Innovations in Retirement Financing

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Chapter 10

Survivor Bonds and Compulsory Annuitization: Reducing the Costs of Pension Provision

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Governments throughout the world are examining how their pension programs might be improved for those who are poorly served by existing systems. Most attention to date has focused on the *accumulation stage,* or the period of active membership in a pension scheme until retirement. Issues here include the advantages and disadvantages of funding versus pay-as-you-go (PAYG), defined benefit versus defined contribution, and active versus passive fund management.[1] What has received much less attention is pension performance at the *retirement stage.* This lack of focus on retirement issues is not surprising, since when a new system is established, the retirement phase is typically 40 years or more ahead. Furthermore, for members of defined benefit schemes (whether public or private sector, funded or unfunded), someone other than the scheme member is guaranteeing or at least promising to deliver a particular level of pension in retirement. However, this is not the case with defined contribution plans, and most new pensions being established throughout the world are DC schemes.

With many DC schemes, there is no guaranteed pension at retirement. Rather, the retiree must live on whatever fund value has been accumulated at the time of retirement. In addition, because of uncertain life expectancy, individuals also face the risk of outliving their resources. They can insure against the risk of living too long by buying a life annuity from an insurance company, although the purchase of an annuity is not compulsory in many countries (e.g., the United States, Australia, and Germany). But two problems may arise with this arrangement:

1) Mortality risk. Mortality has improved substantially over the last century, but it is very difficult to forecast improvements in mortality accurately. This is what is meant by *mortality risk*. Under a state-run unfounded system, the government bears this mortality risk directly. While governments or large occupational schemes may have the ability to adjust contribution rates to bear such a risk, it is quite another thing for insurance companies to take this on. Of special concern is the role of new insurers being established in a country with no previous history of annuity provision. Because lifetimes are uncertain, insurers must construct hedged investment portfolios consisting of many types of long-term bonds; however, such portfolios may be costly to manage and, in any case, often provide imperfect hedges against mortality risk.

2) Adverse selection. Those who expect to live the longest will tend to have the highest demand for annuities. In such circumstances, if people are given choice about whether or when to purchase an annuity asset yields will have to be lower than actuarially fair for the population as a whole to compensate for the fact that the buyers of annuities are likely to experience lighter mortality (Brown et al., this volume). In other words, there is *adverse selection* in the demand for annuities and, to compensate, the providers of annuities need to lower the annuity yields they offer (the amount by which the annuity yield falls is known as the *adverse selection bias*). With defined benefit schemes in the UK, this choice is limited or even nonexistent. However, DC arrangements in the UK permit a wide range of choice over both the amount and timing of the annuity purchase. The pension can currently be provided in one of four ways: a life annuity purchased from a life assurance company, a life annuity provided by the scheme itself in the case of occupational DC schemes, a phased life annuity, or an income drawdown facility.[2] Members of personal pension and group personal pension schemes[3] are required to purchase annuities from life companies before they reach the age of 75, but they are currently not obliged to buy annuities on the date they retire (which can be from age 50 upwards).

This analysis investigates how these two problems can be minimized. We believe that only compulsory pension annuities from a mandatory funded pension system can help resolve the problem of adverse selection. Further, the age of purchase must coincide with the retirement date. But such annuities only cope with the second problem while they do nothing about the first. To address the first problem, we propose that the government help current and future retirees by providing insurance against aggregate or cohort mortality risk. To do so, we show how a government can issue a new type of bond, a *survivor* (or *indexed life*), *bond,* one that allows its holders to hedge aggregate mortality risk and so reduce the management charges associated with constructing a hedged investment portfolio. We expect that there would be a strong demand for the new bond from insurance companies, mature pension funds, and occupational money purchase or 401(k)-type schemes.

Mortality Risk

Consider an individual who will live for exactly T additional years. This individual could use a lump sum to purchase an annuity from an insurance company, or to buy an annuity bond (which pays coupons only and has no principal repayment) directly from the financial markets. Both products will yield a constant income stream for T years. In the absence of arbitrage, both investments will cost the same. The market price of a T-year annuity bond is (Blake, 2000):[4]

$$P = \frac{d}{r}\left[1 - (1 + r)^{-T}\right], \tag{1}$$

where d is the annual coupon and r is the relevant discount rate (as a proportion). If someone purchased this bond at price P and then lived exactly T years, this would be equivalent to someone purchasing a T-year annuity for an amount P which paid d per year in arrears.

