Vanguard

Vanguard research

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Vanguard's approach to model portfolios: From investment principles to scalable solutions

- **Model portfolios enable advisors to scale their practices by simplifying investment implementation.** By reducing the time spent on day-to-day portfolio management, model portfolios create capacity for financial planning, behavioral coaching, and client relationships, helping advisors provide the greatest value to clients.
- **Every portfolio starts with a clear investment objective.** Vanguard applies four enduring investment principles—goals, balance, cost, and discipline—across a broad range of portfolio solutions, from market-capitalization-weighted portfolios to custom models.
- **Our research-driven investment process guides every portfolio.** Capital markets research, portfolio construction tools, manager oversight, and governance work together to turn investment principles into well-informed decisions across a range of investor needs.

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A disciplined process behind every portfolio

Model portfolios are designed to help advisors deliver a consistent investment experience at scale. Behind every portfolio is a series of decisions about investor objectives, asset allocation, investment selection, risk management, implementation, and ongoing oversight. A disciplined investment process not only supports portfolio outcomes but also provides a foundation for advisors to focus on the planning, guidance, and client support that are central to the advisory relationship.

As portfolios evolve to address different investor needs, a shared investment foundation becomes increasingly important. Vanguard translates a common set of principles into a broad range of portfolio solutions. Whether a portfolio is market-cap-weighted, active-passive, dynamic, income-focused, or tax-efficient, each begins with clear objectives and is supported by thoughtful construction, implementation, and oversight, as detailed in **Figure 1**.

This approach makes portfolio construction systematic and repeatable. Decisions are grounded in investment objectives, research, and shared oversight rather than relying on any one viewpoint or short-term market movements. Vanguard can therefore support a broad range of portfolios while maintaining common investment and governance standards.

Model portfolios support the broader value of advice

Investment management is only one component of the value advisors deliver. Vanguard research has shown that advisors can create meaningful value through financial planning, behavioral coaching, implementing tax-aware approaches, and helping clients stay disciplined through changing market environments.

By providing a disciplined and repeatable foundation for portfolio implementation and oversight, model portfolios can create more capacity for financial and wealth planning, behavioral coaching, tax-aware guidance, and client relationships. Viewed through the lens of Vanguard Advisor's Alpha®, model portfolios are not simply investment solutions. They are tools that can help advisors spend less time on day-to-day portfolio management and more time helping clients establish appropriate plans, maintain discipline, and pursue their long-term goals.

FIGURE 1

Vanguard's investment foundation

Layer	Role in the investment process
Investment philosophy	The principles that guide portfolio decisions.
Capital markets research	The insights and assumptions used to assess risk, return, and market opportunities.
Portfolio construction	The process used to build portfolios that align with investor objectives.
Portfolio implementation	The funds, ETFs, and strategies used to put the portfolio into action.
Governance and oversight	The framework for reviewing decisions and maintaining portfolio integrity.
Ongoing monitoring	Evaluation of portfolio performance and risk, including whether changes are needed.

Source: Vanguard.

Vanguard's approach to model portfolio construction

Our investment principles: Goals, balance, cost, and discipline

Every Vanguard model portfolio is built on four enduring investment principles: goals, balance, cost, and discipline.[1] These principles serve as the foundation for every portfolio decision, helping ensure that portfolios remain aligned with investor objectives while providing a consistent framework for portfolio construction, implementation, and oversight, as shown in **Figure 2**.

Goals. Every portfolio starts with investment goals. Whether they are focused on long-term growth, income, capital preservation, retirement, or tax efficiency, these goals shape a portfolio's design and define how success should be measured.

Balance. Balance is about aligning risk with the objective. Diversification helps investors participate in market opportunities while managing risk by combining investments that serve different roles within the portfolio rather than relying on a single source of return.

Cost. While investors can't control the markets, they do have some control over what they pay. In addition to taxes, costs can include expense ratios, trading expenses, liquidity, and implementation complexity. Each investment decision should offer an expected benefit that justifies its cost.

Discipline. Adhering to an investment plan helps keep portfolios aligned with their objectives through changing market environments. Our structured process for monitoring, reviewing, and making decisions helps ensure portfolio decisions are driven by long-term goals rather than short-term market noise.

Together, these principles create a consistent foundation for portfolio construction. They help translate investor goals into portfolio decisions through a disciplined process, allowing Vanguard to deliver a broad range of portfolio solutions while maintaining a common investment philosophy and approach to risk management.

