Department for Work and Pensions

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Survey of annuity pricing

Edmund Cannon and Ian Tonks

'…but if you observe, people always live for ever when there is an annuity to be paid them; and she is very stout and healthy, and hardly forty'

'An annuity is a very serious business; it comes over and over every year, and there is no getting rid of it.'

(Mrs Dashwood, Chapter 2, Sense and Sensibility, by Jane Austen (1811))

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Summary

Introduction and context

A conventional life annuity enables an individual to convert a stock of wealth (paid to a life insurer in a single premium) into an income that is received with certainty until the end of life. The advantage of such an annuity is that it insures the individual against out-living their wealth in the event of living longer than expected. Annuities represent the decumulation phase of a Defined Contribution (DC) pension scheme, and have been available in a variety of contexts since Roman times. They are of increasing importance in the UK because they form a large and growing part of the pension system.

As recently as a hundred years ago, nearly all workers would expect to earn a wage for almost their entire life and would usually only withdraw from the labour force as they became unable to work due to ill-health. Throughout the 20th Century this has gradually been replaced by a model whereby individuals stop working some time before the end of their life and while still relatively healthy. In many cases this long period of retirement would have been financed by a Defined Benefit (DB) occupational pension scheme, which involved the employer, albeit indirectly, continuing to pay a pension to the retired worker.

Greater mobility in labour markets has resulted in demand for more flexible pension provision from employees and greater longevity has made occupational DB pensions increasingly costly for employers (although this was masked by high equity returns towards the end of the 20th Century). Increasingly, therefore, workers have to save for a pension through a DC scheme. DC pension schemes first became a realistic option for retirement income with the 1956 Finance Act, which gave tax relief to such schemes but in return required the funds to be converted into an annuity at, or soon after, retirement. In the 1998 Green Paper *Partnership in Pensions*, the UK government re-emphasised its commitment to individual DC pensions via stakeholder schemes as a means of providing income in old-age.

The 1956 Finance Act introduced two major changes in the UK annuity market: the expansion of the existing annuity market (now called the 'voluntary-purchase'

market) due to a more favourable tax treatment of the capital sum; and the creation of a 'compulsory-purchase' market, selling annuities to those individuals who had taken out a tax-efficient DC personal pension. The prices of annuities differ in the two markets, mainly because average life expectancy of people buying these two sorts of annuity is different.

It is possible to project the demand for compulsory-purchase annuities from existing private pension and estimates by the Association of British Insurers (ABI) suggest substantial increased demand in the next decade: partly due to the increasing number of personal pensions, taken out since 1988, maturing; and also due to the switch from occupational DB to DC schemes.

Although the proposed A-day changes will reduce the compulsory annuitisation constraint to some extent, the magnitude of this change will be small and consequently it will still be important to have a well-functioning annuity market to provide pension income. This survey reviews the theoretical and empirical literature on the demand, supply and regulation for annuities to provide evidence for further policy review.

Annuity demand

The seminal work on annuity demand is the theoretical paper by Yaari (1965), which demonstrates the advantages of annuitisation and, thus, suggests that demand for voluntary annuities should be strong. His paper is highly stylised and assumes that there is a perfect range of annuity products available to savers.

Subject to the individual living, an annuity provides a higher return than a standard savings product, because the annuity is an insurance product in which the individuals who die early cross-subsidise those who survive – a phenomenon called **mortality drag**. The advantage of buying the annuity-type product is that it allows a higher level of consumption, because of the mortality drag.

In practice, annuities are less than perfect, because they are single premium products, which are irreversible and highly illiquid after the point of purchase. These disadvantages may offset the advantages of mortality drag. In addition to this, annuities are bond-backed products and have a lower expected rate of return than equity (although the latter is clearly more risky): some individuals may prefer to hold equity rather than bond-backed annuities. In principle they could hold equity-backed annuities, but, although such products do exist, few annuities of this sort are sold.

Description of annuity markets

The types of annuity sold in the UK depend partly upon supply and demand conditions in the market and partly on the regulations laid down by Her Majesty's Revenue and Customs (HMRC) on the sorts of annuity that can be purchased in the

compulsory-purchase market. The compulsory-purchase market is much larger than the voluntary-purchase market. In 2004 according to the ABI, premiums on newly purchased life annuity policies (voluntary market) were £56.4million, whereas premiums on new pension annuities (compulsory market) were £7,478million.

Nearly all annuities purchased in the UK – probably about 95 per cent – are paid for with a single premium (this follows automatically in the compulsory-purchase market) and most of these provide an income which is constant in nominal terms ('level' annuities), although other annuity products exist, for example, annuities which provide an income constant in real terms ('index-linked' annuities). Apart from the feature that they insure against longevity risk, both these types of annuity are very similar to government bonds: the income paid per month is constant and very secure. An alternative sort of annuity would pay a variable income per month dependent upon the investment performance of the equity market ('investment-linked' annuities). Compared with a more conventional annuity this would pay a higher income on average (since the average return on equity is higher than the average return on bonds), but it would be variable. Very few annuities sold are of this type.

One concern that annuitants might have, is the possibility of dying very soon after purchasing the annuity. This would mean *ex post* that neither the annuitant nor the annuitant's estate received much benefit from the transaction. It is an inherent feature of all insurance products that if the insured event does not occur, the insured person loses the premium: however, it is often thought to be particularly problematic in the context of annuities. Partly to allow for this, it is possible to have an annuity with a guarantee period (of up to ten years), in which case the income payments for the guarantee period are paid regardless of whether the annuitant is alive or not – if the annuitant dies then the payments are made to their estate. Under new legislation an alternative form of annuity will be available from 2006 called 'value-protected'. In this annuity product, the difference between the initial premium paid and the cumulated payments made to the annuitant (assuming this difference is positive) will be paid to the estate if the annuitant dies early, though the value protection element expires at age 75 under current legislation.

All of the annuities discussed so far involve the payment of a premium followed by the receipt of an income that starts immediately. 'Deferred' annuities involve payment of a premium followed by an income stream that only starts at some point in the future. Such annuities are virtually never purchased by individuals: instead they are purchased in bulk by firms as part of a process of closing an occupational pension scheme.

The price of annuities depends upon a variety of factors, which can be summarised as follows:

- prevailing interest rates at the time the annuity is purchased;
- information available to the life insurer about the life expectancy of the annuitant;

- the size of the premium paid for the annuity, which may also be related to life expectancy as wealthier individuals tend to live longer;
- the type of annuity purchased;
- the mark-up paid to the life insurer to cover its costs and profits.

We consider these briefly in turn.

Interest rates. We have already noted that an annuity is similar to a government bond and both for prudential and regulatory reasons life insurers tend to match their annuity liabilities either with government bonds or similarly safe assets such as corporate bonds or mortgages. Cannon and Tonks (2004a) show that much of the variation in voluntary-purchase annuity rates over the period 1957 to 2002 is due to changes in government bond rates.

Life expectancy. Annuity rates depend upon age at time of purchase and gender. Life insurers also offer better rates to people with lower life expectancy through either 'enhanced annuities' or 'impaired-life annuities' – the latter offer the best rates and must be certified by a doctor. It is also known that annuitants in the voluntary market have longer life expectancy than in the compulsory market and they receive lower annuity rates (or equivalently pay higher prices) in consequence. In all these cases the life insurer is able to observe characteristics of the annuitant that provide indications of their life expectancy. But a major concern is that there may be useful information about an annuitant's life expectancy which is known by the annuitant but not available to the life insurer: a case of asymmetric information. Individuals who know that they have a low life expectancy would have less reason to purchase an annuity and they might avoid doing so if possible, resulting in actual annuitants having different characteristics from the population as a whole. This is a potential reason for the much higher life expectancies observed in the voluntary market. Poterba and Finkelstein (2002) distinguish this example of adverse selection, which they call active selection, from passive selection. Active selection is when the annuitant purchases an annuity because of private information about life expectancy. Passive selection is when individuals with characteristics that are correlated with life expectancy (such as risk aversion or wealth) purchase annuities. Selection effects of whatever type will be less severe in the compulsory-purchase market.

The size of premium. Most annuity providers currently offer less favourable annuity rates (charge higher prices) to small annuity purchases (a premium of less than £20,000 in the compulsory purchase market) and this has also been true in the voluntary market over the last fifty years. This may be due to fixed administrative cost of setting up an annuity. However, the Prudential, which is both the largest annuity provider and the largest seller of annuities with a small premium, does not offer lower annuity rates to small purchasers, so it is not clear that poorer annuitants are more costly for providers. Some annuity providers offer lower annuity rates when the premium is very large, possibly because a large annuity premium is a signal that the annuitant is rich and, therefore, likely to have above average longevity.

The type of annuity purchased. An important comparison is between level annuities and either index-linked or escalating annuities (at current inflation rates these two are very similar). In July 2005 a premium of £100,000 would buy a 65-year old man either a constant monthly income of £513 or a monthly income which started at £366 per month but grew over time (so that eventually it was greater than £513). A direct comparison of these annuities is impossible, so Finkelstein and Poterba (2002) calculate and compare the expected present value of these products. They find that the present value of level annuities is higher than the present value of the escalating or indexed annuities. This may be due to there being higher costs of providing escalating or indexed annuities, due to an absence of matching index-linked assets for the annuity provider to purchase, which is not fully taken account of in Finkelstein and Poterba's calculations. A second explanation may be due to myopia, but need not be irrational since relatively short-lived individuals are unlikely to live long enough to benefit from the inflation protection This would be a further example of the phenomenon of adverse selection, where individuals have better knowledge about their life expectancy than the life insurer. Because these different types choose to buy different types of annuity, life expectancy varies systematically with annuity type and life insurers price their annuities accordingly. Unfortunately, life expectancy data are not easily available by type of annuity purchase, so this cannot be tested directly.

The life insurers' mark-up. If annuities were sold at a price that was perfectly actuarially fair then the expected net present value of the income stream should equal the premium paid. Of course, the ratio of the expected net present value to premium, usually called the 'money's worth', will have to be less than one so that the life insurer can cover its costs and make a normal profit. A variety of studies conducted on different countries and for different time periods suggest that the money's worth is usually in the range 0.85 – 1.05. Values in excess of unity suggest that life insurers were making losses; alternatively they were either using different actuarial projections or had access to better interest rates than assumed in the money's worth calculations. These results do not suggest an excessive mark-up. If we compare the money's worths calculated on both population mortality and annuitant mortality, the reduction in the money's worth due to adverse selection (i.e. short-lived individuals withdrawing from the market) appears to lie in the range 0.03 – 0.12. This suggests that less than 0.1 (ten per cent) of the money's worth is absorbed by life insurers' costs and profits.

The annuity puzzle and reasons

Given Yaari's result, the fact that annuity demand is typically low (i.e., the voluntary-purchase market is small) constitutes the 'annuity puzzle'. This puzzle in the voluntary market could provide relevant insights as to why the annuitisation requirement of pensions is unpopular and how people will react to the small relaxation of this requirement following A-day. Of course, the UK annuity market is dominated by the compulsory-purchase market where individuals have chosen to

save for a pension, but *ex ante* they may prefer to hold their pension wealth in non-annuity form. In this section we consider possible reasons why this may be the case.

One possibility is that individuals wish to bequeath wealth to others, which would result in a low demand for voluntary annuities. Attempts to measure the importance of this motivation include both econometric analyses of actual annuitisation decisions in the US (where annuitisation is voluntary) and on questionnaires surveying people's attitudes to bequests. In both types of study the evidence is mixed and other factors also appear very important, in particular the individual's health and life expectancy. This reinforces the view that selection effects are present in the annuity market.

Perhaps a more important consideration is that for many individuals the choice is not between annuitising or not annuitising but deciding whether to purchase additional annuitisation to that provided by the state pension (and any DB pensions that the individual may have as well). Calculations by the Pensions Commission (2004), which have been confirmed by the more recent Institute of Fiscal Studies (IFS) (2005) study, suggest that the present value of the state pension considerably exceeds all other pension wealth for a high proportion of UK individuals. For such individuals the marginal utility of annuitisation might then be relatively low and this would explain the small demand for voluntary annuities.

The incentives to purchase an annuity could also be influenced by means-testing of benefits, but the effect of this is likely to be small for most individuals since benefit entitlements depend upon both private income and capital and the effect of annuitisation is simply to turn a stock of capital into income. In the compulsory purchase market, there is only a choice to buy an annuity if the pension fund is very small: the current limit is about £5,000 (based on an annual income of £260) and this will rise to £15,000 under the 2006 A-day changes. Depending on their circumstances, individuals with pension funds in this range might find that the effect of means-testing would mean that it is preferable to continue to hold pension wealth as capital rather than convert it into an income. However, the pension fund would still be liable to tax and such individuals would also face means-testing if their total capital exceeded £16,000 (the current limit for Housing Benefit (HB)). So the total effect of means testing on the annuity decision is likely to be neutral.

There are also strong advantages for individuals with known lower life expectancy to avoid purchasing an annuity. Since individuals are likely to have better information on their life expectancy, this leads to adverse selection and may reduce demand for annuities, although in the compulsory purchase market it is only possible to limit one's annuity purchase (i.e. by deferring annuity purchase or choosing an annuity with a guarantee period). The evidence of Finkelstein and Poterba (2002) is consistent with long-lived individuals choosing different annuity types to short-lived individuals.

It is well-known that the expected return on equity is much higher than the return on bonds (typically five percentage points per annum) and this premium appears too

high merely to compensate for the additional risk (although this is more controversial). So pensioners might rationally prefer to hold equity to an annuity since they would earn a higher rate of return. However, since mortality drag rises with age, at some point the equity premium will be outweighed by the mortality drag. This suggests there must be an optimal age to annuitise, which Milevsky (2002) calculates to be about 75, the current statutory age, although this depends upon individuals' attitudes towards risk.

All of the results discussed so far have assumed a particular class of models of economic behaviour. However, more modern economic analysis is increasingly looking at more sophisticated psychological representations of savings behaviour, such as habit formation, loss aversion and framing effects. All of these may provide reasons why demand for annuities is low (such low demand may be rational or irrational depending upon the model). One rational reason for avoiding annuitisation is the illiquid nature of conventional annuities: although pensioners typically have lower consumption than those in work, they may wish to reduce their consumption slowly (due to the habitual nature of consumption patterns) and a constant income stream is not well-suited to this. There is some evidence that individuals who choose to annuitise are happier *ex post facto* although whether this is due to irrationality, selection effects or some other cause is unclear.

The supply of annuities

We have noted above that, for whatever reason, nearly all annuities sold in the UK market are level annuities and very few are equity-type products. This means that UK life insurers have annuity liabilities that are very similar to bonds and hence they match these liabilities with large holdings of government bonds, augmented by close substitutes such as corporate bonds or mortgages.

The supply side of the annuity market can thus be characterised as the insurance industry taking an input (bonds), adding value by dealing with longevity risk, and creating annuities as an output. This means that the supply of annuities depends upon the availability of inputs (bonds and near substitutes) and the success with which the insurance industry can cope with longevity risk.

Regarding inputs, the availability of government bonds is determined by the overall size of the national debt, which is currently low by historical standards: the Government is committed to keeping it at this level in the future with a long-run ceiling of 40 per cent. The precise composition of the national debt is determined separately by the Debt Management Office, but in the long term this is probably less important than the overall total (for a given total debt, issuing more very-long-term debt now would reduce the possibility to issue extra long-term debt in the future). Wadsworth (2005) suggests that there may be a shortage of long-term government debt available for life insurers relative to potential demand. Government bonds can be supplemented by corporate bonds, although corporate treasurers are unwilling or unable to provide significant quantities of long-dated indexed bonds. There is

also some opportunity to securitise mortgages, but this is constrained in the UK by the fact that most mortgages are variable interest and there is additional pre-payment risk: only one major insurance firm (Norwich Union) really uses this option, it uses commercial mortgages with fixed interest rates.

This suggests that the projected increased demand for annuities may not be matched by increased supply of long-term bonds and this may result in lower interest rates and lower annuity rates. This would not cause problems for the insurance industry *per se*, but it would result in lower pension incomes, which would be of concern for public policy.

Turning to the effectiveness of the life insurance industry, a potential cause for concern is the high concentration of annuity providers, with the Prudential accounting for 40 per cent of the new sales of annuities and a five-firm concentration ratio of 70 per cent. However, the fact that the money's worth is only a little less than unity suggests that monopoly power is not in operation. Interestingly, the money's worth in the voluntary purchase market doesn't appear to have changed in the last 40 years, despite increasing concentration.

The possibility of other forms of market failure is limited by strict regulation of the industry. The Financial Services Authority (FSA) regulates both the presentation of information to consumers (to increase consumers' understanding of the product) and also the reserving and capital requirements of life insurers. The latter requirements are at the aggregate firm rather than the product level to ensure overall solvency. FSA solvency requirements are risk-based principles analogous to the three pillars in the Basel 2 reforms for the banking industry and anticipate the European Union (EU) Solvency 2 requirements for the insurance industry. HMRC and, to some extent, the Department for Work and Pensions (DWP) also regulate the types of annuity provided.

Our discussion suggests that life insurers are largely able to hedge interest rate risk through matching annuity liabilities with appropriate assets (even if the price paid for this hedging may change over time as demand for annuities increases). This means that the major additional source of risk is changes in cohort longevity risk. From the point of view of the consumer, the main advantage of the annuity is to insure against personal (idiosyncratic) longevity risk and insurance companies are sufficiently large that this is not an issue. However, cohort longevity risk is borne by the life insurer.

There are three potential routes by which life insurers can reduce their exposure to cohort longevity risk: The first is for insurance companies to buy longevity bonds. These are bonds whose coupons fall gradually over time in line with longevity (so for example, the coupon payments could be a constant multiplied by the proportion of individuals still surviving in an appropriate reference cohort). Increases in cohort longevity would result in higher coupon payments. To the extent that the longevity experience of a life insurer's annuitants matched that of the reference cohort, this would be an excellent hedge for annuity liabilities. However, the supply of these

bonds is minimal and an attempted issue by BNP Paribas and Partner Re in 2005 has not been successful to date. Index-linked government bonds also took time to gain acceptance in the 1980s, so perhaps investors need time to adjust to this sort of bond innovation.

The second possible method is to pass the risk on to reinsurers: the effect of this is to spread the risks more widely within the whole insurance industry. Wadsworth (2005) expresses concern that relatively few reinsurers are willing to take on longevity risk (perhaps two or three firms are significantly involved), but Powers and Shubik (2005) show that this would naturally arise in a market where there are only about eight or nine large primary insurers. However, the market for reinsurance is really only effective if different insurance companies' risks are independent (or at least only weakly correlated) and this would seem unlikely. Further, a reinsurer could issue a mortality bond. Whereas with a longevity bond the coupons gradually **fall** over time, a mortality bond has coupons that **rise** over time: these could rise in line with the proportion of individuals from a reference cohort that has **not** survived. With a mortality bond the effect of an increase in cohort longevity is to **reduce** coupon payments (whereas with a longevity bond an increase in longevity increases coupon payments). A reinsurer would be able to buy conventional bonds and then use the proceeds to sell reinsurance to an annuity company and sell mortality bonds to other investors. An increase in cohort longevity would then result in higher payments to the annuity company and lower payments to the investors holding the mortality bond, so the reinsurer would be hedged. Because the longevity risk is uncorrelated with stock and bond returns investors may be prepared to hold this to reduce the risk of their overall portfolio so long as there was a sufficiently high premium. Cox and Lin (2004) cite the issue of a similar bond by Swiss Re in 2003 as an example.

The final method would be for annuity payments to be conditional on the survival of the reference population. In this way cohort longevity risk could be loaded on to the pensioners themselves, through annuities whose annual payments changed in line with cohort longevity

Despite these potential solutions to the issue of cohort longevity risk, it has to be noted that the market for them is currently very small. In any case these solutions would not be applicable for the insurance of cohorts who will retire in the distant future: realistically these risks have to be borne by future generations.

Conclusions

We have provided a survey of the UK annuity market, set against a background of a tripling of demand for compulsory purchase annuities over the period 1991 to 2004, as increasing numbers of people with defined contribution pensions retire. This demand is projected to double again over the next decade.

The market for annuities appears to function satisfactorily: analysis of the money's worth suggests no evidence of monopoly pricing of annuities, and the providers have absorbed the growth in annuity demand to date.

However, there are a number of issues that policymakers need to be aware of:

- the number of annuity providers has fallen significantly over the last fifty years: there are currently fewer than twenty annuity providers writing new business, but one firm (the Prudential) accounts for 40 per cent of this market. Despite this, there is no evidence of abuse of market power;
- the small number of providers also means that the cohort longevity risk is highly concentrated in a small number of firms, and there is a question whether these providers have the capacity to absorb the extra risk associated with increased annuity demand. If this limited number of firms were not able to bear the total longevity risk, then mechanisms would need to be found for this risk to be held elsewhere. Possible candidates are:
  - individual investors or other financial institutions, who would hold mortality bonds (issued by reinsurers) in a diversified portfolio;
  - the government, or other bond issuers, by issuing longevity bonds; and
  - the annuity holders themselves, by making the annuity payments conditional on cohort survival rates;
- annuity providers would be better able to minimise the risks of an asset-liability mismatch by the availability of more long-term government bonds. The Debt Management Office's (DMO's) new issue of longer term gilts has addressed this problem to some extent;
- demand for voluntary annuities is low, and this appears to be due to a combination of rational reasons due to the inflexible nature of existing annuity products, and a misunderstanding of the nature of mortality drag. Better explanations of the annuity products may reduce this second type of annuity aversion.

1 Introduction

The purpose of this report is to survey the economic theory of the supply and demand for annuities and to examine the factors that are likely to affect annuity markets in the near future. It is predicted that the demand for annuity products will increase due to the demographics of an ageing population, and because of the continuing shift of workers between Defined Benefit (DB) and Defined Contribution (DC) pension schemes. The supply situation is more complicated because current annuity products are based on bonds and the state of the bond market is determined, to a large extent, by the UK government's policies on the size and management of the national debt.

A life annuity converts a stock of wealth at retirement into a flow of income that is payable to the annuitant until death. An annuitant pays a **premium** to a life-assurance company who then undertakes to pay an agreed income to the annuitant, usually on a monthly basis. Because the life annuity is paid until the annuitant dies, it insures them against longevity risk, or in other words, it insures them against running out of savings to support consumption expenditure in old age. As with all insurance products, the effect is to re-distribute between individuals: those who are unlucky – paradoxically in this case it is unlucky to live too long – are subsidised by those who are lucky (i.e. those who live for a relatively short period).

Annuities are purchased as part of a pension. In the standard life-cycle model, during the early part of their life, individuals make labour supply decisions and consume and save to maximise permanent lifetime income and they may also wish to save in a pension scheme for tax-efficiency reasons. This period of savings is referred to as the **accumulation** phase of a pension scheme. From retirement onwards individuals cease working and consume by running down their savings. This period is called the **decumulation** phase of a pension scheme and with personal pensions and DC occupational pensions it involves converting the value of the pension fund into an income stream: the annuitisation decision.

In Chapter 2 we document the historical development of annuity markets, and explain how it functions in relation to the UK's overall pension system. We explain that the 1956 Finance Act introduced two major changes in the UK annuity market:

the expansion of the existing annuity market (now called the 'voluntary-purchase' market) due to a more favourable tax treatment of the capital sum; and the creation of a 'compulsory-purchase' market, selling annuities to those individuals who had taken out a tax-efficient DC personal pension. The number of annuity contracts being sold in the compulsory market is growing as an increasing number of personal pension policies mature; the number of new contracts sold in 2003 was 341,000, up from 120,000 in 1993 (ABI, 2004). This growth will continue in the near future and will be augmented by the demand for annuities from people who are transferring from DB to DC schemes. The proposed A-day changes to the taxation of pensions from April 2006 and the introduction of more flexible drawdown products will reduce the compulsory annuitisation constraint slightly. Therefore, understanding the supply and demand for both voluntary and compulsory annuities is an important component of pension policy.

Yaari (1965) demonstrates that a risk-averse individual who is concerned about longevity risk (uncertain length of life) will always purchase actuarially fair annuity contracts, enabling them to smooth consumption in every period of retirement. We will explain Yaari's annuitisation result in Chapter 3, but note that this depends upon a variety of considerations and does not square with the evidence that actual annuity markets are small (Friedman and Warshawsky, 1988, 1990, and Mitchell, Poterba, Warshawsky and Brown, 1999). In Chapter 4 we outline the different types of annuity product that are available, and report on evidence documenting annuity prices quoted by annuity providers and the movement in average annuity prices over time.

One reason for individuals avoiding the purchase of annuities would be that the products were mispriced. In Chapter 4, we explain the **money's worth** calculation of annuities, and show how selection effects might distort annuity prices. While there is strong evidence to suggest that annuities are probably priced slightly higher than would be suggested by actuarial considerations, estimated mark-ups (sometimes called **loadings**) do not seem excessive compared with the cost of other financial services. There is little evidence to suggest that annuities are over-priced due to monopoly power.

There are a variety of reasons why it may be rational to avoid full annuitisation and we discuss these in Chapter 5, although it is important to stress that apparent dislike of annuitising may be due to lack of comprehension or to psychological reasons that are not strictly rational (i.e., they are irrational in the sense that they do not maximise income in the best possible way).

Annuities are supplied in the UK by life-assurance companies who match their annuity liabilities with bonds or similar assets. The reason for this is that annuities typically pay a constant stream of income and, absenting mortality considerations, an annuity product is very similar to a bond product; it is also possible to have annuity-type products which are more similar to equity, but this market is under-developed. Given the current types of bonds purchased, life assurers can be seen as

producers who take bonds as an input and produce annuities as an output. This raises two issues, which we discuss in Chapter 6:

First, a significant determinant of annuity rates is the economy-wide interest rate, in particular the bond market. Since rates of return on bonds are currently low it follows that annuity rates are also low. Of course, low bond yields are the result of a variety of factors, including overall government borrowing, monetary policy, international rates of return and the low inflation environment since the mid-nineties. So it is possible – at least in principle – that the government could influence annuity rates through either monetary or fiscal policy. In practice, however, these policy instruments are used to meet other objectives and monetary policy is undertaken by the Bank of England. Furthermore, the long-run effects of government policy on both the level and shape of the term structure of interest rates – especially if we consider real rather than nominal interest rates – are not well understood by economists. To survey these issues would be beyond the scope of this survey.

Secondly, life assurers are assuming overall cohort mortality risk when they issue annuities, since they bear the cost of overall increases in life expectancy. It is currently very difficult to hedge this risk, due to a paucity of matching assets and a thin reinsurance market.

In Chapter 7 we provide our conclusions on annuity pricing in the UK. We note that while annuity products continue to be an important component of the UK pensions system, there are potential problems on both the supply and demand side.