In reality, neither individuals nor insurance companies know exactly how long any individual annuitant will live. In the case of an annuity bond which continues to pay out coupons for as long as the individual is alive, its price depends on the whole probability distribution of death rates for this individual. In other words, T is a random variable, and not a fixed parameter. As a consequence, the market price of such annuity bonds depends on expectations about the random variable T as follows:

$$P = E\left[\frac{d}{r}\left[1 - (1 + r)^{-T}\right]\right], \tag{2}$$

where E is the expectations operator.

Annuity bonds with random maturities are currently not available on financial markets, but insurance companies do provide life annuities with uncertain T. Each insurance company would be expected to attempt to minimize its exposure to mortality risk by holding a portfolio of fixed-term bonds that matched the anticipated mortality profile of its annuitants, and by building up a large enough pool of annuitants to minimize the risk of lighter than expected mortality. Nevertheless, an insurance company cannot predict mortality perfectly. To consider the effects of errors in forecasting mortality improvements, we denote the probability of dying at age x having survived to age $x - 1$ by q_x. Suppose that the insurance company forecasts mortality improvements by adjusting data from an actuarial table q_x^O by multiplying by an exponential factor f^{x-x_0}, where x_0 is the current age of the annuitant and f is a scalar (which is less than unity if mortality improves over time and equal to unity in the case of no mortality improvement). This is one way in which the United Kingdom Institute of Actuaries Continuous Mortality Investigation Bureau (CMIB) makes mortality adjustments. In terms of the q_x, the unconditional probability of dying after $T > 0$ periods (conditional on having lived to age x_o) is

$$q_{T+x_0} \prod_{x=x_0}^{x_0+T-1} (1 - q_x) ,$$

where q_x is the conditional probability of dying at age x having survived to age x−1. This unconditional probability is used in computing the expected value in equations (2), so (2) is equivalent to (if we also take into account the improvement factors):[5]

$$(3) \quad P = \sum_{T=1}^{\infty} \left[\frac{d}{r} \left[1 - (1 + r)^{-T} \right] \right] q^0_{T+x_0} f^T \prod_{x=x_0}^{x_0+T-1} (1 - q^0_x f^{x-x_0}) \quad .$$

Errors in the adjustment factor f can have a large impact on equation (3). Historical evidence on mortality forecasts in the UK suggest that forecast errors of 15–20 percent in f for intervals of 10 or more years ahead are not uncommon (MacDonald 1996). Another indicator of the difficulty in forecasting mortality improvements is that historical values of these improvement factors are not constants: they differ considerably for men and women, different ages, and different types of pensioners. For instance, the historical improvement rate for men aged 70 between 1967–70 and 1979–82 was 0.74 for life office pensioners and 0.91 for immediate annuitants, i.e., those who purchase annuities voluntarily (MacDonald, 1996). The impact of such forecast errors on survival probabilities is significant. For example, assume a 20-year improvement factor of 0.80 for a 65-year old man and forecast errors for mortality rates of up to 10 percent over a 10-year period. Using the PMA80 mortality tables (constructed to reflect the mortality experiences of males who purchase pension annuities), the forecast probability of a 65-year old man living to 85 ranges between 33.7 and 43.8 per cent, while that of him living to 95 ranges between 5.3 and 15.3 per cent.[6]

To determine the effects of these forecast errors on annuity yields, we use Eq. (2) to solve for the annuity yield d/P:

$$(4) \quad \frac{d}{P} = \frac{1}{E\left[(1 - (1 + r)^{-T})/r \right]} \ .$$

To compute the actuarially fair yield (i.e., one with a zero cost loading), we substitute in survival probabilities determined from standard actuarial tables into Eq. (4). For a male aged 65, using a discount rate r of 7 percent, and a 20-year improvement factor f of 0.80, the PMA80 tables lead to an actuarially fair annuity yield of 10.6 percent, but forecast errors suggest it lies between 10.3 and 10.9 percent. Thus the percentage difference in yields is about 5 percent.[7] For a woman, the PFA80 tables lead to an actuarially fair yield of 9.5 percent in the absence of mortality risk, but forecast errors suggest it lies between 9.2 and 9.7 percent, again a percentage difference of about 5 percent.

