

A Modern Approach to Retirement Planning

A liability-driven approach.

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ABSTRACT

This paper presents an alternative framework for retirement planning that treats retirement as a **liability-driven investment problem**. Rather than focusing primarily on accumulating a target level of wealth and determining a sustainable withdrawal rate, the framework focuses directly on building the capacity to fund a desired stream of future retirement income. Growth assets are used to accumulate wealth, while Treasury Inflation-Protected Securities held to maturity and Social Security are used to progressively secure future real income.

The framework introduces the **Security Ratio**, which measures the proportion of retirement income capacity that has been protected from future market outcomes. Retirement readiness therefore depends on both having sufficient resources to support the desired level of income and having secured the portion of that income the household wishes to protect. Because risk is managed directly against future income liabilities, assets not required to meet the household's security objective can remain invested for growth, preserving participation in favorable market outcomes and creating opportunities to convert future gains into higher secured income.

Monte Carlo simulations compare the LadderUp framework with a traditional 60/40 portfolio using a dynamic withdrawal rule across households with different ages, wealth levels, and preferences for income security. For households with longer horizons, the framework can maintain greater exposure to growth assets, resulting in earlier retirement and greater upside income potential in the representative simulations while also substantially reducing the frequency and severity of income shortfalls. For households approaching retirement with a strong preference for income security, the framework instead shifts more wealth toward income-securing assets, sacrificing some upside and potentially delaying retirement in exchange for greater protection of the household's desired standard of living. By defining the objective in terms of retirement income and security, the framework turns asset allocation from an externally imposed rule into an output of the optimization itself, with the appropriate balance between growth and security determined by each household's circumstances, objectives, and capacity to bear risk.

1. Introduction

Traditional retirement planning frames the central problem as one of portfolio accumulation followed by sustainable withdrawal. Investors save during their working years, allocate wealth across stocks and bonds, and, upon retirement, begin drawing income from the resulting portfolio according to a predetermined or dynamically adjusted withdrawal rule. Retirement planning manages this uncertainty primarily through two decisions: how assets are allocated between stocks and bonds and how much of the portfolio can safely be withdrawn each year. Both are useful tools for controlling risk, but they are ultimately proxies for the outcome retirees care about most—the ability to fund their desired retirement income. A lower equity allocation may reduce portfolio volatility, and a lower withdrawal rate may reduce the probability of exhausting the portfolio, but neither directly measures how much future retirement income can be supported or how secure that income is.

This paper addresses the problem directly by framing retirement readiness in terms of **income**. Assets can then be divided conceptually into two roles:

1. **Growth assets**, primarily equities, which provide the opportunity to convert them to income-generating assets in the future; and
2. **Income-securing assets**, including inflation-protected bonds held-to-maturity and defined benefit pension plans including Social Security.

Under this framework, retirement planning becomes a process of progressively converting uncertain growth assets into secure future income. This leads naturally to the **Security Ratio**, which measures the percentage of future retirement income needs currently matched with income-securing assets. Having enough expected wealth to retire is not necessarily equivalent to being sufficiently secure to retire. Retirement readiness in this framework depends on both income capacity and income security.

The LadderUp model developed in this paper implements this approach through a dynamic allocation between growth assets and a ladder of Treasury Inflation-Protected Securities (TIPS). The bond ladder is designed to mature during retirement to fund retirement income needs. Prior to retirement, when growth assets perform well, assets are shifted to the bond ladder to bring the individual closer to retirement readiness. When growth assets perform poorly, growth assets are held longer and the retirement readiness may be delayed.

A natural implication of this framework is that it produces a Security Ratio glide path that directly determines the allocation between growth assets and income-securing assets over time. Rather than relying on proxy rules—such as increasing bond allocations with age or selecting a withdrawal rate based on portfolio value—the allocation is derived directly from the retiree's stated income needs and desired level of income security. As the target Security Ratio increases, additional assets are shifted from growth assets into the bond ladder to secure future income. The resulting portfolio allocation is therefore an output of the retiree's income objectives rather than the product of independently specified portfolio management rules. The framework shifts the object of retirement management from the investment portfolio to the retirement income it is intended to provide.

