Asset Allocation: Minimizing Short-Term Drawdown Risk and Long-Term Shortfall Risk

An institution's policy asset allocation is designed to provide the optimal balance between minimizing the endowment portfolio's short-term drawdown risk and minimizing its long-term shortfall risk.

TIAA Endowment & Philanthropic Services

In this paper, we propose an asset allocation framework for long-term institutional investors, such as endowments, that are seeking to satisfy annual spending needs while also maintaining and growing intergenerational equity. Our analysis focuses on how asset allocation contributes to two key risks faced by endowments: short-term drawdown risk and long-term shortfall risk.

Before approving a long-term asset allocation, it is important for an endowment's board of trustees and/or investment committee to consider the institution's ability and willingness to bear two risks: short-term drawdown risk and long-term shortfall risk.

We consider various asset allocations along a spectrum from a bond-heavy portfolio (typically considered "conservative") to an equity-heavy portfolio (typically considered "risky") and conclude that a typical policy portfolio of 60% equities, 30% bonds, and 10% real assets represents a good balance between these short-term and long-term risks.

We also evaluate the impact of alpha generation and the choice of spending policy on an endowment's expected risk and return characteristics. We demonstrate that adding alpha through manager selection, tactical asset allocation, and the illiquidity premium significantly reduces long-term shortfall risk while keeping short-term drawdown risk at a desired level. We also show that even a small change in an endowment's spending rate can significantly impact the risk profile of the portfolio.

Introduction: Long-Term vs. Short-Term Risks

We propose an asset allocation framework for long-term institutional investors, such as endowments, that are seeking to satisfy annual spending needs while also maintaining and growing intergenerational equity. Our analysis focuses on how asset allocation contributes to two key risks faced by endowments: short-term drawdown risk and long-term shortfall risk.

Short-term risk is defined as the annual drawdown risk, or more specifically, the worst 1% tail.[1] We use a bootstrap technique to produce a non-parametric probability distribution of annual returns and estimate the 1% tail (see **Appendix A** for details).

We define long-term risk as the probability that the portfolio's real value in the future falls below the portfolio's current value after annual payouts and adjusted for inflation. Our Monte Carlo simulation-based framework can integrate any expected return assumptions and any cash flows between the institution and the endowment (see **Appendix B**). This simulation-based framework can also model special scenarios, e.g., spending for a large capital project.

Because of its simplicity and robustness, we prefer the non-parametric and market information-based statistical approach to estimate short-term risk. For estimating long-term risks, however, we use a simulation-based multi-period framework because it is highly customizable.

On the following pages, we discuss how the framework can be used to analyze policy portfolios and discuss how the model's insights relate to and enhance the results of traditional asset allocation methods. Then we present applications of the model, including an easy method for incorporating alpha into the analysis and discuss spending rates. We describe the technical details in the appendixes.

For estimating long-term risks, we use a simulation-based multi-period framework because it is highly customizable.

