Vanguard research

Vanguard's portfolio construction framework

From investing principles
to custom portfolio solutions

Vanguard

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Summary

- Vanguard's portfolio construction framework consists of investment methodologies and portfolio tools to help investors tackle a variety of important portfolio construction decisions, from setting basic strategic asset allocation, to considering active investments and risk factor exposures, to incorporating more complex strategies such as private investments or ESG preferences.
- The framework has been "codified" into proprietary models such as the Vanguard Capital Markets Model® and the Vanguard Asset Allocation Model,[1] which enables customization of portfolios in a scalable and internally consistent manner across Vanguard multiasset offers. The framework is at the core of Vanguard's investment advice methodology, global model portfolios offer, and funds-of-funds multiasset portfolios.
- In this paper, we apply the framework to derive portfolio solutions based on several combinations of portfolio goals, preferences, and investments. We show that no one strategy is superior to the others. Rather, there are different portfolio solutions for specific investor goals and preferences.

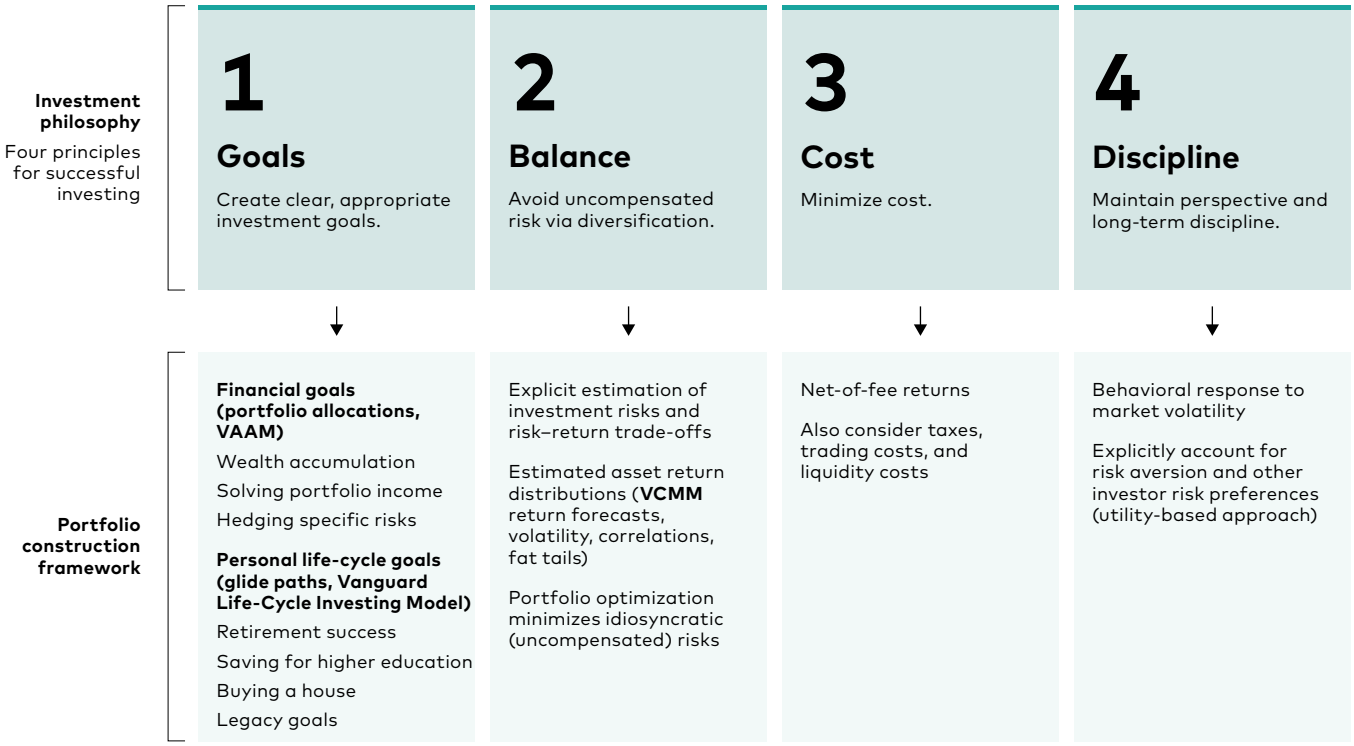
1 U.S. patent pending.

Vanguard has developed a set of investment principles that we believe are important to long-term investment success. Those are: having clear and appropriate investment **goals**, developing a suitable asset allocation using broadly diversified funds (in other words, **balance**), minimizing **costs**, and maintaining perspective and long-term **discipline**.

Vanguard's Principles for Investment Success are foundational and can manifest in a variety of ways. They are not intended to prescribe a one-size-fits-all portfolio, but rather are core tenets that should underlie the different portfolio approaches.

The portfolio construction framework presented in this paper seeks to implement these core principles into practical portfolio construction decision-making that can underpin a wide variety of investor goals, risk profiles, and investments, and enable investors to make choices in a rigorous and internally consistent way **(Figure 1)**.

FIGURE 1.
Vanguard's investment principles



Source: Vanguard.

Having clearly defined **goals** is the first step toward ensuring investment success through portfolio construction. Investment objectives fall broadly into two groups: *personal life-cycle goals*, such as retirement or higher-education funding, and broader *financial goals*, such as building wealth or achieving a certain portfolio income.

While the framework presented in this paper focuses on financial goals, personal life-cycle goals are addressed with "glide paths," or portfolios that shift allocation over time (see Aliaga-Díaz et al., 2021, for further details on our life-cycle goal-based investing framework).

Balance underscores the importance of avoiding uncompensated portfolio risks through diversification. The portfolio construction framework fulfills this principle through a rigorous quantification of investment risks for all asset classes and investment strategies. This is achieved through asset return forecasts and simulation models, such as our proprietary Vanguard Capital Markets Model (VCMM), which captures all the distributional characteristics of the asset returns.[2]

A focus on **cost** encourages prudence about investment fees and other expenses that can compound over time. Our framework accommodates investment cost considerations via net (of fees) returns and can account for more advanced cost aspects such as taxes, trading expenses, and the impact of liquidity in asset prices.

Finally, **discipline** centers on maintaining long-term perspective and avoiding emotional reactions, particularly during periods of market turmoil. A critical element in the framework is an investor's attitudes toward risk, known as investor risk aversion or, alternatively, risk tolerance. Accounting for various degrees of risk tolerance in our portfolio construction models can help investors better withstand periods of market volatility without abandoning the investment program.

In this paper, we first introduce four investment methodologies that, collectively, make up the portfolio construction framework. Second, we apply the framework to derive 14 portfolio solutions based on the most common investor goals, preferences, and available investments. In the final section, we present Vanguard's proprietary models, which constitute the quantitative foundation of our portfolio construction framework. These include the VCMM, our simulation engine for asset return and risk forecasts, and the Vanguard Asset Allocation Model (VAAM), our portfolio optimization engine.

We close with some thoughts and reflections.

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, 2021. Results from the model may vary with each use and over time. For more information, please see the Appendix section "About the Vanguard Capital Markets Model."

2 The VCMM produces more than just asset return forecasts; it also provides volatility, correlation, and other measures of investment uncertainty that play a critical role in portfolio construction.

Evolution of Vanguard investment methodologies

At Vanguard, we believe market-capitalization-weighted portfolios are the most efficient way to achieve market returns via diversified exposures at low cost. Access to the entire market for stocks and bonds can be obtained via the use of world market-cap-weighted indexes, or betas.[3]

A market-cap investment approach can also serve as a sound solution for multiasset portfolios for investors who have a general wealth accumulation goal and are not inclined to bear additional investment risk beyond the broad equity and bond markets.

This methodology might be the right solution for millions of investors. However, it is not designed to address important portfolio construction questions that extend beyond the core equity and bond betas, such as:

- **Active investing:** Investors willing to take on active risk by selecting traditional active managers need to understand how much active exposure should be added, whether it should replace the passive betas or be blended with them, and how to account for active managers' risks and factor exposures in the portfolio.
- **ESG investing:** Investors who have environmental, social, and governance (ESG) objectives need to properly account for ESG's risk exposures and to balance risk–return trade-offs across both financial aspects and nonfinancial ESG preferences.
- **Private investments and alternatives:** Investors considering illiquid private investments, such as private equity or hedge funds, need to evaluate how to join those investments with other forms of active investing and how to properly account for illiquidity risk in the portfolio.
- **Portfolio income:** Investors considering higher-yielding assets—such as high-yield or emerging-market bonds—need to understand how much to allocate to those assets to have fair odds of achieving a high-income goal while appropriately accounting for the additional risks of these exposures.
- **Inflation hedging:** Investors who seek strategic exposure to inflation-sensitive assets such as Treasury Inflation-Protected Securities (TIPS) or commodity futures must decide on strategic portfolio weights to achieve their inflation-hedging goal.
- **Time-varying market conditions:** Investors concerned about sustaining a certain level of portfolio payout, maintaining the level of volatility of the portfolio within a certain risk budget, or meeting a funding need throughout extreme market conditions, such as periods of stretched equity valuations or a low-yield environment, may need to incorporate so-called time-varying return expectations in their portfolio solution.