FIGURE 2

From investment principles to portfolio solutions

Investment principle and philosophy		Role in portfolio construction
Goals	Create clear, appropriate investment goals.	Defining goals, in both financial and personal terms.
Balance	Avoid uncompensated risk through diversification.	Assessing investment risk, correlations, and risk premiums to optimize the portfolio.
Cost	Minimize cost.	Considering fees and taxes that affect investor outcomes.
Discipline	Maintain perspective and long-term discipline.	Matching the investor's portfolio with their risk profile and accounting for behavioral insights.

Model-based investment methodologies: Scalable • Internally consistent • Customizable

Source: Vanguard.

1 For more information about these principles, see Vanguard (2023).

How we turn investment principles into portfolio solutions

The investment principles that provide the foundation for a portfolio must be translated into decisions in a consistent and repeatable way. At Vanguard, we do this through a research-based portfolio construction framework that can be applied across a broad range of portfolio solutions. Whether an investor's objective is long-term growth, income, tax efficiency, active exposure, or a dynamic asset allocation, the same disciplined process is used to align goals with portfolio design, implementation, and oversight.

The process begins with the investor objective, then turns to the relevant investment opportunities, expected risks and returns, portfolio constraints, and implementation considerations. Rather than considering these factors in isolation, evaluating them together helps ensure that portfolios remain aligned with their intended purpose.

To support this process, Vanguard uses a set of research and portfolio construction tools developed from decades of investment research and practical portfolio management experience. These tools help our team evaluate potential investment outcomes, assess trade-offs, and apply portfolio decisions consistently across a broad range of solutions.

The Vanguard Capital Markets Model®

The Vanguard Capital Markets Model (VCMM) helps estimate a range of possible future market outcomes rather than predict a single result. It combines historical relationships with current conditions, including equity valuations and interest rates, to model the drivers of long-term asset returns. A simulation engine then generates a distribution of possible returns, volatility, and correlations across global asset classes rather than relying on a single forecast.

These distributions help our portfolio construction team understand both the potential reward and uncertainty associated with each investment opportunity. For example, the VCMM can show not only the expected return for an asset class but also the range of possible outcomes, how widely those outcomes may vary, and how the asset may interact with other investments. This forward-looking view helps inform portfolio decisions while recognizing that uncertainty is an inherent part of investing.

The Vanguard Asset Allocation Model

The Vanguard Asset Allocation Model (VAAM) helps translate VCMM projections into portfolio decisions. The VAAM takes the forward-looking assumptions generated by the VCMM and combines them with the portfolio's objective, risk preference, investment horizon, eligible investments, costs, and practical constraints. The VAAM then evaluates a broad range of potential portfolios to identify allocations that provide the most appropriate balance between expected risk and reward for the intended objective. In practice, the VAAM supports our team in assessing trade-offs and building portfolios deliberately.[2]

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 the VCMM are derived from 10,000 simulations for each modeled asset class. Results from the model may vary with each use and over time. For more information, please see "About the Vanguard Capital Markets Model" on page 14.

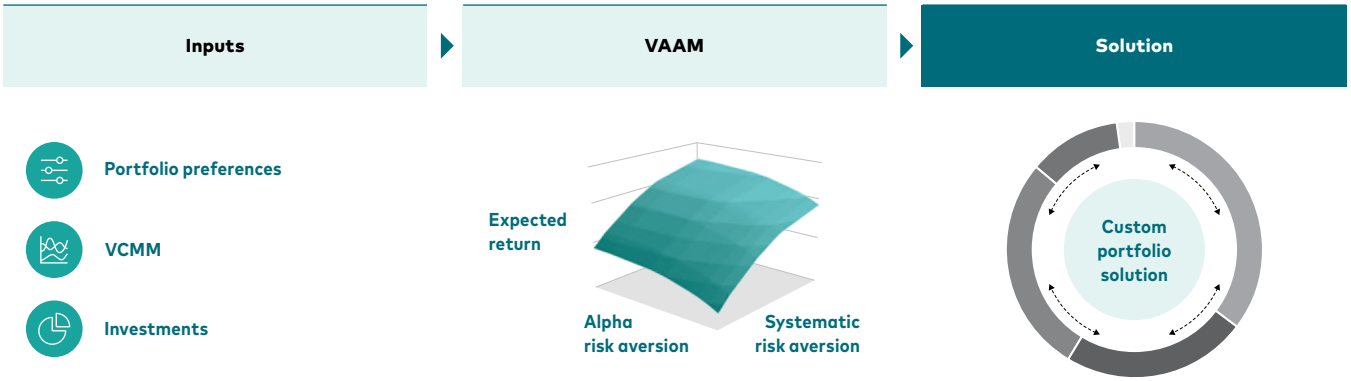
2 For long-term, goal-based asset allocations such as custom glide paths, Vanguard uses the Vanguard Life-Cycle Investing Model (VLCM). For more information about the VLCM, see page 16 as well as Aliaga-Díaz, Rayfield, Daga, and Dinerstein (2025).

