Boosting Retirement Income through Dynamic Withdrawals

Ravi Saraogi, CFA*

August 6, 2025

Abstract

Dynamic withdrawal strategies, extensively researched internationally, remain underexplored in India. This paper bridges this significant research gap by rigorously evaluating popular dynamic withdrawal methods using Indian data. Employing simulations based on historical equity, debt and inflation data from the Indian market, we compare 10 different adaptive and dynamic withdrawal strategies. The study demonstrates that dynamic strategies can improve withdrawals and sustainability compared to static withdrawal methods. However, this improvement comes at a significant cost of volatility in receiving income from a retirement portfolio.

We use multiple metrics to evaluate dynamic withdrawal strategies across four broad areas: ability to support recurring expenditure (spending), possibility of leaving an inheritance (savings), volatility in income generation (stability) and the ability of the corpus to last the full retirement period (sustainability). The study then introduces the RetireAbility™ Index which combines these different metrics to arrive at a composite score for each withdrawal strategy, enabling retirees and advisors to pick a strategy best suited for their needs.

*Ravi Saraogi, CFA is a SEBI Registered Investment Adviser and Co-founder of Samasthiti Advisors (www.samasthiti.in). He can be reached at `ravi.saraogi@samasthiti.in`.

1. Preface: The Evolution of Retirement Income Strategies

The landscape of retirement income planning has undergone a profound transformation. For much of the 20th century, the dominant approach was reliance on company pension and personal savings. This model provided a reliable and diversified income stream for many retirees. Company pensions, in particular, offered a defined benefit— a guaranteed income for life, managed by the employer. The primary task for a retiree was simply to manage their personal savings to supplement this foundation.

Today, things are decidedly different. Defined-benefit pensions have largely disappeared from the private sector, replaced by defined-contribution plans. This shift has transferred the full weight of investment and longevity risk from the employer to the individual. Retirees are no longer just managing supplementary savings. They are now responsible for converting a lifetime of accumulated assets into a sustainable income that must last for an unknown number of years.

This new reality demands a more sophisticated approach than the one that served previous generations. The core challenge is no longer just about accumulating assets, but about decumulating them wisely. Retirees must grapple with a host of complex, interconnected risks: market volatility, inflation, the sequence of investment returns, and the risk of outliving their savings.

In response, a new field of research has emerged, focused on dynamic withdrawal strategies. These strategies move beyond the static, one-size-fits-all rules. This paper will explore the most prominent of these dynamic strategies. We will dissect their mechanics, compare their performance, and analyse the trade-offs they present between withdrawals, stability and preservation. The goal is to provide a clear, practical guide for individuals and financial advisors seeking to navigate the complexities of modern retirement income planning.

2. Background

2.1. Early Foundations: Static Withdrawal Rules and the 4% Paradigm (1990s)

The concept of a "safe withdrawal rate" (SWR) for retirees' portfolios was popularized in the 1990s, establishing the baseline for later dynamic strategies. William Bengen's seminal 1994 study introduced the famous "4% rule" (Bengen, 1994). Bengen found that a 4% initial withdrawal, followed by annual inflation-adjusted withdrawals, could sustain a 30-year retirement in historical U.S. market conditions. Soon after, the "Trinity Study" (Cooley et al., 1998) expanded on Bengen's analysis by examining success rates across various asset allocations and time horizons. The Trinity study confirmed that 4% withdrawals from a balanced (50/50 stock-bond) portfolio had extremely high success historically. These early studies established fixed inflation-adjusted withdrawal strategies as a simple rule of thumb, valued for providing a stable real income stream each year.

By the 2000s, researchers began to question whether more adaptive withdrawal methods could improve retirement outcomes by responding to market performance.

2.2. Emergence of Dynamic Withdrawal Strategies (2000s)

Researchers in the 2000s introduced dynamic withdrawal strategies that adjust spending over time, aiming to balance retirement sustainability with spending flexibility. The earliest of these were decision rule-based methods that made modest tweaks to the rigid 4% rule. For example, financial planners suggested forgoing inflation increases in years following a portfolio loss. Under this rule, if the portfolio declined in a given year, the retiree would skip the inflation adjustment on withdrawals the next year – effectively taking a real cut in income. Though simple, this adjustment accumulates over time; even small spending cuts compound and can improve portfolio longevity.

A more comprehensive set of decision rules was proposed by (J. T. Guyton, 2004) and later (J. Guyton & Klinger, 2006), often termed the "guardrails" strategy. This method sets an initial withdrawal rate (e.g. 4-5%) and then adjusts up or down by a fixed percentage (typically 10%) if the withdrawal rate strays outside predefined "guardrails" relative to the portfolio. In practice, the guardrails approach grants raises in good markets and imposes cuts in bad markets, but with controlled limits to avoid extreme swings.

Overall, these 2000s-era developments demonstrated that retirees willing to adjust their income could enjoy higher initial spending and better longevity odds, at the cost of year-to-year spending variability. This insight that flexibility can enhance both spending and sustainability laid the groundwork for a broader exploration of dynamic strategies in the following decade.

2.3. Diversification of Dynamic Strategies and Comparative Analyses (2010s)

By the 2010s, the literature on retirement withdrawals had expanded to include numerous adaptive strategies, prompting comparative analyses. Wade Pfau's work is especially notable in this period for systematizing the discussion of variable withdrawals. (Pfau, 2015) provided a comprehensive review and classification of variable spending strategies, situating them on a continuum between two extremes: on one end, the traditional fixed inflation-adjusted amount (no adjustment to portfolio outcomes), and on the other, fixed percentage method that recalculates withdrawals based on remaining portfolio balance.

Pfau and others compared these strategies on multiple criteria and not just failure rates (probability of running out of corpus). A key insight was that the traditional failure rate metric (used in static 4% rule studies) is insufficient for evaluating dynamic strategies. For instance, a fixed-percentage withdrawal from remaining balance will never fail (since we are withdrawing a fixed percentage from remaining balance, the portfolio will never deplete) but could force very low income in later years, which a simple failure rate will not capture. Pfau emphasized evaluating trade-offs: how often and how steeply might a retiree's income drop under a given method, versus how high can their initial and lifetime withdrawals be.

Throughout the 2010s, many new variants were proposed to strike different balances. For example, (Zolt, 2013) introduced a "target percentage adjustment" method. Others explored "ratcheting" strategies, where retirees give themselves a permanent raise when markets perform so well that the portfolio hits new highs, like (Kitces, 2015).

The "endowment model" of spending also gained attention. Inspired by university endowments, it involves withdrawing a percentage of a multi-year moving average of portfolio value to smooth out short-term market swings.

Researchers like Blanchett, Finke, and Pfau also began incorporating capital market expectations into withdrawal analysis – notably, (Finke et al., 2013) warned that the low bond yields and high stock valuations of the 2010s could make the historical 4% rule too aggressive going forward.

2.4. Recent Developments

In the 2020s, research has continued to refine dynamic withdrawal approaches. Notably, Morningstar's annual "State of Retirement Income" reports, (Arnott et al., 2024), have provided up-to-date analyses of safe withdrawal rates and strategy comparisons.

Morningstar's findings across these strategies reinforced several key themes in the literature. First, dynamic withdrawal strategies can indeed stretch a portfolio to support higher lifetime income by preventing overspending after market downturns and allowing extra spending in bull markets. For example, flexible approaches in their studies often yielded greater total withdrawals over 30 years than a rigid plan, and often left less unspent money (which is desirable for those prioritizing income over legacy).

However, the tension between spending level and spending stability is unavoidable. Strategies that enabled a higher spending invariably introduced more variability in yearly cash flows. Morningstar explicitly highlighted this trade-off. Retirees must weigh higher withdrawals against the volatility in annual income.

Interestingly, their models showed the highest sustainable withdrawal rates for a 30-year horizon came from portfolios with balanced or moderate equity exposure (around 20%–40% stocks). More aggressive stock allocations produced higher median ending wealth (more upside), but not higher safe withdrawal rates. This is consistent with the findings in (Raju & Saraogi, 2024).

2.5. Toward an Indian Context: Recent Research and Implications

The Indian retirement landscape presents distinct challenges characterised by historically higher inflation and different asset return dynamics. These structural differences make it inappropriate to directly apply frameworks like the U.S.-centric 4% rule without local calibration. Recent research has begun addressing this gap. (Saraogi, 2022) conducted a first-of-its-kind historical analysis using Indian data to estimate safe withdrawal rates for the Indian retiree. This study concluded that the 4% withdrawal rate is not suitable for India, and a more appropriate withdrawal rate is near 3%.

Building on this, (Raju & Saraogi, 2024) extended this inquiry using both Monte Carlo simulations and boot strapping, as well as across varying asset allocations to arrive at safe withdrawals rate for the Indian market. This study argued that a safe withdrawal range of about 3.0%–3.5% is more prudent for Indian retirees. These studies underscore the need to localise retirement planning frameworks, ensuring they reflect the volatility, taxation, and inflation regimes that are unique to the Indian financial system.

Further extending this work, (Raju, 2025), among other things, evaluates adaptive and dynamic strategies in an Indian setting. The study considers fixed real withdrawals versus dynamic and declining spending approaches, similar to those discussed globally. Raju's inclusion of dynamic withdrawal methods indicates that Indian retirees could also benefit from flexible rules – for example, taking smaller withdrawals after bad market years or allowing spending to gradually decline with age.

In summary, over the past 20–30 years the literature has evolved from a one-size-fits-all 4% rule toward a rich array of adaptive withdrawal strategies. This study takes the research further by evaluating a wide range of dynamic withdrawal strategies using a suite of metrics designed to capture their performance.

3. Retirement Withdrawal Strategies

Over the past three decades, a wide spectrum of withdrawal strategies has emerged—ranging from simple static rules to sophisticated adaptive frameworks. This section outlines the ten retirement withdrawal strategies evaluated in this study. Each strategy reflects a distinct philosophy—some seek predictability through inflation-adjusted withdrawals, others aim for flexibility by tying income to market performance. While many of these approaches have been extensively studied in global literature, this paper adapts and implements them in the Indian context using local return, inflation, and tax data. The following descriptions provide conceptual overviews, visuals and mathematical formulations to clarify how each strategy determines spending.

3.1. Baseline: Constant Inflation Adjusted – Bengen Style 4% Rule

The constant inflation-adjusted withdrawal strategy—famously known as Bengen's 4% rule—involves withdrawing a fixed percentage of the initial portfolio (e.g., 4% in the first year) and thereafter adjusting that annual withdrawal only for inflation.

Formally, if P_0 is the initial portfolio value and w is the initial withdrawal rate, then the withdrawal in the first year is:

$$W_0 = w \times P_0$$

Each subsequent year's withdrawal, adjusted for inflation, is calculated as:

$$W_t = W_{t-1} \times (1 + i_{t-1})$$

where i_{t-1} is the inflation rate during period $t-1$.

This rule keeps the retiree's real (inflation-adjusted) income constant over time, regardless of investment performance. An example is a portfolio of ₹1 crore with an initial withdrawal of ₹3.2 lakhs (3.2%). If inflation in the first year is 5%, the second year's withdrawal would rise to ₹3.2 lakh $\times$ 1.05 = ₹3.36 lakh, maintaining the same purchasing power.

Table 1: Dynamic Withdrawal Strategies Overview

S.No.	Withdrawal Strategy	Brief Description
1	Baseline	Constant Inflation-Adjusted Withdrawals; withdrawals increase annually with inflation.
2	Fixed Percentage	Withdraw a fixed percentage of the remaining portfolio each year; spending adjusts automatically with market performance.
3	Forego Inflation	Skip inflation adjustments after years of poor returns, to preserve portfolio longevity.
4	Bengen Hard Floor and Ceiling	Apply nominal floor and ceiling limits on annual withdrawal adjustments to reduce volatility.
5	Vanguard Percentage Floor and Ceiling	Limit the year-over-year change in withdrawals as a percentage of previous withdrawals.
6	Endowment Weighted Average Hybrid	Blend between constant withdrawals and fixed percentage withdrawals to balance spending stability and flexibility.
7	Endowment 3-Year Moving Average	Use the average of portfolio values over the previous three years to smooth withdrawal volatility.
8	Guardrails	Adjust withdrawals based on withdrawal rate bands relative to starting rate; spending is cut or increased as limits are breached.
9	Zolt Glide Path	Adjust spending based on a predetermined portfolio glide path targets.
10	Kitces Ratcheting Rule	Follow constant inflation-adjusted withdrawals but permanently raise spending when portfolio grows significantly above its starting value.
11	Bucket Strategy	Use separate “buckets” for equities and safer assets; withdrawals made from safe assets while replenishing using equity gains.

In our analysis, this static withdrawal strategy serves as baseline against which the dynamic and adaptive withdrawal strategies can be compared. The baseline initial withdrawal rate has been kept as 3.2%, which corresponds to a failure rate of 5% in the simulation configuration being used for this study. The initial withdrawal rate of 3.2% used fits broadly with the safe withdrawal rates estimated in (Saraogi, 2022) and (Raju & Saraogi, 2024).

3.2. Fixed Percentage Withdrawals

The fixed percentage withdrawal strategy is the polar opposite of the constant real amount approach. In this strategy, the retiree withdraws a constant fraction of the current portfolio each year. Mathematically, the withdrawal in year t is:

$$W_t = wP_{t-1}$$

where w (e.g., 3.2%) is the fixed rate applied to the portfolio's value at the start of the year. Withdrawals fluctuate directly with portfolio performance.

This rule has the key advantage that the portfolio can never be fully depleted as withdrawals automatically shrink in bad markets. Because each year's withdrawal adjusts in proportion to remaining assets, sequence-of-returns risk is essentially eliminated (the order of returns does not affect final outcomes).

The trade-off is highly variable income (see Figure 1). For instance, if a ₹1 crore portfolio fell to ₹80 lakhs after a market downturn, a 3.2% fixed percentage annual withdrawal would drop from ₹3.2 lakh to ₹2.56 lakh the next year, but if the portfolio later grew to ₹1.2 crore, the withdrawal would rise to ₹3.84 lakh, tracking the portfolio's fortune.

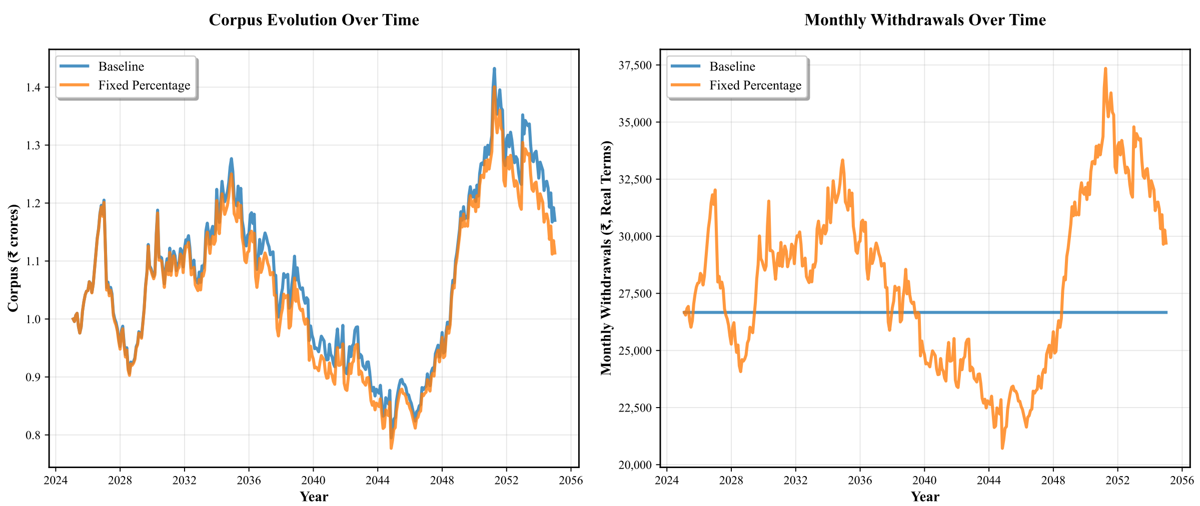

Figure 1: Fixed Percentage Rule vs. Baseline (Constant Inflation-Adjusted Withdrawals)
Fixed-percentage shows high variability depending on market returns, while the baseline ensures stable real income throughout.

3.3. Forego Inflation Adjustment Strategy

The forego inflation adjustment rule modifies the classic constant inflation-adjusted approach by pausing inflation-linked increases in years when the portfolio experiences a loss.

Mathematically,

$$W_t = \begin{cases} W_{t-1} \times (1 + i_{t-1}), & \text{if } P_{t-1} > P_{t-2} \\ W_{t-1}, & \text{otherwise} \end{cases}$$

where W_t is the withdrawal amount in year t, i_{t-1} is the inflation rate in the previous year, and P_{t-1} and P_{t-2} are the portfolio values at the beginning of years $t-1$ and $t-2$, respectively. In other words, the retiree receives an inflation adjustment only if the portfolio has appreciated in the preceding year. If the portfolio has declined or remained flat, the withdrawal remains constant in nominal terms.

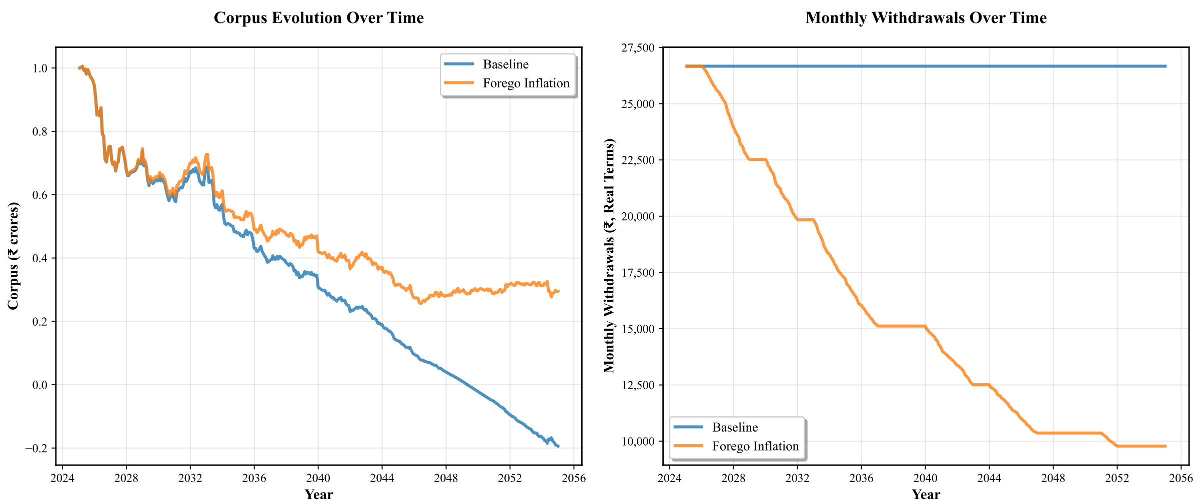

Figure 2: Forego Inflation Rule vs. Baseline (Constant Inflation-Adjusted Withdrawals)
In the forego inflation rule, real withdrawals are not increased in years following a portfolio decline. This leads to gradually declining inflation-adjusted income but helps preserve corpus over time, especially in volatile market periods.

