Integrating Social Security, Taxes, and Life Annuities in Retirement Income Strategies

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July 29, 2026

Abstract

This paper evaluates retirement income strategies using a comprehensive expected-utility framework that carefully incorporates updated return and economic projections, federal income taxes, Medicare premiums, and Social Security bridging, on top of other sophisticated stochastic modeling. Across almost all scenarios, partial annuitization dominates pure withdrawal and full annuitization by better balancing income, risk, and bequest motives, sometimes favoring a one-time life annuity purchase and other times favoring gradual annuitization. For many, delaying Social Security increases retiree welfare by raising lifetime income, though its value depends on retirement age, health, risk preferences, and bequest motives. For some, with person-specific situations or preferences, the value loss of bridge withdrawals outweighs the increased Social Security benefit gained by waiting until age 70.

Key takeaways:

- Partial annuitization (one-time life annuity purchase or gradual annuitization) is found to be superior to pure withdrawal and full annuitization in almost all cases.
- Social Security bridging is generally found to increase retiree welfare, even if benefits are projected to be cut, but is not universally suitable for everyone.
- Systematic withdrawals, life annuities, and Social Security strategies can be integrated in numerous combinations and thus need careful evaluations for personal situations.

Key Words: retirement income, systematic withdrawal, life annuity, Social Security, income tax, Medicare

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This research was supported by the American Council of Life Insurers (ACLI). This paper is solely the responsibility of the authors. Opinions expressed here do not constitute investment advice nor represent the positions of their affiliations.

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I. Introduction

There is a large academic and professional literature on strategies for individuals and households to use to assure retirement income that lasts a lifetime. It is responding to the practical need for advice and policy and product development as more and more retirees in many countries are left to their own devices to manage secure finances in retirement. The many studies done over the years employ varied methodologies, models, data and assumptions, and posit different goals, tools, constraints and situations. An important strand of this literature is the appropriateness and scope of the use of various types of life annuities in retirement income strategies. Realistic broad environmental issues like current income taxes, minimum distribution requirements, Social Security, Medicare premiums, expected and volatile rates of return on investments, interest rates, and inflation are important, as well as personal factors like life uncertainty, health, gender, age, marital status, risk tolerance, bequest desire, consumption needs, insurance coverage, asset holdings and types, investment costs, and sources and levels of income.

This paper further develops the literature, in particular, the expected utility stochastic simulation model presented in Pang and Warshawsky (2025 a, b) on optimal retirement income strategies in several directions and to answer new questions. It updates asset return and volatility, interest rate and inflation expectations to a 2026 baseline. It adds a full simple individual income tax overlay (including minimum distribution requirements), as well as the detailed provisions of Medicare premiums and surcharges. It includes a more realistic estimate, based on a recent empirical study, of the statistical distribution in the recent retired population of Social Security retirement benefits and the association with levels of net worth. It assesses whether these model changes and enhancements alter the evaluation and preference ranking of four basic retirement income strategies found in prior studies.

The paper then models and addresses a common strategy question among retirees – whether claiming Social Security should be postponed ("bridged") to age 70 to increase guaranteed inflation-indexed lifetime income flows on the favorable basis provided by the federal government at the cost of early larger asset withdrawals, in the context of the four basic retirement income strategies. This is done for three base cases of Social Security benefits and net worth but is also expanded to consider different initial retirement ages, gender, investment and annuity costs, health, risk aversion, bequest motive, and initial asset allocations. The general, but not universal, favorability for Social Security bridging is stress-tested for the possibility of a severe benefit cut when the Trust Fund is exhausted in 2032, and in a special case thought to be unfavorable to bridging. Through all these model and strategy enhancements, including Social Security bridging, and in the varied cases, the superiority of partial annuitization strategies found in prior literature still holds, sometimes favoring a one-time life annuity use and other times favoring gradual annuitization.

The remainder of the paper is organized as follows. We review the simulation literature specific to Social Security bridging. We then briefly review our basic model and explain the several changes and enhancements and evaluate four basic retirement income strategies. Next, we put forward our version of Social Security bridging and evaluate its desirability based on model results across base cases and several situational and preference variations. The last section concludes the paper with a discussion of the significance of the primary results favorable toward partial annuitization and Social Security bridging.

II. Literature Review on Social Security Claiming

Pfau and Parrish (2023) constructed two case studies and a historical return model to investigate the consequences for after-tax real wealth at ages 85 and 95 of different Social Security claiming strategies and fixed asset allocations for age 62 retirees. They consider an individual and a couple with tax-deferred, taxable and tax-free (Roth IRA) asset accounts totaling $1 and $3 million, respectively, who are evaluating whether to claim Social Security at age 62, 67 or 70, and to take tax-sensitive distributions from the accounts and do conversions to Roth IRAs to meet pre-set spending goals and minimize taxes through age 95. (Generally, the tax-sensitive ordering of distributions is first, taxable, second, tax-deferred and then tax-free, with aggressive and early conversions to Roth IRAs.) There is stock and bond return and inflation risk in the model, based on rolling 34-year historical periods from 1871, and 2022 household tax, Medicare premium and Social Security benefit rules are modeled in some detail, including minimum distribution requirements. But there is no lifetime uncertainty or risk preferences or expected utility function or dynamic asset allocation or current asset return expectations or use of market annuities. Hence, Pfau and Parrish's evaluation is based simply on comparisons of the simulated statistical distribution of wealth at ages 85 and 95, the probability that spending goals can be met, and how often and by how much final wealth is higher when Social Security claiming is delayed to age 67 or 70.

