New Approach to Strategic Capital Market Assumptions for Long-Horizon Institutional Portfolios

A cash-flow and yield anchored forward-looking framework for fixed income, public equity and alternatives return and risk modeling

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Introduction

This document lays out a detailed framework for building capital market assumptions that I use in my project about Distributionally Robust SAA for Life Insurers. The approach is grounded in empirical observations but driven by a forward-looking perspective. The intention is not to mirror traditional methods, which often rely heavily on backward-looking averages or mechanical volatility estimates, but to offer a more structurally sound way to think about long-term returns and risks.

Life insurers, in particular, face a unique investment environment. They operate under regulatory capital rules, invest to match long-dated liabilities, and often hold fixed income assets for the bulk of their portfolios. Their investment horizon isn't one or two years, it's closer to ten or twenty. That long view demands an approach to capital market expectations that reflects the structural drivers of markets: the shape and evolution of the yield curve, inflation dynamics, credit behavior, and macroeconomic shifts like demographics and fiscal policy. Simply averaging past returns or assuming constant volatilities is not enough, or sound, in my opinion.

What I'm doing here is stepping back from the usual toolkit and asking a more relevant question: what do we really need to know about returns and risks over a strategic horizon? For fixed income, this means focusing on starting yields as a predictor of future returns, not because it's a convenient proxy, but because the evidence shows that it's by far the most reliable predictor at multi-year horizons. And for equities, I apply the same logic later: build return expectations from the ground up using actual cash flows of companies like dividends and buybacks, alongside reasonable views on long-term growth and valuation adjustment.

Instead of leaning on volatility or standard deviation as the main measure of risk, I shift the emphasis to uncertainty around return forecasts, how wrong we might be, and why. That distinction matters when we're building a portfolio to maximize surplus for a life insurer over ten years. We're not worried about mark-to-market noise, we're worried about the possibility that our long-term assumptions are off by enough to throw our plan off course.

So the framework here is designed to be practical, forward-thinking, and combine historical data, structural views, and thoughtful simplifications that help rather than hinder decision-making. The rest of this report walks through the full modeling structure: index selection, return forecasting by maturity bucket, reinvestment logic, yield curve assumptions, spread behavior, and finally, how we handle risk in a way that actually matches the investment problem we're trying to solve.

Fixed Income

Data

All data used is sourced from Bloomberg, capturing flexible yet relatively constant maturity index time series data. Yield to Worst (YTW) series data were collected monthly from 1980 up to June 30, 2025 for the following indices:

- US Treasuries – Intermediate (~5 years) & Long (~22 years)
- US Municipal Bonds (~13 years)
- US IG – Intermediate (~5 years) & Long (~22 years)
- US HY – Intermediate (~5 years) & Long (~16 years)
- Foreign Government Bonds, Hedged (~10 years)
- Foreign IG Corporate Bonds, Hedged (~7 years)
- US Residential Mortgage-Backed Securities (~8 years)
- US Commercial Mortgage-Backed Securities (~4 years)
- US Asset-Backed Securities (~4 years)

Given a strategic investment horizon of 10 years, I segment indices into three distinct (approx.) maturity categories: intermediate (~5Y maturity), long term (~10Y+ maturity), and benchmark horizon bonds (~7–10Y maturity). Detailed methodology on return and risk estimations for those buckets separately are given later in the document.

I also have to make a note about the usefulness and validity of my approach here. Although life insurers typically buy and hold individual bonds to maturity rather than trading like an index, using fixed income indices to model expected returns still makes sense because both are governed by the same underlying economics. In either case, long-horizon returns are driven by starting yield and the rates at which coupons are reinvested, with yield curve movements affecting outcomes whether recognized monthly through index rebalancing or through mark-to-market valuations that flow into insurers' surplus. The index structure simply provides a transparent, market-consistent way to capture these yield and reinvestment dynamics, making it a valid proxy for insurer portfolios in SAA.

Cash

In this analysis, I intentionally exclude cash from the expected return modeling framework. Although cash is essential for liquidity management, it does not function as a strategic return driver over extended investment horizons. Empirical and industry research consistently demonstrates that cash historically underperforms risk-bearing assets such as bonds and equities across multi-year periods. Several factors underpin this long-term underperformance:

- **Structural return deficiency**: bonds allow reliable long-term return forecasting based on starting yields and embedded term premia. Cash, however, lacks such reliability, with short-term interest rates subject to significant fluctuations driven by central bank policy decisions rather than structural macroeconomic drivers such as long-term growth, inflation trends, or persistent risk premia.
- **Forecasting limitations**: empirically, the autocorrelation of cash return time series (1999-2025) is around 70% vs -10% for longer indices (long UST and corporate IG), the volatility and policy-dependent nature of short-term interest rates severely limits the stability and reliability of long-term cash return projections.

Unlike longer-duration assets, cash has no term premium and responds predominantly to short-term monetary cycles rather than fundamental macroeconomic conditions.

- **Portfolio role**: from a portfolio construction standpoint, cash primarily serves as a liquidity buffer rather than a strategic asset. Institutional investors, particularly life insurers, typically maintain only minimal cash holdings (around 1–2%) to facilitate operational liquidity, meet transactional needs, or temporarily hold funds awaiting deployment into productive assets.

Given these factors, I set a fixed minimal cash allocation of 1%, acknowledging its tactical liquidity role but excluding it from surplus-optimizing strategic decisions. This aligns with typical life insurance investment practices that prioritize capital efficiency and liability matching over unproductive cash holdings.

Foreign Currency Bonds

In my framework, foregn currency bonds are modeled using currency-hedged indexes rather than unhedged ones. The reason is that unhedged exposures introduce large amounts of uncompensated FX volatility, which in many cases dominates the bond return variance, as shown in the chart below. While one could make the case that foreign bonds provide diversification when domestic assets sell off alongside the currency, the evidence suggests that such offsets are weak (correlations are modest, around 0.25) and unstable over time. Moreover, correlation does not imply a reliable causal hedge.

Figure 1: Foreign currency volatility makes up the majority of the unhedged foreign currency bond risk
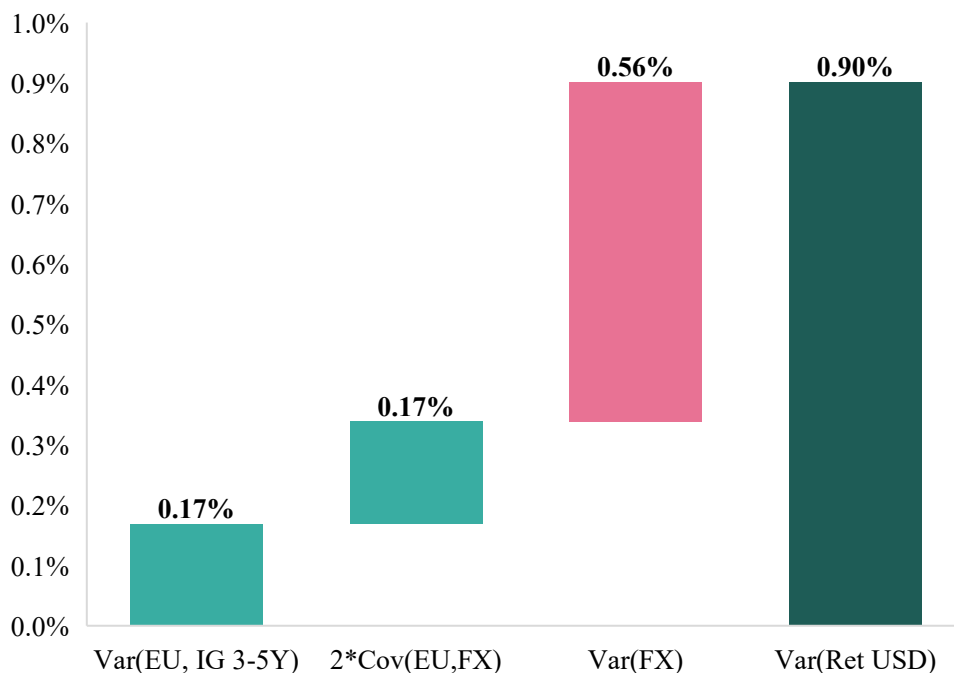
Life insurers and other institutional allocators do in practice allocate to foreign sovereign and corporate bonds, but overwhelmingly on a hedged basis, since their mandate is to capture the bond risk premium rather than currency noise. Following this logic, I include foreign bond exposures in my CMA framework through hedged indexes, ensuring comparability to domestic bonds and aligning with real-world institutional implementation.

Yield Curve

For yield curve forecasts for 2030, I use J.P. Morgan's assumptions from their *Long-Term Strategist* research. Their framework argues that structural forces, such as aging demographics leading to dissaving, higher fiscal and climate-related investment needs, elevated government debt ratios, partial deglobalization, and rising macro volatility, are set to push U.S. real yields higher over the next decade. Anchoring on a 2.5% real yield for the 10-year Treasury by the early 2030s, they extend this to the full curve with estimates of ~1.3% for the 1-year, 2.0% for the 5-year, and 3.0% for the 30-year. The resulting curve is modestly steeper at the short end than in the 2000s-2010s but flatter at the long end, reflecting a balance of higher neutral short rates and only moderate term premia.

For 2035, I assume the U.S. real yield curve settles into a long-run equilibrium that reflects both structural neutral rates and a modest term premium. Short real rates (1–2Y) converge near 1.0–1.2%, consistent with estimates of the Fed's long-run real policy rate. The 10Y real yield anchors around 1.8%, in line with JPMorgan's long-term strategist estimates for sustainable real rates, while the curve maintains a gentle upward slope toward 2.2% at the 30Y point, reflecting persistent demand for term premia at longer maturities. This construction represents a credible normalization path: after the higher-yield environment of 2030, rates ease back toward long-term equilibrium as inflation expectations stabilize around target and real growth moderates, leaving a curve that is upward sloping but not excessively steep.

