
Longevity Risk and Retirement Income Planning (a summary)

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Investors face the challenge of designing and implementing financial asset portfolios capable of providing adequate income throughout their lifetime. This task requires prudent decision making regarding selection of a suitable retirement age, portfolio asset allocations, standard of living targets, precautionary savings amounts, and portfolio withdrawal strategies. Longevity risk—the economic consequences of outliving financial resources—is a critical factor in quantifying the risk–return trade-offs embedded in these asset management decisions. When a finite amount of capital must provide lifetime income, portfolio management often becomes a tug of war between capital preservation (terminal wealth) and lifetime spending (consumption).

A substantial and ever-growing body of research from actuaries, financial economists, trustees and their legal advisers, and investment advisers reflects the challenge of designing, implementing, and monitoring portfolios capable of providing adequate lifetime income. The accretion of publications over the 50-year period from 1965 through 2014 engenders a need to provide a chronological and thematic survey of this research. Incorporated into the CFA Institute Research Foundation literature review are an extensive bibliography of relevant studies, references to supplemental surveys on specialized topics, and reference to an annotated bibliography providing more technical, in-depth discussions of both academic and practitioner-produced literature. We have selected a chronological format because it is instructive to see, over time, how issues and research methods wax and wane. A strictly thematic structure would have pushed the narrative closer to an intellectual history. Such a book, however, would mask the flavor of research endeavors. Disparate topics in seemingly unrelated areas emerge, over time, in actuarial or academic journals written for differing readerships. From time to time, research efforts achieve a synthesis that provides promising insights into issues of common interest. The chronological aspect of the literature survey conveys a better sense of a study's importance and originality because it places it in the context of previous investigations and commentary.

The survey is divided into four sections.

Introduction

The beginning section orients the reader to the intellectual landscape that we survey. We define longevity risk and briefly discuss the economic implication of longer lifespans. A critical issue is whether financial asset portfolios can provide adequate cash throughout the investor's lifespan. One alternative to funding retirement through a financial asset portfolio is to implement an actuarial solution—that is, to annuitize some or all of investment wealth. Annuities appear in the literature in a variety of ways: (1) optimal consumption paths, (2) guides to self-annuitization investment strategies, (3) benchmarks for assessing portfolio performance, (4) cost-of-retirement proxies, (4) portfolio solvency benchmarks, and (5) contracts that compete for the investor's dollar within a marketplace of financial instruments.

Having provided an overview of the various contexts in which annuities appear, we briefly discuss how researchers project the likelihood that a portfolio, operating under a jointly specified asset allocation and periodic withdrawal strategy, will produce a financially successful retirement over a possibly stochastic time horizon. Our introduction focuses primarily on historical back testing and introduces the concept of model risk—that is, the risk that a model may produce spurious probability assessments. We then acquaint the reader with the complexities of introducing dynamic asset allocation and spending strategies into a retirement income risk model. Complexity increases by an order of magnitude as a model incorporates various asset management elections (buy and hold, constant mix, insured portfolio, and so forth) and dynamic spending rules.

With this background in hand, we then discuss risk measures that can serve as portfolio preferencing metrics, including (1) assessments of past investment results with performance evaluation metrics, such as the Sharpe ratio, the information ratio, and Jensen's alpha; (2) shortfall risk metrics (the preference is the asset allocation/spending strategy that exhibits the lowest likelihood of portfolio depletion during the planning horizon), which are based on the outputs of models designed to project future portfolio values; and (3) solvency metrics, which are based on current observables (the current market value of assets relative to the current cost of an annuity providing target income for life).

There are two basic types of retirement income models. Life-cycle models encompass a range of approaches in which investors use information to make sequential decisions to attain financial objectives. Most life-cycle models use a utility (welfare) criterion as an asset management preferencing metric. The life-cycle approach assigns weights to both consumption and terminal wealth utility, and the model identifies the asset management strategy producing the greatest aggregate utility value over the planning horizon. Shortfall minimization models test the ability of various asset management elections

to achieve targeted income and terminal wealth. Historical backtests, bootstrapped reshuffling of historical returns, and Monte Carlo simulations of pre-parameterized distributions are popular methods of assessing shortfall likelihood and magnitude.

Finally, some retirement income models incorporate a solvency or feasibility metric. The feasibility condition requires that the current market value of assets equals the stochastic present value of the lifetime target income plus, if relevant, gifts and bequests. A critical distinction is drawn between *sustainability*—the probability, calculated by a risk model, that future financial market returns are sufficient to defuse targeted cash flows—and *feasibility*, a judgment regarding the current ability of the portfolio to fund the present value of required cash flows. Monitoring the feasibility condition differs from assessing a portfolio's financial health in terms of the likelihood of sustainability over the planning horizon. Unlike the shortfall probability metric, which is the risk model's best guess, the feasibility condition is a function of current market observables.