Pfau and Parrish find that for the individual, with a 25 percent allocation to stocks, the probability of success to meet spending goals is only 57 percent if she claims Social Security at age 62 but is 81 and 94 percent if Social Security is claimed at ages 67 and 70, respectively. This result presumably occurs because the actuarial adjustment for later Social Security claiming is favorable under current law and mortality and interest rate conditions, and the conservative asset allocation does not provide much added boost to the investment accounts. Similarly, the percent of cases at age 95 wealth when Social Security is claimed at ages 67 and 70 exceeds wealth when Social Security is claimed at age 62, is 94 and 89 percent, respectively. At higher allocations to stocks, the success rate jumps notably, even for early claiming, so that it is 97 percent at a 75 percent stock allocation for early claiming and higher still for later claiming. The percentage of cases with higher wealth at age 95 when claiming later than 62, however, declines with the asset allocation to stocks, so that at a 50 percent stock allocation, 82 and 76 percent of the cases produce higher final wealth when claiming at ages 67 and 70, respectively, and at a 75 percent stock allocation, only 67 and 64 percent of the cases produce higher wealth when claiming at ages 67 and 70, respectively. Moreover, at the 75 percent stock allocation, which produces the best overall results, the final wealth differences are quite small at the median and ninetieth percentiles, only becoming large (favoring later claiming) at the tenth percentile. At age 85, which is roughly the life expectancy for the individual and should be the main planning focus, wealth is highest at the median and ninetieth percentiles and not much different at the tenth percentile if Social Security is claimed at age 62, presumably because of the historical sequence of asset returns combined with taxation. A reasonable interpretation of these overall results is that claiming Social Security at ages 67 or 62 would be a good strategy. Results are roughly similar for the couple, who have higher per capita wealth and expenses and lower income, although there is a slight advantage to claiming at age 70 if the stock allocation is 50 percent.

Munnell, Wettstein, and Hou (2020) evaluate various retirement income strategies for a 65-year-old retired individual with $250,000 in initial wealth, using an expected utility model with no bequest motive, measuring utility equivalent wealth, under conditions of lifetime, equity asset return and health and long-term care spending, but no inflation, uncertainty, and no taxes. Wealth is invested in a standard target date fund for that age, starting at an allocation of 50 percent to stocks, declining to 30 percent. Real equity asset returns are modeled using a log normal distribution, where the historical mean is adjusted down to reflect an expectation of overall lower returns in the future, and real bond returns are fixed at 1 percent. The strategies examined (1) claim Social Security at age 65 with no annuitization and take distributions from assets according to the minimum distribution rules (even before the required start age), basically the reciprocal of the joint life expectancy of a couple ten years apart in age, so that, in expectation, spending will increase and then decline with age, (2) claim Social Security at age 65 but devote 20 or 40 percent of wealth to an immediate annuity and take minimum distributions from the rest of the assets, (3) defer claiming Social Security, if possible, through age 70, by using 20 percent of wealth for distributions to cover the equivalent of Social Security claimed at the normal retirement age (Social Security bridge), claim Social Security if and when that fund runs out, and take minimum distributions from the rest of the assets, and (4) claim Social Security at age 65 but devote 20 percent of wealth to buy a deferred annuity that will pay out at age 85, and take minimum distributions from the rest of the assets.

Based on a comparison of equivalent wealth to the no annuitization strategy, the 20 percent immediate annuitization and deferring Social Security strategies are roughly equivalent to each other and for men and women and superior to the no annuitization strategy. The deferred annuity strategy, however, is inferior, even to the no annuitization strategy, because of the risk that assets will be exhausted before the annuity payout kicks in at age 85 and/or will be insufficient to cover health and long-term care shocks later in life. Across the simulated distribution of possible outcomes, the 40 percent immediate annuitization strategy surpasses deferral of Social Security in more cases presumably because it better provides for insurance coverage of longevity and asset return uncertainty.

Horneff, Maurer, and Mitchell (2023) estimate a dynamic stochastic lifetime consumption and portfolio choice expected utility model for an individual who retires at age 66 and has at that point, averaging across six education and gender groupings, $280,000 in assets. The individual is quite risk-averse, has a modest bequest motive, invests in riskless bonds or risky stocks (including in a target-date fund for retirement accounts, starting at age 25, investing so that the stock share at age x is (125 – x)/100)), and must decide on optimal withdrawals to fund their retirement along with Social Security and other income sources. Tax rules, including minimum distribution requirements, are given, and there is mortality, lifetime income and asset heterogeneity across educational and gender groupings, as well as earned Social Security benefit differences. The researchers then consider the welfare consequences of four different retirement income strategies: (1) claim Social Security at age 66 and have no access to life annuities, (2) claim Social Security at age 67 and have no access to life annuities, financing consumption from assets, (3) claim Social Security at age 66 and have access to (a) fixed life annuities and (b) variable life annuities invested 50/50 in stocks/bonds, both priced using annuitant mortality tables which reflect adverse selection of mortality risks. The results presented, for tax rules before and after the passage of SECURE 2.0 legislation, are averages for the simulations of six population groups modeled as prototypes. These researchers consider life annuities whose starting payments are deferred to ages 67, 80 and 85, and therefore, under the qualified longevity annuity contract “QLAC” rules, not subject to minimum distribution requirements. Given that the annuity deferred to age 67 is essentially an immediate annuity, we call it such, as do Horneff, et al., and focus on the results for it under the SECURE 2.0 rules because those outcomes are generally superior to those for the annuities deferred to ages 80 and 85.

The optimal allocation to immediate fixed life annuities is about 40 percent for men and women with high school or college educations, but only about 30 percent for men and women with below high school educations and assumed lower life expectancies. For immediate variable life annuities, the optimal allocations are somewhat higher – as high as 51 percent for high school educated women and about 40 percent for men and women with below high school educations, presumably because the increased exposure to higher return stocks through the variable annuity is beneficial while still providing longevity insurance. Comparing the welfare gains of using retirement assets to purchase life annuities versus delaying the claim of Social Security, there is a uniform advantage to the purchase of immediate life annuities, which is highest for the college educated men and women but is still large for the high school educated group, and small, but still positive, for the below high school educated group, whether for immediate fixed or variable annuities, albeit higher for the latter.

In summary, when read carefully, the literature is only modestly favorable to Social Security bridging strategies across a variety of cases and methodologies.

III. Utility-Maximizing Framework

We establish a utility-maximizing framework that is identical to Pang and Warshawsky (2025a) and borrow significantly its specification of the basic model. But we update the parameterizations and expand to study the effects of income taxes, Medicare premiums, and Social Security.