3 The term *beta* is conventionally used to mean many things relative to investment management. For this paper, we use it to mean asset classes that are built based on a market-cap weighting of the individual securities in the benchmark.

FIGURE 2.

A range of investment methodologies

	Investment methodologies			
Investment vehicles	**Market-cap weighted**	**Model-based strategic asset allocation (SAA)**	**Active-passive**	**Time-varying asset allocation (TVAA)**
Asset class (betas) Equity, fixed income	✓	✓	✓	✓
Sub-asset classes Fixed income factors, equity factors	×	✓	✓	✓
Other fixed income TIPS, high-yield, emerging markets (local currency)	×	✓	✓	✓
Other asset classes Liquid alternatives, commodities	×	✓	✓	×
Active investments Diversified, concentrated, ESG private investments, direct index	×	×	✓	×
VCMM return expectations	Long-run (static)	Long-run (static)	Long-run (static)	Medium-term (time-varying)

Source: Vanguard.

As described in **Figure 2**, for investors who need to go beyond the market-cap approach, there are three additional investment methodologies to consider: model-based strategic asset allocation methodology, active-passive methodology, and time-varying asset allocation methodology.

Next, we briefly explain each of them and we illustrate with portfolio examples.

Model-based strategic asset allocation (SAA): This methodology uses our proprietary models to combine broad betas with sub-asset-class tilts, such as value equities, long-term government bonds, or corporate credit indexes. This methodology extends to asset classes that fall outside the realm of equity and bond betas, such as commodity futures, TIPS (in the U.S.), or high-yield bonds. These are model-based strategic portfolios because they require explicit expectations for sub-asset-class returns, factor premia, and associated factor risks, such as the ones derived from the VCMM. The second model used, the VAAM, balances risk and return forecasts from VCMM, along with factor risk and premia, to determine the optimal allocation (or portfolio weights).

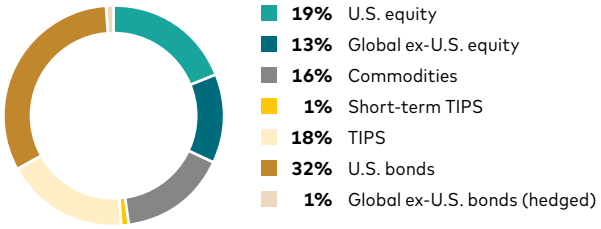
Model-based SAA methodology may also be used to meet different objectives: for instance, when hedging specific investment risks such as inflation or targeting a certain portfolio duration (i.e., portfolio sensitivity to interest rates). In those cases, the SAA portfolio derived from the VAAM may feature sub-asset-class tilts aimed at improving the odds of meeting those risk-hedging goals.

Figure 3 shows an example of an inflation-hedging portfolio compared with the standard 30% stock/70% bond market-cap-weighted portfolio. Investors who expect to fund spending from the portfolio in the near term tend to be more exposed to short-lived inflation shocks. The allocation to commodity futures and TIPS in the model-based SAA portfolio is intuitive given their inflation-hedging characteristics. However, while the inflation-hedging portfolio meets its main objective of being fully hedged to inflation (inflation beta = 1.0) relative to the market-cap-weighted portfolio, it also has higher risk in terms of higher maximum drawdown (–32.0% versus –28.6%) and probability of underperformance (42.6%) in any given year. No portfolio is better than the other across all metrics, but the inflation-hedging portfolio is the one that is most likely to meet the goal for which it was designed.

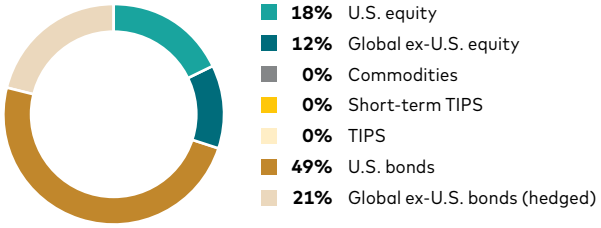
FIGURE 3.

Inflation-hedging portfolios and their risk–return trade-offs

a. Model-based inflation-hedging portfolio



b. 30/70 market-cap-weighted portfolio



c. How the two portfolios differ

	Inflation hedging	Passive market-cap-weighted
Annualized total return	3.7%	3.1%
Annualized volatility	6.2%	5.1%
Excess return	0.6%	—
Probability of underperformance	42.6%	—
Tracking error	2.9%	—
Maximum drawdown	–32.0%	–28.6%
Sharpe ratio	0.29	0.24
Inflation beta	1.00	0.06

Notes: The inflation-hedging portfolio allocations were determined by the VAAM. The assets under consideration were U.S. and non-U.S. equities and fixed income, in addition to commodity futures and TIPS because of their inflation-hedging properties. The VCMM 10-year steady-state projections as of September 2021 were used.

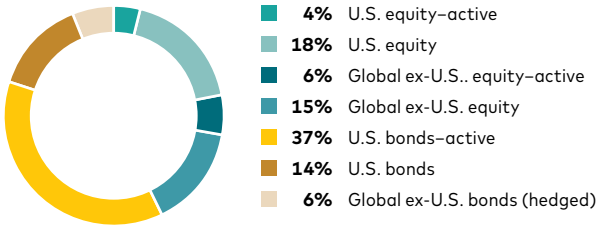
Source: Vanguard.

Active-passive methodology:
For most investors, active investing amounts to blending active with passive in the portfolio. The decision to take active risk is just another form of a risk–return trade-off in investing. Active investments offer the potential to outperform a given benchmark, but they also introduce the risk of underperformance. Vanguard's Active-Passive Decision Framework (see Wallick et al., 2017) involves explicitly quantifying expectations for both estimated outperformance (i.e., expected alpha) and active risk (i.e., tracking error and odds of underperforming the passive benchmark) and then weighing them against each other to tailor an active-passive mix, based on the investor's risk tolerance. As explained later, this methodology is built into the VAAM. It enables active-passive portfolio solutions for many flavors of active funds, from traditional active managers with different degrees of concentration (different levels of tracking error), to private asset fund managers, to rules-based "active" (nonmarket-cap) exposures such as ESG.

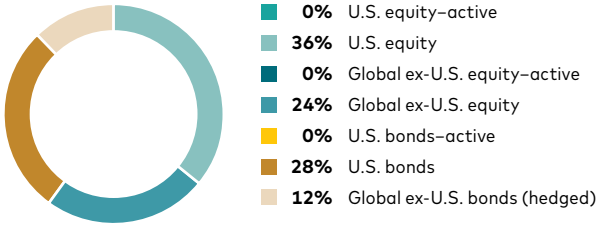
Figure 4 shows an active-passive portfolio implementation and compares it against a 60% stock/40% bond stock market-cap-weighted benchmark. The hypothetical active managers considered in this example (an active U.S. equity manager, an active U.S. core bond manager, and a global ex-U.S. active equity manager) produce a median excess return of 0.20% relative to a 60/40 market-cap portfolio and with a higher Sharpe ratio (a measure of risk-adjusted return). This comes at the expense of active risk (tracking error) of 3.4%, which translates into a 39.4% probability of underperforming the benchmark in any given year.

FIGURE 4.
Active-passive portfolios and their risk–return trade-offs

a. Active-passive portfolio



b. 60/40 market-cap-weighted portfolio



c. How the two portfolios differ

	Active/passive	Passive market-cap weighted
Annualized total return	4.1%	3.9%
Annualized volatility	7.1%	9.6%
Excess return	0.2%	—
Probability of underperformance	39.4%	—
Tracking error	3.4%	—
Maximum drawdown	–35.8%	–49.5%
Sharpe ratio	0.32	0.21

Notes: Active-passive portfolio allocations were determined by the VAAM. The active funds assumed were hypothetical and do not reflect a specific fund, as the portfolios are for illustrative purposes. The assets under consideration were indexed and active U.S. and non-U.S. equities and fixed income. The alpha and tracking error assumptions for the active funds were 1.2% alpha and 4% tracking error for U.S. equity, 1.65% alpha and 5.5% tracking error for global ex U.S. equity, and 1% alpha and 2% tracking error for U.S. bonds. VCMM 10-year steady-state projections as of September 2021 were used.
Source: Vanguard.

