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Longevity risk, retirement savings, and financial innovation ☆

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ABSTRACT

Over the last couple of decades unprecedented increases in life expectancy have raised important concerns for retirement savings. We solve a life-cycle model with longevity risk, which can be hedged through endogenous saving and retirement decisions. We investigate the benefits of financial assets designed to hedge the shocks to survival probabilities. When longevity risk is calibrated to match forward-looking projections, those benefits are substantial. This lends support to the idea that such hedging should be pursued by defined benefit pension plans on behalf of their beneficiaries. Finally, we draw implications for optimal security design.

1. Introduction

Over the last few decades, an unprecedented increase in life expectancy has occurred. For example, a 65-year-old United States male in 1970 had a life expectancy of 78 years.[1] Roughly three and a half decades later, in 2007, a 65-year-old male had a life expectancy of 82.5 years. This represents an increase of 1.2 years per decade. To understand what such an increase implies in terms of the savings needed to finance a given stream of retirement consumption, consider a fairly priced annuity that pays $1 real per year and assume that the real interest rate is 2%. The price of such annuity for a 65-year-old male would have increased from $10.5 in 1970 to $13.5 by 2007. This is an increase of roughly 29%. In other words, to finance a given stream of real retirement consumption, a defined benefit (DB) pension plan (or a 65-year-old male) would have needed 29% more wealth in 2007 than in 1970.

These large increases in life expectancy were, to a large extent, unexpected and as a result they have often been underestimated by pension plans, Actuary's, and insurers. This is hardly surprising given the historical evidence on life expectancy. From 1970 to 2007 the average increase in the life expectancy of a 65-year-old male was 1.2 years per decade, but, from 1933 to 1970, the corresponding increase had been only 0.2 years per decade. This pattern of increases in life expectancy has not been confined to

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[1] The data in this paper on life expectancy were obtained from the Human Mortality Database (www.mortality.org).

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the US. In the United Kingdom, a country for which a longer time series of data on mortality is available, the average increase in the life expectancy of a 65-year-old male was 1.5 years per decade from 1970 to 2009, but only 0.1 years per decade from 1849 to 1970. These unprecedented longevity increases are to a large extent responsible for the underfunding of pay-as-you-go state pensions,[2] and defined benefit company and state-sponsored pension plans, and they show either their benefits must be lowered or contribution rates increased.[3]

The response of governments has been to decrease the benefits of state pensions and to give tax and other incentives for individuals to save privately, through defined contribution pension schemes. Likewise, many companies have closed company sponsored defined benefit plans to new members, while others have reduced their benefits, or increased contribution rates, or both. For instance, in their 2010 review of employer rates, the members of the benefits and program administration committee of Calpers note that what was causing the biggest increase in employer contribution rates was the proposed change to more realistic post-retirement mortality assumptions.[4]

This also raises a question as to how DB pension plans should address the issue of longevity risk or further changes in mortality rates going forward. The risk that plan members live longer could be reduced by the pension plan by the purchase of annuities at retirement age. However, considerable uncertainty exists for younger pension plan members with respect to the level of aggregate life expectancy, and consequently the annuity prices, that they will face when they retire. How should pension plans address such risk? Should they try to hedge it to the extent that it is possible to do so? Naturally, the answer to these questions depends on the extent to which the pension plan beneficiaries might benefit from such insurance. This paper studies the extent to which individuals are affected by longevity risk and the role that different instruments, including financial assets, play in hedging it. Thus, we focus on the demand for such assets.

We first present the existing empirical evidence on longevity, focusing on its historical evolution, on forward-looking estimates of mortality rates, and on the uncertainty surrounding these estimates. For this purpose we use current long-term projections made by the US Social Security Administration (SSA) and by the UK Government Actuary's Department (GAD). We use this evidence to parameterize a life-cycle model of consumption and saving choices. The main distinctive feature of the model is that the survival probabilities are stochastic and evolve according to the specification proposed in Renshaw and Haberman (2006). This generalizes the one proposed in Lee and Carter (1992), which is the leading statistical model of mortality in the demographic literature, by allowing for cohort effects. For part of the analysis we focus on the simpler Lee and Carter formulation.

In our model, the individual receives a stochastic labor income each period and decides how much to consume and save. She knows the current survival probabilities, but she does not know the future survival probabilities, because those are stochastic. Naturally the individual forms an expectation of such probabilities when making her decisions. We allow for endogenous retirement so that, in addition to adjusting her savings in response to changes in life expectancy, she can revise her retirement decision.

Traditionally markets were incomplete in that agents did not have at their disposal the financial assets that would allow them to hedge longevity risk. We say "traditionally" because recent attempts have been made to address this market incompleteness. In December 2003, Swiss Reinsurance Company Ltd. (Swiss Re.) issued a $400 million three-year life catastrophe bond.[5] Swiss Re. tried to insure itself against a catastrophic mortality deterioration (e.g., a pandemic). More recently, there has been a growing interest in longevity swaps. These assets allow pension funds and other annuity providers to hedge the longevity risk to which they are exposed. In recent years several pension funds have actively started hedging their longevity exposure using financial products such as these, provided by some of the major financial institutions. Business Week reported a volume of $15 billion in new life settlement backed securities issued in the US in 2006, and this number was expected to double in 2007.[6] According to Risk.net the volume of new issuances in the UK exceeded £7 billion in 2009, with comparable numbers reported by the Financial Times.[7]

It is with this process in mind that we allow the agent in our model to invest in financial assets whose returns are correlated with the shocks to the survival probabilities, which we call longevity bonds. We study the portfolio allocation between these bonds and risk-free assets, namely how the demand for them changes over the life-cycle and with individual characteristics. Therefore, our model allows us to identify, in a microsetting, which individuals benefit most from longevity bonds and which benefit less, that is, those who might be the counterparty for such bonds.

We find that agents in our model respond to longevity improvements by increasing their savings, and in this way they are able to at least partially self insure against longevity shocks. Because longevity risk is realized slowly over the life-cycle, agents have time to react to the shocks. This requires that agents are well informed of the improvements in life expectancy, and the implications of such improvements for the retirement savings needed.

[2] The decrease in birth rates that has occurred over this period has also contributed to the underfunding.

[3] For individuals who are not covered by such defined-benefit schemes, and who have failed to anticipate the observed increases in life expectancy, a longer live span implies a lower average level of retirement consumption.

[4] http://calpensions.com/2010/04/21/a-second-calpers-rate-hike-for-employers/.

[5] Blake and Burrows (2001) propose the design of financial instruments for hedging longevity risk and recommend that governments issue "survival bonds" to allow the private sector to hedge this source of risk.

[6] Business Week, July 30, 2007.

[7] Financial Times, October 19, 2009.