Lifetime utility. A retiree is assumed to seek an income and wealth management strategy that maximizes her lifetime utility, which is defined as a function of consumption flows and the bequest upon death. Her lifetime utility in retirement is expressed as follows:

$$V_\tau = \sum_{t=0}^{\tau-1} [\beta^t \rho_t u(c_t)] + \beta^\tau \rho_\tau v(b_\tau),$$

where the realized lifetime utility V_τ depends on the survival from $t = 0$ through τ, which is stochastic according to mortality probabilities, ρ_t denotes survival probability at time t, c_t is consumption, b_τ is monetary wealth upon death, and β is the time discount factor, indicating people have a preference to consume now rather than in the future.

The period utility function of consumption takes the constant relative risk aversion (CRRA) form

$$u(c) = \frac{c^{1-\sigma}}{1-\sigma},$$

where a higher value of σ indicates greater risk aversion. The utility from wealth upon death has a similar functional form, as follows:

$$v(b) = \frac{\eta(\kappa + \frac{b}{\eta})^{1-\sigma}}{1-\sigma},$$

where η indicates the strength of the motive to hold assets at or near death, and κ imposes a threshold of regular consumption (in thousands of dollars) above which the bequest motive becomes operative. As the value of κ rises, there is lower utility increase for a given increase in b, which means that higher regular consumption flows are more desirable and bequest becomes less desirable. This bequest functional form is consistent with Ameriks et al. (2011), De Nardi et al. (2010) and Lockwood (2018) and other similar functions in the literature.

The objective of retirees is to maximize the expected V_τ over all possible life outcomes of τ. The numerical result of V_τ is a ranking of utility and does not conveniently measure the magnitude of welfare gain or loss of one strategy versus another. We therefore calculate the so-called certainty equivalent (CE) consumption that would generate the same level of value V_τ for a life path τ. This constant CE consumption is determined such that:

$$\sum_{t=0}^{\tau}[\beta^t u(CE)] = V_\tau.$$

Further, over *N* possible life paths (i.e., *N* series of simulations from $t = 0$ through τ), we calculate the average certainty equivalent consumption (ACE) as

$$ACE = \sum_{j=1}^{N} CE_j / N.$$

The objective of the retiree is now transformed to search for a retirement income distribution strategy that achieves the highest ACE.

Parameterizations. The lifetime utility model starts from $t = 0$ at retirement age 65 through τ (stochastic according to general population mortality probabilities) at maximum age 105. The time discount factor is set as $\beta = 0.97$, as common in the literature. We set the consumption threshold as $\kappa = 30$ + Social Security benefit, as in Pang and Warshawsky (2025a). The Social Security benefit amount is set for each specific retiree profile, based on an empirical study (more details below). Further, we set $\sigma = 4$ and $\eta = 10$. These parameters depict a moderate attitude of retirees toward risk and a significant motive for holding assets, including for a bequest. Significant bequests and assets holdings are feasible but are not necessarily easy to achieve with the relatively high consumption threshold we put forward.

As a baseline assumption, we set a management fee of 65 basis points for funds in retirement accounts, according to Pew (2022) and similarly ICI (2024). For nominal fixed annuity pricing, the calculation of fixed annuity factor uses the 10-year Treasury nominal bond yield, which is stochastic through time, and life tables for annuitants rather than those for the general population, which reflects adverse selection in the voluntary annuity market.

Retirees are assumed to have an initial 50-50 equity-bond mix. As wealth is annuitized, the equity share increases in the remaining assets (up to 100 percent) to maintain roughly the same overall risk exposure. For the underlying asset rates and returns, we run a large number (10,000 at minimum) of stochastically simulated time series throughout retirement. Simulations reflect co-movements and correlations across asset classes plus random shocks in the markets. Means, standard deviations, and correlations are based on the 2026 Capital Market Assumptions (CMAs) of a large reputable asset manager (specifically, JPMorgan (2026)). Equity returns are modeled as the average of large-, mid-, and small-cap returns, and show the high return, high risk characteristics (geometric mean 6.9% and standard deviation 18.3%). Bond returns are approximated by aggregate bond index and show lower returns and risk (geometric mean 4.8% and standard deviation 4.8%). The simultaneously simulated price inflation rate is 2.5% on average, with a standard deviation of 1.8%. We run additional econometrics and simulations to establish a time series of 10-year Treasury yields, to be used in annuity pricing. Specifically, we run a regression of 10-year T yields on Fed Funds rates, based on St. Louis Federal Reserve Bank data (1990-2026). We multiply the estimated regression coefficients by the above simulated 90-day yields, and add random shocks, according to mean and standard deviation estimated from the regression residuals. The simulated 10-year T-yield is 4.5% on average, with a standard deviation of 1.2%. Summary statistics are reported in Table 1.

Table 1. Summary of simulated rates and returns

	Arithmetic Mean (%)	Geometric Mean (%)	Std. Dev. (%)
Equity	8.50	6.90	18.30
Aggregate Bond	4.90	4.80	4.80
Treasury yield	4.48	4.47	1.18
Inflation	2.50	2.50	1.80

Source: Authors' simulations.

We simulate survival and generate stochastic life expectations. The base general population mortality rate is the 2021 period life table for the Social Security area population, as used in the 2024 Trustees' Report (TR).[1] For annuity pricing, the base annuitant mortality rate is the Society of Actuary's individual annuitant mortality 2012 table. Both general and annuitant mortality tables are further adjusted by the SOA's Mortality Improvement Scale MP-2021. We make such calculations to reflect both improvements in recent decades and projections into the future.

