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The rebalancing edge: Optimizing target-date fund rebalancing through threshold-based strategies

- Target-date funds (TDFs) are professionally managed multiasset portfolios designed to have a suitable amount of growth assets and defensive assets for investors saving for retirement. TDFs can differ in various dimensions such as glide-path construction, sub-asset allocation, and rebalancing methodology.
- In this paper we focus on rebalancing approaches—monthly, quarterly, and threshold-based—commonly used by TDF providers. We propose an optimal rebalancing policy that is focused on helping improve long-term investor outcomes by balancing the tradeoff between transaction costs and deviation from the target asset allocation over time.
- For a 60% stock/40% bond portfolio (a "60/40" portfolio), Vanguard's threshold-based rebalancing methodology is expected to generate higher annual returns relative to calendar-based rebalancing approaches due to reduced transaction costs. Similarly, allocation deviations over a 1-year period are lower for threshold-based rebalancing compared with calendar-based approaches, resulting in better risk control.
- For a TDF investor, the expected annual benefit of a threshold-based rebalancing policy is 15–22 basis points (bps) during accumulation years and 22–25 bps during decumulation years compared with a monthly rebalancing approach, and 5–8 bps during accumulation years and 6–10 bps during decumulation years compared with quarterly rebalancing. (A basis point is one-hundredth of a percentage point.)

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Introduction to target-date funds

Target-date funds (TDFs) are professionally managed multiasset portfolios designed to provide retirement savers with a suitable amount of risky and defensive assets based on their time horizon, retirement goals, and other considerations. TDFs are widely adopted in employer-sponsored 401(k) plans as well as IRAs. The investment design and management of TDFs differ in a variety of ways, including the risk level of the glide path, the allocation to sub-asset classes, and the rebalancing methodology.

Previous research detailing Vanguard's approach to TDFs (Daga et al., 2022) discusses our design methodology, including our approach to glide-path construction and sub-asset allocation. In this paper we focus on common rebalancing approaches—monthly, quarterly, and threshold-based—used by various TDF providers, and we expand on previous Vanguard research with a focus on how threshold-based rebalancing can help generate higher returns compared with calendar-based approaches.

Why rebalancing matters

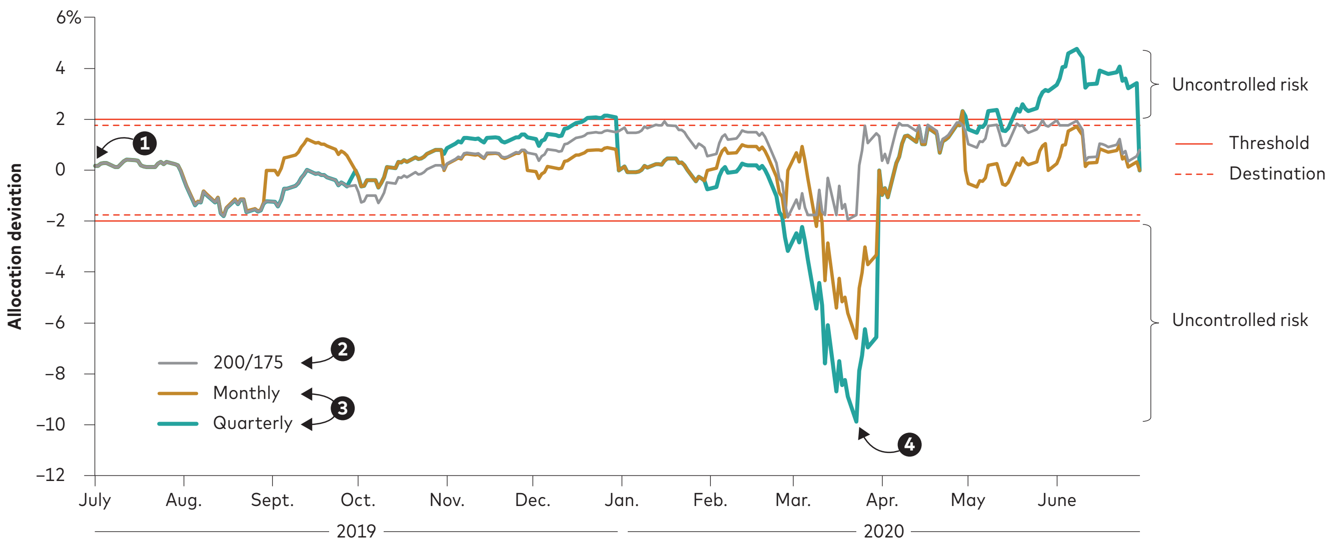
The primary function of portfolio rebalancing is to keep portfolio risk in alignment with the fund's target risk exposure. Without rebalancing, over time portfolio allocations drift from their intended target as the returns of the underlying assets diverge, which is expected among equities and fixed income investments. While numerous portfolio rebalancing strategies can be used, two approaches are most common in the TDF industry:

1. **Calendar-based rebalancing:** In this approach, portfolios are rebalanced back to their target allocation at predetermined intervals, usually monthly or quarterly. A 60/40 portfolio with monthly rebalancing, for instance, is rebalanced back to the 60% stock/40% bond target at the end of each month no matter how much drift has occurred. Calendar-based rebalancing is prevalent among TDF providers due to its ease of implementation, but it can be susceptible to periods of heightened volatility in a given interval, which can lead to large allocation drifts. This approach can also require larger trades, leading to higher transaction costs.
2. **Threshold-based rebalancing:** In this approach, portfolios are monitored daily and rebalanced when the asset allocation has drifted from the target by a predetermined threshold, such as 100 or 200 bps. Unlike a calendar-based approach, this approach allows asset allocations to drift within a controlled range. When the threshold is triggered, the asset allocations are rebalanced back to a set destination point, which could be the target allocation itself or a point between the target and the threshold. For example, for a 60/40 portfolio with "200/175" rebalancing—a threshold of 200 bps and a destination of 175 bps—breaching a threshold of 62% equities (200 bps from the target allocation) leads to a rebalancing to the destination of 61.75% (175 bps from target allocation). Selecting a destination closer to the threshold can help reduce the size of rebalancing trades and lower the associated transaction costs relative to other approaches. Based on our analysis, the need for daily monitoring is well worth the advantages in long-term investment outcomes.

To demonstrate how these two approaches work, in **Figure 1** we show asset allocation deviations of a hypothetical 60/40 portfolio during the market volatility seen at the onset of the COVID-19 pandemic in March 2020. With monthly rebalancing, the portfolio could have drifted up to 7% from its target allocation, while with quarterly rebalancing it could have drifted up to 10% from the target. With a 200/175 threshold-based approach, the portfolio would have never drifted by more than about 2%. This historical example shows how 200/175 threshold-based rebalancing can better manage a portfolio's allocation deviations and risk control relative to its strategic asset allocation.

FIGURE 1

Calendar-based versus threshold-based rebalancing around March 2020



1. The initial allocation consists of 60% stocks and 40% bonds.
2. Threshold rebalancing is monitored daily. The deviation will not move more than 2% from target.
3. Under calendar-based rebalancing, the allocation can drift significantly from the target between rebalancing events.
4. On March 23, 2020, the allocation deviation would have been as large as 7% for monthly rebalancing and 10% for quarterly rebalancing.

Notes: This chart is for illustrative purposes only and is not indicative of any specific investment. It is based on a hypothetical 60% global equity and 40% global fixed income portfolio using daily returns from July 1, 2019, to June 30, 2020. The analysis assumes no cash flows or use of futures. U.S. equities are represented by the CRSP US Total Market Index (36%), non-U.S. equities by the FTSE Global All Cap ex US Index (24%), U.S. bonds by the Bloomberg U.S. Aggregate Float Adjusted Index (28%), and non-U.S. bonds by the Bloomberg Global Aggregate ex-USD Float-Adjusted RIC Capped USD Hedged Index (12%).

Source: Vanguard.