Yield curve	1Y	2Y	5Y	10Y	13Y (interp.)	16Y (interp.)	22Y (interp.)	30Y
Current	3.98%	3.75%	3.83%	4.28%	4.36%	4.44%	4.61%	4.84%
2030	3.50%	3.80%	4.30%	4.80%	4.88%	4.95%	5.10%	5.30%
Error	*0.40%*	*0.40%*	*0.40%*	*0.40%*	*0.80%*	*0.80%*	*0.80%*	*0.40%*
2035	3.30%	3.50%	3.80%	4.10%	4.16%	4.22%	4.34%	4.50%
Error	*0.80%*	*0.80%*	*0.80%*	*0.80%*	*0.80%*	*0.80%*	*0.80%*	*0.80%*

0.40% Error for 5Y horizon reflects moderate uncertainty about monetary policy shifts and inflation forecasts over a medium-term horizon, encompassing potential deviations due to gradual economic structural shifts and moderate cyclical fluctuations. 0.80% Error (10-Year Horizon) incorporates greater uncertainty over a longer-term horizon, capturing the heightened probability of macroeconomic structural changes, policy regime shifts, and unforeseen economic cycles that substantially impact yield movements.

To anchor my nominal yield assumptions, I start from a long-term inflation expectation consistent across both market- and survey-based measures. As of June 30, 2025, the 10-year breakeven inflation rate from TIPS (USGGBE10 Index in Bloomberg) stood at 2.28%. This aligns closely with the Philadelphia Fed's Survey of Professional Forecasters (3Q25), which projects headline CPI inflation at an annual average of 2.31% over 2025–2034. Given the convergence of these two independent sources, I adopt 2.3% as the long-run inflation anchor, which I then combine with real yield projections to arrive at nominal yield estimates across the curve.

JPMorgan's framework is especially compelling for long-term strategic asset allocation because it derives real yield projections not from recent cyclical movements or spot market pricing, but from a weighted assessment of eleven persistent structural forces. These include key macroeconomic dynamics such as:

- Demographic aging and the shift toward dissaving
- Rising public debt levels
- Increased climate-related capital investment
- De-globalization and declining foreign demand for Treasuries
- Sectoral shifts toward lower investment intensity industries like healthcare
- Persistently higher macroeconomic volatility, which raises term premia

By linking each of these forces to historical precedents and then applying weighted average yields from past decades with similar characteristics, JPMorgan builds a real yield curve that reflects long-run capital supply-demand fundamentals. This method accounts for the secular evolution of saving and investment behavior in the U.S. economy, which is ultimately what determines real interest rates over time.

Spreads

I anticipate of at least one recession in the upcoming decade, so spreads are calculated based on a conservative 15-year historical average (which includes COVID), avoiding distortions from extreme crises (like GFC):

15Y history	Average	Standard deviation	Standard error	Corr of changes in UST and spread
IG spread (intermediate)	1.25%	0.43%	0.03%	-14.37%
IG spread (long)	1.60%	0.36%	0.03%	-26.67%
HY spread (intermediate)	4.80%	1.33%	0.10%	-18.69%
HY spread (long)	3.96%	0.84%	0.06%	-38.07%
Foreign Govt spread	0.31%	0.99%	0.07%	-77.33%
Foreign IG spread	0.51%	0.49%	0.04%	-44.81%
RMBS spread	1.22%	0.51%	0.04%	-0.88%
CMBS spread	1.28%	0.65%	0.05%	-19.34%
ABS spread	-0.50%	0.70%	0.05%	-70.58%

Return Estimation

The expected return for each fixed income index is modeled according to its maturity bucket. These return estimations incorporate yield structure, reinvestment dynamics, and capital gain/loss sensitivity based on duration. I adopt a structurally grounded, forward-looking approach rather than relying solely on historical averages, in alignment with industry best practices and empirical research (e.g., JPMorgan's Long-Term Strategist).

Intermediate Bonds (~5-Year Maturity) – these indices have maturities that are significantly shorter than the 10-year horizon, meaning the initial bonds will mature midway through the investment period. Therefore, the expected return includes two components: the return from holding the bond over the first five years and the reinvestment return over the remaining five years.

The expected 10-year return is calculated as:

$$\text{Expected Return} = ((1+Y_0)^5 \times (1+Y_5)^5)^{1/10} - 1$$

Where:

- Y_0 is the starting yield (typically the current YTW of the index)
- Y_5 is the reinvestment yield assumed in year 5, which is forecasted using the 5Y forward yield implied by my yield curve assumptions plus the average spread (for non-Treasury bonds) over the past 15 years

This reinvestment yield reflects expected structural shifts in rates and credit spreads, informed by macroeconomic outlook rather than forward curves alone (which have shown poor historical predictive power).

Long-Term Bonds (~10+ Year Maturity) – these indices are held for the full duration of the strategic horizon. Because the bond's duration typically approximates the horizon itself, return outcomes are highly sensitive to capital gain/loss effects from changes in yields over the 10-year period.

The return is estimated as:

$$\text{Expected Return} = Y_0 - D \times \Delta Y / 10$$

Where:

- Y_0 is the starting yield (YTW at t=0)
- D is the effective duration of the index
- $\Delta Y = Y_{10} - Y_0$ is the change in yield over the 10-year horizon, based on structural macro forecasts

This formula accounts for capital re-pricing through the bond's sensitivity to rate changes (i.e., duration), assuming a linear yield shift over the holding period. Any potential reinvestment component beyond 10 years is ignored, as these bonds are typically matched with the full horizon.

Benchmark Horizon Bonds (~10 Year Maturity)

For indices with maturities close to the 10-year horizon, returns are predominantly determined by their starting yield. Historical data shows that for such maturities, the realized total return over 10 years closely tracks the initial YTW, with minimal sensitivity to yield curve shifts or reinvestment dynamics.
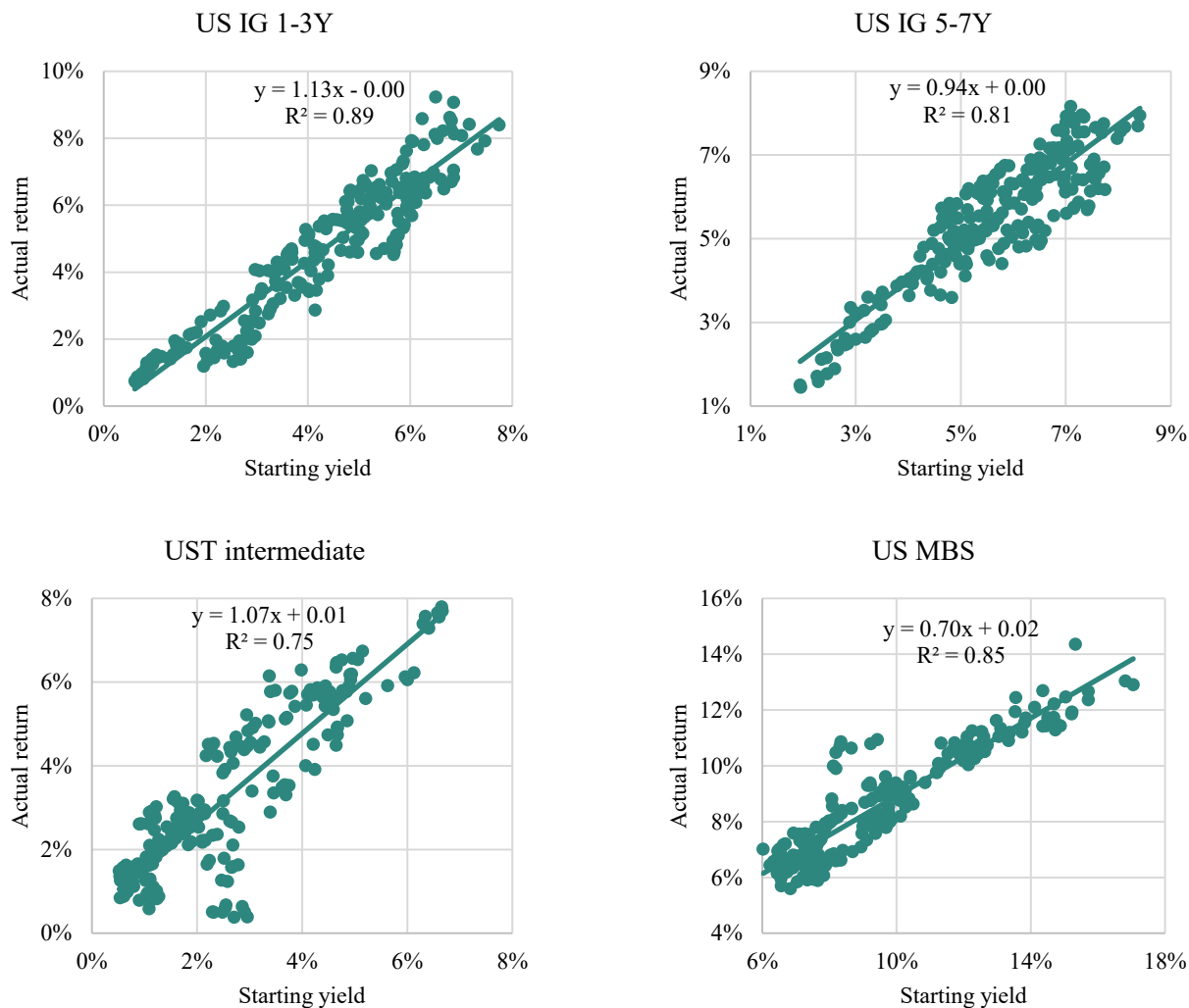
Thus, the return estimate simplifies to:

$$\text{Expected Return} = Y_0$$

Where Y_0 again denotes the starting yield to worst. This assumption leverages empirical findings that yield-based models exhibit lower root mean squared errors (RMSE) compared to models relying on historical CAGR or forward rates at this maturity band.

To illustrate the effectiveness of starting yield as an expeted return, especially for fixed ncome securities, the chart below shows the scatterplot of the actual returns (over the maturity horizon) of some of the indexes and their corresponding starting yields.

