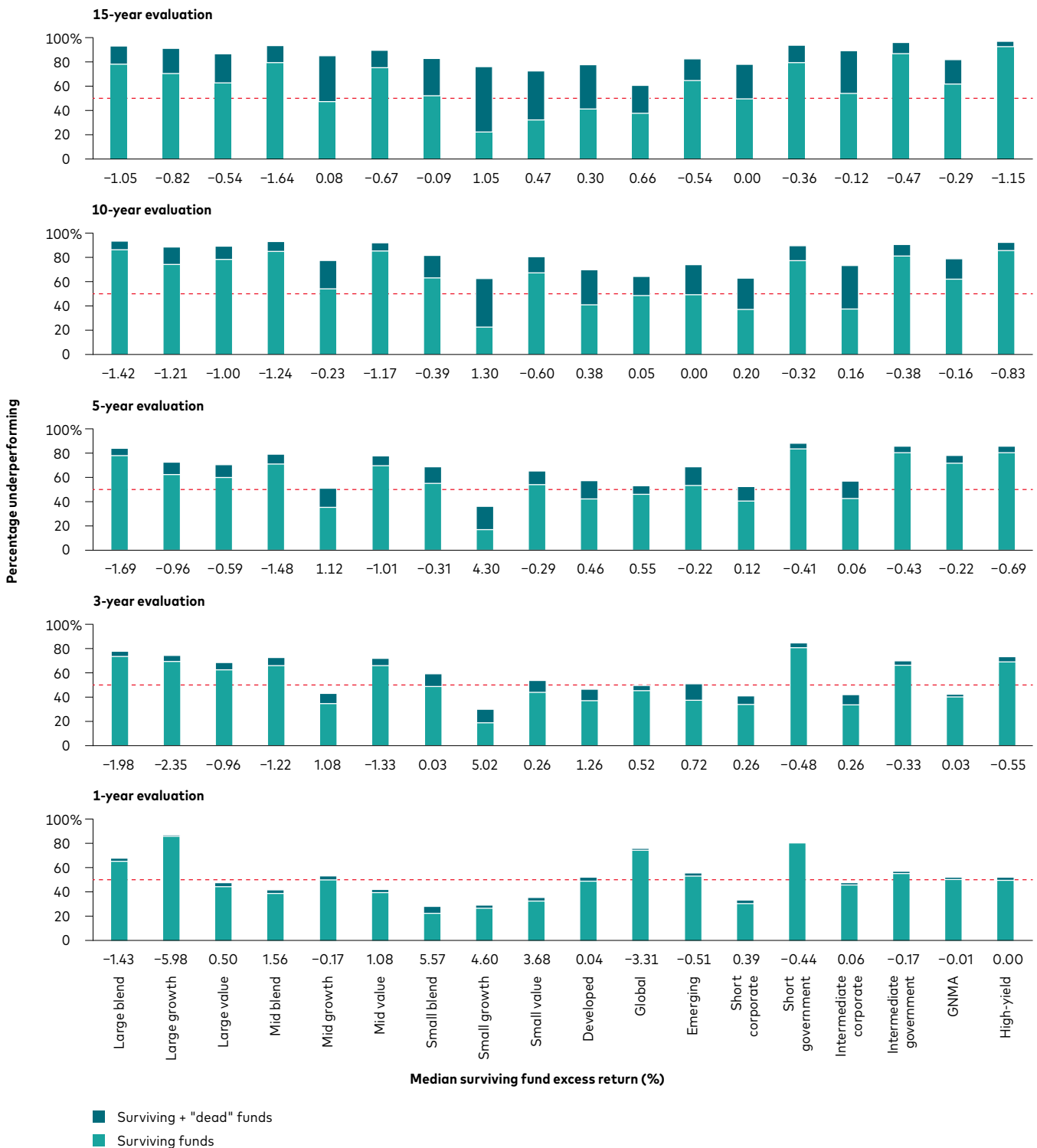