3.4. Endowment Rule: 3-Year Moving Average

Inspired by endowment fund practices, this strategy aims to reduce withdrawal volatility by basing annual spending on a three-year moving average of portfolio values. Let P_t denote the portfolio value at the end of year t, and let w represent the fixed withdrawal percentage (e.g., 3.2%). The withdrawal amount in year t, denoted W_t, is calculated as:

$$W_t = w \times \frac{P_{t-1} + P_{t-2} + P_{t-3}}{3}$$

This averaging approach smooths out short-term fluctuations (see Figure 3) by incorporating recent historical values . A single year of poor market returns has only a partial effect on the withdrawal amount, while unusually strong years are also moderated. The result is a more stable income path compared to the fixed percentage withdrawals.

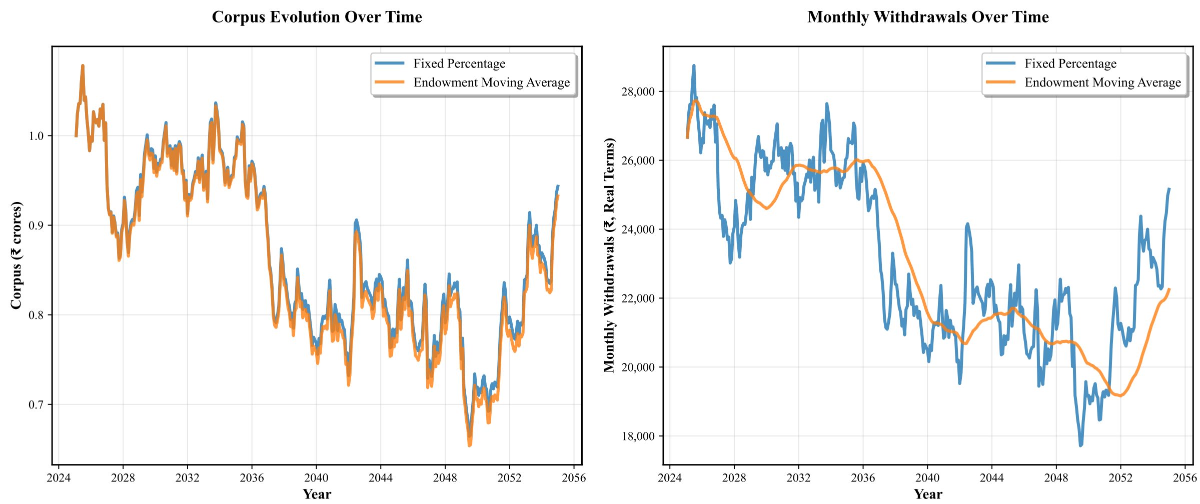

Figure 3: Comparison of Endowment Moving Average vs. Fixed Percentage Withdrawals
The fixed percentage rule delivers highly variable withdrawals, rising and falling directly with portfolio value. In contrast, the endowment moving average rule smooths income by basing withdrawals on a rolling three-year portfolio average. The endowment rule offers greater stability in real income, especially during periods of market turbulence.

3.5. Endowment Weighted Average Hybrid (WAH)

The weighted average hybrid strategy combines the steady income of a constant inflation-adjusted plan with the adaptability of a percentage-based plan. The withdrawal in year t is:

$$W_t = c\,(W_{t-1}(1 + i_{t-1})) + (1 - c)(w \cdot P_{t-1})$$

where $0 < c < 1$ is a weighting parameter that balances stability and flexibility, i_{t-1} is the inflation rate in year $t - 1$, w represents the fixed withdrawal percentage (e.g., 3.2%), and P_{t-1} is the portfolio value at the end of year $t - 1$.

This approach strikes a balance between stabilizing spending and letting it respond to market performance. For example, with $c = 0.5$ which this study uses, a retiree with an ₹1 crore portfolio who withdrew ₹3.2 lakh last year (adjusted for inflation), and whose portfolio is now ₹1.1 crore, would calculate their withdrawal as follows:

$$W_t = (0.5 \times (3.2\,\text{lakh} \times (1 + i))) + (0.5 \times (3.2\% \times 1.1\,\text{crore}))$$

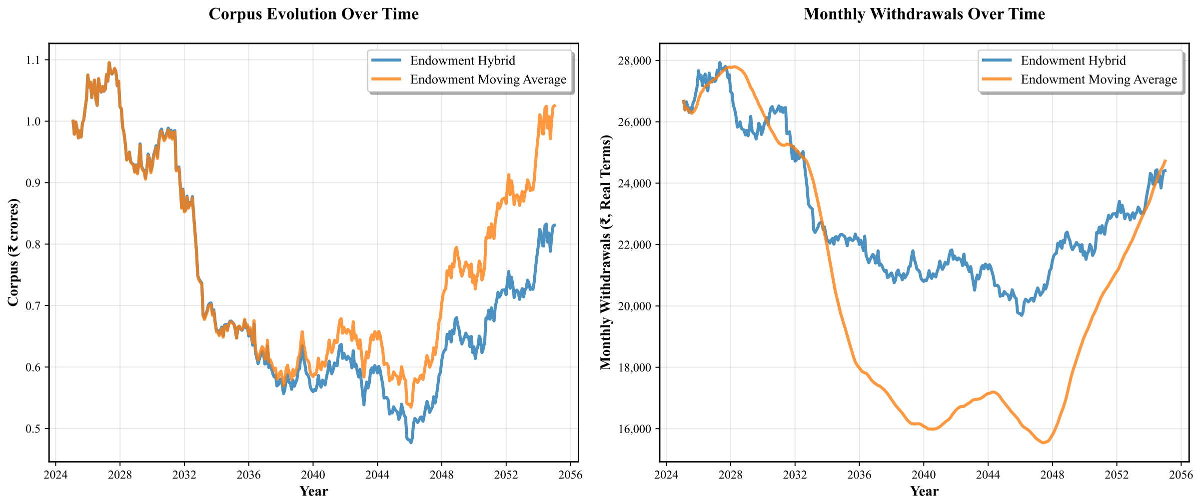

Figure 4: Comparison of Endowment Moving Average and Endowment Hybrid Withdrawal Strategies

The endowment hybrid approach blends inflation-adjusted stability with responsiveness to portfolio value, offering more consistent real withdrawals. This hybrid rule produces less volatile income than a pure fixed percentage withdrawal strategy or the endowment 3 year moving average strategy

3.6. Bengen's Floor and Ceiling Approach

(Bengen, 2001) modified the fixed-percentage approach by limiting how much the annual withdrawal can increase or decrease in nominal rupee terms from one year to the next. The retiree still calculates the recommended withdrawal each year as a fixed percentage of the current portfolio (similar to the fixed percentage withdrawal), but then applies a nominal "floor and ceiling" to prevent excessive changes in withdrawals.

Formally, let W_{t-1} be the withdrawal in year $t-1$. The withdrawal in year t, denoted W_t, is constrained by:

$$W_t = \min\left\{W_{t-1} \times (1+c),\ \max\left[W_{t-1} \times (1-f),\ w \cdot P_{t-1}\right]\right\}$$

where:

- w is the fixed withdrawal rate (e.g., 3.2%),
- P_{t-1} is the portfolio value at the end of year $t-1$,
- c is the nominal ceiling rate (in this study, fixed at +20%),
- f is the nominal floor rate (in this study, fixed at -15%).

This rule ensures that the annual withdrawal cannot rise more than 20% or fall more than 15% compared to the prior year's withdrawal, regardless of what the fixed-percentage formula may recommend.

For example, if the initial withdrawal rate is 3.2% on a portfolio of ₹1 crore, the monthly withdrawals in month t, W_t = ₹26,667, then, next withdrawal next year must lie between:

$$\text{Floor: } 26,667 \times (1 - 0.15) = \text{₹22,667}$$

$$\text{Ceiling: } 26,667 \times (1 + 0.20) = ₹32{,}000$$

This nominal approach keeps income changes within a comfortable range, providing retirees with predictability and insulation from market volatility (see Figure 5) . However, by imposing a floor, it may prevent spending cuts during downturns, potentially increasing the risk of portfolio depletion.

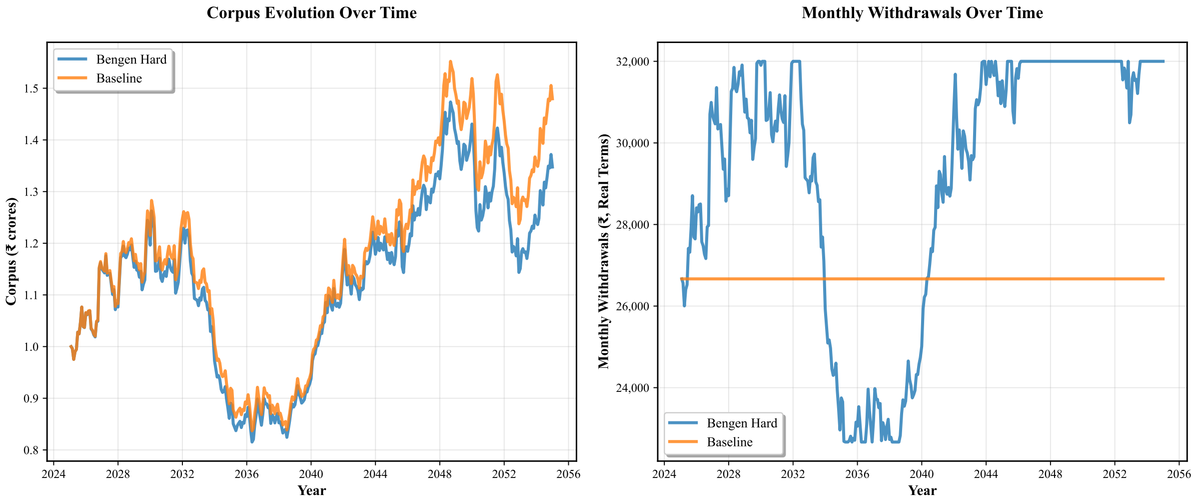

Figure 5: Comparison of Bengen Floor-and-Ceiling Rule and Baseline (Constant Inflation-Adjusted) Strategy

The Bengen rule imposes upper and lower limits on real withdrawal changes, reducing volatility while preserving flexibility. This results in less predictable income than the baseline but avoids extreme drops. In years of market distress, withdrawals are buffered by the floor, while strong market periods see modest increases.

3.7. Vanguard Percentage Floor and Ceiling

The Vanguard floor-and-ceiling strategy is a variation of the fixed-percentage withdrawal method that imposes limits on how much the withdrawal amount can change from year to year, based on percentage bands rather than absolute rupee thresholds. As described by (Jaconetti et al., 2013), the retiree first calculates the withdrawal for the year by applying a fixed percentage withdrawal rate to the portfolio value. However, to limit volatility in annual income, the actual withdrawal is then constrained within a specified range relative to the previous year's amount.

The formula for withdrawal in year t is:

$$W_t = \min\left\{W_{t-1}(1 + 5\%),\ \max\left[W_{t-1}(1 - 2.5\%),\ w \cdot P_{t-1}\right]\right\}$$

where W_t is the withdrawal amount in year t; W_{t-1} is the withdrawal in the previous year; w is the fixed withdrawal rate (for example, 3.2%); and P_{t-1} is the portfolio value at the end of year $t - 1$. The ceiling limit (maximum annual increase) is set to 5%, while the floor limit (maximum annual reduction) is 2.5%.

This approach ensures that the withdrawal amount cannot increase by more than 5% or decrease by more than 2.5% compared to the previous year. By banding the changes, this method smooths out the swings of a pure fixed-percentage rule, providing more predictable income. The trade-off is that it may not reduce spending aggressively enough in sharp market downturns, potentially risking faster portfolio drawdown.

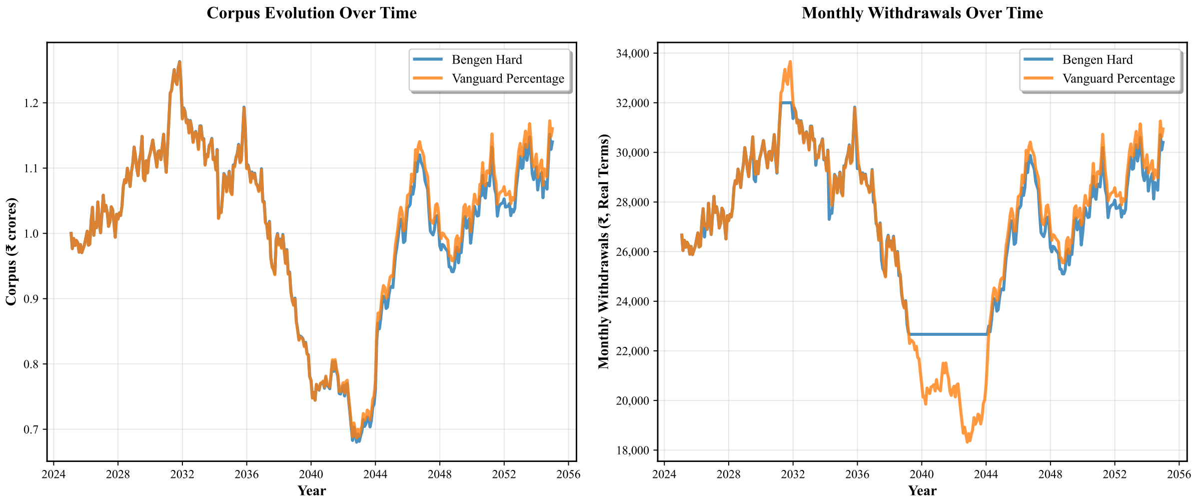

Figure 6: Comparison of Bengen Floor-and-Ceiling Rule and Vanguard Percentage Band Strategy

Both strategies aim to moderate withdrawal volatility. The Bengen rule uses absolute real rupee thresholds to cap annual changes, while Vanguard employs percentage bands relative to prior-year withdrawals.

3.8. Guyton–Klinger Guardrails

(J. Guyton & Klinger, 2006; J. T. Guyton, 2004) proposed a set of decision rules (popularly known as guardrails) to adjust retirement withdrawals dynamically based on the current withdrawal rate relative to its initial level. The decision rule we tested is that if the withdrawal rate deviates by 20% from its initial value (indicating the portfolio has either shrunk or grown significantly relative to withdrawals), then the annual withdrawal amount is adjusted by ±10%.

If the withdrawal rate has fallen by more than 20% compared to the initial withdrawal rate, withdrawals are adjusted upwards by 10%. If the rate has increased by more than 20%, then withdrawals are reduced by 10%.

The withdrawal rule can be mathematically described as follows:

Let W_t be the withdrawal amount in year t, i_{t-1} be the inflation rate for year $t-1$, r_t be the current withdrawal rate at year t defined as $r_t = \frac{W_t}{P_t}$, and r_0 be the initial withdrawal rate:

$$W_t = \begin{cases} W_{t-1} \times 1.10 & \text{if } r_t < 0.8 \times r_0, \\ W_{t-1} \times 0.90 & \text{if } r_t > 1.2 \times r_0, \\ W_{t-1} \times (1 + i_{t-1}) & \text{otherwise} \end{cases}$$

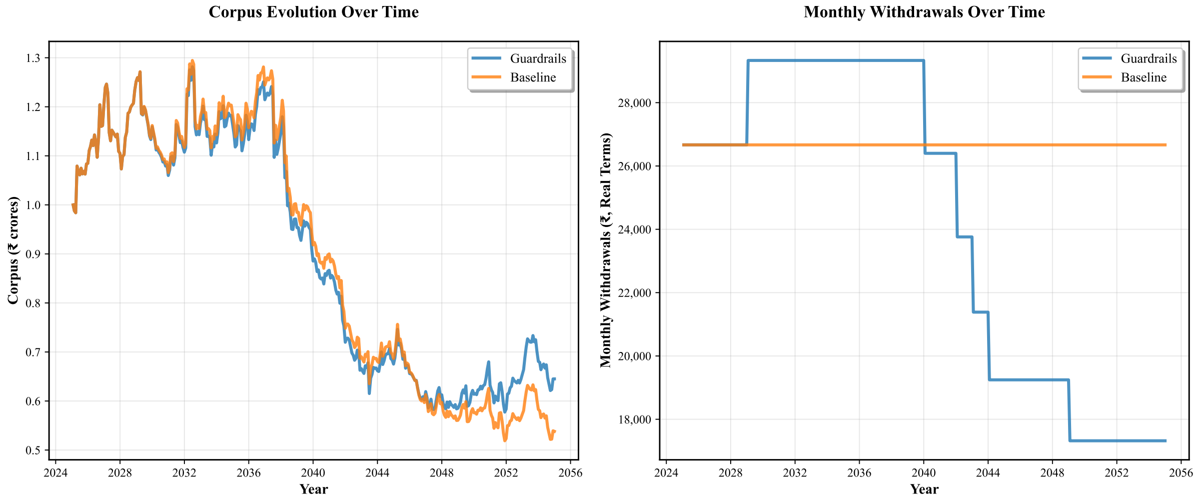

Figure 7: Guardrails (Guyton-Klinger) Rule vs. Baseline (Constant Inflation-Adjusted Withdrawals)
The Guardrails strategy introduces withdrawal flexibility by allowing increases and decreases only when the current withdrawal rate breaches specified thresholds. Compared to the baseline, which maintains fixed inflation-adjusted withdrawals, the Guardrails rule reacts to portfolio performance—cutting or boosting income only when needed. As shown, this results in stepwise adjustments rather than smooth paths, maintaining corpus more robustly in weak markets while offering raises when possible.

3.9. Kitces Ratcheting Rule

(Kitces, 2015) proposed a ratcheting enhancement to the traditional inflation-adjusted strategy, allowing retirees to "unlock" higher income when the portfolio substantially outperforms. Under Kitces's rule, the retiree follows the standard constant inflation adjustment pattern (withdrawals rise with inflation each year) but with an added trigger: any time the portfolio's value grows to 150% of its initial value, the withdrawal amount is increased by 10% above the current level. This increase is permanent and can happen at most once every three years. This spacing is meant to avoid too-frequent adjustments and ensures the portfolio stays consistently above 150% before each raise.

$$\text{If } P_t > 1.5P_0, \quad W_t = 1.1 \times W_{t-1}$$

where, P_t is portfolio at year t and W_t is withdrawals in year t.

This ratcheting mechanism guarantees that the retiree benefits from strong market gains by elevating their real spending level, while in down or average markets the strategy reverts to the safety of no real increase beyond inflation.