2 History of annuities and the UK context

In this chapter we document the historical development of the UK annuity market, and explain how it functions in relation to the UK's overall pension system. We explain the difference between the **voluntary-purchase** annuity market and the **compulsory-purchase** annuity market. The latter was introduced by the 1956 Finance Act which required that individuals who had taken out a tax-efficient defined contribution (DC) personal pension, would be required to annuitise their fund at retirement.

The existence of annuities can be traced back to Roman times and a table of annuity rates calculated by Domitius Ulpianus from about 230 AD was used as late as the early modern period in Europe (Haberman and Sillett, 1995; Dyson, 1969). Annuities were used throughout the Middle-Ages and became popular with governments in the 17th Century as a method of raising money. The bases of modern actuarial science were developed during the eighteenth and nineteenth centuries alongside advances in probability theory and increasing availability of empirical mortality tables (Poterba, 2004). Because annuity products are illiquid, the UK government stopped using annuities as a primary means of finance from the 1690s onwards, converting the national debt into equity and bond instruments between 1694 (with the foundation of the Bank of England) and 1753 (with the consolidation of government bonds into a uniform issue of perpetual bonds – consols). Annuities were then increasingly issued by private companies, such as the Equitable Life Assurance Society (founded in 1762), and from then into the 19th Century there was a continuous growth of life-assurance companies and societies (although predominantly concerned with life assurance rather than annuity business).

The government continued to sell small quantities of annuities and life insurance as a means of financing the national debt, but increasingly realised the possible benefits of annuities, especially deferred annuities purchased with multiple premiums, to assist the elderly poor and sought to encourage sales by allowing sales through friendly societies (1819) or savings banks (1833) (Wilson and McKay, 1941). Gladstone introduced legislation in 1864 to sell annuities and life insurance through

the post office, primarily due to the financial weakness of savings banks (Morley, 1903). Additional stimuli for the legislation were elements of empire building within the post office and paternalism towards the poor (Perry, 1992).

The provision of government annuities through the post office meant that the government was engaged more directly in competition with both private life assurers and friendly societies. These were politically powerful enough to ensure that minimum and maximum limits were placed on life insurance sales to restrict effective competition, but the restrictions on annuity purchases were less important. However, sales of immediate annuities from 1865 to 1884 only numbered 13,897 and deferred annuities for the same period were even fewer, totalling 1,043 (Perry, 1992). Even after the removal of the restrictions in 1882, sales remained poor: by 1907 the total number of insurance policies in force was 13,269 at the post office compared to 2,397,915 from life-assurance companies (Daunton, 1985). This was despite government insurance being sold at better prices and being virtually immune to default risk. With continuing low sales of both forms of insurance, and losses on government annuities, sales ceased in 1928.

There appear to be several reasons for the failure of the scheme to sell government annuities:

- problems in poor people managing to save sufficient wealth in the accumulation phase: these problems were shared, to some extent, by friendly societies too (Johnson, 1985);
- bureaucratic procedures needed to purchase government annuities, an absence of marketing and restricted availability (annuities could not be purchased at all post offices);
- the absence of salesmen to collect premiums on a regular weekly basis. Private insurance companies had large sales forces to collect premiums and sign up new members. A very large number of policies lapsed soon afterwards, strong evidence for unscrupulous sales techniques (Wilson and Levy, 1937). The costs of these insurance salesmen were very high, amounting to nearly half of the premiums that they collected, but insurance companies were able to offset this disadvantage compared with government policies by investing in assets with much higher returns.

The cessation of sales of government annuities may have had some effect on the private market (Norwich Union started selling annuities again in 1928), but by this time two further considerations also reduced demand for annuities. Many workers were now in either occupational pension schemes or state pensions. Among the more affluent middle classes demand would have been reduced by the tax treatment of annuities; the entire annuity payment was treated as income and taxed accordingly, despite the fact that some of the annuity payment was implicitly capital.

In the middle of the 20th Century the annuities market was finally given a boost

under the 1956 Finance Act which implemented the main recommendations of the 1954 Millard Tucker No. 2 Committee on the introduction of tax-efficient personal pensions for the self-employed. This meant that the self-employed were treated the same as the employed sector who had enjoyed the benefits of tax efficient occupational pension schemes for a number of years.

Following the Act, individuals could obtain tax relief on contributions into an **approved** pension contract, and at retirement would be required to annuitise the fund that had been built up. Further, the returns to investments in the pension fund of life-assurance companies during the accumulation part of the pension contract would be exempt from tax. An additional part of the 1956 Act also affected the tax treatment of voluntary annuities: a fixed proportion of the annuity payment for purchased life annuities was to be regarded as a run-down of capital, and an annuitant would only be liable for income tax on the balance. These changes stimulated the demand for annuities in the UK, and Table 2.1 shows the sales of voluntary annuities averaged over five-yearly intervals from the 1950s to the present day. The numbers of annuities purchased each year vary greatly, though the value of the lump sum used to purchase an annuity contract has grown steadily from £106million in the late 1960s to £650million in the first half of the 1990s. The overall trend increase during this period was due to the increase in private pensions that were reaching the point of retirement. Subsequently (in the latter half of the 1990s), the value of annuities premiums fell, due to falls in the stock market.

The 1956 changes introduced a new compulsory-purchase annuities market for those who had built up a personal pension fund, distinct from the existing voluntary annuities market. As noted in Finkelstein and Poterba (2002), these are likely to be quite different markets: only individuals who expect to live for a long time are likely to purchase a voluntary annuity, whereas compulsory annuities are purchased as part of the terms of the pension contract. Typical voluntary annuitants are female and relatively old (over 70), whereas typical compulsory annuitants are male and recently retired (about 65).[1]

Hannah (1986) explains the evolution of a tax-free lump sum of 25 per cent of the pension fund. *'The chapter of accidents which led in absurd progression to this situation,* [the tax-free lump sum] *which was initially desired by no one, began in the early years of [the 20th] century'* (Hannah, 1986, p.115). He notes that at the turn of the last century, occupational pensions varied widely in whether they paid a pension as a lump sum or as an annuity. There were arguments that suggested a lump sum would ease the progression from working to retirement, but against this was the concern that a lump sum would be frittered away. The Radley Commission on the Civil Service said in 1888: *'The payment...of a lump sum is open to the obvious*

[1] Evidence for this can be found for an example life assurer in Finkelstein and Poterba (2004), discussed in Chapter 4. Crude calculations based on the Continuous Mortality Investigation Bureau reports confirm that this generalises to other companies.

objection that in the event of improvidence or misfortune in the use of it, the retired public servant may be reduced to circumstances which might lead to his being an applicant for public or private charity'. The Tax-Exempt (1921) Act occupational directed that funds were not allowed lump sums by the Inland Revenue,[2] though they could be paid by the pension out of non-tax exempt funds. Meanwhile the Civil Service, in 1909, had negotiated a tax-free lump sum, to ensure comparability with widows' pension rights in the railway pension schemes, and in the course of these negotiations the tax-free lump sum was extended to surviving pensioners at retirement age. The Inland Revenue were asked to agree to this scheme. The 1947 Finance Act attempted to clamp down on the proliferation of schemes that had attempted to get round the 1921 Act, and abolished all tax-free lump sums except those that were 'reasonable'. The 1956 Act which introduced personal pensions, explicitly did not allow for tax-free lump sums, but pressure from private sector schemes to mimic the 'reasonableness' of the Civil Service scheme meant that from 1970, all schemes were explicitly permitted to pay tax-free lump sums from untaxed funds. In 1971 one-third of private sector schemes paid a lump sum as part of the pension entitlement. This proportion had risen to more than 90 per cent by 1979.

Immediately after its introduction in 1956 the compulsory-purchase annuity market had zero sales, since it would have been the young working cohort in the late 1950s who would have started saving through a personal pension, and it is unlikely that this cohort would have annuitised immediately. By the 1990s this compulsory annuity market was ten times larger than the voluntary annuities market, and will continue to grow as the percentage of the population with personal pensions grows. Table 2.1 also records the growth in personal pensions throughout the second half of the last century.

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[2] The Inland Revenue has now been subsumed into Her Majesty's Revenue and Customs (HMRC) and, where there is no obvious anachronism, we shall refer to it by the later name.

Table 2.1 Growth in number and value of purchased life annuities, pension annuities and outstanding personal pension schemes 1954-2000: annual averages over successive five-year periods

	1954/55	1956/60	1961/65	1966/70	1971/75	1976/80	1981/85	1986/90	1991/95	1996/00
Panel A: New purchased life annuities immediate and deferred)										
Number of new annuity policies per year (000s)	.	.	.	33.8	173.2	67.6	84.2	67.8	65.4	13.8
Premiums on new immediate annuity policies (£m)	.	.	.	106.0	235.3	159.6	394.5	432.2	650.4	444.8
Annuity pay-outs per annum (£m)	0.7	1.6	.	12.7	44.0	25.1	66.2	80.5	129.8	43.8
Panel B: New pension annuities										
Premiums on new immediate pension annuities (£m)							2,794.6	5,178.4		
Pension annuity pay-outs per annum (£m)								276.4	440.0	
Panel C: Personal pensions in force										
Number of policies (000s)	.	83.9	.	.	620.0	1,309.4	3,151.4	8,835.2	17,916.0	20,634.8
Yearly premiums (£m)	.	10.6	.	.	68.0	212.6	758.1	2,451.6	4,876.2	6,277.3

Source: Life Offices' Association; Association of British Insurers.

An important consideration is how private pensions interact with the state pension and how different private pensions can interact with each other. To discuss this, it is useful to characterise the UK pension system as having several components.[3]

- The Basic State Pension (BSP). This is paid weekly and payments depend upon the number of national insurance contributions made by a pensioner: for a married couple it depends on total contributions. The value of this in 2005 was £82.05 per week for a single individual, or £4,267 per year.[4] Since 1979 the BSP has increased in line with inflation rather than with earnings and has accordingly become increasingly small compared with income from other sources, although this tendency to decline relative to earnings has been attenuated by some discretionary increases since 1997.
- The State Second Pension (S2P). This is an additional unfunded state pension, which is compulsory unless one opts out either into a private pension scheme or into an occupational pension scheme. The addition to the BSP began in 1977 and was called the State Earnings Related Pension Scheme (SERPS). From 2002 the additional pension, S2P, was no longer wholly earnings-related, with benefits skewed towards those with low earnings and the inclusion of carers and disabled people. Unfortunately there have been several revisions both to how SERPS was administered and the degree to which the government of the day was committed to the scheme. The Pensions Commission (2004) characterises these schemes as highly complicated and difficult to understand, even for professionals, and this contributed to mis-selling scandals when individuals were encouraged to opt out of SERPS who should not have done so.
- The Pension Credit. This dates from 2003 and supersedes the MIG. This ensures that pensioners receive a minimum level of income, £109.45 per week (or £5,691 per year) in 2005 for an individual. The original MIG was designed with a withdrawal rate of 100 per cent, so that for every extra £1 income that a pensioner had up to a total (including the BSP) of the MIG, they received a lower contribution. Under the current system the withdrawal rate is 40 per cent, implemented through a scheme called the Saving Credit. The interaction of the BSP, the Pension Credit, the Saving Credit and any other source of income (whether earned or pension income) for an individual who has the full basic state pension is shown in Figure 2.1. This diagram ignores taxation, any other benefits that an individual might receive and any means-testing based on the amount of savings (capital) that the individual might have.

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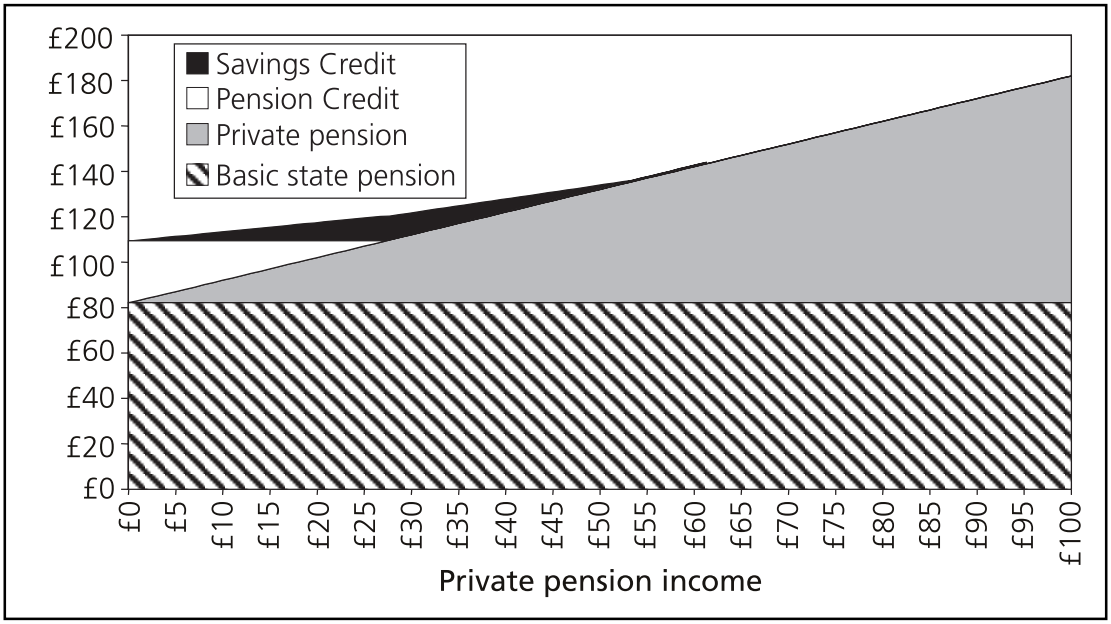
[3] There is some overlap with our characterisation and that of the 1994 World Bank Report *Averting the Old Age Crisis*, which defines a first pay-as-you-go pillar; a second compulsory and funded pillar; and a third voluntary and funded pillar. The most recent World Bank thinking has suggested two more pillars: a basic income and minimum health care (Holzmann and Hinz, 2005). The first of these two additional pillars corresponds partly to the UK minimum income guarantee (MIG), although the UK MIG is means-tested.

[4] Department for Work and Pensions (DWP) Social Security Benefit Rates Leaflet GL23 April 2005.

Figure 2.1 The interaction of state and private pensions



- Occupational and personal pension schemes. Occupational pension schemes are usually **funded** and require contributions (out of pre-tax income) throughout the employees' working life. The fund accumulates over time, and then is converted into a pension on retirement. Occupational schemes are provided by an employer and may pay on a **defined benefit** (DB) or a **defined contribution** (DC) basis. DB schemes offer a pension, guaranteed by the employer, usually defined in terms of some proportion of final year earnings, and are related to the number of years of employment. DC (or money purchase) schemes are always funded and convert the value of the individual's pension fund at retirement into an annuity. Under a DB scheme, the employer bears the risk of fund underperformance, while under DC schemes, the pensioner bears the risk of fund underperformance. In addition, a DC plan also exposes the pensioner to the risk of converting the fund into an annuity at a particular point in time.[5] In contrast, in a DB scheme the individual is promised a pension for each year of service, and this pension promise is equivalent to a deferred annuity.
- Occupational pension schemes for public sector workers are different from those for private workers since some are unfunded and are paid out of taxation. Where public sector schemes are funded, there may be explicit guarantees from the government to make up any shortfall in the event of one occurring.

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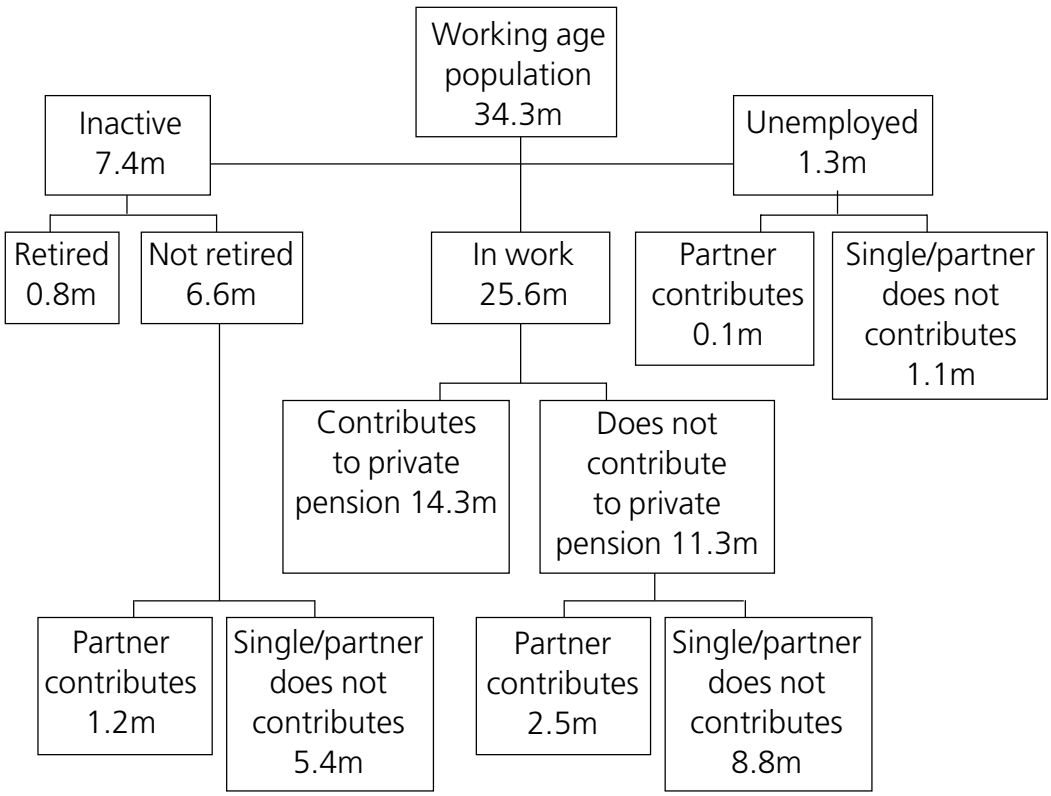
[5] The 1995 Pensions Act allows a pensioner to defer the conversion of the fund into an annuity up to the age of 75, and in the meantime 'draw-down' the fund to provide an income. There are limits on the speed at which the fund can be decumulated in this period. The administrative costs of draw-down means that it is only an option for the better off.

In the tax year ending in April 2003, 28.66million people paid national insurance contributions which will entitle them to some part of the BSP at retirement.[6] The numbers of the working population covered by a private pension is given in Figure 2.2. This shows that out of about 35million people of working age, roughly 25million are in work, but of these, nearly nine million people do not contribute to a private pension.

Figure 2.2 Participation in private pension schemes 2002-03, millions



Source: Pension Commission (2004)

Those individuals with personal pensions who are only receiving contracted-out rebates have been counted among non-contributors since they will only accrue pension rights equivalent in value to the SERPS/S2P rights foregone (assuming that GAD calculations of appropriate rebates are fair).

As the numbers of inactive and unemployed individuals contributing to stakeholder pensions are small (fewer than 0.1m in FRS) they have been ignored for the purposes of this analysis.

Figures may not sum due to rounding

[6] Annual Abstract of Statistics, 2005 Table 10.2.

Up until the 1980s pension provision had been a fundamental bedrock of the welfare state. Concerns about the state's ability to pay for the state pension commitments coupled with the demographic trends of an ageing population, resulted in a change of policy in the 1980s, with an emphasis on the private sector provision of pensions. The Government Green Paper 1998 reported that in 1960 there were over four people of working age for every pensioner; but by 2060 it is projected that there will only be two-and-a-half people of working age for every pensioner. The implication is that a declining workforce will have to support a growing number of pensioners.

The Government Pension Green Papers of 1998 and 2002 both emphasise that the state provision of pensions will decline, and individuals will be expected to contribute to third-tier schemes.

> *'Those who are able to save for their own retirement should do so. For this,* […] *the right schemes* [need] *to be available and affordable; to be able to cope with flexible working and variations in earnings* […]*. The current pension system does not meet these needs. Occupational pensions are usually good value and secure and are generally the best choice, but they are only available if the employer offers one, and can be unsuitable for those who move jobs frequently* […]*. At the heart of our reforms are new stakeholder pension schemes.'*
>
> (Department of Social Security, 1998, Cm 4179, p.5)
>
> *'From the late 1980s, however, there has been a shift towards defined contribution occupational schemes. By 2000, around 16 per cent of private sector occupational scheme members, and nearly 70 per cent of all private sector occupational schemes, were based on defined contributions. The late 1980s also saw the launch of personal pensions.'*
>
> (Department for Work and Pensions, 2002, Cm 5677, pp.51-52, ¶16).

Concurrent with this government's view that pensions should be provided in the private sector, there has been a large decrease in the number of workers covered by occupational DB pensions (The Pensions Commission, 2004). This sudden reduction has arisen for several reasons:

First, the generosity in the 1990s of private occupational pensions was largely driven by a very strong stock market, which may have masked the extent to which underlying trends in labour markets were removing the incentives to employers to provide such schemes. Thus, the extent and speed of the fall in occupational pension provision is more obvious than might have been the case if the stock market had been less buoyant.

Second, the introduction of FRS17 reporting requirements making firms' pension liabilities explicit and the removal of Advanced Corporation Tax were further discouragements to the provision of occupational pensions, since they increased the risk to firms and raised costs.

Finally, changes in labour markets have made the provision of an occupational pension a less useful device for firms to motivate workers (McCarthy and Neuberger, 2003, Chapter 3), since occupational pensions are of less value to workers who expect to move firms more regularly. Conversely, more mobile workers would prefer a portable personal pension. Enthusiasm for occupational pensions may also have been undermined by the Maxwell scandal as well as more recent instances of firms being unable to honour pension promises.

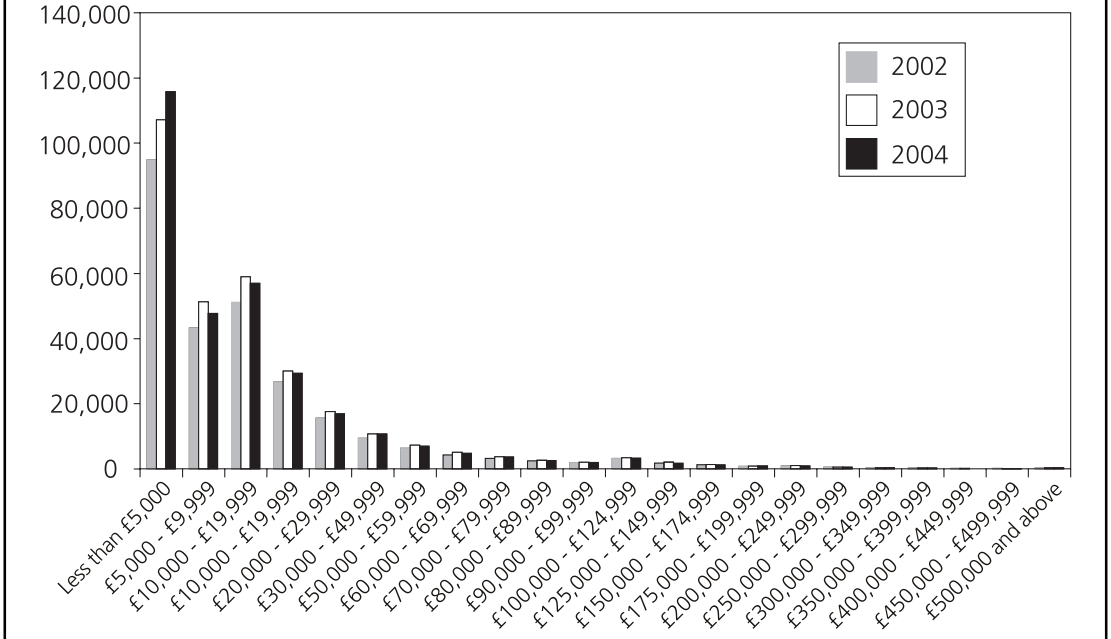
The result of this has been a large transfer of occupational schemes from a DB to a DC basis. This will reinforce the underlying trend increase in demand for annuities arising from personal pension schemes, many of which will enter the decumulation phase in the near future.

According to the 2002 Green Paper *Simplicity, Security and Choice: Working and Saving for Retirement,* the government remains committed to support the market for annuities for three reasons (Department of Work and Pensions, 2002, Cm 5677, pp.87-88, ¶55):

- annuities pool people's risk, ensuring that they are the most financially efficient way of turning capital into an income stream;
- annuities make sure that people continue to receive an income from their savings no matter how long they live; and
- tax relief on pension contributions is provided so people can save for an income in retirement, not for other purposes.

There are serious concerns about the magnitude of the pensions, both in terms of the welfare consequences for pensioners, the relationship with the means test and possibly also in terms of total demand for annuities. Figure 2.3 shows the distribution of annuity fund sizes from 2002 to 2004. The distribution was almost identical in 2001 as discussed by Stark (2002): at that time over 43 per cent of pension funds were less than £10,000.

Figure 2.3 Distribution of annuity funds in 2002-2004



Source: Association of British Insurers

An annuity purchase of £10,000 in 2005 would only provide an income of about £500 per year or £10 per week. Although many pensioners may have more than one pension and, thus, have total incomes much higher than this, the message from Figure 2.3 would appear to be that personal pensions may be insufficient to provide pensioner income, although this would be due to a failure in the accumulation phase of the pension, rather than the decumulation phase which is the focus of this report. Of course the aim of the Pension Credit is to ensure that pensioners are not on very small incomes, but it has the effect that for 40 per cent, the value of small pensions is lost, as illustrated in Figure 2.1.

It is not easy to determine the consequences of 'A-day' (6 April 2006) for annuity demand from Figure 2.3. Under current regulations, pensioners are allowed to avoid annuitisation if the annual income that could be obtained would be less than £260 per year (or £5 per week). This will change on A-day, when it will not be necessary to annuitise capital sums of less than £15,000, which would imply a weekly income of about £15 per week. Back-of-envelope calculations based on the data underlying Figure 2.3, suggest that about 60 per cent of pension funds were less than £15,000, but these account for only about 25 per cent of total premiums. Stark (2003) reports that 30 per cent of annuitants had more than one fund, so 25 per cent is only an upper bound for the proportion of the new annuity business which might be avoidable after the A-day changes. But the A-day change will be of little importance for many of these individuals: although having an annuity would reduce the state pension received through Pension Credit, the state pension is also means-tested on capital, so avoiding annuitisation would only be optimal if the resulting total (non-housing) wealth of the individual was less than £15,000. It should also be noted that tax must be paid on 75 per cent of the fund regardless of the annuitisation decision (the other 25 per cent is tax-free). For these various reasons the overall effect of A-day is unlikely to reduce annuity demand to any significant extent.

3 Annuity demand theory

A life annuity insures an individual against longevity risk, or of running out of savings to support consumption expenditure in old age. Any risk-averse individual will demand insurance, and as with all insurance products, annuities redistribute between individuals: from those who live for a relatively short period to those who live for a relatively long time in retirement. We will explain Yaari's annuitisation result that annuitisation is beneficial but note that this depends upon a variety of considerations and does not square with the evidence that actual annuity markets are small (Friedman and Warshawsky, 1988, 1990, and Mitchell *et al.*, 1999).