The VAAM can evaluate active, passive, and factor-based investments together, taking expected alpha and active risk into consideration alongside systematic and factor exposures. This means that asset allocation and active-passive implementation can be assessed as part of the same portfolio decision rather than through separate, sequential steps. The resulting recommendation is not simply the portfolio with the highest expected return, but the portfolio that best balances expected growth, uncertainty, cost, and the risk of falling short, subject to the portfolio's constraints.

Together, the VCMM and the VAAM provide a consistent foundation for portfolio decisions, as shown in **Figure 3**. The VCMM describes the range of potential market outcomes, and the VAAM evaluates how investments can be combined to support the portfolio objective. These models do not replace investment judgment. Rather, they provide a consistent, transparent framework for assessing trade-offs and making informed portfolio decisions across a broad range of client needs.[3]

FIGURE 3

How we use the VCMM and the VAAM in the portfolio construction process



Our financial simulation engine includes:

- Capital market assumptions for 100+ assets and sub-asset classes
- Global coverage and multiple currencies
- Monte Carlo simulations
- Medium- and long-term forecasts
- Macro and market drivers
- Non-normality (tail risks)

Our portfolio optimization engine considers:

- All properties of the VCMM
- Risk-based allocation: beta, factor premia, alpha
- Investor risk profiles: systematic, active, and liquidity risk
- Dynamic and strategic asset allocation
- Active investments and private assets

Source: Vanguard.

3 For more information about the VAAM, see page 15 as well as Aliaga-Díaz, Renzi-Ricci, Ahluwalia, Nikpour, and Sathe (2024).

Incorporating investor preferences and portfolio constraints

No two investors are exactly alike. While some investors prioritize long-term growth, others may place greater emphasis on income, capital preservation, tax efficiency, or liquidity. Portfolio construction is therefore not simply about maximizing returns. It is about building a portfolio that aligns with an investor's goals, risk tolerance, time horizon, and preferences.

These considerations are an essential part of portfolio design. Risk tolerance helps determine the level of risk a portfolio should take, while income needs, tax circumstances, liquidity requirements, and investment restrictions shape how a portfolio is implemented. Investor priorities vary, and portfolio design should reflect those needs.

By incorporating these preferences directly into portfolio construction, Vanguard can align portfolios with both market opportunities and investor needs. The result is a portfolio that is easier to understand and more closely aligned with the outcomes it is intended to support.

Manager selection and fund evaluation

When allocating to active strategies, the decision begins with where active management has the potential to improve the total portfolio. The opportunity set may span equities and fixed income, U.S. and international markets, and individual market segments based on factors such as market structure, the availability of skilled managers, expected alpha, active risk, cost, and diversification potential. Vanguard therefore evaluates active management relative to the role each exposure is intended to play, rather than applying the same active-passive approach across every market.

Vanguard's manager selection process, outlined in **Figure 4**, draws on dedicated expertise in manager oversight and search, product research, and portfolio construction. The manager oversight and search team evaluates investment managers and helps curate the eligible manager universe. The product research team contributes forward-looking assumptions on active manager performance, including expected alpha and tracking error. These inputs are considered alongside the portfolio's objectives, risk profile, and implementation needs to determine the appropriate mix of active and passive exposures. The resulting decision reflects manager quality, investment rationale, business considerations, and overall portfolio suitability.

FIGURE 4

The manager selection process for active strategies

Decision	Question	Purpose
Identify and evaluate managers	Which managers demonstrate a durable and repeatable investment edge?	Combining continuous market coverage with quantitative and qualitative research.
Design the active exposure	Should the exposure use a standalone manager or a complementary combination of managers?	Diversifying sources of active return and managing overlap in factors, style, and active risk.
Determine the active exposure	How much active management should the total portfolio use?	Integrating expected alpha, active risk, cost, and portfolio fit into the asset allocation.
Monitor the investment thesis	Does the manager continue to demonstrate the characteristics that supported the original selection?	Evaluating whether the manager remains appropriate for their intended portfolio role.