Figure 2: Starting yields are good indicators of actual performance throughout the maturity horizon

US IG 1-3Y

y = 1.13x - 0.00
$R^2 = 0.89$

US IG 5-7Y

y = 0.94x + 0.00
$R^2 = 0.81$

UST intermediate

y = 1.07x + 0.01
$R^2 = 0.75$

US MBS

y = 0.70x + 0.02
$R^2 = 0.85$

Credit Loss Adjustment

While Yield to Worst (YTW) serves as a conservative base case for return expectations, assuming the earliest possible redemption scenario, it does not account for credit losses arising from defaults or downgrades. YTW assumes contractual cash flows will be honored, which makes it insufficient for realistic modeling of credit-sensitive portfolios. To reflect this, I apply expected credit loss adjustment, using 10-year cumulative default probabilities by rating tier and assumed Loss-Given-Default (LGD).

The figures in the final table are based on long-run Moody's and S&P data, with assumed LGDs of 60% for corporates and lower for structured products. Sector-level estimates reflect a weighted average of underlying ratings.

Different Risk Measures

Risk estimation forms a crucial component of the capital market assumptions that inform SAA. I compute three distinct risk metrics for each bond index in my investment universe:

1. **Traditional Standard Deviation of Returns**: Represents the volatility based on the typical yearly fluctuations in bond returns
2. **Standard Deviation of Long-Term CAGR**: Calculated by multiplying the standard deviation of Compound Annual Growth Rates (CAGRs) by the square root of the index's average maturity, enabling direct comparability with the annualized standard deviation
3. **Root Mean Square Error (RMSE)**: Derived from the historical forecasting errors of yield-based return predictions, multiplied by the square root of maturity to align comparably with annualized standard deviation.

The dominant model in classical finance assumes that asset returns are independent and identically distributed (i.i.d.). Under this assumption, the volatility of multi-year returns is derived from short-term volatility by applying the square root of time rule, so the standard deviation of an average annual return over a 10-year period is often modeled as $\sigma_{10Y}=\sigma_{1Y}\times\sqrt{10}$.

This rule forms the backbone of models like the Samuelson Invariance Theorem, which implies that optimal asset allocation does not depend on investment horizon. However, this approach ignores several empirically observed patterns:

- Returns are not i.i.d., and they are partially predictable using valuation measures like yields.
- Short-term volatility does not capture long-term uncertainty accurately.
- Certain asset classes, especially hybrid assets like high-yield bonds, preferreds, and REITs, exhibit mean reversion.

Time Diversification and Mean Reversion

Time diversification is the idea that risk declines as the investment horizon lengthens. Just as investors diversify risk by spreading across asset classes, they can also diversify across time if poor short-term outcomes are offset by stronger subsequent returns. In practical terms, this shows up as annualized volatility falling with longer holding periods, because temporary shocks are gradually "washed out" as prices revert and income compounds.

The mechanism behind time diversification is mean reversion. If returns are negatively correlated across time, where weak years are more likely to be followed by stronger ones, then the dispersion of long-run outcomes narrows. For example, a sudden yield spike hurts bond returns in the short run, but over several years bonds pull back to par and coupons are reinvested at higher rates, reversing much of the initial loss. This tendency for deviations to self-correct explains why multi-year holding-period risks can be materially lower than annual volatility would suggest.

I observe some mean reversion in fixed-income indices once the evaluation horizon is aligned to the index's actual maturity profile. Instead of comparing starting yield to a 10-year CAGR for every bond index, I match starting yield (YTW) to realized total returns over a duration-consistent horizon. On this maturity-matched basis, large yield

moves are increasingly 'undone' as bonds pull to par and coupons are reinvested at evolving rates, which compresses the dispersion of multi-year outcomes, i.e., stronger mean reversion.

The charts below show the relative levels of three different types of risks (distributions for all the FI instruments tested).

Figure 3: RMSE-based risk measure is lower than traditional finance theories and practices suggest


■ Stdev ■ Stdev of CAGRs ■ RMSE
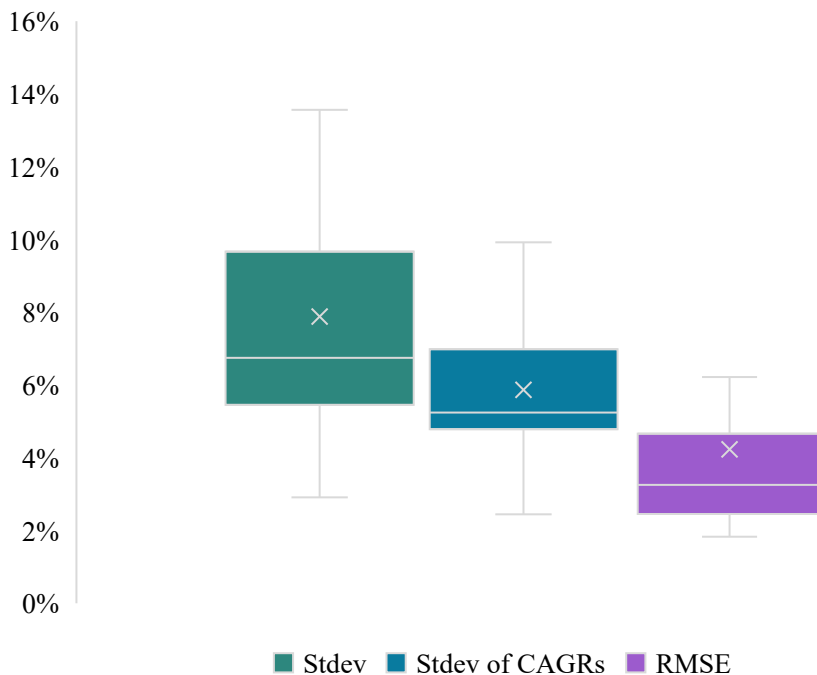
The effect of mean reversion can be seen in the second (blue) bar: the distribution of CAGRs has a noticeably lower mean and median volatility compared to 1-year returns. Intuitively, this happens because extreme short-term shocks (e.g., a sudden yield spike) wash out over multi-year horizons as bonds converge back toward par and reinvestment rates stabilize. In statistical terms, the standard deviation of CAGRs shrinks relative to 1-year volatility precisely because past deviations are gradually reversed, capturing the essence of mean reversion.

The contrast between the first and second distributions is especially pronounced in long-term, high-yield and structured fixed-income indices, where credit spreads tend to overshoot in the short run but mean-revert more strongly as defaults, recoveries, and structural carry effects play out over the investment horizon.

In the context of long-horizon institutional investing, the concept of time diversification has often been underappreciated or misunderstood, particularly in traditional finance theory. However, for strategic asset allocation (SAA) decisions spanning 10 years or more, these phenomena can play a critical role in risk estimation and portfolio design. The chart below illustrates the concept of time diversification by showing how the annualized volatility of compounded U.S. bond returns declines as the investment horizon lengthens, from 1 to 15 years, across four major fixed income categories: U.S. Treasuries (UST), Investment Grade credit (IG), High Yield credit (HY), and Structured products. The steepest decline is seen in HY and Structured bonds, which exhibit markedly lower

volatility at longer holding periods. For instance, HY volatility compresses from 16.4% at a 1-year horizon to just 4.0% over 15 years, a fourfold reduction.

Figure 4: Time diversification effect is most pronounced in HY securities
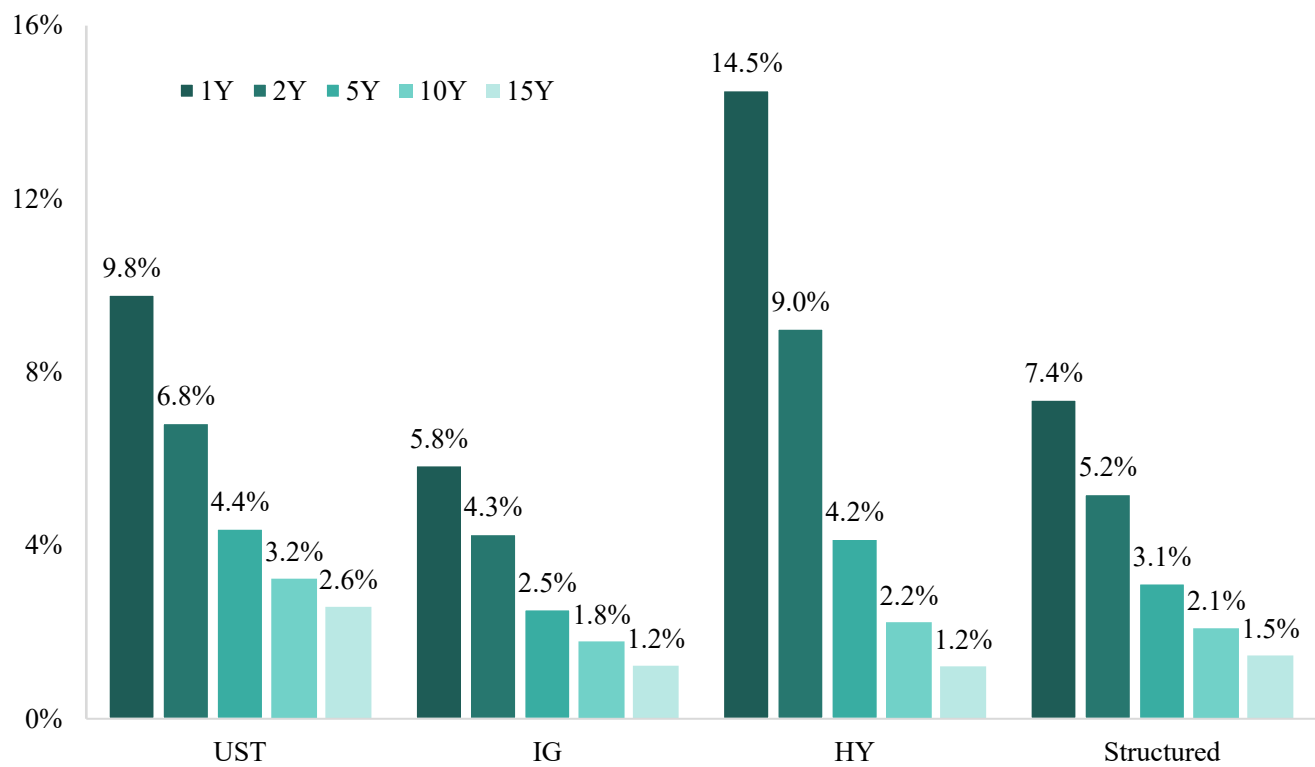

This empirical behavior is not just statistical coincidence but reflects structural features of credit markets. High yield returns tend to be driven by recurring income streams and cyclical credit re-rating patterns that cancel out over time, producing strong mean-reversion dynamics. Meanwhile, interest rate exposure in structured bonds (often backed by amortizing loans or mortgages) introduces a similarly smoothing mechanism via cash flow-driven price anchoring. In contrast, Treasuries, though lower in absolute volatility, display more muted time diversification, as their returns are tightly tethered to evolving rate expectations with less income cushion.