Viewed through this framework, a conventional portfolio-based retirement strategy represents an important limiting case. To the extent that future income needs are not explicitly matched with assets held to fund those liabilities, the portfolio operates with a Security Ratio near zero: future retirement income remains dependent on the value of the investment portfolio when withdrawals are required. Traditional strategies manage this exposure through portfolio allocation and withdrawal rules, including dynamically reducing spending following adverse market outcomes. The liability-driven framework instead allows the retiree to determine explicitly how much future income should be insulated from

those outcomes.

As developed in the following sections, managing risk directly against future income liabilities can allow households to take more investment risk when they have the capacity to bear it while simultaneously locking in the retirement income they are unwilling to place at risk. The empirical analysis examines whether this more targeted allocation of risk translates into improved retirement outcomes, including downside income protection, retirement timing, and the potential for real income growth during retirement.

2. Retirement as Liability-Driven Investing

2.1 Retirement creates a stream of future liabilities

The economic objective of retirement saving is to finance future consumption.

Suppose a household wishes to generate real retirement income of \$100,000 per year. Conceptually, this objective can be viewed as a series of future liabilities:

- \$100,000 of real income in the first year of retirement;
- \$100,000 in the second year;
- \$100,000 in the third year;
- and so forth throughout retirement.

Once retirement is viewed this way, the problem begins to resemble **liability-driven investing (LDI)** used by pension plans and insurance companies.

Rather than asking only what portfolio allocation maximizes expected risk-adjusted wealth, an LDI framework asks what assets are best suited to fund particular future obligations.

For retirement income, Treasury Inflation-Protected Securities have several useful characteristics. Their principal adjusts with inflation, their cash flows are backed by the U.S. Treasury, and a portfolio of TIPS can be constructed to provide real, risk-free cash flows at future dates. A TIPS ladder can therefore be interpreted not simply as a "bond allocation," but as a defined future income stream to fund specific future real-income needs (liabilities).

This distinction matters.

In a conventional portfolio, a bond is typically characterized as a lower-volatility asset that offsets some of the risk associated with growth assets. In a liability-driven framework, the bond has a more explicit economic purpose: **it purchases future retirement income.**

2.2 Managing Retirement Income Rather Than the Portfolio

Once retirement is viewed as a stream of future liabilities, the central risk-management question changes. Rather than asking how much portfolio volatility an investor should accept, the relevant question becomes: how much future retirement income is the individual willing to leave exposed to market risk?

This distinction provides a direct way to incorporate individual risk preferences into retirement planning. A retiree may have a desired level of income but place different values on different portions of that income. Some income represents a minimum standard of living that the retiree wants to protect from future market outcomes, while additional income may be desirable but can reasonably remain dependent on investment performance. Retirement risk can therefore be expressed in terms of the proportion of

future income that must be guaranteed and what portion can be supported by risky assets.

The framework therefore approaches asset allocation from first principles. Assets required to fund the secured portion of future income are matched to those liabilities, while remaining wealth can continue to be invested for growth. The allocation between income-securing and growth assets follows directly from two household preferences—how much future income is desired and how much of that income must be secured—rather than being imposed independently through portfolio rules of thumb. Once sufficient income has been secured, remaining wealth can maintain exposure to higher-expected-return growth assets without placing the matched income at risk.

2.3 Defined pension plans fit naturally into the liability framework

Social Security and other defined-benefit pensions fit naturally within the liability framework because they provide income that directly offsets future retirement liabilities. Social Security, in particular, represents a stream of inflation-adjusted lifetime income and therefore funds a portion of the same future income needs as the TIPS ladder.