The advances in modeling described throughout this literature survey facilitate prudent portfolio surveillance and monitoring in terms of utility, shortfall, and feasibility risk metrics. Over time, the locus of action in retirement income planning shifts from a search for the best portfolio design and spending rules to dynamic portfolio monitoring and intelligent assessment of asset management decisions.

Retirement Income Risk Models (1965–2005)

The origin of many academic commentaries can be traced to Yaari (1965).¹ Yaari demonstrates that investors without a bequest objective and with access to actuarially fair annuities in a complete market setting—one where insurance or financial instruments span all economic risks faced by the investor—will hold all wealth in “actuarial notes.” Yaari considers how the investor can optimize discounted expected utility over both a deterministic period and an uncertain lifespan where the investor places a value on both consumption and bequests. Investors lacking a bequest objective will maximize a utility function for consumption only, and their challenge is to find the optimal feasible consumption plan when the planning horizon is uncertain. Under the Yaari complete market model, annuities put the investor on the optimal feasible consumption path.

Although Yaari's (1965) classic paper is also an important source document for researchers applying a portfolio shortfall probability risk metric, Yaari does not develop a probability-of-success approach to evaluating portfolio choice. Rather, he evaluates investment and actuarial solutions in terms of maximizing

¹Menahem E. Yaari, “Uncertain Lifetime, Life Insurance, and the Theory of the Consumer,” *Review of Economic Studies*, vol. 32, no. 2 (April 1965): 137–150.

investor utility (welfare) over the applicable planning horizon at an appropriate discount rate for a risk-averse investor manifesting a possibly time-varying preference for consumption as a function of age. Yaari's model sets the table for future inquiry in that it acknowledges (1) the usefulness of both utility-based life-cycle modeling and shortfall risk modeling; (2) the existence of both actuarial- and investment-oriented solutions; and (3) the importance of the consumer's preference function ("impatience") with respect to the timing and magnitude of retirement spending. It is not an exaggeration to state that future research papers seek to test, extend, and sharpen Yaari's insights.

We note the appearance of asset/liability matching models that, in turn, introduce new metrics for evaluating a portfolio's financial health and its likelihood for long-term success. One example is the wealth/consumption ratio, which improves or deteriorates over time according to various asset allocation/spending elections. This period also sees the introduction of an option valuation approach to portfolio management. For example, models seek to provide insight, under various economic circumstances and investor conditions, into the optimal time to exercise the option to annuitize wealth.

Modeling becomes more dynamic, investment and actuarial solutions are closely compared and evaluated in terms of utility and shortfall risk preferencing metrics, and a greater premium is placed on ongoing and active portfolio monitoring. We chronicle a split among commentators on the subject of optimal annuity timing. Some suggest that investors should annuitize all wealth when the annuity contract's mortality premium exceeds the expected premium from holding a risky asset portfolio—an option valuation approach that stresses the fact that annuities are a cost-efficient way to generate income. Others suggest that investors should annuitize all wealth as soon as they can lock in their desired future income stream. Finally, others suggest that, if prudent, investors should delay exercising the option to annuitize. The recommendation to delay stems from the observations that (1) immediate annuitization may impose an unacceptable constraint on future consumption and (2) investors value smoothed marginal utility of lifetime consumption more than a fixed periodic dollar-value income.

In this section, we also document a growing dissatisfaction with how models generate the future paths of investment and inflation processes. Model outputs appear to be unrealistic. Specifically, questions emerge concerning the consequences of

- using models incorporating only the first two moments of the distribution of financial asset returns,
- limiting model input to only one or two risky asset classes,

- assuming complete markets operating under frictionless conditions,
- inputting a constant inflation process,
- limiting the form of the utility function to constant relative risk aversion, and
- failing to incorporate a floor (threshold) lower bound for consumption.

Although this period is one of significant research advances, it is also a period of growing controversy regarding financial planning recommendations as well as increased skepticism regarding the model outputs used to support such recommendations.

Academic Research (2005–2014)

We characterize the research of this period as an effort to relax the rigid and oversimplified assumptions of previous retirement income risk models. Additionally, during this period, risk models incorporate many more variables of interest, including economic shocks (e.g., unreimbursed medical/dental costs), the role of human capital, flexibility in spending and in the selection of a retirement date, the effect of illiquidity on the selection of portfolio assets, and other economic factors. Both the implied and explicit financial planning recommendations appearing in the literature are model dependent, and with the rapid expansion of modeling capabilities, there is a marked increase in the heterogeneity of such recommendations.