The declining risk at longer horizons does not stem from serially correlated returns, as classical theory would suggest, but from the fact that long-horizon outcomes are more accurately forecastable based on current yields, reducing forecast dispersion. This phenomenon underscores a profound insight for strategic asset allocators: not all short-term risk translates linearly into long-term risk. Especially in HY and structured credit, the compounding of stable income over time and partial mean-reversion of spread shocks deliver disproportionately lower long-term volatility, supporting higher allocation weights in strategic portfolios with long-duration surplus objectives.

If we compare the traditional (standard error) vs novel (RMSE, not scaled) approaches to how wrong we could be in average return estimation, RMSE beats the Standard Error estimation, with both considerably lower average level and interquantile range.

Figure 5: As expected, RMSE is lower than traditional measure of average return volatility STERR
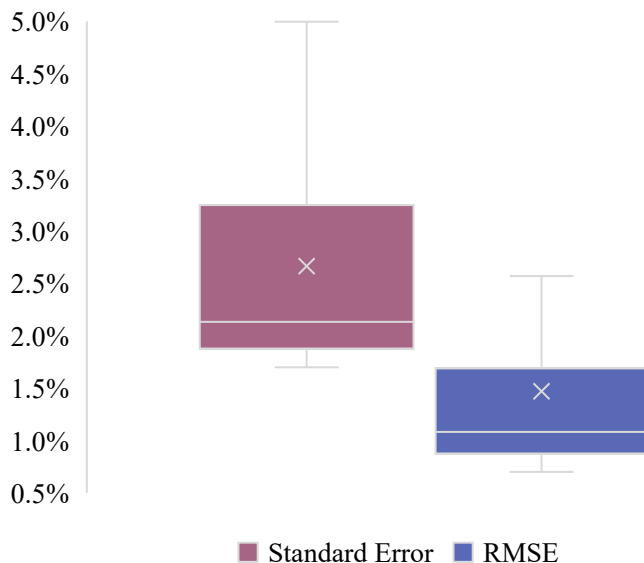
All this indicates that RMSE provides a more reliable and realistic measure of long-term forecast uncertainty. Also, maturity has an impact predictability: the longer the maturity of an index, the more effectively the starting yield predicts actual returns over a 10-year investment horizon. Shorter-term indices face greater reinvestment risk and yield curve uncertainty due to more frequent rollovers, necessitating robust yield forecasting methods.

It should also be noted that the mean error is positive for long-term indexes, which is because the the sample period starts from 2000, and the very low interest rate regime started after like 10 years from 2000, and that decreasing interest rates makes bonds perform better so from the beginning the actual 10-year CAGR returns are higher than the starting yields. Capital gains from falling rates get locked in for longer because short-term bonds mature quickly, prices pull back to par fast, so gains fade quickly, while long-term bonds don't mature soon, so price gains stick and investors enjoy elevated returns longer.

These results illustrate how holding period drastically alters perceived risk: short-term volatility paints a much riskier picture than long-term uncertainty justifies. High-yield and structured bonds, often dismissed as too volatile, emerge as attractive candidates for strategic allocations due to their return stabilization over time.

Rist Estimation

Again, I measure risk as the root mean squared error (RMSE) of my 10-year return forecasts relative to realized outcomes, but because this measure of risk inherently only considers the concern of long-term asset allocators about not hitting the average return targets at the end of investment horizon, I have to combine it with standard deviation measure (weighted average with 30% to the latter) to arrive at a risk measure that also takes into account the investors' willingness to minimize year-to-year volatility for duration, capital charges, and other purposes.

Benchmark-Horizon Bonds (~10Y maturity)

For bonds with maturities close to the 10-year horizon, historical evidence shows realized returns track the starting yield closely. Risk comes only from deviations between starting yield and actual 10-year return.

$$RMSE_{10} = \sqrt{E((R_{10}^{Realized} - Y_0)^2)} * \sqrt{10}$$

I compute this RMSE from historical data, and report it directly as the 10-year forecast error.

Intermediate Bonds (~5Y maturity)

Here I split the horizon into two blocks:

- Block 1: initial holding period until maturity (e.g. 0–5 years).
- Block 2: reinvestment into a new bond for the remainder (e.g. 5–10 years).

Block 1 RMSE: derived from history, scaled by average maturity:

$$RMSE_1 = RMSE_{5Y\ error} * \sqrt{5}$$

Block 2 RMSE: reinvestment uncertainty, driven by rate and spread errors:

$$RMSE_2 = \sqrt{RMSE_1^2 + spread^2} * \sqrt{5}$$

Total 10Y RMSE: the 10-year return is the average of two 5-year returns, so:

$$RMSE_{10} = \sqrt{(\frac{RMSE_1}{2})^2 + (\frac{RMSE_2}{2})^2}$$

Long Bonds (>10Y maturity)

For long-duration indices, risk is dominated by capital re-pricing from yield changes at the 10-year horizon:

$$RMSE_{10} = \sqrt{E((R_{10}^{Realized} - Y_0)^2)} * \sqrt{Maturity} * 1.2$$

Where 1.2 is the factor I use to account for additional uncertainty introduced by yield curve forecast for 2035.

This way each maturity bucket has a clear, tractable formula:

- Benchmark: empirical RMSE vs starting yield.
- Intermediate: 2-block combination of holding + reinvestment errors.
- Long: duration-scaled yield forecast error plus residual.

Strategic Implications for SAA

1. **Risk should not be estimated by volatility alone** – the square-root-of-time method overstates long-term risk. RMSE is a better proxy for actual return uncertainty over strategic horizons.
2. **Mean reversion creates opportunities** – HY and structured credit instruments exhibit risk behaviors more consistent with equities over long holding periods. Their inclusion in a life insurer's portfolio can enhance long-term Sharpe ratios.
3. **Duration enhances forecast accuracy** – the predictive power of starting yield strengthens with bond maturity. This justifies overweighting longer-duration assets in liability-aware frameworks.
4. **Time diversification is real but conditional** – the benefits are most pronounced when:
    o Starting valuations (e.g., yields) are used to forecast returns;
    o Investors are not forced to liquidate prematurely (i.e., drawdown-insensitive);
    o Leverage is managed conservatively.
5. **Policy implication** – a rational, forecast-driven allocator should **redefine risk** as "uncertainty of hitting long-term targets," not year-to-year volatility. This redefinition justifies strategic allocations that might appear aggressive under traditional risk metrics.

Based on all of the above, the final return and risk estimation figures are given below.

Figure 6: Expected return and risk of fixed income indexes
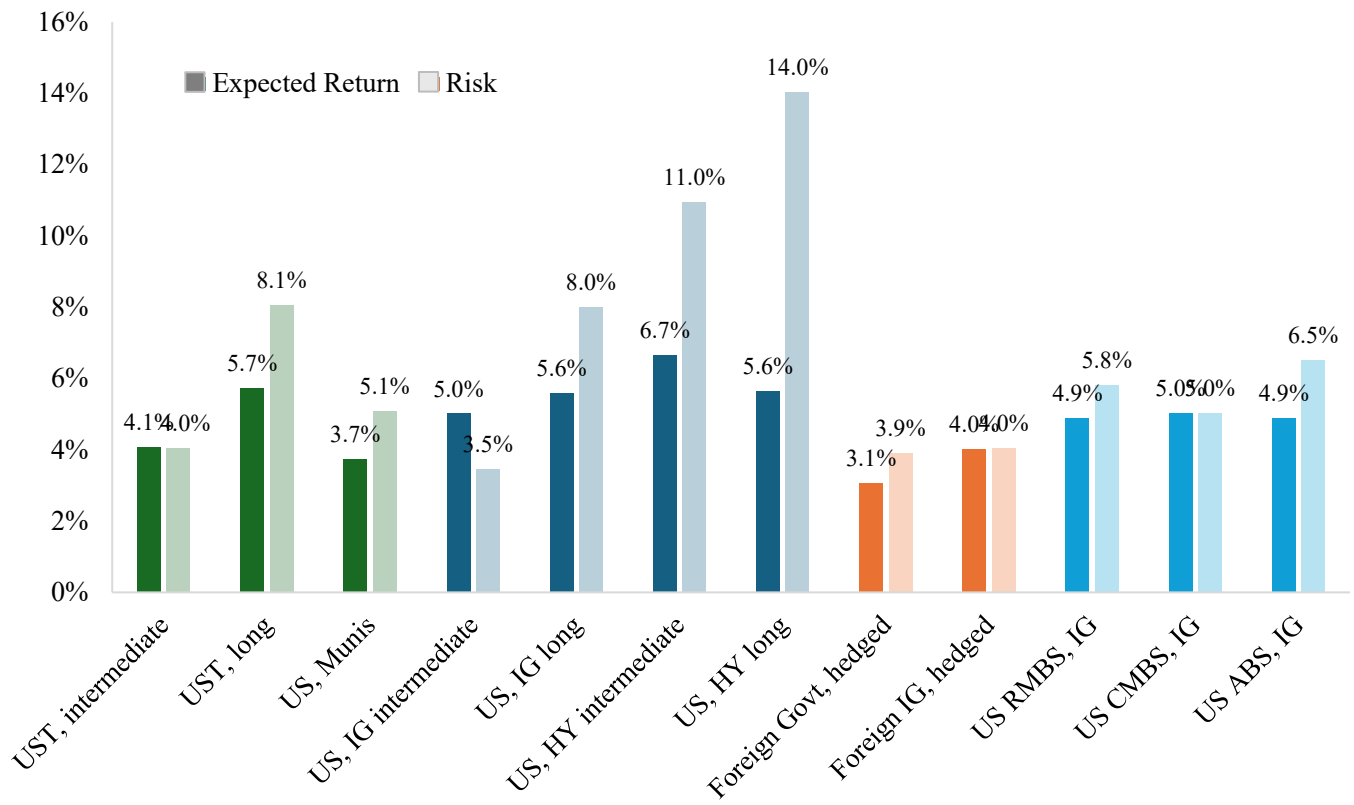
Equity