Source: Vanguard.

Identify and evaluate managers. Where active management is appropriate, the search for managers is continuous rather than tied solely to an immediate portfolio need. Continually assessing the manager universe allows us to identify and evaluate potential candidates over time through quantitative screening, portfolio and performance analysis, manager meetings, and broader due diligence. This longer-term perspective, involving both quantitative and qualitative evaluation, can provide a deeper understanding of a manager's organization, investment capabilities, and potential sources of investment edge.

Design the active exposure. Active strategies are then evaluated within the context of the full portfolio. In some asset classes, multiple managers may be combined to diversify sources of active return. In others, a standalone manager may provide the more appropriate exposure. The analysis considers how each manager's expected alpha, market sensitivity, factor exposures, tracking error, cost, and implementation characteristics interact with other active and passive holdings. This helps determine whether managers are complementary or create unnecessary overlap.

Determine the active exposure. The next decision is how much active exposure to use. Active and passive implementation choices are considered within the broader asset allocation so that active exposure is purposeful, appropriately sized, and aligned with the total portfolio objective. This integrated approach allows expected manager value and active risk to influence the asset allocation itself rather than being added as an implementation decision after the allocation has already been established.

Monitor the investment thesis. Manager evaluation continues after implementation. Ongoing oversight assesses whether the investment team, philosophy, process, portfolio, and performance remain consistent with the original investment thesis. Material changes are evaluated to determine whether conviction in the strategy remains intact and whether the strategy continues to fulfill its intended role in the portfolio.

Model portfolio solutions

Vanguard's model portfolio framework can support a broad range of investor needs through different, but connected, portfolio design decisions. **Figure 5** organizes the available approaches according to their primary role: establishing the asset allocation approach, defining the investor objective, selecting how the portfolio is implemented, and customizing an underlying methodology. These categories are not mutually exclusive; a single portfolio solution may incorporate elements from each.

Market-cap-weighted portfolios. These portfolios provide broad, low-cost exposure to global markets through a simple, transparent approach. They are often a natural starting point for investors seeking diversified market participation without relying on active manager selection or tactical market views. The primary benefit of a market-cap-weighted approach is efficient access to broad market exposure.

FIGURE 5

Vanguard's model portfolio solutions

Primary design dimension	Portfolio approach	Investor need	How it works	What to consider
Asset allocation approach	**Market-cap-weighted**	Broad market exposure	Tracking broad market benchmarks	Diversification, rebalancing, and cost
	Strategic	Long-term portfolio structure	Maintaining long-term target allocations	Risk, diversification, and portfolio guidelines
	Dynamic	Ability to respond to changing market opportunities	Using time-varying asset allocation to adjust allocations within defined guardrails	Market starting point, risk, turnover, and governance
	Glide-path	Alignment of risk with the investment horizon	Adjusting allocations over time	Time horizon, spending needs, and timing of gains and losses
Investor objective	**Income-target and return-target**	Support for a specific income or return goal	Building around a desired outcome	Income, total return, downside risk, and sustainability
Investment implementation	**Active-passive**	Combination of broad market exposure and selected active strategies	Blending active and passive management	Manager potential, cost, diversification, and active risk
	Tax-aware	Improved after-tax outcomes	Incorporating taxes into portfolio decisions	Turnover, capital gains, asset location, and after-tax outcomes
	Public-private	Combination of public and private investments	Evaluating private assets within the total portfolio	Liquidity, valuation, manager selection, and funding needs
Customization approach	**Custom models**	Support for specific advisor preferences	Customizing within defined guardrails	Active preferences, portfolio tilts, home-market bias, product selection, and taxes

Source: Vanguard.

Strategic portfolios. These portfolios are built around long-term asset allocation targets designed to support an investor's goals through a variety of market environments. Strategic portfolios are intended to remain relatively stable over time, with periodic rebalancing and review. This approach may be well suited for investors who prioritize a disciplined long-term allocation over responding to shorter-term market changes.