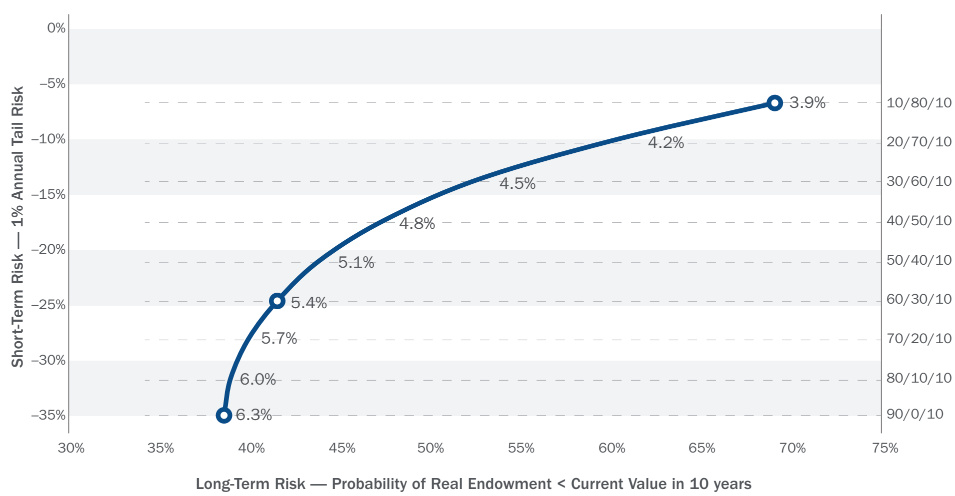
The Policy Portfolio

An endowment's policy portfolio is designed to provide the optimal balance between minimizing the portfolio's short-term and long-term risks. For a typical endowment, the board of trustees or investment committee determines the endowment's risk tolerance taking into consideration the institution's spending policy, as well as its tolerance for volatility in spending. In theory, tolerance for spending volatility determines a risk-aversion parameter, which, in combination with return expectations and estimates of capital market risk, provides a specific optimal asset allocation that maximizes utility. The policy portfolio should reflect a risk level that is consistent with the institution's spending needs balanced with its ability and willingness to bear risk.

We consider a typical policy portfolio consisting of equities (MSCI ACWI), bonds (Bloomberg Barclays U.S. Aggregate Bond), and real assets (MSCI Global REITs).[2] **Figure 1** shows a range of portfolios using these three broad asset classes, plotted along two axes representing short-term risk and long-term risk. The most "conservative" portfolio of 10% equities, 80% bonds, and 10% real assets[3] (10/80/10) provides the lowest relative short-term drawdown risk, but also has the lowest real return and the highest long-term shortfall risk over a 10-year period. It has almost a 70% chance of losing real value over this horizon, given a 5% payout rate. This level of long-term risk is unacceptable for most endowments. Clearly, protecting against a short-term drawdown is costly; long-term investors with a relatively high risk tolerance for a short-term drawdown should carefully assess the cost/benefit of implementing such an allocation.

Figure 1: Risk Trade-Off

Short-term (1 yr) and long-term (10 yr) risk trade-off
Equities/Bonds/Real Assets and Alpha(α)=1.0%
5% Spending



At the other end of the spectrum, the “riskiest” portfolio of 90% equities, 0% bonds, and 10% real assets (90/0/10) offers a reduced probability of losing real value over longer time periods. In the 10-year time horizon, there is a less than a 40% chance of losing real value; however, there is much higher short-term drawdown risk. While equity-heavy portfolios have higher short-term drawdown risk, long-term investors like universities and foundations have a relatively high, but not unlimited, ability to withstand short-term drawdown risk.

For institutions that rely on consistent endowment distributions, a severe drawdown might result in disruptive cuts in spending. For example, a 17% drawdown would cause the spending rule to hit the 6% cap from a 5% base,[4] so a drawdown in excess of 17% might cause a decrease in the dollar payout from the endowment needed to support the institution’s operating budget. Again, balancing short-term drawdown risk with the need for returns high enough to maintain or increase real portfolio value over time is critical.

A typical policy portfolio of 60% equities, 30% bonds, and 10% real assets (60/30/10) represents a good balance between short-term risk and long-term risk. As seen in **Figure 1**, moving from a 90% equity allocation to a 60% equity allocation minimally increases long-term shortfall risk, but it significantly reduces short-term drawdown risk.

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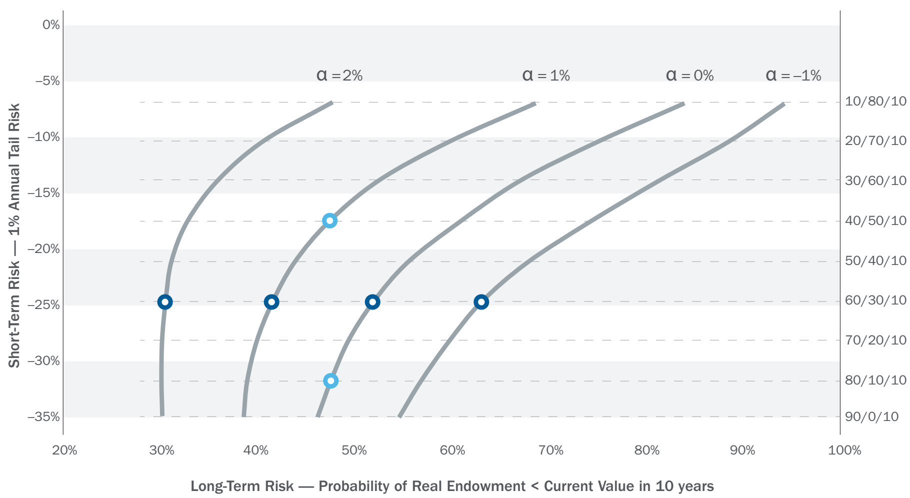
The Impact of Alpha

We define alpha as the value added on top of the passive policy portfolio, including an illiquidity premium from illiquid asset classes, such as private equity. To simplify this analysis, we combine all value-add from manager selection, tactical asset allocation, and the illiquidity premium into one combined measure of alpha.