Past performance is not a 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.

Vanguard's approach to TDF rebalancing

The goal of Vanguard's TDF rebalancing policy is to provide investors with the best long-term retirement outcomes. Minimizing transaction costs, which are a drag on returns, helps achieve this, as does limiting risk from large allocation drifts between rebalancing events. While any number of thresholds could be used for rebalancing TDFs, our research has shown that a threshold of 200 bps is suitable across vintages (Vanguard, 2024). Our research has also determined that a destination of 175 bps results in further transaction cost savings compared with other destinations.

Our research consists of three parts, as illustrated in **Figure 2**. In the first part, we outline our model for forecasting returns and transaction costs, as described in Zhang and Ahluwalia (2024). The second part compares monthly and quarterly rebalancing with our 200/175 threshold-based approach, with a focus on transaction costs, returns, the overall benefit to investors, and allocation deviation analytics. In the third part, we take a deeper dive into why we chose the 200/175 approach over other threshold/destination combinations.

FIGURE 2

Three steps to evaluating different rebalancing strategies

STEP 1	STEP 2	STEP 3
Inputs	**Insights**	**Threshold and destination selection**
• Asset return forecasts • Transaction cost estimates	• Transaction costs • Expected returns • Overall benefit • Risk control	• Test combinations • Threshold: 200 bps • Destination: 175 bps

Source: Vanguard.

The inputs to our forecasting model

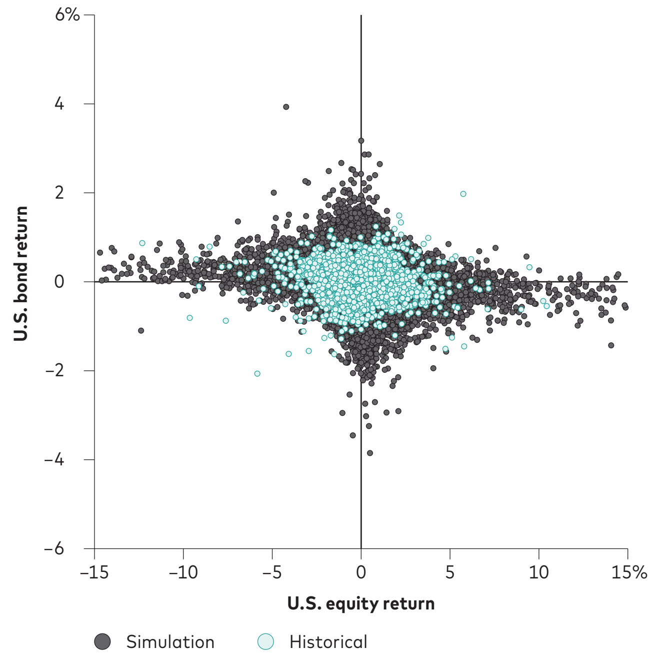
When it comes to forecasting daily asset returns and transaction costs, we take a probabilistic approach as described in Zhang et al. (2022). In doing so, we leverage research from the Vanguard Capital Markets Model® (VCMM), our proprietary asset return forecasting model. **Figure 3** illustrates 10,000 simulations of daily returns as well as over 30 years' worth of actual historical daily returns.

Simulating a wide range of possible asset returns, volatilities, and correlations allows for deeper assessment compared with forecasting using data from a given historical period. Simulations allow us to extract insights that would not be otherwise visible due to a random historical period which may not be representative of the market at large. Even one year's worth of return simulations encompasses decades' worth of historical data, showcasing the robustness our model can add.

Our model incorporates volatility clustering for equities because periods of high volatility tend to be clustered together. We forecast returns and transaction costs jointly via a regression-based Monte Carlo approach, thereby preserving cross-correlations. Asset return forecasts are a function of forecasted macroeconomic variables including interest rates and inflation as well as valuations based on a vector autoregression model that implicitly captures autocorrelation.