3.1 The role of annuities in consumer choice

In the life-cycle model of accumulation and decumulation an important source of uncertainty during the decumulation phase is the time of death. Uncertainty concerning the length of life means either that savings may be exhausted before death or that there could be a legacy of savings (if death occurs earlier than expected). Yaari (1965) demonstrates that the solution to this problem for risk-averse individuals is to purchase annuity contracts, enabling them to smooth consumption in every period of retirement.[7] Fully stated, it is optimal for agents to hold all of their wealth in assets which make payments conditional on survival: this is sometimes called 'complete' or 'full' annuitisation, by which it is meant that the entire portfolio should be held in life-contingent assets.

Given Yaari's (1965) result, it might seem surprising that individuals frequently prefer to avoid buying annuities. As with any economic model, Yaari's result depends formally upon a range of auxiliary assumptions, but Davidoff, Brown and Diamond (2005) show that most of these assumptions can be relaxed without affecting Yaari's substantive conclusion, so we do not analyse all of the technical details here, concentrating instead on the points we think most important.

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[7] In Yaari's model annuities are actuarially fair, but the qualitative results are the same so long as the annuity rates are not too unfair.

At the outset it will be useful to define very precisely what we mean by annuitisation and what is meant by an annuity. To help us do this, consider the distinction between:

- annuitising fully (in the sense meant by Yaari); and
- putting all (or a large part of) one's wealth into the sort of annuity typically sold in the UK annuity market.

In practice, the combination of UK statutory requirements and the range of annuity products offered by the UK insurance industry means that an individual is required to purchase a stream of income which commences immediately upon retirement and continues until the point of death: in nearly all cases this stream of income will be approximately constant (whether in real or nominal terms). One of the key features of an annuity is that it is an **illiquid** asset: once purchased it cannot be re-sold.

This is quite different from how the term 'annuitisation' is defined by Yaari and how the term is used in many academic articles. In Yaari's model the choice that an individual must make in each period is to save:

- in a conventional way and earning the rate of interest r: for each £1 saved this period, the individual will receive £$(1+r)$ in the following period. The payment will be made regardless of whether the individual is alive or dead next period (if the individual dies then the money will be paid to the individual's estate);
- through an actuarially-fair life-contingent savings scheme: for each £1 saved the individual will receive £$(1+r)/p$ where p is the probability of the individual being alive in the following period. The payment will be made only if the agent is alive (if the individual dies then no money will be paid to the individual's estate). Notice that £$(1+r)/p >$ £$(1+r)$ so the individual receives a higher rate of interest.

When contrasted in this way it can be seen that 'annuitisation' in Yaari's sense is rather different from the UK statutory requirement to purchase an annuity: Yaari's model does not require an individual to put irrevocably all of their wealth into an illiquid asset providing a constant stream of income. In fact, Yaari's model is even less restrictive than we have already characterised, because it also assumes that individuals are able to borrow at actuarially fair interest rates in perfect credit markets, or equivalently to borrow at the same rate of interest as paid on savings and buy actuarially fair life insurance: neither of these assumptions represent the situation for elderly people in the UK (or elsewhere).

Our discussion so far shows that it is necessary to define carefully what we mean by an annuity. Accordingly, we shall refer to various annuity products as follows:

Conventional annuity. This is an institutional arrangement that agrees to pay an individual an income each period until death in return for a lump sum (or **premium**)

paid in advance, typically to an insurance company.[8] This annuity allows the individual to insure against the risk of long life, because although an individual is unsure of their own length of life, insurance companies are willing to bear this risk as they offset different individuals' longevity risks. While individuals are able to buy annuities, they are not able to go short in the annuity market – to do this an individual would have to sell a stream of income (continuing until the individual's death) to an insurance company which continues until their death.[9]

Temporary annuity. A temporary annuity is a stream of payments made for a maximum number of years, conditional on being alive. For example, a temporary annuity for five years would make regular payments until either the annuitant died or the limit of five years was reached, whichever came sooner. Post A-day individuals in the compulsory purchase market will be allowed to purchase temporary annuities called term-certain annuities) as part of unsecured income (drawdown) up to the age of 75.

Deferred annuity. A deferred annuity is a stream of payments beginning at some point in the future, made conditional on the annuitant being alive. In this case it is possible that no payments will ever be made. The market for deferred annuities may be particularly susceptible to the problem of **adverse selection**, which is discussed separately in Section 4.4.

As we shall see in Section 3.1 the markets for both temporary and deferred annuities are much smaller than for more conventional annuity products and the near absence of these markets is potentially a form of credit market imperfection. There is a considerable body of economic analysis to show that an optimal consumption plan can be highly sensitive to credit market imperfections and this will equally be true in the demand for annuities: we shall discuss this in detail in Section 5.1.

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[8] Strictly speaking this is a **life** annuity, since there are also **term-certain** annuities, which are income streams independent of survival: if the individual dies before the term of such an annuity then payments are made to the individual's estate. Clearly, the latter are conceptually similar to conventional bonds: while etymologically correct, the use of the word 'annuity' in this context is increasingly out of line with technical usage in the financial service industry.

[9] We prefer the term 'to go short on an annuity' instead of 'to sell an annuity' since it makes explicit that the individual is selling an income stream conditional on their (the seller's) survival, whereas the sale of an annuity by an insurance company involves selling an income stream conditional on the buyer's survival. Confusingly, the two terms are frequently used inter-changeably in the literature on annuities. In principle, an individual could achieve the same objective by taking out a conventional loan against future (life-contingent) income in conjunction with life insurance to ensure that the loan could be repaid if the individual died and the future income were not actually received. In practice, life insurance markets are not usually available for this sort of transaction and most analysis assumes that individuals are unable to follow this strategy.

In principle, a deferred annuity is simply another form of pension product, especially if such an annuity is paid for not by a single premium but by a series of premiums over an individual's lifetime (in which case the deferred annuity encompasses both the accumulation and decumulation phases of the pension). Demand for deferred annuities by individuals has always been very low, but there are two reasons to reinforce their unpopularity:

- the Open Market Option allows individuals with a pension fund to change life assurer at the point of annuitisation, effectively separating the accumulation and decumulation phases of pension planning, and making the purchase of a deferred annuity unnecessary (since to do so would be to abrogate the right to look for a more competitive annuity rate at the point of retirement);
- life assurers are increasingly unenthusiastic about selling deferred annuities because of the perceived additional risk of such long-term liabilities. It is also worth noting that the Equitable Life collapse involved the sale of what were referred to as deferred annuities (even though, strictly speaking, what was being sold was an option to purchase an annuity in the future) and this may have made potential savers increasingly suspicious of deferred annuities.

Although demand for deferred annuities by individuals is minimal, there is a significant bulk-buyout market, amounting to about ten per cent of the whole annuity market. Bulk buyouts are used by occupational pension schemes to transfer pension liabilities (both existing and future) to a life assurer. This may happen in three cases: first, when an employer becomes insolvent; second, when an employer and the trustees wish to terminate a Defined Benefit (DB) scheme (usually to be replaced by a Defined Contribution (DC) scheme); and finally, when an employer wishes to manage the risks consequent on maintaining a DB scheme. The 2004 provision of the Pension Protection Fund (PPF) to insure members of occupational pension schemes against scheme failure provides a further potential source of demand for deferred annuities, since the PPF could meet its obligations to pensioners by purchasing for them deferred annuities. However, this would impose a heavy financing burden on the PPF because all liabilities would have to be financed up-front. Although the precise way in which the PPF will operate has not yet been finalised, it is unlikely to be a significant purchaser in the bulk market.

To provide a benchmark for discussion throughout this survey, we shall start with an explanation of the Yaari theory of annuities, in which risk-averse individuals will use annuity contracts to insure their consumption in retirement.[10] In the absence of an annuities market, an individual at retirement with wealth W_0 and with no further labour or other non-interest income maximises expected utility in equation (3.1) subject to a budget constraint in equation (3.2):

$$EU = \sum_{t=0}^{T} \delta^t p_t u(c_t) , \tag{3.1}$$

$$\sum_{t=0}^{T} R(t) c_t = W, \qquad R(t) \equiv \prod_{i=1}^{t} (1+r_i)^{-1} , \tag{3.2}$$

where p_t is the probability of surviving from age zero to age t, ($p_0 = 1$); T is the maximum longevity; δ is the rate of time preference; and r_t is the interest rate in period t and $R(t)$ is the continuously compounded rate of return from the point of retirement to period t. The individual's problem at retirement is to run down savings optimally to maximize the benefits of consumption over the remaining periods of the individual's life.

For future reference, it is worth noting explicitly at this point the various assumptions that are made:

- geometric discounting of future utility;
- constant preferences;
- time-additive separability of the utility function (i.e. no habit formation);
- perfect credit markets (it is possible to borrow and save and the interest rate for borrowing is the same as the interest rate for saving);
- the absence of uncertainty about the parameterisation of the felicity function, $u(C)$;

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[10] In this example we shall assume that there are no future income payments. The original Yaari (1965) article analyses the more general case where there may be future labour income, which is then clearly contingent on being alive in future periods. Although it is conventional to exclude the possibility of future labour income, there may be future income payments which are conditional on being alive: either state pension or welfare benefits or private pension benefits arising from occupational pensions (where individuals are presented the pension benefit in the form of an annuity and, thus, have no choice). Whenever there are future payments, there is the possibility that agents may wish to borrow against future payments, resulting in the possibility of borrowing constraints: we shall return to this point again in Chapter 5.

- the absence of uncertainty about future interest rates; and
- the absence of other sources of income (such as welfare payments) which may themselves have many of the same features as an annuity.

While it will turn out that some of these assumptions are innocuous when taken in isolation, some prove more important when taken together.

The budget constraint in (3.2) is identical to a certain world case and says that initial wealth must be no less than the present value of consumption over lifetime T. Now suppose that an annuities market with fairly priced annuities exists. This means that individuals are able to purchase financial assets which pay a return of $(1+r)^t / p_t$. By suitable purchases of such assets, the agent can obtain any consumption path of the form:

$$\sum_{t=0}^{T} \frac{p_t c_t}{(1+r)^t} = W = \sum_{t=0}^{T} \frac{p_t y}{(1+r)^t}, \tag{3.3}$$

where y would be the annual payment made if the agent put all of his initial wealth into a conventional level annuity (the value y here corresponds to Friedman's concept of permanent income). Equation (3) is the new effective budget constraint and represents an increase in consumption possibilities: $p_t / (1+r)^t$ can be thought of as the price of future consumption and since:

$$\frac{p_t}{(1+r)^t} < \frac{1}{(1+r)^t} \quad \forall\, t \quad t \neq 0, \tag{3.4}$$

then the existence of an annuities market is equivalent to no annuities market but lower prices of future consumption. (Alternatively, the rate of return on annuities is higher than the rate of return on conventional assets.)

So the conclusion of this section is that the effect of introducing access to an annuity market is to shift the budget frontier outwards and, thus, enable individuals to obtain higher utility. This is because providing insurance to a risk-averse individual always has the effect of raising their utility: the same increase in utility could, in principle, be achieved by giving the individual more initial wealth without removing the risk, but this would clearly be inefficient.

However, we have not yet analysed the amount of annuities that individuals will purchase. Many of the important issues can most easily be illustrated in a two-period example and we proceed to do that now.

3.2 Annuity demand when there are two periods

Consider a simple situation where an individual retires and will live for up to two periods: they will definitely be alive in the period 0 and will be alive with probability p period 1. The individual has wealth W. Suppose that the agent uses θW to purchase an annuity (which has a fair rate of return $(1+r)/p$) and retains $(1-\theta)W$ either to invest in conventional assets (with a rate of return $1+r$) or for consumption in period 0.

The purchase of the annuity means that the individual will receive a payment of:

$$a_\theta = \frac{\theta W(1+r)}{1+r+p} = \theta y \,, \tag{3.5}$$

where the fair annuity rate is determined implicitly by the two-period analogue of equation (3), namely:

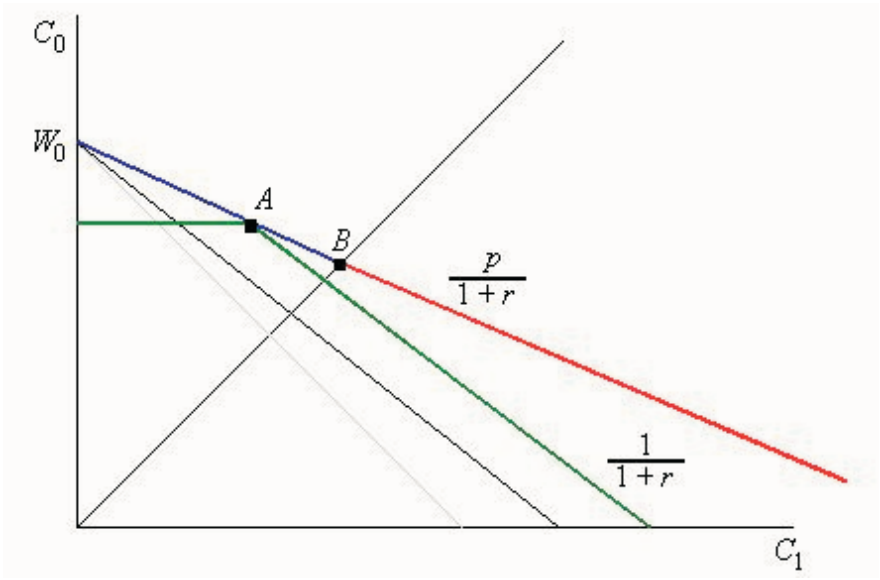
$$a_\theta + \frac{a_\theta p}{1+r} = \theta W \,. \tag{3.6}$$

The effect of this is that while the agent initially had wealth W in period 0, they now have the possibility of spending $(1-\theta)W + a_\theta$ in period 0 and a_q in period 1.

It is reasonable to assume that the individual cannot borrow against the future income (i.e. the annuity payment) that they will receive with probability p in period 1. Unless the agent purchases additional annuities (which would correspond to choosing a different value of θ), they will be able to save their existing wealth in conventional assets.

The relationship between the resulting budget constraints is shown in Figure 3.1. If the agent only had access to conventional assets, their budget constraint would be the downward sloping black line: due to the positive interest rate this has a slope flatter than 45 degrees (the pale grey line). By putting some of the initial wealth into an annuity, the individual can move to a position such as A on the diagram, where the consumption possibilities are $C_0 = (1-\theta)W + a$ and $C_1 = a$. Given our assumption that an individual cannot borrow against future annuity payments, they would now no longer be able to consume more than $(1-\theta)W + a$ in period 0 – resulting in a horizontal section to the budget constraint – so the budget constraint is the section shown by the green line.

Figure 3.1 The budget constraint for someone buying an annuity



The individual can choose to annuitise any amount of their wealth and by so doing can achieve any point on the blue line, which forms an 'envelope' of possible budget constraints and is, thus, the relevant constraint for the utility maximising decision.[11] At point B the individual has used all of his wealth to buy a (conventional) annuity, so $\theta = 1$. The agent could also choose to buy annuities where the payments made in period 1 were greater than those made in period 0, in which case it would also be possible to obtain points on the red line. Such annuities are rare in practice: it is possible to purchase 'escalating' annuities, where the nominal payments rise over time at a specified rate, but the annual increase is typically small (about three per cent) and hence, does little more than compensate for inflation. Alternatively, points on the red line could be interpreted as purchases of **deferred** annuities, but we have already noted that the market for annuities of this sort is very thin.

To determine annuity purchases, we now need to complete the utility maximisation. In the two period case, equation (1) can be written as:

$$EU = u(C_0) + \delta\, pu(C_1) \qquad (3.7)$$

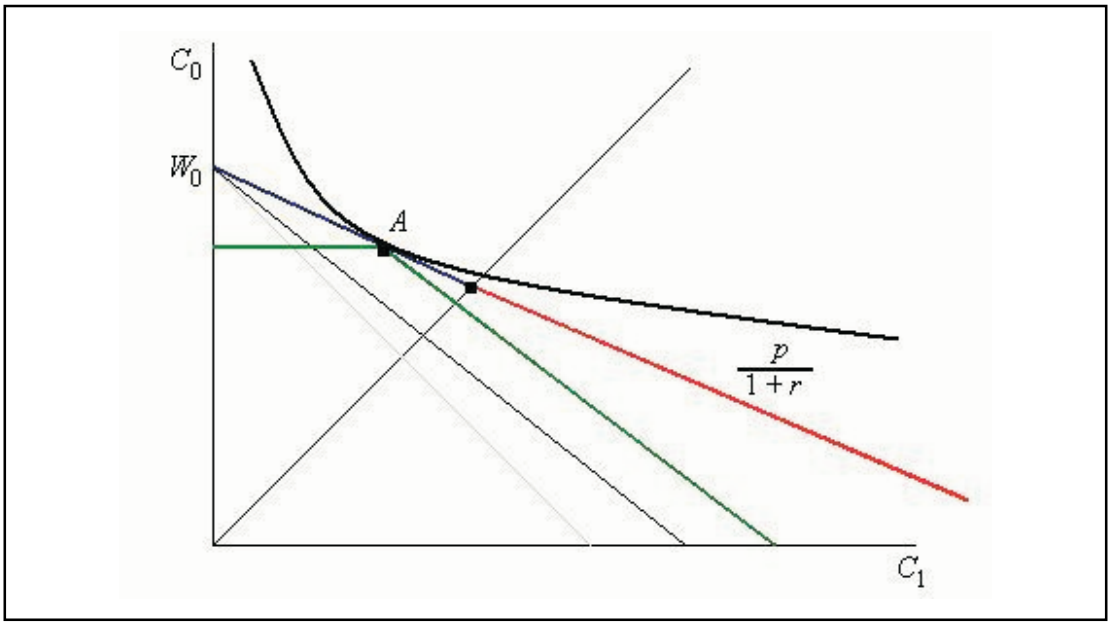
The slope of the resulting indifference curve is where the indifference curves cross the upward-sloping 45 degree line.[12] Point B will be an optimal solution if $\delta = (1+r)^{-1}$, in which case the indifference curve will be tangent to the budget

[11] For a more mathematical discussion of the local constraint implicit in point A, see Moffat (1978).

[12] By implicit differentiation, the slope of the indifference curve is $-\delta\, pu'(C_1)/u'(C_0)$ and on the 45° line $C_1 = C_0$.

constraint on this 45° degree line: in economic terms it is optimal to put all of one's initial wealth into an annuity only if the interest rate is just sufficient to offset the subjective discount rate. It is usually assumed, however, that the interest rate (even after adjusting for risk) exceeds the discount rate, in which case the optimal solution would be just to the left of point B and the agent would wish to consume some of their wealth in period 0 and only put the remainder into an annuity.[13] This situation is shown in Figure 3.2.

Figure 3.2 Utility maximisation using annuities



The optimal consumption plan is shown at point A, where the indifference curve is tangent to the blue envelope of possible budget constraints: as has been shown above, this is achieved by annuitising the appropriate amount of wealth to obtain the green budget constraint.

3.3 Annuities when there are many periods

In the two-period context, the analysis is fairly straightforward, because an individual's maximisation problem consists in deciding how much to consume in two periods and then can always achieve this by purchasing just one annuity. In the multi-period model it becomes much more complex, because it may be impossible to achieve the desired pattern of consumption by buying just one (conventional) annuity.

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[13] Although the individual has not used all of their wealth to buy an annuity, they are still fully annuitised in Yaari's sense, because none of their saving is in assets which aren't annuities.

We can illustrate the issues that arise in a multi-period context by considering a three-period example, where an agent must consume in periods 0, 1 and 2 (i.e., the optimisation problem is to maximise equation (1), subject to equation (3), with $T=2$ in both equations). Clearly one possible solution to this problem is that $C_0^* > C_1^* > C_2^*$. To obtain consumption of C_2^* one could buy an annuity that paid out a constant stream of income $a = C_2^*$ in each period. All that is left is to obtain an extra income of $C_1^* - a$ in period 1.

One solution is to buy a temporary annuity: i.e. an annuity that pays out two payments of $C_1^* - a$, the first in period 0 (paid with certainty) and the second in period 1 (paid with probability p_1 if the individual is still alive). In period 0 it would be easy to consume C_0^* because one would have the income from two annuities of *a* and $C_1^* - a$ and could consume the difference $C_0^* - C_1^*$ from the initial lump sum.

An alternative would be to buy an annuity product that was both temporary and deferred: this would make a single payment of $C_1^* - a$ in period 1 (paid with probability p_1 if the individual is still alive). Initial consumption of $C_0^* - C_1^*$ would be financed from the initial lump sum.

Clearly the optimal consumption plan of $C_0^* > C_1^* > C_2^*$ is only one possibility. With three periods there are six possible consumption paths (if we ignore the possibility of equal consumption in different periods). Table 3.1 illustrates all of these possibilities and how they might be achieved by purchasing different annuity products: not all portfolios are shown since we assume that an agent always purchases the simplest conventional annuity.

Table 3.1 Combinations of annuity types needed in three-period optimisation

Optimal solution	Consume some initial wealth	Conventional annuity (payments in periods 0, 1, 2)	Temporary annuity (payments in periods 0, 1 only)	Deferred annuity (payments in periods 1, 2 only)	Temporary deferred annuity (payment in period 1 only)	Deferred annuity (payment in period 2 only)
$C_0 > C_1 > C_2$	✓	✓	✓			
	✓	✓			✓	
$C_0 > C_2 > C_1$	✓	✓				✓
$C_1 > C_0 > C_2$		✓	✓		✓	
	✓	✓			✓	
$C_1 > C_2 > C_0$		✓		✓	✓	
		✓			✓	✓
$C_2 > C_0 > C_1$	✓	✓				✓
$C_2 > C_1 > C_0$		✓		✓		✓
		✓			✓	✓

4 Description of annuity markets

In this chapter we outline the different types of annuity product that are available, and report on evidence documenting annuity prices quoted by annuity providers, and the movement in average annuity prices over time. We will also outline the changes to compulsory annuitisation requirements following A-day in April 2006.

One reason for individuals avoiding the purchase of annuities would be that the products were mispriced. We will explain the money's worth calculation of annuities, and show how selection effects might distort annuity prices. While there is strong evidence to suggest that annuities are probably priced slightly higher than would be suggested by actuarial considerations, mark-ups do not seem excessive compared with the cost of other financial services.

4.1 Types of annuities

We have already distinguished between conventional, temporary and deferred annuities in Chapter 3 and now provide a more detailed discussion of annuity types.[14] We now consider more carefully different sorts of conventional annuity and illustrate the differences with examples of the sums of money involved. It should be remembered that nearly all sorts of annuities can be purchased in two separate markets: the voluntary-purchase market which is open to any individual; and the compulsory-purchase market which is open only to individuals who have accumulated their fund in a tax-exempt pension plan. In the former market, annuity payments are treated as part income (which is taxed) and part capital repayment (which is not taxed). In the compulsory market, 25 per cent of the pension fund can be taken as a tax-free lump sum (although it could also be used to buy an annuity in either the

[14] The Financial Services Authority's (FSA's) 'Guide to Annuities and Income Withdrawal' (2004) provides a clear description for consumers of the types of annuity product available in the market.

voluntary or compulsory markets). The remaining 75 per cent must be used to purchase an annuity, although this purchase can be deferred until the age of 75, with restrictions on how much can be withdrawn before then.

Single level annuities pay out exactly the same amount to an individual (the annuitant) every month until the annuitant dies.[15] For example, in Table 4.1, the insurance company AXA is offering to pay a monthly pension of £513 per month to a 65-year old man, in exchange for an initial payment (the premium) of £100,000. As women are expected to live longer than men, a woman of 65 would only get £473 per month from AXA.[16] Since there are 12 monthly payments in a year, the annual income generated from these AXA annuities is £6,156 and £5,676 respectively. This means that the annuity rates are 6.16 per cent and 5.68 per cent, higher than the interest rate on a typical conventional savings account of less than five per cent. This inequality, which was introduced in equation (3.4), arises because the savings account would preserve the capital, whereas the annuity runs down the capital. The difference between the annuity rate and the conventional interest rates is often referred to as 'mortality drag'.

Table 4.1 Examples of pension annuity prices

All examples are quotes at 28 July 2005 for a premium of £100,000.

Provider	Monthly income – level	Monthly income – 3%	Monthly income – RPI
Male – 60 years, single, no guarantees			
AXA	454	307	316
Canada Life Limited	518	360	338
Clerical Medical	478	325	316
Friends Provident	502	348	n/a
Legal & General	515	349	318

Continued

[15] It is also possible to purchase annuities that make payments at different frequencies such as annually, half-yearly or every three months. Where the purpose of an annuity is to provide an income stream for immediate consumption (which is true in nearly all cases), such infrequent payments would obviously be inappropriate.

[16] Discrimination on grounds of gender is legal in annuity markets in the UK and the US (although this is not true in all countries). The most recent EU Directive on equal opportunities also allows discrimination on actuarial grounds (European Commission, 2004). Discrimination on grounds of race is not practised, although it is likely that blacks in the USA could gain better annuity rates, since their life expectancy is shorter.