Time-varying asset allocation (TVAA):
This methodology is similar to the model-based SAA approach, but it uses time-varying market return expectations from the VCMM, instead of long-term static return projections.[4] These time-varying asset return expectations are the basis for potential allocation changes through time. The investment merit of using time-varying capital market assumptions in a strategic way would be clear, for instance, in the case of an investor who needs to target a certain level of return or portfolio payout in order to fund a required level of spending from the portfolio. Achieving a desired target payout through changing market conditions may require adjusting the asset allocation over time.

This is a common investment goal for institutional investors, but it can also be relevant for individual investment advice, model portfolios, and multiasset funds. TVAA methodology is appropriate for investors who are willing to take on active risk in the form of "model forecast risk." For investors whose objectives and risk tolerances make it prudent to consider adjusting their asset allocations when market conditions materially change, the VAAM, combined with time-varying VCMM asset returns, provides a consistent and holistic way to analyze the trade-offs in time-varying portfolio solutions.

Figure 5 illustrates a time-varying asset allocation corresponding to a 4% return target portfolio. By design, the expected return of this time-varying portfolio remains at or above 4% in every year. In contrast, the market-cap-weighted portfolio (a 60% stock/40% bond benchmark) falls short of this 4% threshold in September 2017 and again in September 2021. The downside of time-varying portfolios is the higher portfolio risk (both in terms of volatility and maximum drawdown) that is needed to attain the targeted return goal, especially during a low-return environment.

The Vanguard portfolio construction framework is composed of these four investment methodologies: market-cap weighting, SAA, active-passive, and TVAA. Vanguard's Strategic Asset Allocation Committee (SAAC)[5] has approved each of them for use in investment advice, model portfolios, and multiasset funds-of-funds products.

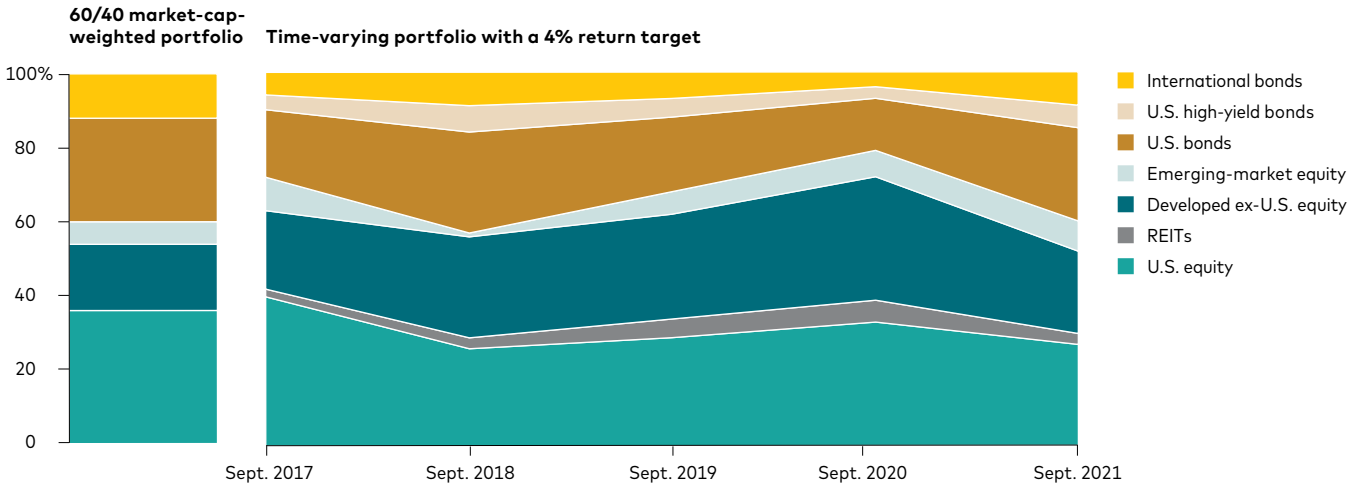
4 Our proprietary VCMM generates two types of asset return expectations (or forecasts): long-term static and medium-term time-varying. For model-based SAA portfolios, asset return expectations correspond to the very long term, and thus they are static and don't change from year to year. However, over medium-term horizons, such as 10 years, expected market returns can be heavily influenced by current market conditions and by the broader economic environment, such as stretched equity valuations, large shifts in interest rates, or entering a period of high inflation, leading to time-varying risk premia.

5 The Vanguard SAAC is a multiasset oversight committee composed of global investment leaders from across Vanguard. The SAAC is responsible for the investment methodologies behind our single-fund solutions, including Vanguard LifeStrategy® Funds, Target Retirement Funds, 529 plans, and model portfolios.

FIGURE 5.

Return target time-varying portfolios and their risk–return trade-offs

a. The time-varying portfolio hits threshold, but with a higher risk



b. How the two portfolios compare

Median portfolio statistics	Sept. 2017		Sept. 2018		Sept. 2019		Sept. 2020		Sept. 2021	
	TVAA	**MCW**	**TVAA**	**MCW**	**TVAA**	**MCW**	**TVAA**	**MCW**	**TVAA**	**MCW**
Annualized total return	4.0%	3.7%	5.2%	4.9%	5.4%	4.8%	5.8%	4.6%	4.2%	3.9%
Annualized volatility	7.6%	6.1%	8.7%	9.3%	10.5%	9.5%	12.3%	9.5%	9.6%	9.4%
Probability of meeting 4% return target	50%	42%	74%	67%	74%	66%	76%	61%	54%	49%
Probability of 10% loss or more in any given year	24%	11%	28%	38%	48%	41%	61%	43%	45%	45%
Maximum drawdown	–49.3%	–41.1%	–37.7%	–45.2%	–48.9%	–49.7%	–55.2%	–49.2%	–45.9%	–48.3%
Sharpe ratio	0.17	0.17	0.21	0.17	0.29	0.27	0.35	0.33	0.22	0.19

TVAA: time-varying asset allocation; MCW: market-cap weighted.

Notes: Time-varying portfolio allocations were determined by the VAAM. The assets under consideration were U.S. and non-U.S. equities and fixed income, in addition to real estate investment trusts (REITs), U.S. high-yield corporates, and emerging-market equity, which were used to illustrate time-varying allocation not only within equities versus fixed income, but also within sub-asset classes. VCMM 10-year projections as of September 2017, September 2018, September 2019, September 2020, and September 2021 were used.

Source: Vanguard.

From investment methodologies to portfolio solutions

The investment methodologies introduced in the previous section provide the quantitative framework for an efficient balance of assets and risks in a portfolio. However, arriving at a portfolio recommendation for an investor requires first defining the investor's specific goal. Investment methodologies such as market-cap, active-passive, and others are just a means to achieve the investor's desired goal. Different investor goals may call for different investment methodologies.

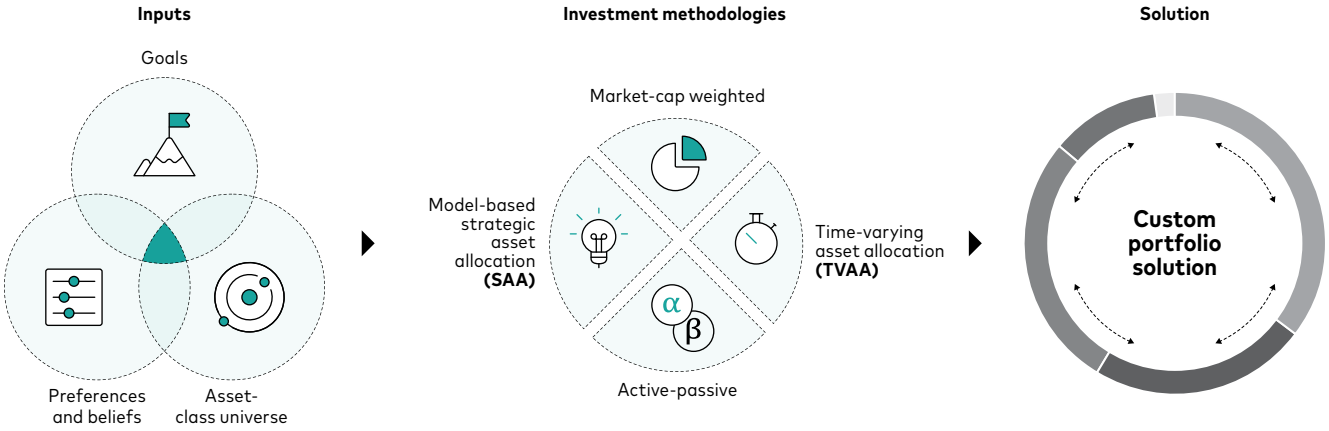
In pursuing their goals, investors may also wish to express certain investment preferences or beliefs. Examples of preferences and beliefs include ESG preferences, conviction on a selected active manager, belief in a certain factor premium, or time-varying asset return expectations. Different goals and preferences will in turn call for different asset and sub-asset classes to create the portfolio solution.