For example, suppose an initial ₹1 crore portfolio grows to ₹1.5 crore after some years of good returns; if the current withdrawal was ₹3.2 lakh, the retiree would "ratchet" it to ₹3.52 lakh, and subsequent yearly withdrawals would then inflate from this higher base. This rule provides a basic idea of how to structure upside spending flexibility without materially jeopardizing the withdrawal plan. Once a portfolio is 50% above its start, a moderate increase in spending does not typically increase failures.

Figure 8: Comparison of Kitces Ratcheting vs. Baseline (Constant Inflation-Adjusted Withdrawals)

The Kitces approach maintains or increases spending in response to strong market performance, never lowering withdrawals below the initial level. As seen in the chart, this leads to more stable or gently increasing real income, while also preserving corpus more effectively in favorable market conditions.

3.10. Zolt Glide Path Spending Rule

In this approach (Zolt, 2013), the core idea is to compute a required wealth glide path for the corpus over time that would exactly support fully inflation-adjusted withdrawals over the planning horizon, given assumed returns and inflation. If the actual corpus is above the glidepath, the retiree takes inflation adjustment, otherwise not. Thus, this approach prioritizes never having to reduce nominal spending, at the cost of sometimes not keeping up with inflation.

For example, using a 30-year horizon with 5% initial withdrawal, 10% equity return, 5% debt return, a 50:50 balanced equity-debt portfolio and 5% inflation, a retirement portfolio will follow the below glidepath.

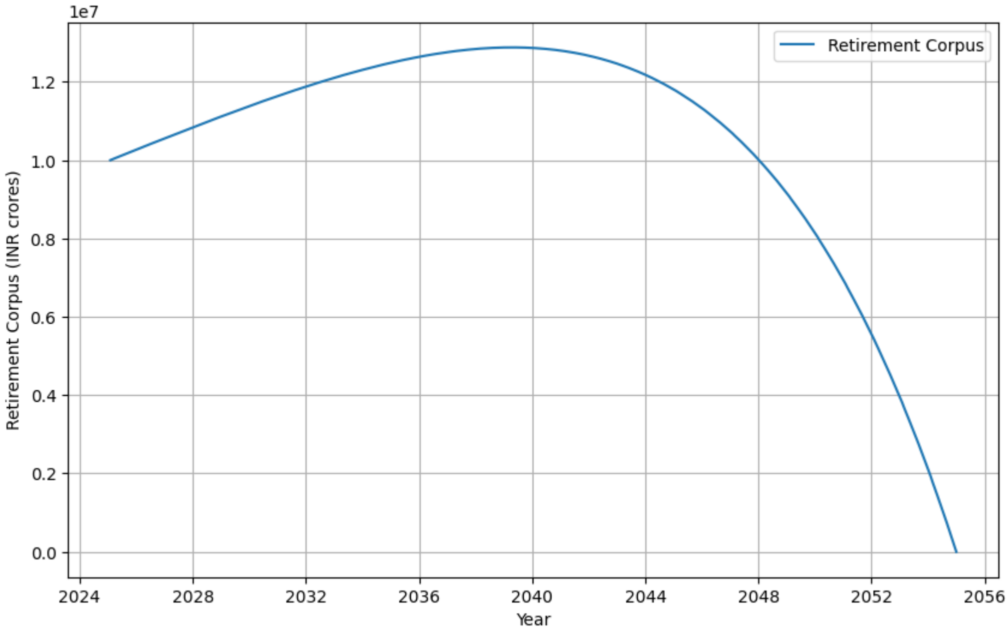

Figure 9: Glidepath – Retirement Corpus Over Time

The Zolt Glide-Path rule introduces a dynamic mechanism for determining retirement withdrawals by referencing a pre-specified portfolio glide path, denoted R_t. This glide path represents the ideal portfolio value trajectory required to sustain fully inflation-adjusted withdrawals through the retirement horizon. At the end of each period t, the retiree compares the actual portfolio value P_t to the target value R_t. The rule allows an inflation adjustment only if the portfolio meets or exceeds the glide path; otherwise, the withdrawal amount remains unchanged in nominal terms.

$$W_{t+1} = \begin{cases} W_t \times (1 + i_t), & \text{if } P_t \geq R_t \\ W_t, & \text{otherwise} \end{cases}$$

where:

- W_t is the withdrawal in year t,
- W_{t+1} is the withdrawal in year $t+1$,
- i_t is the inflation rate during year t,
- P_t is the portfolio value at t, and
- R_t is the required glide-path value of the portfolio at t.

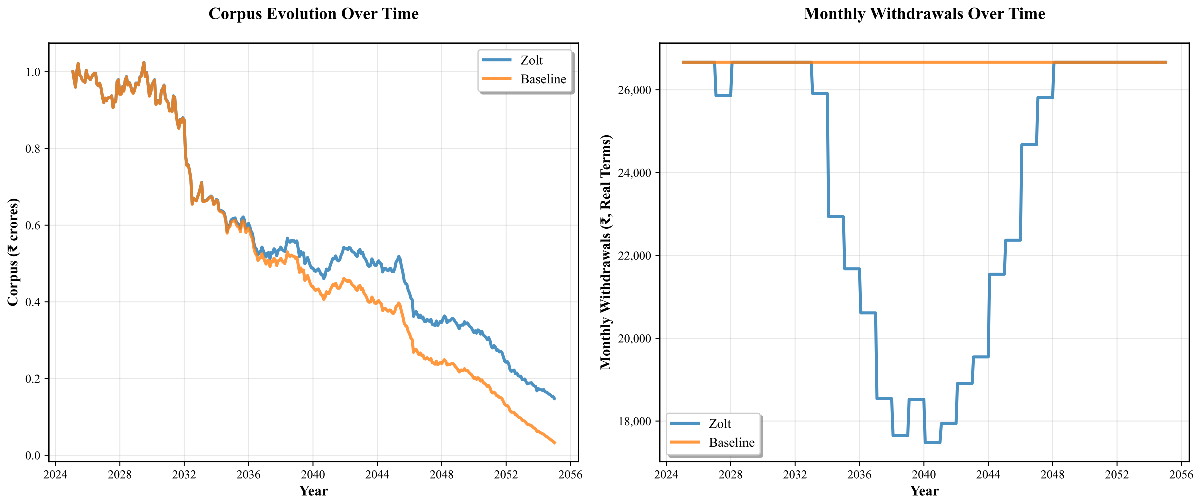

Figure 10: Comparison of the Zolt Glide Path Spending Rule with Baseline (Constant Inflation-Adjusted Withdrawals)
The Zolt strategy freezes real withdrawals unless a predefined glidepath threshold is met. This leads to long stretches of unchanged income, punctuated by discretionary increases once portfolio conditions improve. While this mechanism preserves corpus better than the baseline, it introduces income rigidity and extended periods of flat or falling spending.

This rule is essentially the inverse of the Kitces ratchet: spending never increases in real terms, only decreases when necessary. The glide path approach preserves the retiree's nominal income level as a psychological floor. In an Indian context, this could appeal to retirees who are comfortable letting inflation slowly erode their spending power during bad market periods, rather than ever experiencing a nominal income drop.

3.11. Bucket Strategy (Rule-Based Rebalancing)

The bucket strategy evaluated in this study is based on a two-bucket segmentation of the retirement portfolio— one for equities and the other for debt instruments. The retiree begins with an initial 50:50 allocation between the equity and debt buckets. Withdrawals are made exclusively from the debt bucket to avoid liquidating equity holdings during periods of market stress.

A rule-based rebalancing mechanism governs the interaction between the buckets. Specifically, if the rolling 12-month equity return exceeds 10%, the portfolio is rebalanced by transferring funds from the equity bucket to the debt bucket. This rule is designed to take advantage of strong equity performance, systematically locking in gains and replenishing the debt bucket. If the equity returns do not meet the 10% threshold, no rebalancing occurs and withdrawals continue solely from the debt bucket.

This implementation of the bucket strategy aims to avoid selling equity in down markets and systematically harvest equity gains.

4. Evaluation Metrics for Dynamic Withdrawal Strategies

In evaluating dynamic withdrawal strategies, we must use a range of metrics that inform us about key dimensions of a retirement income plan's performance. For the purpose of this study, we evaluate each strategy across four dimensions that we believe provide a comprehensive overview of their performance:

- the *level of spending* supported (the spending dimension)
- the *stability of periodic withdrawals* (the stability dimension)
- the *remaining wealth or legacy* at the end of the horizon (the savings dimension)
- the *sustainability of the corpus* over the full retirement period (the sustainability dimension)

Within each of these dimensions, we have curated a set of metrics which have been defined below.

4.1. The Spending Dimension

Retirees care about how much they can spend from their retirement portfolio. This dimension assesses the overall level of income that a withdrawal strategy can support throughout retirement. It reflects the retiree's ability to maintain a desired standard of living. The following metrics have been tracked in this dimension:

- **Spending Ratios (Years 10, 20, and 30)**

  To evaluate how effectively a withdrawal strategy supports sustained income throughout retirement, we examine the *spending ratio*, defined as the annual withdrawal at a given year (10, 20 and 30 years) divided by the remaining corpus at that point. Specifically, we calculate:

$$\text{Spending Ratio}_t = \frac{W_t}{P_t}$$

  where W_t is the annualized withdrawal at t, and P_t is the outstanding retirement corpus at that point. This ratio offers insight into how "aggressively" the retiree is drawing down assets relative to the remaining capital base. A higher ratio indicates higher income but also greater potential pressure on the portfolio's future viability, while a lower ratio suggests a more conservative draw that may support legacy objectives or enable future income growth.

  By assessing this ratio at multiple time points—year 10, 20, and 30—we capture how the strategy evolves over the retirement horizon and whether it allows the retiree to maintain or adjust their lifestyle in proportion to remaining wealth.

- **Real Monthly Withdrawals (Years 10, 20, and 30)**

  In addition to spending ratios, we report the absolute level of *monthly withdrawals* at Years 10, 20, and 30 to offer a more intuitive measure of the income delivered by each strategy at different stages of retirement. While ratios provide relative drawdown intensity, absolute withdrawals allow for a concrete understanding of the real-world income that a retiree can expect at different points in time.

These monthly withdrawal figures, are adjusted for inflation and expressed in real terms to maintain comparability across time. They reflect the retiree's actual spending potential, independent of portfolio size or withdrawal aggressiveness.

- **Withdrawals at Year 30 as a Percentage of Initial Withdrawal**

  Another important lens on spending sustainability is the ability to maintain income toward the end of retirement. We measure this through the *terminal spending change ratio*, defined as the withdrawal amount in year 30 as a percentage of the initial withdrawal:

  $$\text{Terminal Spending Change}_{30} = \frac{W_{30}}{W_0}$$

  This metric tracks whether a strategy allows withdrawals to keep pace with inflation and portfolio returns over three decades. A value of 100% indicates full preservation of real income; values below this suggest erosion in real spending capacity, while values above imply that the strategy permits real spending increases.

- **Cumulative Withdrawals as a Percentage of Opening Corpus**

  To capture the overall withdrawals generated by a retirement strategy, we compute the *cumulative withdrawals* over the 30-year period as a percentage of the opening corpus:

  $$\text{Cumulative Withdrawals \%} = \frac{\sum_{t=1}^{30} W_t}{\text{Opening Corpus}}$$

  This metric quantifies total retirement consumption relative to the retiree's starting wealth and provides a holistic measure of spending potential. Higher values reflect strategies that maximize consumption and spending efficiency, while lower values may indicate conservative withdrawal paths that prioritize capital preservation or legacy goals.

4.2. The Stability Dimension

Retirees value a stable standard of living, without large cuts to their income. We therefore examine metrics that describe how much volatility the retiree's spending might experience under the strategy:

- **Cut-to-Boost Ratio**

  This metric captures the frequency asymmetry in withdrawal adjustments by calculating the ratio of downward to upward revisions in monthly retirement withdrawals. A value greater than 1 indicates that withdrawals were cut more frequently than they were increased, reflecting a strategy prone to spending retrenchment. Formally, if D and U denote the counts of downward and upward revisions respectively, then the ratio is:

  $$\text{Cut Boost Ratio} = \frac{D}{U}$$

This measure serves as a proxy for behavioural discomfort, as retirees may find frequent income reductions more distressing than foregone increases.

- **Cut-to-Boost Amount Ratio**

  While the cut-to-boost ratio measures frequency, this complementary metric evaluates magnitude. It compares the total amount by which withdrawals were reduced to the total amount by which they were increased across the retirement period. Let Δ_D and Δ_U be the cumulative absolute rupee values of all reductions and increases respectively, then:

$$\text{Cut Boost Amount} = \frac{\Delta_D}{\Delta_U}$$

  A high value indicates that not only were withdrawals cut more frequently, but the cumulative extent of cuts dominated the increases. This is particularly relevant for retirees who prioritize income consistency.

- **Frequency of Shortfall**

  The proportion of simulations in which the retiree's cumulative withdrawals over the retirement horizon fall short of target withdrawals,

$$\text{Actual Withdrawal}_t < \text{Target Withdrawal}_t$$

  where $\text{Target Withdrawal}_t$ in our study represents a fixed real spending path (a constant inflation-adjusted 3.2% withdrawal). This metric captures how often retirees were unable to achieve their targeted consumption.

- **Spending Floor Breaches**

  To assess critical spending failures, (Arnott et al., 2024) define a *Spending Floor*, typically set at 70% to 80% of the initial planned real withdrawal amount. A *Spending Floor Breach* is recorded if:

$$\text{Actual Withdrawal}_t < \text{Spending Floor}_t$$

  where Spending Floor_t represents an inflation-adjusted essential spending level necessary to meet basic needs. In our case, we have set the spending floor at two-third's of the initial planned real withdrawals. Breaching this spending floor indicates potential financial hardship, even if the portfolio technically survives.

- **Standard Deviation of Withdrawal Changes**

  This metric captures the volatility in retirement income by calculating the standard deviation of the percentage change in yearly withdrawals. The standard deviation provides an intuitive measure of instability in spending levels. High values indicate more erratic spending paths and potentially lower financial confidence for the retiree.

- **Downside Spending Volatility**

  Proposed by (Pfau, 2017), this statistic isolates the average annualised percentage declines in withdrawals, conditional on months where such declines occur. It is calculated by taking the sum of all declines and dividing the same by the retirement period, in this case by 30 years.

  This measure reflects the severity of income reductions retirees are exposed to, making it an important complement to overall volatility measures. A strategy with low total volatility but high downside volatility may be especially problematic for retirees with non-discretionary expenses.

4.3. The Savings Dimension

We also consider metrics related to the amount of wealth remaining at the end of the 30-year period. While not the primary goal for many retirees, end-of-horizon wealth plays a role for those seeking to leave bequests, manage unforeseen longevity, or maintain a financial cushion. Strategies that preserve a substantial portion of the portfolio offer a greater legacy potential and optionality for late-life expenses or unexpected needs:

- **Corpus at Year 30 as a Percentage of Initial Corpus**

  We compute the *terminal corpus change ratio* as the final value of the retirement portfolio at the end of the 30-year analysis horizon, expressed as a proportion of the initial corpus:

  $$\text{Terminal Corpus Change}_{30} = \frac{\text{Corpus}_{30}}{\text{Corpus}_0}$$

  A higher value reflects better capital preservation, indicating the strategy's ability to safeguard wealth over the full retirement period. This is particularly important for retirees wishing to maintain flexibility for unforeseen late-life expenses or to leave a financial legacy.

- **Spending-to-Ending Ratio**

  Inspired by (Arnott et al., 2024), this ratio compares cumulative real withdrawals W_t across the 30-year period to the terminal portfolio value Corpus_{30}:

  $$\text{Spending to Ending Ratio} = \frac{\sum_{t=1}^{30} W_t}{\text{Corpus}_{30}}$$

  This ratio encapsulates the trade-off between current consumption and capital retention. A higher ratio implies a more consumption-focused strategy that extracts a larger share of the portfolio for retirement spending. Conversely, a lower ratio signals greater emphasis on capital preservation. This metric is useful in evaluating the efficiency with which a strategy balances withdrawals and end-of-horizon wealth.

- **Minimum Corpus Value**

The *minimum corpus* measure captures the lowest portfolio value reached during the 30-year horizon, again expressed relative to the starting corpus:

$$\text{Minimum Corpus} = \frac{\min\left(\text{Corpus}_t\right)}{\text{Corpus}_0} \quad \text{for } t = 1, \ldots, 30$$

It is particularly informative in identifying how close a retiree comes to financial distress during adverse market sequences. While terminal corpus offers a snapshot at the end, this metric reveals whether the portfolio endured periods of acute stress. A high minimum value suggests strong mid-retirement resilience, while a low figure may signal elevated behavioural or liquidity risks even if the strategy ultimately recovers.

4.4. The Sustainability Dimension

The conventional failure rate– the probability that a retirement portfolio is depleted before the end of the planning horizon– is a widely used metric for static withdrawal strategies. However, it has significant shortcomings, especially when applied to dynamic withdrawal strategies (Pfau, 2015, 2017). First, failure rate is a blunt measure that ignores when a failure occurs and how severe it is. As (Estrada, 2017a) points out, a plan that collapses 10 years into retirement and one that only fails in year 29 are both counted equally as "failures". Second, the simple success/fail dichotomy does not capture partial shortfalls or the magnitude of failure. A retiree who falls modestly below their income target is treated the same as one who runs out of money entirely.

Relying solely on the plain-vanilla failure rate can be very misleading for dynamic strategies which deliberately cut or raise withdrawals in response to market performance. Nevertheless, we report the standard failure rates along with other metrics, with the warning that this metric alone is insufficient to judge a dynamic plan's efficacy.

To comprehensively assess the performance of withdrawal strategies in the sustainability dimension, we employ the following metrics:

- **Failure Rate**

  The conventional metric defined as the proportion of simulations in which the retirement corpus depletes before the end of the retirement horizon. While widely used, this measure does not account for scenarios where retirees avoid depletion but endure significant reductions in spending.

- **Modified Failure Rate**

  We propose and use a refined failure definition that considers a simulation as failed if either:

  1. The portfolio is depleted (ending corpus ≤ 0), or
  2. *Spending floor breaches* exceeds 33%

  This metric recognizes that severe and sustained income reductions constitute practical failure for retirees, even if nominal portfolio survival is achieved.

As per our earlier definition, a spending breach is considered to occur when actual withdrawals fall by more than 33% below the planned withdrawal amount. A modified failure is then characterized as a case where such spending breaches persist for over 33% of the entire retirement period.

In other words, if *spending is reduced by at least one-third of the planned amount for one-third or more of the retirement horizon, this is treated as equivalent to a portfolio failure*. This metric captures not only outright depletion but also prolonged material reductions in living standards, providing a more nuanced assessment of retirement sustainability.

