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Vanguard's framework for constructing globally diversified portfolios

Vanguard Research

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- When building a portfolio to meet a specific objective, it is critical to select a combination of assets that offers the best chance for meeting that objective, subject to the investor's constraints. A sound investment strategy starts with an asset allocation that is built upon reasonable expectations for risk and returns and uses diversified investments to avoid exposure to unnecessary risks.

- This paper reviews the decisions individual investors face when constructing a globally diversified portfolio.[1] We discuss the importance of broad asset allocation and diversification within sub-asset classes before homing in on specific funds. When building portfolios, broadly diversified, market-capitalization-weighted global index funds are a valuable starting point for many investors. They can be delivered inexpensively and provide exposure to the broad market while offering diversification and transparency.

- For investors willing to accept controlled model risk, a robust portfolio construction engine such as the Vanguard Asset Allocation Model can help form portfolios with active, passive, factor, and illiquid investment vehicles while explicitly accounting for risk-return considerations along with an investor's risk preferences and goals. There is no one-size-fits-all portfolio or recommendation under this construct.

Acknowledgments: This paper is a revision of Vanguard research first published in 2007 as *Portfolio Construction for Taxable* Investors, by Scott J. Donaldson and Frank J. Ambrosio, and revised in 2013 as *Vanguard's Framework for Constructing Diversified Portfolios* and in 2017 as *Vanguard's Framework for Constructing Globally Diversified Portfolios*, both by Scott J. Donaldson and others.

1 Individual investors are the primary audience for this paper. See Wallick et al. (2016) for a paper addressing a framework for institutional portfolio construction.

Most investment portfolios are designed to meet a specific future financial need—either a single goal or a multifaceted set of objectives. To best meet that need, the investor must establish a disciplined method of portfolio construction that balances the potential risks and returns of various types of investments. Many investors expect lower nominal returns in the future. Accordingly, many portfolio strategies have recently focused on higher income, tactical factor timing, and the use of alternative investments.

Although no one can predict which individual investments will do best in the future, we believe the best strategy for long-term success is to have a well-thought-out plan with an emphasis on balance and diversification and a focus on keeping costs low and maintaining discipline. A written investment plan that clearly documents the investor's goals, constraints, and investment decisions provides the framework for a well-diversified portfolio.

This paper discusses how to create and maintain a diversified portfolio by focusing on five major components:

1. Defining investment goals and constraints and the importance of a sound investment plan.
2. Broad strategic allocation among the primary asset classes such as equities, fixed income, and cash.
3. Sub-asset allocation within classes, such as domestic and nondomestic securities or large-, mid-, or small-capitalization equities.
4. Allocation to indexed or actively managed funds or both.
5. The importance of rebalancing to maintain a consistent risk profile.

Defining investment goals and constraints

A sound investment plan—or policy statement, for institutions—begins by outlining the investor's objective(s) as well as any significant constraints. Defining these elements is essential because the plan needs to fit the investor; copying other strategies can prove unwise. Because most objectives are long-term, the plan should be designed to endure through changing market environments and should be flexible enough to adjust for unexpected events along the way. If the investor has multiple goals (for example, paying for both retirement and a child's college expenses), each needs to be accounted for. Once the plan is in place, the investor should evaluate it at regular intervals. Figure 1 provides an example of a plan framework.

Most investment objectives can be viewed in the context of a required rate of return, or RRR. That is the return a portfolio would need to generate to bridge the gap between an investor's current assets, any future cash flows, and the investment goal(s). For example, say an investor has determined that to be comfortable in retirement, he or she must save $1 million over the next 40 years in today's dollars (inflation-adjusted). If that investor starts today by depositing $10,000 and saves the same inflation-adjusted amount each year over 40 years, the real RRR needed to reach the goal

Notes on risk

All investments are subject to risk, including the possible loss of the money you invest. Investments in bond funds are subject to interest rate, credit, and inflation risk. Prices of mid- and small-cap stocks often fluctuate more than those of large-company stocks. Funds that concentrate on a relatively narrow market sector face the risk of higher share-price volatility. Foreign investing involves additional risks including currency fluctuations and political uncertainty. These risks are especially high in emerging markets. Currency hedging transactions may not perfectly offset the fund's foreign currency exposures and may eliminate any chance for a fund to benefit from favorable fluctuations in those currencies. The fund will incur expenses to hedge its currency exposures.

Diversification does not ensure a profit or protect against a loss. There is no guarantee that any particular asset allocation or mix of funds will meet your investment objectives or provide you with a given level of income. Past performance is no guarantee of future results. The performance of an index is not an exact representation of any particular investment, as you cannot invest directly in an index.

2 For simplicity, we assume the investor has a predetermined savings goal in today's dollars; however, in practice, the goal is more likely to be maintaining a certain level of income throughout retirement.

Figure 1. Example of a basic framework for an investment plan

Objective	Save $1 million for retirement, adjusted for inflation.
Constraints	40-year horizon.
	Moderate tolerance for market volatility and loss; no tolerance for nontraditional risks.
	Current portfolio value: $50,000.
	Monthly net income of $4,000; monthly expenses of $3,000.
	Consider the effect of taxes on returns.
Saving or spending target	Willing to contribute $5,000 in the first year.
	Intention to raise the contribution by $500 per year, to a maximum of $10,000 annually.
Asset allocation target	70% allocated to diversified stock funds; 30% allocated to diversified bond funds.
	Allocations to foreign investments as appropriate.
Rebalancing methodology	Rebalance annually.
Monitoring and evaluation	Periodically evaluate current portfolio value relative to savings target, return expectations, and long-term objective.
	Adjust as needed.

Notes: This example is hypothetical. It does not represent any real investor and should not be taken as a guide. Depending on an actual investor's circumstances, such a plan or investment policy statement could be expanded or consolidated. For example, many financial advisors or institutions may find value in outlining the investment strategy—that is, specifying whether tactical asset allocation will be employed, whether actively or passively managed funds will be used, and the like.

Source: Vanguard.

Constraints, on the other hand, can be simple or complex, depending on the investor and the situation. One primary constraints in meeting any objective is the investor's tolerance for risk.[3] Risk and expected return are generally related, in that the desire for greater return will require greater exposure to market risk. Time can be another constraint; a shorter time frame, as with an investor looking to fund a child's college education, allows for different risks than does an infinite time horizon, such as that faced by many university endowments. Other constraints can include tax exposure, liquidity requirements, legal issues, and unique limitations such as a desire to avoid certain investments entirely. Because constraints may change over time, they should be closely monitored.

Investors should consider both their RRR and tolerance for risk when putting together an investment plan. Because increased return almost always comes with increased risk, they should carefully weigh how much risk they are willing to take on to meet their objectives.

The danger of lacking a plan

Without a plan, investors often build their portfolios from the bottom up, focusing on investments piecemeal rather than on how the portfolio as a whole is serving the objective. Another way to characterize this process is "fund collecting": These investors are drawn to evaluate a particular fund, and if it seems attractive, they buy it—often without thinking about how or where it may fit within the overall allocation.

Although paying close attention to each investment may seem logical, this process can lead to an assemblage of holdings that doesn't serve the investor's ultimate needs. As a result, the portfolio may wind up concentrated in a certain market sector, or have so many holdings that portfolio oversight becomes onerous. Most often, investors are led into such imbalances by common, avoidable mistakes such as chasing performance, market-timing, or reacting to market "noise."

3 There are many definitions of risk, both traditional (including volatility, loss, and shortfall) and nontraditional (such as liquidity, manager, and leverage). Investors commonly define risk as the volatility inherent in a given asset or investment strategy. See Ambrosio (2007) for more on the various risk metrics used in the financial industry.

A sound investment plan can help the investor avoid such behavior, because it demonstrates the purpose and value of asset allocation, diversification, and rebalancing. It also helps the investor stay focused on intended contribution and spending rates.

We believe that investors should employ their time and effort up front on the plan, rather than in ongoing evaluation of each new idea that hits the headlines. This simple step can pay off tremendously in helping them stay on the path toward their financial goals.

Broad strategic asset allocation

When developing a portfolio, it is critical to select a combination of assets that offers the best chance of meeting the plan's objective, subject to the investor's constraints. In portfolios with broadly diversified holdings, the mix of assets will determine both the aggregate returns and their variability.[4] A seminal 1986 study by Brinson, Hood, and Beebower (henceforth BHB) showed that the asset allocation decision was responsible for the vast majority of a diversified portfolio's return patterns over time. These findings were confirmed by Vanguard's own study in 2020 and other research, including Ibbotson and Kaplan (2000), suggesting that a portfolio's investment policy is an important contributor to return variability (Figure 2).

Our analytical framework covers the United States, Canada, the United Kingdom, Australia, and Japan from January 1, 1990, and the euro area from January 1, 1999, through September 30, 2020. This research confirms our earlier conclusions that, over time and on average, most of the return variability of a broadly diversified portfolio that engages in limited market timing is due to its underlying static asset allocation.

Figure 2. Role of asset allocation policy in return variation of balanced funds

	United States	Canada	United Kingdom	Euro area	Australia	Japan	BHB (1986)
Number of balanced funds in each market sample	951	967	1,007	3,529	682	661	91 U.S. pension funds
Median percentage of actual-return variation explained by policy return	92.1%	91.9%	82.8%	80.2%	90.0%	84.8%	93.6%

Notes: For each fund in our sample, a calculated adjusted R2 represented the percentage of actual-return variation explained by policy-return variation. Percentages shown in the figure—92.1% for the U.S., 91.9% for Canada, 82.8% for the United Kingdom, 80.2% for the euro area, 90.0% for Australia, and 84.8% for Japan—represent the median observation from the distribution of percentage of return variation explained by asset allocation for balanced funds. For the period January 1990–September 2020, the sample included: for the U.S., 951 balanced funds; for Canada, 967; for the U.K., 1007; for Australia, 682; and for Japan, 661. For the euro area, the sample included 3,529 balanced funds—domiciled in Austria, Belgium, Finland, France, Germany, Italy, the Netherlands, Portugal, and Spain—for the period January 1999–September 2020. Calculations were based on monthly net returns, and policy allocations were derived from a fund's actual performance compared with a benchmark using returns-based style analysis (as developed by William F. Sharpe) on a 36-month rolling basis. Funds were selected from Morningstar's Multi-Sector Balanced category. Only funds with at least 48 months of return history were considered in the analysis. The policy portfolio was assumed to have a U.S. expense ratio of 1.5 basis points per month (18 bps annually, or 0.18%) and a non-U.S. expense ratio of 2.0 bps per month (24 bps annually, or 0.24%).

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

4 For asset allocation to be a driving force, it must be implemented using vehicles that approximate the return of market indexes. These indexes are commonly used tidentify the risk and return characteristics of asset classes and portfolios. Using an alternative vehicle may deliver a result that differs from that of the market index and potentially lead to a different outcome than that assumed in the asset allocation process. As an extreme example, using a single stock to represent the equity allocation in a portfolio would likely lead to a very different outcome than would either a diversified basket of stocks or any other single stock.

Active investment decisions such as market timing and security selection had relatively little impact on return variability over time. For investors who held broadly diversified portfolios, asset allocation primarily drove return variability. In addition, we found that market-capitalization-weighted indexed policy portfolios provided higher returns and lower volatility than the average actively managed fund. We also found that those funds that were able to generate positive alpha tended to share two characteristics: larger average assets and lower costs.

Disagreements or misunderstandings about the relevance of BHB's findings to investors have led to an ongoing asset allocation debate. Jahnke (1997) argued that BHB's focus on explaining return variability over time ignored the wide dispersion of returns among broadly diversified active balanced funds over
a specific time horizon. In other words, he maintained that a portfolio could achieve very different terminal wealth levels, depending on which (active) funds were selected. Jahnke emphasized that, as a result of active management strategies, actual returns earned should be examined across different active balanced funds within a set holding period. It is correct that the BHB study did not show that two funds with the same asset allocation could have very different holding-period returns. Jahnke's assertion was confirmed by research by Ibbotson and Kaplan (2000) that focused on determining how much asset allocation affects actual portfolio return dispersion across funds, through a cross-sectional analysis that compared actual returns with policy returns.

Some key terms

R-squared (R2). A measure of how much of a portfolio's performance can be explained by the returns from the overall market (or a benchmark index).