Figure 6 is a schematic of the portfolio construction process, which combines goals, preferences, available investments, and investment methodologies, all leading to a portfolio solution.

In terms of investor goals,[6] there are three common objectives that investors may desire to accomplish with portfolio construction:

- **Wealth growth:** Achieve maximum wealth growth over the long term but within the limits of a risk profile that is acceptable to the investor.
- **Risk-hedging objective:** Mitigate or control specific investment risks, such as inflation risk, portfolio duration (i.e., sensitivity to changes in interest rates), or projected portfolio volatility targets.
- **Return target objective:** Seek a certain level of portfolio payout or return target through time.

FIGURE 6.
Portfolio solutions depend on an investor's goals and preferences



Source: Vanguard.

6 As noted earlier, investor goals can be grouped into one of two broad categories: life-cycle personal goals and financial goals. Financial goals require a different type of portfolio than goals-based glide paths, since these are investment solutions that are independent of any calendar date or the investor's age. In this paper, we cover portfolio solutions that are designed to achieve financial goals.

These three types of goals, in combination with various types of investor preferences and beliefs and their corresponding investment methodologies, result in 14 possible portfolio solutions, which are depicted in a map in **Figure 7**. As shown in the portfolio solution map, there is no one-size-fits-all solution, and no one methodology dominates the others in both risk and return dimensions. Rather, each portfolio is designed to best fulfill the specific investor's goals and preferences.

Each type of portfolio recommendation in the solutions map can be further tailored to the investor's specific risk profile. This is achieved by specifying different risk tolerance settings in the VAAM. For personal advice, the risk tolerance settings may be fully personalized to match an individual investor's risk aversion. For comingled portfolio solutions, such as model portfolios or funds of funds, the risk tolerance setting may correspond to the average risk tolerance of the investor archetype for which the solution has been designed.

FIGURE 7.
Portfolio solutions map

Objectives	Investment methodologies	Portfolio solutions			
Wealth growth	Market-cap weighted	Market-cap portfolios			
	Model-based SAA	Factor premia portfolios			
	Active-passive methodology	Traditional active-passive portfolios	Private asset portfolios	ESG portfolios	Direct-indexing portfolios
	TVAA	Time-varying portfolios	Tax-efficient portfolios*		
Risk hedging	Model-based SAA	Inflation-hedging portfolios	Duration target portfolios		
	TVAA	Risk target portfolios*			
Return target	TVAA	Total return target portfolios	Income target portfolios		

Note: *Currently under research.
Source: Vanguard.

Next, we discuss in more detail each portfolio solution currently available in the Vanguard portfolio construction framework.

Wealth growth goal

The most common investment goal for investors is wealth growth or wealth accumulation. Some investors may just be looking for an efficient way to save by remaining invested in the markets. For other investors, personal life-cycle goals (such as saving for retirement or for university) may still be unclear and far into the future, so for them a wealth growth goal is a great starting point for saving for unknown future funding needs.

Because this is the broadest type of investment objective, any of the four investment methodologies can be valid approaches to achieve wealth growth. Which one should be chosen in each case? Investor preferences and beliefs, such as ESG preference, investor conviction on a given active fund or manager, belief in factor premia and risk, or preference for time-varying return expectations, play a critical role in arriving at the right choice.

Figure 8 describes the preferences and beliefs along with the corresponding asset choices for each type of portfolio solution.

The first portfolio solution for wealth growth is the market-cap-weighted portfolio. These portfolios follow our market-cap-weighted methodology, and they offer well-diversified broad exposures at low cost. They provide market-like returns with no potential for outperforming the market, but no risk of underperforming it, either. Their simplicity and low fiduciary risk can make them a great starting place for many investors with general wealth accumulation goals.

Portfolios other than the market-cap-weighted option rely on the remaining three investment methodologies: model-based SAA, active-passive, and TVAA. These nonmarket-cap portfolios all require explicit asset return forecasts (from the VCMM) and asset allocation optimization (from the VAAM). While the use of models introduces certain model risks (as listed in Figure 8), the benefits, in the form of robustness and personalization of portfolio solutions, far outweigh those potential costs to investors (as discussed below). These models include:

- **Factor premia portfolios:** Some investors believe in factor premia and wish to harvest factor premium over the long term. For such investors, factor portfolios overweight sub-asset classes such as value equities or fixed income credit, while appropriately accounting for the additional investment risks due to potential underperformance relative to the broad market.
- **Traditional active-passive portfolios:** Investors who prefer active management and are able to select skilled managers (either directly or through their professional consultants or advisors) may wish to adopt active-passive portfolios that combine their passive investments with active funds. These portfolios allow harvesting of potential alpha throughout time, while ensuring that the main asset allocation decision among stocks, bonds, and other asset classes remains appropriate (see Aliaga-Díaz et al., 2019, for a full description of traditional active-passive portfolios).

FIGURE 8.

Portfolio solutions for wealth growth goal

Portfolio solution	Investor preferences and beliefs	Asset choice	Strategy and model risk
Static			
Market-cap-weighted portfolios	✓ Broad equity and bond premia ☒ Active risk ☒ Factor risk	✓ Broad equity and bond indexes	None relative to market benchmark
Factor premia portfolios	✓ Broad equity and bond premia ✓ Factor premia and risk ☒ Active risk	✓ Broad equity and bond indexes ✓ Equity factors and styles ✓ Bond factors and styles ✓ Alts: Commodity futures, liquid alternatives	✓ Factor risk ✓ Model (long-term forecast) risk
Traditional active-passive portfolios	✓ Broad equity and bond premia ✓ Factor premia and risk ✓ Active risk and manager selection	✓ Broad equity and bond indexes ✓ Active funds ✓ Equity factors and styles ✓ Bond factors and styles ✓ Alts: Commodity futures, liquid alternatives	✓ Active risk ✓ Factor risk ✓ Model (long-term forecast) risk
Private asset portfolios (active-passive portfolios)	✓ Broad equity and bond premia ✓ Factor premia and risk ✓ Active risk and manager selection ✓ Liquidity risk premia	✓ Broad equity and bond indexes ✓ Private equity, private real assets ✓ Active funds ✓ Equity factors and styles ✓ Bond factors and styles ✓ Alts: Commodity futures, liquid alternatives	✓ Liquidity risk ✓ Active risk ✓ Factor risk ✓ Model (long-term forecast) risk
ESG portfolios (Active-passive portfolios)	✓ ESG premia or nonfinancial preference ✓ Factor premia and risk ✓ Active risk and manager selection	✓ ESG inclusionary or exclusionary	✓ ESG fund selection risk ✓ Risk in accuracy of ESG quality scores ✓ Model risk in factor exposures ✓ Risk introduced by intensity of nonfinancial ESG preference
Direct-indexing portfolios	✓ Tax-loss harvesting or ✓ Factor premia and risk or ✓ ESG premia or nonfinancial preference	See factor premia, active-passive, or ESG sections	See factor premia, active-passive, or ESG sections
Time-varying			
Time-varying portfolios	✓ Broad equity and bond premia ✓ Medium-term returns are time-varying ✓ Factor premia and risk	✓ Broad equity and bond indexes ✓ Equity factors and styles ✓ Bonds factors and styles ✓ Alts: Commodity futures, liquid alts	✓ Factor risk ✓ Model (medium-term forecast) risk
Tax-efficient portfolios	✓ Broad equity and bond premia ✓ Tax-efficient assets ✓ Factor premia and risk ☒ Active risk	✓ Broad equity and bond indexes ✓ Bonds: Muni-funds ✓ Tax-efficient sub-asset classes with different income and price-appreciation mixes	✓ Tax-efficient calculation risk ✓ Factor risk ✓ Model (medium-term forecast) risk

Source: Vanguard.