Table 4.1 Continued

Provider	Monthly income – level	Monthly income – 3%	Monthly income – RPI
Norwich Union	517	363	333
Prudential	520	363	344
Reliance Mutual	470	311	n/a
Scottish Equitable	528	366	n/a
Scottish Widows	505	348	327
Standard Life	507	350	342
Male – 65 years, single, no guarantees			
AXA	513	366	375
Canada Life Limited	582	427	404
Clerical Medical	551	397	388
Friends Provident	585	426	n/a
Legal & General	570	406	375
Norwich Union	581	428	391
Prudential	583	427	408
Reliance Mutual	522	363	n/a
Scottish Equitable	591	431	n/a
Scottish Widows	571	417	390
Standard Life	569	413	404
Male – 70 years, single, no guarantees			
AXA	596	448	457
Canada Life Limited	674	519	497
Clerical Medical	659	502	493
Friends Provident	695	530	n/a
Legal & General	647	484	453
Norwich Union	694	551	513
Prudential	674	518	514
Reliance Mutual	597	438	n/a
Scottish Equitable	684	523	n/a
Scottish Widows	665	513	492
Standard Life	656	501	491
Female – 60 years, single, no guarantees			
AXA	426	277	286
Canada Life Limited	496	335	313
Clerical Medical	447	291	283
Friends Provident	449	301	n/a
Legal & General	486	314	284
Norwich Union	506	334	320

Continued

Table 4.1 Continued

Provider	Monthly income – level	Monthly income – 3%	Monthly income – RPI
Prudential	478	320	321
Reliance Mutual	444	283	n/a
Scottish Equitable	501	338	n/a
Scottish Widows	473	311	301
Standard Life	467	307	300
Female – 65 years, single, no guarantees			
AXA	473	325	334
Canada Life Limited	551	391	369
Clerical Medical	507	349	340
Friends Provident	518	366	n/a
Legal & General	529	358	327
Norwich Union	557	390	367
Prudential	532	375	370
Reliance Mutual	484	324	n/a
Scottish Equitable	551	389	n/a
Scottish Widows	521	364	348
Standard Life	520	362	354
Female – 70 years, single, no guarantees			
AXA	538	389	398
Canada Life Limited	628	468	444
Clerical Medical	591	430	420
Friends Provident	613	456	n/a
Legal & General	583	414	383
Norwich Union	623	455	444
Prudential	613	454	447
Reliance Mutual	541	382	n/a
Scottish Equitable	622	461	n/a
Scottish Widows	606	450	426
Standard Life	595	438	429
Male – 65 years, joint, no guarantees; spouse 65 years full annuity payment on death of male			
AXA	428	286	294
Canada Life Limited	492	339	318
Clerical Medical	449	302	293
Friends Provident	431	290	n/a
Legal & General	485	321	292

Continued

Table 4.1 Continued

Provider	Monthly income – level	Monthly income – 3%	Monthly income – RPI
Norwich Union	497	333	325
Prudential	481	331	320
Reliance Mutual	435	283	n/a
Scottish Equitable	499	344	n/a
Scottish Widows	469	318	300
Standard Life	473	322	315
Male – 65 years, single, five year guarantee			
AXA	511	364	373
Canada Life Limited	580	425	403
Clerical Medical	548	395	386
Friends Provident	577	421	n/a
Legal & General	568	406	374
Norwich Union	577	425	389
Prudential	579	425	406
Reliance Mutual	520	362	n/a
Scottish Equitable	588	429	n/a
Scottish Widows	565	414	388
Standard Life	565	411	402
Male – 65 years, single, no guarantees, smoker			
Provider	Available to	Monthly income – level	Monthly income – 3%	Monthly income – RPI
GE Life	Smokers only	672	519	500
Just Retirement Ltd	Smokers only	599	447	437
Reliance Mutual	Smokers only	683	528	n/a

Source for all tables: FSA web-site – Comparative Tables.

Guaranteed annuities pay out the annuity payment each month, for at least the length of the guarantee period, even if the annuitant dies before the end of the guarantee period; in which case the guaranteed annuity payments are made into the annuitant's estate. Guarantee periods are typically either five years or ten years: the ten-year limit is the maximum allowed under current Her Majesty's Revenue and Customs (HMRC) rules. Continuing our example of a 65-year old man buying an annuity from AXA, we can contrast the monthly payments that he would receive of £513 for an annuity without a guarantee and £511 for an annuity with a five-year guarantee period. The monthly payment is slightly less for the guarantee period to take account of the fact that the first five years' payments will definitely be paid: however, since the probability of a 65-year old man dying before the age of 70 is

quite small, there is only a small premium in forgoing these payments in the event of death. The advantage of an annuity with the guarantee period is that the annuitant can be sure that there will be some payments made back from the life assurer and, thus, hedges against the possibility of receiving no payments in the event of a very early death. However, this advantage does not translate into a direct increase in the annuitant's welfare through higher retirement income and spending, since the benefit is felt by the annuitant's estate. This means that the benefits from a guaranteed annuity cannot easily be accommodated in an economic model of the type presented in Chapter 3.[17] The disadvantage is a lower income throughout retirement, although from the numbers in Table 4.1 it can be seen that the magnitude of this is small.

Inflation-linked annuities will increase the annual payments by the rate of increase in the Retail Price Index (RPI) to give the pensioner protection against inflation. **Escalating annuities** will increase the monthly payments by say three or five per cent to give the pensioner some protection against inflation, and to allow for possible increased income needs as the annuitant ages. In consequence, the initial payments on inflation-linked and escalating annuities are lower than with level annuities. Continuing with the example of the AXA annuities for a 65-year old man, the monthly payments are compared in Table 4.2: although the monthly payments from the escalating annuity are growing over time, it takes 13 years before they are higher than the monthly payment from a level annuity.

Table 4.2 Comparison of monthly annuity rates for level and escalating annuities

Payment at beginning of year	1	3	5	7	9	11	13	15	17	19
Level annuity	513	513	513	513	513	513	513	513	513	513
Escalating three per cent	366	388	412	437	464	492	522	554	587	623

Comparing these simple annuity products, the advantage of a level annuity is that it maximises the initial income stream, especially if it has no guarantee. From the AXA example, an annuitant would have to live for 13 years before the annual income

[17] It is true that it is fairly straightforward to extend the model in Chapter 3, to include the possibility that the agent gains utility from bequeathing wealth to someone else. However, the guarantee period is a very clumsy and risky way of ensuring a bequest (since it is more likely than not that the annuitant will outlive the guarantee period). For this reason we hypothesise the motivation advanced in the text: that annuitants worry about dying early and hence, earning a poor return on the annuity purchase *ex post*. Such a motivation more naturally falls within the area of modern economic psychological analysis, which we discuss in Section 5.6.

from the escalating annuity were higher than that from a level annuity and considerably more than 13 years before the money received overall was higher.[18] From the evidence of the term structure of interest rates, expected inflation rates are expected to be a little less than three per cent, so in terms of money received, very similar arithmetic applies to inflation-protected annuities (although these do have the additional benefit of insuring against inflation risk). We saw in Chapter 2 that many annuitants have small pension funds and, therefore, need to maximise income: furthermore, a comparison of pensioner mortality by both 'amounts' and 'lives' suggests that life expectancy is lower for smaller annuity purchasers and so these are least likely to benefit from an escalating annuity or from inflation protection. The problem is that the benefits from escalating or index-linked annuities are only realised in the distant future so annuitants whose life expectancy is relatively low are very unlikely to survive long enough to experience these benefits.

Joint-life or **Last-survivor annuities** pay an agreed annuity payment to an annuitant and the annuitant's partner while both are alive. Following the death of the annuitant, the contract will pay either the same amount or an agreed reduced amount each month until the partner dies. Joint annuities always pay out smaller amounts than on single-life annuities because the expected number of annuity payments is higher.

The simple annuity theory presented in Chapter 3 is based on the maximisation of an individual's utility. In the context of a household, it is more appropriate to consider maximisation of household utility, which depends upon the utility of both partners. A joint-life annuity would smooth retirement income and consumption more effectively for the whole household and in the absence of other considerations would often be superior to a single-life annuity. However, from Figure 2.1, it can be seen that the marginal benefit of a small pension can be quite low due to means testing. In this circumstance it might be better for the household not to smooth retirement income, since this would maximise overall retirement income.

Investment-linked annuities involve the fund backing the annuity to be invested in an equity product, and the annuitant receiving a random annuity payment which is related to the performance of the equity market. Investment-linked annuities are also a hedge against inflation, and can either be *with-profits* or *unit-linked*. With-profits annuities mean that the pension fund is invested in a with-profits fund of an insurance company, so that annual bonuses are generated, which will allow the annuity payments to grow. The annuity payment from a 'Unitised' annuity is directly related to the value of the underlying fund of investments.

Some insurance companies offer annuities that pay a higher income if the annuitant has a health problem that is likely to reduce life expectancy. **Impaired-life annuities** will pay an increased annuity payment if the annuitant has health

[18] Life expectancy would be about 18 years for a man aged 65, so the probability of dying before 13 years would be quite high.

problems certified by a doctor, such as cancer, chronic asthma, diabetes, heart attack, high blood pressure, kidney failure, multiple sclerosis or stroke. **Enhanced annuities** will pay a higher annuity payment if the annuitant is overweight or smokes regularly and these are self-certified. With both of these types of annuity the regular payment implicitly contains a higher proportion of capital repayment than for a normal annuity, although this distinction is not taken into account when tax is applied: to this extent these annuities receive slightly less favourable tax treatment.

Phased-retirement or **staggered-vesting**. Instead of converting the whole pension fund at one point in time, it is possible to schedule withdrawals over several years, buying a separate annuity at each successive withdrawal. This is achieved by splitting the fund into many separate segments. Each segment can now effectively be treated as a separate pension fund and taken as part tax-free lump sum and part annuity. Segments can be converted at different times (subject to all of them being converted by age 75 in the compulsory market). This allows individuals to convert only part of their pension fund into a pension if they decide that they do not need the full pension at one go. An example of when this may be useful is when an individual moves to part-time working before retiring completely.

Income draw-down defers the purchase of an annuity, and instead generates an income by drawing from the fund itself. This facility allows pensioners to receive higher rates of return (since the fund can be invested in equity) and they could also benefit from increases in annuity rates if interest rates rose. Of course, these higher expected rates of return are offset by the riskiness of the returns compared to the certainty of an annuity. Because of the risk and also the administrative costs involved in setting up an income draw-down plan, the FSA recommends that this is only suitable for individuals with a pension fund of more than £100,000. HMRC sets maximum and minimum income that can be drawn down each year, and the amount withdrawn must be reviewed every three years to ensure that it will fall in the appropriate range.

From 6 April 2006 ('A-day') the current system of taxation for pensions will be replaced by a lifetime allowance on the amount of pension savings that can benefit from tax relief, set at £1.5m on A-day,[19] but rising annually; with a maximum annual allowance of £215,000. Also under the new proposals the minimum pension age will rise to 65 by 2010.

There will also be changes on the decumulation phase of a pension, and there will be three ways in which the HMRC will allow a pension to be taken post A-day:

[19] A corresponding change to occupational defined benefit (DB) schemes will capitalise the pension as 20 times the annual pension paid, although variations on this will be allowed for occupational pensions with benefits that differ significantly from typical DB schemes.

- Secured income (pension) but where the annuity payment may be either guaranteed for up to ten years or value protected, which is a taxed (35 per cent) lump sum payable on death as the difference between the original purchase price and cumulated payments made. Value protection stops at 75.
- Unsecured Income (equivalent to the present drawdown scheme, and is also available to occupational scheme members), where the maximum amounts in each year are 120 per cent of best flat-rate, single-life annuity payment at the respective age and sex, published by FSA. At 75 the pensioner must switch to secured income or alternatively secured income. On death before 75, remaining funds may be repaid as a capital sum, subject to tax of 35 per cent, or transferred to a pension for a dependant. In addition, a pensioner who opts for unsecured income may purchase term-certain annuities ('limited-period' or 'fixed-term' annuities) with a maximum term of five years, and stops at 75.
- Alternatively secured income (drawdown post-75). Maximum amounts that can be taken in any year reduce to 70 per cent of best annuity rate at age 75. On death, remaining funds must be transferred to a pension for a dependant, or revert to the scheme provider, or nominated charity. After 75 the best annuity rate for 75 year olds will still apply, which makes this option unattractive, since annuity rates improve with age. This option was introduced for pensioners who have religious objections to pooling mortality risk, but it could also be used by individuals as a means of inter-generational transfer, which the government would interpret as avoidance. The government intends to monitor the situation to see if avoidance becomes a problem.[20]

The new rules also propose allowing those individuals with small pensions (less than one per cent of the life time allowance, i.e. £15,000) to take all their pension as a lump sum: with 25 per cent tax-free, and the remainder taxed at the appropriate marginal rate.

These changes will make the decumulation phase of a pension similar between occupational defined benefit and individual defined contribution schemes, and will make the constraints on how an individual can decumulate a personal pension more flexible. There are still constraints on how an individual may take a DC pension, but there will no longer be a compulsory requirement to annuitise at 75.

4.2 Data on annuity rates

Warshawsky (1988), and Brown, Mitchell, Poterba and Warshawsky (2001) document the movement in annuity prices in the USA. Cannon and Tonks (2004a) construct a consistent time series on UK annuity prices from 1957 to 2002 for the voluntary annuity market. Although the compulsory-purchase annuity market is both much larger and more interesting for government policy, it did not come to maturity until

[20] Written Ministerial Statement in Commons Hansard, 432(58), 21 March 2005.

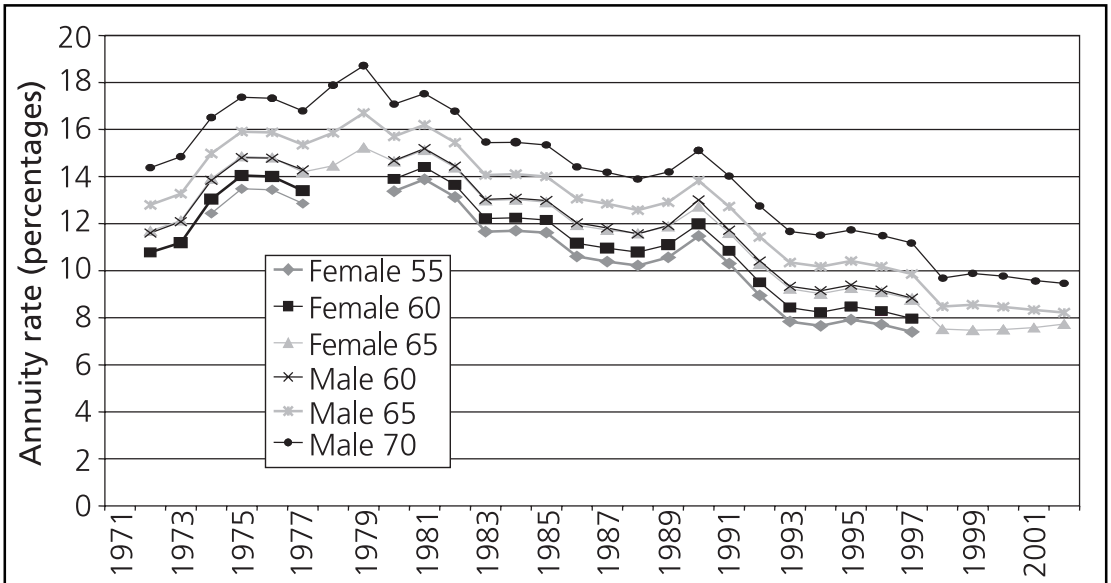
considerably later than 1957, and such a long run of data does not exist for the compulsory-purchase market. Finkelstein and Poterba (2002) compare the two markets in the year 2000. We know of no formal comparison over the earlier period of the 1980s and 1990s, but our informal analysis suggests that the variation of annuity rates in the two markets was similar.

A detailed discussion of the voluntary-purchase market data can be found in Cannon and Tonks (2004b): we summarise the most important points here. The data are primarily for level immediate voluntary annuities purchased for 1957 to 2002: data from 1973 onwards are for annuities with a five-year guarantee and earlier data have no guarantee. According to Stark (2002) over 70 per cent of purchased annuities are level annuities, so the series are reasonably representative: more importantly historical data are not available for any other types of annuity. The data were collected from a series of trade magazines such as *Pensions World* and *Money Management* for the later period and *The Policy* for the earlier period.

Figure 4.1 plots a series of five-year guaranteed annuity rates for men aged 60, 65 and 70, and for women aged 55, 60 and 65, over the period 1972 to 2002. It can be seen that annuity rates for men are consistently higher than for women of the same age; and that annuity rates are higher for both men and women as age increases. Age and sex are two personal characteristics that annuity-providers condition on when quoting annuity prices, since life expectancy of women is higher than men, and of younger adults of both sexes is higher than older adults. The striking aspect of this graph is the extent to which the six series move together: we should expect this since the major cause of variation in annuity rates over a period as short as this is the variation in the entire term structure of interest rates – and clearly all annuity rates at any given point in time are based on the same term structure of interest rates.[21]

[21] Although the relative importance of interest rates of different maturities varies between annuities purchased for different ages

Figure 4.1 Immediate (voluntary) annuity rates by age and gender



Source: Cannon and Tonks (2004b)

Figure 4.2 illustrates the complete annual series for men aged 65 over the longer time period: for comparison, the consol rate is also plotted as a representative long-term interest rate.[22] The consol rate (as well as shorter rates, not illustrated here) was roughly the same in both 1957 and 2002, making comparison of the beginning and end of the period straightforward. Although consol rates were the same, annuity rates were lower in 2002 than in 1957. Cannon and Tonks (2004a) show that all of this narrowing is due to increases in longevity: as life expectancy increases the gap between the annuity rate and the consol rate ('mortality drag') will narrow.[23]

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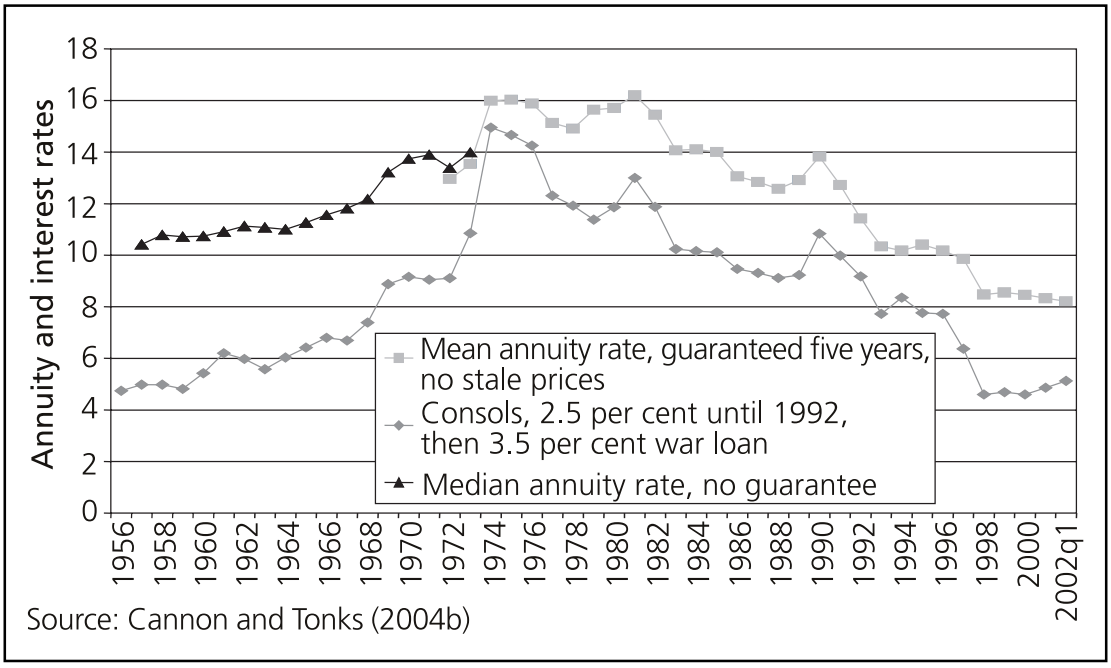
[22] A 'consol' is a government bond paying a total annual coupons of between 2½ and 3½ per cent on a par value of £100, with no redemption date: in principle, the government is allowed to re-purchase the bonds (dependent on the market price and sometimes after giving notice), but it has never done so. Historically there have been several conversions involving changing the coupon rate and hence, the effective par value, but the last of these was in 1888, and a consol is usually treated as a perpetual bond. The most recent issue of consols was an issue to fund the First World War with a coupon of 3½ per cent (often referred to as the War loan). In Figure 4.2, the consol rate is shown to be about five per cent at both the beginning and end of the period: this would imply that the market price of 2½ per cent consols with a face value of £100 (i.e. paying £2.50 per year) was about £50.

[23] If longevity increased so much that annuitants were immortal, the annuity rate and the consol rate would be the same, since the two products would be virtually identical.

In addition to the gradual trend of a narrowing gap between annuity and consol rates, there is also a temporary narrowing of the gap in the mid 1970s when all interest rates were high. The reason for this can be explained as follows: when interest rates are high the present value of future payments in the relatively distant future contributes very little to the total present value of an asset and most of the present value of the asset depends upon payments in the very near future. Since the probability of annuity payments in the near future is very high (in fact it is certain for the first five years of a guaranteed annuity), the expected present value of the annuity payments for the near future is almost the same as the expected present value of a consol. Of course, this reasoning relies upon annuities being priced fairly, but all of the evidence we shall present below suggests that this is approximately the case.

Figure 4.2 Immediate (voluntary) annuity rates for men aged 65



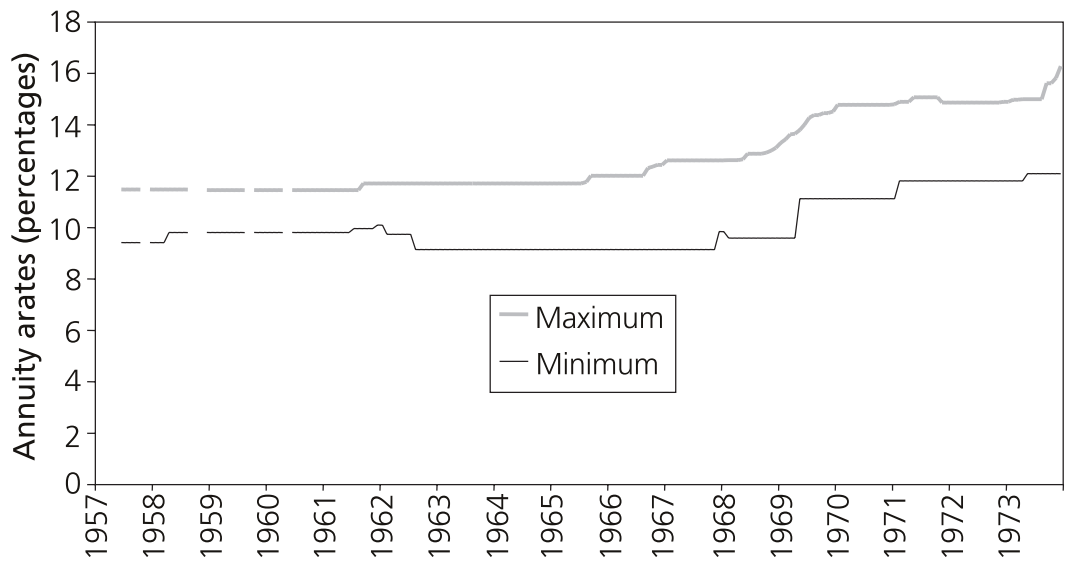
Source: Cannon and Tonks (2004b)

The series plotted so far are of simple average annuity rates for which we have quotes, with no attempts to weight these by importance of annuity provider. The spread between the best and worst annuity rate over this period is often about two per cent, but the worst rates may be stale (out-of-date) prices in our sources or prices being offered by firms that were not actually writing business. Evidence from the Continuous Mortality Investigation Bureau suggests that over this period there was considerable variety in mortality experiences of different life offices, and that this persisted over time (CMIR, 1993): it may be the case that some annuity rates were lower simply because annuitants were longer lived.[24] Such differences appear too

[24] We have been unable to test this hypothesis because the Continuous Mortality Investigation Report (CMIR) anonymises the life offices it compares.

large to be sustained in the 21st Century because it is easy to obtain different annuity quotations (as has been seen already it is possible to get quotes for the compulsory purchase market from the FSA). However, over the period for which the historical data were collected, prices of annuities were not easily available (for example, they weren't published in the daily press, although they were reviewed twice in *Which?* magazine, in 1964 and 1970) and many life offices sold annuities on a regional basis through their own sales forces. So we do not view these spreads as evidence of market failure *per se*, although they are clearly consistent with market failure.[25] Figures 4.3 and 4.4 illustrate our estimated spreads for this period.

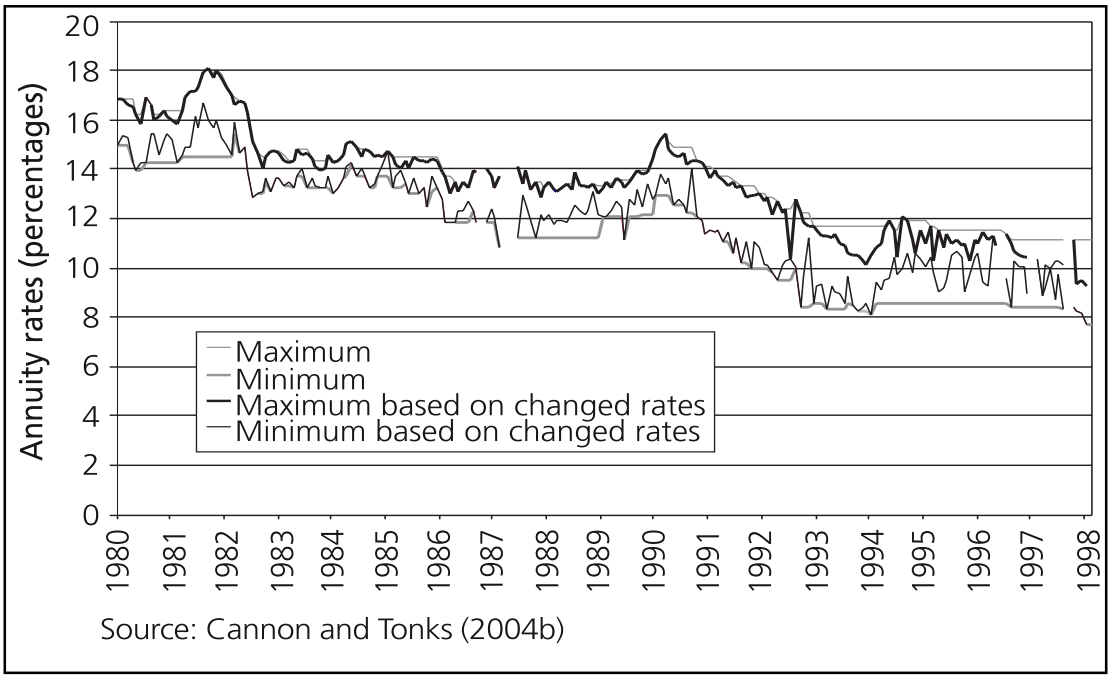
Figure 4.3 Immediate (voluntary) annuity rates for men aged 65, minimum and maximum annuity rates quoted 1957 to 1973



Source: Cannon and Tonks (2004b)

[25] An alternative and more pessimistic view is that for some of our period we may be underestimating the spreads between worst and best annuities because we only have data on the better annuity prices quoted.

Figure 4.4 Immediate (voluntary) annuity rates for men aged 65, minimum and maximum annuity rates quoted 1980 to 1998



Source: Cannon and Tonks (2004b)

In theoretical work on annuities Abel (1986) and Walliser (2002) note that quantities of annuities purchased can be chosen by the purchaser, so that a large pension fund could be split into smaller annuity premiums, and indeed Stark (2002) reports that about one-third of annuitants purchase more than one annuity. This would suggest that life-assurance companies would be unable to offer lower annuity rates for larger purchase prices: they might wish to do so since larger purchase prices would be paid by richer individuals who would be healthier and have systematically higher life expectancy. For very small purchase prices, life-assurance companies might wish to offer lower annuity rates because of the fixed cost of writing an annuity being larger relative to the premium. However, estimates of costs of writing an annuity do not suggest that this cost is high (in the range £25 to £75), so this would not be prohibitive.[26]

Cannon and Tonks (2004b) find some historic evidence for non-linear pricing in the voluntary market for very low purchase prices and minimal non-linear pricing for larger purchase prices, illustrated in Figures 4.5 and 4.6.