The claiming decision can consequently be evaluated jointly with portfolio construction. Delaying Social Security sacrifices current benefits in exchange for a larger future income, while claiming converts the available benefit into current guaranteed income. The optimal Social Security claiming decision therefore need not be separated from the portfolio decision. Social Security and the TIPS ladder are complementary mechanisms for funding the same retirement-income liabilities.

3. Retirement Optimization Framework

3.1 Retirement Objectives

The optimization begins with two inputs that describe the individual's retirement objectives: Desired income level and a target Security Ratio. Desired Income specifies the real annual income the individual would like to have in retirement, while the target Security Ratio specifies the minimum proportion of that income that must be secured through income-securing assets before the individual is willing to retire.

A Security Ratio below one does not imply that the household lacks the capacity to support its full desired income. Rather, it means that a portion of that income capacity remains dependent on risky assets. If those assets decline in value, the household's future capacity to support the same level of income may also decline. Desired Income can therefore be interpreted as the household's retirement-income objective, while $\text{Desired Income} \times \text{target Security Ratio}$ represents the portion of that objective the household requires to be protected from future market outcomes.

3.2 Retirement Trigger

Retirement occurs when two conditions are simultaneously satisfied. First, the individual's accumulated resources must have sufficient income capacity (IC) to support the desired income (DI). Income capacity is the annual real retirement income that could be secured if the individual's entire investment portfolio—including both growth assets and the existing bond ladder—were converted into a liability-matching bond ladder at current market rates. It represents the total retirement income the portfolio is capable of securing at a given point in time, regardless of whether the individual has actually chosen to secure that income. Second, the ratio of the annual income provided by income-securing assets (G) to income capacity must be greater than or equal to the user-defined target Security Ratio (SR). Mathematically,

retirement occurs when:

$$IC(t) \geq DI(t)$$

and

$$SR(t) = \frac{G(t)}{IC(t)} \geq SR^*$$

where SR^* is the user-defined target Security Ratio.

3.3 Security Ratio Glide Path

The Security Ratio also provides a natural dynamic structure for the investment strategy. The desired level of income security need not remain constant throughout retirement. Instead, the target Security Ratio can follow a glide path, generally increasing as the individual's remaining retirement horizon shortens. Assets are progressively converted from growth assets into income-securing assets as required to follow this path. Unlike a conventional asset-allocation glide path, however, the stock/bond allocation is not itself the target. It emerges from the amount of future income that the individual wishes to secure at each point in time.

The optimization continues after retirement. At the retirement date, the individual may intentionally leave a portion of future income capacity unsecured in order to maintain exposure to growth assets. As retirement progresses, however, the target Security Ratio gradually increases toward 100 percent, causing growth assets to be progressively converted into the bond ladder. The value of maintaining exposure to growth assets declines as the remaining retirement horizon shortens, while the objective of securing the remaining income liabilities becomes increasingly important. The framework therefore ultimately converts accumulated wealth into the retirement income it was intended to provide.

4. Comparison with a Traditional 60/40 Portfolio

To understand the economic consequences of the liability-driven approach, it is useful to compare it with a familiar alternative.

The benchmark considered here maintains a traditional 60% equity / 40% fixed-income portfolio during retirement and funds spending through a dynamic withdrawal rule. The dynamic withdrawal rule uses a Guyton–Klinger-style framework. Annual withdrawals are targeted to be 4% of the portfolio but can be adjusted over time in response to market conditions while guardrails limit the magnitude of annual changes to no more than $\pm 10\%$.

Retirement readiness is determined when the total portfolio value is sufficient to support the desired level of income or:

$$0.04 P(t) \geq DI(t)$$

Where $P(t)$ is the total stock plus bond portfolio. Note that the bond portfolio is a traditional allocation to bonds or funds, not a TIPS ladder used in the approach outlined above. Viewed through the liability framework, the traditional strategy is analogous to operating with a Security Ratio near zero: none of the retirement-income liability is explicitly matched with assets held to maturity to fund that liability. This means that 100% of the portfolio is subject to valuation changes.