- **Private asset portfolios:** Private investments such as private equity or private real estate also introduce active risk into the portfolio. Thus, private investment portfolios are a type of active-passive portfolio. As they should with traditional (public market) active managers, investors who allocate to private investments need to select skilled managers and secure access to them. However, in addition to their active risk, some private investments may also be highly illiquid. Thus, for private investment portfolios, the active-passive portfolio construction methodology needs to be adjusted to account for the illiquidity risks (see Aliaga-Díaz, et al., 2020, for a full description of private equity portfolios).
- **ESG portfolios:** These seek to incorporate investors' ESG preferences into the portfolio while preserving risk–return efficiency. Because ESG funds, whether exclusionary or inclusionary, introduce active risk in the form of tracking error relative to the market-cap benchmark, ESG portfolios are another example of an active-passive portfolio. However, while traditional active investments are expected to produce alpha outperformance as a compensation for their active risk, ESG investments may or may not be expected to outperform their market-cap benchmark. Thus, for ESG portfolios, the active-passive methodology needs to be adjusted to account for the role of "nonpecuniary" ESG motivations and the extent to which investors are willing to exchange financial outcomes for ESG objectives (see Renzi-Ricci, Grim, and Madamba, 2022 [forthcoming], for a full description of ESG portfolios).
- **Direct-indexing portfolios:** These give investors access to all the advantages of a personalized equity index in the context of a holistic portfolio solution. Direct indexing can benefit investors by enhancing the gains from tax-loss harvesting strategies and enabling highly personalized ESG filters, as well as through tailored factor investing strategies. However, by construction, the security-level customization of direct-indexing investments introduces tracking error relative to the broad public benchmarks. Thus, direct indexing entails active risk in the portfolio; direct-indexing portfolios are another special case of active-passive investment methodologies implemented via the VAAM. Just like an allocation to traditional active managers in an active-passive blend, the VAAM helps determine the optimal allocation between a direct-indexing "active" strategy and a passive one (see Khang et al., 2022, for a full description of direct-indexing portfolios).

- **Time-varying portfolios:** These portfolios tap an additional source of potential outperformance relative to a static benchmark. Investors who believe in the medium-term predictability (typically 10-year horizons) of VCMM returns, and are willing to take on active risk in the form of forecast risk, may invest in time-varying portfolios. Relative and absolute constraints are also normally added to have reasonable levels of portfolio diversification. Constraints around the risk budget (e.g., volatility bounds) can be added to limit swings in risk exposures over time. Vanguard time-varying portfolios differ from other industry tactical asset allocation (TAA) approaches that follow short-term tactical bets based on discretionary market calls. Vanguard's TVAA methodology is model-based, which means that it's a systematic and repeatable process, as opposed to being discretionary. Also, the TVAA methodology is based on VCMM predictability of asset returns over the medium term (10-year forecasts), in contrast to the very short-term nature of most TAA approaches. Finally, our model-based time-varying framework carefully discounts model forecast risk in a holistic distributional setting (as opposed to relying on precise point forecasts). We discuss benefits and limitations of time-varying return expectations and asset return forecasting models in the next section (see Wallick et al., 2020, and Zhang et al., 2021, for a full description of time-varying portfolios).
- **Tax-efficient portfolios:** These are designed for high-net-worth investors who are primarily focused on an after-tax return risk-efficient portfolio, because they may have limited tax-sheltered shelf space. These portfolios fall within the TVAA because they rely on VCMM return expectations over the medium term and are adjusted by estimated tax effects. In this case, sub-asset-class tilts may result from differences in after-tax returns across sub-asset classes.

Risk hedging

Risk hedging is another type of financial goal, in which an investor is more concerned about insulating the portfolio from certain investment risks, such as inflation risk, interest rate risk, or unexpected bouts of market volatility (see **Figure 9**). For certain investors, risk hedging could be more important than seeking long-term wealth growth (which could be a secondary objective).

The portfolio solutions include:

- **Inflation-hedging portfolios:** These are strategic portfolios designed for inflation-hedging purposes. They seek to immunize investors against loss in real inflation-adjusted value. This is achieved by gaining exposure to assets with high sensitivity to inflation (high inflation beta[7]), such as TIPS, inflation-sensitive sectors of the stock market, or commodity futures. While these assets may outperform the broader stock and bond betas during rising inflation regimes, they may underperform when inflation subsides, so on average the inflation-hedging portfolio may not necessarily outperform a traditional market-cap benchmark (see Aliaga-Díaz and Maciulis, 2018, for a description of the trade-offs in strategic inflation-hedging portfolios). Inflation-hedging portfolios follow a model-based SAA methodology in combination with a minimum inflation beta constraint in the VAAM optimization.
- **Duration target portfolios:** Duration risk (also known as interest rate risk) refers to the return sensitivity of an asset or portfolio to movements in interest rates. Portfolio duration risk can be managed by over- or underweighting different sectors of the fixed income market, and possibly even limiting exposure to segments of the equity market more affected by interest rates, such as growth stocks. The resulting duration tilts in the portfolio are not designed for outperformance purposes. Duration-hedged portfolios follow a model-based SAA methodology in combination with a maximum portfolio duration constraint in the VAAM optimization.
- **Risk target portfolios[8]:** The objective of a risk target strategy, a strategy that is based on the TVAA methodology, is to maintain portfolio volatility below a specific level by shifting the asset allocation toward more conservative assets during periods of high market volatility and moving it back to benchmark allocation as volatility decreases to normal levels. While the risk target portfolio is time-varying, it does not seek to outperform a static benchmark. This contrasts with the time-varying portfolios constructed for wealth-growth purposes. The risk target portfolio follows a TVAA methodology in combination with a maximum portfolio volatility constraint in the VAAM optimization and requires volatility to be modeled stochastically.

7 A common mistake in building inflation-hedged portfolios is to focus on assets that exhibit high correlation to inflation. However, the concept of inflation beta is the appropriate metric to consider in immunizing a portfolio against inflation shocks. The inflation beta measures the percent move in the asset when inflation increases by 1%. For instance, TIPS have a high correlation to inflation, but a beta of 1. Commodity futures, on the other hand, may have a similarly high correlation to inflation as TIPS but a much higher beta, in excess of 2 (albeit with more volatility).

8 This portfolio approach is currently in the research-and-development stage and not ready to be implemented in actual client portfolios.

FIGURE 9.

Portfolio solutions for risk hedging

Portfolio solution	Investor preferences and beliefs	Asset choice	Strategy and model risk
Static			
Inflation hedging	✓ Inflation protection of portfolio ✓ Largely believe in broad equity and bond premia	✓ Broad equity and bond indexes ✓ Inflation-sensitive assets like short-term TIPS, commodity futures, inflation-sensitive sectors of stock market, etc.	✓ Risk of underperformance in absence of inflation shock ✓ Assets like commodity futures can have wide dispersion of outcomes (long cycles) ✓ Model (long-term forecast) risk
Duration target	✓ Limiting interest rate sensitivity of portfolio ✓ Comfortable giving up term premia ✓ Largely believe in broad equity and bond premia	✓ Broad equity and bond indexes ✓ Bond factors and styles ✓ Equity factors and styles	✓ Factor risk ✓ Model (long-term forecast) risk
Time-varying			
Risk target	✓ Sensitive to portfolio "risk" – risk = volatility or drawdown risk ✓ Focus is on projected risk control	✓ Bond factors and styles ✓ Equity factors and styles ✓ VIX ✓ Derivatives ✓ Portfolio leverage	✓ Risk of underperformance ✓ Model (short-term stochastic volatility and correlation forecast) risk

Source: Vanguard.

Return target

A third type of financial goal is a medium-term return target, which can be used, for example, to fulfill recurring spending needs. Examples of these portfolios are:

- **Total return target portfolios:** In this portfolio, a minimum expected return constraint is established in the VAAM asset allocation process, along with relaxing risk budget constraints. This is especially relevant in the current low-return environment, in which ensuring a reasonable chance of achieving the targeted return objective requires taking on more risk. In other words, additional risk and variation in allocation may be needed to meet the return target goal. However, the optimization involved in the target return portfolio follows a cautious and efficient risk-taking approach in pursuit of that return target goal. (Refer to Wallick et al., 2020, for further details.)
- **Income target portfolios:** This variation of target return portfolios specifically targets portfolio income or yield over a long horizon. Because of mental accounting behavioral bias in investing, many investors equate portfolio spending with portfolio income. By using the VAAM in combination with TVAA methodology, we impose a minimum income target, but without ignoring the portfolio total return in optimizing for risk–return efficiency. In this way, these portfolios offer a good compromise between high-income behavioral bias and overall portfolio efficiency (a total-return approach). (Refer to Schlanger, O'Connor, and Ahluwalia, 2021, for further details.)