The effects of mortality forecast errors are more serious for escalating annuities, because payments in the future will be higher than with flat annuities. For escalating annuities, Eq. (4) becomes:

$$\frac{d}{P} = 1 \Big/ E\left[(1+\pi)\left(\frac{1+\big((1+\pi)/(1+r)\big)^{T}}{r-\pi}\right)\right]. \tag{5}$$

where π is the uprating factor. For example, with an annuity escalating at 4 percent per annum, the percentage difference between upper and lower forecast bounds[8] rises considerably, to 9.5 percent for women and to 8.9 percent for men.

Given the significance of mortality forecasts for insurance company profitability, it is not surprising that cost loadings to cover mortality risk are built into prices. Further, some insurers may simply offer uncompetitive annuity rates, thereby effectively staying out of the market. Insurance companies cannot at present reduce these loadings without taking on unreasonable risks; indeed, anecdotal evidence for the UK indicates that the failure of some insurance companies accurately to predict improvements in mortality has led to serious problems among suppliers of deferred annuities, which are even more susceptible to mortality risk than immediate annuities.[9] Similar calculations for a 20-year deferred annuity escalating at 4 percent per annum to be received by a woman when she reaches the age of 65 suggest a range of about 22 percent in annuity yields under different mortality forecasts. These business considerations may explain why the market for deferred annuities in the United Kingdom is relatively thin.[10] Deferred annuities are particularly important in the case where a defined benefit scheme is wound up, say, as a result of the insolvency of the sponsoring company and also, potentially, for early leavers.

Because the private sector may be less able to absorb the aggregate risks associated with mortality forecast errors than the government, we next evaluate what a government might do to help alleviate this problem and reduce costs to annuitants. First, however, we review another factor which can reduce the value of DC pensions.

Adverse Selection

A second problem which contributes to the cost of annuities is adverse selection: people who purchase annuities tend to live longer than the population as a whole. This issue may be illustrated in the UK context by comparing annuities priced using the English Life Tables (ELT14), which reflects the mortality experiences of the population as a whole, with those priced using PMA80 and PFA80, which reflect the mortality experiences of, respectively, male and female pension annuitants.[11] No life insurance company would be prepared to offer an annuity yield based on ELT14. People who want to purchase annuities have private information (say, from their own family history and health experience) that they will likely have higher than average life expectancies. The insurers are thus subject to an adverse selection problem in that demanders of annuities do not reflect the statistical experience of the population as a whole.

How much does adverse selection contribute to the cost loadings for annuities in the U.K? Using equation (4) with r set at 8 percent and no future mortality improvements, the PMA80/PFA80 tables (downrated two years)[12] suggest annuity yields (annual in arrears) of 11.2 percent for a 65-year-old man, and 10.2 percent for a 65-year-old woman. ELT14 (downrated two years) suggests much higher annuity yields: 12.9 percent for a 65-year-old man, and 11.2 percent for a 65-year-old woman. This adverse selection bias increases with age: ELT14 suggests that a 75-year-old man purchasing an annuity should receive an actuarially fair rate of 17.5 percent, whereas PMA80 suggests a rate of just 14.6 percent.

Consider the case of two identical 65-year-old males: one retires with a state PAYG pension of £20 per week, and the second retires with a DC pension and purchases an annuity from an insurance company. Suppose for simplicity that all insurance companies are nonprofit organizations and that there is no mortality risk, so that actual experience corresponds exactly with PMA80 (downrated two years). If the second retiree were typical of the population as a whole (i.e., ELT14), he should receive an annuity with a 12.9 percent yield. Suppose this also results in a pension of £20 per week. But the insurance company will only offer an annuity yield of 11.2 percent or £17.36 per week, a reduction of close to 15 percent. Administrative cost loadings and adjustments to cover mortality risk will result in an even lower pension.[13]

The second 65-year-old may even be worse off than indicated, because state PAYG schemes usually provide indexed or inflation linked pensions. For escalating annuities, the adverse selection problem is more severe because there is a greater gain from living longer. PMA80 suggests that a 4 percent escalating annuity should offer a yield of 8.24 percent, whereas ELT14 suggests 9.93 percent, which implies a pension reduction of nearly 20 percent.