Traditional bond funds can reduce portfolio volatility but do not necessarily match specific retirement liabilities. Because their securities are continually marked to market and are not necessarily held to fund predetermined cash flows at maturity, their value remains exposed to changes in interest rates. The sharp decline in long-duration Treasury prices in 2022 illustrates this distinction: Treasury credit risk remained negligible, but rising yields produced substantial mark-to-market losses. A retiree relying on the market value of those assets could therefore experience a material decline in retirement readiness. In the liability-driven approach, TIPS are instead held to maturity against specific future income needs, insulating the matched cash flows from intervening changes in market interest rates.

The following table summarizes the key differences between the liability-driven approach and the traditional 60/40 strategy.

Table 1: Liability-driven strategy compared with the traditional 60/40 strategy

	Liability-Driven Strategy	Traditional 60/40 Strategy
Investment strategy	Accumulates wealth primarily through growth assets and progressively converts assets into liability-matching income	Maintains a diversified stock/bond portfolio
Income strategy	Builds secured income through a TIPS ladder and Social Security	Liquidates assets and withdraws income from the investment portfolio as needed
Primary risk control	Secures future consumption before it occurs	Adjusts future withdrawals when portfolio performance deteriorates
Role of bonds	Matches future real-income liabilities	Reduces overall portfolio volatility and provides diversification
Response to strong markets	Locks in additional income-securing assets to support earlier retirement and/or higher retirement income	Portfolio value rises, potentially supporting earlier retirement and/or higher withdrawals
Response to weak markets	Previously secured income is insulated from equity-market declines	Spending may need to adjust downward to preserve the portfolio

Neither approach eliminates risk. The liability-driven strategy incurs an opportunity cost when assets are moved from growth assets to income-securing assets, and the additional Security Ratio constraint adds another condition to the retirement-readiness decision. The benchmark strategy does not require any retirement income to be guaranteed, but in exchange accepts a greater possibility that future spending will need to adjust downward.

This produces a measurable tradeoff.

Requiring sufficient secured income before retirement can result in a somewhat later retirement date. In exchange, the household may experience substantially less downside variability in retirement income while retaining growth assets that allow income to increase when markets perform well.

The relevant comparison is therefore not simply which strategy produces the earliest retirement date or the highest median terminal wealth.

It is a multidimensional comparison involving:

- retirement timing;
- initial retirement income;
- downside income protection; and
- potential income growth.

In the following section we evaluate these differences through a Monte Carlo simulation exercise comparing the outcomes of both strategies for a range of retirement profiles.

5. Empirical Results

5.1 Simulation framework

To evaluate these tradeoffs, we compare the LadderUp model and benchmark 60/40 strategy using a Monte Carlo analysis that simulates the path of equity and bond returns calibrated to historical experiences. The same simulated economic scenarios are applied to both strategies for representative households, and the key outcome metrics are compared, including

- Retirement age;
- Initial income at retirement;
- Potential income growth; and
- Likelihood of income falling below desired income.

This paired-scenario structure allows differences in outcomes to be attributed to the retirement strategies rather than to different simulated market environments.

The LadderUp model operates quarterly and incorporates uncertainty in investment returns while explicitly modeling the evolution of the household's growth asset portfolio, TIPS ladder, Social Security benefits (optional), retirement date, Security Ratio, and retirement income.

Pre-retirement, the model solves for the household's retirement date and portfolio allocations over time. It optimizes the allocation between growth assets and income-securing assets, balancing the value of securing future income to achieve the target Security Ratio against the value of maintaining exposure to growth assets to increase income capacity. Retirement readiness will occur when the portfolio satisfies both retirement conditions:

1. Sufficient income capacity to fund the household's desired retirement income; and
2. Achievement of the required target Security Ratio.

After retirement, the model continues to optimize the portfolio by balancing the value of securing future income against the value of retaining exposure to higher-expected-return growth assets. As the planning horizon shortens, the relative value of securing income increases, producing the rising Security Ratio glide path.