FIGURE 10.

Portfolio solutions for return target

Portfolio solution	Investor preferences and beliefs	Asset choice	Strategy and model risk
Time-varying			
Total return target portfolios	✓ Target a required rate of return ✓ Medium-term returns are time-varying ✓ Factor premia and risk	✓ Broad equity and bond indexes ✓ Bond factors and styles ✓ Equity factors and styles	✓ Factor risk ✓ Model (medium-term forecast) risk
Income target portfolios	✓ Target a required rate of portfolio income ✓ Medium-term returns are time-varying ✓ Factor premia and risk	✓ Broad equity and bond indexes ✓ Bond factors and styles ✓ Equity factors and styles	✓ Factor risk ✓ Model (medium-term forecast) risk

Source: Vanguard.

Vanguard proprietary models for portfolio construction

Vanguard's proprietary portfolio construction models are the quantitative foundation of Vanguard's portfolio construction framework. Two models used in tandem are the VCMM, our simulation engine for asset return and risk forecasts, and the VAAM, our portfolio optimization engine.

VCMM and the role of asset return expectations in portfolio construction

Asset return forecasts (or capital market assumptions) always play a critical role in portfolio construction, either implicitly or explicitly. In the case of "model-free" portfolios such as the 60/40 market-cap-weighted portfolio, the asset return assumptions are implicit in the asset allocation recommendation. For model-based portfolios, the asset return forecasts are an explicit input in the asset allocation process.

The VCMM is our proprietary statistical engine for estimating asset class expected returns, volatilities, correlations, and other statistical distributional properties of asset returns.[9]

Asset return distributions, not just asset return point forecasts, are the main output from the VCMM and the key input in portfolio construction.[10] Since portfolio construction can be defined as the practice of investing amid uncertainty, it's necessary to go beyond asset return point forecasts in order to properly capture the role of uncertainty and the benefits of portfolio diversification. Thus, portfolio construction uses the full range of VCMM statistical return distributions, including return volatility and correlations, in addition to the long-term average (or expected) returns.

Important features of the VCMM return forecast include:

- A probabilistic or distributional framework.
- Reliance on key economic and market valuation forecasting signals proven to work better at medium- and long-term horizons. Short-term forecasting is extremely difficult and very inaccurate.
- The context that medium-term return projections are sensitive to initial conditions; over the medium term, expected returns depend on initial valuations such as price-earnings ratios and interest rate levels.
- Reliance on forward-looking equilibrium assumptions for certain economic or market drivers, such as long-run inflation, productivity growth, currency trends, and central bank neutral policy rates. The VCMM incorporates long-term forward-looking equilibrium views based on inputs from Vanguard's Global Economics team.
- Allowance for nonnormal distribution, featuring a higher probability of tail events than a normal distribution would suggest.

For a detailed overview of the VCMM, refer to Davis et al. (2014) and Davis et al. (2022).

9 The VCMM also estimates higher-order moments for the return distributions of all asset classes, such as kurtosis or "fat tails," as it allows for departures from the standard normal distribution assumptions.

10 Portfolio construction is the science of investing under uncertainty. If we didn't care about the uncertainty part, and we just focused on the point forecasts, then a portfolio wouldn't be needed. With point forecasts, the best recommendation would be to allocate 100% to the asset with the highest forecasted return. However, most investors care about uncertainty, and forecasting models are never infallible. Hence, all moments of the return distribution are equally important for portfolios.

The VCMM can produce asset and sub-asset-class return forecasts at different time horizons. Specifically, the two sets of VCMM forecasts generally used in our portfolios are long-term forecasts (30 years or more), and medium-term forecasts (typically 10 years). Long-term VCMM forecasts reflect equilibrium of the global capital markets (or steady-state returns), and thus those return expectations (and their bell curves) are essentially constant and don't change over time. (See **Figure 11** for a summary of all VCMM steady-state equilibrium asset return forecasts.) Medium-term VCMM forecasts differ from their long-term counterparts in that return expectations may change over time, as market conditions change, making them time-varying.

Time-varying expected returns and portfolio implications

Medium-term asset return forecasts (i.e., the full distribution of returns) can change with the market environment, such as periods of extreme equity market valuations, large and persistent shifts in interest rates, or high-inflation regimes, to name a few market drivers. As discussed previously, for certain financial goals such as portfolio payout or income targets, it may be appropriate to consider time-varying asset return forecasts.

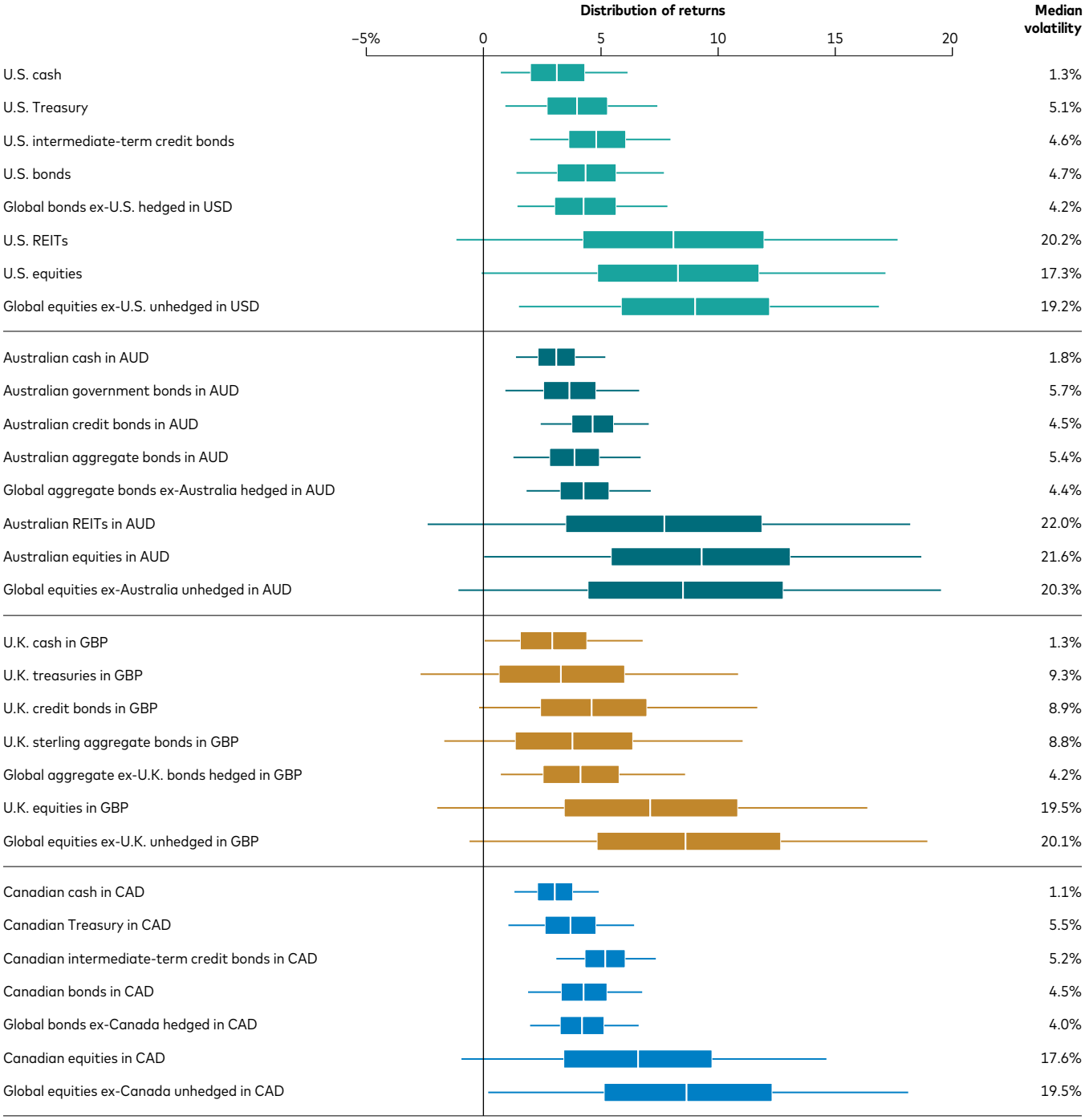
Time-varying expected returns has been an area of intense study by academics over the last three decades, giving rise to what Cochrane (1999) terms the "new facts in finance" (NFF).