Returns-based style analysis. A statistical method for inferring a fund's effective asset mix by comparing the fund's returns with the returns of asset-class benchmarks. Developed by William F. Sharpe, this is a popular attribution technique because it doesn't require tabulating the actual asset allocation of each fund for each month over time; rather, it regresses the fund's return against the returns of asset-class benchmarks.

Sharpe ratio. A measure of excess return per unit of deviation in an investment.

What matters most to investors

The risk interpretation of BHB's finding is that about 90% of the volatility of a broadly diversified balanced portfolio comes from its policy asset allocation decision and broad market movements. Jahnke's assertion that actual portfolio returns can vary significantly over a specific investment horizon means that the selection of active managers and strategies can lead to outcomes very different from those of the policy asset allocation benchmark. Vanguard's research, along with Ibbotson and Kaplan (2000), supports both of these positions.

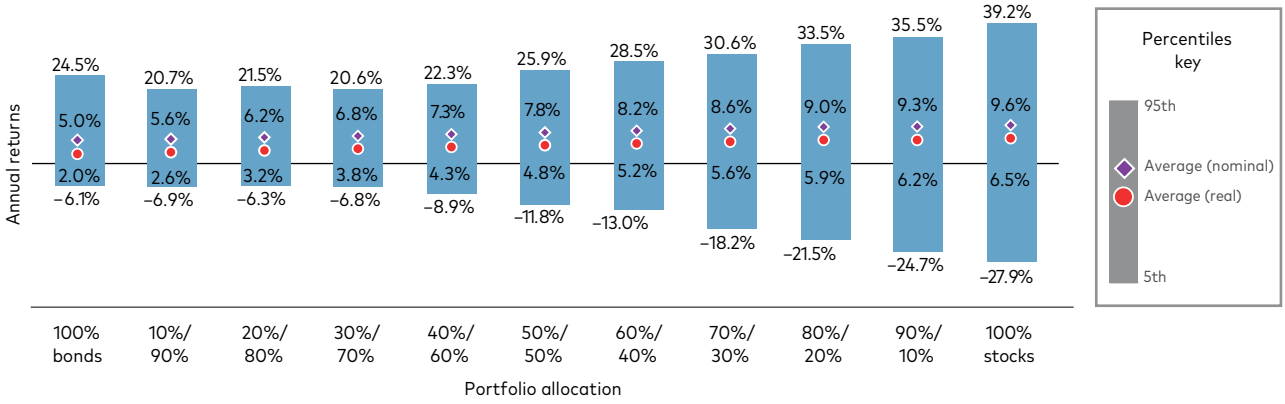
Thus, once the policy allocation has been determined, the portfolio's expected risk will not depend much
on how it is implemented (passive index or active); however, the portfolio's ultimate performance relative to the policy benchmark is critically dependent on the selection of a particular active manager or strategy.

Return and risk

An informed understanding of the risk and return characteristics of the various asset classes is vital to the portfolio construction process. Figure 3 shows a simple example of this relationship, using two asset classes—global stocks and global bonds—to demonstrate the impact of broad asset allocation on returns and their variability. (For individual regions, see Figure A-1 on page 22 in Appendix 2.) Although the average annual returns represent averages over 121 years and should not be expected in any given year or time period, they provide an idea of the long-term historical returns and downside market risk that have been associated with various allocations.

The risk and return trade-off should be a primary consideration when determining one's strategic asset allocation. For example, the hypothetical investor described earlier, who is saving for retirement with a 4% real RRR, should select an asset mix that meets or exceeds that amount, with an acceptable corresponding risk of potential loss. If either of those requirements is not met, the investor may need to revisit them. Of course, shorter time horizons may require investing more in bonds and cash, which have less downside volatility, than in equities.

Figure 3. The mixture of assets defines the spectrum of return



Notes: Data cover January 1, 1900, through December 31, 2020, and are in U.S. dollars. Nominal value is the return before adjustment for inflation; real value includes the effect of inflation. Moving from left to right in the figure, the stock allocation relative to bonds increases in 10-percentage-point increments. The bars' length indicates the range, from 5th to 95th percentile, of annual returns for each allocation; the longer the bar, the larger the variability. The numbers inside each bar show the average annual nominal and real returns for that allocation for the 121 years covered.

Sources: Vanguard calculations, using Dimson-Marsh-Staunton global returns data from Morningstar, Inc. (the DMS World Equity Index and the DMS World Bond Index, both in nominal and real terms). The data set includes returns from Australia, Austria, Belgium, Canada, China, Denmark, Finland, France, Germany, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Russia, South Africa, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

Figure 4 illustrates the risk and return trade-off at the portfolio level. Using our asset simulation model, the Vanguard Capital Markets Model® (VCMM), we generated forward-looking metrics for four portfolios with a range of expected risk and return over a 10-year period. As the figure shows, expected returns increase with equity allocations, but so does expected volatility. Portfolio A, with the highest expected return, consists of 80% equity/20% fixed income; its expected return volatility is 13.0%. Portfolio D, consisting of 20% equity/80% fixed income, has the lowest expected return, but its return volatility is about one-third that of Portfolio A.

Figure 4. Risk and return trade-off for different portfolios over a 10-year period

	Portfolios			
Asset class	A	B	C	D
Global equity allocation	80%	60%	40%	20%
Global bonds allocation	20	40	60	80
Median returns	5.4	4.5	3.5	2.4
Median real returns	3.9	3.0	2.0	1.0
Median volatility	13.0	9.7	6.5	3.7

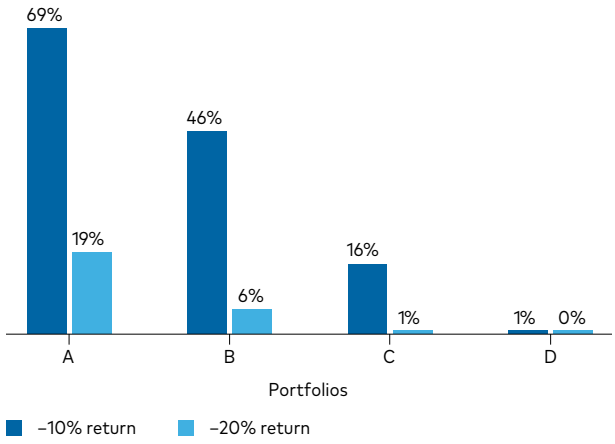
Notes: Global equities are represented by the MSCI All Country World Index. Global bonds are represented by the Bloomberg Barclays Global Aggregate Bond Index.

Source: Vanguard, from VCMM forecasts as of September 30, 2020.

IMPORTANT: The projections and other information generated by the VCMM regarding the likelihood of various investment outcomes are hypothetical in nature, do not reflect actual investment results, and are not guarantees of future results. Distribution of return outcomes from VCMM are derived from 10,000 simulations for each modeled asset class. Simulations as of September 30, 2020. Results from the model may vary with each use and over time. For more information, see Appendix 1 on page 21.

Also important is estimating the downside risk and assessing an investor's risk comfort level. Underestimating risk aversion can be problematic because it can derail the strategic objective. If, for example, equity markets steeply decline, as they did in 2008 and early 2020, and an investor sells Portfolio A in a panic, the investor's balance may not recover for many years. To illustrate potential downside risk, we forecast in Figure 5 the probability of a return below –10% and below –20% for Portfolios A through D. Note that Portfolio D has nearly zero probability of a –10% or –20% return in the next 10 years. Portfolio A, however, has a 69% probability of a return below –10% in any one year over that period and a 19% chance of a return below –20%.

Figure 5. Downside risk—probability of a negative return in the next 10 years



Source: Vanguard, from VCMM forecasts as of September 30, 2020.

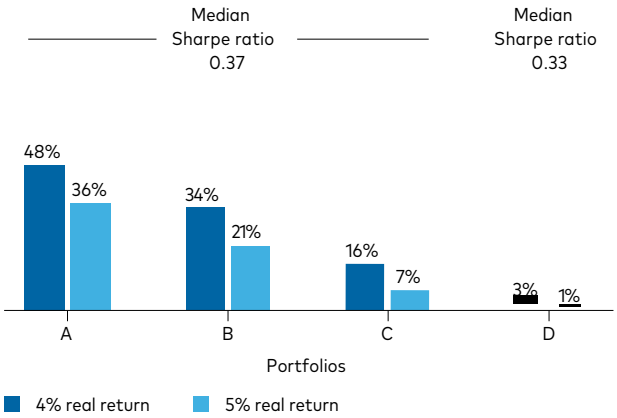
In managing the risk-reward balance, investors must still not lose sight of the objective. For the investor with the 4% real RRR, we forecast the probability of achieving that objective for each of the four portfolios (Figure 6). Portfolio A, with the highest risk, also has the highest probability of meeting the real return objective over a 10-year period. Portfolio B has lower risk but still has a 34% chance of achieving a 4% real return, and nearly the same expected risk-adjusted return, measured as the Sharpe ratio. Compare this with Portfolio D, which has a considerably lower probability of meeting the return objective and a lower risk-adjusted return than Portfolio B. This example highlights the need to consider risk and return relatively.

Inflation risk is often overlooked and can have a major effect on asset-class returns, changing the portfolio's risk profile. This is one reason why Vanguard generally does not believe that cash plays a significant role in a diversified portfolio with long investment horizons. Rather, cash should be used to meet liquidity needs or be integrated into a portfolio designed for shorter horizons.

Figure 7 shows the long-term historical returns of global stocks, bonds, and cash on both a nominal and an inflation-adjusted basis. (Figure A-2, on page 23 in Appendix 2, shows specifics for various regions.) As highlighted, cash has produced a negative nominal return in only 1% of the years examined, whereas stock returns have been negative in 27% of them.

Looking at real inflation-adjusted returns, we see a different picture, with cash delivering a negative return much more frequently, in 38% of the years examined. Because many longer-term goals are measured in real terms, inflation can be particularly damaging, as its effects compound over long time horizons. Over the short term, the effects of inflation are generally less damaging than the potential losses from assets with higher expected real returns (Bennyhoff, 2009).

Figure 6. Likelihood of achieving real return objectives over a 10-year period



Source: Vanguard, from VCMM forecasts as of September 30, 2020.

Each investor will have unique cash requirements, and the amount of cash to keep on hand will depend on such factors as liquidity needs, dependability of employment or other income sources, and level of financial conservativeness. Investors should first identify their specific needs by assessing major expenses and when those will come due, and then determine what assets are available to meet those needs. Separately, investors should keep a certain amount of cash for emergencies—typically three to 36 months' worth of living expenses (Kinniry and Hammer, 2012).

Inflation risk is projected to be modest over the next 10 years, but expected real and nominal returns should still be considered. In Figure 8, again using our VCMM, we illustrate the 10-year distribution of real and nominal return forecasts for Portfolios A through D. Across the distribution, inflation is expected to decrease nominal returns by 0.7 to 2.3 percentage points.