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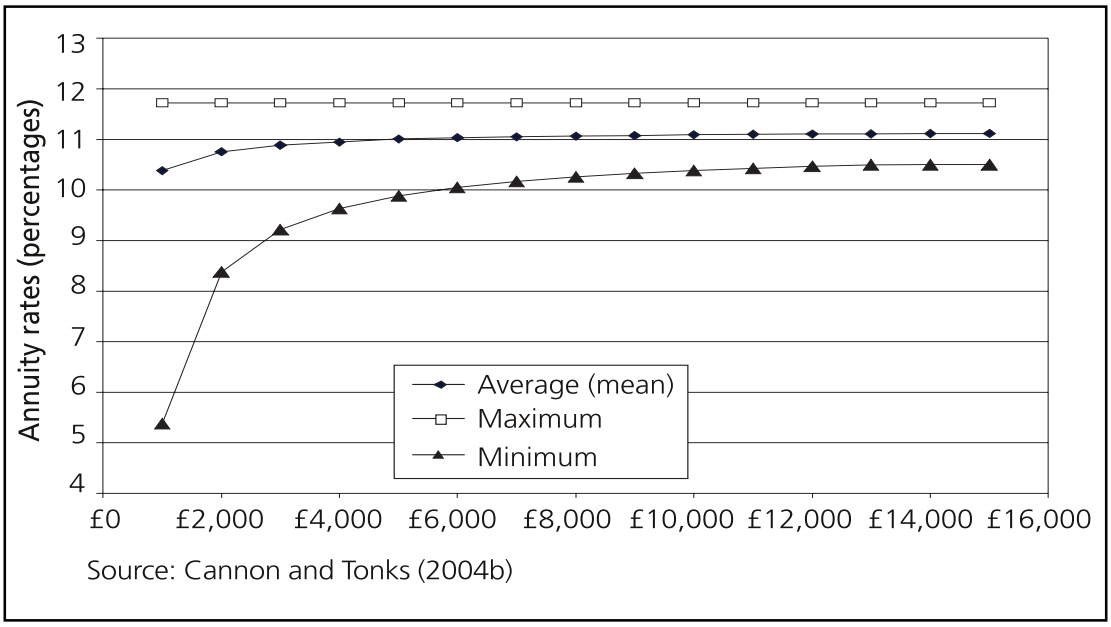
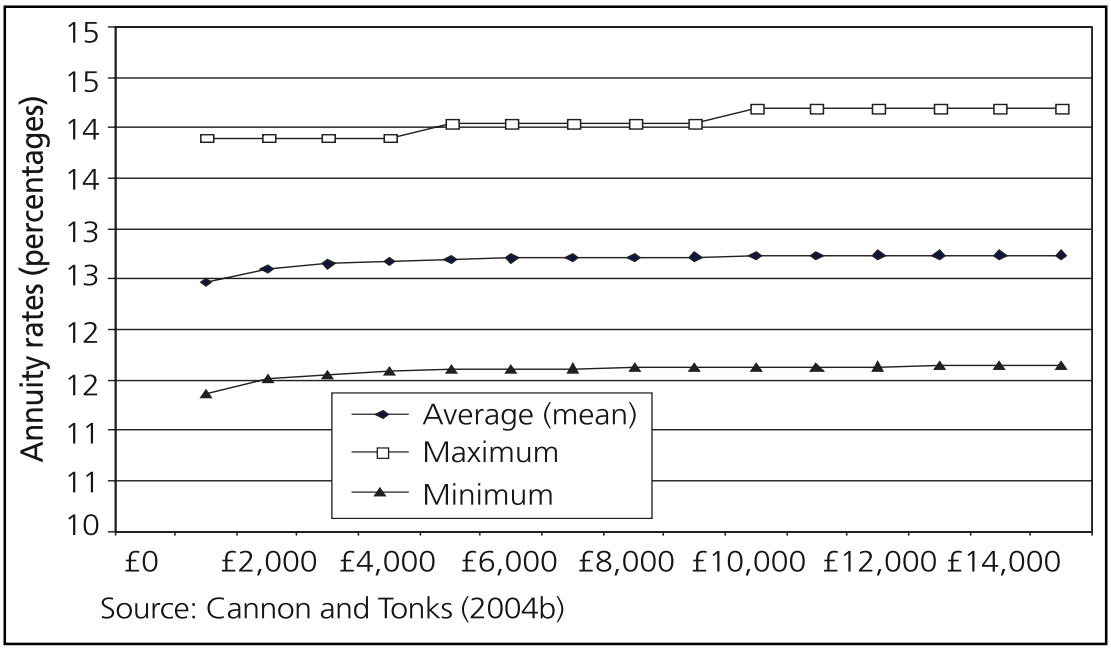
[26] More substantial costs would be ceding costs (these are the administrative costs involved with closing the individual's account with an investment fund in preparation for the purchase of the annuity: they are borne by the life assurer and absorbed into the effective rate of return in the accumulation phase) and brokerage fees, typically one per cent or perhaps two per cent for impaired lives. Brokerage fees (paid to a financial adviser) would not affect the annuity rate offered, but would affect the amount of money an annuitant had to annuitise. In nearly all cases, life assurers will only sell annuities through a financial adviser, mainly to avoid any problems with mis-selling.

Figure 4.5 **Immediate (voluntary) annuity rates for men aged 65, relationship between annuity rate and purchase price, January 1965**



Source: Cannon and Tonks (2004b)

Figure 4.6 **Immediate (voluntary) annuity rates for men aged 65, relationship between annuity rate and purchase price, September 1972**



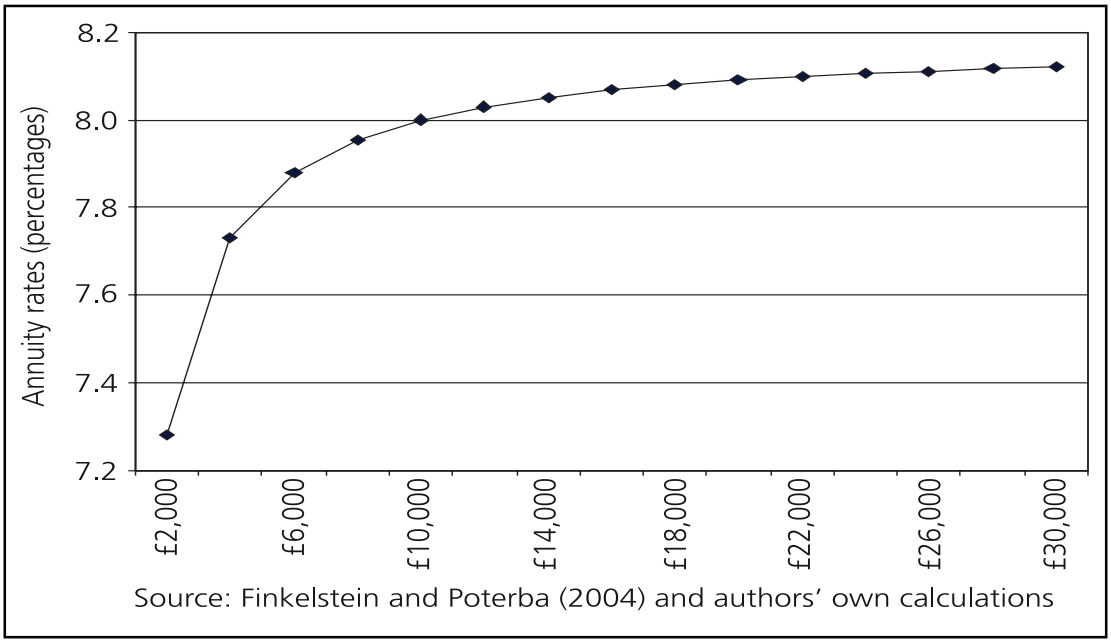
Source: Cannon and Tonks (2004b)

These figures are consistent with the formula in Finkelstein and Poterba (2004) for an anonymous life-assurance company over the period 1981 to 1998: they report that if the annuity rate for a £10,000 purchase is X, then the annuity payment for a purchase of P is:

$$\frac{PX + (P - 10,000)f}{10,000} \tag{4.1}$$

where the policy fee f = £18 in 1998. The average annuity rate in 1998 was eight per cent so suppose that this was the annuity rate offered for a purchase of £10,000. Then the annuity rate would range from 6.38 per cent for a purchase of £1,000 up to 8.12 per cent for a purchase of £30,000. These figures are illustrated in Figure 4.7.

Figure 4.7 Non-linearity in annuity rates in 1998

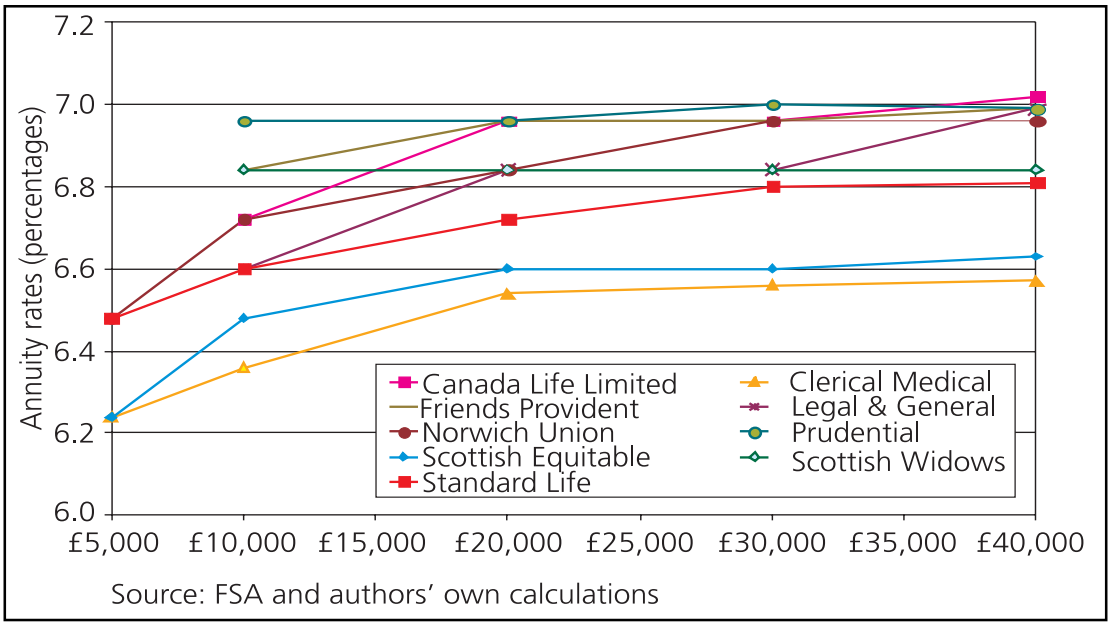


Source: Finkelstein and Poterba (2004) and authors' own calculations

The most recent evidence for the compulsory purchase market is slightly different. Figures 4.8 and 4.9 report annuity rates by purchase price for small and large purchases, respectively, on 29 July in 2005 (these figures are consistent with those shown in Table 4.1). For small purchases the annuity rate rises with purchase price in a way similar to that already reported, although it is noteworthy that the largest overall provider, the Prudential, offers rates that are both highly competitive and flat across all small purchases prices.[27]

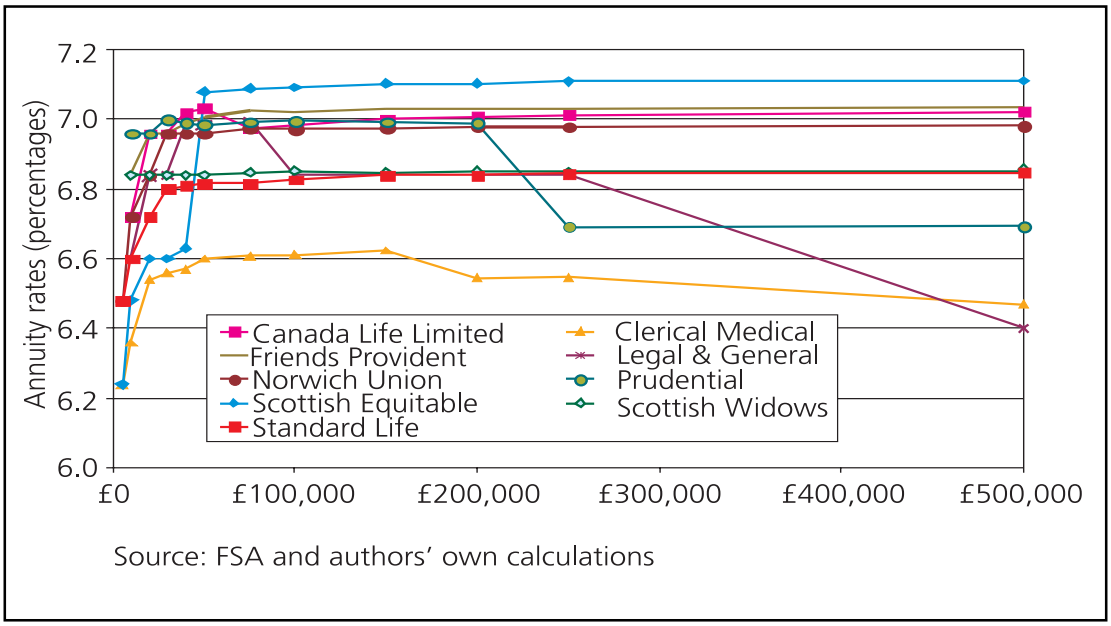
[27] For relative size of different companies, see Chapter 6.

Figure 4.8 **Compulsory purchase annuity rates for men aged 65, July 2005 relationship between annuity rate and purchase price for small purchase prices**



Source: FSA and authors' own calculations

Figure 4.9 **Compulsory purchase annuity rates for men aged 65, July 2005 relationship between annuity rate and purchase price for large purchase prices**



Source: FSA and authors' own calculations

For larger purchases the situation is quite different. Annuity rates are independent of purchase price for most companies but Legal and General, Clerical and Medical and the Prudential offer much lower rates for larger purchases, suggesting a dislike for richer individuals who may be higher risk. It is impossible to determine how much richer individuals can overcome this by splitting their pension fund into several

smaller funds: Stark's (2002) evidence is inconclusive since those individuals who do hold more than one annuity may do so for legal and tax reasons.[28] However, it is clear that not all companies are trying to avoid large purchase prices and Scottish Equitable's annuity rates would seem designed to deter smaller funds in favour of larger ones.

4.3 Money's worth calculations

The most common way to compare the value of annuities with other assets is to use a measure called the **money's worth**.[29] This is the value of the expected annuity payments that would be received if the annuity were purchased with £1. If the money's worth is £1 then the annuity is perfectly fairly priced in actuarial terms (and the life-assurance company receives no money for administrative costs or profit). Given that the life-assurance company incurs some costs and has to make some profit, we should expect the money's worth to be a little less than one.

To illustrate this concept, consider the simple arithmetic example of an annuitant who will live at most three periods and who buys an annuity paying 40 pence per period for a single premium of £1. The interest rate each period is ten per cent.

Table 4.3 Example of money's worth calculation

Period	Probability of being alive in this period	Present value of 40p annuity payment	Expected present value of 40p annuity payment
1	1	$\frac{40}{1.10}$	$1 \times \frac{40}{1.10} = 36.4$
2	0.6	$\frac{40}{(1.10)^2}$	$0.6 \times \frac{40}{(1.10)^2} = 19.8$
3	0.3	$\frac{40}{(1.10)^3}$	$0.3 \times \frac{40}{(1.10)^3} = 9.0$

[28] Some personal pension plans, connected with contracting out, have received preferential tax treatment on the condition that they are annuitised using unisex tables for a joint life annuity (this has also needed to be an inflation-indexed annuity, although this requirement is being dropped from 2005). A male annuitant would rationally annuitise any pension fund not liable to these restrictions at the better male annuity rate (and might also prefer to avoid buying a joint life annuity).

[29] A less-commonly used method is to calculate the internal rate of return implied by an annuity rate. The advantage of this approach is that it is necessary only to project life expectancies and no assumptions about interest rates are necessary.

The total of the expected payments, calculated in present value terms, is 36.4 + 19.8 + 9.0 = 65.2, so the money's worth is just over 65 pence in the pound, sometimes expressed as a fraction of 0.65. If the life-assurance company had a large number of customers then this would mean that 65 pence out of every £1 would be paid back to the annuitants and 35 pence would go to the life-assurance company, either to cover costs or as profit.

Mitchell *et al.* (1999) have used the money's worth procedure to analyse the annuities market in the USA and similar exercises have been conducted by Murthi, Orszag and Orszag (1999), Finkelstein and Poterba (2002, 2004) and Cannon and Tonks (2004a) to analyse the UK annuity market. For a general discussion of the calculation of the money's worth, see the introduction to the collection of papers in Brown *et al.* (2001).

To calculate money's worth: define the annuity rate z as the payment made per year of an annuity that costs £1 to buy. The money's worth for a level annuity can be written as:

$$MW = z\left\{\sum_{t=0}^{T} p_t R(t)\right\} \tag{4.2}$$

where notation is that used in section 3: recall that p_t is the probability of surviving from age zero to age t, $(p_0=1)$; T is the maximum longevity; and $R(t)$ is the continuously compounded rate of return from the point of retirement to period t. With a guaranteed annuity the first five years' payments are made regardless of the annuitant's death, so in this case the money's worth can be written as:

$$MW = z\left\{\sum_{k=0}^{4} R(t) + \sum_{t=5}^{T} p_t R(t)\right\} \tag{4.3}$$

There are two ways to implement these money's worth calculations, which Cannon and Tonks (2004a) refer to as *ex ante* and *ex post*. *Ex ante* implementation uses expectations of interest rates and survival probabilities that were available at the time when the annuity was sold, i.e. historic expectations information. Since life-assurance companies usually back their annuity liabilities with bond assets of appropriate maturity[30] it is probably appropriate to use historic yield curves for the interest rates anyway. The Bank of England does not publish detailed yield curve data for years before 1980 and Cannon and Tonks reconstructed the relevant figures from contemporaneous term structures information available in hard copy. So, for example, the interest rates used to value an annuity sold in 1957 are the implicit rates in the 1957 yield curve. Apart from consistency across time, this approach has the advantage that it can be compared directly with Mitchell *et al.* (1999), Murthi *et al.* (1991) and Finkelstein and Poterba (2002), who all estimated money's worths at given dates using the appropriate yield curves.

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[30] For a discussion of this, see Chapter 6.

Ex ante mortality projections were taken from the various tables (four in the period 1957 to 2002) published by the Continuous Mortality Investigation Committee (CMIC). A census of life offices is taken every four years and the aggregate data published with a lag of between three and five years, the delay presumably being due to the time taken to collect the data in a satisfactory format and, on a less regular basis, CMIC publishes a statistical analysis of the data and proposes new standard tables which include projections of future improvements in mortality. Since it is impossible to know the precise date at which various life-assurance companies moved from one set of projections to another, estimates for the money's worth using both sets of tables were provided for likely transition years.

Finkelstein and Poterba (2002) calculate the money's worth using two sets of mortality statistics: one based on 'Lives', Immediate Male Lives (IML), calculated as a simple average of mortality experience and one based on 'Amounts', Immediate Male Amounts (IMA), calculated as a weighted average of mortality experience where the weights are the size of the policy. Because of selection and socio-economic effects, we should expect the money's worth calculated on Lives mortality to be lower, which is borne out in the analysis of both Finkelstein and Poterba (2002) and ourselves. Unfortunately, the mortality statistics for immediate annuitants were not published on both bases until the IML/A92 tables of 1999, so it is impossible to undertake this comparison before that year.

In addition to the *ex ante* estimates of the money's worth Cannon and Tonks also calculate *ex post* money's worth using the actual one-year interest rate and actual mortality experiences of annuitants.[31] For the later years (mortality after 1998 and interest rates after 2004) actual data do not exist and appropriate projections are used, meaning that *ex post* estimates for the later years are really a mixture of *ex post* and *ex ante*: for 1992, the proportion of the money's worth for a man aged 65 based on actual data is approximately 75 per cent and that on estimates is the remaining 25 per cent.

Cannon and Tonks' estimates of the money's worth are reproduced in Table 4.4. In all cases the money's worth is very close to unity, implying that annuities were sold at a rate which was approximately fair in actuarial terms. To obtain a single statistic on the money's worth over the whole sample, it is necessary to splice together the guaranteed and non-guaranteed annuity series. There are two overlap years (1972 and 1973), where we have annuity rates for both five-year guaranteed and non-guaranteed annuities, and the ratio between these is 0.94. Combining these two series the overall mean value of the money's worth is 0.98, which is statistically significantly different from unity, but it is arguable whether the difference is economically significant. Of course, these money's worth calculations are based on annuity rates which are themselves a simple average of different companies' prices: the money's worth for the companies quoting the highest rates would have been very good indeed.

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[31] Data for 1999-2002 mortality experiences were not available until after the Cannon and Tonks paper was published in 2004.

In line with Finkelstein and Poterba (2002), we also calculate the money's worth using population rather than annuitant mortality: consistent with them this shows a much lower money's worth. This follows directly from the fact that population mortality is higher than annuitant mortality (conversely, population life expectancy is lower than annuitant life expectancy). This could be due to adverse selection or merely due to the fact that annuitants tend to be richer, and hence, healthier, than the general population. Since Cannon and Tonks (2004a) are analysing the voluntary-purchase market, both adverse selection and wealth/health effects are likely to be present. Finkelstein and Poterba (2002) suggest that there may also be some adverse selection effects in the compulsory-purchase market, although it may not be so severe: in the latter market it is likely that wealth and health effects are quantitatively more important. We shall discuss this point in more detail below.

Table 4.4 Ex ante money's worth of UK annuities, male, aged 65, 1957-2002

Years	Type of annuity	Actuarial table	Mean MW	95 per cent confidence interval	Test
Panel A					
1957-1973	No guarantee	a(55)	1.034	1.001 - 1.066	0.042
1972-2002	Five-year guarantee	Various	0.985	0.963 - 1.008	0.187
1972-1980	Five-year guarantee	a(55)	1.004	0.942 - 1.066	0.887
1978-1991	Five-year guarantee	a(90)	0.978	0.955 - 1.001	0.060
1990-1999	Five-year guarantee	IM80	0.985	0.954 - 1.017	0.316
1990-2002	Five-year guarantee	IM80	0.976	0.951 - 1.002	0.064
1957-2002	No guarantee spliced with five-year guarantee	Various	0.981	0.965 - 0.998	0.028
Panel B					
1972-2002	Five-year guarantee	Population	0.956	0.975 - 0.937	

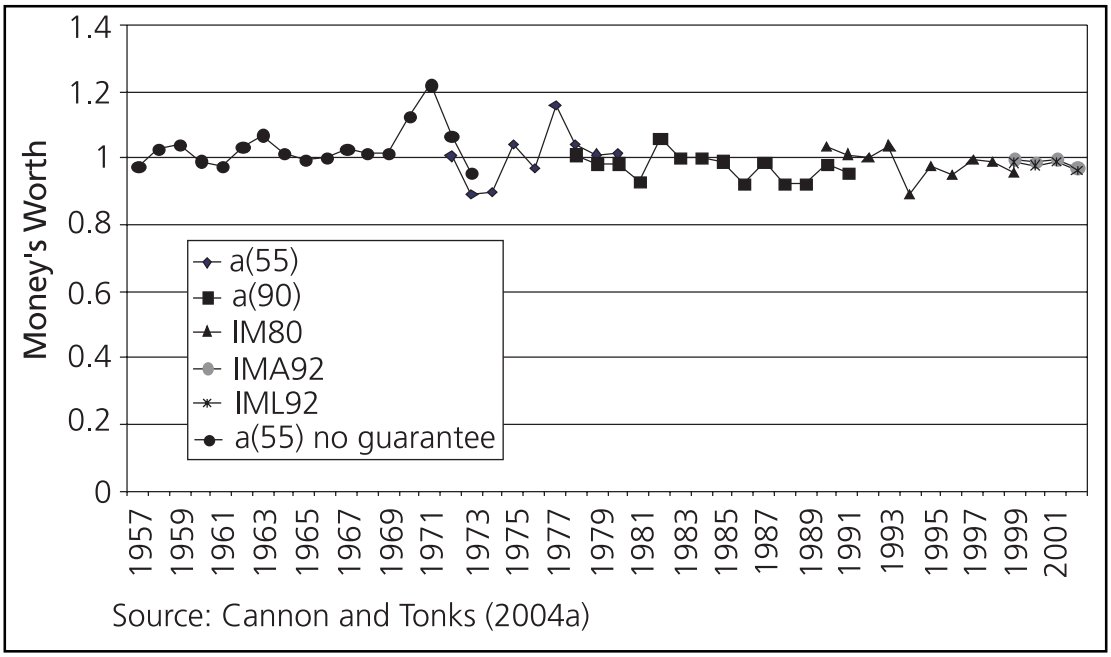
Panel A computes the money's worth over different sub-samples of the dataset. 'Test' reports the p-value of a (two-tailed) t-test for whether the average money's worth is significantly different from unity. Panel B computes money's worth using population life tables to assess the degree of selection.

The *ex ante* money's worth from Cannon and Tonks (2004a) is illustrated in Figure 4.10. It is clear that while the money's worth has varied it has remained within a band of just under 90 pence and 110 pence per £1. Both of the more recent revisions to the mortality projections illustrated have shown increases in the money's worth, i.e. actuaries believe that they have underestimated increases in life expectancy. It is noteworthy, however, that actuaries have not always underestimated increases in longevity and the improvements projected in the a(55) tables were not realised.[32]

[32] These improvements (for both male and female mortality rates) were based upon the actual improvements in female annuitant mortality over the period 1880-1945: the data for male mortality over this period was too variable to be used for a projection. Note that the number of female annuities in force over that period was considerably larger than the number of male annuities.