Figure 2 illustrates the important role of alpha. For example, the 40/50/10 at 1% alpha[5] and 80/10/10 at 0% alpha portfolios both share a long-term risk level of around 50%, but with very different short-term risk profiles. The 40/50/10 with 1% alpha portfolio has much less short-term risk than the 80/10/10 with 0% alpha portfolio, as the former portfolio relies on higher, constant alpha contributions to annual returns versus the latter, which relies on relatively higher, more volatile equity returns to generate the overall portfolio's expected return. Clearly, the risk trade-off analysis is highly sensitive to underlying assumptions of estimated alpha.

Figure 2: Risk Trade-Off for Different Alpha Levels

Short-term (1 yr) and long-term (10 yr) risk trade-off
Equities/Bonds/Real Assets
5% Spending with different alpha



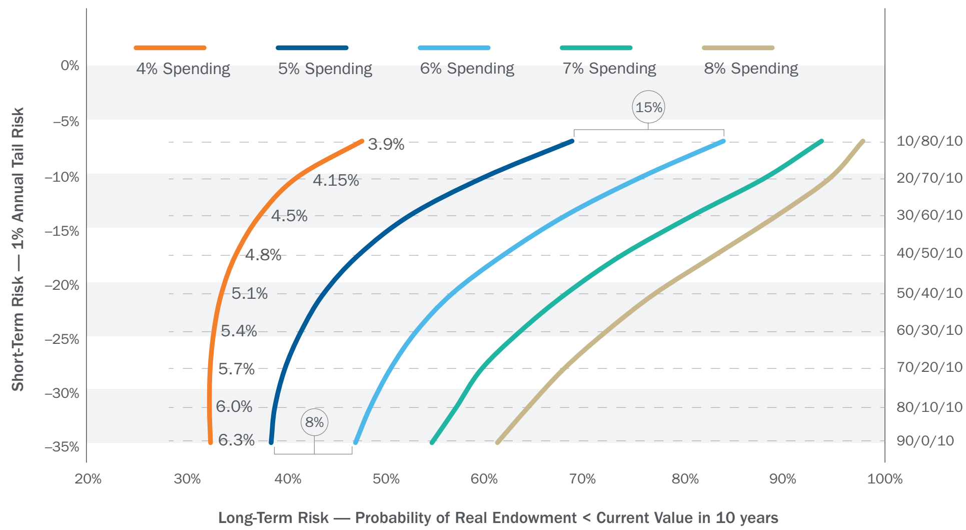
Adding alpha through active management significantly reduces the long-term shortfall risk, while keeping the short-term drawdown risk at a desired level. The 60/30/10 portfolio's long-term probability of losing real value is reduced by more than 10% for every 1% increase in alpha, while maintaining the same short-term drawdown risk profile. This is based on the assumption that alpha can be maintained and beta is managed to target at all times. Alpha could come from manager selection, tactical asset allocation, and the illiquidity premium from investing in private equity.

The Impact of Spending

We also run additional analyses to review various policy portfolios at different spending rates. To simplify the analysis, in **Figure 3**, we removed the floor and the cap of the spending rule and used a constant payout rate from 4% to 8% during the 10-year horizon.

Figure 3: Risk Trade-Off for Different Spending Rates

Short-term (1 yr) and long-term (10 yr) risk trade-off
Equities/Bonds/Real Assets and Alpha(α)=1.0%
At different spending rates



As expected, reducing the spending rate causes the short-term/long-term risk trade-off to steepen, as reductions in spending greatly reduce the long-term probability that the real value of the endowment falls over a 10-year time frame. Similarly, increasing the spending rate flattens the curve. We note that increasing the spending rate from 5% to 6% increases the long-term shortfall risk of the endowment by about 8% to 15%, depending on the asset allocation. Therefore, an institution's board of trustees and investment committee should carefully consider any material increases in spending.

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We then take a look at the case for 60/30/10 over a longer time horizon (30 years). In **Figures 4 and 5**, we compare the real endowment values and average annual payouts at different spending rates over 30 years.