Retiree wealth and Social Security. We make assumptions about retiree wealth and Social Security benefits. We employ some estimates of the relationship between mean Social Security annual retirement benefits and deciles of net worth, based on Table 2 in Warshawsky (2026). There he uses the 2020 Health and Retirement Study (HRS) population-weighted data supplemented with pension and retirement account data created by code from the Boston College Retirement Research Center to measure the statistical distributions of 2020 net worth on an individual basis and 2019 Social Security annual benefits for individuals ages 62 to 74 who are not getting disability benefits, are not working if below the full retirement age, or did not work for a government employer. Note that although there is a positive relationship between individual net worth and the level of Social Security benefits in the data, it is not particularly strong. That is

[1] https://www.ssa.gov/oact/STATS/table4c6.html

because the benefit formula is quite progressive, the data includes early retirees and spouses and others with relatively modest Social Security benefits who are otherwise wealthy, and high lifetime earners who were poor savers or experienced asset setbacks. Social Security benefits are reported in the HRS as net of deductions for Medicare premiums, for those above age 65 or not covered by private health plans or Medicaid. Note that since mid-2019 through February 2026, average Social Security retirement benefits have increased by 42 percent. Here we use the mean annual Social Security retirement benefits in the fourth, ninth and tenth net worth deciles, as reported by Warshawsky (2026), inflated to the current levels, at $21,850, $25,750 and $27,375, respectively, corresponding roughly to $250,000, $1 million and $2 million in retirement assets. The middle retiree serves as the baseline profile, with further analysis of other retirees to follow. Table 2 provides a summary of wealth and Social Security details.

Table 2. Summary of retiree wealth and annual Social Security benefits

	Wealth ($)	Social Security Benefit Amount (annual, $)
Retiree with lower wealth	250,000	21,850
Baseline Retiree	1,000,000	25,700
Retiree with higher wealth	2,000,000	27,375

Source: Authors' assumptions based on empirical analysis of Warshawsky (2026).

Income Tax and Medicare Premium. We incorporate Federal income tax for singles, program the progressive tax rates, with the tax-brackets indexed to inflation, and take standard deductions (no itemization, no separate treatment of capital gains). We model the conventional additional deduction for seniors (age 65 and older) and the bonus senior deduction (with phase-out for incomes higher than certain thresholds) for 2025–2028 under the One Big Beautiful Bill Act. We incorporate Medicare premiums, including the base premiums ($202.90 per month for Part B and

$34.50 per month for Part D) and additional surcharges as income-related monthly adjustment amount (IRMAA) for those with incomes exceeding certain thresholds. The premiums and surcharges are assumed to increase 1.25 percentage points faster than general inflation, that is, total 3.75 percent on average. The income thresholds for IRMAA are indexed to general inflation. We program the Medicare Part B Hold-Harmless provision where premium increases are capped by the Social Security dollar increase, provided the individual is claiming Social Security and is not subject to IRMAA. Further, current law states that the Part D premium cannot increase more than 6 percent in any year, a provision controlling through 2029.

In the utility-maximizing framework, we originally focused on gross income in Pang and Warshawsky (2025a), which is equal to the sum of systematic withdrawals, Social Security benefits, and annuity payouts. Now we update the framework and subtract federal income tax and Medicare premiums so that the consumption c_t and the utility are defined on a net basis. The bequest b_τ is set as the fund balance upon death, if greater than zero.

Strategies Considered. We consider systematic withdrawals, nominal immediate payout life annuities, and their combinations as retirement income strategies. Specifically, we mainly compare the following four strategies, showing the distribution of inflation-adjusted incomes and account balances across the years of retirement, and mostly rely on the ACE, described above, as the metric for evaluation. The income approaches are chosen to highlight pure strategies as well as those combination strategies that look promising in professional literature. These strategies are simple rules that are easy to understand and implement.

A. Systematic withdrawals (SW): 4% withdrawal of initial retirement savings, subsequently indexed to inflation

B. Fixed payout life annuity (FA): complete (100%) annuitization of wealth upon retirement into nominal annuities

C. Systematic withdrawals + fixed life annuity (SW + FA, one time): one time annuity purchase by 50% of wealth and systematic withdrawals on the remaining

D. Systematic withdrawals + fixed life annuity (SW + FA, gradual): gradual purchase from 20% to 60% of savings, during ages 65-75, and systematic withdrawals on the remaining

Strategy A is a fixed withdrawal of real dollars, as in the Bengen rule. Withdrawals in strategies C and D are also fixed in real dollars, set as 4% of the un-annuitized wealth. The withdrawals are increased above the Bengen rule, however, if the required minimum distribution is larger, which generally happens at older ages. Strategies B, C and D use a nominal immediate life annuity for the individual, female or male, if purchased in the retail market, or unisex if provided by an employer-sponsored plan. Annuitization can be a one-time purchase upon retirement, i.e., 50% of retirement savings (C), or it can be a gradual phased process, from 20% of wealth initially to 60% of wealth by age 75 (D). The degree of annuitization is expressed as a percentage of the (expected) current value of initial retirement savings, which is determined by including the accumulation of interest over time (at the average rate).[2]

Each strategy has a logical support and natural advantages and disadvantages. The Bengen rule provides the most liquidity and flexibility (perceived investor control and upside potential), but there is a significant risk of failure to produce income sometime in the future, particularly if the individual lives long or the markets have an extended bad turn. Full annuitization will produce the highest initial income level, given its implicit mortality credits, and assures the continued

[2] Alternatively, one could express it as a percentage of the account balance, but this would be misleading. An extreme example: 100% annuitization of the remaining $1 balance appears as a strong preference for annuity but may be trivial if $99 has been withdrawn over prior years.

flow of income regardless of the length of life and investment outcomes. It is illiquid, however, and does not provide for a bequest nor cover contingencies, such as the need for long-term care. It can be subject to timing risk – interest rates may be low and annuity prices relatively high. Combination strategies therefore can perhaps give the best of both worlds.

We model required minimum distribution (RMD) carefully, following the new SECURE 2.0 law. Previously, the minimum distribution rules disadvantaged partial annuitization strategies, because total distributions were taxed more heavily than straight withdrawal strategies. The SECURE 2.0 legislation removes that extra layer of taxation and makes partial annuitization more tax efficient. See Pang and Warshawsky (2025b) for a detailed analysis.