Figure 7. Trade-off between market risk and inflation risk

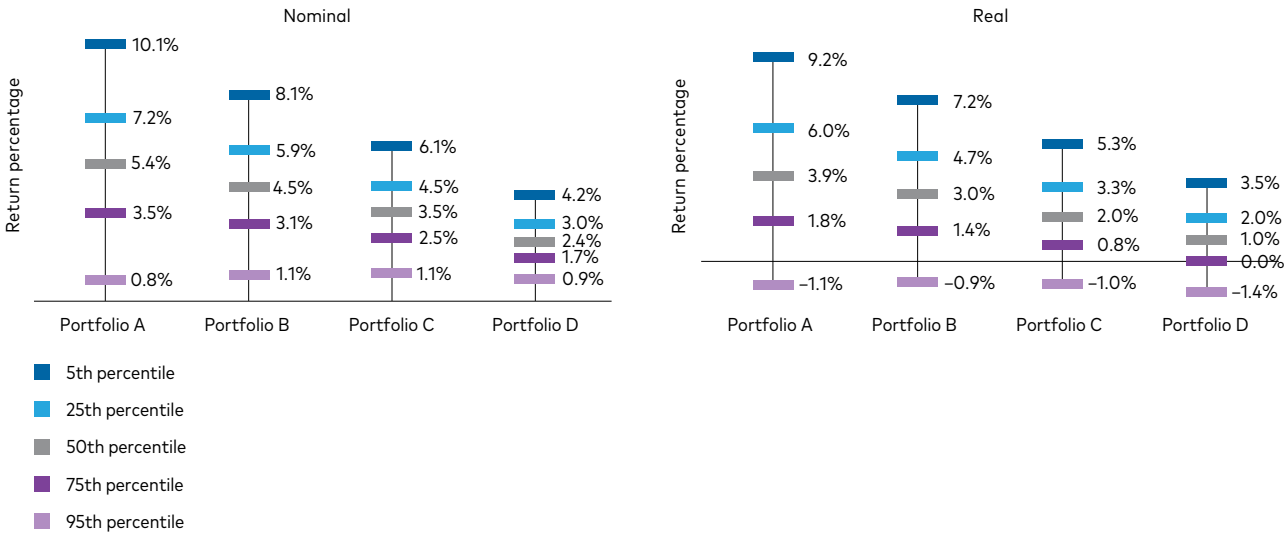
	Nominal			Real (inflation-adjusted)		
1900–2020 total returns	Average annual return	% of years with negative return	Greatest annual loss*	Average annual return	% of years with negative return	Greatest annual loss*
100% Treasury bills	3.68%	1%	—	0.73%	38%	–8.24%
100% bonds	4.93%	24%	–7.77%	1.95%	39%	–14.07%
100% stocks	9.46%	27%	–9.15%	6.35%	34%	–1.34%

* Greatest annual loss is represented by the lowest 5th percentile of annual returns. At the 5th percentile, Treasury bills did not experience a loss but was up 0.02%. Treasury bills did, however, experience a slight nominal loss in one year that fell below the 5th percentile.

Notes: Data cover January 1, 1900, through December 31, 2020. Returns are in U.S. dollars. Nominal value is the return before adjustment for inflation; real value includes the effect of inflation.

Sources: Vanguard calculations, using Dimson-Marsh-Staunton global returns data from Morningstar, Inc. (the DMS World Equity Index and the DMS World Bond Index, both in nominal and real terms, plus the DMS World Bill Index).

Figure 8. 10-year return forecasts: Nominal versus real



Source: Vanguard, from VCMM forecasts as of September 30, 2020.

Sub-asset allocation

Once the appropriate strategic asset allocation has been determined between riskier assets (equities) and less risky ones (fixed income), the focus should turn to diversification within these asset classes to reduce exposure to risks associated with a particular region, company, sector, or market segment.

We explore these diversification decisions for both equities and fixed income. We also explore additional considerations for alternative assets and strategies.

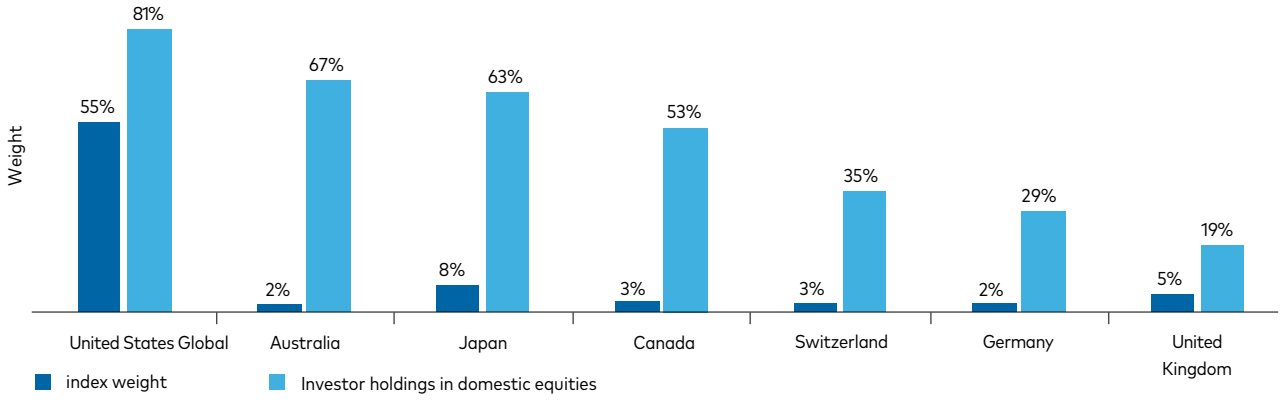
Domestic and nondomestic equities

A primary way to diversify the equity allocation is through nondomestic investing. To the extent a broadly diversified market-cap-weighted index fund is a valuable starting point, it could well follow that using a global market-cap-weighted fund is a reasonable default for investors. However, we find that investors have, on average, a home country bias, tending to own more equity and more fixed income assets of their resident country than the market-cap weighting would suggest (Figure 9).

For example, as of December 31, 2020, Canadian equities accounted for 3% of the global equity market. To the extent that investors choose to invest in the global market regardless of their home country, they would hold 3% of their equity portfolio in Canadian stocks. But on average, this was not the case among Canadian investors, who collectively held over 50% at year-end in 2020. This situation was similar in each country we analyzed.

Several reasons can explain home country bias—with inertia perhaps chief among them. To the extent the portfolio bias is a conscious decision, it is typically made for one of two major reasons: return expectations or risk mitigation. But to the extent the portfolio has been constructed incrementally over time, the home-bias results may have been unintended. For both types of investors, we offer a framework (highlighted in Figure 10) surrounding the home/global securities decision to help them determine the proper weighting between the two in their distinctive circumstances.

Figure 9. Equity market home bias by country



Notes: Data as of December 31, 2020—the latest available from the International Monetary Fund (IMF)—in U.S. dollars. Domestic investment is calculated by subtracting total foreign investment (as reported by the IMF) in a given country from its market capitalization in the MSCI All Country World Index. Given that the IMF data is voluntary, there may be some discrepancies between the market values in the IMF survey and in the MSCI index.

Sources: Vanguard calculations, based on data from the IMF's Coordinated Portfolio Investment Survey (2020) and FactSet.

Figure 10. Factors affecting the decision to invest in foreign assets

	Validate home-bias decision	Reduce home bias
Risk and return impact of adding foreign securities	Limited benefits	Significant benefits
Concentration of home market by sector or issuer	Unconcentrated	Highly concentrated
Domestic transaction costs	Low	High
Domestic liquidity	High	Low
Domestic asset taxes	Advantages	Disadvantages
Other domestic market-risk factors	No impact	Significant risks
Additional considerations: Regulatory limits and liability-matching systems	Impact unique to each investor	

Source: Vanguard.

In determining the right mix of domestic and international equity and fixed income, a number of factors should be evaluated, such as worldwide market cap, asset classes' expected returns, volatilities, pair-wise correlations, the investor's existing home bias, and costs. For many investors, the tax treatment of foreign versus domestic assets can be significant. The investor's degree of exposure to these taxes could help determine whether increasing foreign allocations would be advantageous or disadvantageous. We believe in balancing these factors with the additional diversification benefits that are achieved.

Another needed decision is whether to hedge the nondomestic currency exposure. It is a reasonable forward-looking assumption that over extended time horizons, the gross returns will be similar between a hedged and unhedged investment. Therefore, whether to hedge equity currency exposure should be based on risk and diversification effects, not on return, for those investors willing to tolerate a modest return drag from hedging. Factors that will influence this decision include the availability of a low-cost hedging program or hedged product, a smaller domestic allocation resulting in greater currency exposure, a belief that foreign currency is unlikely to be a diversifier in the local market, and a portfolio objective specifically targeting volatility.[5]

Sub-asset allocation within domestic and nondomestic equities

Investors seeking exposure to the stock and bond markets must decide on the degree of exposure to the various risk and return characteristics appropriate for their objectives. For equities, in addition to domestic and nondomestic exposure, attributes include market cap (large-, mid-, and small-) and style (growth and value). Each category can have specific risk factors.

In practice, diversification is a rigorously tested application of common sense: Markets and asset classes will often behave differently from one another—sometimes marginally, sometimes greatly—at any given time. Owning a portfolio with at least some exposure to many or all key market components ensures the investor of some participation in stronger areas while also mitigating the impact of weaker areas. Vanguard believes that gaining exposure to these asset classes through a market-cap-weighted portfolio that matches the risk-return profile of the asset-class target through broad diversification is a valuable starting point for many investors. We also recognize that this is not a one-size-fits-all solution and that others are appropriate depending on an investor's goals and, more importantly, ability to take on active or model risk.

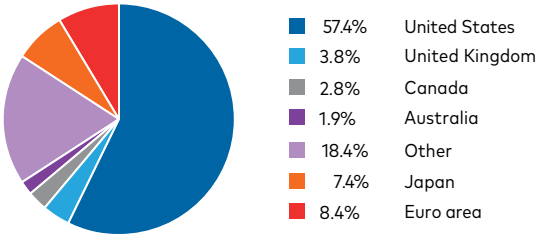
5 See LaBarge et al. (2014) for a further discussion of whether to hedge the currency exposure in global equity portfolios.

We discuss this model-based asset allocation approach in later sections. Figure 11 shows market-cap weights by region for the global equity market, as well as equity size and style weights.

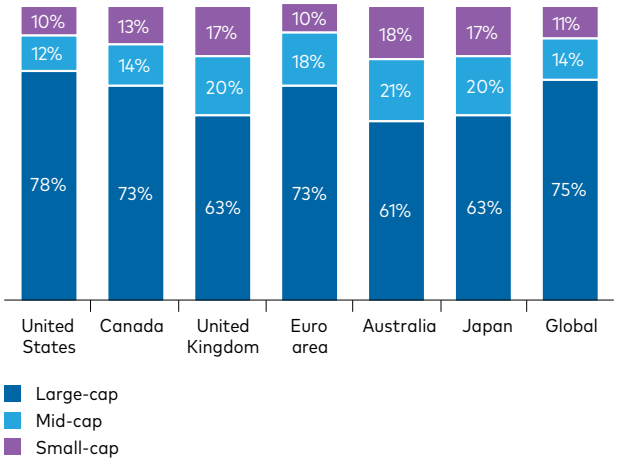
Broad-market index funds are one way to achieve market-cap weighting within an asset class. Price is a powerful mechanism collectively used by market participants to establish and change views about a company's future performance. Relevant information is continuously incorporated into stock prices through investor trading, which then affects market capitalization. Market-cap-weighted indexes therefore reflect the consensus investor estimate of each company's relative value and how the average investor has performed for a specific targeted beta.

Figure 11. Global equity market capitalization weights by region

a. Breakdown by region

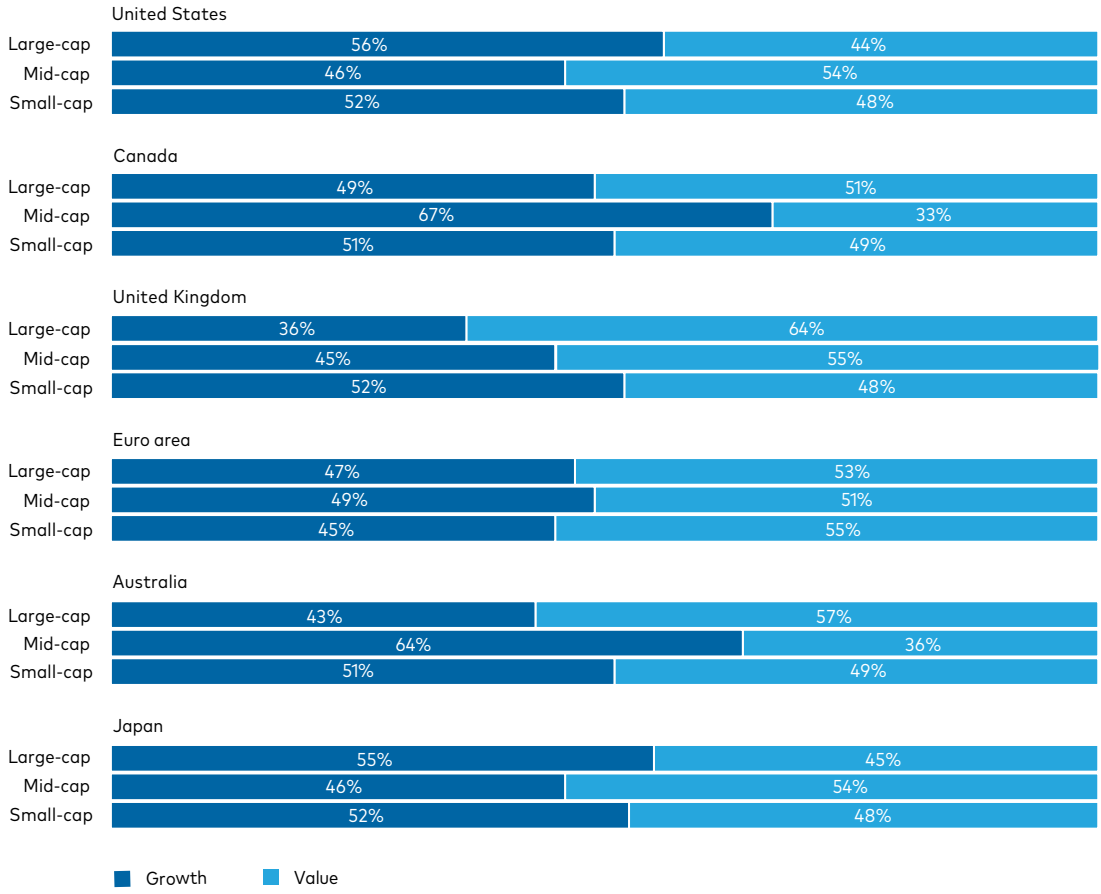


b. Breakdown by size



Notes: Data as of September 30, 2020. Because of rounding, percentages shown may not total precisely 100%. The MSCI All Country World Investable Market Index (IMI) represents investable large-, mid-, and small-cap securities across developed, emerging, and frontier markets. Euro-area market capitalization is represented by the MSCI EMU (European Economic and Monetary Union) IMI.
Sources: Vanguard, based on data from MSCI and FactSet.