The benchmark strategy uses a fixed stock/bond allocation mix and retirement occurs when 4% of the portfolio value is greater than or equal to the desired income level. Post-retirement, withdrawals start as 4% of the total portfolio value and can rise or fall by at most 10% in a year. The lower bound is the

larger of last year's spending minus 10% and 4% of the current portfolio balance (B). Mathematically the withdrawal at time t is given by:

$$W(t) = \min(1.1W(t-1), \max(0.04B(t), 0.9W(t-1)))$$

5.2 Representative households

We evaluate three representative household profiles to illustrate how the strategies differ across ages, wealth levels, and preferences for income security. The starting assumptions for each household are shown in Table 2.

Table 2: Representative household assumptions

	Household 1	Household 2	Household 3
Starting Age	25	45	60
Current Portfolio Balance	\$10,000	\$500,000	\$2,500,000
Annual Contribution	\$25,000	\$40,000	\$10,000
Target Security Ratio	50%	30%	80%
Desired Income	\$150,000	\$150,000	\$150,000

The key outcomes for each household under LadderUp and the benchmark strategy are shown in Tables 35.

Table 3: Household 1 simulation outcomes

	LadderUp	60/40 Benchmark
Average retirement age	62	64
Median Income at retirement	\$158,315	\$150,000
Upside (75th percentile) income at age 75	\$250,428	\$219,615
Lowest annual income in downside (25th percentile) scenarios	\$142,068	\$105,161
Quarters below target in downside (25th percentile) scenarios	8	60

5.3 Economic Interpretation of the Results

The representative simulations illustrate several general differences between the LadderUp approach and the benchmark approach. Most importantly, LadderUp is not inherently more or less aggressive than the 60/40 portfolio. Instead, the appropriate level of investment risk depends on the household's time horizon, desired income, and target Security Ratio.

For younger households, LadderUp tends to produce earlier retirement ages and greater upside potential. With a long retirement horizon, the household has greater capacity to tolerate short-term market volatility

Table 4: Household 2 simulation outcomes

	LadderUp	60/40 Benchmark
Average retirement age	66	68
Median income at retirement	\$158,390	\$150,000
Upside (75th percentile) income at age 75	\$260,378	\$203,181
Lowest annual income in downside (25th percentile) scenarios	\$135,029	\$108,515
Quarters below target in downside (25th percentile) scenarios	10	52

Table 5: Household 3 simulation outcomes

	LadderUp	60/40 Benchmark
Average retirement age	69	66
Median income at retirement	\$154,623	\$150,000
Upside (75th percentile) income at age 75	\$178,355	\$211,639
Lowest annual income in downside (25th percentile) scenarios	\$147,745	\$107,473
Quarters below target in downside (25th percentile) scenarios	5	56

and recover from adverse market outcomes. LadderUp can therefore allocate a larger portion of wealth to higher-expected-return growth assets while the household has greater capacity to bear market risk.

A longer horizon also gives LadderUp more opportunities to lock in gains from favorable market cycles. When growth assets perform well, some of the resulting gains are converted into income-securing assets to help prepare for retirement readiness. The remaining growth portfolio can then continue to participate in future market gains even after retirement. Conversely, when returns are poor, a household with a long horizon has time for the growth portfolio to recover before additional income needs to be secured. LadderUp therefore benefits not simply from higher equity exposure, but from having time to progressively convert investment gains into secured retirement income.

This dynamic can be seen in Households 1 and 2. In both cases, LadderUp produces an earlier average retirement age than the benchmark while also generating greater upside income potential. At the same time, retirement income is considerably more stable in downside scenarios. For Household 2, for example, upside retirement income at age 75 reaches approximately \$260,000 under LadderUp compared with \$203,000 under the benchmark, illustrating the framework's ability to convert favorable post-retirement market outcomes into higher retirement income. Yet in the downside scenarios, the lowest annual income is approximately \$135,000 under LadderUp compared with \$109,000 under the benchmark, and the number of quarters below the desired income falls from 52 to 10. The framework is therefore able to preserve substantial exposure to growth while progressively protecting the income those assets are intended to support.