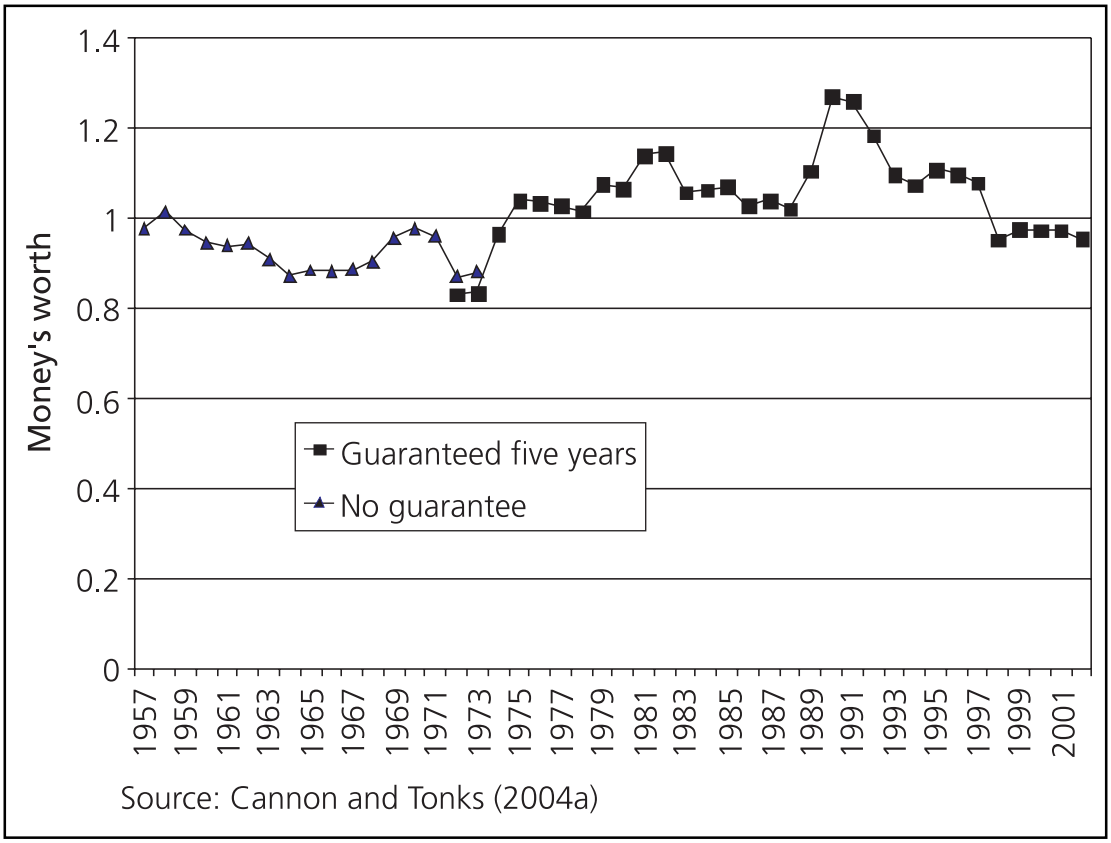
The corresponding *ex post* money's worths are shown in Figure 4.11 for comparison and also suggest that the historical norm is about £1.

Figure 4.10 ***Ex ante*** **money's worth for annuities, male, aged 65**



Source: Cannon and Tonks (2004a)

Figure 4.11 ***Ex post*** **money's worth for annuities, male, aged 65**



Source: Cannon and Tonks (2004a)

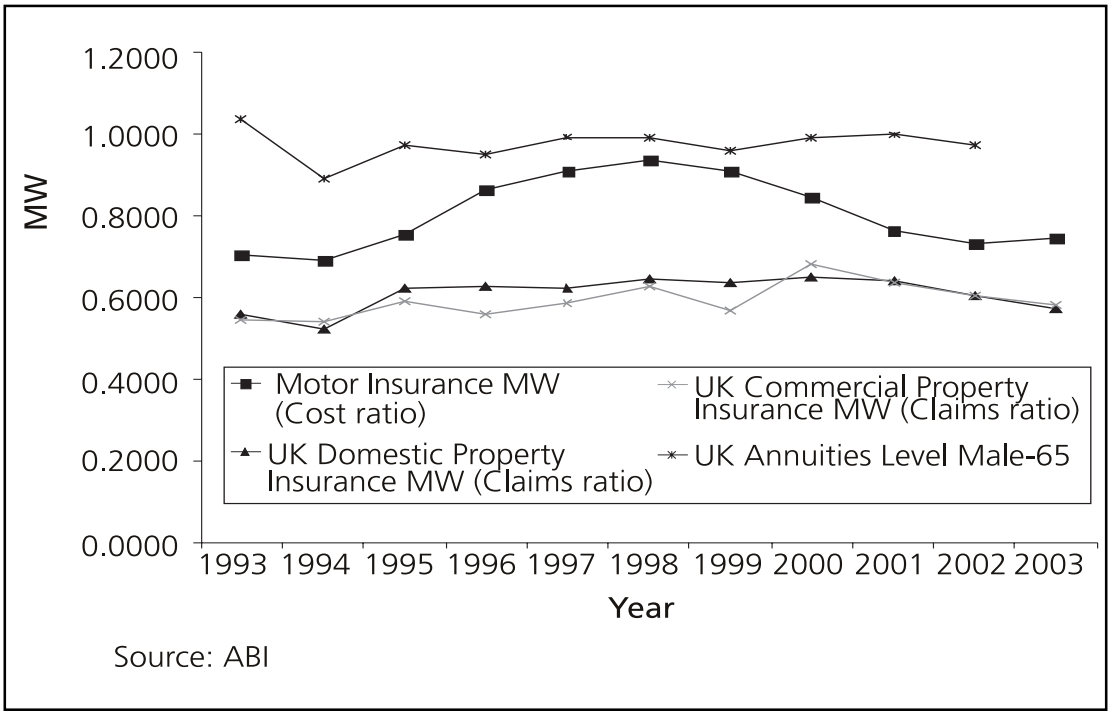
These results are very similar to the cross-sectional analysis of Finkelstein and Poterba (2002) and Murthi *et al.* (1999). The former found the money's worth to be 98.80 pence and the latter 93.2 pence in 1998, compared with our *ex ante* figure of 98.9 pence. Murthi *et al.* (1999) also provide estimates of 99.6 pence in 1990 and 92.1 pence in 1994; our analogous figures are 98 pence[33] and 89 pence. But our evidence is that over the whole period 1957-2002, the average money's worth is much closer to unity than the snapshot evidence of the earlier work for specific years in the 1990s. Murthi *et al.* (1999) categorise three types of costs in pension schemes: costs during the accumulation phase, costs during ceding, and the loading on the annuity (i.e. the difference between the money's worth and unity). They find that the loading is the smallest of these three costs.

James (2000) examines the cost of investing in a variety of retail investment products in the UK, and finds that to get the market rate of return on £1, a consumer would have to invest £1.50 in a managed fund, and between £1.10 and £1.25 in an index tracker. These figures imply a money's worth of 0.66 for a managed fund, and less than 0.91 for a tracker. This suggests that it is during the accumulation phase that charges from the insurance companies have a significant reduction on the effective rate of return and not in the decumulation phase.

How does the money's worth of annuities compare with the value of other insurance products? The Association of British Insurers (ABI) have provided us with estimates of the premiums paid, and the claims made for a number of insurance markets: motor, domestic property and commercial property insurance over the period 1993-2003. The ratio of the value of claims to premiums paid is a crude measure of the money's worth of these insurance products. We plot these ratios for each year for level annuities for 65 year-old males, and for the three general insurance products in Figure 4.12. It can be seen that the money's worth of annuities is consistently higher than the other insurance products.

[33] The figure of 98 pence for 1990 is based upon the money's worth calculated using the a(90) table. Using the IM80 table, which was just available in that year, the figure would be 103 pence.

Figure 4.12 Money's worth of alternative insurance products 1993-2003



Source: ABI

4.4 Theory of adverse selection in annuity markets

It is well known to actuaries that there are selection effects in annuities markets. In discussing the Millard Tucker Report in 1954, *The Economist* notes: *'the purchase of an ordinary life annuity has become highly imprudent to anyone…unless he rates his expectation of life very highly'* (*The Economist*, 20th February 1954, p.554). In summarising the Finance Act 1956, the Institute of Actuaries recognised that *'in the case of self-employed contracts one favourable factor was that there should be less self-selection than in the case of immediate annuity purchases'* (*Journal of Institute of Actuaries, LXXXIII,* 1957, p.19).

Within economic theory the importance of adverse selection has been recognised since the 1970s within the more general context of the effects of asymmetric information. However, while there is widespread agreement that adverse selection is likely to be present in the annuities market, two different models have been suggested. The difference between the models hinges on whether firms are able to specify different annuity prices for purchases of annuities of different sizes: in particular, whether annuity providers can offer lower annuity rates to larger annuity purchases. The evidence reviewed in Section 4.2 suggests that this is not occurring in practice.

We now briefly present the two different models of adverse selection in annuity markets. In each case we shall build upon the simple models presented above, where agents live for one period with complete certainty and for a second period with some probability p_i, where i varies between individuals and is known to the individual alone (neither the insurance company nor any government regulator

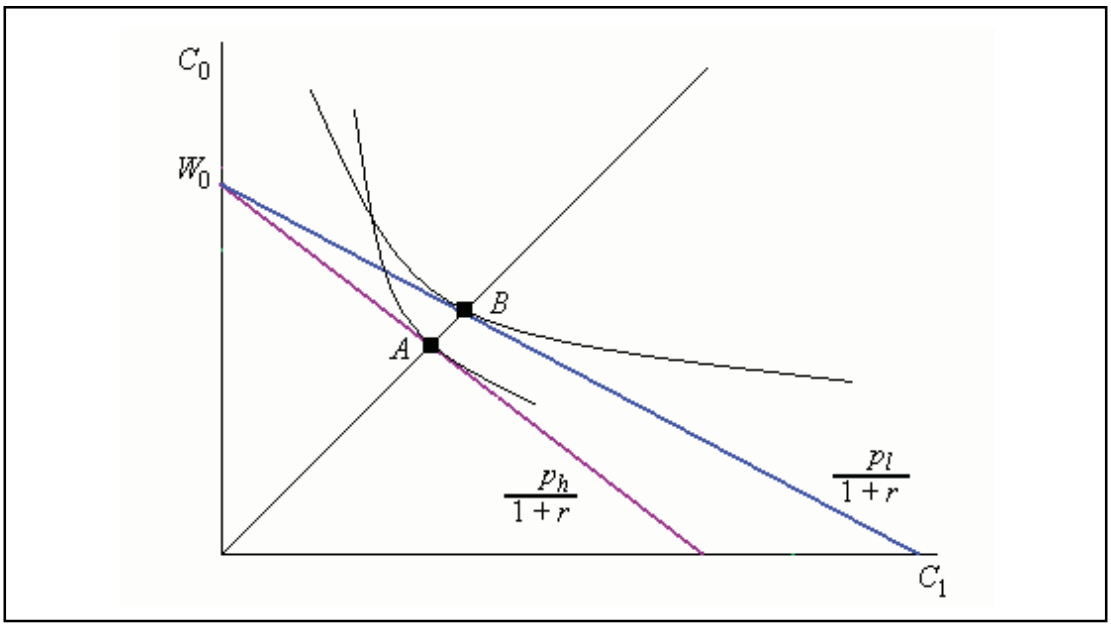
knows any individual's p_i). The distribution of the p_i is common knowledge. An important consideration is whether agents differ in any other respect: typically it is assumed that they do not. A more natural assumption might be that agents with higher life expectancy (higher p_i) would also be richer and have a larger sum of money (larger W) to annuitise. We shall discuss the relevance of this later.

4.4.1 The Eckstein-Eichenbaum-Peled approach

Eckstein, Eichenbaum and Peled (1985) assume that there are just two types of agent (this is a simplifying assumption) who are identical except for different survival probabilities. As noted in our discussion of annuity theory earlier, the slope of an individual's indifference curve depends upon p_i, so individuals with low life expectancy (i.e. low-risk individuals so far as insurance companies are concerned, with low values of p_i) will tend to have flatter indifference curves and be offered better annuity rates.

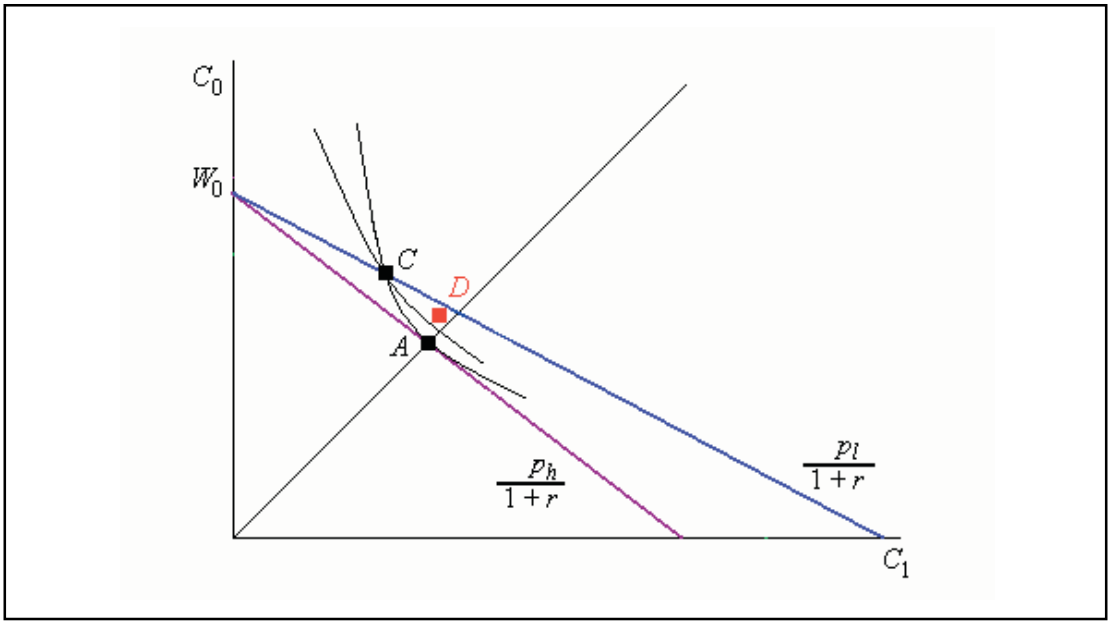
If there were perfect information so that high- and low-risk individuals could be offered different contracts, then the situation that we should expect to see is that illustrated in Figure 4.13. Low life-expectancy individuals can purchase contracts on the blue line at point B and high life expectancy individuals can purchase contracts on the (less generous) purple line at point A. So the result with perfect information would be full annuitisation. (For simplicity we have assumed that both types would prefer to choose equal consumption in both periods, resulting in their indifference curves being tangent to the different budget constraints on the 45 line.) However, since the annuity provider cannot distinguish the high-risk individuals from the low-risk individuals this is not possible: if the life assurer offered contract B (designed only for low life-expectancy individuals), then everyone would choose the more generous contract, in which case the annuity company would make a loss.

Figure 4.13 A perfect-information separating equilibrium



The solution proposed by Eckstein *et al.* (1985) is that two forms of annuity contract are provided, namely at points A and C in the Figure 4.14. High-risk individuals are indifferent between points A and C and so can choose contract A, which means that annuity providers will break even on these contracts. Low-risk individuals have flatter indifference curves and, therefore, strictly prefer point C at which point the insurance company is also breaking even. Low-risk individuals may also be able to increase their utility by saving some of their wealth in a conventional bond, but clearly they would be less well off than they would be if they could fully annuitise. This potential solution is called a 'separating equilibrium' – assuming that it is in fact an equilibrium.

Figure 4.14 A potential separating equilibrium with adverse selection



Unfortunately, it is not clear whether this is an equilibrium. If contracts A and C were being provided, and a new annuity provider offered a contract at point D, it would clearly be purchased by everyone in the market, since it is preferable to A for high-risk and C for low-risk individuals, respectively. A contract which is purchased by both high- and low-risk individuals is a 'pooling' contract. The question then is whether any new annuity provider would offer such a contract.

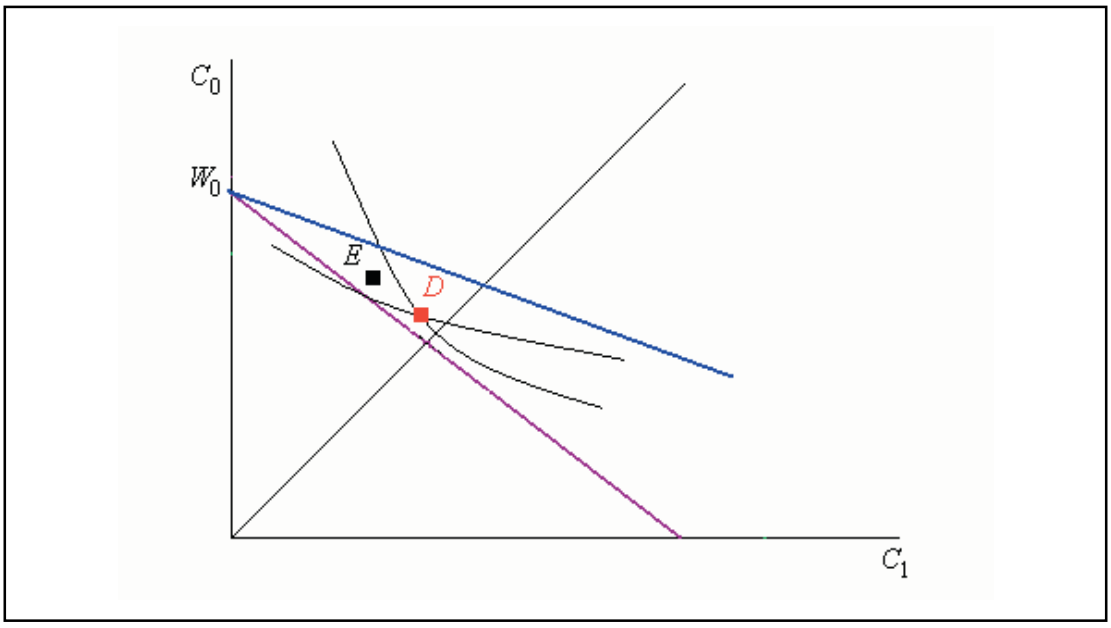
A necessary condition is that such a contract at least breaks even. Writing the proportions of high- and low-risk individuals as ψ_h and $\psi_l = 1 - \psi_h$, then the firm will break even so long as it offers an annuity rate:

$$z \leq \frac{\psi_h p_h + (1-\psi_h) p_l}{1+r}. \tag{4.4}$$

If ψ_h is relatively high, then points such as D will not make a profit and hence such contracts will not be offered. But if ψ_h is relatively low, then a point such as D would make a profit, so it might be offered and it would not be possible to have a separating equilibrium.

This suggests that there might be a 'pooling equilibrium', where one contract is offered which is purchased by both high- and low- risk individuals. In fact this is not possible, because no pooling equilibrium can exist. To see why this is, consider the potential pooling contract at point D in the Figure 4.15.

Figure 4.15 Non-existence of a pooling equilibrium



It is now possible for another annuity provider to offer a contract at a point such as E, which has the property that high-risk individuals prefer D to E, while low-risk individuals prefer E to D: in addition to this, it is clear that the contract at point E makes a profit if only low-risk individuals purchase it. Since all of the low-risk individuals would purchase E in preference to D, the annuity provider offering D, would make a loss and, hence, such a contract could not be offered. It follows that a pooling equilibrium cannot exist.[34]

[34] This also suggests that if there were originally a separating equilibrium then no firm would offer the contract at D, since they would rationally anticipate that it would not be sustainable. Further analysis on this point requires a more sophisticated discussion of game-theoretic equilibrium concepts than we attempt here: for details see Eckstein, Eichenbaum and Peled (1985). The key conclusions are unaltered: a pooling equilibrium is never possible and a separating equilibrium can exist under some circumstances.

The conclusion from this analysis is that adverse selection will lead to under-insurance and a less efficient outcome than would be the case if there were perfect information. All individuals will put some of their wealth in an annuity product but that some (low-risk) individuals many choose to put some more of their wealth in a conventional bond (thus resulting in less than full annuitisation).

The problem with this approach is that it assumes insurance companies specifies contracts such as A, B or C. This means that different prices are related to different size of purchase, that larger purchases are offered poorer annuity rates, and that only certain purchase sizes are allowed. However, this is not an appropriate characterisation of the annuity market, because the evidence reviewed already suggests that most annuity providers do not use size of purchase to separate high and low risk types in this way. Furthermore, note that annuity companies cannot observe whether individuals are purchasing multiple annuities from different companies and so cannot observe the total amount of wealth being annuitised, which is crucial to the analysis of Eckstein *et al.* (1985). We now turn to a model where annuity providers quote a price and allow individuals to make any size of annuity purchase.

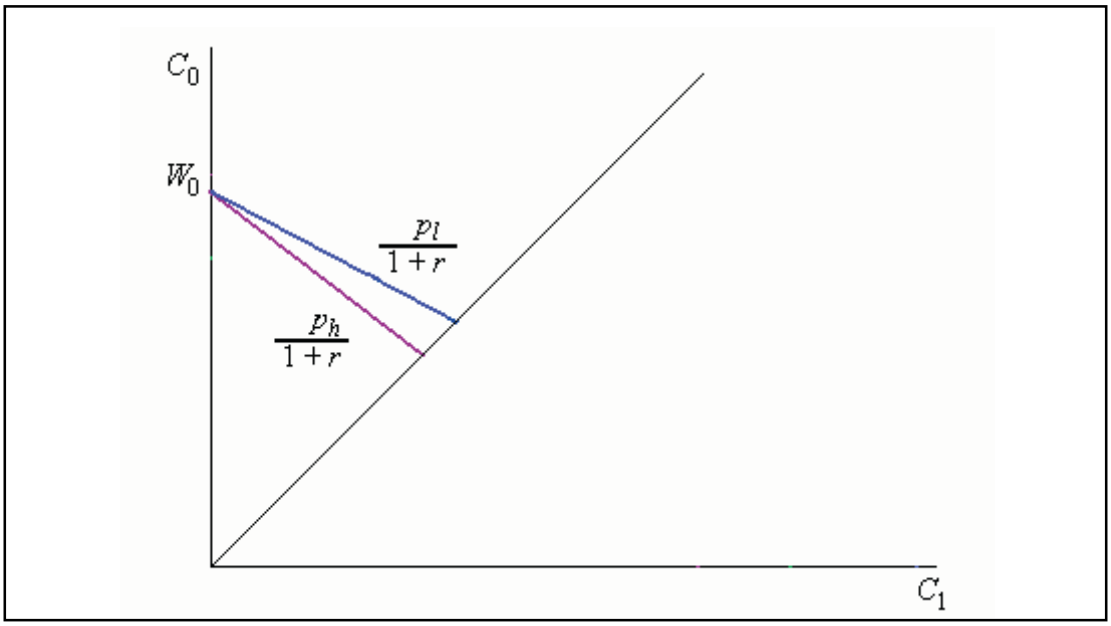
4.4.2 The adverse selection models of Abel and Walliser

This type of model was first suggested by Abel (1986) and has been extended by Walliser (2000). The latter also makes a further change in the model: so far we have assumed that high- and low-risk individuals are the same in all respects, but Walliser notes that high-risk (i.e. long life expectancy) individuals will also tend to be richer and hence have a higher W.[35]

Suppose that annuity providers offer an annuity rate at which anyone can purchase any quantity of an annuity. Two extreme cases are that the annuity rate offered would be those at which the annuity provider would break even if either everyone were high-risk or everyone were low-risk. We shall also assume that no individual can sell annuities. Then the two possibilities are illustrated in Figure 4.16 in the blue and purple lines respectively.

[35] A further complication arises if such individuals also have different tastes: for example, inherently prudent individuals might have longer life expectancy, more patience (lower subjective discount rate) and be more risk averse.

Figure 4.16 Potential annuity contracts when annuity rates are independent of purchase price



With the annuity rate set to be appropriate for low-risk individuals (on the purple line) the annuity provider would get a mixture of high- and low-risk individuals purchasing annuities and, hence, make a profit; with the annuity rate set to be appropriate for high-risk individuals (on the blue line) the annuity provider would definitely make a loss. With fairly weak assumptions about preferences, there will be at least one annuity rate somewhere between these two annuity rates where the annuity provider will break even.[36] Writing the equilibrium annuity rate as z, we can say that:

$$1+r < \frac{1+r}{p_h} < z < \frac{1+r}{p_l}, \tag{4.5}$$

and that the annuity rate is determined by the break-even condition:

$$\frac{\psi_h p_h a(z, W_h, p_h) + \psi_l p_l a(z, W_l, p_l)}{1+r} = z, \tag{4.6}$$

where, as defined above, and are the proportions of high- and low-risk individuals in the population. The average population survival probability is then:

$$\overline{p} = \psi_h p_h + \psi_l p_l, \tag{4.7}$$

---

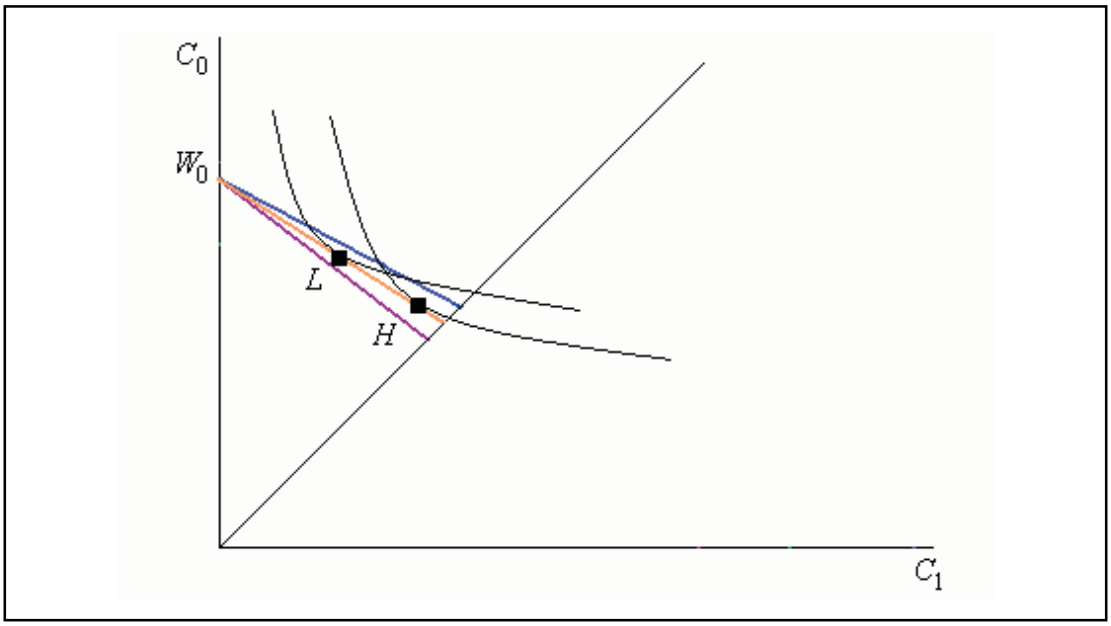
[36] Continuity of preferences would be sufficient for existence of an equilibrium. It is possible for there to be multiple annuity rates that would break even. Presumably in this case, competition would force annuity providers to offer the highest of these multiple alternatives, although this is not discussed fully in either Abel or Walliser (although see Abel, n.12).

and Abel (1986) shows that[37]:

$$\frac{1+r}{p_h} < z < \frac{1+r}{\bar{p}}, \tag{4.8}$$

which follows because high-risk individuals will tend to make larger annuity purchases than low-risk individuals as shown in Figure 4.17.