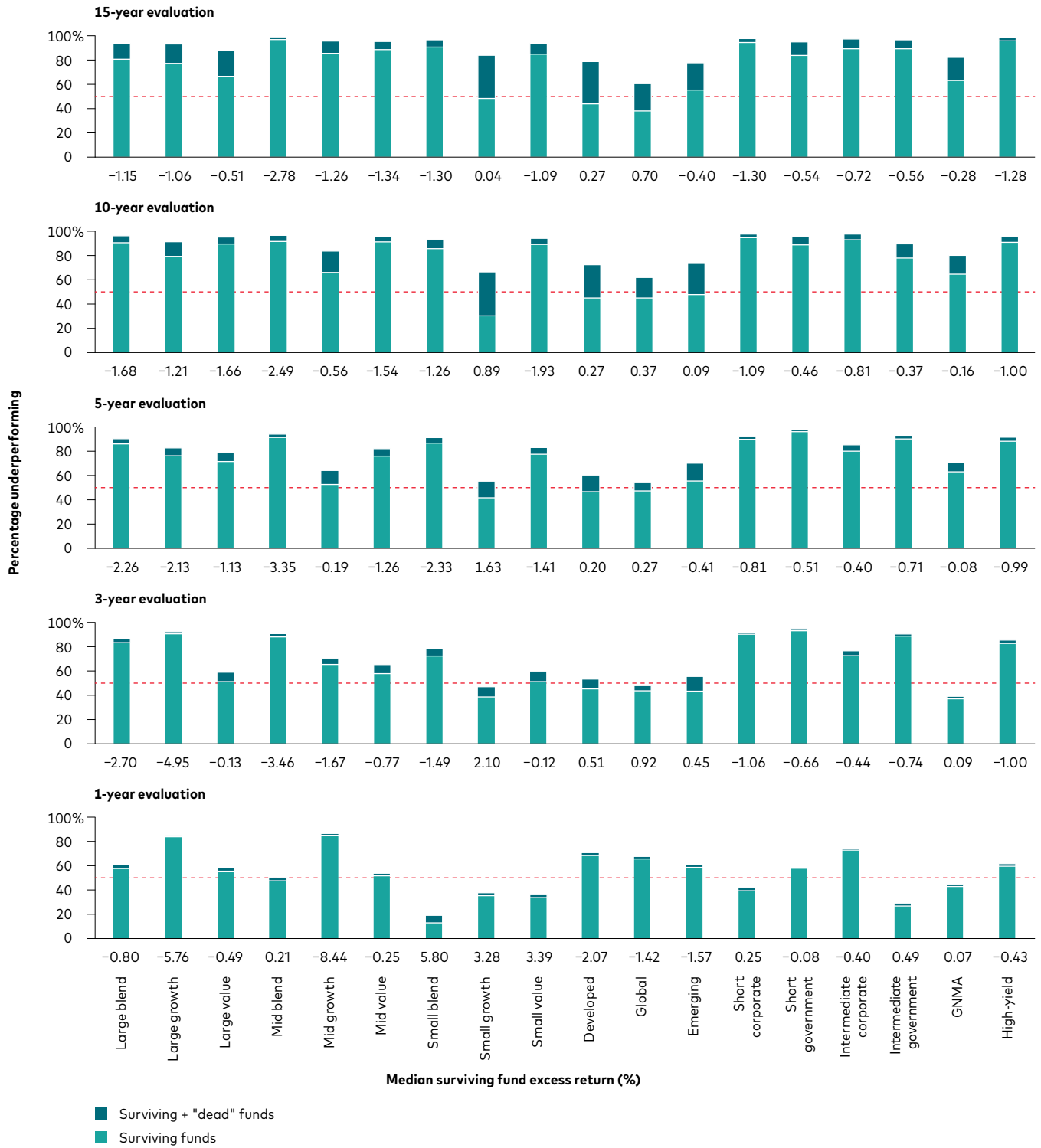