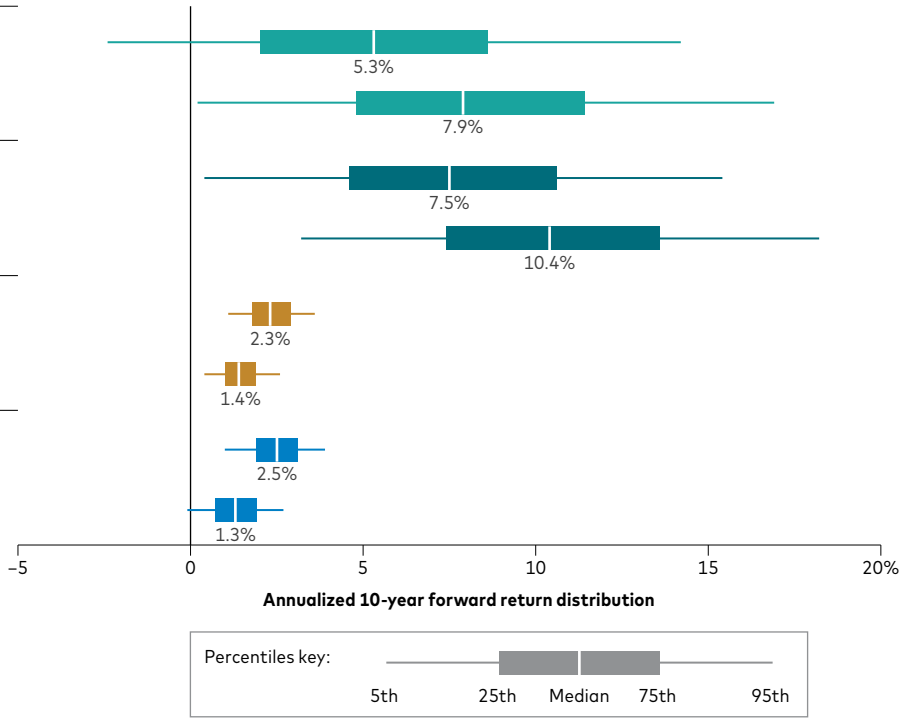
Dynamic portfolios. These portfolios use time-varying asset allocation (TVAA) methodology to adjust allocations as market opportunities and risks evolve. Unlike tactical asset allocation (TAA), which focuses on the very near term, TVAA adjustments are driven by changes in expected risk and return trade-offs and implemented within defined risk and governance parameters. The goal is to adapt thoughtfully to changing market conditions while maintaining a disciplined investment process.[4]

Rather than reacting to recent declines, dynamic portfolios are designed to respond to changes in the forward-looking opportunity set. The COVID-19 market shock provides a useful example, as shown in **Figure 6**. As equity valuations reset in early 2020, forward-looking equity return expectations improved while expected bond returns worsened amid interest rate cuts. For a dynamic portfolio, such a shift could support a more constructive view of equity risk despite the difficult market environment.

FIGURE 6

Comparison of VCMM projections during the COVID-19 market shock

Asset class	Period	Median volatility
U.S. equities	Q4 2019	**16.0%**
	Q1 2020	**16.5%**
Global ex-U.S. equities (USD unhedged)	Q4 2019	**19.7%**
	Q1 2020	**20.5%**
U.S. aggregate bonds	Q4 2019	**5.2%**
	Q1 2020	**4.3%**
Global aggregate bonds (USD hedged)	Q4 2019	**4.0%**
	Q1 2020	**3.6%**



Source: Vanguard.

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 are as of December 31, 2019, and March 31, 2020. Results from the model may vary with each use and over time. For more information, please see "About the Vanguard Capital Markets Model" on page 14.

4 For more information about Vanguard's approach to TVAA, see Schlanger, Aliaga-Díaz, Li, and Ahluwalia (2024).

Glide paths. These portfolios evolve as an investor's time horizon changes. Commonly used for retirement and other long-term goals, glide paths typically weigh growth potential and risk differently at various stages of the investment journey. The objective is to align the portfolio with changing investor needs over time.

Income-target and return-target portfolios. These portfolios are designed around a specific investment outcome. Whether the objective is to generate a certain amount of income or to achieve a target return, the portfolio seeks to balance that goal with appropriate diversification and risk management. The focus is not simply on maximizing yield or return, but on achieving the desired outcome in a sustainable way.

Active-passive portfolios. These portfolios combine broad market exposure with carefully selected active strategies. The objective is to retain diversification and cost efficiency while seeking opportunities for active managers to add value. With active-passive portfolios, key decisions include where active management has the strongest potential to add value and how much active risk is appropriate.