Bridge finance for delay in Social Security. Retirees are often recommended to consider delaying the claim of Social Security benefits until age 70, to maximize lifetime payments while using retirement savings (401(k) or IRA) to cover living expenses during the early years of retirement. This strategy increases monthly Social Security benefits by up to 8 percent for each year delayed beyond full retirement age (FRA) up to 70, plus cost of living adjustment (COLA). Bridge finance, i.e., drawdowns from personal savings, is to replace the income Social Security would have provided between retirement and age 70. There are multiple implications. Withdrawals from pre-tax retirement accounts are taxable, which may increase the retiree's tax bracket during the bridge years. Earlier withdrawals can reduce future RMDs, as the account balance is lower. Relying on withdrawals means exposure to market volatility early in retirement and has the risk of savings depletion in a sequence of bad returns.

The bridging is in general on favorable terms because the government conversion factors assume a high real interest rate (3 percent) and an old mortality table and there are no transactions costs charged. Delaying Social Security can be beneficial if the retiree expects to live longer than average and has enough savings to bridge the spending until 70. If the retiree is a higher earner in a marriage (not modelled here), she could ensure a larger survivor benefit for her spouse.

In our analysis, to match the anticipated Social Security benefit at age 70, we calculate the assets that need to be carved out upfront for bridge withdrawals. If the bridge withdrawals exhaust assets for any of the transition years, the retiree is assumed to file and claim Social Security immediately.

IV. Stochastic Simulation Results

A Primer. We first present the results without considering taxes or Medicare premiums. This provides a basis for readers to assess the effects of tax and Medicare once those factors are modeled. Our starting case is for a single female individual age 65 with $1 million net worth, who is assumed to claim Social Security immediately upon retirement. Table 3 shows the statistical distributions of real asset balances and incomes (including Social Security), and the ACEs for the four strategies over the possible lifetime of the retired individual. The percentile income and balance metrics are complementary to the aggregate ACE measure. These statistics are based on the potentially 36 x 10,000 (years x simulation runs) observations, with those excluded post death.

Strategy B produces the highest level of average income with the lowest risk (as measured by the standard deviation). But the combination strategies C and D give nearly as much income, on average, albeit with more risk. Of the two, strategy D gives a somewhat higher and steadier income flow. The Bengen rule (strategy A) gives lower real income, in accordance with its definition, at $40,000 inflation-indexed; more is taken out when the RMD rule demands it. By contrast, and as expected, strategy A gives the highest real asset balances. Strategy B retains no wealth, and strategies C and D are in between. According to the ACE score, strategies C and D are preferred to either of the pure strategies, because they strike a more nuanced balance between sustaining a good income level and consideration of the desire to hold assets and leave a bequest. The higher asset balances (potential bequests) of C give it a slight edge over D.

Table 3 Simulation outcomes for a female retiree ages 65-105, without tax or Medicare

Balance ($000, real)

Strategies	95%tile	50%tile	5%tile	Mean	Std.Dev.
A	1431.0	861.8	129.1	827.5	387.8
B	0.0	0.0	0.0	0.0	0.0
C	1321.0	479.6	0.0	537.1	452.3
D	1102.2	432.2	0.0	470.5	423.6

Income ($000, real)

Income	95%tile	50%tile	5%tile	Mean	Std.Dev.
A	97.9	62.3	62.3	66.9	16.8
B	92.4	76.2	57.6	75.7	10.8
C	108.9	71.9	45.6	74.9	25.3
D	99.5	73.8	51.7	75.4	21.5

Strategies	ACE
A	60.80
B	59.19
C	66.22
D	65.63

Source: Authors' simulations.

Baseline Outcomes and Strategy Rankings. We now establish the baseline case, where federal income tax and Medicare premiums are being subtracted from gross income for a female retiree with $1 million initial retirement savings. She is assumed to claim Social Security immediately upon retirement at age 65. Table 4 shows the results. The statistical distribution of asset balances is almost identical to those in Table 3 because the same strategies are implemented – minor differences are due to randomness of simulations. The income distributions are lower across the

board than in Table 3 because the income is now net of tax and Medicare premiums. Correspondingly, the life-time utility ACE is lower than before. The relative rankings of the strategies, however, do not remain the same: C > D > B > A, instead of C > D > A > B.
Strategy A delivers the highest balance across percentiles (mean $827 thousand) but the lowest average income (mean $58.1k). This reveals A as a strategy that under-utilizes assets for consumption to ensure a safety net or a large inheritance. At the same time, strategy A includes the risk that assets will run out sometime before death, resulting in a dramatic drop-off in income. The simulations (not shown) indicate that this failure rate is around 5 percent at age 85, increasing to 12 percent at age 90, to 24 percent at age 95, and to 38 percent at age 100. Strategy B represents a "spend-to-zero" approach. It results in $0 remaining balance in every scenario, but it yields the most consistent income (lowest standard deviation). It effectively converts all principal into a stable cash flow. Strategy C produces the highest peak income (95th percentile at $91.3 thousand) and the highest ACE at 59.12. It has the widest range of income: at the 5th percentile, the balance drops to $0 and income falls to its lowest point ($39.4 thousand), showing high sensitivity to poor market returns. Strategy D is a moderated version of strategy C. It maintains a similar ACE (58.94) and mean income ($65.2 thousand) but offers a slightly better floor in worst-case scenarios (5th percentile income of $44.6 thousand versus $39.4 thousand for strategy C). Apparently, strategy A is also rather tax-inefficient, with no relief from minimum distribution requirements when the encouragement given to annuitization in the new rules is considered.

Comparatively, strategy A (SW) is conservative in income and preserves high asset balances, strategy B (FA) uses full depletion for steady income, strategy C (SW + FA, one time) makes an aggressive split between income and growth, while strategy D (SW + FA, gradual) is a middle ground to manage the pace of annuitization. Overall, strategy A is more oriented towards legacy (highest wealth), strategy B is more oriented towards income stability (lowest income volatility), while strategies C and D aim to address the desires for both lifestyle and bequest (based on ACE).