Unlike the costs analyzed in the previous section associated with mortality risk, adverse selection costs depend on the choices exercised by purchasers of insurance. The introduction of a lump sum option (known in the U.K. as an income drawdown), while increasing choice, also leads to yet larger adverse selection problems and thus higher costs for annuities for those who might need them most.

A Possible Solution: Survivor Bonds and Compulsory Annuitization

When insurance companies write annuities, they often use premiums collected to buy *matching assets,* that is, assets whose cash payments match as closely as possible the anticipated pattern of payouts on the liabilities that they face. In the case of level annuities, insurers invest principally in fixed-income bonds. In the case of index-linked annuities, insurers may hold index-linked bonds: insurers would not be prepared to write index-linked annuities if they could not lay off the resulting inflation risk through the purchase of an index-linked bond (issued by the government or a utility). However, insurance companies face two risks for which there are no existing matching assets: mortality risk and adverse selection, as already discussed.

A potential simple solution to the problem of mortality risk would be for the government to issue *survivor* (or *life-indexed*) *bonds.* These would be bonds whose future coupon payments depend on the percentage of the population of retirement age (say 65) at the date of issue still alive at future coupon payment dates. For a bond issued in 2000, for example, the coupon in 2020 will be proportional to the fraction of 65-year-olds in the population who have lived to age 85. The coupon is therefore directly proportional to the amount an insurance company needs to pay out as an annuity to the average individual with an average pension. Large employer or occupational schemes that also bear aggregate mortality risk could similarly be purchasers of such bonds.

Survivor bonds aim to lower the costs of retirement provision for the average pensioner, because they help to hedge *aggregate* mortality risk. However, they cannot hedge *specific* mortality risks. There are two key specific risks to take into account: (1) pensioner annuitants are a select group who are likely to live longer than the average of the population of the same age, and (2) given that an insurance company is underwriting a finite sample of lives, the characteristics of any particular insurance company's pool of annuitants may differ from that of the pensioner annuitant population as a whole. For example, women and wealthy pensioner annuitants with large lump sums to annuitize tend to live longer than the average pensioner annuitant. The bonds we describe here can only eliminate the risk associated with aggregate mortality improvements for the entire population, but they do not eliminate idiosyncratic risks such as those associated with wealth or other select effects.

In short, by minimizing aggregate risk, insurance companies would have the proper incentives to develop wide mortality pools and do what they do best: provide insurance against idiosyncratic risks. For instance, if the mortality of the rich improved more than that of the poor and the insurance company chose an equally weighted pool of rich and poor, the payouts by the insurance company would decline less rapidly than the coupon payments from the survivor bonds. The rate at which this happens depends on the differences between terms in

$$q^0_{T+x_0} f^T \prod_{x=x_0}^{x_0+T-1} (1 - q^0_x f^{x-x_0})$$

for the insurance company's own annuitant pool, versus those for the population as a whole. The q's and f's will be lower for the insurance company's annuitant pool and the forecast errors higher than for the population as a whole. The implication of this is that insurance companies that have mortality pools different from the population at large continue to bear specific mortality risk. Of course this is a commercial decision, and insurance companies should be expected to charge a residual load based on these differences to cover them.

An important point to recognize is that there are no obvious matching assets for the select mortality risks assumed by annuity providers, once they hold survivor bonds to hedge aggregate mortality risk. The provider will hedge these select risks by offering *lower* annuity rates to *all* annuitants. This disadvantages the average annuitants who are not members of the select groups. One way of dealing with this problem is to reduce the select mortality risks to zero by making pension plans and pension annuities mandatory for all members of society.[14]

The issue price of survivor bonds would be determined by a central body such as the Government Actuary in the UK. We do not envisage any major problems with determining the issue price: the government could publish its underlying assumptions concerning mortality. It is likely that the risk of underestimating mortality improvements is a smaller risk than that of underestimating future inflation, and there appears to be no problem with determining the issue price of retail price index-linked bonds in the UK or the U.S. Thereafter, the government would have to produce a monthly mortality index just as it produces a monthly retail price index. These bonds could be traded on the open market and could be resold with the secondary market prices indicating the market's expectations concerning future mortality.