This section provides a comprehensive explanation of the methodology, rationale, and data inputs used to estimate strategic long-term expected returns for U.S. equities within the Strategic Asset Allocation (SAA) framework. Unlike traditional top-down approaches, which often rely on index-level heuristics or aggregate macro projections, this analysis adopts a granular bottom-up structure, designed to be both cash-flow based and valuation-sensitive, while integrating structural economic insights and historical data patterns. Each step of the equity CMA construction reflects an effort to align financial modeling with the actual behaviors of public companies, equity markets, and sector-specific business models over time.

To begin with, the scope of the equity analysis is intentionally narrowed to U.S. large-cap equities only, and more specifically, to the eleven GICS sectors within the S&P 500 index. The rationale for this focused approach stems from both methodological and operational considerations:

- Bottom-up equity modeling at the sector level requires extensive historical data collection for constituent firms, including detailed variables such as dividends, buybacks, and growth estimates.
- Expanding this framework to multiple geographies or indices would have proven logistically prohibitive and would risk compromising the rigor of the estimation.
- Restricting the analysis to the U.S. large-cap equity universe avoids the complications of FX forecasting and cross-border tax and liquidity assumptions.

Historical data from Bloomberg were collected for all eleven sector-specific equity indices from 2003 to 2025, specifically the Bloomberg tickers corresponding to each sector such as B500CT (Consumer Staples), B500E (Energy), B500I (Industrials), and so forth. The monthly time series included index level prices, dividend yields, trailing-twelve-month (TTM) earnings per share (EPS), price-to-earnings (P/E) ratios, and net profit margins. This multi-decade data foundation ensures a sufficiently long observation window to capture both cyclical and structural patterns, including periods of economic expansion, contraction, and crisis.

The foundational component of the expected return estimation is the concept of a "cash yield," the equity market's closest analog to a bond's starting yield. Accounting earnings can be systematically manipulated and often diverge from the underlying economic reality that investors should rely on, making cash-based measures significantly more robust. Academic literature and regulatory commentary consistently highlight that companies frequently engage in earnings management through accrual adjustments, one-off items, or strategic timing of expenses and revenues, which distorts reported earnings quality. Earnings may reflect accounting judgment rather than actual cash flows, rendering traditional P/E or EPS-based return models vulnerable to these distortions. In contrast, empirical evidence suggests that shareholder yield components, dividends and buybacks, are harder to manipulate and better reflect real cash returned to investors. Dividend-paying stocks, on average, exhibit lower return volatility, even when controlling for firm size, indicating that cash distributions are associated with greater stability and transparency. Moreover, accrual-based earnings quality improves only when internal controls are strong, otherwise companies may still distort earnings figures even in ostensibly well-governed firms. These findings reinforce the superiority of using cash-based yields as forward return anchors in equity return modeling framework, dividends and buybacks cannot be fabricated, they reflect real value returned to shareholders, and they are less subject to managerial discretion or manipulation.

For equities, this is defined as the sum of dividend yield and share buyback yield. While dividend yield data are readily available at the sector index level, buyback data is not directly accessible in aggregated form. To overcome this, a bottom-up methodology was employed:

- For each year-end, the constituent companies of every sector index were retrieved via Bloomberg's Excel API.
- Key data included market capitalization, share prices, shares outstanding, and actual buyback amounts.
- These values were used to compute market-capitalization-weighted buyback yields at the sector level, creating a robust and replicable proxy for shareholder yield.

Figure 7: Buyback yields have considerably increased since 2012
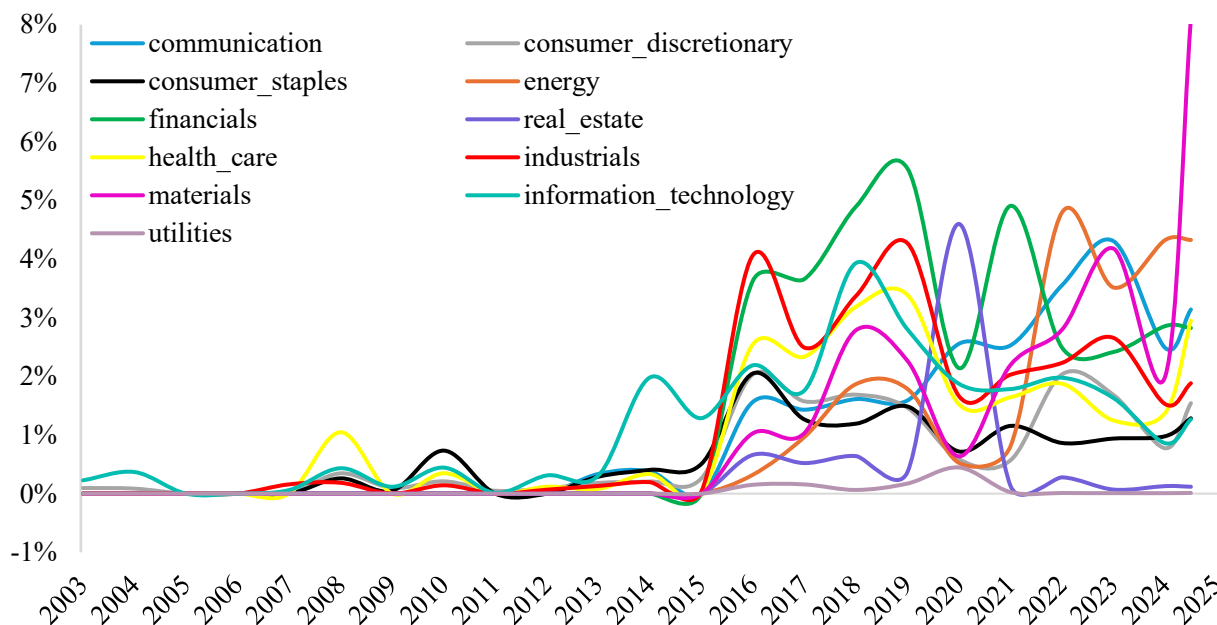
Over the past two decades, share buybacks have become a structurally important component of shareholder return policy across nearly all U.S. equity sectors. As illustrated in the chart, buyback yields were negligible or even negative during the early 2000s but began rising meaningfully post-2010, with an especially sharp acceleration following the 2017 corporate tax reform and the COVID-19 recovery period. By 2022–2025, many sectors, including Financials, Technology, and Industrials, consistently delivered buyback yields in the 3% to 6% range, rivaling or exceeding their dividend yields. This shift reflects a broader transformation in corporate capital allocation strategies, where buybacks have become the preferred mechanism for returning cash to shareholders due to their flexibility, tax efficiency, and perceived signaling value. The growing prominence and persistence of buyback activity underscore the need to incorporate them explicitly into any forward-looking equity return model, particularly for sector-level strategic allocation analysis.

An important technical adjustment was made to both dividend and buyback yields to better reflect the timing of cash distributions. Specifically, raw dividend yield figures, which are calculated based on the year-end index level, were adjusted by dividing by the average index level over the course of the preceding year. This correction accounts for the fact that dividends and buybacks are distributed throughout the year rather than as a single lump sum at year-end, improving the fidelity of the cash yield as an annualized figure.

To estimate forward growth, 5-year consensus EPS growth forecasts were constructed using Capital IQ data. As these forecasts were not available in aggregate at the sector index level, another bottom-up process was employed:

- For each year-end in the historical period, EPS growth expectations were retrieved for all constituent companies in each sector, if available (they were available for majority of index constituents all of the time).
- These forecasts were then market-cap weighted to arrive at a sector-level forward growth rate.
- It is assumed that the growth in cash yield (dividends and buybacks) matches EPS estimated growth rate.

With both cash yield and expected growth in hand, the next step involved computing the implied cost of equity for each sector at each year using a two-stage dividend discount model, a version of the Gordon Growth Model. The structure of the model includes an initial five-year phase of elevated growth, followed by a perpetual growth phase at a lower terminal rate. The formula applied is as follows:

$$P = \sum_{t=1}^{5} \frac{D_0(1+g)^t}{(1+r)^t} + \frac{D_0(1+g)^5(1+g_{term})}{(r-g_{term})(1+r)^5}$$

- P is the index level at year-end
- D_0 is the current cash yield (dividends + buybacks)
- g is the 5-year EPS growth rate
- rfr is the terminal growth rate (set equal to the long-term risk-free rate)
- r is the cost of equity to be solved for

This nonlinear equation was solved using a VBA-automated goal-seek macro to determine the implied cost of equity for each sector and year. After obtaining the implied cost of equity, the long-term risk-free rate was subtracted to derive the implied equity risk premium (ERP), the primary input into the SAA model. The choice of using the long-term rate (long treasury index) as the discount rate and terminal growth assumption is consistent with equity's long-duration nature, as equities represent claims on a very long stream of future cash flows.