Table 4 Baseline outcomes for a female retiree age 65-105 with taxes and Medicare

Balance ($000, real)

Strategies	95%tile	50%tile	5%tile	Mean	Std.Dev.
A	1431.5	862.5	128.6	827.4	387.1
B	0.0	0.0	0.0	0.0	0.0
C	1319.2	479.5	0.0	536.6	448.5
D	1101.9	432.2	0.0	470.0	420.3

Income ($000, real)

Income	95%tile	50%tile	5%tile	Mean	Std.Dev.
A	83.0	54.6	53.7	58.1	13.3
B	80.4	66.2	49.6	65.7	9.4
C	91.3	62.9	39.4	64.7	18.6
D	84.0	64.4	44.6	65.2	15.9

Strategies	ACE
A	53.79
B	54.58
C	59.12
D	58.94

Source: Authors' simulations.

Bridging for delayed Social Security. In this scenario, we assume that the retiree delays Social Security until age 70 and withdraws from retirement savings to bridge the spending for the transition years. A portion of wealth is carved out upfront for the bridging purpose. Comparing the new results (Table 5) to the previous baseline outcomes (Table 4), the shift reveals a trade-off: the retiree is consuming more of her wealth now to "buy" a higher, inflation-indexed guaranteed income later.

Bridging increases total expected utility, i.e., higher ACE, across every single strategy. This confirms that the bridging strategy provides a more efficient way to spend total lifetime wealth. Strategy C remains the winner for the life-long value, increasing from 59.12 to 60.30. Bridging generates higher income on average for all strategies and improves the worst-case outcomes. By delaying Social Security, the retiree has reduced the impact of a poor asset market on future income. For instance, strategy A average income increases from $58.1 thousand to $60.7 thousand, while the 5th percentile income increases from $53.8 thousand to $56.7 thousand; strategy C 5th percentile income rises from $39.4 thousand to $43.8 thousand. If the market performs poorly, the higher Social Security check (locked in by the bridge) creates a higher safety net. Strategy A again beats out strategy B because the Social Security bridging in essence increases the guaranteed lifetime level of retirement income and hence is particularly helpful to it; bridging does not assist the other strategies as much because they have life annuity coverage already. Still the partial annuitization strategies are superior to both primary strategies. Because the retiree is aggressively spending down retirement savings early to delay Social Security, the ending balances are naturally lower than in the previous data. The bridge strategy is a deliberate choice to favor personal consumption over bequests/inheritance.

Table 5 Simulation outcomes with bridge finance for delay in Social Security

Balance ($000, real)

Strategies	95%tile	50%tile	5%tile	Mean	Std.Dev.
A	1,245.8	745.0	94.2	722.9	350.8
B	142.1	8.5	0.0	29.2	43.7
C	1,192.3	435.8	0.0	485.2	417.7
D	997.1	374.0	0.0	427.4	392.5

Income ($000, real)

Income	95%tile	50%tile	5%tile	Mean	Std.Dev.
A	82.6	57.8	56.9	60.7	11.8
B	78.7	67.6	53.7	66.9	7.6

C	91.4	64.7	43.8	66.4	17.5
D	84.7	65.6	48.8	66.7	14.8

Strategies	ACE
A	56.69
B	55.99
C	60.30
D	59.92

Source: Authors' simulations.

Early and later retirement. We now consider longer and shorter retirement periods, not because of differential mortality, but owing to earlier and later cessation of work. The initial wealth is assumed to remain the same as in the baseline, but Social Security benefits are adjusted for birth year and claim age, using the official age-adjustment factor (i.e., benefit reduction for early retirement and delayed credit for late retirement). In strategy D, the retiree is assumed to annuitize gradually from retirement through age 75, starting from 20% of wealth to 60% eventually. For early retirement at 62, this gradual purchase is over ages 62-75, while for later retirement at 67, the purchase is over 67-75. The Bengen rule (4% withdrawal) is applied to the remaining un-annuitized wealth. To save space, and without much loss of insights, we only report ACE and omit the income / balance statistical distributions hereon.

Table 6 shows two distinct retirement scenarios for each retirement age, one that does not and the other that does delay Social Security benefits until age 70. The differences lie in when the retiree stops working, one at age 62 and the other 67, and begins using her 401(k)/IRA as a bridge to cover expenses.

Across all strategies (A–D), retiring at 62 produces a lower financial outcome and lifetime utility (ACE) than retiring at 67. This is mainly because the retirement wealth in the former case is being spread to cover more years both for normal retirement and for bridge withdrawals; the income level that can be sustained is lower and the asset balances face a greater risk of depletion.

The bridging strategy increases lifetime utility in many cases, whether retiring at 62 or 67, but the magnitude of improvement is larger for the former, as indicated by higher ACE. This reveals that a longer delay of Social Security likely leads to greater financial gain. When the time window is fairly short, the delay could be counterproductive because the income gain is small and there is less time to make up for any investment losses, actual or opportunity. For instance, ACE is lower in strategies C and D when bridging strategy is implemented from age 67 through 70, in comparison with claiming immediately. It is also noteworthy that the rankings of strategies change somewhat with different retirement ages – strategy D is superior to C with immediate claiming or nearly so with bridging at age 62 as gradual partial annuitization reduces risks, and strategy A beats strategy B for last place regardless of bridging at age 67 as the risk of portfolio exhaustion is lower with a shorter horizon.

Table 6 Life-time utility (ACE) for alternative retirement horizons and claiming strategies

Earlier retirement at age 62			Later retirement at age 67	
Strategies	Claim immediately	Bridge finance	Claim immediately	Bridge finance
A	48.40	52.89	59.38	59.67
B	51.27	53.85	57.02	57.07
C	53.79	55.91	63.98	63.43
D	54.12	55.89	63.41	62.82

Source: Authors' simulations.