c. Breakdown by style



Notes: Data as of September 30, 2020. Global equities are represented by the MSCI All Country World Investable Market Index (IMI), U.S. stocks by the MSCI USA IMI, Canadian stocks by the MSCI Canada IMI, U.K. stocks by the MSCI United Kingdom IMI, the euro area by the MSCI EMU IMI, Australian stocks by the MSCI Australia IMI, and Japanese stocks by the MSCI Japan IMI.

Sources: Vanguard, based on data from MSCI and FactSet.

Often, investors try to determine the sub-asset allocations of their portfolio by looking at outperformance; however, relative performance changes often. Over very long-term horizons, most sub-asset classes tend to perform in line with their broad asset class, but over short periods there can be sharp differences.

For examples, see Figure 12, which shows annual returns for various asset and sub-asset classes within the U.S. market. (Figure A-3, on pages 24–28 in Appendix 2, shows such returns across other markets.)

Figure 12. Annual returns for selected categories, ranked from best performance to worst

- Large-cap U.S. stocks (LC)
- Mid- and small-cap U.S. stocks (MSC)
- Developed non-U.S. stocks (DEV)
- Emerging-market stocks (EMS)
- U.S. investment-grade bonds (IGB)
- U.S. high-yield bonds (HYB)
- Non-U.S. bonds (IB)
- Emerging-market bonds (EMB)
- U.S. real estate (RE)
- Non-U.S. real estate (IRE)
- Commodities (COM)

2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
IRE	EMS	IB	EMS	RE	RE	IRE	MSC	RE	RE	HYB	EMS	IB	LC	MSC
45.6%	39.8%	5.8%	79.0%	28.0%	8.3%	40.9%	38.2%	30.1%	3.2%	17.1%	37.8%	3.2%	31.5%	32.2%
RE	COM	IGB	HYB	MSC	IGB	EMS	LC	LC	IB	MSC	IRE	IGB	MSC	EMS
35.1%	16.2%	5.2%	58.2%	27.5%	7.8%	18.6%	32.4%	13.7%	1.4%	16.0%	26.6%	0.0%	27.9%	18.7%
EMS	DEV	EMB	IRE	EMS	EMB	MSC	DEV	IB	LC	LC	DEV	HYB	RE	LC
32.6%	12.9%	–14.7%	47.5%	19.2%	7.0%	18.4%	21.6%	8.8%	1.4%	12.0%	24.8%	–2.1%	26.0%	18.4%
DEV	IGB	HYB	MSC	IRE	HYB	RE	HYB	MSC	EMB	COM	LC	EMB	DEV	DEV
26.2%	7.0%	–26.2%	37.7%	17.2%	5.0%	18.1%	7.4%	7.5%	1.3%	11.8%	21.8%	–2.5%	23.2%	8.1%
LC	LC	COM	DEV	COM	IB	EMB	IRE	IGB	IGB	EMS	MSC	LC	IRE	IGB
15.8%	5.5%	–35.6%	34.4%	16.8%	3.9%	17.9%	4.4%	6.0%	0.5%	11.6%	18.1%	–4.4%	21.9%	7.5%
MSC	EMB	LC	EMB	HYB	LC	DEV	RE	EMB	IRE	EMB	EMB	RE	EMS	HYB
15.3%	5.2%	–37.0%	34.2%	15.1%	2.1%	17.0%	2.5%	4.8%	–1.8%	9.9%	8.2%	–4.6%	18.9%	7.1%
HYB	MSC	RE	RE	LC	MSC	LC	IB	IRE	DEV	RE	HYB	IRE	HYB	EMB
11.8%	4.5%	–37.7%	28.0%	15.1%	–3.7%	16.0%	1.2%	3.4%	–2.6%	8.5%	7.5%	–9.4%	14.3%	6.5%
EMB	IB	MSC	LC	EMB	DEV	HYB	IGB	HYB	MSC	IB	RE	MSC	EMB	IB
10.0%	4.3%	–38.9%	26.5%	12.8%	–11.8%	15.8%	–2.0%	2.5%	–3.4%	4.9%	5.2%	–9.6%	13.1%	3.9%
IGB	IRE	DEV	COM	DEV	COM	IB	EMS	EMS	HYB	DEV	IGB	COM	IGB	COM
4.3%	1.9%	–43.2%	18.9%	9.4%	–13.3%	6.5%	–2.3%	–1.8%	–4.5%	3.3%	3.5%	–11.2%	8.7%	–3.1%
IB	HYB	IRE	IGB	IGB	IRE	IGB	EMB	DEV	EMS	IGB	IB	DEV	COM	IRE
3.2%	1.9%	–53.0%	5.9%	6.5%	–16.0%	4.2%	–4.1%	–3.9%	–14.6%	2.6%	2.5%	–13.6%	7.7%	–6.8%
COM	RE	EMS	IB	IB	EMS	COM	COM	COM	COM	IRE	COM	EMS	IB	RE
2.1%	–15.7%	–53.2%	4.4%	3.3%	–18.2%	–1.1%	–9.5%	–17.0%	–24.7%	2.0%	1.7%	–14.2%	7.6%	–8.0%

Best

Worst

Notes: Large-capitalization U.S. stocks are represented by the Standard & Poor's 500 Index, mid-cap and small-cap U.S. stocks by the Wilshire 4500 Completion Index, developed non-U.S. stock markets by the MSCI World ex USA Index, and emerging markets by the MSCI Emerging Markets Index. Commodities are represented by the Bloomberg Commodity Index, U.S. real estate by the FTSE NAREIT Equity REITs Index, and non-U.S. real estate by the S&P Global ex-U.S. Property Index. U.S. investment-grade bonds are represented by the Bloomberg Barclays U.S. Aggregate Bond Index, U.S. high-yield bonds by the Bloomberg Barclays U.S. Corporate High Yield Bond Index, non-U.S. bonds by the Bloomberg Barclays Global Aggregate Bond Index ex USD (Hedged), and emerging-market bonds by the Bloomberg Barclays Emerging Markets USD Aggregate Bond Index.

Sources: Vanguard calculations, based on data from Standard & Poor's, Wilshire Associates, MSCI, FTSE, and Bloomberg.

A portfolio that diversifies across asset classes is less vulnerable to the impact of significant swings in performance by any one segment. Portfolios concentrated in assets such as real estate, commodities, or emerging markets tend to be risky and vulnerable. This is why we believe that most investors are best served by significant allocations to investments that represent broad markets, such as domestic and nondomestic stocks and bonds.[6]

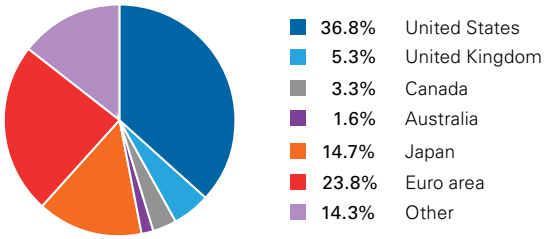
Investors examining Figure 12 might conclude that market divergences are cyclical and that they can capitalize on them. But if this were the case, data should show that most active managers have been able to beat market indexes. In reality, market leadership has proven difficult to predict, and research has shown that historically, even most professional managers have underperformed market benchmarks (see "Active and passive strategies" on page 17).

Domestic and nondomestic fixed income

As we discussed with equities, a bond portfolio's allocation to nondomestic securities is potentially a way to reduce overall volatility or improve expected returns. Although the bonds of any one country may be more volatile than the comparable bonds of an investor's home country, a portfolio that includes the bonds of many countries and issuers would benefit from imperfect correlations across those issuers. Figure 13 illustrates the fixed income global market-cap weighting by region. Note that currency fluctuations account for a significant portion of the volatility in international bonds. For this reason, Vanguard recommends hedging currency exposure to decrease risk and mitigate this volatility.

Although no allocation is optimal for all investors, having some nondomestic exposure can be better than none. That said, a home bias may be defensible on grounds other than pure diversification. Investors considering foreign bonds should balance the benefits against both the costs involved and the value of preserving a core allocation to their home market.

Figure 13. Global fixed income market-capitalization weights by region



Notes: Data are as of September 30, 2020, from the Bloomberg Barclays Global Aggregate Bond Index and Bloomberg Barclays Euro Aggregate Bond Index. Because of rounding, percentages shown may not total precisely 100%.

Sources: Bloomberg and FactSet.

Sub-asset allocation within fixed income

Investors seeking an allocation to parts of the bond market must decide on the degree of exposure to domestic and foreign issues; short-, intermediate-, or long-term maturities; high, medium, or low credit quality; corporate versus sovereign debt; and inflation-protected issues. Each category can have specific risk factors.

As highlighted with the U.S. market in Figure 12, annual returns of bond market segments can vary widely as well.

As with equity allocation decisions, bond investors should be cautious and understand the risks of moving away from a market-cap-weighted portfolio. For example, with the U.S. market, overweighting corporate bonds to try to obtain higher yields has had disadvantages in years such as 2008, when a flight to quality resulted in negative returns for corporate bonds but strong positive returns for U.S. Treasuries. On the other hand, seeking to reduce credit risk by overweighting Treasuries can result in lower long-run returns versus a market-cap-weighted benchmark.

To try to match asset-class risk and return assumptions, bond sector weightings should generally be similar to those of the broad bond market. Exposure to the nominal investment-grade bond segments through a total bond market fund would achieve the goals of both market proportionality to those segments and similar average duration to the broad market.[7]

6 We believe that if nondomestic bonds are to play an enduring role in a diversified portfolio, their currency exposure should be hedged. For more perspective, including an analysis of the impact of currency on the return characteristics of foreign bonds, see Philips et al. (2014).

7 Duration, a measure of a bond's price change relative to changes in interest rates, can be used to estimate the level of potential return volatility.

Nontraditional asset classes

Nontraditional and alternative asset classes and investment strategies include real estate, commodities, private equity, emerging-market bonds, and currency. Among alternative strategies sometimes included are long/short and market neutral approaches. Each of these can offer advantages compared with investing in traditional stocks, bonds, and cash, including:

- Potentially higher expected returns.
- Lower expected correlation and volatility vis-à-vis traditional market forces.
- The opportunity to benefit from market inefficiencies through skill-based strategies.

These potential advantages are often debated, and assessing the degree to which they can be relied on can be difficult. This is even more evident for strategies in which investable beta is not available. Strategies such as long/short, market neutral, and private equity largely depend on manager skill; success will therefore depend on consistently selecting top managers. One downside to all these nontraditional asset classes is their potential to be very expensive relative to traditional investments in stocks and bonds.