FIGURE 3

Robust asset return simulations encompass real-life returns



Notes: The simulation data include U.S. equities, which are represented by the MSCI Broad Market Index, and U.S. bonds, which are represented by the Bloomberg Barclays U.S. Aggregate Index. The historical returns are daily and include U.S. equities, which are represented by the Russell 3000 Index, and U.S. bonds, which are represented by the Bloomberg Barclays U.S. Aggregate Index. Data use both steady-state simulations and historical daily returns from January 1989 to March 2023.

Source: Vanguard.

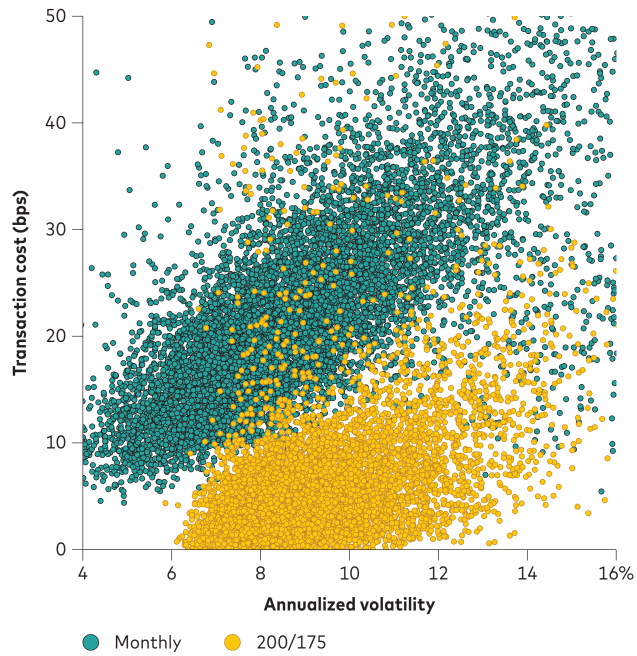
Note on risk

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. Simulations are as of March 2024. 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 13.

Transaction cost estimates are modeled as a function of market volatility and trade size. As shown in **Figure 4**, transaction costs are expected to be higher when markets are more volatile and when larger trades are executed. Since a 200/175 approach can reduce the size and frequency of transactions, the cost advantage relative to a monthly approach can be clearly observed.

FIGURE 4

Transaction cost advantages of 200/175 rebalancing across volatility regimes



Notes: This figure is based on a global 60% equity and 40% fixed income portfolio using 10,000 simulations of daily returns and transaction costs over a 1-year period. U.S. equities are represented by the MSCI Broad Market Index (36%), non-U.S. equities by the MSCI ACWI ex USA Index (24%), U.S. bonds by the Bloomberg Barclays U.S. Aggregate Index (28%), and non-U.S. bonds by the Bloomberg Barclays Global Aggregate ex-USD Index (12%). The analysis assumes no cash flows or use of futures. Transaction costs are a function of underlying market volatility and transaction size. Transaction costs also account for simultaneous rebalancing across all target-date vintages. Data use steady-state simulations.

Source: Vanguard.

Insights

Using our dynamic simulations of returns and transaction costs, we compare 200/175 rebalancing with monthly and quarterly methods commonly used by other TDF providers. The starting portfolio in the simulations is assumed to be a global 60% stock/40% bond portfolio where the only difference in the comparisons is the rebalancing approach. The results extend to other asset allocation mixes without loss of generality. (To see the benefits of 200/175 rebalancing for other asset allocations, see **Appendix 2** on page 13.)