- **Downside Risk Adjusted Score (D-RAS)**
  We adopt the *Downside Risk Adjusted Score (D-RAS)* framework proposed by (Estrada, 2017b), which combines both the *likelihood* and *severity* of retirement funding failures into a single, interpretable metric:

$$\text{D-RAS} = (1 \text{ - Failure Rate}) \times (1 - \text{Mean Relative Shortfall})$$

Here, *failure rate* refers to the proportion of simulation paths where the withdrawal strategy exhausts the portfolio before the end of the retirement horizon. *Mean relative shortfall* quantifies the average shortfall severity among the failed simulations only, comparing the actual withdrawals achieved to a predefined benchmark of planned withdrawals.

Formally, *mean relative shortfall* is calculated as:

$$\text{Mean Relative Shortfall} = \frac{1}{N_f} \sum_{i=1}^{N_f} \left(1 - \frac{\text{Actual Withdrawals}_i}{\text{Planned Withdrawals}_i} \right)$$

where,

  - N_f is the number of failed simulations (i.e., simulations where the corpus is depleted before the end of the retirement horizon),
  - Actual Withdrawals$_i$ is the cumulative real withdrawals achieved in simulation i,
  - Planned Withdrawals$_i$ is the cumulative real withdrawals that would have been received under a fixed baseline strategy (in our case, the constant 3.2% inflation-adjusted withdrawals).

This formulation improves upon traditional success-rate-based metrics by accounting not just for whether a strategy fails, but also for the *extent* of failure. A lower D-RAS indicates poorer overall performance, while a higher D-RAS reflects both a high success rate and relatively minor shortfalls in failure scenarios.

- **Modified D-RAS**

D-RAS still assumes that any non-depleting scenario is a full success, even if retirees endured prolonged and substantial reductions in withdrawals. As a result, strategies that preserve capital by drastically reducing withdrawals (e.g., forego-inflation) are rewarded, despite potentially compromising retiree lifestyle.

To address this, we propose a modified D-RAS ratio where,

1. Instead of failure rate, we use the modified failure rate
2. The *mean relative shortfall* is computed not only for simulations when ending corpus becomes negative, but also for simulations classified as a modified failure.

The modified D-RAS thus penalizes both portfolio depletion and withdrawal inadequacy. Unlike D-RAS, this modified version does not treat mere survival as full success. It penalizes strategies that sustain the portfolio by sacrificing withdrawals, capturing both lifestyle and sustainability dimensions in a single composite score.

Taken together, these metrics allow for a balanced assessment of the ability of each strategy to maintain the portfolio while delivering adequate and stable income throughout retirement.

5. Methodology

This study employs a rigorous simulation-based approach to evaluate the performance of various dynamic withdrawal strategies in the Indian context. Similar to (Saraogi, 2022) and (Raju & Saraogi, 2024), we focus on data from the year 2000 onward, acknowledging that India's macroeconomic and financial landscape has changed considerably over the past two decades. Consequently, earlier data may not be representative of current or future conditions.

The following data has been used in the study,

- **Equity Returns:** Monthly return data for equities is based on the BSE Sensex Price Return Index, beginning from January 2000. This benchmark captures large-cap equity performance and is used as a proxy for Indian equity market exposure.
- **Debt Returns:** Debt returns are proxied using monthly interest rates on 1–3 year fixed deposits, obtained from RBI publications. This captures short-duration, non-credit-risk fixed income instruments, aligning with typical conservative allocation strategies in Indian retirement portfolios.
- **Inflation:** Consumer Price Index (CPI) data is used to estimate inflation. Monthly inflation rates are computed from the CPI series to model real withdrawal adjustments.

To estimate long-term retirement outcomes, we conduct 10,000 Monte Carlo simulations for each withdrawal strategy. Each simulation spans 360 months (30 years), reflecting a typical retirement horizon.

In each simulation:

Table 2: Summary of Metrics and Evaluation Dimension

Metric	Description	Dimension
Spending Ratios (Years 10, 20, 30)	Spending relative to corpus at Years 10, 20, and 30.	Spending
Real Monthly Withdrawals (Years 10, 20, 30)	Real monthly withdrawals at Years 10, 20, and 30.	Spending
Terminal Spending Change Ratio	Year 30 withdrawal as a percentage of initial real withdrawal.	Spending
Cumulative Withdrawals (% of Corpus)	Total real withdrawals over 30 years as a percentage of initial corpus.	Spending
Cut-to-Boost Ratio	Ratio of withdrawal reductions to increases.	Stability
Cut-to-Boost Amount Ratio	Ratio of total reductions to total increases of withdrawals.	Stability
Frequency of Shortfall	Proportion of months where cumulative withdrawals fell below planned amount.	Stability
Spending Floor Breaches	Proportion of months where withdrawals fell by more than a third of the planned amount.	Stability
Standard Deviation of Withdrawals	Variability in withdrawals over retirement.	Stability
Downside Spending Volatility	Average size of annual real withdrawal cuts.	Stability
Terminal Corpus Change Ratio	Portfolio value at end of 30 years relative to initial corpus.	Savings
Spending-to-Ending Ratio	Cumulative withdrawals divided by ending corpus.	Savings
Minimum Corpus Value	Minimum portfolio value during retirement relative to starting corpus.	Savings
Failure Rate	Simulations where corpus depleted before horizon ends.	Sustainability
Modified Failure Rate	Simulations where corpus depleted or spending floor breached for over a third of the retirement period.	Sustainability
D-RAS	Risk-adjusted success metric (Estrada).	Sustainability
Modified D-RAS	Enhanced D-RAS incorporating modified failure.	Sustainability

- Monthly values for equity return, debt return, and inflation are drawn at random with replacement from the historical dataset (2000–2025), assuming that future return-inflation behaviour is reasonably approximated by the empirical distribution of the post-2000 period (Saraogi, 2022).
- The portfolio starts with a 50:50 equity-to-debt allocation. Both withdrawals and rebalancings happen at a monthly frequency, and the portfolio is taken back to its 50:50 equity-to-debt allocation.
- Each strategy is implemented in monthly steps, ensuring accurate tracking of withdrawal mechanics and compounding. Outcomes are analyzed across multiple dimensions: spending, savings, stability, and sustainability.

We assume a flat 15% effective tax rate on both equity and debt returns to reflect a realistic, tax-efficient retirement portfolio achievable under prevailing Indian tax regulations. For equity and equity-oriented mutual funds, long-term capital gains (LTCG) exceeding ₹1 lakh are taxed at 12.5%, with applicable surcharge and 4% health and education cess in the case of high-income earners, resulting in a maximum effective rate of 15%.

For debt instruments, the Finance Act, 2023, removed indexation benefits for debt mutual funds. Capital gains from such funds—defined as those with less than 35% equity allocation—are now taxed at the investor's marginal slab rate, regardless of the holding period. This could significantly increase the effective tax rate for high-income retirees.

However, Indian retirees seeking tax efficiency may allocate their fixed income exposure through arbitrage funds and/or multi-asset funds, thereby qualifying for equity-like taxation (i.e., 12.5% LTCG + cess).

Therefore, we model both equity and debt returns with a uniform 15% tax rate, assuming the retirement portfolio is structured to optimize post-tax outcomes.

6. Results

Based on the above methodology, below are the detailed results and discussions for each withdrawal strategy.

6.1. Portfolio Preservation and Final Corpus Outcomes

One critical metric for assessing withdrawal strategies is how well they preserve the retirement portfolio in adverse scenarios. At a 3.2% initial withdrawal rate, the baseline static strategy exhibited low safety margin. Its 10th percentile remaining portfolio after 30 years was about 20% of the initial corpus, and the minimum corpus value (lowest portfolio level reached during the horizon) was similar at 20% (see Table 3).

By contrast, most dynamic withdrawal strategies improved this downside protection. Strategies that adjust spending downward in bad markets – such as fixed percentage withdrawals, Vanguard's percentage (ceiling/floor), the endowment rules, and Guyton-Klinger Guardrails – all show much higher 10th-percentile ending wealth (typically 45%

Table 3: Output - Savings Dimension

Spending Strategy	Initial Spending Rate (%)	Percentile	Terminal Corpus Change	Spending to Ending Ratio	Min. Corpus
Baseline	3.20	90th	1.94	4.8	1.0
		Median	0.77	1.2	0.7
		10th	0.20	0.5	0.2
Fixed Percentage	3.20	90th	1.52	1.5	0.9
		Median	0.86	1.1	0.7
		10th	0.48	0.8	0.4
Forego Inflation	3.20	90th	2.23	1.4	1.0
		Median	1.08	0.7	0.7
		10th	0.47	0.3	0.4
Bengen Hard	3.20	90th	1.70	2.9	0.9
		Median	0.83	1.1	0.7
		10th	0.29	0.6	0.3
Vanguard Percentage	3.20	90th	1.51	1.5	0.9
		Median	0.85	1.1	0.7
		10th	0.48	0.8	0.4
Endowment Hybrid	3.20	90th	1.67	2.4	1.0
		Median	0.80	1.2	0.7
		10th	0.34	0.7	0.3
Endowment Moving Avg.	3.20	90th	1.55	1.6	0.9
		Median	0.85	1.1	0.7
		10th	0.46	0.7	0.4
Guardrails	3.20	90th	1.63	1.7	0.9
		Median	0.85	1.1	0.7
		10th	0.44	0.7	0.4
Zolt	3.20	90th	1.93	3.7	1.0
		Median	0.78	1.2	0.7
		10th	0.24	0.5	0.2
Kitces	3.20	90th	1.88	4.7	1.0
		Median	0.78	1.2	0.7
		10th	0.20	0.5	0.2
Bucket Strategy	3.20	90th	1.14	6.0	0.9
		Median	0.54	1.8	0.5
		10th	0.16	0.8	0.2

of initial corpus) and higher minimum corpus levels in worst cases.

This underscores the known trade-off: strategies that cut spending when the portfolio falters can virtually eliminate outright failure, preserving far more capital in poor sequences. In fact, a true fixed-percentage rule can never deplete the portfolio completely because withdrawals scale down with assets.

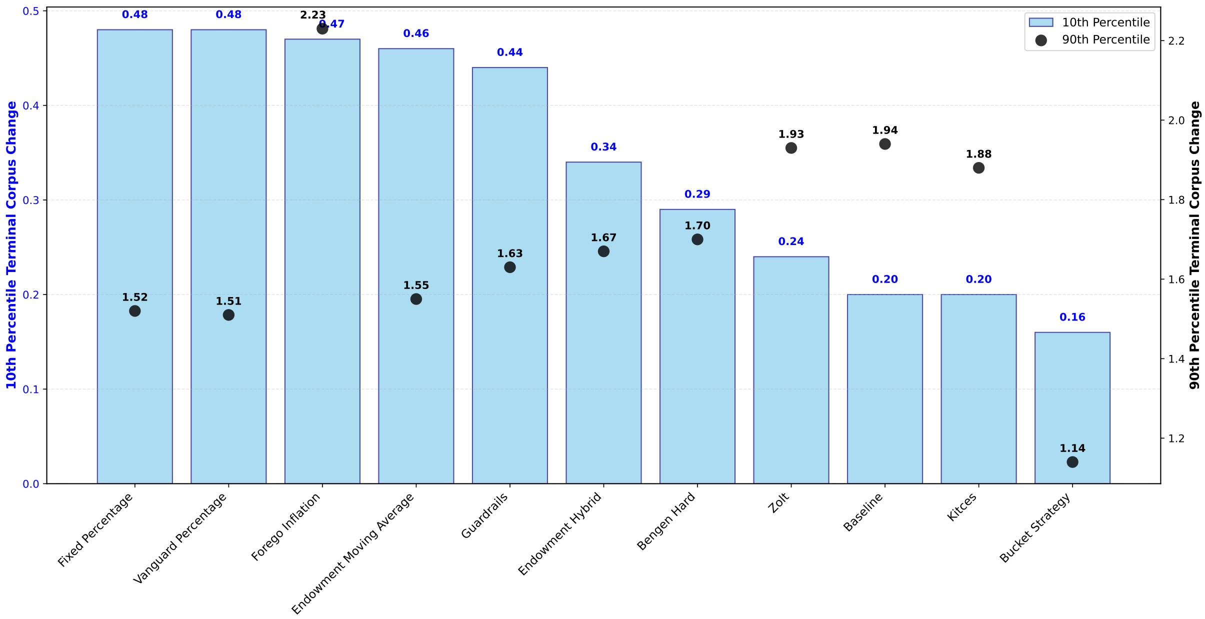

Figure 11: Terminal Corpus Change at the 10th Percentile for Each Withdrawal Strategy

This chart compares the terminal corpus change for each withdrawal strategy at the 10th percentile of outcomes. Strategies such as Fixed Percentage, Vanguard Percentage, and Forego Inflation maintain significantly higher corpus levels even in poor market scenarios, offering strong downside portfolio preservation. In contrast, strategies like Zolt, Baseline, Kitces, and Bucket deplete the corpus more severely, especially in adverse scenarios, indicating a potential tradeoff between stable spending and wealth preservation.

Not all dynamic methods delivered improved safety, however. Notably, strategies that avoid downward adjustments showed little to no improvement in portfolio preservation. The Kitces Ratchet strategy (which only increases spending after market gains, but never cuts below the initial level) and David Zolt's target percentage method behaved almost like the baseline in bad scenarios (see Figure 11).

Similarly, a bucket strategy (segregating cash reserves to meet early withdrawals) did not translate into better worst-case outcomes – if anything, the bucket approach left only 16% of the initial corpus in the 10th percentile (less than baseline). This suggests that merely structuring assets in buckets without reducing withdrawal rates still subjects the portfolio to heavy depletion.

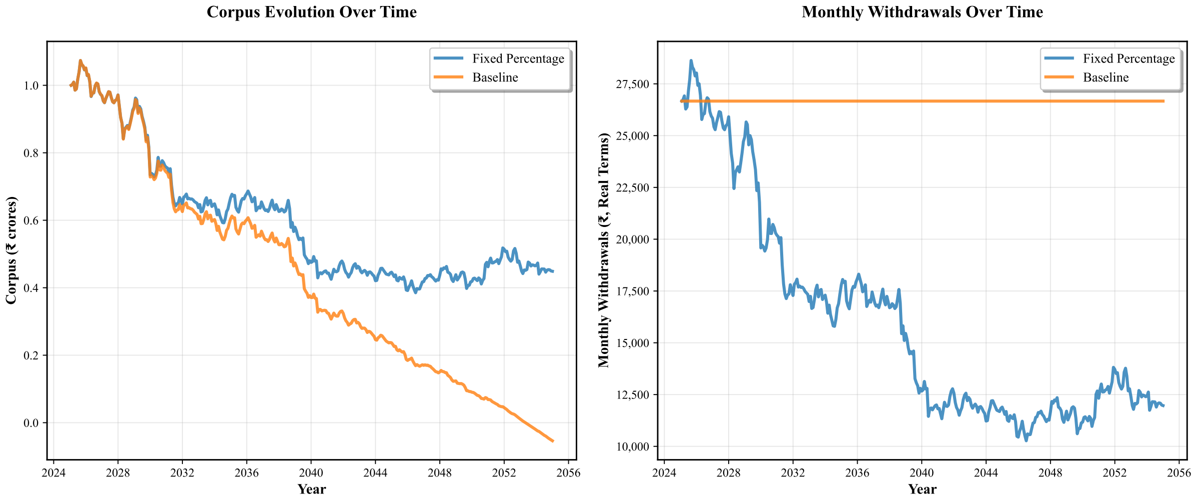

Figure 12: Fixed Percentage Rule Ensures Corpus Never Depletes
This figure demonstrates that under the fixed percentage rule, the withdrawal amount is always a set percentage of the remaining portfolio. As a result, the portfolio value never falls to zero, since withdrawals decline in tandem with corpus levels. While this feature ensures no formal portfolio failure, it also means that in adverse market conditions, real income can fall to unsustainably low levels—highlighting the limitation of using failure rate alone to evaluate such strategies.

Thus, only strategies that proactively trim withdrawals during downturns succeeded in materially reducing sequence-of-returns risk, while those that held withdrawals steady (or ratcheted only upward) offered no improvement in downside wealth outcomes (see Figure 13).

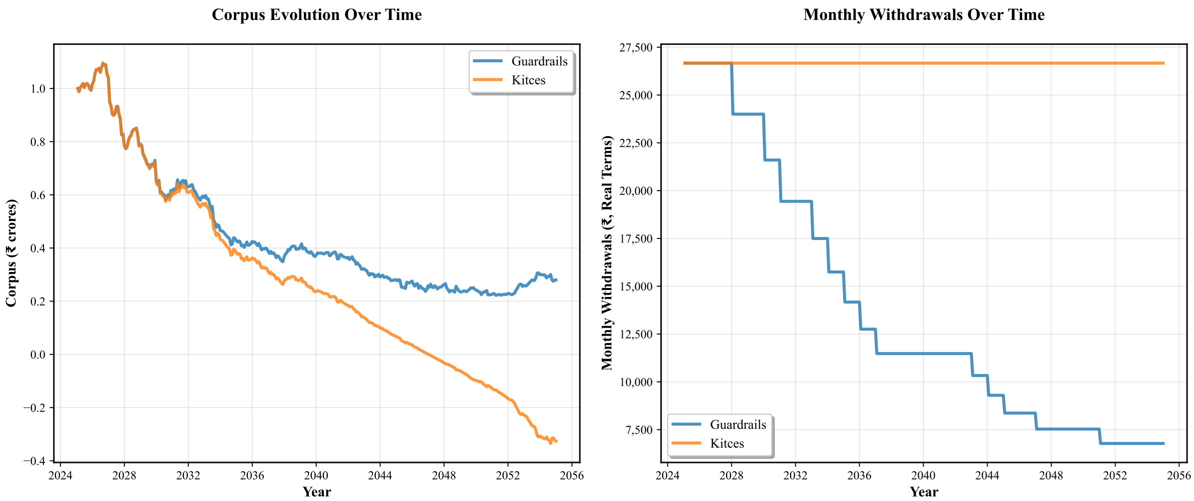

Figure 13: Downward Adjustment in Guardrails Improves Safety Compared to Kitces Ratcheting Rule
This figure contrasts the Guardrails and Kitces Ratcheting strategies. Both begin with the same initial withdrawal, but only the Guardrails rule includes mechanisms to reduce withdrawals during portfolio stress. As seen, Guardrails dynamically scale down income, preserving corpus sustainability, while the Kitces rule—designed only to raise withdrawals when conditions are favorable—fails to prevent eventual portfolio exhaustion.

In very favorable market scenarios (90th percentile outcomes), dynamic strategies tended to leave less money on the table than the static plan (see Figure 14). The baseline's 90th-percentile final corpus was about 194% of the initial portfolio, reflecting that a static rule often accumulates excess wealth in bull markets (since spending never increases beyond inflation). Adaptive strategies actively spent more in such scenarios, resulting in moderately lower final balances – typically around 150–170% of initial. For example, the fixed-percentage rule's 90th-percentile ending wealth was 152% and guardrails 163% of initial, substantially below the baseline's 194%. This indicates that dynamic rules are more efficient in "spending down" wealth when market growth allows, rather than letting the surplus compound untapped.