Figure 4: Mean Endowment Assets (Real)

60/30/10 and Alpha(α)=1.0%

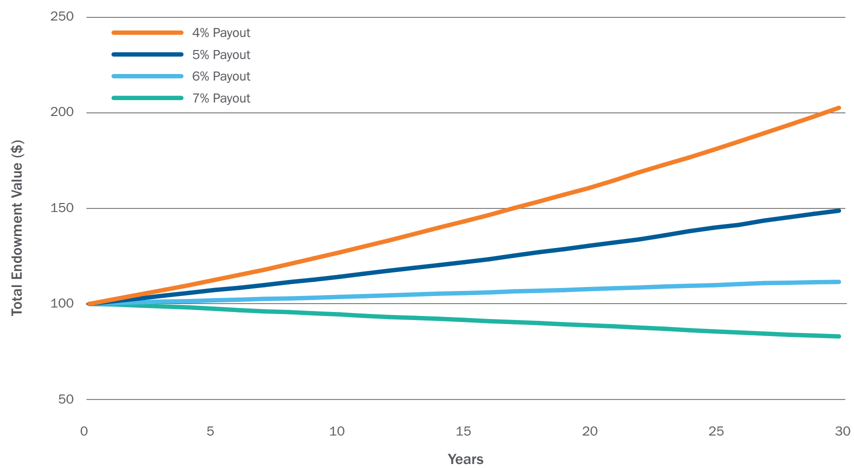
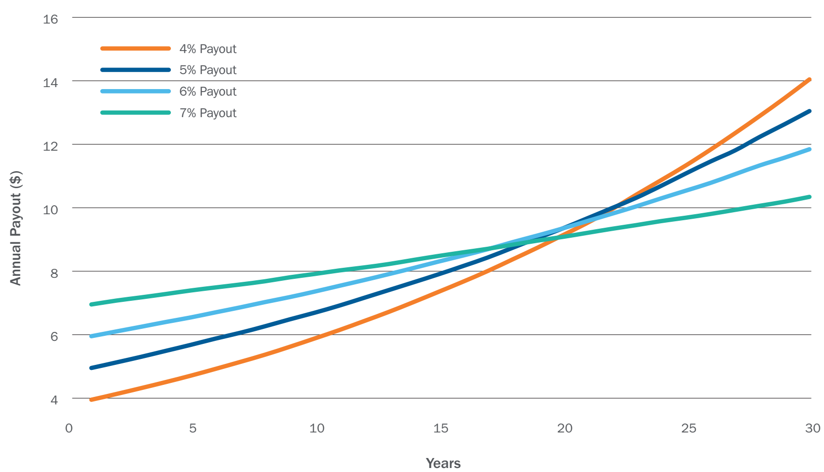


Figure 5: Mean Annual Payout

60/30/10 and Alpha(α)=1.0%



The real endowment values grow much faster at lower payout rates. The real endowment value with the 7% spending rate actually decreased in year 30 because the real expected return is well below 7%. Additionally, after approximately 20 years of compounding, the dollar amount of the annual payout at a 4% spending rate is higher than at the other higher payout rates. Even small increases in the spending rate should be considered carefully because of the significant consequences to the risk profile of the portfolio.

Conclusion

It is important for a portfolio with a dual mandate of preserving intergenerational equity and satisfying annual spending needs to be managed with a focus on liquidity, risk, and investment opportunity. In this paper, we have discussed how the primary levers of influence that an institution has over its portfolio—return generation and spending—relate to its ability to meet its short-term drawdown risk and long-term shortfall risk objectives.

On the return-generation side, meeting the long-term risk objective without exceeding the tolerance for short-term risk requires a thoughtful asset allocation and alpha creation. An equity-oriented asset allocation of 60% equities, 30% bonds, and 10% real assets that is actively managed is a suitable investment solution that balances these risks.

On the spending side, portfolio withdrawals compound and act as a drag on a portfolio's long-term growth. However, because funding institutional initiatives is an endowment's core purpose, spending must be executed in a way that sustains both the institution and the long-term portfolio.

We encourage an institution's board of trustees, investment committee, and finance staff to look carefully at its short-term drawdown risk and long-term shortfall risk whenever they review the endowment's asset allocation and spending policies.

Because funding institutional initiatives is an endowment's core purpose, spending must be executed in a way that sustains both the institution and the long-term portfolio.