One consequence of these developments is of special significance. A large number of articles written for a practitioner audience focused on the issue of how much can be safely withdrawn each year from a retirement income portfolio. These practitioner-oriented articles often resort to pure empiricism in an attempt to parse historical return evolutions to find rules for safe and sustainable portfolio withdrawals. The period 2005–2014, however, saw a marked decrease in the use of risk models based primarily on historical back testing. On one hand, this result is owing to an increasing appreciation of the limitations of this modeling method; on the other, it has much to do with the unexpected virulence of the 2008–09 global recession.

Life-cycle models undergo a similar transformation. They provide valuable insights into complex interactions among longevity, asset allocation, labor income, work/leisure trade-offs, timing of annuitization options, and portfolio withdrawal strategies (investor spending). Furthermore, optimal asset allocation and portfolio management decisions vary substantially across the population of investors depending on (1) the form of the investor's utility of wealth function (e.g., relative or absolute risk aversion) and (2) the degree of investor

risk aversion (i.e., the concavity of the utility function). In general, the life-cycle model research of this period shreds conventional wisdom. It rejects the one-size-fits-all rules of portfolio design and safe withdrawal rate management derived from historical back testing. Retirement planning advice changes as models incorporate differing utility of wealth functions, dynamically changing risk aversion, and period-by-period threshold income requirements.

The actuarial literature outlined in the previous section commands increased attention as investigation into the techniques for and costs of producing adequate income throughout the planning horizon becomes an increasingly important topic in a low interest rate environment. At least two issues emerge: (1) a benchmarking issue—to what extent the annuity benchmark represents a reasonable way to compare and contrast retirement income strategies—and (2) a debate regarding the prudence of when and how to annuitize retirement assets. Neither issue is new. However, the incorporation of a threshold income requirement into risk modeling changes the nature of the investigation. Commentators are split on whether to annuitize as soon as possible lest a forthcoming bear market jeopardize the ability to secure threshold income or to delay annuitization to capture the expected risk premium and, potentially, enter into a lower-cost annuity contract issued at an older age. The literature survey describes studies advocating an “annuitize ASAP strategy,” as well as studies espousing an “annuity-as-safety-net strategy.”

New definitions of prudent asset management emerge alongside new characterizations of risk and portfolio preferencing metrics. The topics of state preference utility, threshold income, consumption variance, maximization of lifetime income, conditional versus unconditional shortfall risk, and subjective discounting to reflect consumer impatience begin to take the forefront in model building. Indeed, the advances in model building during this period are striking. Particularly noteworthy is the emergence of monitoring and performance benchmarks based on a single premium immediate annuity. Such a benchmark shapes new methods for assessing a portfolio’s ability to provide needed future funds.

A Survey of Academic Literature on Annuities

We examine several studies that consider the merits of annuitizing some or all of financial wealth to guarantee lifetime periodic income payments. This asset management election is often evaluated in the context of a life-cycle model seeking to gauge the utility value of an actuarially fair annuity. Actuarially fair annuities are, however, unavailable to investors. The prudence of exercising an option to annuitize depends, of course, on a variety of factors, including contract costs. The cost of an actuarial solution determines the capital

sacrifice required to transfer longevity risk from the investor to the insurance industry. That is, it quantifies the amount of wealth that must leave the financial asset portion of the retirement portfolio to secure a target amount of periodic lifetime income.

We review a large body of research on the topic of annuity costs and benefits. The initial discussion focuses on academic papers seeking to develop and apply a variety of methods (value per premium dollar, expected present discounted value, internal rate of return, the money's worth ratio, implied annuity yield, and so forth) to estimate the costs and loads of commercially available single premium immediate annuity contracts. The review compares and contrasts cost estimation methods and details the conclusions of a variety of research studies looking at both the US and European annuity markets. Conclusions can vary greatly depending on a number of assumptions regarding interest rate discounting factors, population mortality, and the choice of the utility function for determining the value of annuitization for retired investors.

We further look at how actuaries decompose annuity costs to account for sales compensation, insurance carrier profit objectives, reserve requirements and crediting spreads, adverse selection risk, contract administration, investment opportunities and asset mixes, and other relevant factors. This discussion is more of a bottom-up attempt to quantify annuity costs as opposed to the top-down methodologies found in the academic approaches described in the previous paragraph.

Two additional topics are covered in this section. First, there is a brief discussion of whether annuities are, in fact, risk-free financial instruments. The review includes examples of insurance carrier insolvency, the role of state-sponsored guarantee funds, and the need to diversify the annuity portfolio. Second, we provide a spectrum of opinion regarding the wisdom of purchasing an annuity contract in a low interest rate environment. A concluding section provides final thoughts, and an extensive bibliography follows.

The complete book can be found at
<http://www.cfapubs.org/toc/rflr/2015/10/2>.



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