Figure 8: Implied ERP levels have been more volatile in the last decade
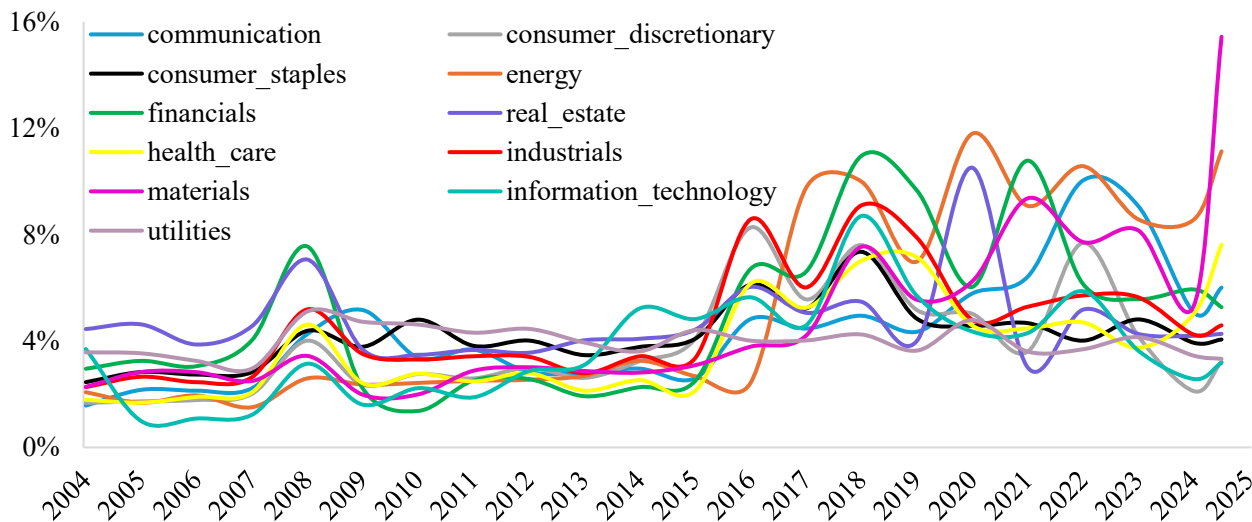
The chart below plots the evolution of implied ERP by sector over the 2004–2025 period. The series are highly dynamic, influenced by fluctuations in valuation, payout behavior, and forward growth expectations. Notably, a pronounced upward shift in implied ERP levels is visible post-2015 across most sectors, with a further spike during periods of market stress, including 2020 and late 2023. These ERP movements capture not just investor sentiment and risk appetite, but also cyclical inflections in fundamentals and pricing.

Beliefs about market efficiency inherently shape how equity risk premiums are estimated. For long-horizon allocators, the choice of methodology reflects underlying assumptions about whether markets are efficiently priced. If one believes that public markets are broadly efficient over time, or at least that their direction is inherently unpredictable, then the current implied equity risk premium (ERP), derived from prevailing market prices and cash flows, offers the most rational anchor for return expectations. However, if one sees recurring valuation dislocations or structural inefficiencies at the sector or macro level, then using longer-term average implied ERPs or even historical realized premiums may be more appropriate. Survey-based ERPs, while occasionally used, may be preferred only by those who lack confidence in market-based signals altogether.

Since this framework is designed primarily with institutional allocators in mind, and I believe in general market efficiency with some sector-level inefficiencies, the implied ERP is adopted as the core signal, which is then refined through valuation-aware and structurally-informed adjustments, as described in the subsequent CAPE-based and profitability-based enhancements.
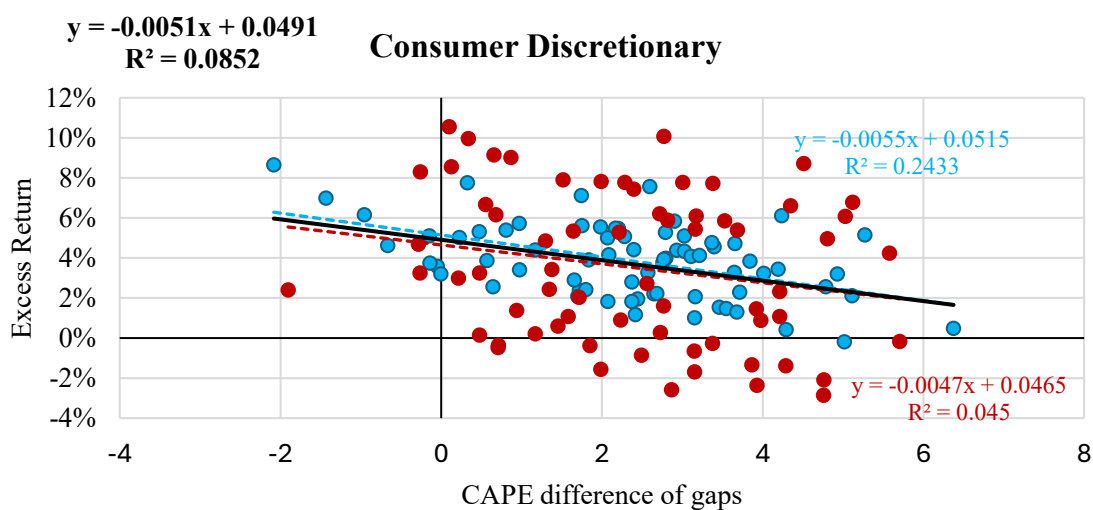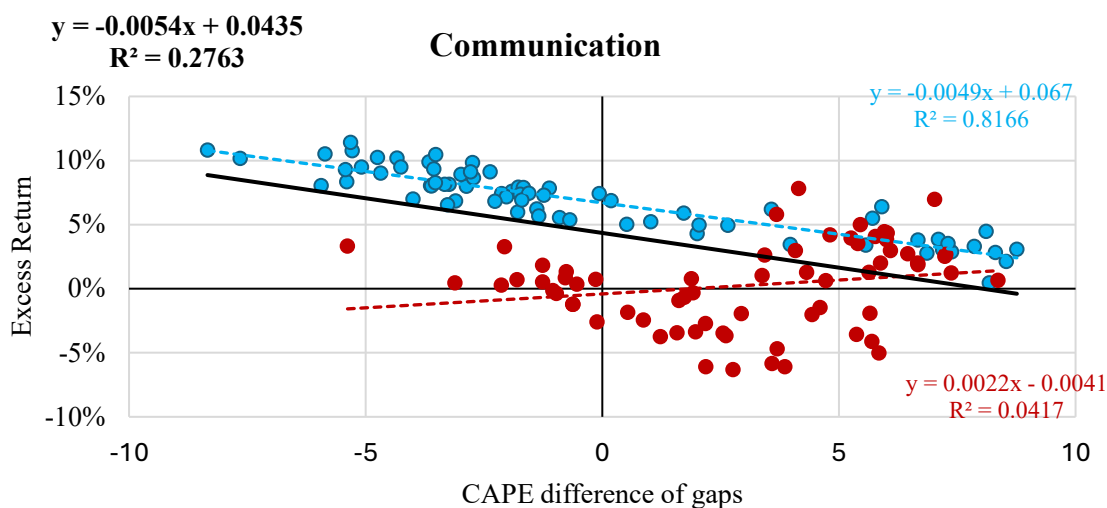
Having established base return expectations using implied cost of equity (implied ERP + long-term riskfree rate), the next step introduces a valuation-sensitive overlay via sector-specific CAPE adjustments. The cyclically adjusted P/E ratio (CAPE) serves as a signal of valuation deviation from historical norms. The methodology here avoids simplistic valuation heuristics and instead uses a regression-based framework to determine whether CAPE ratios have explanatory power for future sector-level excess returns. Rolling regressions were performed for each sector, regressing subsequent 5-year excess returns on CAPE deviations from historical norms. Three sub-periods were evaluated:
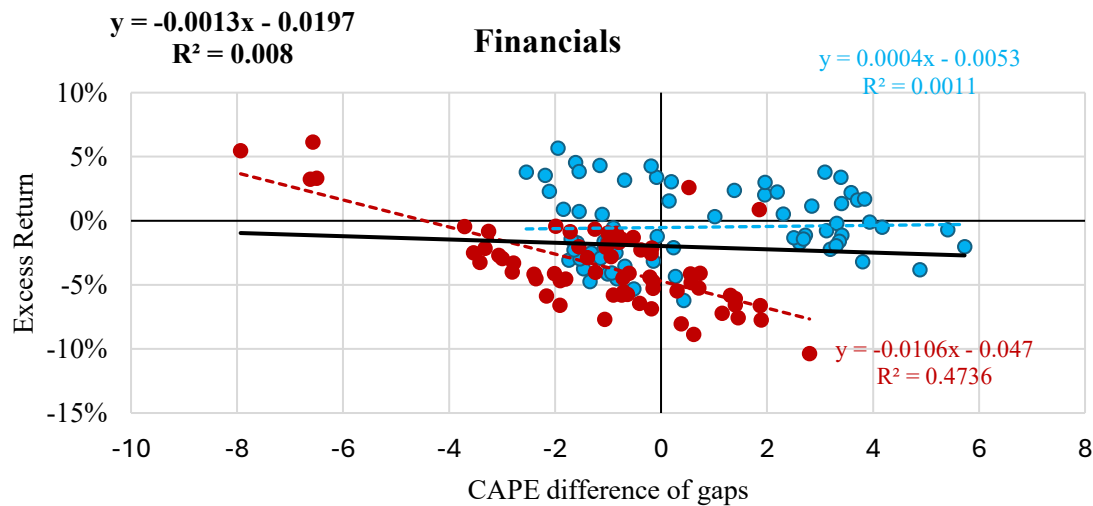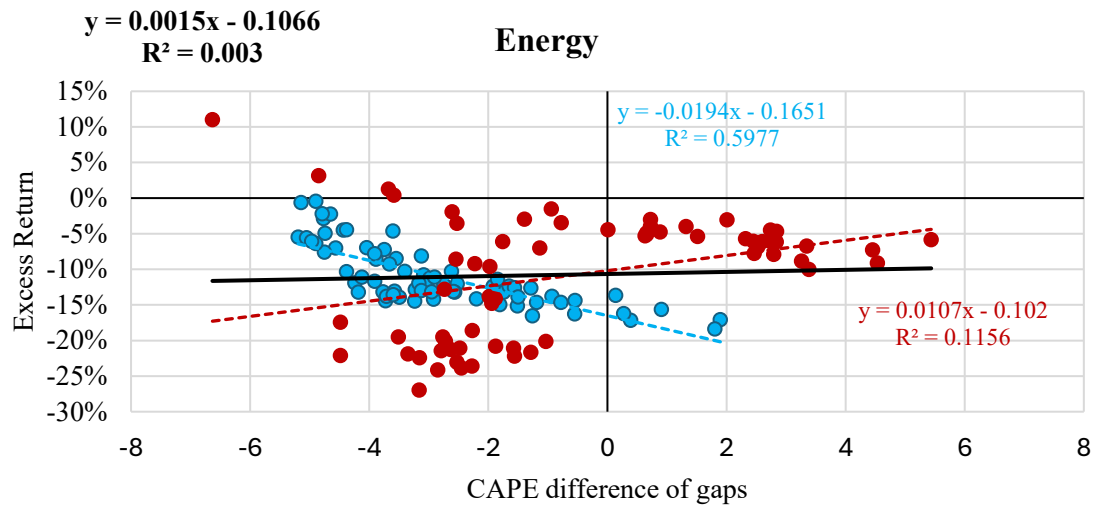
- The full historical sample
- The post-GFC expansion (2009–2015)
- The more recent cycle (2015–2020)

