



## Optimizing the equity-bond-annuity portfolio in retirement: The impact of uncertain health expenses

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### ABSTRACT

This paper derives optimal equity-bond-annuity portfolios for retired households who face stochastic capital market returns, differential exposures to mortality risk and uncertain uninsured health expenses, and differential Social Security and defined benefit pension coverage. The results show that the health spending risk drives household portfolios to shift from risky equities to safer assets and enhances the demand for annuities due to their increasing-with-age superiority over bonds in hedging against life-contingent health spending and longevity risks. Households with higher income have a greater incremental demand for life annuities. The annuities in turn provide greater leverage for equity investment in the remaining asset portfolios.

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### 1. Introduction

With the recent decline of traditional defined benefit (DB) pension plans, there has been a corresponding shift to defined contribution (DC) plans by many US corporate plan sponsors. The Social Security (SS) system may also have reductions in its scheduled benefit payouts in order to move it to sustainable solvency. Because DC plans are typically self-managed by their participants and lack the withdrawal discipline featured in the life annuity distributions of SS and most DB plans, a legitimate concern arises that many retirees may run out of their DC funds or underconsume given that the length of life is uncertain.

To protect people against longevity risk, experts have suggested setting annuitization as a default or mandatory option in DC plans. Despite the superior nature of annuities as insurance against

longevity, however, most retired households have historically shown relatively little interest in voluntarily annuitizing their wealth. Various factors have been cited as the potential explanations to this “annuity puzzle.” Among them, uncertain health expenses have recently gained particular attention. The literature has thus far offered inconclusive findings. [Sinclair and Smetters \(2004\)](#) and [Turra and Mitchell \(2008\)](#) find that uncertain uninsured health expenses and their negative correlation with life expectancy reduce the attractiveness of annuities. [Davidoff et al. \(2005\)](#), on the other hand, show that uncertain health expenses, if occurring in late life, may actually increase the demand for annuities.

Our study offers a comprehensive stochastic life-cycle framework to address the major risks and choices for households in the retirement phase. We assume that annuitization can be made at any age and in any amount, in contrast to a one-time choice of annuitization upon retirement in many previous studies. We consider jointly the household investment choices of bonds, equities, and annuities. The annuitization decision is modeled as a portfolio allocation choice because a life annuity basically represents a class of financial assets with its own unique risk and return features.

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Specifically, households in the retirement phase optimize consumption and allocate their financial wealth among stocks, bonds and annuities, in the context of pre-existing annuities such as Social Security and DB pension coverage. Households in the model have differential exposure to mortality risks and uninsured health care costs, in addition to facing common stochastic capital market returns. They also do or do not have a bequest motive.

Our key findings and the logic are as follows. The uncertainty in uninsured health expenses generally leads to precautionary savings and rational households should shift their assets from risky equities to riskless bonds for a desired level of risk exposure. The simulated optimal equity portfolio is similar to the practice of life-cycle (target-date) funds in the retirement phase.

Life annuities are assumed to be as safe as bonds, though contingent on survival, provide higher returns than bonds due to the embedded survivorship premium that increases with age, and eventually dominate bonds, even with a load, for hedging against longevity risk. Occurrences of health care are also life contingent and the expected expense magnitudes increase with age, as empirically observed, which makes annuities superior to bonds in also hedging against this health spending risk. The existing annuity payouts can be rolled over to finance new annuity purchase so as to capture higher returns and provide greater old-age insurance.

It is optimal for households to hold precautionary savings in the equity-bond bundle prior to annuitization when the annuity return (considering some load) has not yet exceeded the reference returns on the conventional assets. The shift to annuities also provides greater leverage than do bonds for higher-risk-and-return equity investment in the remaining asset portfolios. The health-spending-uncertainty-enhanced annuitization is compatible with the broader theory about liquidity constraints and precautionary savings because the relatively low uninsured health care costs in the early retirement years are largely buffered by the pre-existing SS and DB coverage.

This paper proceeds as follows: a brief literature review, the details of the stochastic life-cycle model, the findings from the simulations (focusing on the effect of uncertain health expenses on equity-bond-annuity choices), and concluding remarks.

