



# Portfolio choice in retirement: Health risk and the demand for annuities, housing, and risky assets



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## ABSTRACT

In a life-cycle model, a retiree faces stochastic health depreciation and chooses consumption, health expenditure, and the allocation of wealth between bonds, stocks, and housing. The model explains key facts about asset allocation and health expenditure across health status and age. The portfolio share in stocks is low overall and is positively related to health, especially for younger retirees. The portfolio share in housing is negatively related to health for younger retirees and falls significantly in age. Finally, out-of-pocket health expenditure as a share of income is negatively related to health and rises in age.

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## 1. Introduction

As a large cohort of baby boomers enters retirement, there is growing fiscal pressure to reduce the benefits promised by Social Security and Medicare, and the impact of such reforms on private saving and the demand for health care remains unclear. At the same time, there is growing availability of financial products like annuities, reverse mortgages, Medigap insurance, and long-term care insurance that supplement or replace public insurance. Despite enormous practical interest, there is relatively little academic work on consumption and portfolio decisions in retirement when households face health risk, compared with a large literature that studies consumption and portfolio decisions in the working phase when households face labor-income risk. This paper is an attempt to fill this gap in the life-cycle literature.

I develop a life-cycle model in which a retiree faces stochastic health depreciation, which affects her marginal utility of consumption and her life expectancy. The retiree receives income and chooses consumption, health expenditure, and the allocation of wealth between bonds, stocks, and housing to maximize expected lifetime utility. The life-cycle model takes three important inputs, which are estimated for single retirees, aged 65 or older, in the Health and Retirement Study. The first input is health transition probabilities, which are estimated from self-reported health status, mortality, and various measures of health care utilization. The second input is health insurance coverage (including Medicare), which are estimated from the ratio of out-of-pocket to total health expenditure. The third input is retirement income from Social Security and defined-benefit pension plans.

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Given these inputs, the preference and health parameters are calibrated to explain the observed variation in asset allocation and health expenditure across health status and age. The portfolio share in stocks is low overall and is positively related to health, especially for younger retirees. The portfolio share in housing is negatively related to health for younger retirees and falls significantly in age. Since stocks account for a small share of financial and housing wealth, the portfolio share in bonds (net of mortgages and home equity loans) is essentially the mirror image of the portfolio share in housing. That is, the portfolio share in bonds is positively related to health for younger retirees and rises significantly in age. Finally, out-of-pocket health expenditure as a share of income is negatively related to health and rises in age.

These results are primarily driven by three economic mechanisms. The first mechanism is the horizon effect in portfolio choice, which is that younger investors should invest a higher share of their liquid wealth in risky assets (Bodie et al., 1992). The horizon effect explains why healthier retirees, who have a longer life expectancy, invest a higher share of their financial wealth in stocks instead of bonds. The horizon effect also explains why retirees substitute from risky housing to safe bonds as they age. The second mechanism is preferences that imply that non-health consumption and health are substitutes. This explains why younger retirees in worse health have a higher portfolio share in housing, which implies higher consumption of housing services. The third mechanism is decreasing returns to health investment. This explains why out-of-pocket health expenditure is higher for retirees in worse health, for whom the marginal product of health investment is higher.

Although this paper is primarily about portfolio choice, the facts about health expenditure are also important for two reasons. First, out-of-pocket health expenditure is the only measure of consumption expenditure that is available in the Health and Retirement Study. Therefore, the facts about health expenditure impose additional discipline on models of portfolio choice in retirement, just as the hump-shaped consumption profile imposes discipline on models of portfolio choice during the working phase (Cocco et al., 2005). Second, health expenditure can be thought of as an investment in “health capital”, just as bonds and stocks are investments in financial wealth, and housing expenditure is an investment in housing wealth. Therefore, it is natural to think about health expenditure as part of a bigger portfolio decision between financial and housing wealth versus health capital.

The remainder of the paper proceeds as follows. Section 2 presents the life-cycle model of consumption and portfolio choice in retirement. Section 3 estimates the key inputs and outputs of the life-cycle model using the Health and Retirement Study. Section 4 calibrates and solves the life-cycle model to explain key facts about asset allocation and health expenditure across health status and age. Section 5 uses the calibrated model to examine how asset allocation would respond to a one-time reduction in Social Security benefits. Section 6 concludes with a discussion of open issues and extensions for future work. All appendices are available online at the journal website (Yogo, 2016).

## 2. Life-cycle model of consumption and portfolio choice in retirement

This section presents a life-cycle model of consumption and portfolio choice in retirement. The basic structure of the model can be summarized as follows. An individual enters retirement with an initial endowment of financial wealth, housing wealth, and health. In each period while alive, the retiree receives income and faces stochastic health depreciation, which affects her marginal utility of consumption and her life expectancy. In response to the health shock, the retiree chooses consumption, housing expenditure, health expenditure, and the allocation of financial wealth between bonds and stocks.

The life-cycle model in this paper allows health expenditure and the allocation of wealth between bonds, stocks, and housing to all respond endogenously to health shocks. Individual features of the model have appeared in the literature. For example, several papers allow health expenditure to respond endogenously to health shocks, but they do not model housing or portfolio choice (Picone et al., 1998; Hugonnier et al., 2013). Several papers study housing and portfolio choice during the working phase when households face labor-income risk, instead of retirement when they face health risk (Cocco, 2005; Hu, 2005; Yao and Zhang, 2005). Finally, several papers study portfolio choice between bonds, stocks, and annuities (but not housing) in the context of a life-cycle model in which health expenditure and mortality are exogenous (Edwards, 2008; Horneff et al., 2009; Pang and Warshawsky, 2010; Inkmann et al., 2011; Kojen et al., 2016).

### 2.1. Housing expenditure

The retiree enters each period  $t$  with an initial housing stock  $D_{t-1}$ . The level of the housing stock incorporates both the size and the quality of the home. Housing depreciates at a constant rate  $\delta \in [0, 1)$  in each period. After depreciation, the retiree chooses housing expenditure  $E_t$ , which can be negative in the case of downsizing. Whenever housing expenditure deviates from zero, the retiree pays a transaction cost of  $\tau P_t D_t$  in period  $t+1$ , where  $\tau \in [0, 1)$  and  $P_t$  is the home price. The presence of a fixed cost, which is proportional to the value of the existing housing stock, makes housing expenditure lumpy. The accumulation equation for housing is

$$D_t = (1 - \delta)D_{t-1} + E_t. \quad (1)$$

Housing is a unique asset that serves a dual purpose. On the one hand, the retiree enjoys a utility flow from living in a home. On the other hand, housing is a form of savings, which the retiree can use for consumption or health expenditure

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