FIGURE 7 (CONTINUED).

Percentage of actively managed mutual funds that underperformed versus their benchmarks

b. Versus representative "style benchmark"



Past performance is not a guarantee of future results.

Notes: Data reflect periods ended December 31, 2021. Fund classifications are provided by Morningstar. See Appendix Figure A-1 for a list of benchmarks used. Dead funds are those that were merged or liquidated during the period.

Sources: Vanguard calculations, using data from Morningstar, Inc., CRSP, MSCI, and Bloomberg.

Mutual funds are not the entire market

Another factor that can complicate the analysis of real-world results is that mutual funds, which are used as a proxy for the market in most studies (including this one), do not represent the entire market and therefore do not capture the entire zero-sum game. Mutual funds are typically used in financial market research because their data tend to be readily available and because, in many markets, their assets represent a reasonable sampling of the overall market. However, mutual funds are merely a market sampling. In cases where they constitute a relatively smaller portion of the market being examined, the sample size studied will be that much smaller and the results more likely to be skewed. Depending on the direction of the skew, this could lead to either a less favorable or more favorable result for active managers.

Portfolio exposures can make relative performance more difficult to measure

Differences in portfolio exposures versus a benchmark or broader market can also make relative performance difficult to measure. Benchmarks are selected by fund managers on an ex ante basis and do not always reflect the style in which the portfolio is actually managed. For example, during a period in which small- and mid-cap equities are outperforming, large-cap managers may hold some of these stocks in the portfolio to increase returns (Thatcher, 2009). They may maintain an over/underexposure to certain factors (such as size or style) for the same

reason. These tilts can cause the portfolio to either outperform or underperform when measured against the fund's stated benchmark or the broad market, depending on whether the manager's tilts are in or out of favor during the period examined. Over a full market or factor cycle, however, we would expect these tilts' performance effects to cancel out and the zero-sum game to be restored.

Short time periods can understate the advantage of low-cost indexing

Time is an important factor in investing. Transient forces such as market cycles and simple luck can significantly affect a fund's returns over shorter time periods. These short-term effects can mask the relative benefits of low-cost index funds versus active funds in two main respects: the performance advantage conferred on index funds over the longer term by their generally lower costs, and the lack of persistent outperformance among actively managed funds.

A short reporting period reduces low-cost index funds' performance advantage because the impact of their lower costs compounds over time. For example, a 50-basis-point difference in fees between a low-cost and a higher-cost fund may not greatly affect performance over the course of a single year. However, that same fee differential compounded over longer periods can make a significant difference in the two funds' overall performance.

Time also has a significant impact on the application of the zero-sum game theory. In any given year, the zero-sum game states that there will be some population of funds that outperforms the market. As the period examined becomes longer, however, the effects of luck and market cyclicalities tend to cancel out, reducing the number of funds that outperform. Market cyclicalities are an important factor in the lack of persistent outperformance because investment styles and market sectors go in and out of favor, as noted earlier.

This concept is illustrated in **Figure 8**, which compares the performance of domestic funds over rolling one- and ten-year periods to that of their benchmarks. As the figure shows, active funds were much less likely to outperform over longer

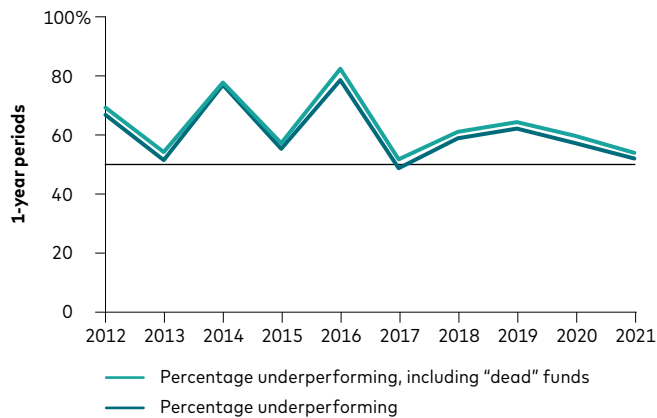
periods compared with shorter ones; this was especially true when merged and liquidated funds were included. Thus, as the period examined became longer, the population of funds that consistently outperformed tended to shrink, ultimately becoming very small.

Low-cost indexing—a simple solution

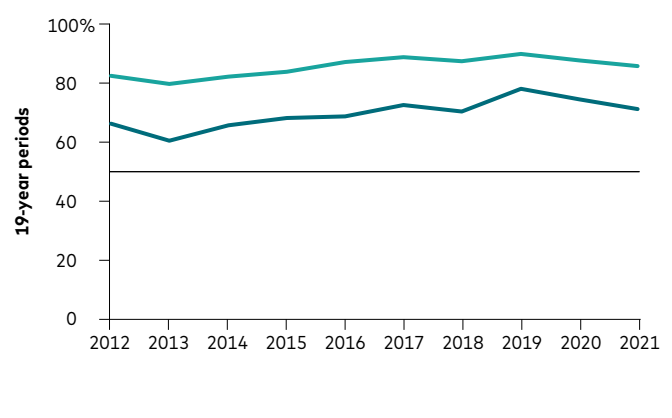
One of the simplest ways for investors to gain market exposure with minimal costs is through a low-cost index fund or ETF. Index funds seek to provide exposure to a broad market or market segment through varying degrees of index replication, ranging from full (in which every security in the index is held) to synthetic (in which index exposure is obtained through derivatives).