Why should governments (and ultimately taxpayers) issue survivor bonds and absorb the risks associated with mortality fluctuations? A possible justification can be found in the Arrow-Lind Theorem (1970) on social risk-bearing, which shows that by dispersing an aggregate risk across the population (of taxpayers) as a whole, the associated risk premium can be reduced to zero. A government might then issue survivor bonds at a lower yield (namely, the risk-free rate) than could any private corporation. A private company would have much fewer shareholders than there are taxpayers, and some of the shareholders might hold large blocks of shares which would constitute a significant proportion of their net worth. These shareholders would demand a risk premium, whereas the government can act as a risk-neutral player. Another potential justification lies in the government's own public health campaigns, which are aimed directly at reducing mortality in the entire population; this has important implications for annuity provision by the private sector. Similarly, the reform of Social Security and the transfer of pension provision from the public to the private sector would be greatly eased by the existence of survivor bonds.[15]

By issuing survivor bonds, a government could help to complete markets. But why has the private sector not issued survivor bonds? One apparent natural class of issuer is insurance companies themselves, since they are in a position to hedge mortality risk with their other products: greater longevity raises the payouts on annuities but lowers them on endowment or life insurance policies. But in practice, endowment or life insurance policies provide a poor hedge for annuities, since mortality improvements are not spread evenly across ages, but rather are concentrated at older ages. To illustrate, the percentage improvement in mortality between the PMA80 and PA90M tables (based on mortality experience for United Kingdom male annuitants in 1980 and 1990 respectively) was 12 percent at age 35, 9 percent at age 55, 23 percent at age 75 and 20 percent at age 95. The family itself also provides an informal mechanism for the issuing survivor bonds between different generations of the same family, as implied by Kotlikoff and Spivak (1981), but the breakdown of the family in many countries makes this an increasingly unreliable mechanism. So we may be left with the state as the only realistic issuer of survivor bonds.

Conclusion

Some governments have helped pension funds insure against inflation by issuing index-linked bonds in the UK and more recently in the United States. We contend that the issuance of survivor bonds would help mature pension funds insure against the uncertainties involving an increasingly aging population. The reduction in cost loadings on annuities could be significant, and might be further reduced by eliminating the select effects associated with the voluntary purchase of annuities and requiring the mandatory annuitization of pension funds on retirement.

Appendix: A Brief Overview of the UK Annuities Market

Although annuities have been available in the United Kingdom for several centuries, the market for annuities did not develop until after the adoption of self-employed pensions (the precursor to personal pensions) in the 1950s. These policies, known as Section 226 retirement annuities, stipulated that at retirement a tax-free cash sum could be paid and the remaining balance had to be used to purchase an annuity from an authorized insurance company. The legislation provided for an open market option which allowed the policyholder to purchase an annuity from another insurance company. This was the beginning of the competitive market in UK annuities.

The calculation of annuity yields is based primarily on: (1) mortality tables, (2) prevailing long term interest rates, (3) the insurance company's balance sheet and capital requirements, (4) the insurance company's tax position, and (5) the insurance company's corporate strategy. For example, one major insurer (Legal & General) has recently repriced its annuities, favoring smaller annuities; such a strategy helps develop a wide pool of annuitants and minimizes the adverse selection problems discussed above. In general, large annuities are offered at more favorable rates, which benefits the wealthier investor at the expense of those who have smaller pension policies. The reason for this is the relatively high cost associated with administering each new policy.