Commodities provide another example of the complexity introduced with alternative assets. While recognizing the historical portfolio diversification benefit of including commodities (specifically, commodities futures), we caution against doing so based solely on an extrapolation of historical returns. The long-term economic justification for expecting significant positive returns from a static, long-only commodities futures exposure is subject to ongoing debate. Other aspects to consider with commodities include the choice of indexing methodology and tax and regulatory issues surrounding the nature of the "income" generated by commodities futures positions in a mutual fund.

Investing in private equity may offer the potential of higher returns. Private equity can provide an economic exposure to a different set of businesses than those available on public exchanges. Given that there is no investable "index" option to obtain exposure to the private equity market, investors must be willing to accept some form of active risk (Aliaga-Díaz et al., 2020). As a result, factors such as manager, deal size, fund stage, and vintage also affect the potential returns of private equity. Another aspect that's different about investing in the private versus public market is the illiquid nature of private equity investing. There may potentially be a lockup period of 10 years or more. Although access to liquidity is possible through secondary sales, those frequently come with a discount to net asset value. Hence, private equity can play an important role in a portfolio, but it is important for the investors to maintain long time horizons.

With real estate, the challenge investors face is that the available liquid vehicles such as real estate investment trusts (REITs) offer only a slice of the broad commercial real estate market. As a result, real estate investors must be comfortable with the potential for their investment to deviate from that broad market's performance.

For investors who understand the risks, REITs offer liquid, diversified, transparent, and low-cost exposure to commercial real estate. Investors must also be comfortable, though, with the risk of a sector overweighting. At the end of the day, REITs are already represented in most broadly diversified equity indexes. As of September 30, 2020, REITs accounted for 3.4% of the broad U.S. stock market.[8] So any additional allocation to REITs can represent a significant overweighting of a potentially volatile and concentrated sector.

8 The U.S. stock market is represented by the CRSP US Total Market Index. REITs also accounted for 2.3% of the S&P/TSX Composite Index in Canada, 2.5% of the FTSE All-Share Index in the U.K., 1.0% of the MSCI EMU (European Economic and Monetary Union) Investable Market Index in the euro area, 6.8% of the S&P/ASX 300 Index in Australia, and 2.7% of the MSCI Japan IMI in Japan. All data are as of September 30, 2020.

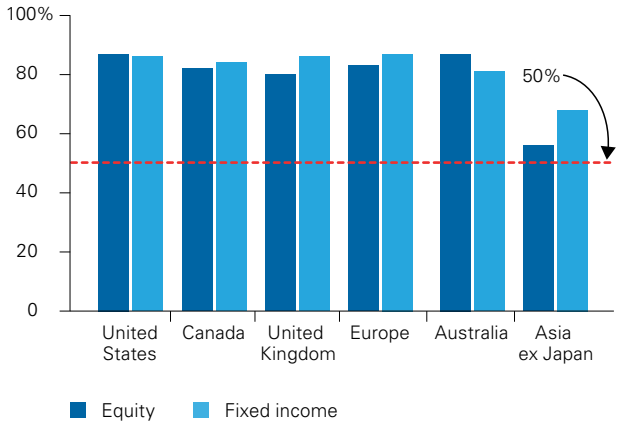
Active and passive strategies

Market-cap-weighted indexing is a valuable starting point for many investors. It can be delivered inexpensively and provides exposure to the broad market while offering diversification and transparency. Yet for investors looking for the opportunity to outperform a target benchmark, an actively managed portfolio strategy can be appealing. Despite the debate about whether active or passive is better, both strategies have distinct benefits and trade-offs.

Active management typically comes with higher costs, manager risk, decreased tax efficiency, and variability relative to the market.[9] Higher fees are typically due to the research cost and generally higher turnover while trying to outperform the market. After accounting for all applicable costs (commissions, management fees, bid-ask spreads, administrative costs, market impact), the average fund trails the market. (Figure A-4, on page 29 in Appendix 2, displays some of the cost differences for active and passive investments.) Although skilled managers can provide the opportunity for outperformance, the track record of active management has historically been less than stellar.[10] Figure 14 shows that over longer periods, most managers have underperformed their prospectus benchmarks.

Investors who choose to implement all or part of their portfolio in an index strategy should know that not all index funds (and the benchmarks they seek to track) are the same. Index funds can capture their desired exposure through varying degrees of replication, ranging from full (in which every security in the index is held) to synthetic (in which index exposure is obtained through derivatives). In addition, different index providers may offer slightly different exposures or market coverage. Although a relatively strong convergence of methodologies has come about in recent years, benchmarks from different providers covering the same market segment have historically realized different returns. Ultimately, there are no universal criteria for choosing an appropriate benchmark, and the decision typically comes down to personal preference.[11]

Figure 14. The performance of actively managed mutual funds versus their prospectus benchmarks



Notes: Data reflect active open-end funds available for sale in the respective regions. Asia ex Japan includes funds in China, Hong Kong, India, Indonesia, Malaysia, New Zealand, Pakistan, the Philippines, Singapore, South Korea, and Taiwan. Europe includes funds in Belgium, the Netherlands, Luxembourg, Sweden, Denmark, Norway, Finland, Germany, and France. Fund data include surviving funds plus ones that closed or merged during the period. We are assuming that the funds that closed or liquidated were underperforming funds. Data for the United States, the United Kingdom, Europe, and Australia cover the 15 years ended December 31, 2020. Data for Canada and Asia ex Japan cover the 10 years ended December 31, 2020.

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

If active management is used, a wide spectrum of active strategies exist. They can involve factor exposures, tactical moves, rules-based quantitative strategies, concentrated (high-conviction) strategies, traditional bottom-up security selection, or alternatives, to name a few. Factors are underlying exposures that help explain and influence an investment's risk. Commonly recognized ones include market, value, size, momentum, and low volatility for equities, and term and credit for fixed income. Factor investing can approximate and in some cases replicate the risk exposures of a range of active investments. Although factor investing can potentially offer transparency and control over risk exposures, investors have additional issues to examine, including their tolerance for active risk, the investment rationale supporting specific factors, and the cyclical variation of factor-based performance.[12]

9 For a more detailed discussion on tax-efficient investing, see Donaldson et al. (2015). 10 For a more detailed discussion on indexing, see Rowley, Walker, and Ning (2018). 11 For a more detailed discussion on benchmark selection, see Philips and Kinniry (2012). 12 For a more detailed discussion on factor investing, see Pappas and Dickson (2015).

With use of an active manager, selection is critical to success. The active management universe varies widely, and successfully choosing a manager that will outperform in the future is difficult. Focusing on the advisory firm and its people, philosophy, and process can help in the search for a skilled manager. Ultimately, identifying talent, choosing low-cost investments, and staying patient are important to succeeding with active management.[13]

Because both indexing and low-cost active management have potential advantages, combining these approaches can prove effective. As indexing is incrementally
added to active management strategies, a portfolio's risk characteristics converge closer to those of the benchmark, decreasing tracking error and providing diversification. The combination offers the opportunity to outperform while adding some risk control relative to the benchmark. The appropriate mix should be determined by the goals, active risk tolerance, and objectives of the investment policy statement, keeping in mind the trade-off between tracking error and the possibility of outperformance. For investors inclined toward active management, risk tolerance, cost, tracking error, and conviction in their ability to pick winning managers can all be factors in deciding the active/passive mix.

We remind readers that although the active/passive question is a consideration for many investors, establishing an appropriate asset allocation is the first and most important step in the portfolio construction process.

Rebalancing

Over time, as a portfolio's investments produce different returns, the portfolio is likely to drift from its target asset allocation. Figure 15 shows that over a long horizon, the equity allocation of a never-rebalanced globally diversified portfolio drifts upward significantly, to 98%, and it is 82% on average through the time period. With the additional equity allocation, the portfolio also acquires risk-and-return characteristics that may be inconsistent with the investor's goals and preferences. In the example shown in Figure 15, the portfolio produces a slightly higher return, but its volatility increases significantly, from 9.7% to 13.3%. By periodically rebalancing, investors can diminish the tendency for "portfolio drift" and thus potentially reduce their exposure to risk relative to their target asset allocation.

Figure 15. Comparing a 50/50 rebalanced portfolio with a 50/50 never-rebalanced portfolio

1926 through September 2020	Annually rebalanced	Never rebalanced
Maximum stock weighting	60%	98%
Minimum stock weighting	35%	27%
Average stock weighting	51%	82%
Final stock weighting	49%	98%
Average annualized return	8.0%	8.8%
Annualized standard deviation	9.7%	13.3%

Notes: This table does not represent the returns of any particular investment. It assumes a portfolio of 50% global stocks and 50% global bonds, with all returns in nominal U.S. dollars. It also assumes that no new contributions or withdrawals were made, that dividend payments were reinvested in equities, that interest payments were reinvested in bonds, and that there were no new taxes. All statistics are annualized. Stocks are represented by the Standard & Poor's 90 Index from 1926 through March 3, 1957; the S&P 500 Index from March 4, 1957, through 1969; the MSCI World Index from 1970 through 1987; the MSCI All Country World Index from 1988 through May 31, 1994; and the MSCI All Country World Investable Market Index from June 1, 1994, through September 30, 2020. Bonds are represented by the S&P High Grade Corporate Index from 1926 through 1968, the Citigroup High Grade Index from 1969 through 1972, the Lehman Long-Term AA Corporate Index from 1973 through 1975, the Barclays U.S. Aggregate Bond Index from 1976 through 1989, and the Barclays Global Aggregate Bond Index (USD Hedged) from 1990 through September 30, 2020.

Sources: Vanguard calculations, based on data from FactSet.

As part of the portfolio construction process, it's important for investors to develop a rebalancing strategy that formally addresses "how often, how far, and how much"—that is, how frequently the portfolio should be monitored, how far an asset allocation can be allowed to deviate from its target before it is rebalanced, and whether periodic rebalancing should restore a portfolio to its target or to a close approximation of it. Although each of these decisions affects a portfolio's risk-and-return characteristics, the differences in risk-adjusted returns among the strategies are not very significant. Thus, the "how often, how far, and how much" are mostly questions of investor preference. The only clear advantage for any of these strategies—so far as maintaining a portfolio's risk and return characteristics, and without factoring in rebalancing costs—is that a rebalanced portfolio more closely aligns with the characteristics of the target asset allocation than a portfolio that is never rebalanced.[14]

13 For a more detailed discussion on factor investing, see Tidmore and Hon (2020).

14 See Zilbering, Jaconetti, and Kinniry (2015) for a more detailed discussion and analysis of portfolio rebalancing.

A quantitative model-based approach to portfolio construction

As far as asset allocation goes, we have established that consideration should be given to an investor's goals; risk aversion; and expected asset returns, correlations, and volatility. But is there a quantitative way to determine asset allocation?

Vanguard's proprietary quantitative asset allocating framework, the Vanguard Asset Allocation Model (VAAM), does exactly that and more. Asset return distributions are generated by the VCMM, while the VAAM optimizes asset allocation by maximizing the expected utility of portfolio wealth over a long horizon, such as 10 years or longer (Aliaga-Díaz et al., 2019). Utility maximization is an extensively studied concept in investing and economics. Its conceptual underpinnings are similar to economist Harry Markowitz's mean-variance optimization for portfolio construction.

More importantly, the VAAM can help allocate to different types of assets (active, passive, factor, and illiquid investment vehicles) in a conceptually rigorous fashion. Here, the expected return of the optimal portfolio can be assessed against the RRR, to determine feasibility toward the investor's goals. The actual portfolio allocations depend on several inputs described above, and there is no one-size-fits-all portfolio or recommendation under this construct. This makes the VAAM ideal for personalization and advice applications.

Such a process for portfolio construction requires one to take on active risk. However, it can be mitigated by embedding reasonable allocation constraints that support broader diversification principles discussed throughout this paper.