For each rebalancing approach, our research yields four valuable insights:

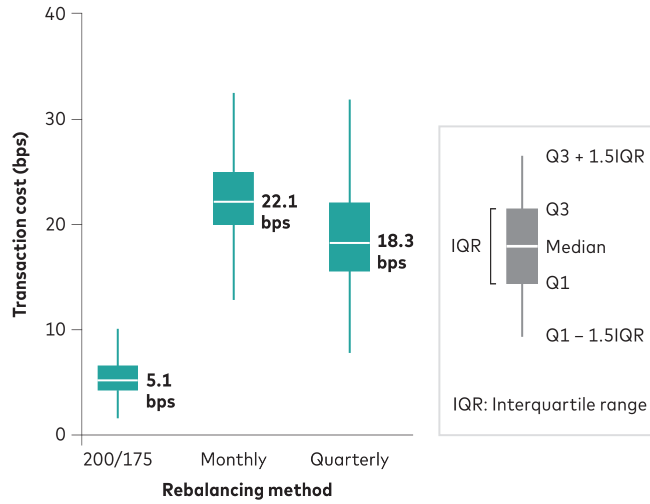
- Estimated transaction costs.
- Expected returns.
- Overall benefit to investors.
- Risk control.

Estimated transaction costs

The expected transaction costs for 200/175 rebalancing are about 13–17 bps lower relative to quarterly and monthly approaches, as shown in **Figure 5**. In other words, 200/175 rebalancing incurs roughly one-third the average transaction cost of quarterly rebalancing and roughly one-fourth that of monthly rebalancing. Analysis in *Vanguard's Approach to Target-Date Fund Rebalancing* (2024) supports these findings using historical daily return data.

FIGURE 5

Expected transaction costs are lowest for 200/175 rebalancing



Notes: This figure is based on a global 60% equity and 40% fixed income portfolio using 10,000 simulations of daily returns and transaction costs over a 10-year period. The analysis assumes no cash flows or use of futures. U.S. equities are represented by the MSCI Broad Market Index (36%), non-U.S. equities by the MSCI ACWI ex USA Index (24%), U.S. bonds by the Bloomberg Barclays U.S. Aggregate Index (28%), and non-U.S. bonds by the Bloomberg Barclays Global Aggregate ex-USD Index (12%). Transaction costs are a function of the underlying market volatility and transaction size. Transaction costs also account for simultaneous rebalancing across all target-date vintages. Data use steady-state simulations. For each distribution, Q1 is the first quartile (25th percentile), Q3 is the third quartile (75th percentile), and IQR is the difference between them. The upper limit of each distribution is calculated by adding 1.5 times the IQR to the Q3 figure, and the lower limit is calculated by subtracting 1.5 times the IQR from the Q1 figure.

Source: Vanguard.

Figure 6 breaks down transaction costs over 10 years into the number of rebalancing events and the transaction cost per rebalancing event; the average transaction cost is the product of the two. Compared with monthly and quarterly rebalancing, a 200/175 policy has the lowest transaction cost per rebalancing event as well as the lowest average transaction cost.

Quarterly rebalancing has the highest transaction cost per rebalancing event but the lowest number of rebalancing events, resulting in an lower average transaction cost than monthly rebalancing, whose average transaction cost is increased due to having the most rebalancing events. Intuitively, a larger trade size leads to a larger transaction cost per rebalancing event.

FIGURE 6

Decomposition of transaction costs over 10 years

	200/175	Monthly	Quarterly
Rebalancing events	92	120	40
Transaction cost per rebalancing event	0.0006%	0.002%	0.005%
Average transaction cost	0.05%	0.22%	0.18%
Trade size	0.88%	2.00%	3.68%