Annuity yields have been falling since 1990 in the UK; by 2000, they had fallen by over 30 percent. This trend is set to continue as longer term interest rates fall and companies readjust their mortality tables to take into account longer life expectancy. The government responded to the reduction in annuity yields by introducing income drawdown with the Finance Act of 1995. Income drawdown allows individuals with personal pensions to defer annuity purchase until age 75 and in the meantime invest in higher yielding assets. Income drawdown plans typically have reasonably high charges and hence are only economical for the relatively well-off.

The difference between the best and worst annuity yields can be as much as 50 percent over all the companies offering annuities; even across the top 10 providers, the difference can be substantial. These price differentials between suppliers are quite surprising, given there is almost no variation in the type of policy offered. There is a distinct absence of competition outside the few companies which compete at the very top of the annuity yield tables. Most companies make an active decision to offer unattractive annuity yields, thereby effectively staying out of the market. This leaves only a handful of companies in the UK now prepared to write new annuity business. Although companies wanting to attract new business will want to offer the best annuity yields, there must invariably come a point when some of these companies will either have written their quota or make a commercial decision to concentrate on other types of business which are subject to smaller long-term risks.

There was very little innovation in the standard annuity policy at first and, although companies such as Commercial Union, M&G, and the then Provident Mutual offered investment-linked annuities, these were restricted to their own policyholders. It was not until 1987 that Equitable Life launched a range of with-profit annuities and unit-linked annuities that were available to all retiring pensioners through the open market option. The other important recent developments in the annuity market included the introduction of inflation-linked annuities and impaired life annuities (see also Finkelstein and Poterba 1999).

Notes

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1. For a review of issues involved in the debate in the United Kingdom see Blake and Orszag (1997, 1998), and Finkelstein and Poterba (1999).

2. Income drawdown is also known as income withdrawal, pension fund withdrawal, or drawdown, cash withdrawal or capital withdrawal. For more details, see the Appendix.

3. These are broadly comparable with individual retirement accounts and 401(k) plans in the United States, respectively.

4. We assume for simplicity a flat yield curve.

5. An alternative way of writing Eq. (3) is:

$$P = \sum_{T=1}^{\infty} \left[d(1+r)^{-T} \right] \prod_{x=x_0}^{x_0+T-1} (1 - q_x^0 f^{x-x_0}) \quad .$$

6. The quoted improvement factors are in units of 20 years and need to be converted to one-year factors. This is done in our case as follows. For a 20-year improvement factor of 0.8, the one-year improvement factor is $0.8^{1/20}$. The lower bound on the improvement factor is the one-year improvement factor times $0.90^{1/10}$, while the upper bound is the one-year improvement factor times $1.10^{1/10}$; this converts a 10 percent forecast error either way over 10 years to the appropriate one-year forecast error.

7. Computed as $(10.9 - 10.3) / 10.6$.

8. We use the term "bound" to represent outcomes with typical historical forecast errors.

9. Currently, life companies are having to make annuity payments for two years longer than originally anticipated, according to UK industry information.

10. Only £10 million in single premium deferred annuities were issued in 1996, about one-eightieth of the level of single premium immediate annuities sold that year (Association of British Insurers 1997).

11. PMA80/PFA80 reflects the mortality experiences of pension annuitants subject to some degree of compulsion on annuity purchase. Adverse selection arises here as a result of: (1) commutation into lump sums, (2) choice of retirement date, (3) fund size at retirement, and (4) income drawdown election, all of which depend on individuals' private information. The IM80/IF80 tables, in contrast, reflect the mortality experiences of immediate annuitants who willingly purchase annuities; we have chosen instead to focus on the problem as experienced by typical pensioners.

12. This reflects mortality improvements since the PMA80 tables were constructed.

13. The United Kingdom Government Actuary's Department allows for a cost loading of 2 percent for the annuity purchase in its calculations for DC occupational schemes contracting out of the second state pension (SERPS).

14. There is an alternative way of dealing with the problem, namely for the government to select the population of pensioner annuitants as "the population" for which

it issues survivor bonds, but it is highly unlikely that any government would agree to do this, on the grounds that it may represent a substantial subsidy to the better-off members of society.

15. The risk associated with unexpected cohort longevity will likely be correlated with the tax burden of paying off this now more-costly survivor bond, and if older persons shoulder some of this risk, the Arrow-Lind theorem would be violated.

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