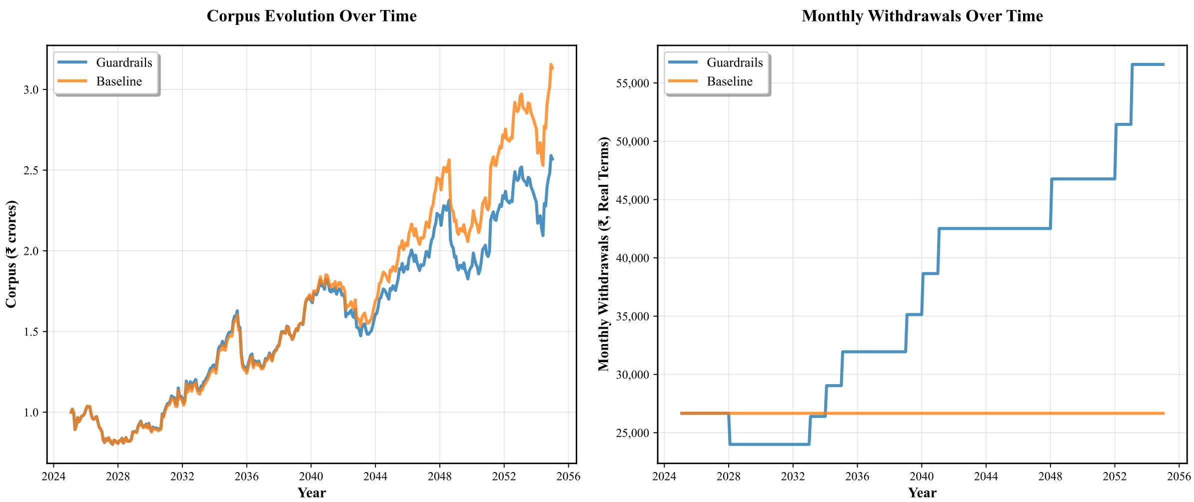

Figure 14: Guardrails Strategy Enables Better Wealth Spend-Down Compared to Baseline

This figure demonstrates the contrasting behavior between the guardrails strategy and the baseline rule. Under favorable market conditions, the guardrails rule increases withdrawals, allowing retirees to enjoy a higher standard of living and reduce unintentional legacy accumulation. In contrast, the baseline rule maintains flat real withdrawals regardless of market performance, often leading to under-consumption and a sizable terminal corpus. Dynamic strategies like Guardrails thus align more closely with the goal of efficient decumulation.

6.2. Withdrawal Trajectories and End-of-Plan Spending

Another important perspective is how each strategy's annual withdrawal amounts evolve over time, especially by the final year (year 30). The static baseline, by definition, keeps real spending constant at 100% of the initial withdrawal throughout the 30-year period. In our analysis, this meant that the year 30 withdrawal was exactly the same as the initial withdrawal (in real terms) for all outcome percentiles. By contrast, most dynamic strategies result in end-of-horizon withdrawals that differ (often substantially) from the initial level, depending on market performance. This is evident in the ratio of year-30 withdrawal to the initial withdrawal (see Figure 15).

The fixed-percentage rule exhibited a dramatic range. In a booming market (90th percentile), the year-30 withdrawal grew to roughly 153% of the initial amount (i.e., a 53% real increase in annual income by year 30). But in a poor market (10th percentile), the final withdrawal was only about 47% of the initial, a drastic reduction. This wide spread reflects the inherently volatile nature of a fixed-percentage strategy, which permits higher spending when markets do well (see Figure 16) and forces spending reductions when markets do poorly.

The Vanguard dynamic spending rule (a variant of the fixed-percentage method) also yielded final withdrawals around 152% (90th pct) to 48% (10th pct) of the initial level. This strategy limits year-to-year adjustments (in our case, no more than a 5% increase or 2.5% decrease annually in real terms), which smooths the trajectory but ultimately still allows significant cumulative changes over decades.

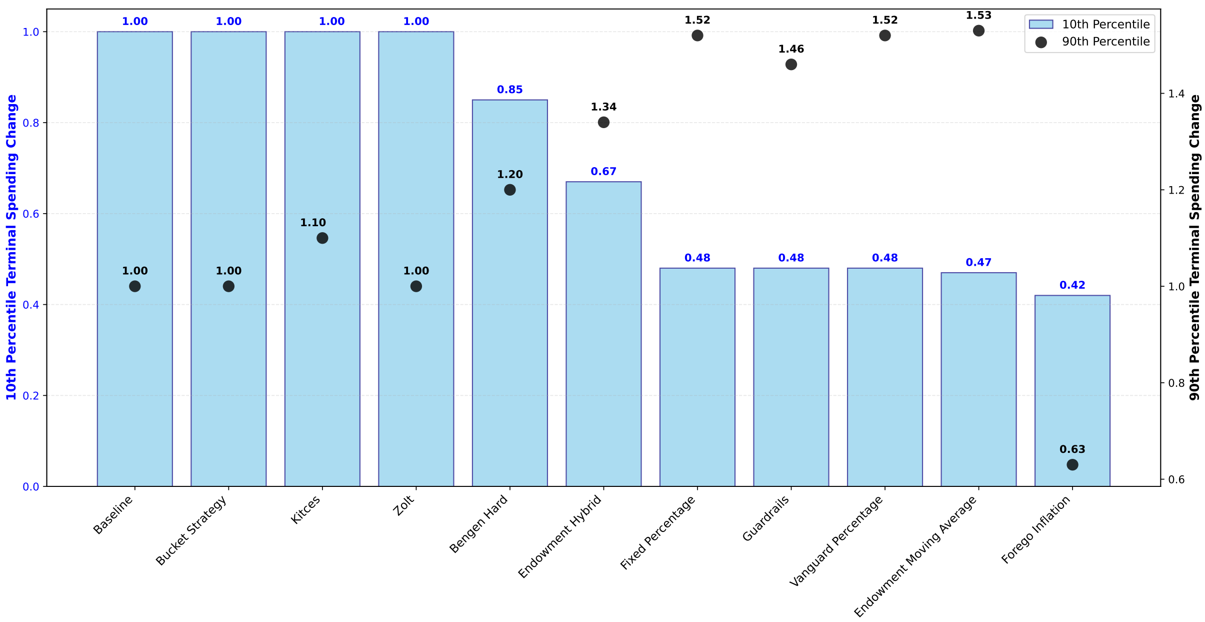

Figure 15: Terminal Spending Change – 10th and 90th Percentile by Strategy
This chart compares the year-30 real withdrawal amount relative to the initial withdrawal across strategies at both the 10th and 90th percentile levels. Kitces, Zolt, and Baseline maintain stable withdrawals across percentiles. In contrast, strategies like Fixed Percentage and Guardrails show wide dispersion — indicating potential for higher spending in favorable markets, but with the risk of severe cuts in adverse conditions.

The guardrails (Guyton-Klinger) strategy also permits significant variability. In our data, guardrails led to a year-30 withdrawal of 146% of initial in the 90th percentile. In the 10th percentile, the final withdrawal fell to 48% of initial – indicating that successive 10% cuts were invoked in extended downturns. Thus, guardrail strategies achieve a similar range of spending outcomes as a pure fixed-percentage rule, but with somewhat gentler, stepwise changes. Guardrails will increase withdrawals by +10% after sustained gains and decrease by –10% after heavy losses, keeping spending within a bounded corridor. This provides a measure of discipline and psychological comfort.

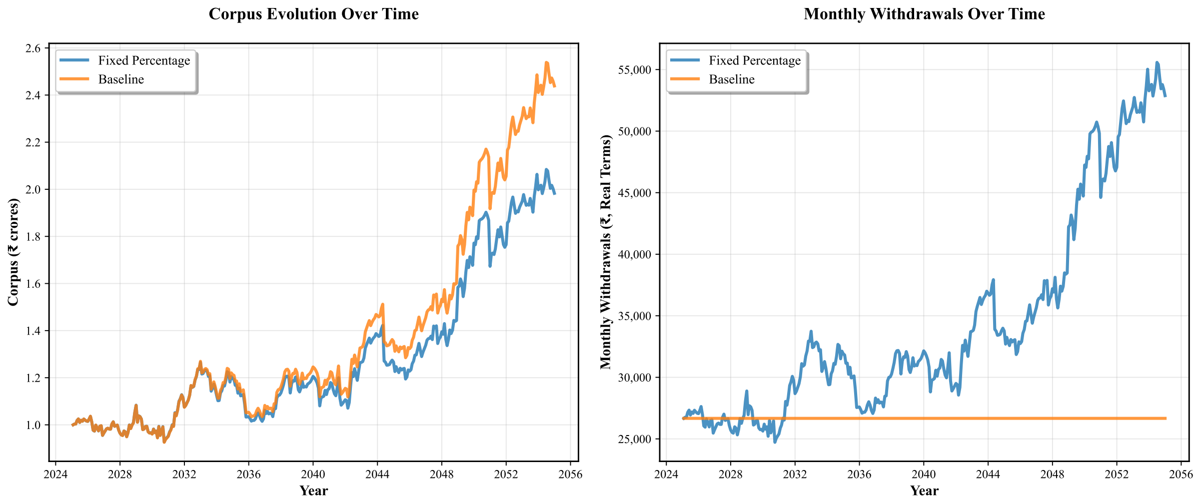

Figure 16: Fixed Percentage Strategy: Windfalls in Bull Markets, Drawdowns in Bear Markets
This figure illustrates how the fixed percentage withdrawal strategy can lead to substantial increases in real withdrawals when markets perform well—often far surpassing the constant inflation-adjusted baseline. However, this flexibility is a double-edged sword: the same mechanism that boosts income in bull markets can severely compress spending in downturns. The strategy provides high upside potential but exposes retirees to significant income volatility, making it better suited for those with flexible spending needs.

In the endowment approach, two flavors were considered: a moving average rule and a hybrid rule. Both approaches intend to smooth spending changes (as endowments do to stabilize budgets).The moving-average strategy had a simmilar spread in withdrawals as the fixed-percentage, but the path to get there is more gradual (we will see this in volatility metrics). The hybrid strategy allowed more bounded results, ending around 90% (median) of initial by year 30, 134% in best case and 67% in worst case. Thus the hybrid strategy results in more narrow bands for withdrawal dispersion.

The endowment-hybrid rule tends to produce less extreme cuts by year 30 in bad markets (e.g. 67% for hybrid, versus 48% for fixed-percentage), because the formulas inherently resist drastic changes. However, the trade-off is that if the portfolio suffers extended poor returns, the hybrid rule can leave the withdrawal rate elevated (see Figure 17) and run down the assets more (e.g., hybrid's 10th percentile final wealth was only 34% of initial, lower than most other adaptive strategies, reflecting that it did not cut as aggressively).

The forego inflation adjustment strategy (modeled on skipping inflation raises when equity returns are poor) effectively causes a slow real decline in spending over time. In our results, even in the 90th percentile scenario, the year-30 withdrawal was only 63% of the initial amount in real terms, and 42% in the 10th percentile (median 52%). This is because the rule intentionally keeps nominal withdrawals flat (or only sporadically adjusted upward), so inflation steadily erodes the purchasing power. Thus, by design the retiree ends year 30 with a substantially lower real income than at the start under this approach (see Figure 18) . The benefit is improved legacy and sustainability. This strategy led to one of the highest leftover portfolios.

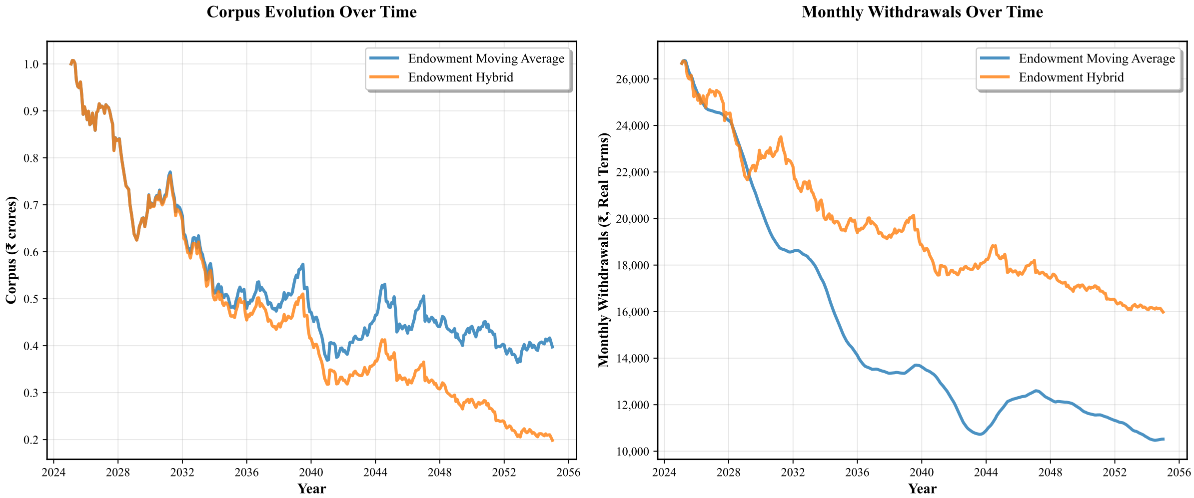

Figure 17: Endowment Hybrid strategy resists spending changes more aggressively than the Moving Average rule

Hybrid results in smoother withdrawals, however, its rigidity (as compared to moving average) can lead to greater portfolio stress—especially in adverse market scenarios—ultimately depleting corpus more than its more adaptive counterpart.

Compared to other withdrawal strategies, Kitces's Ratchet stands out because the withdrawal amount stays at or above the initial level. The year-30 withdrawal was at least 100% of the initial income. Kitces's ratchet rule increases spending by 10% after exceptional growth, and never decreases below the starting amount. Indeed, we see the 90th-percentile withdrawal for Kitces was about 110% of initial (indicating one such 10% ratchet up occurred in the best cases), whereas in median and worst cases it stayed at 100%. Zolt's strategy was similar – essentially holding withdrawals roughly constant. Consequently, retirees using these methods would have enjoyed stable real income throughout retirement in most scenarios.

To put these patterns in perspective, we see a continuum of withdrawal flexibility. At one extreme, the static and no-cut strategies keep real spending constant (100% of initial every year), offering high short-term spending stability but high long-term risk. Next, strategies like Kitces's allow some upside but no downside change, yielding a final spending level that is usually the same as initial (except in rare good cases). Moving further, guardrails and other decision-rule methods allow moderate adjustments (±10% increments) – by year 30 those increments can compound to large changes (40–50% cuts in worst case, 50% gains in best case), but the ride is smoother.

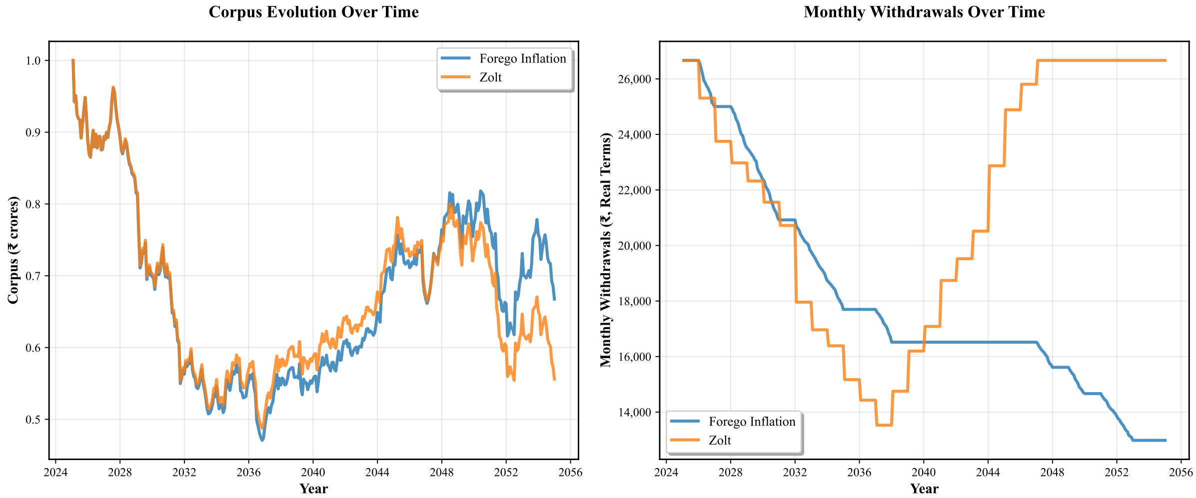

Figure 18: Comparison of Spending Adjustments: Forego Inflation vs Zolt

The *Forego Inflation* strategy suppresses withdrawal increases after market declines but never raises them again—resulting in a steadily declining income path in real terms. In contrast, the *Zolt* strategy permits both downward adjustments (to preserve corpus) and upward adjustments (when the portfolio performs well), enabling more responsive spending that adapts to market conditions. This makes Zolt more flexible while still preserving sustainability.

6.3. Variability of Annual Withdrawals

The flip side of the above discussion is the volatility in withdrawals that a retiree experiences. A desirable strategy might smooth out small market fluctuations to avoid drastic budget changes, whereas a less constrained strategy will see withdrawals jump around with the portfolio. We can quantify this by looking at the stability metrics.

Unsurprisingly, the static baseline, Kitces and Zolt had near-zero withdrawal volatility. Their standard deviation of withdrawals was essentially 0 in our analysis (since these methods keep the payout fixed or only rarely change it). This provides maximal short-term consistency. In contrast, fully dynamic approaches, like the fixed-percentage method, exhibited significant withdrawal fluctuations.

The hybrid endowment strategy had intermediate volatility. These outcomes make sense: the hybrid method, with partial base spending, stabilizes cash flows, as compared to say its moving average variant. The guardrails and Bengen floor-ceiling strategies also had intermediate volatility, since they apply a withdrawal change occasionally. Essentially, these strategies convert what might have been a large continuous fluctuation into a few stepwise adjustments.