A few key advantages of VAAM methodology are:

1. This process for portfolio construction explicitly accounts for risk, return, and investors' risk tolerance.
2. VAAM-based asset allocations strategically account for the current environment (low rates) and form suitable long-term-oriented portfolios that target an investor's goals (RRR) and risk preferences.
3. In today's low-return environment, it allows for systematically allocating between passive, active, factor, and even illiquid assets to increase a portfolio's expected returns. Traditional models such as mean-variance optimization make perfect rebalancing assumptions that are not appropriate for illiquid assets. They also do not account for an investor's aversion toward active risk. The VAAM overcomes these issues by design.
4. Based on a total-return approach, the model can help form income-oriented portfolios, tax-aware portfolios, or even environmental, social, and governance (ESG) portfolios under a rigorous and consistent portfolio framework.

Conclusion

The portfolio construction process starts with investors choosing an asset allocation policy based on a well-thought-out investment plan. An investor can then determine the strategy for implementing the policy decision, based on the risk-return expectations and their risk tolerance. Global market-cap-weighted index funds are a valuable starting point for many investors.

Based on an investor's willingness to accept model risk, portfolios with active, passive, factor, and/or illiquid assets require a robust framework for portfolio construction such as the VAAM. The actual portfolio allocations depend on several inputs such as expected return, risk, goals, constraints, and risk preferences. There is no one-size-fits-all portfolio or recommendation under this construct.

Most importantly, investing evokes emotion, and even sophisticated investors should arm themselves with a long-term perspective and a disciplined approach. Abandoning a planned investment strategy can be costly, and research has shown that some of the most significant derailers are behavioral: the failure to rebalance, the allure of tactical timing, and the temptation to chase performance. Focus on those factors within your control. We believe that a rigorous investment approach, principles of broad diversification aligned with the investor's goals and constraints, offers the best chance of success.

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Appendix 1. About the Vanguard Capital Markets Model

IMPORTANT: The projections and other information generated by the Vanguard Capital Markets Model regarding the likelihood of various investment outcomes are hypothetical in nature, do not reflect actual investment results, and are not guarantees of future results. VCMM results will vary with each use and over time.

The VCMM projections are based on a statistical analysis of historical data. Future returns may behave differently from the historical patterns captured in the VCMM. More important, the VCMM may be underestimating extreme negative scenarios unobserved in the historical period on which the model estimation is based.

The Vanguard Capital Markets Model is a proprietary financial simulation tool developed and maintained by Vanguard's Investment Strategy Group. The model forecasts distributions of future returns for a wide array of broad asset classes. Those asset classes include U.S. and international equity markets, several maturities of the U.S. Treasury and corporate fixed income markets, international fixed income markets, U.S. money markets, commodities, and certain alternative investment strategies. The asset return distributions shown in this paper are drawn from 10,000 VCMM simulations based on market data and other information available as of September 30, 2020.

The theoretical and empirical foundation for the Vanguard Capital Markets Model is that the returns of various asset classes reflect the compensation investors require for bearing different types of systematic risk (beta). At the core of the model are estimates of the dynamic statistical relationship between risk factors and asset returns, obtained from statistical analysis based on available monthly financial and economic data. Using a system of estimated equations, the model then applies a Monte Carlo simulation method to project the estimated interrelationships among risk factors and asset classes as well as uncertainty and randomness over time. The model generates a large set of simulated outcomes for each asset class over several time horizons. Forecasts are obtained by computing measures of central tendency in these simulations. Results produced by the tool will vary with each use and over time.

Appendix 2. Regional data

Figure A-1. Long-term historical returns for various portfolio allocations (1900–2020)

	Portfolio allocation										
Bonds/ Stocks	100%/ 0%	90%/ 10%	80%/ 20%	70%/ 30%	60%/ 40%	50%/ 50%	40%/ 60%	30%/ 70%	20%/ 80%	10%/ 90%	0%/ 100%
United States											
95th percentile	24.5%	20.7%	21.5%	20.6%	22.3%	25.9%	28.5%	30.6%	33.5%	35.5%	39.2%
Average (nominal)	5.0%	5.6%	6.2%	6.8%	7.3%	7.8%	8.2%	8.6%	9.0%	9.3%	9.6%
Average (real)	2.0%	2.6%	3.2%	3.8%	4.3%	4.8%	5.2%	5.6%	5.9%	6.2%	6.5%
5th percentile	–6.1%	–6.9%	–6.3%	–6.8%	–8.9%	–11.8%	–13.0%	–18.2%	–21.5%	–24.7%	–27.9%
Canada											
95th percentile	20.3%	19.7%	19.2%	20.5%	21.6%	24.2%	25.1%	26.8%	29.9%	31.4%	35.1%
Average (nominal)	5.3%	5.8%	6.2%	6.7%	7.1%	7.5%	7.8%	8.1%	8.4%	8.6%	8.8%
Average (real)	2.3%	2.8%	3.2%	3.7%	4.1%	4.4%	4.7%	5.0%	5.3%	5.5%	5.7%
5th percentile	–5.7%	–5.0%	–5.3%	–5.5%	–6.1%	–7.3%	–9.7%	–11.3%	–13.6%	–16.4%	–19.1%
United Kingdom											
95th percentile	27.8%	27.1%	26.7%	25.3%	26.0%	29.2%	33.3%	35.4%	34.7%	35.1%	37.8%
Average (nominal)	5.6%	6.1%	6.5%	7.0%	7.4%	7.7%	8.1%	8.4%	8.7%	8.9%	9.2%
Average (real)	2.0%	2.4%	2.9%	3.3%	3.7%	4.0%	4.3%	4.7%	4.9%	5.2%	5.4%
5th percentile	–9.7%	–9.2%	–9.6%	–9.5%	–9.6%	–9.9%	–10.1%	–12.5%	–15.8%	–17.6%	–18.7%
Europe											
95th percentile	30.3%	27.4%	25.9%	25.7%	25.2%	27.5%	28.4%	30.7%	33.8%	36.8%	39.9%
Average (nominal)	4.3%	4.7%	5.1%	5.5%	5.8%	6.1%	6.4%	6.7%	7.0%	7.2%	7.4%
Average (real)	1.3%	1.7%	2.1%	2.5%	2.8%	3.1%	3.4%	3.7%	3.9%	4.1%	4.3%
5th percentile	–18.2%	–18.4%	–18.6%	–18.5%	–18.4%	–19.1%	–19.3%	–19.5%	–19.6%	–19.8%	–21.3%
Australia											
95th percentile	23.2%	24.1%	23.1%	22.3%	23.5%	27.1%	28.8%	32.6%	37.0%	41.5%	45.4%
Average (nominal)	5.7%	6.3%	6.9%	7.5%	8.1%	8.6%	9.1%	9.5%	9.9%	10.3%	10.7%
Average (real)	1.8%	2.5%	3.1%	3.6%	4.1%	4.6%	5.1%	5.5%	5.9%	6.3%	6.6%
5th percentile	–12.4%	–11.4%	–10.4%	–10.2%	–10.2%	–10.2%	–13.1%	–13.5%	–13.5%	–13.9%	–17.5%
Japan											
95th percentile	22.4%	23.1%	28.3%	30.4%	37.6%	37.5%	43.8%	47.0%	50.8%	56.9%	61.6%
Average (nominal)	5.6%	6.5%	7.3%	8.1%	8.7%	9.3%	9.7%	10.2%	10.5%	10.8%	11.0%
Average (real)	–0.8%	0.0%	0.8%	1.5%	2.1%	2.6%	3.1%	3.5%	3.8%	4.0%	4.2%
5th percentile	–9.2%	–8.0%	–6.8%	–7.3%	–11.3%	–14.7%	–4.0%	–16.2%	–17.8%	–20.0%	–23.0%

Notes: Data cover January 1, 1900, through December 31, 2020. Returns are in local currency. Nominal value is the return before adjustment for inflation; real value includes the effect of inflation.

Sources: Vanguard, using Dimson-Marsh-Staunton global returns data from Morningstar, Inc. (the DMS US Equity Index, the DMS US Bond Index, the DMS Canada Equity Index, the DMS Canada Bond Index, the DMS UK Equity Index, the DMS UK Bond Index, the DMS Europe Equity Index, the DMS Europe Bond Index, the DMS Australia Equity Index, the DMS Australia Bond Index, the DMS Japan Equity Index, and the DMS Japan Bond Index).

Figure A-2. Trade-off between market risk and inflation risk

1900–2019 total returns	Nominal			Real (inflation-adjusted)		
	Average annual return	% of years with negative return	Greatest annual loss*	Average annual return	% of years with negative return	Greatest annual loss*
United States						
100% Treasury bills	3.65%	1%	—	0.72%	38%	–8.04%
100% bonds	4.96%	24%	–6.09%	1.98%	39%	–13.21%
100% stocks	9.55%	27%	–27.94%	6.45%	34%	–30.04%
Canada						
100% Treasury bills	4.36%	0%	—	1.40%	35%	–6.41%
100% bonds	5.27%	24%	–5.69%	2.29%	40%	–12.48%
100% stocks	8.83%	28%	–19.13%	5.74%	31%	–21.93%
United Kingdom						
100% Treasury bills	4.62%	0%	—	1.01%	35%	–10.32%
100% bonds	5.60%	28%	–9.71%	1.96%	43%	–18.84%
100% stocks	9.17%	28%	–18.70%	5.41%	33%	–21.43%
Europe						
100% Treasury bills	3.65%	1%	—	0.72%	38%	–8.04%
100% bonds	4.27%	30%	–18.23%	1.32%	38%	–21.84%
100% stocks	7.35%	31%	–21.31%	4.31%	37%	–29.95%
Australia						
100% Treasury bills	4.38%	0%	—	0.59%	38%	–8.60%
100% bonds	5.68%	28%	–12.43%	1.84%	40%	–19.30%
100% stocks	10.67%	23%	–17.52%	6.65%	29%	–25.48%
Japan						
100% Treasury bills	4.50%	4%	—	–1.87%	38%	–19.50%
100% bonds	5.65%	19%	–9.16%	–0.79%	38%	–39.72%
100% stocks	10.99%	28%	–22.97%	4.23%	38%	–40.86%

* Greatest annual loss is represented by the lowest 5th percentile of annual returns.

Notes: Data cover January 1, 1900, through December 31, 2020. Returns are in local currency. Nominal value is the return before adjustment for inflation; real value includes the effect of inflation.

Sources: Vanguard, using Dimson-Marsh-Staunton global returns data from Morningstar, Inc. (the DMS US Equity Index, the DMS US Bond Index, the DMS Canada Equity Index, the DMS Canada Bond Index, the DMS UK Equity Index, the DMS UK Bond Index, the DMS Europe Equity Index, the DMS Europe Bond Index, the DMS Australia Equity Index, the DMS Australia Bond Index, the DMS Japan Equity Index, and the DMS Japan Bond Index).