Tax-aware portfolios. These portfolios incorporate tax considerations directly into portfolio construction and implementation by evaluating after-tax outcomes, including tax-equivalent yield, capital gains exposure, portfolio turnover, municipal bond exposure, asset location, and other implementation considerations. The objective is to improve after-tax investor outcomes while maintaining an appropriate risk and return profile. This approach requires balancing investment opportunities with factors such as portfolio turnover, asset location, and tax impact.[5]

Public-private portfolios. These portfolios combine traditional public-market investments with private assets to seek differentiated sources of return and diversification. Private assets may offer additional opportunities, but they also introduce considerations about liquidity, transparency, and implementation. With this approach, the role of private assets is evaluated within the broader portfolio rather than as a standalone allocation.[6]

Custom models. These approaches provide greater flexibility to reflect specific advisor preferences, such as active or passive implementation, portfolio tilts, home-market bias, product selection, or tax considerations. Customizations are made within defined risk and governance guardrails, helping advisors meet clients where they are while keeping portfolios aligned with investor objectives.

5 For more information about tax-aware portfolio construction, see Zilbering, Zhu, Banis, and Ahluwalia (2025).

6 For more information about incorporating private assets into a portfolio, see Grim, Daga, Rocha, and Abousaeedi (2026).

Governance and oversight

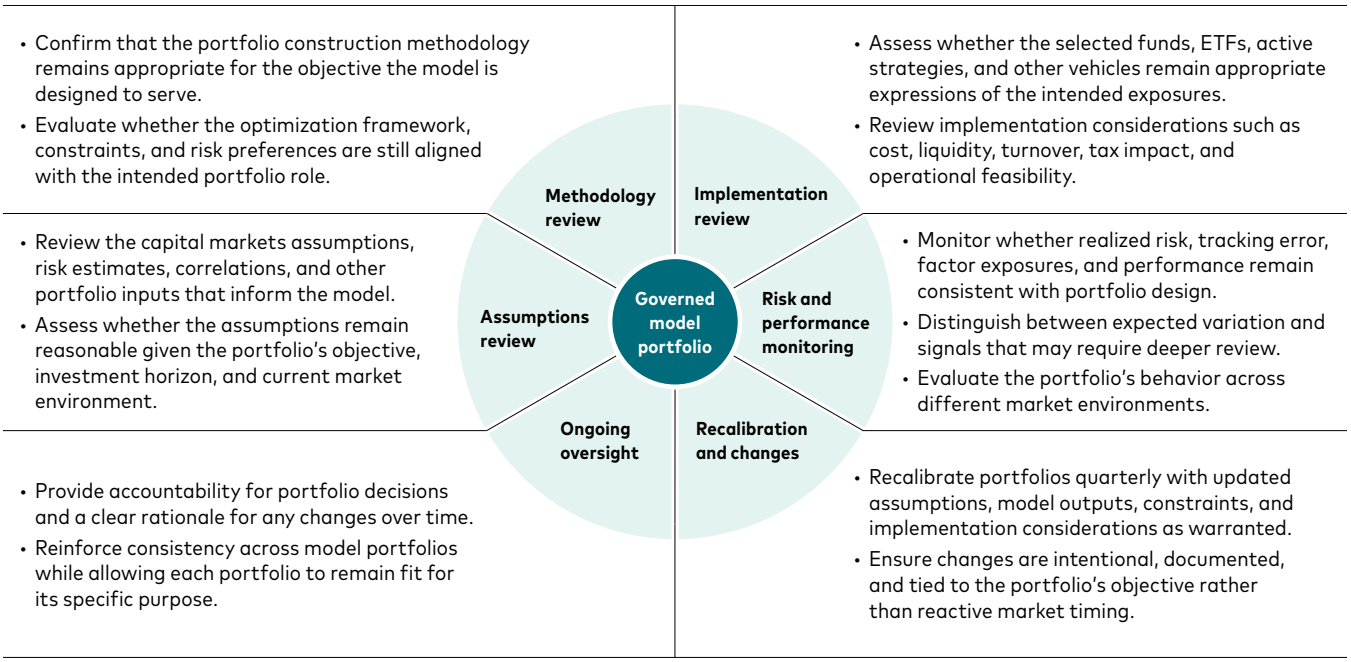
Governance is an essential part of the investment process because portfolio construction involves assumptions, trade-offs, and decisions that must be evaluated over time. Model portfolios at Vanguard are supported by a robust oversight framework, outlined in **Figure 7**, that includes investment committees, portfolio managers, risk professionals, and subject matter experts who regularly review portfolio assumptions, methodology, positioning, performance, and risk exposures.