FIGURE 8.
Percentage of active U.S. equity funds underperforming over rolling periods versus prospectus benchmarks

a. 1-year periods



b. 10-year periods



Past performance is not a guarantee of future results.

Notes: Performance is calculated relative to the prospectus benchmark. "Dead" funds are those that were merged or liquidated during the period. Performance is NAV-based, and returns are in USD, net of fees with income reinvested.

Sources: Vanguard calculations, using data from Morningstar, Inc.

Regardless of the method used, all index funds seek to track the target market as closely as possible and, by extension, to provide market returns to investors. This is why index funds, in general, are able to offer market exposure at minimal cost. Because index funds do not attempt to outperform their market, as many active managers do, they do not require the significant investment of resources necessary to find and capitalize on opportunities for outperformance (such as research and increased trading costs) and therefore do not need to pass those costs on to investors.

By avoiding these costs, index funds are generally able to offer broad market exposure with returns at very low cost relative to that of most actively managed funds. Furthermore, because index funds do not seek to outperform the market, they do not face the challenges of either persistent outperformance or beating the zero-sum game. In short, by accepting market returns while keeping costs low, low-cost index funds lower the hurdles that make successful active management so difficult over the long term.

Although we believe that low-cost index funds offer most investors their best chance at maximizing fund returns over the long run, we acknowledge that some investors want or need to pursue an active strategy. For example, those in some markets may have few low-cost, domestic index funds available to them. For them, or any investor choosing an active strategy, low-cost, broadly diversified actively managed funds can be a viable alternative, and in some cases may prove superior to higher-cost index funds, although this advantage is quickly eroded as costs increase.

Conclusion

Since its inception, low-cost index investing has proven to be a successful strategy over the long term and has become increasingly popular globally. This paper has reviewed the conceptual and theoretical underpinnings of index investing and discussed why we expect it to remain successful and gain in popularity.

The zero-sum game, combined with the drag of costs on performance and the lack of persistent outperformance, creates a high hurdle for active managers in their attempts to outperform the market. This hurdle grows over time and can become insurmountable for the vast majority of active managers. However, as we have discussed, circumstances may make low-cost indexing seem less or more compelling.

This is not to say that a red line exists between actively managed funds and index funds. For investors who wish to use active management, either because of a desire to outperform or because of a lack of low-cost index funds in their market, many of the benefits of low-cost indexing can be achieved by selecting low-cost, broadly diversified active managers. However, the difficult task of finding a manager who consistently outperforms, combined with the uncertainty that active management can introduce into the portfolio, means that, for most investors, we believe the best chance of successfully investing over the long term lies in low-cost, broadly diversified index funds.

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Additional selected Vanguard research on active and index investing

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Benchmark mismatch: A manager's exposure to market-risk factors outside the benchmark may explain outperformance more than individual skill in stock selection.

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Rowley, James J., Joshua M. Hirt, and Haifeng Wang, 2018. *Setting the Record Straight: Truths About Indexing*. Valley Forge, Pa.: The Vanguard Group.

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Appendix

Assessing investors' performance

An alternative way to evaluate the relative success of investors is to view performance results in terms of asset-weighted performance. In such a computation, larger funds account for a larger share of the results because they reflect a greater proportion of investors' assets. Relative to equal weighting or using a category's median fund, which may be large or small, asset weighting provides a

clearer sense of how investors collectively performed. One caveat to such an approach, however, is that not all funds report asset values on a regular basis. For our analysis, a fund would need to have both asset and return figures for any given month in order for its performance for that month to be included. As a result, the funds shown in Figure A-2 are not necessarily the same as those shown in Figure 7.