Only when these regressions exhibited meaningful explanatory power, defined as an R-squared above 0.2 in at least one sub-period, was an adjustment applied. The size of the adjustment was proportional to the statistical significance and stability of the relationship:

- If both long- and short-term regressions showed strong fit, a full adjustment of the implied excess return was imposed.
- If only one period met the criteria, a smaller 25 to 50 percent adjustment was applied.
- In sectors where CAPE-return linkages were weak or unstable, no adjustment was made.
- In sectors undergoing structural change, such as Information Technology, greater emphasis was placed on recent regressions to reflect evolving valuation paradigms.

The regression charts for each sector are given below (blue dots represent time period 2009-2015, red dots are for 2015-2020, while black line represents the full sample).

Communication

$y = -0.0054x + 0.0435$
$R^2 = 0.2763$

$y = -0.0049x + 0.067$
$R^2 = 0.8166$

$y = 0.0022x - 0.0041$
$R^2 = 0.0417$

Consumer Discretionary

$y = -0.0051x + 0.0491$
$R^2 = 0.0852$

$y = -0.0055x + 0.0515$
$R^2 = 0.2433$

$y = -0.0047x + 0.0465$
$R^2 = 0.045$

y = -0.0085x - 0.0494
R² = 0.2869

Consumer Staples

y = -0.0067x - 0.0373
R² = 0.119

y = -0.0061x - 0.0544
R² = 0.2097

Excess Return

CAPE difference of gaps

y = 0.0015x - 0.1066
R² = 0.003

Energy

y = -0.0194x - 0.1651
R² = 0.5977

y = 0.0107x - 0.102
R² = 0.1156

Excess Return

CAPE difference of gaps

y = -0.0013x - 0.0197
R² = 0.008

Financials

y = 0.0004x - 0.0053
R² = 0.0011

y = -0.0106x - 0.047
R² = 0.4736

Excess Return

CAPE difference of gaps

y = -0.0028x - 0.0483
R² = 0.0435

Real Estate

y = -0.009x - 0.0171
R² = 0.5321

y = 0.0006x - 0.0767
R² = 0.0044

Excess Return

CAPE difference of gaps

y = -0.0059x + 0.0018
R² = 0.1871

Health Care

y = -0.0099x + 0.0177
R² = 0.6187

y = -0.0009x - 0.0201
R² = 0.0132

Excess Return

CAPE difference of gaps

y = -0.0078x + 0.0052
R² = 0.5166

Industrials

y = -0.0065x + 0.019
R² = 0.6974

y = -0.0063x - 0.0106
R² = 0.4289

Excess Return

CAPE difference of gaps

Materials

y = -0.006x - 0.0698
R² = 0.2994

y = -0.0085x - 0.0762
R² = 0.7238

y = -0.0012x - 0.0573
R² = 0.0091

Excess Return

CAPE difference of gaps

Information Technology

y = 0.0002x + 0.0685
R² = 0.0002

y = -0.0096x + 0.1033
R² = 0.6828

y = -0.0113x - 0.0035
R² = 0.3723

Excess Return

CAPE difference of gaps

y = -0.0036x - 0.0094
R² = 0.2853

Utilities

y = 0.0013x - 0.0022
R² = 0.0338

y = -0.0098x + 0.0306
R² = 0.399

Excess Return

CAPE difference of gaps

The CAPE adjustment process led to the following modifications:

- Technology and consumer staples received a slight upward adjustment due to persistent undervaluation relative to realized performance.
- Industrials and Utilities saw downward adjustments due to persistent overvaluation and a historically robust connection between high CAPEs and poor forward returns.

The output tables for all three testing period regressions are given below:

2009-2015	consumer_staples	industrials	information_technology	utilities
Alpha	-0.0373	0.0190	-0.0035	-0.0022
p-value	0.0000	0.0000	0.6075	0.3927
Beta	-0.0067	-0.0065	-0.0113	0.0013
p-value	0.0027	0.0000	0.0000	0.1227
R-squared	0.119	0.697	0.372	0.034
CAPE deviation (x)	0.00	0.00	0.00	0.00
Implied excess return (y)	**-3.73%**	**1.90%**	**-0.35%**	**-0.22%**

2015-2020	consumer_staples	industrials	information_technology	utilities
Alpha	-0.0544	-0.0106	0.1033	0.0306
p-value	0.0000	0.0000	0.0000	0.0042
Beta	-0.0061	-0.0063	-0.0096	-0.0098
p-value	0.0001	0.0000	0.0000	0.0000
R-squared	0.210	0.429	0.683	0.399
CAPE deviation (x)	0.00	0.00	0.00	0.00
Implied excess return (y)	**-5.44%**	**-1.06%**	**10.33%**	**3.06%**

Entire period	consumer_staples	industrials	information_technology	utilities
Alpha	-0.0494	0.0052	0.0685	-0.0094
p-value	0.0000	0.0038	0.0000	0.0005
Beta	-0.0085	-0.0078	0.0002	-0.0036
p-value	0.0000	0.0000	0.8855	0.0000
R-squared	0.287	0.517	0.000	0.285
CAPE deviation (x)	-9.84	9.84	9.71	7.46
Implied excess return (y)	**3.41%**	**-7.12%**	**7.06%**	**-3.63%**

Finally, a third layer of refinement was applied to expected returns based on structural sector-specific trends in profitability and margins. These adjustments recognize that valuation-based models such as CAPE, while informative, do not always capture evolving fundamentals, particularly when sector economics are undergoing transformation or degradation.

- **Real Estate** was adjusted downward by 50 basis points due to a sustained decline in sector-wide net profit margins, which have fallen to levels last seen during the Global Financial Crisis. Net margins now hover around 11.9 percent, down nearly 12 points from their 2015 peak, with a negative annual trend of minus 1.83 percent. Structural pressures include higher interest rates compressing cap rate spreads and secular weakening of office and retail segments.
- **Communication Services** received a 50 basis point upward adjustment. Net margins have expanded consistently, reaching 19.2 percent in 2025, nearly double the average from a decade prior. This improvement stems from a sectoral shift toward scalable, digital platform companies.
- **Utilities** were adjusted upward by 25 basis points, supported by a secular rise in profitability to 14.4 percent, driven by inflation-linked rate bases, electrification demand, and renewable energy investment.

**Figure 9: Net profit margins by sector**
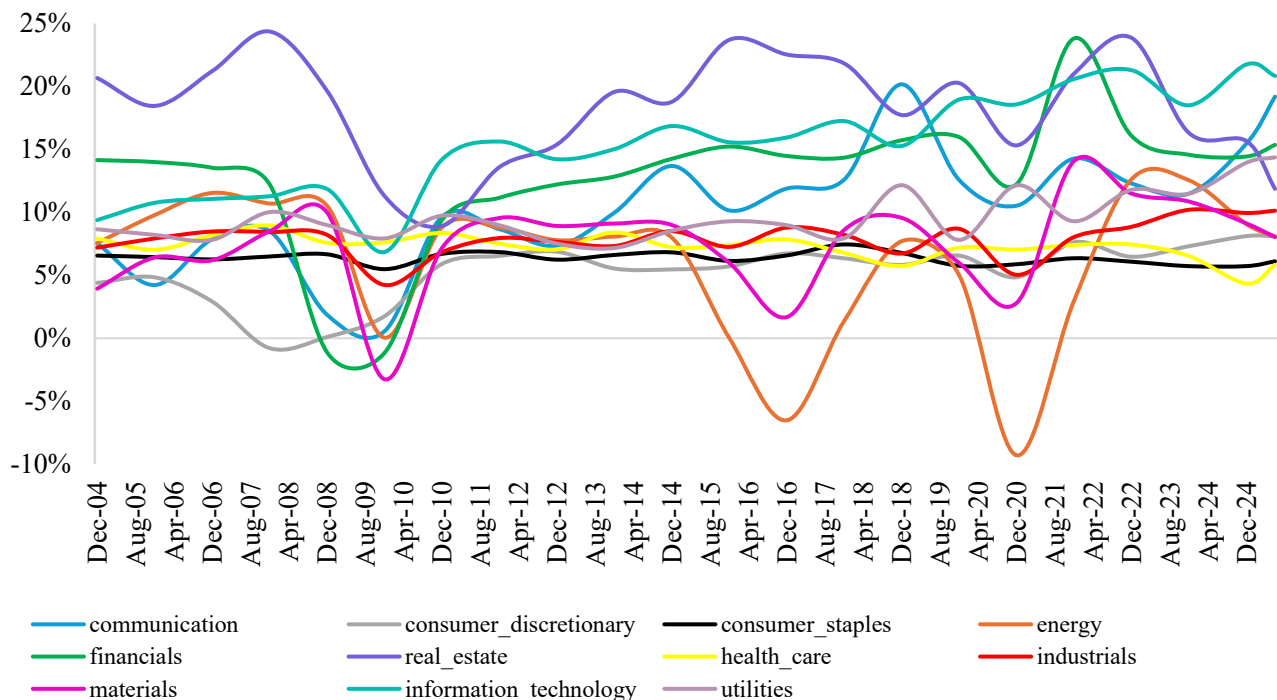
Together, the methodology outlined above represents a rigorous, data-intensive, and forward-looking approach to equity return forecasting. By anchoring expectations in actual cash flows, layering in valuation and structural considerations, and avoiding reliance on simplistic heuristics or backward-looking averages, this framework aims to produce credible, institutionally relevant return forecasts for use in long-horizon strategic allocation decisions.