Alternative retiree wealth profiles. We consider different retirees with smaller ($250 thousand) versus larger ($2 million) initial retirement savings, with correspondingly smaller and larger Social Security benefits, respectively, as reported earlier in Table 2. Wealth levels have a direct effect on income and asset balances and additionally affect the activation of the bequest function, through the parameter representing basic consumption needs beyond which the bequest motive becomes operative. Results are reported in Table 7. For the retiree with lower wealth ($250 thousand), maximizing income via strategy B seems to be the best move (ACE = 28.45) under "claim immediately", while maximizing liquidity via strategy A ranks last. Delaying Social Security and bridging spending improves lifetime utility across all strategies – the biggest improvement occurs for strategy A, while strategy D emerges as the best act in combination with bridging.

For the retiree with higher wealth ($2 million), a split between annuity and withdrawal via strategy C is the best move (ACE = 91.70) under "claim immediately" as with baseline wealth. Bridging improves lifetime utility across all strategies and maintains the advantage of combination strategies (C and D) over pure strategies (A and B), although B improves the most because it gains more life annuity income coverage with higher Social Security.

Table 7 Life-time utility (ACE) for alternative retiree wealth profiles and claiming strategies

	Retiree with lower wealth ($250 thousand)		Retiree with higher wealth ($2 million)	
Strategies	Claim immediately	Bridge finance	Claim immediately	Bridge finance
A	25.90	28.22	84.80	87.67
B	28.45	28.69	69.58	71.14
C	27.71	28.84	91.70	92.54
D	27.84	28.96	89.12	89.50

Source: Authors' simulations.

Robustness checks. Testing robustness of our analysis, we model alternative scenarios by considering different preferences and situations relative to the baseline. Table 8 reports the ACE metric for these various scenarios. We report results for additional scenarios (male, alternative risk aversion, and alternative asset allocations) in the Appendix.

Institutional Pricings. In a large employer-sponsored retirement plan, we can expect investment management fees to be lower (we assume a 0.46% fee, according to Pew (2022)), and annuities cheaper (we assume 10% cheaper than retail, according to Poterba and Warshawsky (2000)).

Also, owing to a 1983 Supreme Court decision barring sex discrimination in the terms of employment conditions and compensation, annuities from an employer plan must be priced on a unisex basis[3]. This latter consideration advantages women, who generally live longer and would otherwise get less income for the same contributions, and disadvantages men.

With institutional pricing, strategy C ranks the highest for claiming Social Security immediately (but B is higher than A) and remains so for the bridging route. All strategies demonstrate higher lifetime utility when the bridging is implemented, but strategy A overtakes B.

Table 8 ACE for alternative scenarios

Claiming Social Security immediately

Strategy	Baseline	Institutional Pricing	Excellent health	Poor health	Cut SS 28%	Weaker bequest	Stronger bequest
A	53.79	54.71	53.55	54.66	50.91	65.79	48.67
B	54.58	56.26	55.48	53.44	52.49	65.68	34.33
C	59.12	61.70	59.34	59.48	56.45	68.06	49.25
D	58.94	61.32	59.36	59.02	56.95	71.78	46.57

Bridge finance

Strategy	Baseline	Institutional Pricing	Excellent health	Poor health	Cut SS 28%	Weaker bequest	Stronger bequest
A	56.69	57.47	56.81	57.23	52.80	68.75	49.67
B	55.99	57.43	57.05	54.76	53.02	69.19	35.21
C	60.30	62.46	60.84	60.43	56.58	70.46	48.94
D	59.92	61.91	60.60	59.83	56.98	73.38	46.31

Source: Authors' simulations.

Excellent versus Poor Health. We model differential survival probabilities for the female retiree, by applying a mortality adjustment factor for poor health (1.57) and excellent health (.74), both compared to the average, based on the findings in Gan, Hurd, and McFadden (2005). Given the

[3] See Arizona Governing Committee for Tax Deferred Annuity and Deferred Compensation Plans v. Norris, 463 U.S. 1073 (1983). This ruling does not apply to individually purchased insurance and annuities

market reality that there is essentially no underwriting for health among life annuity providers, we assume that the baseline annuity pricing continues to hold. That is, annuity pricing is based on regular annuitant mortalities, not linked to health status.

Partial annuitization (strategies C and D) remains superior to the two book-end strategies (A and B) regardless of health status. Among the latter two, full annuitization would beat systematic withdrawals for a retiree with excellent health, while the ordering would be reversed for poor health; this is logical because a life annuity is a better deal for those in excellent health. For both health statuses, bridging increases lifetime utility, with a larger magnitude of improvement for excellent health than poor health.

Possible cuts in Social Security. Social Security's Old-Age and Survivors Insurance (OASI) Trust Fund is projected to be depleted by 2032, leading to automatic benefit cuts if Congress does not act. The law then dictates that benefits be limited to incoming tax revenue. Potential reform solutions often debated include raising the payroll tax, adjusting the retirement age, or lowering benefits for high earners. We here model a scenario where a 28% cut (the current estimate from the Congressional Budget Office) will apply to all recipients from 2033 onward. Gradual annuitization in strategy D stands out as the best choice. This phased and eventually larger annuitization helps generate income to supplement the reduced Social Security benefits. Further, despite the prospect of benefit cuts, delaying Social Security and bridging consumption is still beneficial as measured by ACE; the cut does not apply to immediately claimed benefits, but that is only relevant for six years on a lower base.

Weaker versus Stronger Desire for Bequest and Asset Holdings. We change the utility function parameters directly, making the desire for a bequest weaker or stronger. Technically, this is accomplished by increasing κ to \$65 thousand and lowering η to 1 (weaker desire) or lowering κ

to \$30 thousand and increasing η to 15 (stronger desire). Note that with a change in utility parameters, we cannot compare ACEs across parameter settings, only within the same setting. With a weaker desire for bequest, the utility function attaches greater importance to income, revealing strategy D as the best option; bridging improves utility across the board. With stronger desire for bequest, one-time (less) annuitization in strategy C ranks the highest; bridging improves the appeal of systematic withdrawals in strategy A and elevates it to the highest, while bridging at the same time makes strategies C and D worse off because it uses up valuable assets early in retirement.