Cochrane effectively compares asset return forecasting to a coin flip and to the weather. Under the traditional view, return forecasts are like a coin flip—with each flip, the probabilities of a given outcome are the same, 50/50, which means that the outcome is completely unpredictable. The weather, by contrast, changes over time, with the expected temperature in the summer quite different from that in the winter.

Cochrane's NFF suggests that, just as no one will know exactly what the temperature will be tomorrow but can expect certain ranges based on the season, there are "seasons" to stock returns, and our expectations of returns will differ over time based on current conditions. As a result, time-varying expected returns do not occur over the short term and perfectly, but rather over the longer term and directionally (see Wallick et al., 2020).

FIGURE 11.

Distribution of returns in VCMM

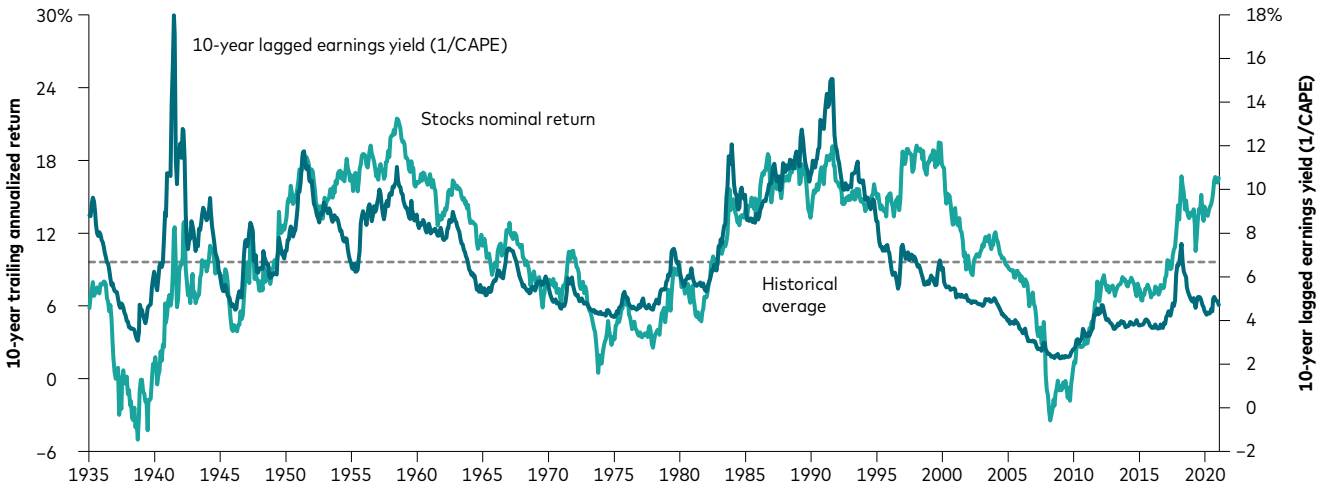


Note: The 10-year annualized returns are based on 10,000 VCMM simulations in steady state, as of September 2021.
Source: Vanguard.

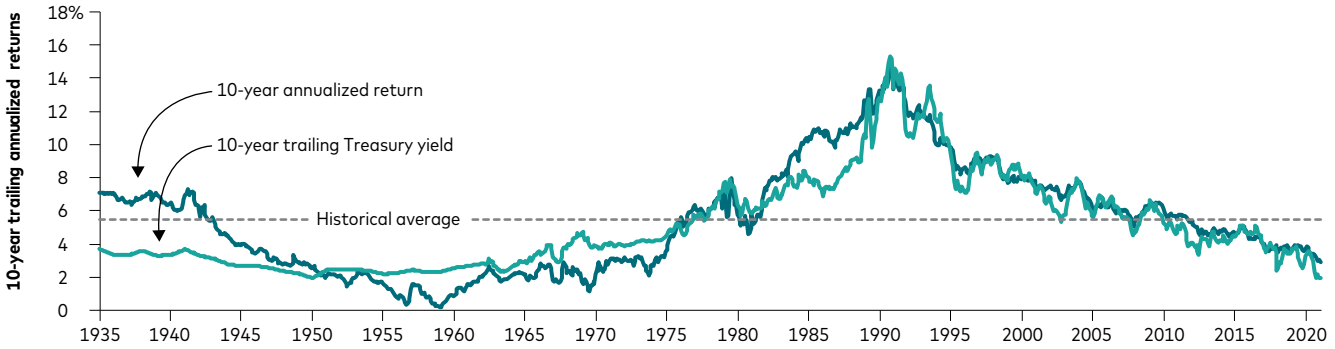
As shown in **Figure 12a** and **Figure 12b**, the average annual return since 1926 for U.S. equities has been 9.8% and for U.S. bonds, 5.5%. However, the market performances over rolling 10-year periods have historically oscillated anywhere between –5% and 20% for stocks and between 0% and about 14% for bonds. Return variability across extended periods such as the Great Depression, the mid-1960s through 1970s, and 1999 to 2009 can significantly reduce the odds of successfully achieving investment goals for investors who have medium-term investment horizons (typically 10-year horizons) and have a portfolio payout goal.

FIGURE 12.
Medium-term (10-year) returns are time-varying

a. Returns for U.S. stocks



b. Returns for U.S. fixed income

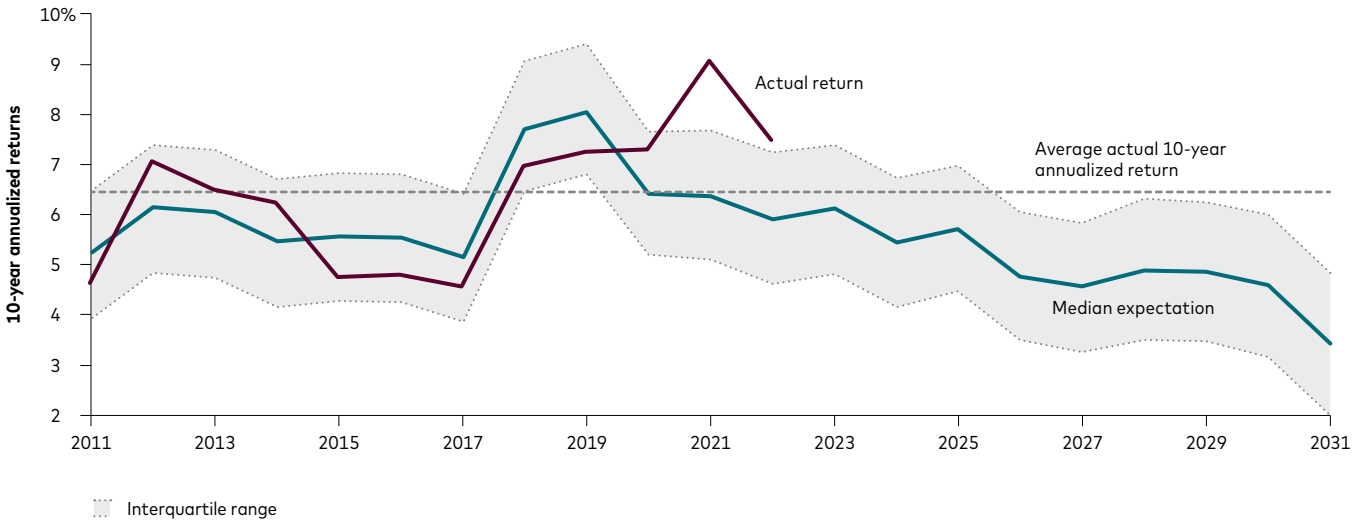


Notes: U.S. stock returns are represented by the Standard & Poor's 500 Index. U.S. fixed income returns are represented by the Standard & Poor's High Grade Corporate Index from 1926 to 1968, the Citigroup High Grade Index from 1969 to 1972, the Lehman U.S. Long Credit Aa Index from 1973 to 1975, and the Bloomberg U.S. Aggregate Bond Index thereafter. Earnings yield is represented by 1/CAPE and 10-year Treasury yields are represented by the Long Interest Rates, both from Robert Shiller. Return data are from 1926 to 2021, with the first 10-year return period starting in 1935.

Sources: Vanguard calculations, based on data from FactSet and Robert Shiller's website, at www.econ.yale.edu/~shiller/data.htm.