FIGURE A-1.
Categories and benchmarks represented in this analysis

Category	Morningstar category	Asset class	Assigned "style" benchmark index	Notes
Developed	U.S. Fund Foreign Large Blend	Equity	MSCI World Ex USA IMI (NR) Index	
	U.S. Fund Foreign Large Growth	Equity	MSCI World Ex USA IMI (NR) Index	
	U.S. Fund Foreign Large Value	Equity	MSCI World Ex USA IMI (NR) Index	
	U.S. Fund Foreign Small/Mid Blend	Equity	MSCI World Ex USA IMI (NR) Index	
	U.S. Fund Foreign Small/Mid Growth	Equity	MSCI World Ex USA IMI (NR) Index	
	U.S. Fund Foreign Small/Mid Value	Equity	MSCI World Ex USA IMI (NR) Index	
Emerging	U.S. Fund Diversified Emerging Mkts	Equity	MSCI Emerging Markets IMI (NR) Index	Until 04/2010: MSCI Emerging Markets (NR) Index
Global	U.S. Fund World Large-Stock Blend	Equity	MSCI ACWI IMI (NR) Index	Until 04/2010: MSCI ACWI (NR) Index
	U.S. Fund World Large-Stock Growth	Equity	MSCI ACWI IMI (NR) Index	Until 04/2010: MSCI ACWI (NR) Index
	U.S. Fund World Large-Stock Value	Equity	MSCI ACWI IMI (NR) Index	Until 04/2010: MSCI ACWI (NR) Index
	U.S. Fund World Small/Mid Stock	Equity	MSCI ACWI IMI (NR) Index	Until 04/2010: MSCI ACWI (NR) Index
Large blend	U.S. Fund Large Blend	Equity	CRSP U.S. Large Cap (TR) Index	Until 12/2012: S&P 500 (TR) Index
Large growth	U.S. Fund Large Growth	Equity	CRSP U.S. Large Cap Growth (TR) Index	Until 12/2012: S&P 500 Growth (TR) Index
Large value	U.S. Fund Large Value	Equity	CRSP U.S. Large Cap Value (TR) Index	Until 12/2012: S&P 500 Value (TR) Index

FIGURE A-1 (CONTINUED).

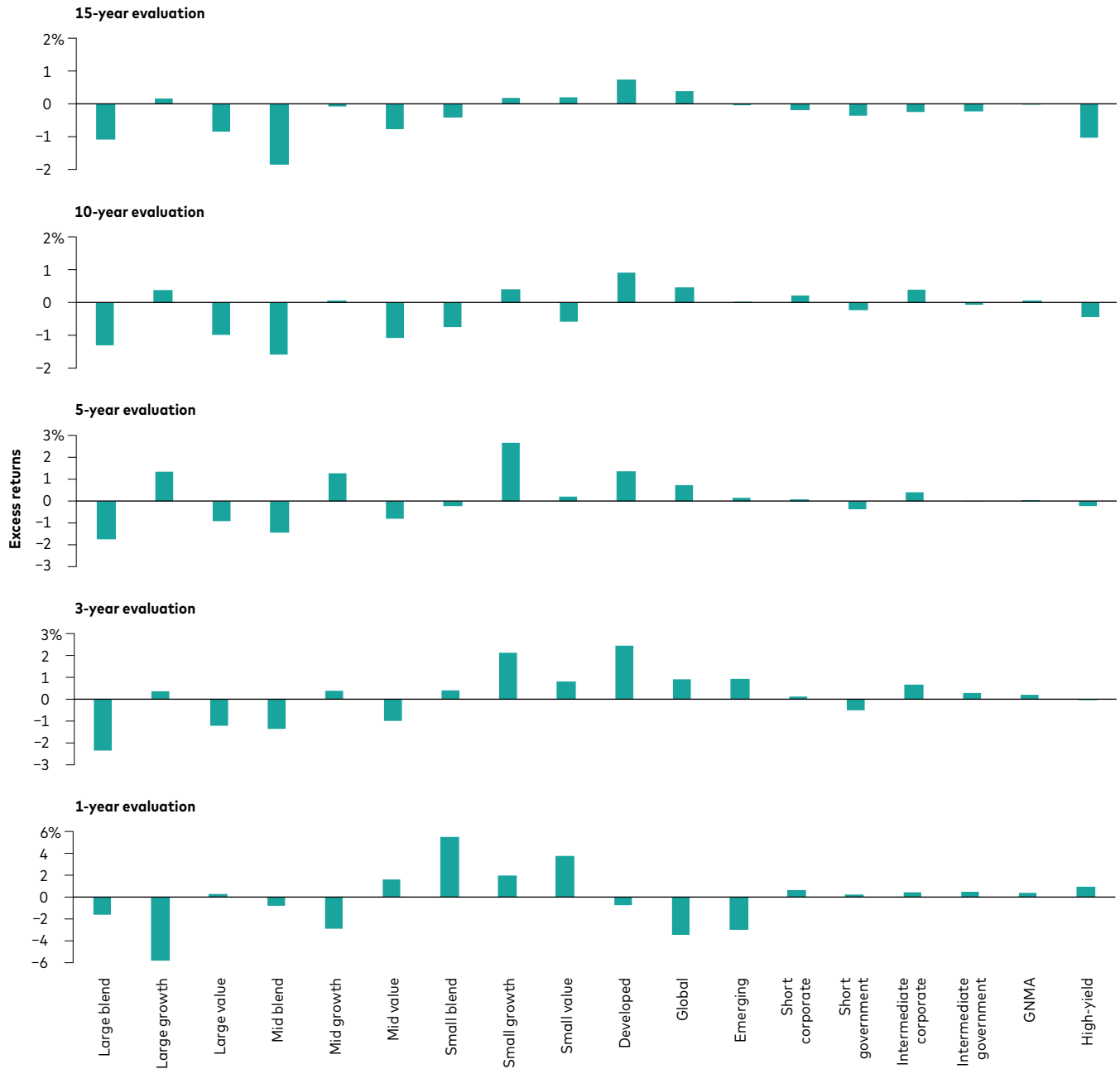
Categories and benchmarks represented in this analysis