Figure A-3. Annual returns for selected categories, ranked from best performance to worst

a. United Kingdom

- U.K. stocks (**UKS**)
- Europe ex-U.K. stocks (**EUS**)
- North America stocks (**NAS**)
- Global stocks (**GS**)
- Developed Asia stocks (**DEV**)
- Emerging-market stocks (**EMS**)
- U.K. investment-grade corporate bonds (**UKB**)
- U.K. index-linked gilts (**UKG**)
- U.K. government bonds (**UKGB**)
- Hedged global bonds (**GB**)

2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
EUS	**EMS**	**UKGB**	**EMS**	**EMS**	**UKG**	**EUS**	**NAS**	**NAS**	**DEV**	**EMS**	**EMS**	**NAS**	**NAS**	**NAS**
20.33%	37.38%	13.02%	62.54%	23.58%	20.33%	17.43%	28.30%	19.59%	8.78%	35.43%	21.06%	0.78%	26.46%	16.45%
EMS	**EUS**	**GB**	**UKS**	**DEV**	**UKGB**	**UKB**	**EUS**	**UKG**	**EUS**	**NAS**	**DEV**	**UKGB**	**GS**	**GS**
16.77%	16.40%	7.59%	30.12%	21.27%	16.68%	15.54%	23.97%	18.78%	5.48%	34.11%	17.18%	0.50%	22.31%	12.98%
UKS	**GS**	**UKG**	**EUS**	**NAS**	**UKB**	**EMS**	**GS**	**UKGB**	**NAS**	**GS**	**EUS**	**GB**	**EUS**	**DEV**
16.75%	10.85%	3.62%	21.76%	19.07%	6.52%	12.76%	21.03%	14.64%	5.35%	29.56%	16.86%	0.10%	21.25%	12.82%
GS	**UKG**	**UKB**	**GS**	**GS**	**GB**	**UKS**	**UKS**	**UKB**	**GS**	**DEV**	**GS**	**UKG**	**UKS**	**EMS**
7.18%	8.31%	–9.99%	21.24%	16.74%	5.80%	12.30%	20.81%	12.51%	4.04%	25.48%	13.84%	–0.39%	19.17%	11.93%
GB	**DEV**	**DEV**	**NAS**	**UKS**	**NAS**	**GS**	**DEV**	**GS**	**GB**	**UKG**	**UKS**	**UKB**	**EMS**	**UKG**
3.30%	6.61%	–13.19%	14.84%	14.51%	1.22%	12.00%	13.59%	11.30%	1.39%	25.41%	13.10%	–2.24%	15.91%	11.34%
UKG	**GB**	**NAS**	**UKB**	**UKB**	**UKS**	**DEV**	**UKB**	**GB**	**UKS**	**EUS**	**NAS**	**GS**	**DEV**	**UKB**
2.80%	5.76%	–13.34%	14.70%	8.85%	–3.46%	11.18%	1.64%	7.92%	0.98%	21.17%	11.27%	–3.44%	14.03%	9.09%
NAS	**NAS**	**GS**	**DEV**	**UKG**	**GS**	**NAS**	**UKG**	**EMS**	**UKB**	**UKS**	**UKB**	**EMS**	**UKB**	**UKGB**
1.71%	5.63%	–19.36%	13.63%	8.75%	–6.57%	10.73%	0.55%	7.87%	0.70%	16.75%	4.86%	–7.64%	10.96%	8.88%
UKB	**UKS**	**EUS**	**UKG**	**UKGB**	**DEV**	**GB**	**GB**	**DEV**	**UKGB**	**UKB**	**UKG**	**DEV**	**UKGB**	**EUS**
0.80%	5.32%	–25.94%	6.34%	7.54%	–12.58%	5.93%	0.04%	2.81%	0.49%	12.27%	2.46%	–8.03%	7.15%	7.84%
UKGB	**UKGB**	**UKS**	**GB**	**EUS**	**EUS**	**UKGB**	**UKGB**	**UKS**	**UKG**	**UKGB**	**UKGB**	**EUS**	**GB**	**GB**
0.53%	5.18%	–29.93%	5.30%	6.57%	–15.01%	2.91%	–4.22%	1.18%	–1.10%	10.73%	1.95%	–9.08%	6.46%	4.96%
DEV	**UKB**	**EMS**	**UKGB**	**GB**	**EMS**	**UKG**	**EMS**	**EUS**	**EMS**	**GB**	**GB**	**UKS**	**UKG**	**UKS**
–0.25%	0.42%	–34.78%	–1.19%	4.82%	–18.36%	0.57%	–5.29%	–1.35%	–10.31%	3.66%	1.93%	–9.47%	6.33%	–9.82%

Best

Worst

Notes: Benchmarks represent the following asset classes: for U.K. stocks, the FTSE All-Share Index; for Europe ex-U.K. stocks, the FTSE All World Europe ex-UK Index; for developed Asia stocks, the FTSE All World Developed Asia Pacific Index; for North America stocks, the FTSE World North America Index; for emerging-market stocks, the FTSE Emerging Index; for global stocks, the FTSE All World Index; for U.K. government bonds, the Bloomberg Barclays Sterling Gilt Index; for U.K. index-linked gilts, the Bloomberg Barclays Global Inflation-Linked UK Index; for hedged global bonds, the Bloomberg Barclays Global Aggregate Bond Index (Hedged in GBP); and for U.K. investment-grade corporate bonds, the Bloomberg Barclays Sterling Corporate Bond Index. All returns are in British pounds.

Source: FactSet.

Figure A-3 *(Continued).* Annual returns for selected categories, ranked from best performance to worst

b. Canada

- Large-cap Canadian stocks (**LC**)
- Small-cap Canadian stocks (**SC**)
- Developed international stocks (**DEV**)
- Emerging-market stocks (**EMS**)
- Canadian government bonds (**CGB**)
- Canadian investment-grade bonds (**CIGB**)
- International bonds (**IB**)
- Emerging-market bonds (**EMB**)
- Commodities (**COM**)
- Real estate (**RE**)

2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
RE	**EMS**	**CGB**	**SC**	**SC**	**CIGB**	**RE**	**DEV**	**RE**	**EMB**	**SC**	**EMS**	**EMB**	**LC**	**EMS**
41.46%	18.55%	12.00%	62.38%	35.10%	10.07%	28.53%	31.57%	23.73%	21.47%	38.48%	28.70%	6.33%	22.88%	16.61%
EMS	**LC**	**CIGB**	**EMS**	**LC**	**EMB**	**EMS**	**LC**	**EMB**	**RE**	**LC**	**DEV**	**CGB**	**RE**	**SC**
32.08%	9.83%	7.58%	52.03%	17.61%	9.62%	16.00%	12.99%	14.20%	20.24%	21.08%	17.36%	2.42%	17.75%	12.87%
DEV	**CGB**	**EMB**	**LC**	**EMS**	**CGB**	**EMB**	**RE**	**LC**	**DEV**	**COM**	**RE**	**RE**	**DEV**	**CIGB**
26.38%	5.02%	6.63%	35.05%	12.97%	9.54%	15.33%	8.54%	10.55%	19.46%	7.90%	10.72%	1.40%	16.45%	8.35%
LC	**IB**	**IB**	**RE**	**RE**	**IB**	**DEV**	**SC**	**CIGB**	**CIGB**	**EMS**	**LC**	**CIGB**	**SC**	**CGB**
17.26%	4.51%	5.73%	14.72%	12.39%	6.33%	15.28%	7.60%	8.93%	3.72%	7.74%	9.10%	1.37%	15.84%	7.34%
SC	**CIGB**	**COM**	**EMB**	**COM**	**RE**	**LC**	**EMS**	**IB**	**CGB**	**EMB**	**SC**	**IB**	**EMS**	**DEV**
11.61%	4.20%	–19.51%	13.99%	10.73%	–6.15%	7.19%	4.29%	8.59%	3.71%	6.08%	2.75%	1.06%	12.87%	6.38%
EMB	**SC**	**DEV**	**DEV**	**EMB**	**LC**	**IB**	**EMB**	**CGB**	**EMS**	**IB**	**IB**	**COM**	**IB**	**LC**
9.54%	0.90%	–28.78%	12.49%	6.95%	–8.71%	6.55%	2.31%	7.46%	2.42%	3.73%	2.60%	–3.25%	7.43%	5.60%
CIGB	**COM**	**LC**	**IB**	**CIGB**	**DEV**	**CIGB**	**IB**	**EMS**	**IB**	**CIGB**	**CIGB**	**DEV**	**EMB**	**IB**
3.99%	–1.43%	–33.00%	5.04%	6.74%	–9.55%	3.03%	0.62%	7.03%	1.61%	1.26%	2.28%	–5.55%	7.39%	5.33%
CGB	**DEV**	**RE**	**CIGB**	**CGB**	**COM**	**CGB**	**CIGB**	**DEV**	**LC**	**CGB**	**EMB**	**EMS**	**CIGB**	**EMB**
3.54%	–5.33%	–36.55%	2.69%	6.18%	–11.17%	2.19%	–1.69%	4.12%	–8.32%	–0.34%	1.06%	–6.51%	6.57%	4.65%
IB	**EMB**	**EMS**	**COM**	**IB**	**EMS**	**SC**	**CGB**	**SC**	**COM**	**RE**	**CGB**	**LC**	**CGB**	**COM**
2.58%	–10.81%	–41.44%	0.98%	5.04%	–16.15%	–2.23%	–2.28%	–2.34%	–9.64%	–0.40%	0.10%	–8.89%	3.82%	–4.82%
COM	**RE**	**SC**	**CGB**	**DEV**	**SC**	**COM**	**COM**	**COM**	**SC**	**DEV**	**COM**	**SC**	**COM**	**RE**
1.68%	–17.48%	–45.49%	–1.71%	2.56%	–16.43%	–3.25%	–3.45%	–9.53%	–13.31%	–2.00%	–4.98%	–18.17%	2.25%	–7.32%

Best

Worst

Notes: Benchmarks represent the following asset classes: for large-cap Canadian stocks, the S&P/TSX Composite Index; for small-cap Canadian stocks, the S&P/TSX SmallCap Index; for developed international stocks, the MSCI EAFE Index; for emerging-market stocks, the MSCI Emerging Markets Index; for commodities, the Bloomberg Commodity Total Return USD Index; for real estate, the MSCI ACWI Real Estate Index; for Canadian government bonds, the FTSE Canadian Government Bond Index; for Canadian investment-grade bonds, the Bloomberg Barclays Canadian 500MM Index; for international bonds, the Bloomberg Barclays Global Aggregate Bond Index (CAD Hedged); and for emerging-market bonds, the Bloomberg Barclays Emerging Markets USD Aggregate Bond Index. All returns are in Canadian dollars.

Sources: FactSet and Morningstar, Inc.

Figure A-3 *(Continued).* Annual returns for selected categories, ranked from best performance to worst

c. Australia

- Australian stocks (**AS**)
- Australian small-cap stocks (**SAS**)
- Non-Australian developed global stocks (**DGS**)
- Non-Australian developed small-cap stocks (**DSC**)
- Emerging-market stocks (**EMS**)
- Australian investment-grade bonds (**AIGB**)
- Australian government bonds (**AGB**)
- Global bonds (**GB**)
- Australian real estate (**ARE**)
- Short-term interest rates (**STIR**)

2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
SAS	EMS	AGB	SAS	SAS	AGB	ARE	DSC	ARE	ARE	DSC	EMS	AGB	DGS	SAS
34.21%	25.47%	19.07%	57.43%	13.05%	13.44%	32.79%	55.99%	26.79%	14.38%	13.74%	27.53%	5.08%	28.72%	9.21%
ARE	SAS	AIGB	EMS	DSC	AIGB	AS	DGS	DGS	DSC	SAS	SAS	AIGB	DSC	EMS
34.05%	17.05%	14.95%	38.78%	11.01%	11.37%	19.74%	48.85%	15.64%	12.78%	13.18%	20.02%	4.54%	27.13%	8.12%
AS	AS	GB	AS	GB	GB	EMS	AS	DSC	DGS	ARE	DGS	ARE	AS	DGS
24.51%	16.22%	9.23%	37.59%	9.28%	10.51%	17.14%	19.68%	12.18%	12.43%	13.18%	14.01%	3.27%	23.77%	6.28%
EMS	STIR	STIR	DSC	AIGB	STIR	DSC	EMS	GB	SAS	EMS	DSC	DGS	SAS	DSC
23.39%	6.77%	7.60%	11.01%	6.04%	5.00%	16.90%	13.41%	10.37%	10.16%	12.14%	13.93%	2.09%	21.36%	5.83%
DGS	GB	DGS	ARE	AGB	ARE	DGS	ARE	AGB	GB	AS	AS	STIR	ARE	GB
12.02%	6.63%	−24.46%	9.56%	5.16%	−1.56%	14.86%	7.27%	10.30%	3.35%	11.79%	11.94%	1.92%	19.57%	5.09%
DSC	AGB	DSC	GB	STIR	DGS	GB	STIR	AIGB	AS	DGS	ARE	GB	EMS	AIGB
8.62%	4.01%	−25.49%	8.03%	4.66%	−4.80%	9.66%	2.87%	9.81%	2.80%	8.57%	6.44%	1.65%	19.06%	4.48%
STIR	AIGB	AS	STIR	EMS	DSC	AIGB	GB	EMS	AIGB	GB	GB	AS	AGB	AGB
6.00%	3.50%	−38.92%	3.47%	4.58%	−8.38%	7.70%	2.27%	7.34%	2.59%	5.24%	3.68%	−3.06%	7.84%	4.06%
GB	DGS	EMS	AIGB	AS	AS	SAS	AIGB	AS	STIR	AIGB	AIGB	DSC	AIGB	AS
5.40%	−2.14%	−41.04%	1.73%	1.90%	−10.98%	6.58%	1.99%	5.30%	2.33%	2.92%	3.66%	−3.78%	7.26%	1.73%
AIGB	ARE	SAS	DGS	ARE	EMS	AGB	AGB	STIR	AGB	AGB	AGB	EMS	GB	STIR
3.12%	−8.36%	−53.17%	0.34%	−0.68%	−18.19%	5.51%	0.27%	2.69%	2.32%	2.51%	3.49%	−4.72%	7.19%	0.37%
AGB	DSC	ARE	AGB	DGS	SAS	STIR	SAS	SAS	EMS	STIR	STIR	SAS	STIR	ARE
2.40%	−10.17%	−55.31%	−2.25%	−1.52%	−21.43%	3.97%	−0.76%	−3.81%	−3.94%	2.07%	1.75%	−8.67%	1.50%	−3.96%

Best

Worst

Notes: Benchmarks represent the following asset classes: for Australian stocks, the S&P/ASX 300 Total Return Index; for Australian small-cap stocks, the S&P/ASX Small Ordinaries Index; for non-Australian developed global stocks, the MSCI World ex Australia Index; for non-Australian developed small-cap stocks, the MSCI World ex Australia Small Cap Index; for emerging-market stocks, the MSCI Emerging Markets Index; for Australian real estate, the S&P/ASX 300 A-REIT Index; for Australian investment-grade bonds, the Bloomberg AusBond Composite 0+ Year Index; for short-term interest rates, the Bloomberg AusBond Bank Bill Index; for Australian government bonds, the Bloomberg AusBond Treasury 0+ Year Index; and for global bonds, the Bloomberg Barclays Global Aggregate Index (AUD Hedged). All returns are in Australian dollars.