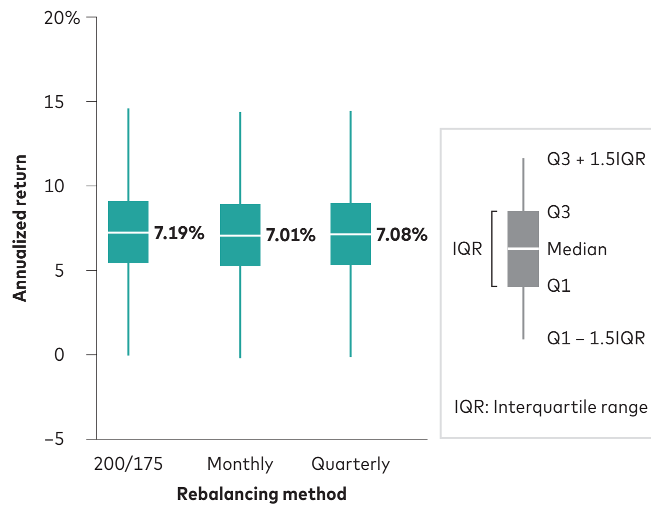
Notes: This figure is based on a global 60% equity and 40% fixed income portfolio using 10,000 simulations of daily returns and transaction costs over a 10-year period. The analysis assumes no cash flows or use of futures. U.S. equities are represented by the MSCI Broad Market Index (36%), non-U.S. equities by the MSCI ACWI ex USA Index (24%), U.S. bonds by the Bloomberg Barclays U.S. Aggregate Index (28%), and non-U.S. bonds by the Bloomberg Barclays Global Aggregate ex-USD Index (12%). Transaction costs are a function of the underlying market volatility and transaction size. Transaction costs also account for simultaneous rebalancing across all target-date vintages. Data use steady-state simulations. Trade size is the amount of trading (both buying and selling) across all underlying asset classes in the rebalancing.

Source: Vanguard.

The relative returns of a portfolio with 200/175 rebalancing are 11–18 bps per year higher compared with calendar-based approaches, as shown in **Figure 7**. This is primarily due to the reduced average transaction costs of threshold-based rebalancing, which leads to greater expected returns.

FIGURE 7

A 200/175 rebalancing policy has higher relative returns than calendar-based approaches



Notes: This figure is based on a global 60% equity and 40% fixed income portfolio using 10,000 simulations of daily returns and transaction costs over a 10-year period. The analysis assumes no cash flows or use of futures. U.S. equities are represented by the MSCI Broad Market Index (36%), non-U.S. equities by the MSCI ACWI ex USA Index (24%), U.S. bonds by the Bloomberg Barclays U.S. Aggregate Index (28%), and non-U.S. bonds by the Bloomberg Barclays Global Aggregate ex-USD Index (12%). Transaction costs are a function of the underlying market volatility and transaction size. Transaction costs also account for simultaneous rebalancing across all target-date vintages. Data use steady-state simulations. For each distribution, Q1 is the first quartile (25th percentile), Q3 is the third quartile (75th percentile), and IQR is the difference between them. The upper limit of each distribution is calculated by adding 1.5 times the IQR to the Q3 figure, and the lower limit is calculated by subtracting 1.5 times the IQR from the Q1 figure.

Source: Vanguard.

Overall benefit to investors

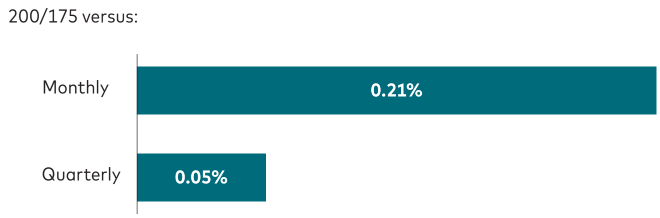
Another way of measuring the relative benefit of rebalancing approaches is by using the certainty fee equivalent (CFE), which can be thought of as the overall benefit of one rebalancing approach over another or, conversely, as the fee an investor would be willing to pay relative to another rebalancing method.

With 200/175 rebalancing, investors can obtain a relative benefit ranging from 5–21 bps versus calendar-based approaches, as shown in **Figure 8**. Importantly, CFE is measured using results from all 10,000 simulations, whereas our other insights focus on the median of the distribution. (The benefit is directionally similar for other target asset allocations; see Appendix 2 on page 13 for details.)

For a TDF investor, the annual relative benefit of 200/175 rebalancing over monthly rebalancing is 15–22 bps during accumulation years and 22–25 bps during decumulation years; compared with quarterly rebalancing, the relative benefit of a 200/175 policy is 5–8 bps during accumulation years and 6–10 bps during decumulation years. (Note that these calculations do not include the impact of cash flows.)