## 2. Literature review

Our work builds on the relevant literature. One strand examines the relationship between health expenses and general household saving behavior. Palumbo (1999) shows that uncertain health expenses play a potentially important role in generating precautionary saving, which helps explain the slow rates of dissaving among elderly families in retirement. Dynan et al. (2004) posit that the precautionary saving with uncertain health expenses and bequest motives are likely the main driving forces for the non-dissaving in old age and saving variations across income groups. These two saving motives need not be mutually exclusive in that the precautionary savings may end up being part of the bequest eventually left to heirs. De Nardi et al. (2006) find that out-of-pocket health care costs increase quickly with both age and permanent income. Households in higher income groups, compared with the lower-income, need to save more because they have a higher probability of living to advanced ages (differential mortality) and tend to face larger health expenses (differential health expenses).

Some studies examine the effects of health status and medical expenditures on equity-bond portfolio choices. Feinstein and Lin (2006) show that a prospect of poor health and substantial medical expense may lead the elderly to a more risk-averse investment behavior (less equity). Love and Perozek (2007) show that the introduction of age-dependent background risks such as health expenses lowers the optimal portfolio shares of risky assets with age for older households.

Another strand of research examines what factors are causing the empirically observed lack of voluntary annuitization, in contrast to general theories that suggest annuities are welfare-improving. The seminal work by Yaari (1965) finds that full annuitization of wealth is optimal if the consumer has no bequest motive. Milevsky and Young (2002) show that there exists a real option value to defer annuitization to an older age because the waiting time gives retirees, if sufficiently risk tolerant, opportunities to gain from higher equity returns, better assessment of the length of one's future lifespan, and more favorable terms on annuity purchase. Kotlikoff and Spivak (1981) and Brown and Poterba (2000) show that the intra-family risk pooling reduces the benefit of annuitization for married couples. Dushi and Webb (2004) show that the high levels of pre-existing annuities in the retirement phase significantly reduce the need to annuitize further.

Particularly relevant are the studies about how uncertain health expenses affect the demand for annuities. Turra and Mitchell (2008) find that uninsured health expenditures motivate precautionary savings and that this need for liquidity makes annuities less attractive at retirement, especially for those whose life expectancy is shortened by health shocks. They also show, however, that the optimal fraction of wealth annuitized remains large in most situations. Sinclair and Smetters (2004) share a similar view – annuities become less effective in providing financial security if health shocks cause large uninsured expenses and simultaneously shorten life expectancy. Davidoff et al. (2005) show that people without a bequest motive should fully annuitize their wealth under market completeness, so long as a positive premium exists, comparing the annuity return (including mortality credit) to the reference returns on conventional assets. Significant, albeit partial, annuitization remains optimal widely even with market incompleteness or a bequest motive. These conditions for a full or partial annuitization are much less restrictive than assumed by Yaari (1965). Moreover, the authors show that the impact of uninsured health expenses on the demand for annuities is critically dependent on the timing of such expenses. Uncertain health expenses, when occurring early in retirement, call for more liquidity holdings and less (illiquid) annuities, but will make annuities better financial instruments to hedge against such expenses if they occur late in life. Yogo (2008) models health as a durable consumption good and health expenditures as endogenous investments in health, rather than treating them as exogenous negative income shocks. The author finds that the need for precautionary savings essentially disappears because the retiree can invest directly in health and accumulate health capital, in place of accumulating liquid assets.

Researchers have recently devoted more effort to integrating equity-bond allocation choices with annuitization decisions to better address the needs and strategies in the wealth decumulation phase. Dus et al. (2005), Horneff et al. (2006a,b, 2007, 2008, 2009), and Maurer et al. (2008) examine various investment portfolios and wealth withdrawal strategies in a life-cycle framework, quantify welfare gains with the addition of fixed or variable annuities, and generally show that a well designed equity-bond-annuity portfolio will offer retirees the chance to capture an equity premium when younger and exploit longevity insurance and mortality credit of annuities in later life. These studies, however, do not address the impact of uninsured health expenses on asset allocation and annuitization choices, which are considered specifically in our analysis.

## 3. A life-cycle model starting at retirement

### 3.1. Preferences

We set up a discrete-time life-cycle model in retirement with age  $t \in \{0, \dots, T\}$ , where  $t = 0$  indicates the retirement age and

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