Figure 4.17 Pooling equilibrium and adverse selection in Abel's model



Allowing high-risk individuals also to have more wealth will reinforce this tendency. Finkelstein and Poterba (2002) suggest that there may also be some separation because of the ability to purchase different types of annuities: individuals with low life expectancy would prefer front-loaded (e.g. level (i.e. nominal) annuities) or guaranteed annuities, while individuals with high life expectancy would prefer real or escalating annuities.

The conclusion from this model is that all agents would choose to buy an annuity and all would be fully annuitised (none would choose to purchase bonds). So it might appear that this model provides no more realistic conclusions than the Eckstein-Eichenbaum-Peled model, even if the assumptions are more realistic. But a further very important extension would also explain why some agents would buy no annuity at all.

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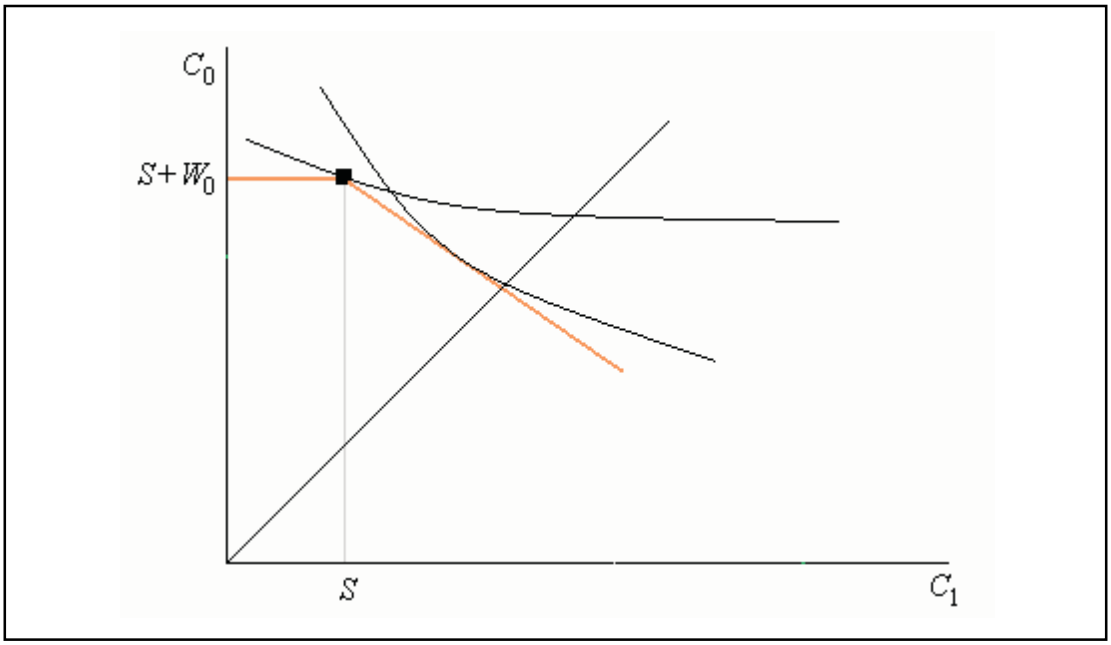
[37] Note that in Abel's notation p is the probability of dying, whereas in our notation it is the probability of living: the equation here is in **our** notation.

Suppose agents received a state pension of s per period for the duration of their life, i.e. a life contingent form of income (if agents received an occupational pension the effect would be the same). We shall discuss the full conclusions of this in Chapter 5. But to see how it would affect a market with adverse selection, consider a redrawn utility diagram where the budget constraint has a kink, as shown in Figure 4.18.

Figure 4.18 Adverse selection and welfare payments



In this example, high-risk individuals would prefer to annuitise their wealth, but low-risk individuals would prefer not to do so. The reason for this is that, as we have already seen, low-risk individuals would prefer to purchase a smaller annuity than high-risk individuals. Because low-risk individuals have flatter indifference curves, they would prefer to consume more in period 0 and less in period 1 than is provided for by the state pension. As they are unable to sell annuities, they are forced to choose to consume on the kink of the budget constraint. Hence, annuities are only sold to high-risk individuals (resulting in z being based on the mortality experience of only a subset of the population).

The conclusions of this extended adverse selection model can then be summarised as follows:

- in the presence of a state pension, individuals with low life expectancy may choose not to purchase any annuities because their wealth (predominantly the state pension) is already in annuity form. This would mean that annuitants would have longer life expectancy than non-annuitants;

- among individuals who do choose to annuitise, the lowest risk individuals will tend to make smaller purchases, so that the actual annuity rate will be lower than one based on the average life expectancy of all annuitants.[38] There are two-corollaries of this:
  - if annuitant mortality tables (based on mortality by 'Lives') are used to calculate break-even annuity rates, then these should be higher than observed annuity rates (i.e. the money's worth is less than one). Of course this would also be true if there were significant administrative costs of annuity provision; and
  - if annuitant life tables are available both on a 'Lives' and an 'Amounts' basis, then life expectancy should be larger for Amounts than Lives;
- these effects will all be reinforced if high-risk (long life expectancy) individuals are richer.

4.5 Evidence of adverse selection

Warshawsky (1988) suggests that differences in the money's worth calculation from using population life tables and annuitant life tables is a measure of adverse selection in annuity markets. Individuals who expect to live for a long time are more likely to purchase annuities, and the annuity providers recognise these incentives, and price annuities to incorporate these adverse selection problems, but in doing so, annuities are priced relatively highly and may exclude from the annuities market some low-risk (short-lived) individuals. Finkelstein and Poterba (2002) note that differences in the money's worth are not necessarily a measure of adverse selection, since adverse selection involves active selection by the annuitant, and the difference in money's worth may also be measuring passive selection. The difference between active and passive selection is that active selection occurs when annuitants purchase annuities because they have private information not available to the insurance company (i.e. that their life expectancy is longer than the population average). In contrast, passive selection reflects the fact that 'careful' persons are likely to purchase annuities. That is, the characteristics of people who purchase annuities are different from the general population, and long life expectancy may be correlated with the underlying characteristics. For example, it may be the wealthy who purchase annuities, and wealth is correlated with life expectancy.

Taking into account Finkelstein and Poterba's point about active and passive selection, we will refer to these effects as selection effects. Table 4.5 summarises a number of studies' empirical findings on money's worth and the extent of selection effects in a number of international annuity markets for males and females aged 65

[38] In the models presented in the text, we have only considered the possibility that there are two types of individual. In a model with many types, the lowest risk types will purchase no annuities and among the types that do purchase annuities, the size of annuity purchase will depend postively upon life expectancy.

years. Focusing first on the UK, the earlier reported results on money's worth for a 65-year old male with a level single annuity guaranteed for five years averaged over all years from 1972-2002 is 98.5 per cent of the purchase price using the life tables of annuitants. Instead, we may calculate the money's worth using the survival probabilities of the general population, which will tend to be lower than for annuitants. For the period 1972-2002, we have calculated the average of the money's worth series based upon population mortality. The population life tables are obtained from English Life Tables no. 15 (published in 1997, based on the 1991 Census). The mean value of the money's worth calculated using population life tables has a value of 95.6 per cent. The difference in means of money's worth over the period 1972-2002 using annuitants and population life tables, representing a selection effect, is 2.9 per cent.[39]

This means that the financial value of annuity for an actual annuitant would have been about three per cent more than it would have been for an 'average' member of the general population, the difference arising through the higher life expectancy of the annuitant. Of course, the fact that annuitants live longer than the general population is evidence for selection – although whether this is primarily adverse selection or passive selection is less certain.

The figure of 2.9 per cent is low relative to the findings of Finkelstein and Poterba (2002) who find that a 65-year old male annuitant who faces the annuitants' life tables receives a 14.2 per cent increase in the money's worth over an annuitant who faces the population life table. The Finkelstein and Poterba (2002) results are for a particular point in time in 1998, and the Cannon and Tonks results are an average over a much longer time-period. On the other hand, Cannon and Tonks' selection effects may not be as pronounced as Finkelstein and Poterba (2002), possibly because (i) the population life projections in Cannon and Tonks (2004) were too generous in projecting reductions in mortality; and (ii) Cannon and Tonks (2004a) are actually using *ex post* mortality for some of the period. On the other hand the finding of only a small degree of adverse selection over the time series is consistent with their earlier findings that the money's worth over the whole period is only slightly less than unity.

Furthermore, Finkelstein and Poterba find that the money's worth of escalating or indexed annuities are particularly poor value. This may be due to there being higher costs of providing escalating or indexed annuities, due to an absence of matching index-linked assets for the annuity provider to purchase, which is not fully taken account of in Finkelstein and Poterba's calculations. A second explanation may be due to myopia, but this need not be irrational since relatively short-lived individuals are unlikely to live long enough to benefit from the inflation protection, as was illustrated in Table 4.2. This would be a further example of the phenomenon of

[39] This difference is statistically significant, since the t-statistic on the difference is 2.13.

adverse selection, where individuals have better knowledge about their life expectancy than the life assurer. Because these different types choose to buy different types of annuity, life expectancy varies systematically with annuity type and life assurers price their annuities accordingly. Lopes (2003) uses this low money's worth of real annuities (0.749), to show that in an empirically parameterised dynamic optimisation model, risk averse individuals will not wish to purchase real annuities, because of their unfair prices.

In support of the view that adverse selection may have been less important in the earlier time periods, Cannon and Tonks (2004a) make use of information on guaranteed and non-guaranteed annuities from the early 70s. Finkelstein and Poterba (2002, Table 5, p. 46) suggest that under adverse selection, long-lived individuals will self-select into non-guaranteed annuities, and short-lived individuals will self-select into guaranteed annuities, which pay an income into the annuitant's estate even after death. They find in their cross-section sample for 1998 (using population life tables) that the money's worth is **lower** for the non-guaranteed annuity than guaranteed which is consistent with the presence of adverse selection in the non-guaranteed annuities market. In Cannon and Tonks' data sample for 1972 and 1973 there is information on annuity rates for both five-year guaranteed and non-guaranteed annuities, and as can be seen from Figure 4.9, the data suggests that the money's worth of non-guaranteed is **higher** than for the five-year guaranteed for the two overlapping years 1972 and 1973. This suggests that in 1972 and 1973 there was no evidence of adverse selection in the annuities markets. They are not quite comparing like-for-like, since the annuity rates are for different samples of firms and the data for five-year guaranteed is a relatively small sample. So there is no strong evidence that the money's worths are 'wrong', but conversely there is no evidence at all for adverse selection from looking at these data points.

Table 4.5 International evidence on money's worth and selection effects in annuity markets

Study	Data period	Type of annuity	UK		US		Canada		Australia		Switzerland		Germany	
			Pop	Ann	Pop	Ann	Pop	Ann	Pop	Ann	Pop	Ann	Pop	Ann
Panel A: 65-year old males														
Cannon-Tonks (2004a)	1972-2002	Level + 5YG	95.6	98.5										
Finkelstein-Poterba (2002)	1998	Level	86.5	98.8										
	1998	Escalating (five per cent)	80.4	97.2										
	1998	Compulsory annuities	90.0	96.2										
Mitchell *et al.* (1999)	1985	After-tax level			76.4	86.5								
	1990	After-tax level			81.2	92.6								
	1995	After-tax level			81.4	92.7								
	1995	After-tax joint			86.8	92.9								
James-Song (2001)	1999	Level	91.2	98.3	85.8	97.4	91.4	98.1	91.1	101.0	91.6	108.2		
	1999	Level+ 10YG	94.4	99.3			92.8	97.4	91.5	99.6	94.5	108.0		
	1999	Joint	93.3	98.8	86.4	95.1	93.9	98.0	86.7	93.6				
	1999	Escalating (three per cent)	91.8	100.6										
	1999	Real level	81.7	89.4										
von Gaudecker-Weber (2004)		Level											88.7	98.0

Continued

Table 4.5 Continued

Study	Data period	Type of annuity	UK		US		Canada		Australia		Switzerland		Germany	
			Pop	Ann	Pop	Ann	Pop	Ann	Pop	Ann	Pop	Ann	Pop	Ann
Panel B: 65-year old females														
Finkelstein-Poterba (2002)	1998	Level	85.3	93.9										
	1998	Escalating (five per cent)	79.3	91.1										
	1998	Compulsory annuities	90.4	94.5										
Mitchell *et al.* (1999)	1995	After-tax level			85.4	92.7								
James-Song (2001)	1999	Level	92.6	97.4	87.1	95.4	95.0	97.6	91.5	98.4	96.9	105.7		
	1999	Level+ 10YG	94.9	98.7			95.5	97.3	91.2	97.2	98.2	105.7		
	1999	Escalating (three per cent)	92.5	98.8										
	1999	Real level	81.3	86.7										
von Gaudecker-Weber (2004)													93.9	101.3

The table summarises a series of studies that have examined the money's worth of different types of annuities in a number of countries, using population (Pop) and annuitant (Ann) life tables. The annuitant life table is not always the life experience of the actual relevant annuitants, but is proxied for it in a number of ways.

There is also international evidence on money's worth and the degree of selection effects in various annuity markets around the developed world. This information is documented in Mitchell *et al.* (1999), James and Song (2001), James and Vittas (2000) and McCarthy and Mitchell (2002), and a summary of this evidence is also presented in Table 4.5. It can be seen that in the US there appears to be a secular trend towards lower selection effects, as Mitchell *et al.* (1999) report that in 1985 the selection effects for 65 year old males was 10.1 per cent, but by 1995 this had decreased to 6.1 per cent and the money's worth for both annuitants and the general population had increased. The international comparison made by James and Song (2001), updating earlier work by James and Vittas (2000), found higher money's worth in general, and smaller selection effects than the earlier US studies, and in fact the selection effects for the UK are much closer to the Cannon and Tonks (2004) numbers.

Finkelstein and Poterba (2004) emphasise that selection effects are also important in terms of the type of annuity purchased, since people with long life expectancy are more likely to purchase back-loaded annuities such as escalating and real annuities; and further, people with shorter life expectancy are more likely to buy guaranteed annuities, that pay an income into the annuitant's estate even after death. They find in their cross-section sample for 1998 (using population life tables) that the money's worth is **lower** for the non-guaranteed annuity than guaranteed which is consistent with the presence of adverse selection in the non-guaranteed annuities market. They also find that longer-lived individuals self-select into back-loaded annuities (escalating and real).

Furthermore, the evidence on the differential money's worth reported by James and Song (2001), and reproduced in Table 4.5, confirms these effects. Level annuities in the UK for a 65 year old male in 1999 had a differential money's worth of 7.1 per cent, whereas ten-year guaranteed annuities had a money's worth differential of 4.9 per cent. Escalating and real annuities had money's worth differentials of 8.8 per cent and 7.7 per cent respectively.

Panel B of Table 4.5 shows the similar money's worth differentials for 65 year-old women, and as with the men the money's worth using annuitants survival probabilities is typically between 90 and 100 per cent, with selection biases apparent to some degree.

As has already been discussed, the UK is unusual in having both a voluntary and a compulsory annuities market. Finkelstein and Poterba (2002) note that selection effects are likely to be more important in the former than the latter. Only individuals who expect to live for a long time are likely to purchase a voluntary annuity, whereas compulsory annuities are purchased as part of the terms of the pension contract,

though there could be selection effects in terms of the types of people that subscribe to a personal pension. Finkelstein and Poterba (2002) examine a cross-section sample of UK annuity rates in 1998, and using the most recent life tables, compare life expectancy of the UK general population, with those who purchase voluntary annuitants, and those who purchase compulsory annuities. They suggest that if E(LI) is the life expectancy of the voluntary purchases (Vol), or the compulsory purchasers (Comp) of the general population (Population) then selection effects would suggest the following relationship between groups of annuitants:

(4.9) E(LI Vol) > E(LI Comp) > E(LI Population).

Figure 4.19, taken from Finkelstein and Poterba's paper, shows the probability that a 65-year old man will survive to various ages if he faces the mortality rates for the population at large, those for compulsory annuitants, and those for voluntary annuitants. It is clear that the average 65-year-old male compulsory annuitant has a higher survival probability at all ages than an individual who faces the mortality rates for the population at large. The average 65-year old male voluntary annuitant has a still higher survival probability at all ages. To illustrate this, consider the probability of surviving from age 65 to age 82. For the average 65-year-old man, this probability is 41 per cent. For the average 65-year-old male compulsory annuitant it is 48 per cent, and for the average 65-year-old voluntary annuitant, this probability is 56 per cent. Mortality rates for women show a similar pattern.

Figure 4.19 Cumulative survival probabilities for 65-year old male cohort 1998

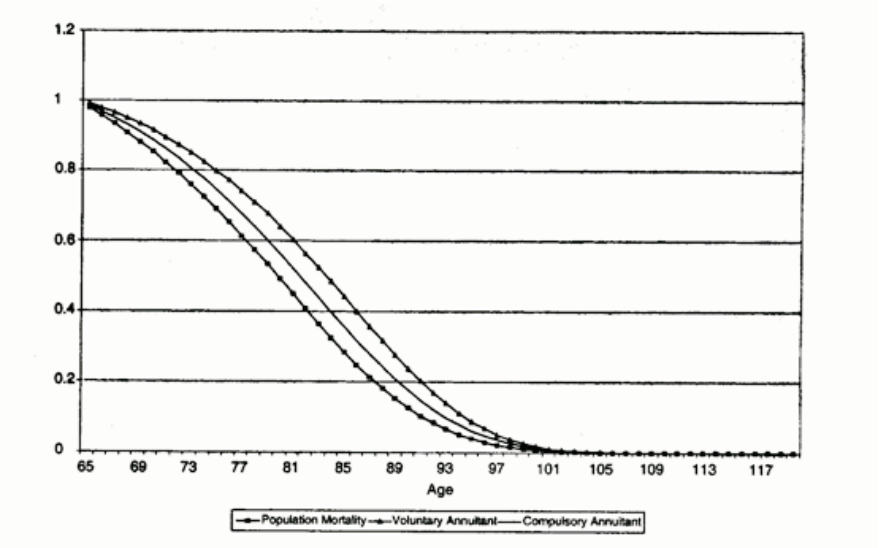
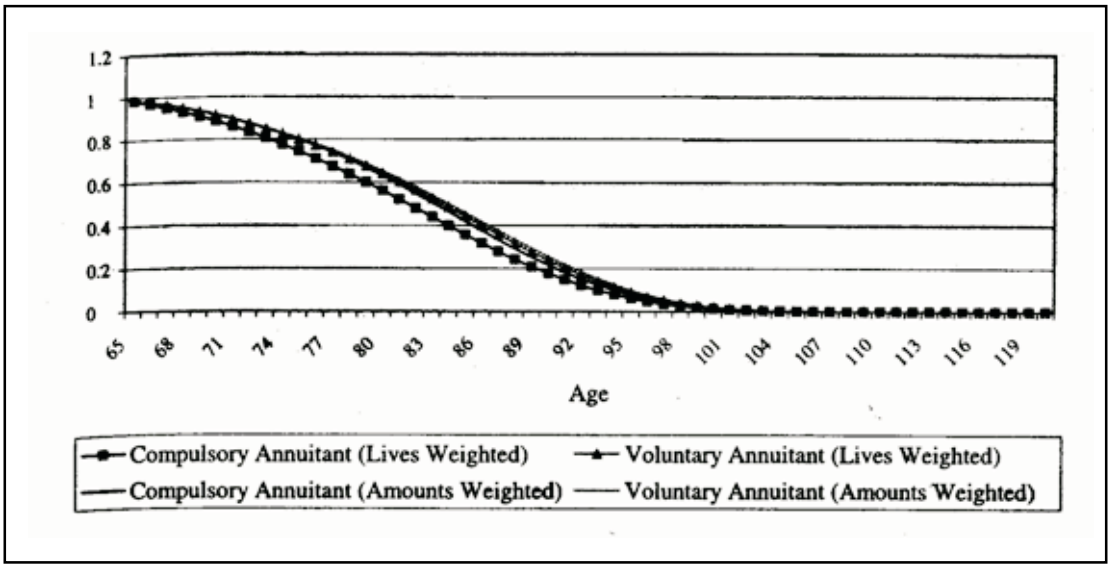


Figure 4.20 Cumulative survival probabilities for 65-year old male cohort in 1998



Finkelstein and Poterba (2002) also suggest that under adverse selection, long-lived individuals will purchase larger amounts of annuities – bigger premiums – an inverse relation between size of premium and money's worth. In fact they find that the money's worth of larger amounts of annuities is bigger than the money's worth of smaller amounts of annuities, implying that there is no adverse selection in the larger amounts market. However, they note that this finding is also consistent with fixed costs in the provision of insurance, which might dominate the selection effects. We have already seen that for smaller purchases there is evidence that annuity rates increase with purchase price, which would be consistent with fixed costs but not adverse selection.

In further work using data on a single UK insurance company from 1981-1998, Finkelstein and Poterba (2004) examine selection along three features of annuity policies that affect the effective quantity of insurance provided:

- Initial annual annuity payment. This is the analogue of the payment in the event of a claim, or 'quantity' in most stylised theoretical models and in previous empirical studies. It is straightforward to see that the amount of insurance is increasing in the initial amount of annuity payment.
- The annuity's degree of back-loading. A more back-loaded annuity is one with a payment profile that provides a greater share of payments in later years. Payments from real and escalating annuities are both back-loaded relative to those from nominal annuities. An annuitant with a longer life expectancy is more likely to be alive in later periods when the back-loaded annuity pays out more than the flat annuity.

- Some annuities offer guarantee periods. The insurance company continues to make payments to the annuitant's estate for the duration of the guarantee period even if the annuitant dies before the guarantee period expires. 'Capital protection' is another form of payment to the annuitant's estate. If at the date of the annuitant's death, the cumulative sum of nominal annuity payments is less than the premium paid for the annuity, a capital-protected annuity pays the difference to the estate as a lump sum. Payments to the estate decrease the effective amount of insurance in a given annuity contract. Similarly, an annuity that pays out more in the event of an early death, either with a guarantee period or with capital protection, is more valuable to a short-lived than to a long-lived individual.

All three of these features thus satisfy the single-crossing property: at a given price, the marginal value of each annuity product feature varies monotonically with risk type. Theoretical models of equilibrium with adverse selection, therefore, make clear predictions about the relative mortality patterns of individuals whose annuities differ along these features. Those who buy back-loaded annuities should be longer-lived, conditional on observables, than other annuitants. Similarly, those who buy annuities that make payments to the estate should be shorter-lived, and those who buy annuities with larger initial annual payments should be longer-lived, conditional on what the insurance company observes about the insured, than other annuitants.

The methodology in Finkelstein and Poterba (2004) is to estimate a hazard function, the probability that an annuitant with specific characteristics dies t periods after purchasing the annuity, conditional on living until t. The characteristics include: 1) initial payments; 2) whether escalating; and 3) whether guaranteed. They estimate the hazard model for both compulsory and voluntary markets. They expect adverse selection problems to be more acute in the voluntary market.

Their results support their theoretical predictions of asymmetric information. Back-loaded annuities are associated with longer-lived individuals; guaranteed annuities are purchased by short-lived individuals. However, with respect to initial payment there is evidence of adverse selection in the compulsory market (individuals with larger initial payments live longer) but not in the voluntary market. They then compute money's worth (using population life tables) to get 'price of an annuity' (1 – MW), and regress 'price' on various characteristics.

Finkelstein and Poterba (2004) recognise the limitations of their analysis, in that *'the results are an artefact of the particular firm whose annuity sales we have analysed. This small sample concern is difficult to address without detailed data from other insurance firms, and we do not have such data'* (p.31).

In summary they find: a) no evidence of selection in the initial payments for voluntary markets; and b) evidence of selection in back-loading and guaranteed annuities. But caveats are that the selection effects could be a result of moral hazard rather than adverse selection. Also the equilibria that they identify could be the outcome of a non-competitive equilibrium with symmetric information (Chiappori *et al.,* 2002). A final caveat is that individuals may have different preferences as well as different risk types (Walliser, 2000).

A similar test can be conducted without calculating money's worths: since any differences in money's worth are due entirely to differences in mortality, one can also test for selection by comparing directly the mortalities in different life tables. Mitchell and McCarthy (2002) compute the A/E population metric, which expresses the number of deaths anticipated in a given population using one mortality table, compared with the expected number of deaths in a population using a second mortality table, which acts as a benchmark. Using the US male population period table as the benchmark, they then regress the A/E metrics against gender, type of mortality table (for voluntary or compulsory annuity markets) and country effects. They find that voluntary annuitants have a 32 per cent lower mortality rate, and compulsory annuitants a 26 per cent lower mortality rate than the general US male population. They conclude that this indicates adverse selection, though as we noted earlier it would better be described as evidence of either active or passive selection effects.

4.6 Demand for annuities

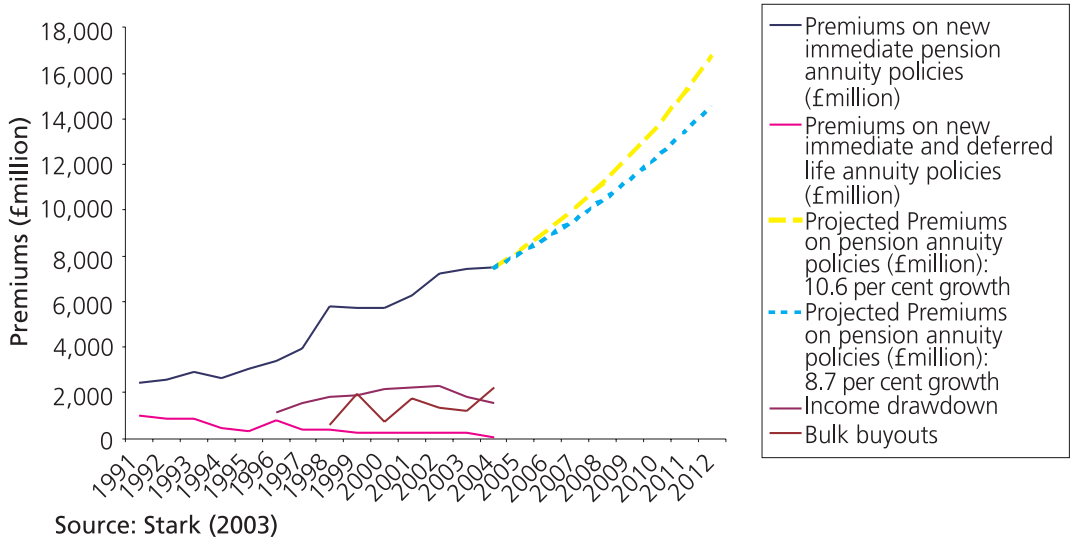
Having considered the pricing of annuities and the extent of adverse selection in the market we now examine patterns in the demand for annuities, and ask the question: who buys annuities?

The answer is that not many people do voluntarily buy annuities. The private immediate annuity market in the US is small: *'In 1999 premiums for individual immediate annuities totalled $7billion. By comparison individual life insurance premiums were $94billion'* (Brown *et al.*, 2001, p.7). This lack of annuitisation is not confined to the US, and the same limited demand in voluntary annuity purchases has been observed in international markets: UK (Blake, 1999), Canada (Kim and Sharp, 1999), Australia (Knox, 2000), Latin America (Callund, 1999) and Israel (Spivak, 1999).