This oversight helps keep portfolios aligned with their objectives as markets and investor needs evolve. It also provides accountability, helping confirm that changes are supported by research, portfolio methodology, and documented review rather than short-term market noise or a single viewpoint.

For advisors, governance provides confidence that portfolios are not simply built and left alone. Rather, they are regularly reviewed through a structured process designed to assess risks, evaluate opportunities, and maintain alignment with long-term investor objectives. The result is transparent portfolio management supported by rigorous investment and risk oversight.

FIGURE 7

Vanguard's governance framework for model portfolios



Source: Vanguard.

The value of model portfolios

The value of model portfolios can be summarized in three words: scale, clarity, and discipline.

- **Scale.** Model portfolios help advisors serve a wider range of client needs without rebuilding portfolios for every relationship.
- **Clarity.** A common investment approach makes portfolios easier to understand, explain, and monitor.
- **Discipline.** Portfolio decisions remain grounded in research, governance, and long-term objectives rather than short-term market reactions.

Ultimately, the value of a model portfolio goes beyond implementation efficiency. It provides a bridge between investment research and portfolio management, helping advisors deliver a disciplined investment experience while maintaining the flexibility to address different client goals, preferences, and circumstances. As portfolios become increasingly personalized, a strong framework helps ensure that greater customization does not come at the expense of investment rigor or governance.

Conclusion

Model portfolios are designed to turn investment principles into practical portfolio solutions. Although investor needs differ, each portfolio should begin with a clear objective and be supported by thoughtful construction, implementation, and oversight. This approach helps advisors serve a broad range of clients without sacrificing investment discipline.

Looking ahead, advances in technology, data, and AI may help strengthen portfolio analytics, expand personalization, and better connect portfolio design with implementation and monitoring. The opportunity is not simply to create more types of portfolios, but to deliver solutions better tailored to investor preferences while preserving the investment rigor and governance that support long-term outcomes.

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Appendix

About the Vanguard Capital Markets Model

IMPORTANT: The projections and other information generated by the Vanguard Capital Markets Model (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. 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 importantly, the VCMM may be underestimating extreme negative scenarios unobserved in the historical period on which the model estimation is based.

The VCMM 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, U.S. municipal bonds, 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 time. Forecasts represent the distribution of geometric returns over different time horizons. Results produced by the tool will vary with each use and over time.

Indexes for VCMM simulations

The long-term returns of our hypothetical portfolios are based on data for the appropriate market indexes. We chose these benchmarks to provide the most complete history possible, and we apportioned the global allocations to align with Vanguard's guidance in constructing diversified portfolios.

Asset classes and their representative forecast indexes are as follows:

- **U.S. equities:** MSCI US Broad Market Index.
- **Global ex-U.S. equities:** MSCI All Country World ex USA Index.
- **U.S. aggregate bonds:** Bloomberg U.S. Aggregate Bond Index.
- **Global ex-U.S. aggregate bonds:** Bloomberg Global Aggregate ex-USD Index.

The Vanguard Asset Allocation Model

The Vanguard Asset Allocation Model (VAAM) is a portfolio construction tool that translates return and risk forecasts into allocations reflecting investor objectives, preferences, and guidelines. It compares portfolios that meet those guidelines and helps identify an allocation aligned with the objective.

Like any model, the VAAM has its assumptions, limitations, and measurement imprecisions. It relies on VCMM forecasts, which are based on historical data but also include forward-looking return assumptions and assumptions about asset-class risk characteristics. The accuracy of these VCMM forecasts, and thus the optimal weights the VAAM calculates, can be compromised if historical data do not accurately predict future conditions. Additionally, the factor decomposition used to estimate factor-adjusted alpha and tracking error is prone to estimation errors, leading to parameter uncertainty.

The VAAM offers a simplified representation of reality and may not capture the complex decision-making processes of every investor. It assumes a universal power utility function for all investors (shown below), which, despite its common acceptance, might not accurately reflect every attitude toward risk and expected wealth. Furthermore, the VAAM uses an algorithm to determine optimal portfolio weights, a stochastic method that introduces randomness and potential variability in the results. Despite these limitations, the VAAM provides a valuable framework for addressing multidimensional asset allocation challenges involving systematic, alpha, and factor risks.