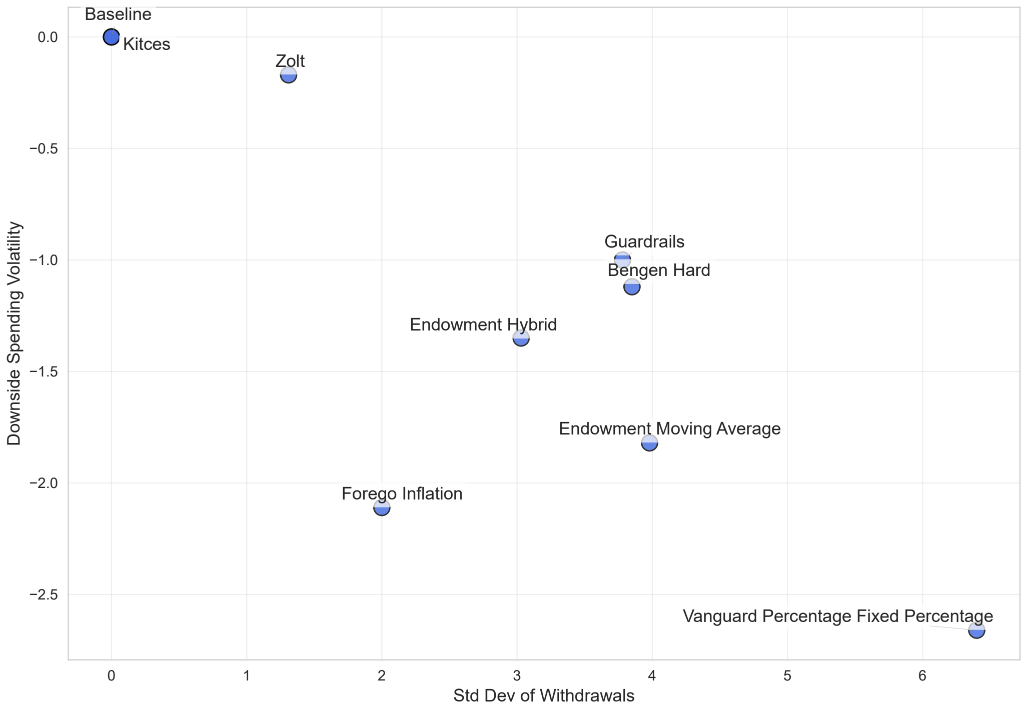

Figure 19: Meidan Volatility Comparison Across Withdrawal Strategies
This scatter plot compares the standard deviation of real withdrawals (x-axis) against downside spending volatility (y-axis) across different withdrawal strategies. Strategies like the Baseline, Kitces and Zolt exhibit low volatility on both axes, reflecting stable and predictable income paths. In contrast, Guardrails, Bengen Hard and Endowment rules show higher overall and downside volatility. The percentage-based rules demonstrated the highest variability.

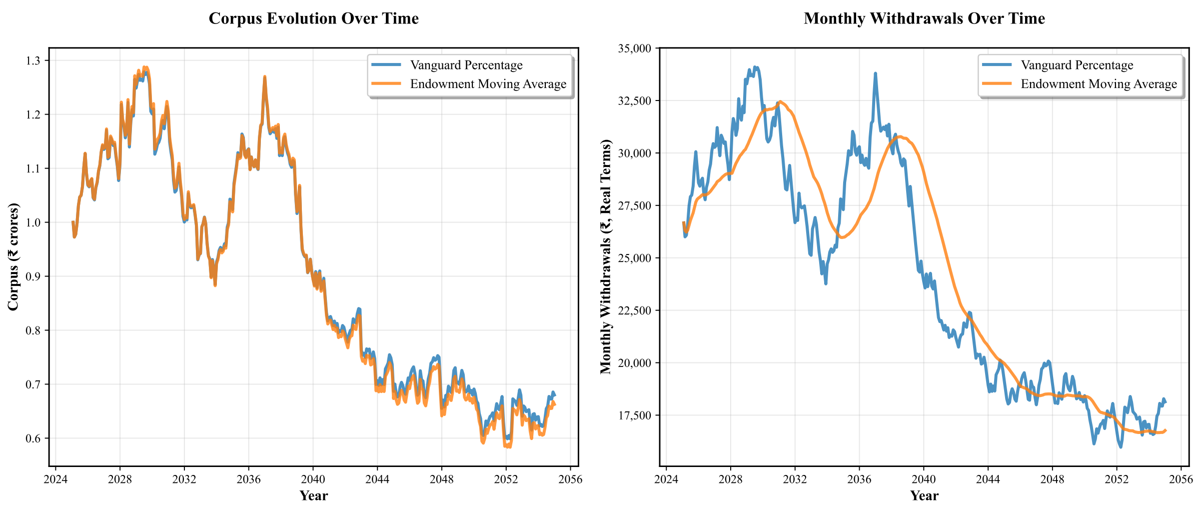

Figure 20: Smoothing Effect of the Endowment Moving Average Strategy on Withdrawals
The Endowment Moving Average rule smooths income by averaging portfolio values over a three-year period. This approach reduces volatility in monthly withdrawals compared to the more reactive Vanguard Percentage rule, resulting in a more stable income stream for retirees.

Table 4: Output - Stability Dimension

Spending Strategy	Initial Spending Rate (%)	Percentile	Cut Boost Ratio	Cut Boost Amount	Std Dev	Downside Spending Volatility	Frequency of Shortfall	Spending Floor Breaches
Baseline	3.20	90th	-	-	-	-	-	-
		Median	-	-	-	-	-	-
		10th	-	-	-	-	-	-
Fixed Percentage	3.20	90th	1.1	1.3	7.7	(1.7)	98.6	54.2
		Median	1.0	1.1	6.4	(2.7)	66.7	-
		10th	0.8	0.9	5.3	(3.8)	5.0	-
Forego Inflation	3.20	90th	-	-	2.3	(1.5)	96.7	58.1
		Median	-	-	2.0	(2.1)	93.3	37.8
		10th	-	-	1.7	(2.8)	83.3	10.0
Bengen Hard	3.20	90th	1.2	1.4	5.6	(0.3)	98.6	-
		Median	1.0	1.1	3.9	(1.1)	67.2	-
		10th	0.8	0.8	1.8	(2.0)	4.4	-
Vanguard Percentage	3.20	90th	1.3	1.3	7.7	(1.7)	98.6	53.9
		Median	1.1	1.1	6.4	(2.7)	66.1	-
		10th	1.0	0.9	5.3	(3.8)	5.3	-
Endowment Hybrid	3.20	90th	1.2	1.4	4.0	(0.9)	98.9	2.8
		Median	1.0	1.1	3.0	(1.4)	69.4	-
		10th	0.8	0.9	2.3	(1.8)	3.9	-
Endowment Moving Avg.	3.20	90th	2.5	4.0	5.2	(0.8)	99.4	52.8
		Median	1.2	1.3	4.0	(1.8)	65.8	-
		10th	0.6	0.5	2.9	(3.1)	3.6	-
Guardrails	3.20	90th	3.0	3.0	4.9	-	90.0	56.7
		Median	-	-	3.8	(1.0)	53.3	-
		10th	-	-	2.5	(2.3)	-	-
Zolt	3.20	90th	1.0	1.0	5.1	-	53.3	6.7
		Median	0.5	1.0	1.3	(0.2)	6.7	-
		10th	-	-	-	(1.7)	-	-
Kitces	3.20	90th	-	-	1.7	-	-	-
		Median	-	-	-	-	-	-
		10th	-	-	-	-	-	-
Bucket Strategy	3.20	90th	-	-	-	-	-	-
		Median	-	-	-	-	-	-
		10th	-	-	-	-	-	-

We also tracked the frequency of cuts versus raises via a cut/boost ratio. A ratio of 1.0 would mean the strategy on average made an equal number of downward adjustments as upward adjustments over retirement. For the fixed-percentage rule, this ratio was indeed close to 1 at the median, implying roughly symmetric ups and downs over 30 years.

Vanguard's rule and the endowment moving average similarly had cut/boost ratios near 1 in median cases (e.g. 1.14 for Vanguard, 1.18 moving average). The guardrails strategy showed an interesting pattern. In median and worst-case scenarios, the cut/boost ratio effectively appears as 0 (because no boost events occurred at all, only cuts). Indeed, for a retiree who never sees the market recover enough to warrant an increase, guardrails would impose cuts but never get the chance to raise spending again. In the 90th percentile scenario, guardrails had a ratio around 3.0, suggesting that cuts in this strategy can be three times as frequent as raises.

From a retiree's perspective, these findings highlight that there is a spectrum between income stability and volatility. On the one end, the static and no-cut approaches give a near-pension-like steady paycheck, which might appeal to those with low risk tolerance. On the other hand, fixed-percentage and similar approaches let income bounce around with the market, which may suit those who fear outliving their money and are comfortable with volatility. In between, methods like guardrails and endowment hybrid rule attempt a compromise– they introduce some volatility, but only as needed, and with explicit bounds on the magnitude of change.

6.4. Spending Efficiency and Legacy Trade-offs

A key objective of a dynamic strategy is to improve the spending efficiency of the portfolio, that is, to allow the retiree to enjoy more of their assets, rather than end up with an unexpectedly large bequest due to underspending. We can examine this via the cumulative withdrawals over 30 years, corpus at year 30 and spending-to-ending ratio (total spending relative to final wealth). These measures illustrate how each strategy balances lifetime consumption versus remaining principal.

Under the baseline 3.20% rule, total real withdrawals over 30 years amounted to about 100% of the initial portfolio. In median scenarios this left roughly 77% of the initial asset base at year 30, yielding a spending-to-ending ratio around 1.2 (meaning the retiree spent 1.2 rupees for every rupees remaining). In other words, the static strategy tends to leave a substantial portion of the portfolio intact, especially if markets perform well. This is even more pronounced in the best cases: at the 90th percentile, baseline total spending is still 100% (since it never adjusts upward), but final wealth swells to 194%, so the ratio drops to 0.5 (see Table 3). This corroborates a common criticism of fixed withdrawal rules that they can lead to under-spending in favorable outcomes.

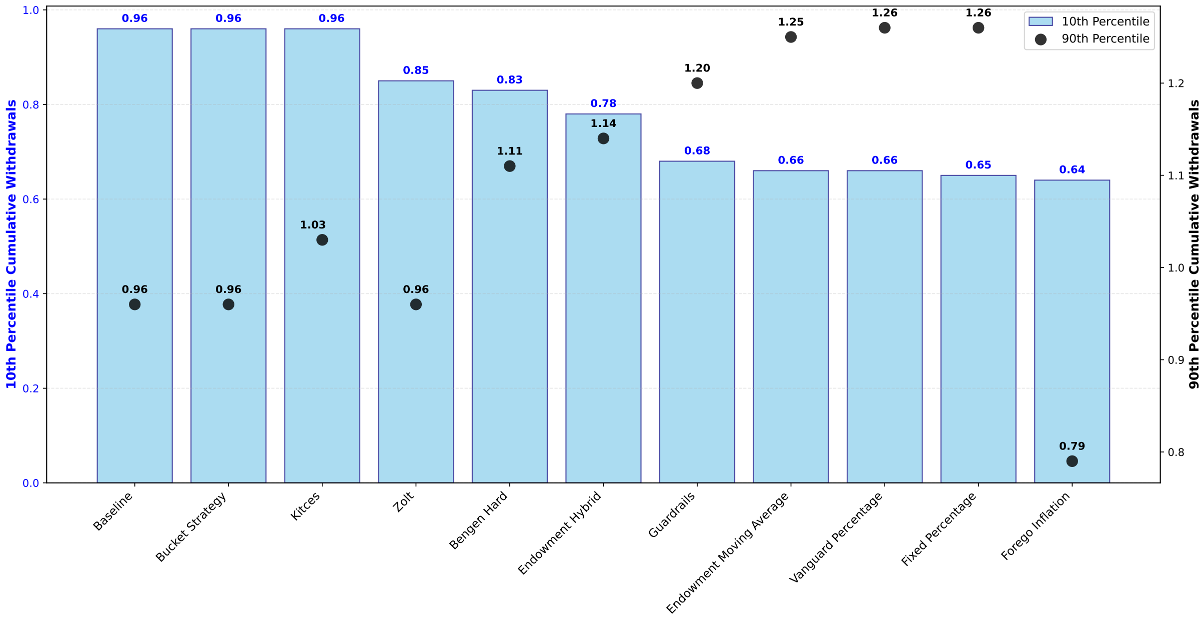

Figure 21: Cumulative Real Withdrawals as a Percentage of Initial Corpus (10$^{\text{th}}$ and 90$^{\text{th}}$ Percentiles)

This chart illustrates the cumulative inflation-adjusted withdrawals made over 30 years, expressed as a fraction of the initial retirement corpus. While most dynamic strategies exceed the baseline in favorable scenarios (90$^{\text{th}}$ percentile), some like Fixed Percentage and Endowment Moving Average also exhibit significant under-performance at the 10$^{\text{th}}$ percentile. The baseline and Kitces strategy show limited dispersion, indicating more predictable spending outcomes but lower upside.

Dynamic strategies generally aim to correct this by allowing more spending when affordable. Indeed, in our analysis many adaptive rules showed higher lifetime withdrawals in the good scenarios. For example, the Guardrails strategy had a 90th-percentile cumulative withdrawal of about 120% of initial portfolio (vs about 100% for baseline).

Other strategies like fixed-percentage and Vanguard's rule similarly delivered greater total spending in prosperous outcomes as can be seen in Figure 21) (e.g., around 130% of initial cumulative withdrawals at 90th percentile) and correspondingly lower terminal wealth at about 150% of initial wealth (as compared to 194% in the static baseline case). This is a key benefit of variable spending rules. Such strategies can be better at spending down wealth, allowing retirees to enjoy more spending rather than ending with a large inheritance.

However, the flip side is what happens in median or poor scenarios. Here, dynamic strategies often ended up with lower cumulative spending than the static strategy (because they cut back to preserve capital). For instance, in a median market outcome, the baseline plan spent 100% of initial principal, leaving 77% of the corpus at the end. A fixed-percentage strategy, by contrast, spent only 86% of initial withdrawals and ended with 86% remaining corpus. Its spending-to-ending ratio at median was 1.1, compared to baseline's 1.2. That lower ratio implies that the fixed% retiree was more conservative and consumed less relative to what they ultimately still had. The same pattern held for guardrails, Vanguard and endowment strategies.

Table 5: Output - Spending Dimension

Spending Strategy	Initial Spending Rate (%)	Percentile	Withdrawals Year 10	Withdrawals Year 20	Withdrawals Year 30	Spending Ratio Year 10	Spending Ratio Year 20	Spending Ratio Year 30	Terminal Spending Change	Cum. Withdrawals
Baseline	3.20	90th	26,667	26,667	26,667	5.0	7.0	16.0	1.00	1.0
		Median	26,667	26,667	26,667	3.0	4.0	4.0	1.00	1.0
		10th	26,667	26,667	26,667	2.0	2.0	2.0	1.00	1.0
Fixed Percentage	3.20	90th	35,203	38,426	40,620	3.0	3.0	3.0	1.52	1.3
		Median	25,334	24,078	22,863	3.0	3.0	3.0	0.86	0.9
		10th	18,172	14,955	12,794	3.0	3.0	3.0	0.48	0.7
Forego Inflation	3.20	90th	24,064	20,442	16,916	4.0	3.0	3.0	0.63	0.8
		Median	21,912	17,334	13,817	3.0	2.0	2.0	0.52	0.7
		10th	19,299	14,538	11,142	2.0	1.0	1.0	0.42	0.6
Bengen Hard	3.20	90th	32,000	32,000	32,000	4.0	6.0	9.0	1.20	1.1
		Median	25,377	23,864	22,667	3.0	3.0	3.0	0.85	0.9
		10th	22,667	22,667	22,667	3.0	3.0	2.0	0.85	0.8
Vanguard Percentage	3.20	90th	35,301	38,454	40,451	3.0	3.0	3.0	1.52	1.3
		Median	25,411	24,067	22,869	3.0	3.0	3.0	0.86	0.9
		10th	18,159	14,987	12,783	3.0	3.0	3.0	0.48	0.7
Endowment Hybrid	3.20	90th	31,367	33,699	35,644	4.0	5.0	6.0	1.34	1.1
		Median	25,927	25,042	24,059	3.0	3.0	4.0	0.90	0.9
		10th	22,042	19,810	17,845	3.0	3.0	3.0	0.67	0.8
Endowment Moving Avg.	3.20	90th	34,684	38,342	40,850	4.0	4.0	4.0	1.53	1.3
		Median	25,486	24,093	22,756	3.0	3.0	3.0	0.85	0.9
		10th	18,644	14,982	12,633	3.0	3.0	3.0	0.47	0.7
Guardrails	3.20	90th	32,267	35,493	39,043	4.0	4.0	4.0	1.46	1.2
		Median	26,667	24,000	23,287	3.0	3.0	3.0	0.87	0.9
		10th	19,440	15,746	12,755	3.0	3.0	3.0	0.48	0.7
Zolt	3.20	90th	26,667	26,667	26,667	4.0	6.0	13.0	1.00	1.0
		Median	26,667	26,667	26,667	3.0	4.0	4.0	1.00	1.0
		10th	19,906	26,667	26,667	2.0	2.0	2.0	1.00	0.9
Kitces	3.20	90th	29,333	29,333	29,333	5.0	7.0	16.0	1.10	1.0
		Median	26,667	26,667	26,667	3.0	4.0	4.0	1.00	1.0
		10th	26,667	26,667	26,667	2.0	2.0	2.0	1.00	1.0
Bucket Strategy	3.20	90th	26,667	26,667	26,667	5.0	8.0	20.0	1.00	1.0
		Median	26,667	26,667	26,667	3.0	4.0	6.0	1.00	1.0
		10th	26,667	26,667	26,667	2.0	3.0	3.0	1.00	1.0

It mighty seem counter-intuitive that dynamic withdrawal strategies, which allow us to spend more when you can, should have lower spending/ending ratio. The resolution of this paradox is that dynamic strategies tend to front-load caution. In any scenario that is not clearly very strong, they impose belt-tightening (e.g., skipping inflation, minor cuts) to guard against downside (see Figure 22). As a result, in an average scenario they actually underspend relative to what the static 3.20% rule would have allowed. They trade this reduction in middle-case consumption for improved security (avoiding ruin) and the option to spend more in boom times. If the strong boom never comes (i.e. the scenario is merely average), they end up having spent less and preserved more assets.

In summary, when evaluating lifetime spending vs. legacy trade-offs, we find that no single strategy dominates across all scenarios. The static strategy gives decent spending in median cases but at the cost of either under-spending (in good outcomes) or over-spending (in bad outcomes). Fully flexible rules (fixed-%) do the opposite – they assure no disaster and maximize upside spending, but may under-spend in an average scenario (leaving more unused wealth than necessary). Intermediate strategies strike various balances. For instance, guardrails and Vanguard's rule moderately improved upside spending and still protected the downside; their median cumulative withdrawals ended up slightly below baseline, but not drastically so. This aligns with the idea that retirees must decide where to focus their priorities in the distribution of outcomes. As Pfau (2015) explains, greater initial or ongoing spending requires a greater willingness to accept potentially lower spending later.