Figure 13 illustrates VCMM 10-year annualized return forecasts for a 60% stock/40% bond portfolio. Actual returns have largely fallen within the VCMM's 25th–75th percentile range, showcasing the imperfect, yet reasonable, accuracy of the model. Importantly, neither the projections nor the actual returns for this portfolio have been constant over the last decade.

FIGURE 13.
VCMM time-varying forecasts



Notes: The chart shows the actual 10-year annualized return of a 60/40 stock/bond portfolio compared with the VCMM forecast for the same portfolio made 10 years earlier. For example, the 2011 data point at the beginning of the chart shows the actual return for the 10-year periods 2001–2011 (dark red line) compared with the 10-year return forecast made in 2001 (dark green line). After 2021, the dark green line is extended to show how our forecasts made between 2012 and 2021 (ending between 2022 and 2031) are evolving. The interquartile range represents the area between the 25th and 75th percentile of the return distribution. The portfolio is 36% U.S. stocks, 24% international stocks, 28% U.S. bonds, and 12% international bonds.

Source: Vanguard calculations, as of May 31, 2022, using data from MSCI and Bloomberg. **Past performance is no guarantee of future returns. The performance of an index is not an exact representation of any particular investment as you cannot invest directly in an index.**

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 December 31, 2000, and September 30, 2021. Results from the model may vary with each use and over time. For more information, please see the "important information" section.

VAAM and model-based portfolio construction

There are several dimensions to consider when constructing a portfolio around an investor's financial goals: the type of financial goal, the assets to be considered, the investment horizon, asset return expectations, and the investor's appetite for financial risk.

Model-free approaches may yield very reasonable portfolios when no more than two or three asset classes are considered. However, for more complex portfolios with numerous asset and sub-asset classes, the simpler mental math of the model-free portfolio gives way to more complex accounting, and it becomes necessary to rely on a model that can keep track of multiple estimates for average returns, volatilities, and their correlations.

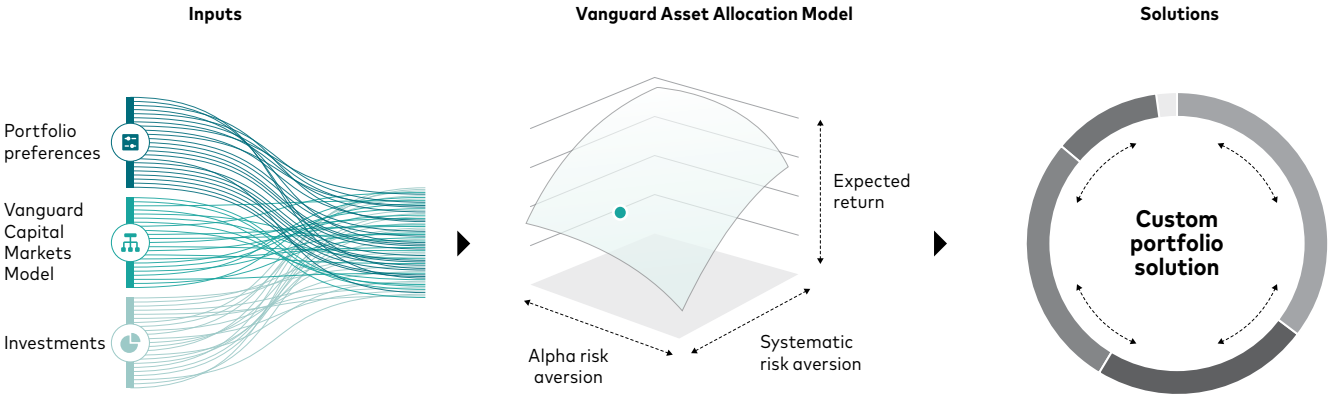
To account for all these dimensions simultaneously in portfolio optimization, Vanguard's Investment Strategy Group has created an asset allocation engine called the Vanguard Asset Allocation Model. This model uses a utility-driven representation of investor outcomes to maximize investors' chances of achieving their financial goals, conditional on their risk tolerance.

One of the main benefits of a utility-based approach[11] is that it explicitly takes into account investors' tolerance for risk, including different types of risk, such as active manager risk, factor risk, and illiquidity risk. The VAAM is constructed to simultaneously optimize asset allocation solutions among key elements—asset class, sub-asset class, and active investments. This way, the VAAM can implement both model-based SAA and active-passive methodologies. Additionally, by using the VCMM time-varying forecasts over medium-term horizons, the VAAM can also accomplish TVAA methodologies.

Figure 14 illustrates how the VAAM embodies the overall portfolio construction process.

The process begins with establishing an investor goal, along with its corresponding investment horizon, investor preferences, and risk tolerances. Next, the set of eligible investments is defined, and can include asset classes, sub-asset classes including factors, and actively managed products. Distributions of asset returns from the VCMM are an input for each eligible asset. VCMM distributions include asset return volatility, and correlations, in addition to return expectations. The VAAM is then able to weigh the trade-offs between the potential benefits and risks of each investment while considering the investor's risk tolerance via the utility-driven optimization.

FIGURE 14.
VAAM-based portfolio construction process



Source: Vanguard.

11 In the context of portfolio construction, utility functions are mathematical representations of an investor's attitude toward investment risk. The utility function captures the trade-off any investor faces in balancing the desire for higher portfolio returns with the increased risk that comes with it. Utility functions are widely used in finance, and they're increasingly adopted by investment professionals and practitioners to build more complex portfolios.

There are four key benefits to using the VAAM.

First, by directly leveraging VCMM simulations, the VAAM "inherits" some important VCMM features, such as sensitivity to current market conditions, forward-looking capital market equilibrium assumptions, nonnormal distributions, and important linkages between asset returns and macroeconomic fundamentals.

Second, the model codifies Vanguard's portfolio construction framework into a digital technology platform. This allows for full customization of portfolios to specific client financial goals and needs, while at the same time enabling scalability in mass service offerings through technology implementations and ensuring consistency of the underlying investment methodology across the different portfolio solutions. Customization, scalability, and consistency of portfolio recommendations are critical in building investment advice offers.

Third, from a portfolio due-diligence and fiduciary risk perspective, using the VAAM injects more transparency into the portfolio construction process. Whether the model is used on an advice platform or in investment committees, this added transparency leads to more straightforward oversight and review processes for portfolio recommendations. After all, the model's methodological underpinnings are based on well-established theories in the academic literature on portfolio choice and household finance.

Fourth, the VAAM forces investors to think through many decisions that they may otherwise make in a subconscious or implicit way if they are selecting portfolio allocations in an ad hoc manner. The input requirements in the VAAM enable a conversation between investors and advisors about the conscious and explicit choices that must be made and that are critical to the portfolio. These topics include setting realistic alpha expectations for the active strategies under consideration, selecting the best estimates for the associated alpha risk, and even reconsidering the investor's own risk aversion.

Conclusion

The expanding universe of investments beyond traditional market-cap-weighted bond and stock indexes, as well as the need for portfolio customization in advice settings, has significantly increased the complexity of portfolio construction. Market-cap-weighted investment methodology and its standard stock/bond portfolio recommendation continue to be valid for millions of investors who seek market performance at low cost and who have no appetite for risk beyond equity premium and interest rate risk.

For many other investors who need to extend beyond the broad equity and bond betas building blocks, additional investment methodologies are required.

The portfolio construction framework introduces three additional methodologies along with the traditional market-cap-weighted approach: model-based strategic asset allocation, active-passive, and time-varying asset allocation. Collectively, these four methodologies can help investors make all sorts of portfolio construction decisions, from setting basic strategic asset allocation, to considering active investments and risk factor exposures, to contemplating more complex strategies such as incorporating illiquid private investments or ESG preferences.

The portfolio construction framework has been codified into proprietary models such as the VCMM and the VAAM. This allows portfolios to be tailored to a variety of investor goals, preferences and beliefs, risk tolerances, and market environments in a scalable and internally consistent manner across Vanguard multiasset offers.

In this paper, we applied the framework to derive several portfolio solutions based on different combinations of portfolio goals, preferences, and available investments. We showed that no one strategy is superior to the others, and that there is no one-size-fits-all portfolio. Rather, there are different portfolio solutions for specific investor goals and preferences.

We derived 14 types of portfolio solutions that cover the most common investor financial goals. These portfolio solutions can serve as the asset allocation shell to be filled with actual funds or ETFs. They are the base of Vanguard's investment advice methodology, our global model portfolios offer, and Vanguard's funds-of-funds multiasset portfolios.

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Appendix

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 primary investment research and advice teams. 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 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 from as early as 1960. 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.

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