Category	Morningstar category	Asset class	Assigned "style" benchmark index	Notes
Mid blend	U.S. Fund Mid-Cap Blend	Equity	CRSP U.S. Mid Cap (TR) Index	Until 12/2012: S&P MidCap 400 (TR) Index
Mid growth	U.S. Fund Mid-Cap Growth	Equity	CRSP U.S. Mid Cap Growth (TR) Index	Until 12/2012: S&P MidCap 400 Growth (TR) Index
Mid value	U.S. Fund Mid-Cap Value	Equity	CRSP U.S. Mid Cap Value (TR) Index	Until 12/2012: S&P MidCap 400 Value (TR) Index
Small blend	U.S. Fund Small Blend	Equity	CRSP U.S. Small Cap (TR) Index	Until 12/2012: S&P Small Cap 600 (TR) Index
Small growth	U.S. Fund Small Growth	Equity	CRSP U.S. Small Cap Growth (TR) Index	Until 12/2012: S&P SmallCap 600 Growth (TR) Index
Small value	U.S. Fund Small Value	Equity	CRSP U.S. Small Cap Value (TR) Index	Until 12/2012: S&P Small Cap 600 Value (TR) Index
GNMA	GNMA	Fixed Income	Bloomberg GNMA (TR) Index Unhedged	
High-yield	U.S. Fund High Yield Bond	Fixed Income	Bloomberg U.S. Corporate High Yield (TR) Index Unhedged	
Intermediate corporate	U.S. Fund Intermediate Core Bond	Fixed Income	Bloomberg Intermediate Corporate (TR) Index Unhedged	
Intermediate government	U.S. Fund Intermediate Government	Fixed Income	Bloomberg U.S. Treasury (TR) Index Unhedged	
Long corporate	U.S. Fund Long-Term Bond	Fixed Income	Bloomberg U.S. Corporate 10+ Year (TR) Index Unhedged	
Long government	U.S. Fund Long Government	Fixed Income	Bloomberg U.S. Long Treasury (TR) Index Unhedged	
Short corporate	U.S. Fund Short-Term Bond	Fixed Income	Bloomberg U.S. Corporate 1–5 Year (TR) Index Unhedged	
Short government	U.S. Fund Short Government	Fixed Income	Bloomberg U.S. Treasury 1–5 Year (TR) Index Unhedged	

Note: All indexes are in USD.

FIGURE A-2.

Asset-weighted relative performance of actively managed mutual funds versus their benchmarks



Past performance is not a guarantee of future results.

Notes: Data reflect periods ended December 31, 2021. Asset-weighted excess returns were calculated by taking a time series of monthly cross-sectional average excess returns relative to each fund's prospectus benchmark. Monthly excess returns were weighted by previous month-end asset size. Performance is NAV-based, and returns are calculated in USD, net of fees with income reinvested.

Sources: Vanguard calculations, using data from Morningstar, Inc.

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