Specific scenario. We consider a specific yet plausible scenario, where the retiree is age 67, male, and has a low risk aversion ($\sigma = 3$) and high desire for bequest (κ = \$30 thousand and η = 15). He is assumed to be enrolled in a large employer plan with institutional pricing for annuity and asset management. Everything else is the same as the baseline case.

Table 9 shows the outcomes of claiming Social Security immediately versus using a bridge financing strategy. Strategy A is the strongest option for this specific retiree profile, while strategy B has the lowest overall value, across both claiming strategies. Partial annuitization appears to be less attractive than systematic withdrawals; full annuitization is the least desirable. The retiree is less concerned about the security of income than leaving a meaningful bequest. Unlike previous scenarios, these results show that claiming Social Security immediately is generally more effective across these specific strategies. In three out of four strategies (A, C, and D), claiming immediately yields a higher value than bridge financing. Strategy C shows the largest ACE decrease (-1.12) when switching to a bridge strategy. Strategy B is the only exception where bridge financing outperforms claiming immediately, though the gain is very slim (+0.10). For strategies A, C, and D, the cost of withdrawing from the 401(k) as a bridge appears to outweigh the increased Social Security benefit by waiting until age 70, consistent with the preferences posited in this scenario.

Table 9 ACE for specific scenario

Strategies	Claim immediately	Bridge finance
A	48.15	47.45
B	31.48	31.58
C	47.40	46.28
D	44.55	43.57

Source: Authors' simulations.

V. Conclusions

The model presented in this paper, an update and enhancement of earlier work, is among the most comprehensive in the literature examining retirement income and Social Security claiming strategies. It maximizes expected utility in a stochastic simulation, with current projections of uncertain asset returns, inflation, and interest rates, in a structure that includes income taxes, minimum distribution requirements, Social Security, and Medicare, as well as the personal factors of life uncertainty, health, gender, retirement age, risk tolerance, bequest desire, consumption needs, asset holdings and allocations, investment costs, and sources and levels of income. All the parameters are based on estimations in the literature or current financial industry projections; careful attention is paid to the empirical relationship between Social Security retirement benefits and net worths computed on an individual basis.

Four basic retirement income strategies are evaluated as is Social Security bridging in the context of those strategies. Across various scenarios, past results favoring partial annuitization strategies found in a less comprehensive model are confirmed here; the dominant one-time purchase of life annuity is now sometimes supplanted by gradual partial annuitization: and sometimes complete annuitization is found superior to the 4 percent withdrawal rule, even with a bequest motive. The latter result derives from the tax-inefficiency when the new minimum distribution rules improving the tax efficiency of annuitization are implemented within a simple income tax structure.

Social Security bridging, that is, postponing claiming to age 70 and using assets to support consumption in the meantime, is generally found to improve retiree welfare, even with alternative retiree wealth profiles, institutional pricing, alternative health statuses, future benefit cuts, male gender, higher risk aversion, weaker bequest motive, and alternative asset allocations. It generally does not change the rankings of retirement income strategies away from partial annuitization. It is particularly helpful to the 4 percent withdrawal strategy because it adds some more guaranteed life annuity coverage. The exceptions are for older retirement ages, a strong bequest motive and lower risk aversion, separately and especially in combination, where Social Security bridging produces lower retiree welfare.

Retirement income strategies are truly the next frontier in consumer finance, given the aging of the population and the retreat of defined benefit pension plans, the popularity of target-date funds and investment advice, software and products for workers accumulating assets with 401(k) plans and IRAs. Moreover, the question of when to claim Social Security, even independent of the retirement decision, looms large for many retirees. Therefore, well-founded intellectual contributions based on good data and theory are critical practical enhancements to the knowledge base of product developers, financial advisors, investment journalists, and public policymakers in the retirement field.

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Appendix

Male Retirees. Men have lower life expectancies than women. The overall ranking of combination strategies (C and D) remains higher than pure strategies (A and B), as shown in Table A1. Bridging improves utility and maintains the relative rankings. The main difference is that strategy A is superior to B for the male retiree, as opposed to baseline outcomes.

Alternative Risk Aversions. Another preference alteration to consider is risk aversion, the parameter σ in the expected utility function. Technically, the individual's risk aversion is decreased to 3 and increased to 5, respectively. These changes affect the evaluation of life-long utility, but have no impact on outcomes, given the same strategies are being run.

A lower aversion to risk might mean a greater tolerance for investment risk and lesser concern about mortality uncertainty. With lower risk aversion, the ranking of strategies is C > D > A > B; this continues to hold when bridging is implemented. On the other hand, a higher risk aversion might mean that the individual is more concerned about income stability. With higher risk aversion, the ranking is D > C > B > A when claiming Social Security is immediate; bridging moves strategy C to the front of D.

Alternative Asset Allocations. We consider different assets allocations in the initial portfolio, which remains constant during the retirement years under the Bengen rule and changes with annuitization steps under the other strategies, as explained above. In particular, we evaluate 30/70 and 70/30 equity/bond allocations.

The overall ranking of combination strategies (C and D) remains higher than pure strategies (A and B), whether Social Security is claimed immediately or strategically delayed. A subtle difference is that strategy A ranks higher than B when a greater equity allocation is assumed. Potentially larger returns make the liquid holdings more attractive.

Table A1 ACE for additional scenarios

Claiming Social Security immediately

Strategy	Baseline	Male	Lower risk aversion	Higher risk aversion	30/70 Equity/Bond	70/30 Equity/Bond
A	53.79	54.50	52.30	54.05	53.19	53.94
B	54.58	53.46	51.90	55.83	54.61	54.54
C	59.12	59.38	56.64	60.07	58.50	59.07
D	58.94	59.03	56.18	60.13	58.41	58.96

Bridge finance

Strategy	Baseline	Male	Lower risk aversion	Higher risk aversion	30/70 Equity/Bond	70/30 Equity/Bond

A	56.69	57.12	54.62	57.34	56.07	56.98
B	55.99	54.87	53.06	57.39	55.85	56.17
C	60.30	60.35	57.54	61.54	59.71	60.31
D	59.92	59.86	56.94	61.30	59.37	60.03

Source: Authors' simulations.