Appendix A: Short-Term Risk

To estimate short-term risk, we use a simple bootstrap technique to produce a non-parametric probability distribution of annual returns. We consider the worst 1% of these returns as the 1% tail risk of various portfolios. As an example, we look at a hypothetical portfolio consisting of 60% equities, 30% bonds, and 10% REITs.[6] The model randomly selects returns for three consecutive months from all three indexes simultaneously, with full replacement. Consequently, there could be overlap between different iterations/draws (that is, the same three-month experience could be selected more than once, or there could be partial overlap if months 1–3 are selected for one draw and months 3–5 are selected for another). As shown in **Table 1**, each of the blue lines represents one draw by the bootstrapping process. We use monthly returns over the period January 1995 to October 2015, resulting in a total sampling pool of 250 months in total, and produce 10,000 iterations to ensure limited statistical variability in our estimates.

Table 1: Asset Class Total Return Levels

	MSCI ACWI	MSCI Global REIT	Bloomberg Barclays US Aggregate Bond
10/30/15	773.1	179.5	1936.8
9/30/15	716.6	168.7	1936.4
8/31/15	743.2	168.4	1923.4
7/31/15	797.6	180.5	1926.2
6/30/15	790.4	176.2	1912.9
5/29/15	809.1	185.1	1934.0
4/30/15	809.6	189.1	1938.7
3/31/15	786.3	188.1	1945.6
2/27/15	798.2	189.4	1936.6
1/30/15	755.8	189.4	1955.0
12/31/14	767.6	181.7	1914.9

The practice of drawing three consecutive months for each selection is intended to account for potential near-month serial correlation and heteroskedasticity in the monthly returns—two prevalent features of financial time series—ensuring that our results accurately represent the true experience of investors over that sample period. In addition, drawing from all three indexes contemporaneously preserves cross-sectional correlation between asset classes to accurately represent real-world diversification in a non-parametric framework.

We assume monthly rebalancing and apply the weights of the three indexes, although the specific implementation is flexible. Our process generates 10,000 quarterly portfolio returns, implying 2,500 (10,000/4) annual returns for the combined portfolio, which forms the annual return distribution. We use this return distribution to calculate relevant statistics, such as a 1% annual drawdown or an alternative short-term risk measure. **Table 2** shows the 1% annual drawdown of different portfolios, ranging from conservative (10% equities, 80% bonds, and 10% real assets) to aggressive (90% equities, 0% bonds, and 10% real assets). Obviously, more risk assets leads to greater short-term risk, as would be expected.

Table 2: Example Allocations and Short-Term Risk

	Mix 1	Mix 2	Mix 3	Mix 4	Mix 5	Mix 6	Mix 7	Mix 8	Mix 9
Equities	10%	20%	30%	40%	50%	60%	70%	80%	90%
Bonds	80%	70%	60%	50%	40%	30%	20%	10%	0%
Real Assets	10%	10%	10%	10%	10%	10%	10%	10%	10%
1% Annual Drawdown	–6.9%	–10.3%	–13.8%	–17.5%	–21.1%	–24.6%	–28.1%	–31.7%	–34.9%

Obvious benefits of the bootstrapping approach include:

- Completely abandoning assumptions about the parametric form of the underlying distribution of returns. Instead, we let the realized time series of the chosen investments drive the results.
- Capturing the effects of changing correlations (time series and cross-sectional) through the selection process.
- Enhanced transparency because the procedure relies only on the relative stability of the asset-price-generating process over the long term.
- Analytical tractability, as the procedure attaches a probability to the maximum drawdown, facilitating statistical inference on the results.

Appendix B: Long-Term Risk

For long-term risk, we use a Monte Carlo simulation to integrate our expected return assumptions and spending. We consider 10 years a reasonable time horizon for long-term investors and use the following 10-year real expected return assumptions in **Table 3**.

Table 3: Asset Class Expected Return and Volatility

	Real Return	Volatility
Equities	5.5%	16.0%
Bonds	2.5%	4.0%
Real Assets	3.0%	20.0%
Inflation	2.0%	1.0%
Alpha	1.0%	3.0%

We assume a multivariate normal distribution for the market and generate correlated random outcomes based on the following correlation matrix in **Table 4**.