The mathematics of the VAAM's expected utility maximization

The VAAM uses a power utility function to model an investor's preferences and attitude toward risk:

$$U(W_T) = \begin{cases} \frac{W_T^{1-\gamma}}{1-\gamma} & , \gamma > 1 \\ \ln(W_T) & , \gamma = 1 \end{cases}$$

Here, γ is the relative risk aversion (RRA) coefficient and W_T is the level of terminal wealth relative to starting wealth.

Consider an investor facing the portfolio choice problem presented in investing their wealth over a particular investment horizon. Wealth will compound in each period at the total multiasset portfolio return R_t:

$$R_t = \sum_{i=1}^{N} x_i r_{i,t} = \sum_{i=1}^{N} x_i^p r_{i,t}^p + \sum_{i=1}^{N} \sum_{f=1}^{F} x_i^f r_{i,t}^f + \sum_{i=1}^{N} x_i^a r_{i,t}^a$$

$$\begin{cases} r_{i,t}^p = r_{i,t}^M \\ r_{i,t}^f = r_{i,t}^M + \delta_{i,t}^f \\ r_{i,t}^a = \alpha_i + \beta_i r_{i,t}^M + \sum_{f=1}^{F} L_i^f \delta_{i,t}^f + \varepsilon_{i,t} \qquad \varepsilon_{i,t} \sim t(v)\sqrt{\sigma_{a_i}^2} \end{cases}$$

Here, x_i and r_i are the portfolio weights and relative total returns for each asset class i, and superscripts p, f, and a refer to passive, factor, and active, respectively. The market benchmark return is represented by $r_{i,t}^M$, $\delta_{i,t}^f$ is the excess (to the market benchmark) factor return for factor f, and β_i and L_i correspond to the market beta and factor loading for each asset class, respectively. α_i is the net (that is, factor-adjusted) excess active return.

The portfolio choice problem consists of finding optimal weights for each passive asset class, factor, or active manager or strategy in the portfolio. We then express the utility-based optimization problem that we want to solve for as:

$$\max_x \mathbb{E}\left[U\left(\frac{W_T}{W_0}\right)\right] \longrightarrow \max_x \left\{\mathbb{E}\left[\frac{W_p^{1-\gamma_p}}{1-\gamma_p}\right] + \mathbb{E}\left[\frac{W_f^{1-\gamma_f}}{1-\gamma_f}\right] + \mathbb{E}\left[\frac{W_a^{1-\gamma_a}}{1-\gamma_a}\right]\right\}$$

$$s.t.\ \{x_i \in \mathbb{R} \mid 0 \le x_i \le 1\} \wedge \sum_i x_i = 1$$

$$\sum_i C \cdot x_i \le b$$

Here, W_p, W_f, and W_a are the wealth at maturity coming from systematic, factor, and factor-adjusted alpha exposures, respectively; γ_p, γ_f, and γ_a are the systematic, factor, and alpha risk aversions, respectively; and C and b refer to the set of linear inequality constraints.

The Vanguard Life-Cycle Investing Model

The Vanguard Life-Cycle Investing Model (VLCM) is designed to identify the product design that represents the best investment solution for a theoretical, representative investor who uses target-date funds to accumulate wealth for retirement. The VLCM generates an optimal custom glide path for a participant population by assessing the trade-offs between the expected (median) wealth accumulation and the uncertainty about that wealth outcome, for thousands of potential glide paths. The VLCM does this by combining two sets of inputs: the asset-class return projections from the VCMM and the average characteristics of the participant population. Along with the optimal custom glide path, the VLCM generates a wide range of portfolio metrics such as a distribution of potential wealth accumulation outcomes, risk and return distributions for the asset allocation, and probability of ruin, such as the odds of participants depleting their wealth by age 95.

The VLCM inherits the distributional forecasting framework of the VCMM and applies to it the calculation of wealth outcomes from any given portfolio.

The most impactful drivers of glide-path changes within the VLCM tend to be risk aversion, the presence of a defined benefit plan, retirement age, savings rate, and starting compensation. The VLCM chooses among glide paths by scoring them according to the utility function described and choosing the one with the highest score. The VLCM does not optimize the levels of spending and contribution rates. Rather, the VLCM optimizes the glide path for a given customizable level of spending, growth rate of contributions, and other plan sponsor characteristics.

A full dynamic stochastic life-cycle model, including optimization of a savings strategy and dynamic spending in retirement, is beyond the scope of this framework.

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