Household 3 demonstrates the other side of this relationship. This household has a much shorter retirement horizon and a substantially higher target Security Ratio of 80%. With relatively little time before retirement, a significant decline in the growth portfolio could prevent the household from recovering sufficiently before it wants to retire. In addition, the high target Security Ratio indicates that the household places a high value on knowing that most of its desired income is secured during retirement.

LadderUp responds by allocating a much larger share of the household's wealth toward income-securing assets. The resulting tradeoff is visible in the simulation results. LadderUp produces an average retirement age of 69 compared with 66 for the benchmark, while the upside income at age 75 is approximately \$178,000 compared with \$212,000. However, this reduction in upside is accompanied by substantially greater downside protection. The lowest annual income in the downside scenarios remains approximately \$148,000 under LadderUp compared with \$107,000 under the benchmark, and the number of quarters below the desired income falls from 56 to only 5.

These results illustrate that income security is not costless. A household that specifies a high Security Ratio is explicitly choosing to exchange some potential future growth for greater certainty around its desired standard of living. The framework does not attempt to maximize expected wealth or retirement income independently of the household's risk preferences. Instead, the Security Ratio determines how much of the household's retirement objective should be protected from future market outcomes.

The comparison also highlights an important limitation of using a fixed asset allocation as a retirement benchmark. A 60/40 portfolio applies the same broad level of investment risk regardless of the household's retirement horizon or desired level of income security. For a young household with decades before retirement, this allocation may be unnecessarily conservative. For a household approaching retirement with a strong preference for income certainty, the same allocation may instead expose too much of the retirement objective to near-term market risk. Under LadderUp, the asset allocation is not specified in advance or determined by a rule of thumb. Instead, it is an output of the optimization process, with the allocation for each household determined by its individual circumstances and retirement objectives.

Taken together, the simulations demonstrate the central implication of the liability-driven framework: there is no inherently appropriate level of portfolio risk independent of the retirement liability it is intended to fund. A 60/40 allocation can be unnecessarily conservative for a young household with substantial time to recover from market losses, yet too aggressive for a household approaching retirement that requires most of its future income to be secured. LadderUp instead allocates risk according to the household's time horizon and desired level of income security. When time permits, the framework maintains greater exposure to growth assets and uses favorable returns to progressively secure higher levels of retirement income. As the retirement horizon shortens or the household demands greater income certainty, the same framework shifts toward protecting the income already within reach.

Conclusion

Retirement planning has traditionally been organized around portfolios: how much wealth to accumulate, how to allocate that wealth between stocks and bonds, and how much can safely be withdrawn each year. A liability-driven framework reorganizes the problem around income.

Future retirement spending represents a stream of real liabilities. Growth assets can be used to accumulate the resources needed to fund those liabilities. Inflation-protected bonds and Social Security can then progressively convert accumulated wealth into secured future income.

The Security Ratio provides a way to measure that transition. Rather than using age or stock/bond allocation as an indirect proxy for retirement security, it measures the proportion of retirement income

capacity that has already been protected from future market performance.

This leads to a broader definition of retirement readiness. A household should have both sufficient resources to support its desired income and sufficient security around that income before leaving the workforce.

The resulting strategy does not eliminate the fundamental tradeoff between risk and return. Securing income has an opportunity cost, and requiring greater security can delay retirement. But the relevant benefit is not simply lower portfolio volatility. It is greater protection of the household's future standard of living.

Importantly, targeting income security directly can also make more efficient use of the household's capacity to take risk. Once the desired level of income security has been achieved, remaining assets can remain exposed to growth. The household can therefore achieve its chosen level of income security while retaining greater participation in favorable market outcomes. This explains how the framework can simultaneously produce stronger downside income protection and substantial upside income growth: rather than minimizing investment risk across the entire portfolio, it concentrates protection on the retirement income the household actually wants to secure and preserves risk-taking capacity elsewhere.