Risk Estimation

The chart below compares the 10-year scaled root mean square error (RMSE × √10) of return forecasts to the historical standard deviation of total returns for each sector. RMSE here is calculated based on the forecast error between the modeled expected return (implied cost of equity) and the realized return over rolling 5-year periods, and then scaled by √10 to represent volatility over a strategic 10-year horizon, consistent with the time frame of our SAA optimization. This scaling adjusts for the fact that forecast errors over time are not necessarily i.i.d., but it still offers a more forward-looking, model-anchored estimate of risk than raw historical volatility.

Figure 10: RMSE vs Standard Deviation
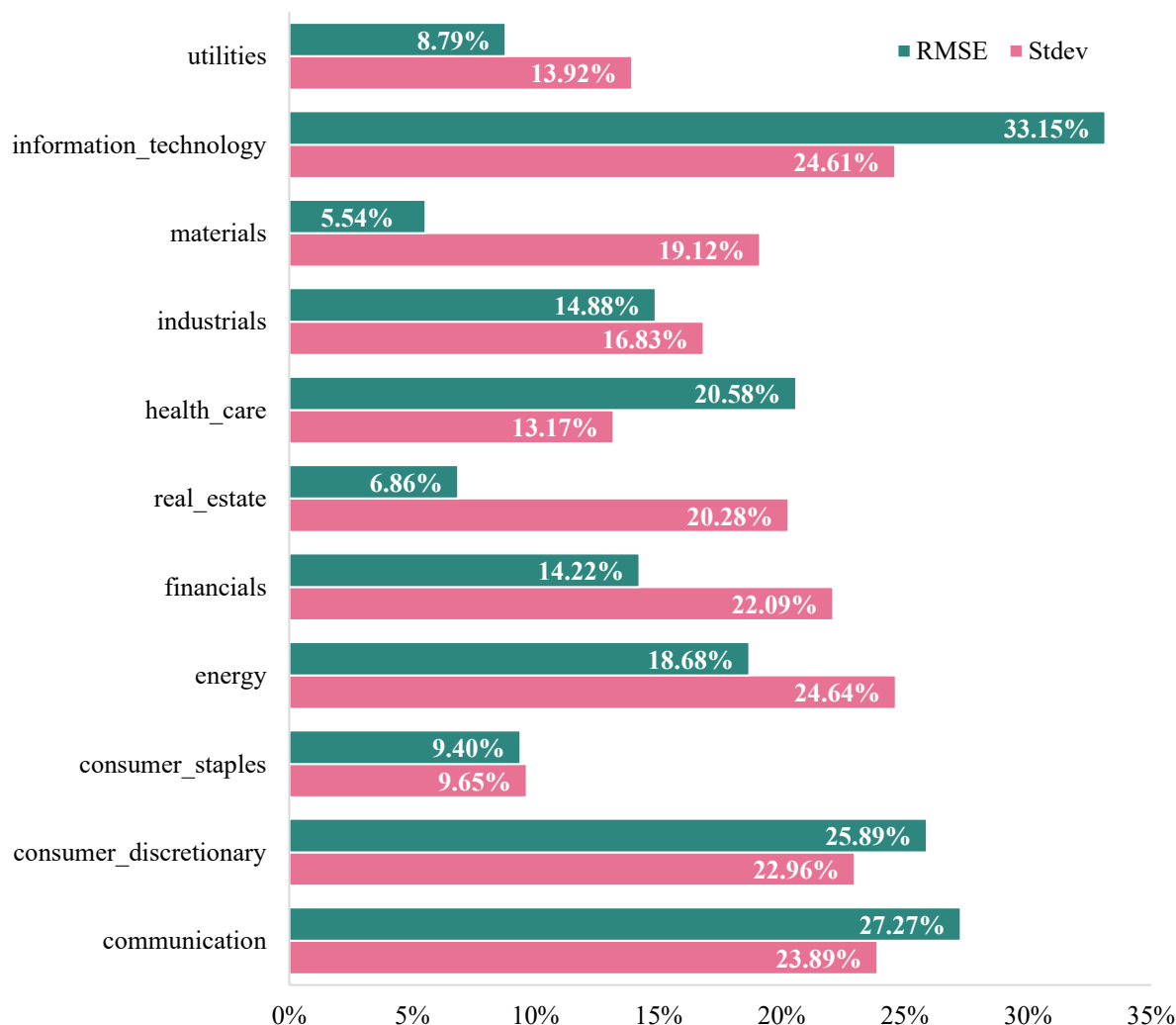
Notably, in some sectors, specifically Communication Services, Consumer Discretionary, Health Care, and Information Technology, the RMSE actually exceeds the observed standard deviation of returns. This counterintuitive outcome suggests that for these sectors, return forecasts have historically exhibited higher miss errors than the typical annual price fluctuation, which may reflect structural shifts, model misspecification, or simply the inherent difficulty in forecasting sectors undergoing rapid transformation. Conversely, more stable sectors like Consumer Staples, Utilities, and Real Estate exhibit RMSEs that are meaningfully lower than their historical volatilities, underscoring the higher accuracy and reliability of forecast models in those segments.

Despite these nuances, RMSE remains the preferred measure of risk in this SAA framework. It directly reflects the historical uncertainty of our modeled expected return inputs, rather than backward-looking price fluctuations, making it more consistent with a forward-driven optimization approach. This methodological choice ensures internal consistency between return assumptions and risk estimates.

Based on all of the above, the final return and risk estimation figures are given below:

Sector	Implied ERP	CAPE adjustment	Structural adjustment	Expected return	Risk (RMSE)
Communication	6.01%		0.50%	6.51%	27.27%
Consumer discretionary	3.22%			3.22%	25.89%
Consumer staples	4.06%	0.85%		4.91%	9.40%
Energy	11.13%		-0.50%	10.63%	18.68%
Financials	5.27%			5.27%	14.22%
Real estate	4.27%			4.27%	6.86%
Health care	7.62%			7.62%	20.58%
Industrials	4.59%	-3.56%		1.03%	14.88%
Materials	15.44%			15.44%	5.54%
Information technology	3.18%	5.16%		8.34%	33.15%
Utilities	3.33%	-0.91%	0.25%	2.67%	8.79%

Alternatives

Private equity

I view the expected return profile of private equity relative to public markets through the lens of factor exposures. Buyout strategies, which dominate the private equity universe, systematically load more heavily on certain risks than public equities. Because leverage is central to the buyout model, PE portfolios effectively run at higher equity betas, closer to 1.2–1.5 in practice rather than the sub-1.0 estimates implied by smoothed NAVs. This means the true risk is higher than what reported returns suggest, and that risk tends to show up in prolonged bear markets rather than in short, sharp drawdowns.

The illiquidity angle is more nuanced. In theory, locking capital for 5–10 years should command a premium, but in practice, much of it is competed away. Many investors seem content to trade off some economic compensation in exchange for smoother reported returns and the reduced headline volatility that comes with appraisal-based valuations. As a result, the realized illiquidity premium often looks small or even nonexistent.

The industry track record also points to little evidence of persistent net alpha. Several large-sample studies find that, once you control for leverage, small-cap exposure, and fees, private equity returns are largely explained by traditional risk factors. In other words, the outperformance often attributed to manager skill or illiquidity premia is better understood as compensation for bearing higher equity beta and structural tilts. Fees in particular eat up much of the gross excess return, making it difficult to justify a positive "alpha" at the asset-class level.

Beyond leverage, private equity tends to tilt toward smaller and historically cheaper companies. The small-cap bias is visible in the typical characteristics of buyout targets, while the value bias has become less consistent in recent years as entry multiples have risen. Taking these exposures together, I think it is most realistic to treat private equity as a leveraged small-cap equity exposure, with higher sensitivity to the equity risk premium, some residual size tilt, and no persistent net alpha after fees.

For my expected return modeling, I primarily use a discounted cash-flow framework similar to AQR's yield-based approach: I start from an estimate of the unlevered return (income yield plus real growth), then add the effects of financial leverage, conservatively account for potential multiple expansion, and subtract fees. This makes the drivers of PE returns more transparent and allows me to stress-test assumptions around valuations, leverage costs, and growth. That said, I also supplement this analysis with a simpler public-equity-based comparison, where I treat private equity as a leveraged small-cap exposure with no net alpha. Using this as a cross-check provides an additional perspective and helps ensure that my forward-looking assumptions remain grounded against public market benchmarks.

In constructing my CMA inputs, I use arithmetic mean expected returns rather than geometric, since arithmetic returns are the appropriate measure for portfolio optimization and strategic asset allocation, they represent the expectation of a one-period return and avoid deducting variance drag, which the optimizer already accounts for through the volatility input. Reported geometric means, while more intuitive for compounding, understate the inputs required for allocation modeling. For the cash or risk-free rate, I do not rely on today's short-term SOFR or T-bill yield, which are cyclical and unsuitable for a strategic horizon. Instead, I assume a long-run real cash rate (anchored

by historical averages and central bank estimates of the neutral rate) combined with long-term inflation expectations from breakeven markets, ensuring consistency with a 10-year investment horizon.