Table 4: Asset Class Correlations

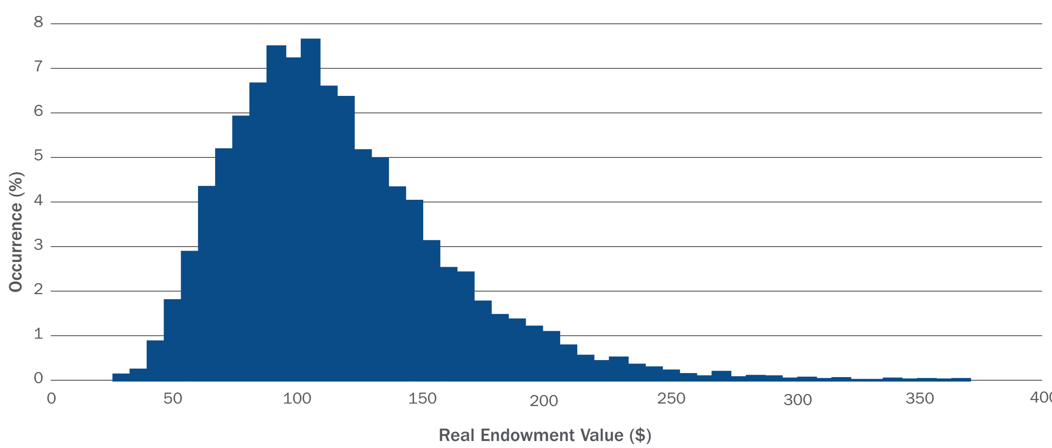
	Equities	Bonds	Real Assets	Inflation	Alpha
Equities	1.0	0.1	0.7	0.0	0.0
Bonds		1.0	0.3	–0.3	0.0
Real Assets			1.0	0.3	0.0
Inflation				1.0	0.0
Alpha					1.0

To simulate payouts, we follow a typical spending rule: at year t=1, we pay out 5% of the initial portfolio value (t=0). The payout grows at a predetermined rate, such as HEPI (for example, 2.5%) or any inflation-linked rate. If the payout ratio turns out to be below 4% or above 6% of the portfolio value, we reset it to 5%. New contributions and any other cash flows between the endowment and the university can be included in the model. Cash flows can be of any predetermined amounts or modeled as a random variable. For this study, we focus only on payout, which follows the rule described previously.

We generate 10,000 iterations of five correlated variables for 10 years. We grow each asset class by its nominal returns from year to year. Every year, the total nominal value of the portfolio is the sum of all asset class values, plus the value-add due to alpha, minus the payout. **Figure 6** shows the distribution of real endowment value at year 10 from the simulations.

Figure 6: Distribution of Real Endowment Value at Year 10

60% Equities/30% Bonds/10% Real Assets; Alpha(α)=1.0% and payout at 5% growth at HEPI



At year 10, we compare the real terminal value of the portfolio adjusted for inflation, which occurred during the 10-year horizon, to the initial value of the portfolio. Among all of the 10,000 iterations, we count the number of cases in which the real portfolio value in year 10 is less than the initial value (at t=0). This gives us the simulated probability of the long-term real portfolio value falling below the current value, which is our definition of long-term risk.

Table 5 shows the long-term risks of different portfolios based on the payout rule and assumptions for expected return, alpha, and inflation. The more risk assets the portfolio contains, the lower the long-term risk due to the relatively higher expected returns from equities versus bonds. We include a 10% allocation to real assets because it is a typical allocation to inflation-sensitive assets.

Table 5: Example Allocations and Long-Term Risk

	Mix 1	Mix 2	Mix 3	Mix 4	Mix 5	Mix 6	Mix 7	Mix 8	Mix 9
Equities	10%	20%	30%	40%	50%	60%	70%	80%	90%
Bonds	80%	70%	60%	50%	40%	30%	20%	10%	0%
Real Assets	10%	10%	10%	10%	10%	10%	10%	10%	10%
Long-Term Risk	68.6%	59.8%	52.5%	47.3%	43.8%	41.6%	39.9%	38.9%	38.6%

Endnotes

[1] In practice, we use several metrics to estimate short-term risks, such as a 5% tail and volatility.
[2] The policy portfolio discussed here only consists of highly liquid, investable, and transparent market indexes.
[3] We include a 10% allocation to real assets in all policy portfolios because it is a typical allocation to inflation-sensitive assets.
[4] See Appendix B for details about spending rules.
[5] This value is in line with the 10-year performance of median endowments with more than $2 billion in assets.
[6] We use the MSCI ACWI Index, the Bloomberg Barclays U.S. Aggregate Bond index and the MSCI Global REIT index, respectively, to represent the asset classes.

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