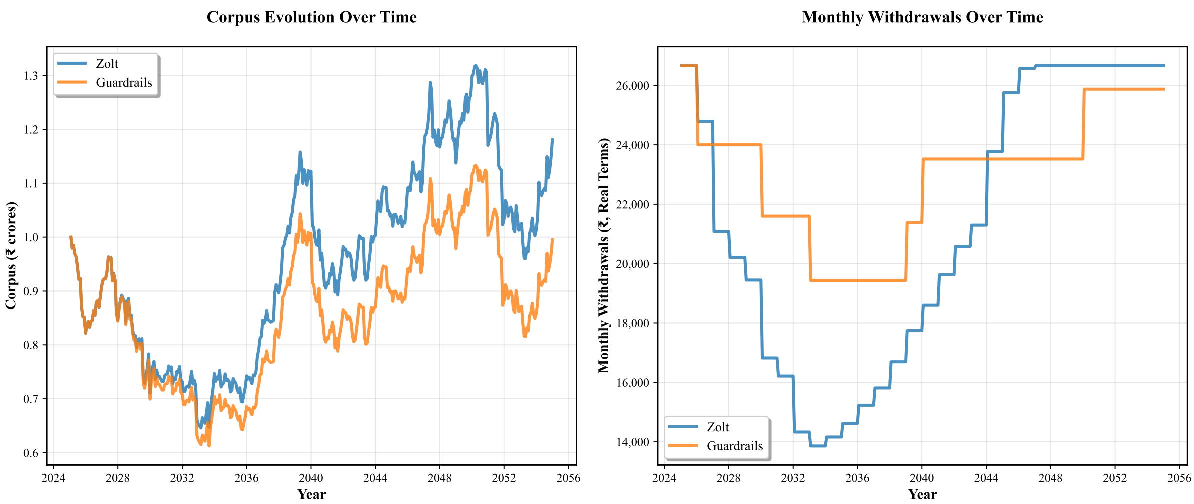

Figure 22: Early Belt-Tightening in Zolt and Guardrails Strategies
Both the Zolt and Guardrails strategies reduce withdrawals early in the retirement period to safeguard the portfolio, a form of cautionary restraint. This behavior helps preserve the corpus but results in lower lifetime spending relative to terminal wealth, as reflected in a reduced spending-to-ending ratio.

6.5. Corpus Sustainability

In the sustainability dimension, the comparative results reveal clear trade-offs among the dynamic withdrawal strategies. We use six metrics to comment on the sustainability of the different withdrawal strategies: failure rate, modified failure rate, D-RAS, modified

Table 6: Output - Sustainability Dimension

Spending Strategy	Initial Spending Rate (%)	D-RAS	Modified D-RAS	Failure Rate (%)	Modified Failure Rate (%)
Baseline	3.20	85	85	4.9	4.9
Fixed Percentage	3.20	100	67	-	20.0
Forego Inflation	3.20	63	71	-	59.2
Bengen Hard	3.20	78	78	1.3	1.3
Vanguard Percentage	3.20	100	67	-	19.8
Endowment Hybrid	3.20	64	73	0.1	2.2
Endowment Moving Avg	3.20	100	68	-	19.7
Guardrails	3.20	100	71	-	22.1
Zolt	3.20	94	68	-	4.6
Kitces	3.20	85	85	4.9	4.9
Bucket Strategy	3.20	86	86	4.8	4.8

D-RAS, spending floor breaches, and frequency of shortfall.

The 3.2% initial withdrawal, which has been used as a common benchmark to evaluate all withdrawal strategies, leads to a 5% failure rate for the baseline. Because the baseline strategy never reduces withdrawals unless forced by depletion, it incurs no spending shortfalls or floor breaches prior to failure. Retirees receive their full intended income every year until a sudden stop if the portfolio fails. This gives the baseline a fairly high D-RAS or modified D-RAS (both the metrics are same for baseline as there are no spending breaches), since it maintains the spending target consistently in all but the few failed scenarios (see Table 6). The downside, of course, is that those few scenarios can be catastrophic (complete income cut-off), which is captured by its D-RAS value being lower than 100. In short, the baseline offers excellent short-term spending reliability at the cost of a small long-term failure risk.

At the other end of the spectrum, fixed percentage withdrawals (spending a constant percentage of the remaining portfolio each year) eliminate the risk of outright failure. By design, one can never deplete the fund completely when taking a fixed percent as spending just dwindles as the balance shrinks. This strength is reflected in a perfect 100 D-RAS score for fixed-percentage withdrawals.

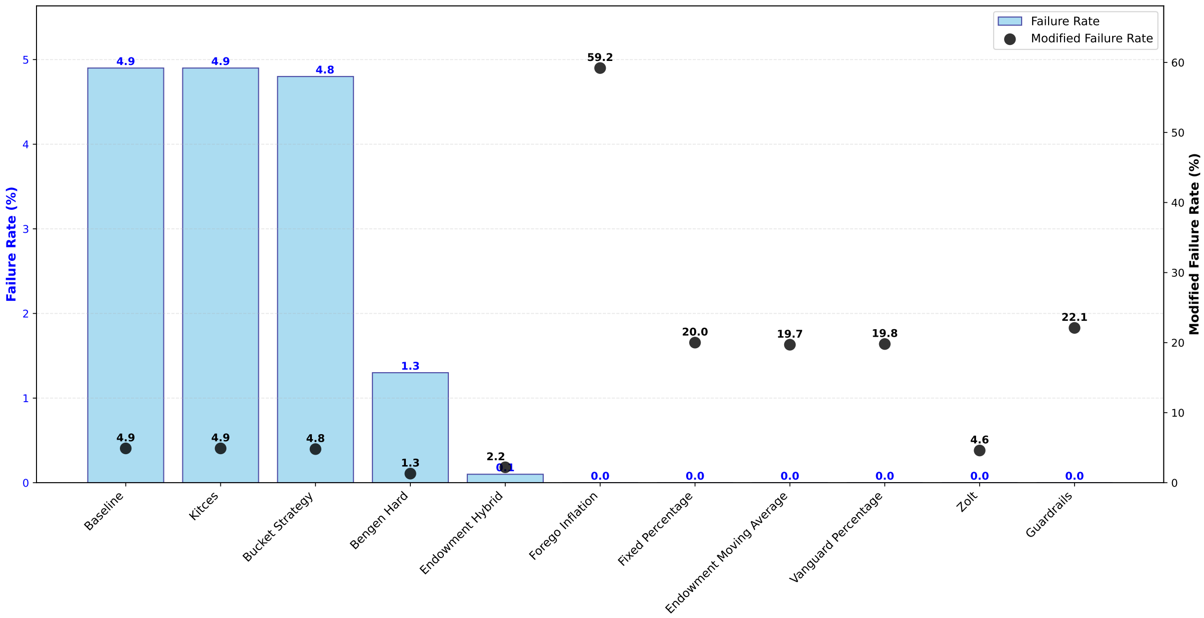

Figure 23: Failure Rate vs. Modified Failure Rate across Withdrawal Strategies
While several strategies exhibit a conventional failure rate close to zero, the modified failure rate—which accounts for spending floor breaches—reveals substantial vulnerability. Guardrails, in particular, show a modified failure rate exceeding 59%, despite a zero conventional failure rate, highlighting the need for careful scrutiny beyond traditional metrics.

The trade-off is much greater income volatility and frequent shortfalls relative to the desired spending level. In many scenarios, especially those with poor market returns, the retiree ends up withdrawing less than the initial target for a large portion of the retirement period. The frequency of shortfall under a fixed-percent rule is high. In the worst-case scenarios, nearly all years of retirement involve spending below the initial target (see Table 4 where 90th percentile frequency of shortfall for fixed-percentage is close to 100%). Even in a median market scenario, about two-thirds of the retirement period witnesses spending breaches. Consequently, the modified failure rate is sizable (around 20% of simulations). The modified D-RAS score accordingly drops to below 70 once these spending breaches are factored in. The fixed-percentage approach maximizes financial longevity and safety at the cost of substantial spending fluctuations and a high incidence of cuts in real income.

A very similar outcome is observed with the moving average endowment strategy (which bases withdrawals on a percentage of a smoothed portfolio value): it too avoids insolvency but often forces significant downward adjustments to spending. Even the Vanguard ceiling-and-floor-rule, which attempts to limit annual changes, ended up producing nearly the same results as the simple fixed-percentage rule in our analysis.

The guardrail strategy achieved a more balanced middle ground. This strategy managed to completely avert portfolio failure in our simulation (see Figure 23). In most market environments, guardrails allow the retiree to broadly continue with planned inflation-adjusted withdrawals. Only in markedly poor investment scenarios does the strategy mandate a deep cut to prevent ruin. The worst-case and median shortfall frequency for guardrails is also more moderate as compared to fixed-percentage and forego-inflation.

Importantly, by heading off full portfolio depletion, guardrails achieve a perfect 100 D-RAS score (reflecting no outright failures), though their modified D-RAS comes in around 71 after accounting for the spending breaches. Overall, the guardrail strategy significantly improves safety over the pure baseline (0% vs 5% failure risk) and does so with fewer spending disruptions than a continuously flexible withdrawal scheme.

Another notable strategy is Zolt, which in our results provided one of the best combinations of safety and consistency. This method also virtually eliminated terminal failures (0% failure rate), and it required spending adjustments in only a small fraction of scenarios (roughly 10% experienced any cuts). In other words, almost 90% of the time the Zolt approach maintained full planned spending throughout retirement. This led to an excellent modified failure rate of only 4.6%. The Zolt strategy appears to offer a very appealing risk-spending trade-off that almost matches the steady income of the baseline in most cases while almost matching the protection of adaptive strategies against failure in tail scenarios (see Figure 24).

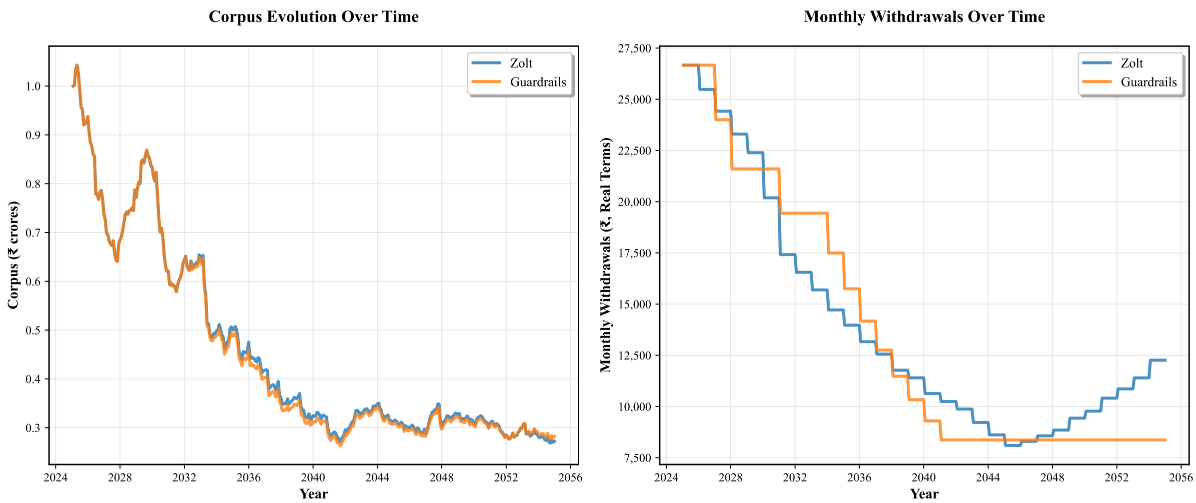

Figure 24: Guardrails and Zolt Strategies Avert Portfolio Ruin Through Spending Adjustments

In this illustration, both Zolt and Guardrails strategies significantly curtailed spending from around 2040 onwards on account of portfolio depletion. These timely adjustments prevented the portfolio from ruin, enabling sustenance in subsequent years—a key advantage of dynamic withdrawal strategies over static rules.

In the case of Bengen's hard constraints, the failure risk is drastically reduced. Our analysis showed only 1.3% failure rate which is higher than for Zolt but lower than the baseline (see Figure 25). In the case of forego-inflation, by allowing inflation to silently erode the real withdrawal value over time, the portfolio is spared from over-drawing in down markets, hence the elimination of ruin. The trade-off, however, is guaranteed significant erosion of purchasing power.

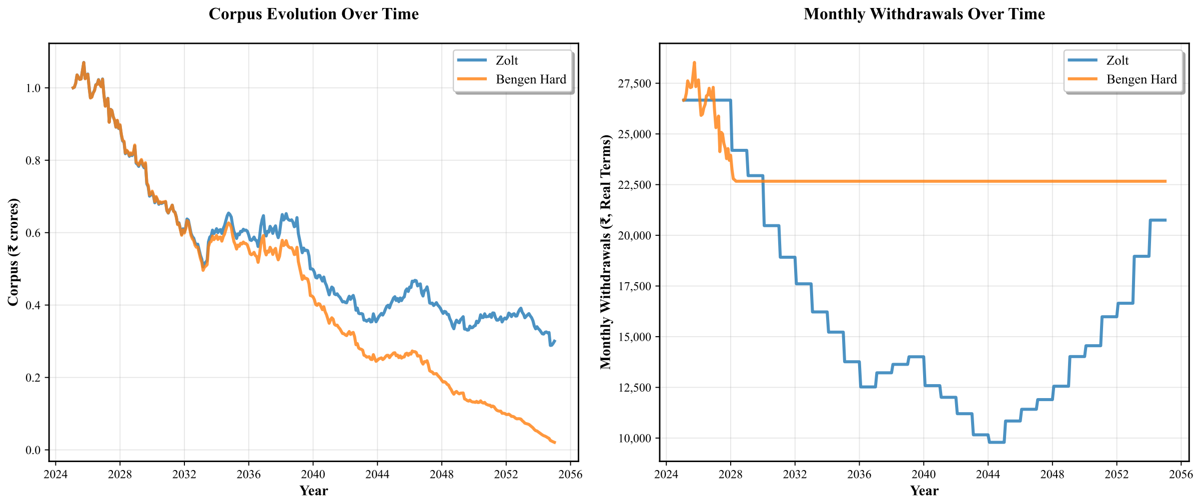

Figure 25: Bengen Hard vs. Zolt: Ruin Avoidance Through Withdrawal Adjustments
The Bengen Hard strategy incorporates a withdrawal floor, providing some protection against market declines. However, it lacks the flexibility of strategies like Zolt or Guardrails, which can push withdrawals even lower when needed. This constraint limits Bengen Hard's effectiveness in preventing ruin, leading to higher failure rates relative to Zolt or Guardrails, though still lower than the baseline.

Finally, the endowment-style hybrid strategy proved to be an especially effective compromise, though its evaluation depends on the metric considered. This method (which smooths withdrawals by blending a fixed percentage rule with prior-year spending) delivered almost the best of both worlds. It nearly eliminated failures and it kept spending close to the target in the vast majority of scenarios (see real withdrawals in Table 5). In our results, the hybrid had a minuscule failure rate (0.1%), essentially matching the most aggressive adaptive approaches in safety, with moderate cuts in withdrawals. As a result, its modified failure rate (2.2%) was markedly better than other adaptive strategies. These traits gave the endowment hybrid a good modified D-RAS score of 73, underscoring its strong combined performance on sustainability and lifestyle stability.

Another notable aspect is the way each strategy handles worst-case adjustments. The spending floor breach metric, in particular, highlights how often each strategy allowed income to fall below a critical threshold level. Strategies that apply withdrawal cuts, such as guardrails or percentage withdrawal variants, show high spending floor breaches in severe market downturns (90th percentile spending breaches exceeding 50% in Table 4). In contrast, the hybrid and Zolt strategies had far fewer floor breaches in bad scenarios (on the order of around 5%), demonstrating a greater ability to stay above the minimum income floor even when conditions were poor.

Traditional approaches like the baseline or bucket plan technically never breach a predetermined floor until the moment of failure (since they hold spending constant), but of course their floor breach metric is moot. When failure happens in those strategies, the spending drops straight to zero.

In summary, each dynamic withdrawal strategy exhibits distinct strengths and weaknesses when evaluated across multiple risk metrics. Methods on one extreme (like fixed-percentage and moving-average strategies) maximize longevity and virtually eliminate failure risk, but at the cost of very frequent spending shortfalls and breach of spending floor in bad scenarios. On the other extreme, strategies that hold spending rigid (like the baseline or Kitces ratcheting) offer a high degree of spending certainty year-to-year but expose retirees to a small yet significant chance of complete portfolio depletion.

7. Can Dynamic Strategies Support Higher Initial Withdrawal Rates?

A natural question that arises when evaluating dynamic withdrawal strategies is whether their built-in adaptability permits retirees to start with a higher initial withdrawal rate. Theoretically, since dynamic rules can adjust spending downward in adverse market conditions, they could allow a retiree to begin with a more generous income level compared to static strategies. Several prior studies have explored this hypothesis.

(Pfau, 2015) showed that dynamic rules could raise initial withdrawals, though the gains were not large. (J. Guyton & Klinger, 2006) illustrated that their guardrails framework could support higher withdrawals. (Arnott et al., 2024) show that dynamic withdrawals can start with higher initial withdrawals, but barring the Guardrails strategy, the increase in initial withdrawals is limited. (Raju, 2025) documents the increase in initial withdrawal rates in his study of dynamic withdrawal strategies as well.

To evaluate this in the Indian context, we conducted 10,000 Monte Carlo simulations for each strategy using historical return and inflation data. For a given equity allocation, we determined the maximum initial withdrawal rate (SWR) that resulted in a failure rate close to 5%. We conducted this analysis for the following dynamic strategies: Bengen Floor-and-Ceiling (Bengen Hard), Endowment Hybrid, Guardrails (Guyton-Klinger), Zolt Glidepath, and Kitces Ratchet Rule. Strategies like Fixed Percentage, Vanguard Percentage, and Endowment Moving Average were excluded, as varying initial withdrawals in these fixed-percentage type withdrawals is not meaningful. The Bucket Strategy was also excluded, as it is essentially a variant of the Baseline.

As seen in Figure 26, most dynamic strategies yield an improvement in initial safe withdrawal rates, though such improvements are not large. Forego inflation leads to a decent improvement, but given the severe compression in real withdrawals that this strategy entails, the improvement in initial withdrawals is not relevant. In this respect, the endowment hybrid and Zolt strategies provide a good balance. Our results support typical findings that the primary benefit of dynamic strategies lies in better spending sustainability and flexibility, not in significantly higher starting income.

One striking exception is the guardrails strategy, which offers a dramatic increase in withdrawal rates. However, this comes with a major caveat as shown earlier in our results. Guardrails has among the highest *modified failure rates*, due to frequent spending floor breaches. In effect, the retiree is granted a higher starting amount but faces a much greater risk of hardship through repeated income cuts. This calls into question the utility of the higher withdrawal rate. As Pfau (2015) cautioned that while rules with more flexibility appear promising in simulations, real-world behavioral tolerance for downward adjustments may be limited.

In conclusion, while the idea of raising initial income is appealing, our results suggest that dynamic rules should not be selected on this basis alone. Their strength lies in enabling more responsive spending and reducing extreme portfolio outcomes which are benefits that come from their flexibility, not necessarily from a higher withdrawal rate.