FIGURE 8

The relative benefit of 200/175 rebalancing compared with monthly and quarterly rebalancing



Notes: This figure is based on a global 60% equity and 40% fixed income portfolio using 10,000 simulations of daily returns and transaction costs over a 10-year period. The analysis assumes no cash flows or use of futures. U.S. equities are represented by the MSCI Broad Market Index (36%), non-U.S. equities by the MSCI ACWI ex USA Index (24%), U.S. bonds by the Bloomberg Barclays U.S. Aggregate Index (28%), and non-U.S. bonds by the Bloomberg Barclays Global Aggregate ex-USD Index (12%). Transaction costs are a function of the underlying market volatility and transaction size. Transaction costs also account for simultaneous rebalancing across all target-date vintages. Data use steady-state simulations.

Source: Vanguard.

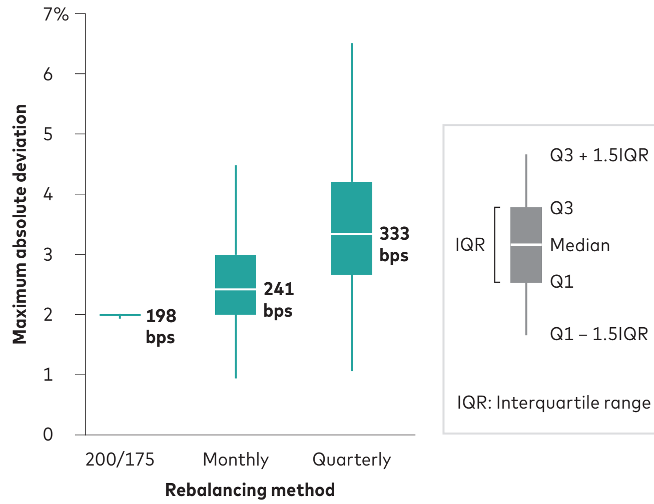
Risk control

In the time between rebalancing events, a portfolio's asset allocation drifts from its target as daily asset returns differ. Periods of heightened volatility can lead to particularly large allocation drifts, which can necessitate larger trades, which can lead to higher transaction costs. Threshold-based rebalancing by design rebalances only when asset allocations drift beyond the threshold.

Based on our simulations, the expected allocation deviations over a 1-year period are the smallest for 200/175 rebalancing, at 198 bps, compared to 241 bps for monthly rebalancing and 333 bps for quarterly rebalancing, as shown in **Figure 9**. Said another way, a 200/175 policy is expected to result in 43 bps less allocation deviation per year relative to monthly rebalancing and 135 bps less deviation per year relative to quarterly rebalancing. As we saw in March 2020, allocation deviations for calendar-based rebalancing can be much more extreme during tail events, whereas threshold-based approaches are designed with better risk control.

FIGURE 9

Allocation deviations are lower and better controlled with 200/175 rebalancing



Notes: This figure is based on a global 60% equity and 40% fixed income portfolio using 10,000 simulations of daily returns and transaction costs over a 10-year period. The analysis assumes no cash flows or use of futures. U.S. equities are represented by the MSCI Broad Market Index (36%), non-U.S. equities by the MSCI ACWI ex USA Index (24%), U.S. bonds by the Bloomberg Barclays U.S. Aggregate Index (28%), and non-U.S. bonds by the Bloomberg Barclays Global Aggregate ex-USD Index (12%). Transaction costs are a function of the underlying market regime and transaction size. Transaction costs also account for simultaneous rebalancing across all target-date vintages. Data use steady-state simulations. For each distribution, Q1 is the first quartile (25th percentile), Q3 is the third quartile (75th percentile), and IQR is the difference between them. The upper limit of each distribution is calculated by adding 1.5 times the IQR to the Q3 figure, and the lower limit is calculated by subtracting 1.5 times the IQR from the Q1 figure.

Source: Vanguard.

Threshold and destination selection

We have shown how threshold-based rebalancing can lead to better outcomes than calendar-based approaches, but the question remains: How do we select the threshold and destination of our rebalancing policy?