Source: Factset.

Figure A-3 *(Continued).* Annual returns for selected categories, ranked from best performance to worst

d. Japan

Global stocks (**GS**)
U.S. stocks (**USS**)
Japan stocks (**JS**)
Emerging-market stocks (**EMS**)
China stocks (**CS**)
Global bonds (**GB**)
Emerging-market bonds (**EMB**)
Commodities (**COM**)
Global real estate (**GRE**)

2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
CS	**CS**	**GB**	**EMS**	**GRE**	**GB**	**GRE**	**USS**	**GRE**	**JS**	**USS**	**CS**	**GB**	**USS**	**CS**
85.32%	58.44%	2.70%	87.81%	7.54%	4.92%	39.04%	62.15%	40.08%	11.22%	9.23%	45.76%	–0.83%	29.90%	23.11%
GRE	**EMS**	**EMB**	**CS**	**EMS**	**EMB**	**CS**	**JS**	**USS**	**EMB**	**COM**	**EMS**	**EMB**	**GS**	**USS**
40.11%	31.40%	–30.83%	73.85%	4.73%	1.48%	38.36%	54.65%	28.34%	1.62%	8.37%	32.59%	–5.00%	25.83%	15.05%
EMS	**COM**	**JS**	**GS**	**GB**	**GRE**	**EMS**	**GS**	**CS**	**USS**	**EMS**	**JS**	**GRE**	**GRE**	**EMS**
33.42%	8.97%	–41.58%	40.88%	4.13%	–3.52%	33.82%	50.94%	22.17%	0.98%	6.94%	21.37%	–7.25%	23.31%	12.85%
GS	**GS**	**COM**	**EMB**	**USS**	**USS**	**EMB**	**CS**	**EMB**	**GRE**	**EMB**	**GS**	**USS**	**CS**	**GS**
22.61%	4.69%	–47.78%	37.85%	2.08%	–3.97%	32.55%	28.38%	19.50%	0.93%	6.54%	20.33%	–7.67%	21.75%	10.98%
USS	**GB**	**USS**	**GRE**	**COM**	**GS**	**GS**	**GRE**	**GS**	**GB**	**GS**	**USS**	**GS**	**JS**	**JS**
16.80%	0.23%	–48.86%	37.29%	1.78%	–12.18%	31.53%	24.97%	19.05%	0.47%	5.65%	17.14%	–11.97%	18.88%	7.85%
EMB	**USS**	**GS**	**USS**	**JS**	**JS**	**USS**	**EMS**	**EMS**	**GS**	**GRE**	**GRE**	**COM**	**EMS**	**GB**
11.00%	–0.83%	–52.94%	32.19%	1.22%	–17.22%	30.83%	19.29%	12.45%	–1.35%	3.65%	4.92%	–13.56%	16.98%	4.48%
JS	**EMB**	**GRE**	**COM**	**GS**	**COM**	**JS**	**EMB**	**JS**	**CS**	**GB**	**EMB**	**JS**	**EMB**	**EMB**
4.03%	–1.41%	–55.40%	22.11%	0.08%	–17.77%	21.06%	16.54%	10.45%	–5.92%	2.25%	4.47%	–15.43%	12.04%	1.20%
COM	**JS**	**CS**	**JS**	**EMB**	**EMS**	**COM**	**COM**	**GB**	**EMS**	**JS**	**GB**	**EMS**	**COM**	**COM**
3.04%	–10.79%	–60.33%	9.13%	–1.69%	–23.39%	11.19%	9.98%	7.30%	–13.26%	0.44%	1.32%	–16.93%	6.67%	–7.96%
GB	**GRE**	**EMS**	**GB**	**CS**	**CS**	**GB**	**GB**	**COM**	**COM**	**CS**	**COM**	**CS**	**GB**	**GRE**
–1.29%	–16.68%	–62.38%	4.45%	–7.23%	–24.82%	5.27%	–0.40%	–5.33%	–24.41%	–2.88%	–1.77%	–20.74%	5.07%	–12.70%

Best
Worst

Notes: Benchmarks represent the following asset classes: for global stocks, the MSCI All Country World Investable Market Index (IMI); for U.S. stocks, the MSCI USA IMI; for Japan stocks, the MSCI Japan IMI; for emerging-market stocks, the MSCI Emerging Markets IMI; and for China stocks, the MSCI China IMI. Commodities are represented by the Bloomberg Commodity Index, global real estate by the S&P Global REIT Index, global bonds by the Bloomberg Barclays Global Aggregate Bond Index (Yen Hedged), and emerging-market bonds by the Bloomberg Barclays Emerging Markets USD Aggregate Bond Index. All returns are in Japanese yen.

Sources: FactSet and Morningstar, Inc.

Figure A-3 *(Continued).* Annual returns for selected categories, ranked from best performance to worst

e. Euro area

- Euro-area stocks (**EAS**)
- North America stocks (**NAS**)
- Global stocks (**GS**)
- Developed Asia stocks (**DAS**)
- Emerging-market stocks (**EMS**)
- Euro bonds (**EB**)
- Hedged global bonds (**HGB**)
- Emerging-market bonds (**EMB**)
- Commodities (**COM**)
- Global real estate (**GRE**)

2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
GRE	**EMS**	**EB**	**EMS**	**GRE**	**EMB**	**GRE**	**NAS**	**GRE**	**DAS**	**NAS**	**EMS**	**EMB**	**NAS**	**NAS**
24.15%	26.46%	6.22%	77.18%	32.01%	10.55%	21.83%	25.35%	39.85%	14.54%	16.73%	20.59%	2.46%	33.43%	10.46%
EAS	**EAS**	**HGB**	**GS**	**EMS**	**HGB**	**EAS**	**EAS**	**NAS**	**EMB**	**COM**	**EAS**	**EB**	**GS**	**EMS**
23.28%	6.66%	6.04%	36.09%	28.57%	6.03%	19.56%	24.00%	27.16%	12.83%	15.11%	12.88%	0.41%	28.12%	8.97%
EMS	**GS**	**EMB**	**EMB**	**NAS**	**GRE**	**EMS**	**GS**	**EMB**	**GRE**	**EMS**	**DAS**	**GRE**	**GRE**	**DAS**
18.15%	5.45%	–10.33%	30.05%	26.01%	5.10%	17.25%	17.55%	19.30%	12.05%	13.60%	12.68%	0.03%	26.78%	6.80%
GS	**COM**	**COM**	**GRE**	**DAS**	**EB**	**EMB**	**DAS**	**GS**	**EAS**	**EMB**	**GS**	**HGB**	**EAS**	**GS**
8.68%	4.83%	–32.32%	29.52%	25.74%	3.24%	16.13%	10.73%	18.45%	10.71%	13.17%	8.57%	–1.04%	25.87%	6.13%
NAS	**HGB**	**DAS**	**EAS**	**COM**	**NAS**	**GS**	**EB**	**EMS**	**NAS**	**GS**	**NAS**	**NAS**	**DAS**	**HGB**
3.68%	3.89%	–34.06%	28.63%	24.95%	3.16%	14.63%	2.17%	12.25%	10.33%	11.23%	6.29%	–1.14%	20.79%	4.24%
DAS	**EB**	**NAS**	**NAS**	**GS**	**GS**	**DAS**	**HGB**	**EB**	**GS**	**GRE**	**HGB**	**GS**	**EMS**	**EB**
1.73%	1.45%	–34.57%	26.96%	20.99%	–6.65%	14.51%	–0.33%	11.10%	9.05%	10.10%	1.06%	–5.39%	20.27%	4.05%
HGB	**DAS**	**GS**	**DAS**	**EMB**	**DAS**	**NAS**	**GRE**	**DAS**	**EB**	**DAS**	**EB**	**COM**	**EMB**	**EAS**
1.48%	–2.20%	–38.69%	23.66%	20.68%	–10.33%	13.95%	–1.64%	10.22%	1.00%	8.34%	0.68%	–6.77%	15.19%	0.13%
EB	**NAS**	**GRE**	**COM**	**HGB**	**COM**	**EB**	**EMS**	**HGB**	**HGB**	**EAS**	**GRE**	**DAS**	**COM**	**EMB**
–0.03%	–3.13%	–42.19%	15.20%	4.70%	–10.42%	11.19%	–6.11%	7.57%	0.68%	4.27%	–4.58%	–9.04%	9.67%	–2.28%
EMB	**EMB**	**EAS**	**EB**	**EAS**	**EAS**	**HGB**	**EMB**	**EAS**	**EMS**	**EB**	**EMB**	**EMS**	**EB**	**COM**
–1.64%	–5.16%	–44.87%	6.95%	3.25%	–15.69%	5.53%	–8.27%	3.99%	–3.70%	3.32%	–4.99%	–10.41%	5.98%	–11.13%
COM	**GRE**	**EMS**	**HGB**	**EB**	**EMS**	**COM**	**COM**	**COM**	**COM**	**HGB**	**COM**	**EAS**	**HGB**	**GRE**
–8.70%	–19.85%	–51.23%	5.14%	2.18%	–16.54%	–2.58%	–13.43%	–5.49%	–16.07%	2.44%	–10.67%	–12.95%	5.10%	–15.70%

Best

Worst

Notes: Benchmarks represent the following asset classes: for euro-area stocks, the Euro STOXX Total Market Index; for global stocks, the STOXX Global Total Market Index; for North America stocks, the MSCI North America Investable Market Index; for developed Asia stocks, the FTSE All World Developed Asia Pacific Index; and for emerging-market stocks, the MSCI Emerging Markets Investable Market Index. Commodities are represented by the Bloomberg Commodity Index, global real estate by the S&P Global REIT Index, euro bonds by the Bloomberg Barclays Euro Aggregate Bond Index, hedged global bonds by the Bloomberg Barclays Global Aggregate Bond Index (EUR Hedged), and emerging-market bonds by the Bloomberg Barclays Emerging Markets USD Aggregate Bond Index. All returns are in euro.

Sources: FactSet and Morningstar, Inc.

Figure A-4. Asset-weighted expense ratios

	Active	Index	Difference
U.S. equity	0.67%	0.09%	0.59
U.S. fixed income	0.43%	0.07%	0.36
Canadian equity	0.50%	0.17%	0.33
Canadian fixed income	0.28%	0.18%	0.10
U.K. equity	0.50%	0.11%	0.39
U.K. fixed income	0.30%	0.05%	0.25
Euro area equity	0.78%	0.15%	0.63
Euro area fixed income	0.34%	0.15%	0.19
Australian equity	0.92%	0.19%	0.73
Australian fixed income	0.45%	0.19%	0.26
Japan equity	1.22%	0.14%	1.08
Japan fixed income	0.46%	0.19%	0.27

Note: Data are as of November 30, 2020, and include both open-end funds and ETFs domiciled in the various markets.

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

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