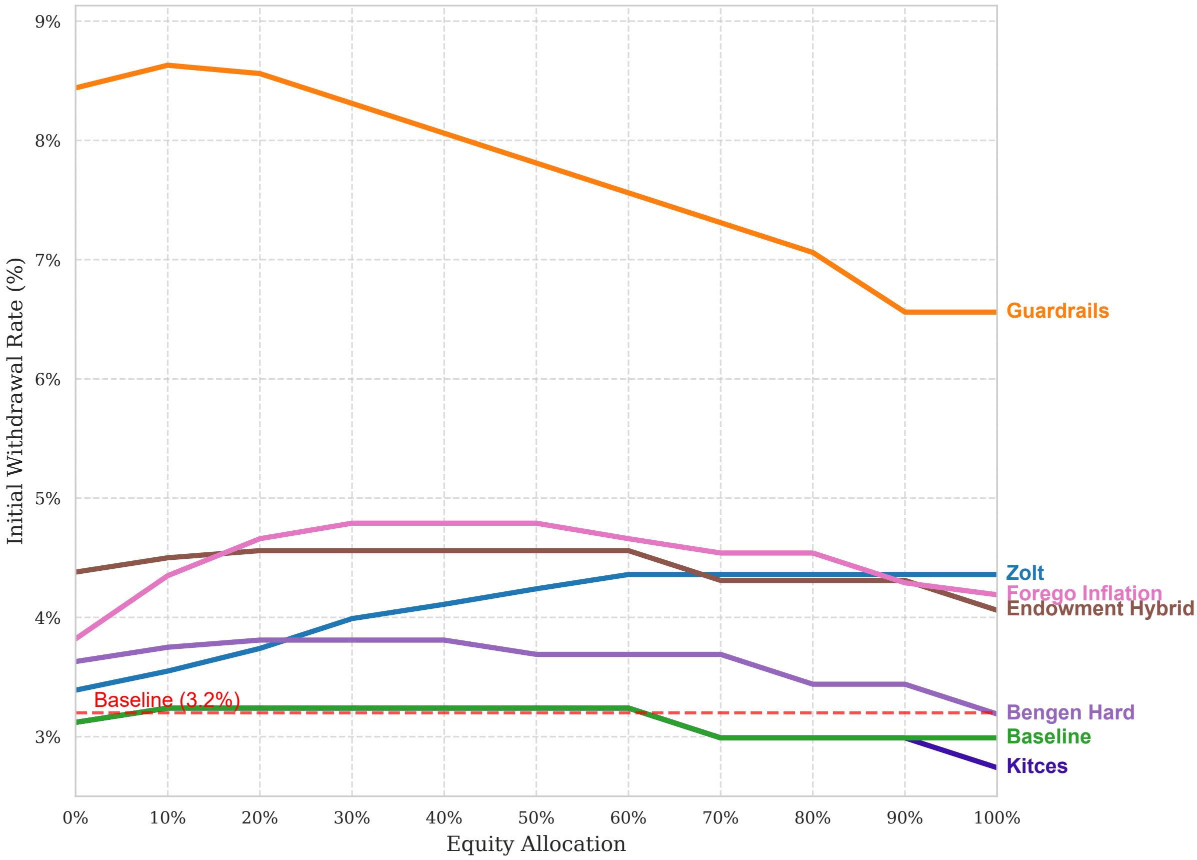

Figure 26: Safe Withdrawal Rates by Strategy and Equity Allocation.
This chart illustrates the maximum initial withdrawal rate (for a 5% failure rate over 30 years of retirement) achievable under various dynamic withdrawal strategies at different equity allocations. While most strategies offer modest improvements over the Baseline (constant 3.2%), guardrails shows a marked increase, though this comes with a trade-off in the form of high modified failure rate.

8. RetireAbility™ Index

Retirees evaluating withdrawal strategies must consider multiple criteria simultaneously. Throughout this study, we have tracked a wide range of metrics spanning spending outcomes, remaining savings, income stability, and plan sustainability, to assess each strategy's performance. To facilitate an overall comparison, we introduce a composite measure called the *RetireAbility™ Index*, which condenses these various metrics into a single score. This Index is designed to capture a strategy's holistic efficacy by combining certain metrics from the four key dimensions of a retirement plan:

- **Spending Dimension:** To capture the spending power of a withdrawal strategy, we include (i) the total real withdrawals over 30 years as a percentage of the initial portfolio (*Cumulative Withdrawals as a % of Corpus*), and (ii) the final withdrawal amount at year 30 as a percentage of the initial year's withdrawal (*Terminal Spending Change Ratio*). These metrics indicate how much a retiree could spend in total and how their annual income holds up in the future.

- **Savings Dimension:** Measures the remaining wealth or legacy potential. We use (i) the portfolio balance at the end of 30 years relative to the starting corpus (*Terminal Corpus Change Ratio*), and (ii) the minimum portfolio value observed during retirement as a percentage of the initial corpus (*Minimum Corpus Value*). These capture whether the strategy preserves capital over the horizon and how close the retiree might come to depleting their savings.

- **Stability Dimension:** Assesses how smooth or volatile the withdrawals are. We use (i) the average magnitude of any real cuts in yearly withdrawal amounts (*Downside Spending Volatility*), and (ii) the frequency of shortfall instances, defined as the share of simulation trials where cumulative withdrawals fell below the originally planned schedule (*Frequency of Shortfall*). This dimension penalizes strategies that require significant or frequent spending cuts, favoring those that deliver a steadier income stream.

- **Sustainability Dimension:** Evaluates the risk of running out of money or breaching a spending floor. We consider (i) the the percentage of simulations in which the portfolio was fully depleted or a minimum spending floor was violated (*Modified Failure Rate*) , and (ii) the *Modified D-RAS* metric that synthesizes the depth and risk-adjusted severity of failures.

For each strategy, we compute a score for the above dimensions by appropriately combining and normalizing its constituent metrics (so that a score of 100 represents the best-performing strategy on that dimension among the cohort). The composite RetireAbility™ Index is then calculated as a weighted sum of the four dimension scores.

The key challenge in computing such a composite score is choosing the weighting structure, since different retirees may prioritize certain dimensions over others. In practice, retiree preferences can vary widely. Some may be most interested in maximizing spending, whereas others care more about leaving a bequest or ensuring a stable, safe income. Rather than fix a single weighting, we define three prototypical retiree profiles- Optimistic, Neutral, and Defensive, each with a different set of weights reflecting their priorities. Table 7 shows the weight allocations assigned to each dimension for the three profiles.

This approach is conceptually similar to creating retiree personas, a method often used in behavioral finance and retirement research to represent different types of retirees based on their goals, risk preferences, and behavioral traits. By assigning distinct weightings to key retirement dimensions, we can capture the diversity in retiree preferences in a structured and analytically tractable way.

This line of inquiry opens up an interesting avenue for further research, where a broader set of retiree personas can be developed—each with tailored weightings that reflect different financial circumstances, psychological dispositions, and cultural contexts. Such personas can help improve retirement planning tools, enabling more personalized and relevant advice for individuals navigating the complexities of retirement decision-making.

Dimension	Optimistic	Neutral	Defensive
Spending	50%	25%	15%
Savings	10%	25%	15%
Stability	20%	25%	20%
Sustainability	20%	25%	50%

Table 7: Weighting structure in the RetireAbility™ Index for different retiree profiles.

The *Optimistic* retiree places 50% of the index weight on the Spending dimension. This profile assumes the retiree's primary goal is to enjoy higher withdrawals in retirement (and perhaps expects favorable market outcomes), while placing comparatively less emphasis on ending wealth. Accordingly, the Savings dimension is given only a 10% weight. The remaining 40% is split equally between Stability and Sustainability (20% each), acknowledging some concern for volatility and failure risk but to a lesser degree than spending.

The *Neutral* retiree is a balanced case, assigning 25% to each of the four dimensions. effectively valuing spending, savings, stability, and sustainability equally.

Finally, the *Defensive* retiree heavily prioritizes safety. A large 50% of the weight is on the Sustainability dimension. Savings and Spending are still important but secondary (15% each in the index), and 20% weight is allotted to the Stability dimension (consistent with a defensive retiree who would be sensitive to volatility in withdrawals).

To further align the analysis with retiree preferences, we apply the above weightings on specific points in the distribution of possible retirement outcomes. For the Optimistic retiree, weights are applied to the 90th percentile of outcomes, reflecting this retiree's expectation of favorable market conditions and strong portfolio performance.In contrast, the Neutral retiree bases decisions on median (50th percentile) outcomes, representing a balanced view that neither assumes particularly good nor particularly bad outcomes. Finally, the Defensive retiree applies weights to the 10th percentile outcomes, consistent with a cautious mindset that emphasizes planning for adverse scenarios.

This distributional approach ensures that each retiree profile is evaluated not just by differing priorities but also by differing levels of risk tolerance and outcome expectations. Using this approach, we compute the Index score for each withdrawal strategy under each retiree persona.

This yields a unified performance score (on a 0–100 scale) that reflects how well a strategy meets the objectives of that particular retiree type. Table 8 illustrates the outcomes, showing the withdrawal strategy's composite scores for the Optimistic, Neutral, and Defensive profiles.

For the Optimistic retiree, strategies that allow higher withdrawals, especially those that can ratchet spending upward in favorable market conditions, score the highest. For example, the Kitces ratcheting strategy (which increases the withdrawal amount when portfolio growth triggers are met) achieves a top composite score for this type of retiree. Guardrails comes a close second in the composite score. The baseline constant-inflation adjustment strategy and endowment-style spending rules also perform well.

These approaches excel in the Spending dimension by delivering greater cumulative withdrawals or higher late-life income, which is rewarded under the Optimistic retiree's 50% spending weight. However, some of the highest-spending strategies suffer in stability or sustainability, preventing any one strategy from dominating across all metrics.

For the Neutral retiree (equal weights), the highest-scoring strategies are those that achieve a balanced performance without extreme trade-offs. Notably, the Kitces and the classic constant-inflation adjusted rule rank at the top in the neutral composite score. This is because these strategies provide strong outcomes in spending and sustainability while maintaining perfect stability (no real cuts in withdrawals by design).

Another strategy that fares well under neutral weighting is Zolt's adaptive formula, which makes gradual adjustments to withdrawals. It avoids large swings and thus provides moderate stability and good overall performance across dimensions. In general, 'bland' strategies that do not introduce significant volatility or risk are rewarded by the neutral weights.

Finally, the Defensive retiree's weighting (dominated by sustainability concerns) yields results similar to the neutral case. The emphasis on avoiding failure strongly favors strategies with robust safety profiles. The Baseline and the Kitces ratcheting approach emerge as the top-ranked strategies for a defensive retiree, reflecting their very low failure rates and high stability. These safety-first strategies garner high Sustainability scores under defensive weights.

Meanwhile, more aggressive adaptive strategies that might maximize spending at the expense of higher failure risk (for instance, rules that frequently raise withdrawals or have looser floor safeguards) fall to the bottom under defensive weighting. For example, the guardrail-based approach and the endowment moving-average rule – which were favored by the optimistic profile – receive much lower composite scores for conservative retirees, due to the heavy penalty for their higher volatility and failure probabilities.

In summary, the RetireAbility™ Index provides a comprehensive evaluation that integrates the full spectrum of retirement strategy metrics into a single number for each strategy. This index approach greatly simplifies the process of comparing withdrawal strategies by encapsulating the trade-offs across spending, savings, stability, and sustainability dimensions. It thereby offers retirees and planners a clearer decision framework to identify which strategy best aligns with a given retiree's goals and risk tolerance.

Table 8: RetireAbility™ Index

Strategy Name	Spending Dimension Score	Saving Dimension Score	Stability Dimension Score	Sustainability Dimension Score	RetireAbility™ Index
Optimistic Retiree (Weights)	50%	10%	20%	20%	
Kitces	51.6	71.4	100.0	92.9	71.5
Guardrails	89.7	35.0	54.7	40.9	67.5
Baseline	38.6	74.2	100.0	93.7	65.5
Endowment Moving Avg	98.9	18.8	25.2	36.5	63.7
Endowment Hybrid	76.7	49.3	24.2	63.7	60.9
Bengen Hard	65.7	38.2	40.7	77.5	60.3
Bucket Strategy	38.6	12.5	100.0	97.0	60.0
Fixed Percentage	99.4	29.9	0.4	33.9	59.6
Vanguard Percentage	99.4	17.0	0.7	34.3	58.4
Zolt	38.6	73.7	73.2	49.8	51.3
Forego Inflation	-	100.0	8.2	8.8	13.4
Neutral Retiree (Weights)	25%	25%	25%	25%	
Kitces	100.0	53.2	100.0	92.9	86.5
Baseline	100.0	49.9	100.0	93.7	85.9
Bucket Strategy	100.0	-	100.0	97.0	74.2
Zolt	100.0	50.8	93.2	49.8	73.5
Bengen Hard	76.4	62.6	43.0	77.5	64.9
Endowment Hybrid	81.6	55.0	37.5	63.7	59.4
Guardrails	72.5	62.0	52.7	40.9	57.0
Endowment Moving Avg	72.4	62.0	30.7	36.5	50.4
Fixed Percentage	73.4	65.3	14.3	33.9	46.7
Vanguard Percentage	73.4	64.4	14.8	34.3	46.7
Forego Inflation	-	100.0	10.5	8.8	29.8
Defensive Retiree (Weights)	15%	15%	20%	50%	
Baseline	100.0	13.9	100.0	93.7	83.9
Kitces	100.0	13.9	100.0	92.9	83.5
Bucket Strategy	100.0	-	100.0	97.0	83.5
Bengen Hard	66.8	43.4	70.8	77.5	69.5
Endowment Hybrid	43.4	58.9	74.2	63.7	62.0
Zolt	82.8	26.0	78.2	49.8	56.9
Guardrails	11.4	88.0	69.6	40.9	49.3
Endowment Moving Average	7.4	95.0	57.4	36.5	45.1
Vanguard Percentage	8.3	100.0	46.8	34.3	42.8
Fixed Percentage	6.7	100.0	47.0	33.9	42.3
Forego Inflation	-	96.5	13.4	8.8	21.6

9. Conclusion

This study offers a comprehensive evaluation of dynamic withdrawal strategies for retirement income in the Indian context— an area that has been largely unexplored until now. Using extensive simulations grounded in local return, inflation, and tax data, we analyze 10 distinct withdrawal strategies across multiple dimensions, including spending power, savings preservation, income stability, and sustainability.

Our findings affirm that dynamic withdrawal strategies can improve retirement outcomes. In particular, dynamic methods can adapt spending to market conditions, thereby enhancing portfolio longevity, increasing total lifetime withdrawals in favorable scenarios, and mitigating the risk of total portfolio depletion. However, these benefits are accompanied by substantial trade-offs in the form of withdrawal volatility and spending uncertainty.

Our study also demonstrates that applying a singular metric like failure rate is inadequate to evaluate dynamic strategies. The study accordingly uses over twenty metrics for a close evaluation of withdrawal strategies. Moreover, through the RetireAbility™ Index, we integrate these diverse metrics into a unified score, allowing retirees and advisors to align strategy selection with specific goals and risk tolerance.

The study also notes that while dynamic strategies do offer scope for higher initial withdrawal rates, our findings caution against selecting them solely for this purpose. The true strength of dynamic strategies lies in their flexibility and their ability to adapt to market realities, rather than in offering significantly higher starting income. In particular, retirees must weigh the appeal of higher initial spending against the potential for future income cuts, and choose strategies that align with their behavioral comfort and financial needs.

Overall, this study reinforces the importance of tailoring withdrawal strategies to local economic conditions and individual retiree preferences. Dynamic withdrawal strategies offer valuable flexibility, but their effectiveness hinges on thoughtful implementation that considers not just financial outcomes but also behavioral tolerances and lifestyle needs.

Retirees differ in their risk tolerance, willingness to accept income variability, legacy objectives, and capacity to adjust spending. It is therefore imperative that these factors be systematically assessed and incorporated into the selection of an appropriate withdrawal strategy.

References

Arnott, A. C., Benz, C., & Rekenthaler, J. (2024). *The state of retirement income: 2024*. Morningstar, Inc.

Bengen, W. P. (1994). Determining withdrawal rates using historical data. *Journal of Financial Planning*, *7*(4), 171–180.

Bengen, W. P. (2001). Conserving client portfolios during retirement, part iv. *Journal of Financial Planning*, *14*(6), 110–119.

Cooley, P. L., Hubbard, C. M., & Walz, D. T. (1998). Retirement Savings: Choosing a Withdrawal Rate That Is Sustainable. *AAII Journal*, *10 (3)*, 16–21.

Estrada, J. (2017a). Refining the failure rate. *The Journal of Retirement*, *4*(3), 63–74. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2851748

Estrada, J. (2017b). Replacing the failure rate: A downside risk perspective. *The Journal of Retirement*, *4*(3), 31–47. https://www.pm-research.com/content/iijpracapp/6/3/12

Finke, M. S., Pfau, W. D., & Blanchett, D. M. (2013). The 4 percent rule is not safe in a low-yield world. *Journal of Financial Planning*, *26*(6), 46–55.

Guyton, J., & Klinger, W. J. (2006). Decision Rules and Portfolio Management for Retirees: Is the “Safe” Initial Withdrawal Rate Too Safe? *Journal of Financial Planning*.

Guyton, J. T. (2004). Decision rules and maximum initial withdrawal rates. *Journal of Financial Planning*, *17*(3), 49–57.

Jaconetti, C. M., Jr., F. M. K., & DiJoseph, M. A. (2013). *Sustainable withdrawal rates: The historical evidence on buffering volatility with a dynamic withdrawals strategy* (tech. rep.). The Vanguard Group. https://personal.vanguard.com/pdf/ISGSWB.pdf

Kitces, M. E. (2015). *The ratcheting safe withdrawal rate – a more dominant version of the 4% rule*. https://www.kitces.com/blog/the-ratcheting-safe-withdrawal-rate-a-more-dominant-version-of-the-4-rule/

Pfau, W. D. (2015). Making sense out of variable spending strategies for retirees. *Journal of Financial Planning*, *28*(10), 42–51.

Pfau, W. D. (2017). *How much can i spend in retirement? a guide to investment-based retirement income strategies*. McLean Asset Management Corporation.

Raju, R. (2025, January). Safe Withdrawal Rates in India: Balancing Portfolio Sustainability and Flexibility (1992-2024). https://doi.org/10.2139/ssrn.5114252

Raju, R., & Saraogi, R. (2024, January). Balancing Acts: Safe Withdrawal Rates in the Indian Context. https://doi.org/10.2139/ssrn.4697720

Saraogi, R. (2022, September). Computing the Safe Withdrawal Rate for a Retirement Portfolio in India. https://doi.org/10.2139/ssrn.4216077

Zolt, D. M. (2013). Achieving a higher safe withdrawal rate with the target percentage adjustment. *Journal of Financial Planning*, *26*(1), 51–59.