Figure 10 shows the expected returns relative to daily rebalancing of policies with various thresholds and destinations. The highest expected return is observed for a 200/175 policy, at 28 bps. A destination closer to the threshold is preferred, as a 200/175 policy has a higher expected return compared with a 200/150 policy, due to lower average transaction size and lower transaction costs. The difference in expected return increases as the destination gets further from the threshold. Therefore, a destination 25 bps lower than the threshold is preferred.

Higher thresholds are preferred because they have lower transaction costs due to less frequent trading relative to a lower-threshold approach, such as a 50/25 policy, for instance. A threshold of 200 bps is selected to control the allocation drift within an acceptable level relative to our rebalancing objective. A 200/175 policy is preferred as it is expected to result in the best investment outcome while limiting allocation drifts. While this research focuses on a 60/40 portfolio, similar trends hold true for other asset allocation mixes. At Vanguard, we review and refine this analysis periodically to ensure investors get the best chance for long-term outcomes.

FIGURE 10

Expected relative return of threshold-based rebalancing policies for a 60/40 portfolio

		Threshold (bps)						
		50	75	100	125	150	175	200
Destination (bps)	25	0.15%						0.16%
	50		0.21%					0.19%
	75			0.24%				0.21%
	100				0.26%			0.23%
	125					0.27%		0.24%
	150						0.28%	0.26%
	175							0.28%

Notes: This figure is based on a global 60% equity and 40% fixed income portfolio using 10,000 simulations of daily returns and transaction costs over a 10-year period. The analysis assumes no cash flows or use of futures. U.S. equities are represented by the MSCI Broad Market Index (36%), non-U.S. equities by the MSCI ACWI ex USA Index (24%), U.S. bonds by the Bloomberg Barclays U.S. Aggregate Index (28%), and non-U.S. bonds by the Bloomberg Barclays Global Aggregate ex-USD Index (12%). Transaction costs are a function of the underlying market volatility and transaction size. Transaction costs also account for simultaneous rebalancing across all target-date vintages. Data use steady-state simulations.

Source: Vanguard.

Conclusion

Compared with common calendar-based rebalancing approaches, a 200/175 rebalancing policy is expected to generate higher annual returns while resulting in smaller deviations from the target allocation, with approximately one-third and one-fourth the average transaction cost of quarterly and monthly rebalancing, respectively.

For a TDF investor, the expected benefit of a 200/175 policy compared with monthly rebalancing is 15–22 bps during accumulation years and 22–25 bps during decumulation years, and the expected benefit compared with quarterly rebalancing is 5–8 bps during accumulation years and 6–10 bps during decumulation years.

Just as each investor's circumstances differ, TDFs can differ in various dimensions, such as glide-path design, sub-asset allocation, and rebalancing methodology. When it comes to rebalancing, we believe a threshold-based approach, particularly a 200/175 policy, gives investors the best chance of investment success by reducing transaction costs while delivering the expected asset allocation experience.

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Appendix 1

About the Vanguard Capital Markets Model
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. 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, commodities, and certain alternative investment strategies. The theoretical and empirical foundation for the VCMM 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.

Appendix 2

The relative benefit of 200/175 rebalancing compared with monthly and quarterly rebalancing is not limited to a 60/40 portfolio. It holds true for asset allocation mixes ranging from 30% stocks/70% bonds to 90% stocks/10% bonds, as shown below, where the benefit shown is the CFE.

FIGURE 11
The relative benefit of 200/175 rebalancing by asset allocation

Stock/bond asset allocation	Benefit of 200/175 over monthly rebalancing	Benefit of 200/175 over quarterly rebalancing
30%/70%	0.25%	0.10%
40%/60%	0.23%	0.07%
50%/50%	0.22%	0.06%
60%/40%	0.21%	0.05%
70%/30%	0.20%	0.05%
80%/20%	0.18%	0.06%
90%/10%	0.15%	0.08%

Source: Vanguard.

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All investing is subject to risk, including possible loss of principal.

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There is no guarantee that any particular asset allocation or mix of funds will meet your investment objectives or provide you with a given level of income.

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