However, in the UK the market for compulsory annuities (or pension annuities) is projected to grow in the future as the sales of personal pension policies that increased from the late 1980s move into their decumulation phase. A condition of the tax-efficient personal pension schemes in the UK is that except for a 25 per cent lump sum, the pension fund must be annuitised before the age of 75. Stark (2003) provides a summary of Watson-Wyatt (2003), which examined trends in the demand for annuities. She points out that pension annuity sales have increased from £2.45billion in 1991 to £8.55billion in 2002, and this increase will continue for four reasons: a) maturity of past defined contribution pension schemes; b) increased numbers of elderly people; c) pension schemes shifting from DB to Defined Contribution (DC), means that DB schemes whose pensions previously were self-financing will be replaced by DC schemes that involve annuitisation at maturity; and d) bulk buyouts as DB schemes are closed and the schemes are wound up by an insurance company taking on the scheme's pension liabilities. These factors are likely to increase the demand in the compulsory market for pension annuities premiums by between 8.7 per cent and 10.6 per cent per year over the next ten

years, depending upon assumptions made about equity returns, bond yields and inflation over the same period.

Figure 4.21 Growth in annuity demand in the UK



Source: Stark (2003)

Figure 4.21 plots the actual and projected growth in annuity premiums from 1992 for both the voluntary life annuity market and the compulsory pension annuity market. The annuity premium is the value of the fund annuitised. The projections illustrated were made in 2003 and three additional considerations have arisen since then: First, the subsequent introduction of the Pension Protection Fund (PPF) will reduce the need for these annuities. This is because prior to the PPF, DB schemes that were wound up because the sponsoring company went into liquidation would have resulted in the liabilities of the pension fund being provided by an insurance company. The PPF will cover the deficits in such schemes using transfers from solvent pension schemes and is unlikely to use the bulk buyout market. Second, some DB schemes that are not insolvent (and hence, do not fall under the PPF) may be wound up by companies as a way of drawing a line under their exposure to pension risk: this would involve the purchase of annuities in the bulk market. The Pensions Commission (2005) emphasises that projections for this type of demand are highly uncertain and may exceed that illustrated in Figure 4.21. Third, the suggested pension reforms in The Pensions Commission (2005) would have an ambiguous effect on the annuity market: the proposed National Pensions Savings Scheme would result in more people buying annuities (thus increasing demand), but at the same time individuals would be encouraged to retire later and only buy an annuity after a period of drawdown (which would reduce demand for annuities, at least by value).

It can be seen that the voluntary annuity market is small in relation to the compulsory market, and indeed the requirement to annuitise a personal pension, may result in less annuitisation in the voluntary market, as individuals who would otherwise have

purchased a life annuity, might obtain the required amount of longevity protection from the compulsory market.

We have already discussed Finkelstein and Poterba's (2004) discussion of adverse selection. Their analysis was based on a set of both compulsory and voluntary immediate annuities sold by an anonymous large UK annuity company from 1981-1998. At the end of the sample period, the firm was among the ten largest sellers of new compulsory annuities in the UK. The sample includes a total of 42,054 annuity policies sold by this insurance company over the 17-year period, which Finkelstein and Poterba argue are representative of the UK annuity industry in general.

Table 4.6 shows that the vast majority of annuities sold are in the compulsory market, reflecting the characteristics of the market already alluded to: that the voluntary annuity market is small, and that the future growth in the annuities market will continue to be in the compulsory sector. Most annuity purchasers in the voluntary market are women, and at a much older age than in the compulsory market, where the majority of purchasers are men. This follows from the men being more likely to have taken out a personal pension.

Table 4.6 Overview of the compulsory and voluntary annuities in the UK sold by the sample firm over the period 1981-98

	Compulsory market	Voluntary market
Number of policies	38,362	3,692
Number of annuitants who are deceased	6,311	1,944
	16.50%	52.70%
Number of annuitants who are male	29,681	1,272
	77.40%	34.50%
Average age at purchase	63.2	76.4
Back-Loaded Annuities		
Number of policies that are index-linked	428	66
	1.30%	3.50%
Number of policies that are escalating in nominal terms	1,492	175
	3.90%	*4.70%*
Payments to estate		
Number of policies that are guaranteed	28,424	872
	74.10%	23.60%
Number of policies that are capital-protected	0	
		22.80%

Continued

Table 4.6 Continued

	Compulsory market	Voluntary market
Initial annual annuity payments (£)		
Average initial payment	1,151	4,773
Median initial payment	627	3,136
Standard deviation of initial payment	1,929	5,229
Average premium	10,523	25,603

Note: All monetary figures in the paper are in December 1998 pounds. The first index-linked policy was sold in February 1985; therefore, percentage of policies index-linked refers to percentage of policies sold since that date.

Most annuities purchased are flat rate, paying the same nominal sum over the annuitant's life, though a small percentage in both markets are back-loaded, meaning that the payments are increasing over time (real and escalating). Three-quarters of the annuities purchased in the compulsory annuity market have some guarantees, meaning that even on death, some annuity payments will still be paid into the annuitant's estate. But in the voluntary market, guarantees are less common, though this may reflect the fact that in the voluntary market the purchasers are characterised as more elderly women. Finally, the table shows that the average size of the amount annuitised in the compulsory market is just over £10,500 and in the voluntary market is £25,603, yielding annual initial annual annuity payments of £1,151 and £4,773 respectively.

Stark (2003) confirms that the average size of the pension fund that is annuitised is relatively small at £24,357 in 2001 from a sample of 100,000 pension annuities from ABI providers. But we have already seen in Figure 2.3 that the distribution of annuity funds is highly skewed and that 43 per cent of funds in 2001 were less than £10,000: another 20 per cent were between £10,000 and £19,000. Given the annuity rates reported in Figure 4.1, a purchase of £10,000 in 2005 would generate an annuity payment of around £500 per annum.

Stark (2003) also reports the results of a telephone survey with 500 annuitants aged between 60 and 74 who had purchased a compulsory pensions annuity between 1999 and 2002, and 101 interviews with retired persons aged between 60 and 74 who had not yet annuitised their pension fund. Almost 70 per cent of the sample had retired before 65 with women retiring earlier than men. Of the sample who had purchased an annuity, two-thirds had purchased an annuity immediately on retirement, and one-third had deferred. The 'deferrers' were more likely to have retired before the age of 60, and the main reason given for deferring an annuity purchase was that the retired person had other income so that they did not need the annuity income yet. Interestingly, only one per cent stated 'inheritance reasons' as the reason for deferring. For 44 per cent of the sample the state pension was the main source of income, implying that the annuity income for this group would be small, with 26 per cent of the sample stating that the pension annuity was their main source of income.

Over 30 per cent of the sample had purchased more than one annuity, with 57 per cent of the sample choosing a level single annuity (either not guaranteed, 42 per cent, or guaranteed, 15 per cent). Only five per cent chose an index-linked annuity. Only 12 per cent of the sample purchased a joint annuity, with men being slightly more likely than women to purchase a joint annuity. Two thirds of the sample had taken advice before purchasing the annuity, either from a financial adviser (40 per cent), or a provider (20 per cent), with a third of the sample exercising their open market option to purchase their annuity from a provider other than their pension provider, and 15 per cent had considered the open market option, but had remained with the pension provider.[40]

Gardner and Wadsworth (2004) undertook a survey of 3,511 individuals' (aged between 50 and 64) attitudes to annuitising a hypothetical sum of £100,000. In the sample 55 per cent were working, 33 per cent were retired, and 11 per cent were out of work. With regard to pension provision, 20 per cent had no private pension and were reliant on the state pension; 45 per cent had one private pension, and 35 per cent had more than one private pension. For those with a private pension, 50 per cent were reliant on a DB pension, and 30 per cent on a DC as their main source of income.

They found that almost 60 per cent of the sample would prefer not to annuitise this hypothetical £100,000 sum, if they had the option not to do so. Of the sample that had DC pensions (and would, therefore, have to annuitise their pension fund), 53 per cent would prefer not to annuitise a hypothetical lump sum. Reasons given for annuitisation-aversion included: flexibility (74 per cent), self-investment preferred (45 per cent); annuity income too low (45 per cent), bequests (38 per cent); low life expectancy (37 per cent). Of those that were willing to annuitise there was a preference for annuitising at earlier ages. In subsequent regression analysis, Gardner and Wadsworth (2004) found that the willingness to annuitise was positively related to perceived health status, positively related to education-status achieved, positively related to the degree of patience of the individual, but negatively related to household size, presumably because the family unit can serve as insurance against longevity risk (Kotlikoff and Spivak, 1981).

In order to identify the determinants of annuity demand through an individual's utility maximising framework, Brown (2001) constructs a measure of the utility-based measure of the value of an annuity, which he calls annuity-equivalent-wealth

[40] HMRC rules required that individuals must purchase a real joint annuity with unisex rates with respect to the value of their 'protected rights' in their personal pension fund. Protected rights are the requirement that contracted-out rebates must provide equivalent pension provision to the Second State Pension. From April 2005 the requirement for a real annuity was dropped.

(AEW).[41] He does this by asking how much an individual's stock of wealth would have to be increased to compensate the individual **in utility terms** for not being able to buy an annuity. The utility value of the annuity depends upon the individual's degree of risk aversion (since this determines the value of the insurance), but also upon how much wealth is already held in annuity form (for example, social insurance). Formally, AEW is the value of x in the equation:

(4.10) $$U_t(A, W, S) = U_t(0, xW, S)$$

where A is the annuity payment, W is wealth held as a lump sum and S is any other regular income in annuity form. If AEW is high for an individual then they should be more likely to purchase an annuity voluntarily.

Brown relates the value of AEW to the decision to annuitise their wealth by a sample of 869 households in 1992, where the head of the household is aged between 51 and 61 years, in the US Health and Retirement Study (HRS). The HRS asks the individuals in the sample the form in which they intend to take their DC pension benefits, and identifies those individuals that they will take their benefits as a monthly pension: half of the sample reports that they will annuitise their DC plan. The average household has over half of their wealth 'pre-annuitised' by social security and private DB pension plans. Another ten per cent of wealth is in DC plans which average $60,000 in the sample. The average age in the sample was 55 years old, with an average expected retirement age of 63, and 84 per cent of households consisting of a couple. He then calibrates the AEW for each individual household, and compares the likelihood of the household annuitising their wealth as a function of four basic characteristics: mortality risk (proxied by gender), risk aversion (from a series of questions), fraction of total wealth that is pre-annuitised, and marital status. Brown (2001) finds that differences in annuity equivalent wealth can partly explain the probability of annuitising balances in defined contribution pension plans. The calibrated AEW variable in the probit regression has a mean value of 0.6089 and is highly significant. This value means that a one per cent increase in AEW increases the probability of the household annuitising their wealth by 0.6089 percentage points. Further, Brown adds other explanatory variables (race, education, industry and occupation) into the probit estimation, but finds they are not significant, and do not alter the basic AEW coefficient. These results give some comfort to the basic life-cycle model of savings/consumption behaviour.

The HRS asks a series of questions concerning the time horizon of the individual which is related to their health and likely survival, but the results are slightly contradictory. For example, one question concerns whether the time horizon for

[41] Brown's AEW measure can be contrasted with the money's worth measure discussed above which looked at the financial value of an annuity (the two would be identical if the agent were completely risk neutral). The AEW measure corresponds to the concept in consumer demand theory of the compensating variation.

financial planning is one year or less. Brown finds that myopic individuals are much less likely to annuitise. Another HRS question asks about self-reported health status, and individuals with excellent, very good or good health were more likely to annuitise than those in fair or poor health. However, the HRS also asks a question about subjective survival probabilities, but these were found to have no effect on the annuitisation decision.

There is contradictory evidence in the literature concerning the relevance of bequests. Research by Bernheim (1991), Laitner and Juster (1996) and Wilhelm (1996) argue that individuals do deliberately leave wealth to their heirs, whereas Hurd (1997, 1989) and Brown (1999) suggest that the bequest motive is unimportant.

Brown (2002) assesses the importance of the bequest motive by examining whether the decision to annuitise is affected by whether the household in the HRS sample has any children. If the bequest motive is important, then we would expect to see the decision to annuitise would be negatively related to the number of children. In fact, Brown finds there is little relation between the annuitisation decision and the number of children, which suggests bequests are unimportant.

Rowlinson and McKay (2005) have undertaken a survey of attitudes to inheritance in Britain using a nationally representative sample of 2,000 people. They find that 46 per cent of adults have inherited something, but most inheritances are small, with only five per cent of their sample inheriting more than £50,000. It appears that people like the idea of leaving a bequest, but do not think that older persons should be careful with their money just so that they have something to bequeath. They report that 90 per cent of the sample are likely to have the potential to bequeath, but two-thirds of those with the potential to bequeath intend to enjoy life, and will not restrict their spending to ensure that they are able to leave a bequest. A quarter of those with the potential to bequeath report that they intend to be careful with their spending to ensure they can bequeath. Rowlinson and McKay conclude that although inheritance is important to most people, it has not become entrenched either as an expectation or a duty. Most people are willing and intend to use their assets for themselves, and the bequests are a residual at the time of death.

Overall there is conflicting evidence on whether bequests are important or not to individuals. To the extent that bequests are regarded as important, this would be an explanation for the unpopularity of annuities. On the other hand if bequests are unimportant, then the explanation for the unpopularity of annuities must lie elsewhere.

5 Reasons for the 'annuity puzzle'

Yaari's theoretical work suggests that an annuity is the best way for an individual with an uncertain lifetime to obtain a secure income. But we know that empirical work on institutional arrangements in the US by Friedman and Warshawsky (1990) and Mitchell *et al.* (1999) has found that annuity markets are very thin and of limited size. The failure of Yaari's theory to match the evidence constitutes the 'annuity puzzle'. In this chapter we consider possible reasons for the annuity puzzle. If low annuity demand is consistent with rational behaviour and well-functioning markets then there would not be much more to say. However, if low annuity demand is due to irrationality or market failure then we should have to see whether government intervention could improve upon the market outcome.

It is important to note at the outset that the annuity puzzle is only one of a series of phenomena which are not fully consistent with current economic theory: Zeldes (1989) observes a series of 'consumption puzzles', including the facts that:

- the elderly do not dis-save during retirement;
- consumption expenditure falls discontinuously at the point of retirement, which is inconsistent with consumption smoothing.[42]

Poterba's (1994) collection of articles contains savings evidence which demonstrates that these puzzles are an international phenomenon. Thus, the annuity puzzle is not a unique problem but part of a general issue in understanding savings behaviour.

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[42] Some of the fall in consumers' expenditure can be explained by the reduction in costs faced by the elderly, including an absence of work-related costs and implicit and explicit price discounting. The Pensions Commission (2004, pp.134-141) provides evidence on this.

5.1 The role of imperfect annuity markets

One problem with Yaari's (1965) model is that it emphasises longevity risk at the expense of all other forms of risk. Bodie (1990) claims that risk in retirement also arises from: the riskiness of social security payments, the riskiness of investment returns during the accumulation phase and riskiness in the annuity rate. These risks may turn out to be equally important to longevity risk.[43] These contribute to risk in the **replacement ratio**, which is the ratio of retirement income to earned income (usually net of pension contributions) in the years immediately before retirement. The Pensions Commission (2004) suggests that an appropriate target for the replacement ratio is about 77 per cent – less than 100 per cent is needed because retired individuals avoid work-related costs and also are able to benefit from lower prices due to discounts. Cannon and Tonks (2004a) show that the total risk from investment returns during the accumulation phase and annuity rates is slightly less than the risk from the two components individually because they are negatively correlated, but despite this the total replacement risk is substantial. To this can be added shocks to health and related consequences, such as long-term care (Zeldes, 1989): these are doubly risky since the extent of state subsidy to care services is also subject to variation. This selection of risks may suffice to explain why the elderly engage in precautionary saving and hence, do not dis-save, but it would not immediately lead us to conclude that there would be under-annuitisation.

Davidoff, Brown and Diamond (2005) consider the effect of some of these potential problems and extend their analysis to look at imperfect credit markets and habit formation. They conclude that it is optimal to annuitise less than 100 per cent of one's wealth, but that the optimum is still very high. Further reasons for under-annuitisation would be poor rates of return on annuities (due either to administrative costs or adverse selection), the bequest motive, substitutes for the private annuity markets and behavioural reasons (Poterba, 2004).

Davidoff *et al.* (2005) note that the key feature of an annuity is that it provides a higher regular income than a conventional bond: this would be true even if there were some adverse selection or administrative costs so that the annuity rate was not actuarially fair. So long as the annuity rate is higher than the bond rate, the budget constraint resulting from an agent using annuities must lie further from the origin than the budget constraint using bonds (as we have already seen in our theoretical analysis in Chapter 3). Empirically, annuity rates are always higher than bond rates and the evidence on the money's worth presented already suggests that, even if not actuarially fair, annuity rates are still quite close to being actuarially fair. Thus load factors and adverse selection cannot alone explain why so many individuals fail to annuitise.

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[43] It is possible that longevity risk (unlike the other risks) can be insured through the extended family (Kotlikoff and Spivak, 1981). But current social patterns in the UK may mean that the extended family is not particularly good at providing insurance.

Furthermore, we would naturally assume individuals to be non-satiated, so a budget constraint which is further from the origin would always yield greater utility, regardless of the specifics of individuals' preferences. The assumptions of constant preferences and time-additive separability made by Yaari (1965) cannot, therefore, be essential to Yaari's result (Davidoff *et al.* provide formal proofs of this). The same comments apply to the form of subjective discounting (Yaari did not assume geometric discounting) and differences in the subjective discount rate: the result that annuitisation is optimal relies upon the budget constraint with annuities being further from the origin than the budget constraint without annuities, so the particular form of preferences (i.e. the shape of the indifference curve) is irrelevant.

But as we have already noted, Yaari's (1965) result relies upon either a continuous spot market where agents can both buy and go short in the annuities market or a complete choice of annuity instruments including both temporary and deferred annuities. We shall refer to this as a **perfect annuity market**. This is important because a typical annuity (i.e. a stream of payments which is constant in real terms) is appropriate only if agents actually wish their expenditure to follow the same pattern, i.e. to be fairly constant over time. Table 3.1 has illustrated the need for complex annuitisation patterns when desired consumption would not be constant over time. One important issue then is under what circumstances agents would not choose their consumption to be fairly constant. Since the proposal of Friedman's permanent income hypothesis, economists have usually thought that consumption would be approximately constant over time and most commonly-used utility functions demonstrate this behaviour.[44] However, elderly people may have substantial lumpy health-related costs, which would result in the need for non-smooth consumption paths. Following a rather similar three-period framework to that used above, Davidoff *et al.* (2005) discuss formally the circumstances when conventional bonds will be preferred to annuities when the only annuity product available is one providing a constant real stream of income payments.

Davidoff *et al.* (2005) note that there are various instances where consumers will not desire smooth consumption paths, in which case agents may prefer to under-annuitise when annuity markets are imperfect (clearly no issue arises if markets are perfect).

If it is the case that under-annuitisation is a consequence of imperfect annuity markets interacting with other factors, then the policy consequence is that it may be

[44] A possible exception arises when the subjective discount rate and the interest rate are not approximately equal, in which case individuals would want their consumption to be either rising or falling over time. However, one would usually assume that the magnitude of this effect would be small – and it is also possible to buy annuities that approximate these features (level nominal annuities fall in real terms over time, albeit stochastically, while escalating annuities grow slowly over time).

possible to encourage greater degrees of annuitisation without changes to annuity markets if the other factors are either directly or indirectly under the control of the government.

We now consider various suggestions why full annuitisation may be inappropriate.

5.2 Necessary expenditure early in retirement

We have seen that in the presence of imperfect annuity markets individuals will not wish to annuitise fully if their desired consumption path is not smooth. Typically one thinks of elderly individuals being likely to need substantial health and general care at the end of their lives, but they may also wish to make substantial expenditures early in retirement either for health reasons[45] or to ease the transition from a working to a retired life.[46] A potential way of modelling this is to replace equation (3.7) with:

$$EU = u(c_0 - e_0) + \mathrm{d}\, pu(c_1 - e_1), \tag{5.1}$$

where the e_i could be randomly determined and would be subject to the requirement that $e_i > 0$. The usual interpretation of these parameters in a utility function is within the economic development literature where they are a subsistence level of living, but in our context they represent necessary expenditures.[47]

Davidoff *et al.* (2005) note that the effect on annuity demand then depends crucially on the relative size of e_0 and e_1. Where these costs are interpreted as health costs, the presence of a perfect market in health insurance allows individuals to remove the risk of health shocks, so for health expenditures to have any affect on annuity demand we must assume problems in health insurance, possibly arising from similar adverse selection problems to those found in annuity markets. However, it may be the case that more sophisticated annuity products could overcome this problem (Warshawsky, Spillman, Martaugh, 2001) and we shall consider this possibility below.

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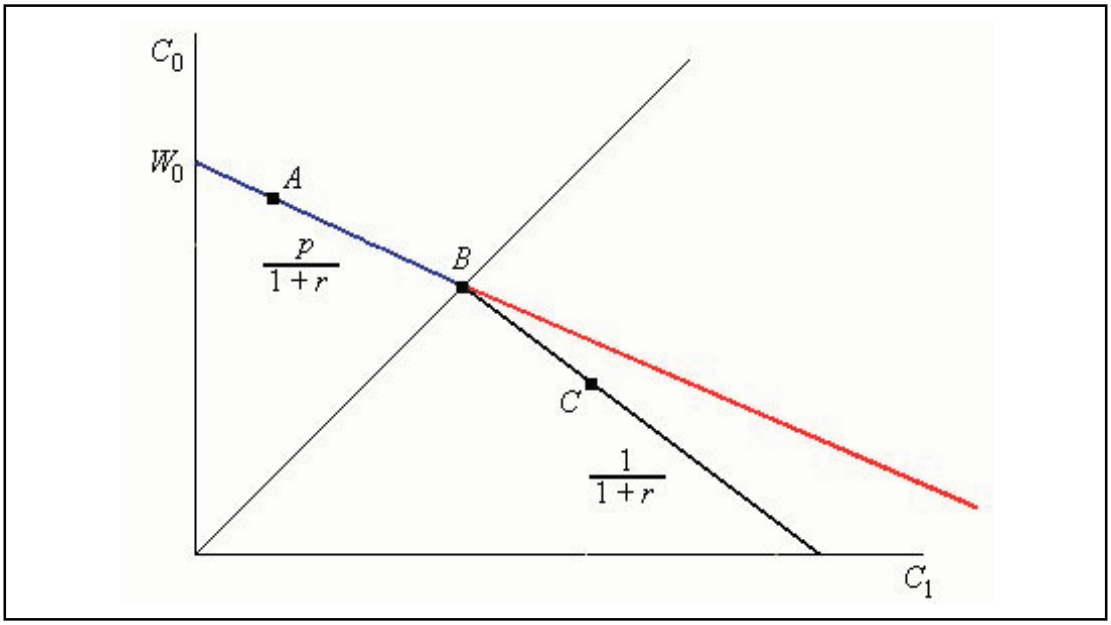
[45] In the UK, health care is provided largely through the National Health Service (NHS) and the quality of this care thus depends upon the commitment (or the perceived commitment) of both current and future governments to state health provision.

[46] Alternatively, one could view such expenditures as an investment whose rate of return in utility terms was higher than the rate of return that could be earned on financial assets (either annuities or bonds).

[47] The term 'necessary' is being used fairly loosely here: we mean simply that without these expenditures the well-being of the individual will be severely reduced. However, it is the case that they are necessary in that they impose a minimum expenditure each period.

We can illustrate how high demand for necessary expenditures late in life (i.e. in period 1 thought a high value of e_1) by considering a model where e_0 and e_1 are not actually stochastic. If the necessary expenditures occur late in life, then individuals would plan to consume more in the second period of their retirement, *i.e.*, they would choose the appropriate consumption path $\{C_0^*, C_1^*\}$, where it would follow that $C_0^* < C_1^*$. Note that this would mean that individuals would be on the red section of the budget constraint in Figure 5.1. As has been discussed already, this would require the purchase of life-contingent products such as deferred annuities or escalating products, which are typically unavailable. So it appears that the need for rising care expenditure alone might explain why agents chose to hold some of their wealth in bond form. To explore this possibility consider the diagram below.

Figure 5.1 Annuitising with necessary costs (such as care costs)



Situation A – There is complete annuitisation (i.e. all wealth is held in life-contingent assets), but the agent chooses to consume more in period 0 than in period 1. This situation would only arise if and only if:

$$\frac{\delta p u'(y-e_1)}{u'(y-e_0)} < \frac{p'}{1+r}$$

which seem unlikely if $e_1 > e_0$.

Situation B – There is complete annuitisation (i.e. all wealth is held in life-contingent assets), and the individual chooses to consume the same amount in both periods. This will occur if and only if:

$$\frac{p}{1+r} < \frac{\delta p u'(y-e_1)}{u'(y-e_0)} < \frac{1}{1+r}.$$

Situation C – At the beginning of period 0 the individual puts all their wealth into an annuity, but then consumes less in period 0 than the annuity payment and purchases conventional bonds to save into period 1. This will occur if and only if:

$$\frac{1}{1+r} < \frac{\delta p u'(y-e_1)}{u'(y-e_0)}.$$

Only in situation C is it optimal to avoid full annuitisation and even in this situation an agent would choose to put all of their pension wealth into an annuity at the beginning of period 0. So we can conclude that rising necessary expenditures alone do not provide sufficient reason to explain the annuity puzzle.

We now turn to the possibility that e_0 is uncertain (it simplifies the analysis to treat e_1 as known) and only becomes apparent when the individual chooses how much to consume in period 0, having already made an annuity decision. We also suppose that e_0 is only revealed after the individual has chosen his annuity purchase. Now in situations where e_0 is large the optimal consumption plan is to have $C_0^* > C_1^*$. If an agent has purchased an annuity, then it will be impossible to bring forward consumption expenditure because of the impossibility of borrowing against future annuity payments. Anticipating this, the optimal strategy is to buy a smaller annuity and save the rest of the wealth in conventional bonds: although these bear a lower rate of return than annuities, this is more than offset by the value of their increased liquidity.

We can conclude from this that the effect on annuity demand of variable and uncertain necessary expenditures is ambiguous. The timing (or likely timing) of these expenditures is crucial in determining whether demand is increased or reduced. In particular, to avoid annuitising is only optimal when there is a risk of high expenditures early in retirement.

Within the UK context the policy issue is whether the characterisation of health-related costs is appropriate. The widespread provision of health care by the NHS, which is largely free at the point of consumption, means that most individuals may be adequately insured against health shocks, even if richer individuals often choose to purchase additional private health care. The poorest members of society are unlikely to be in a position to use any health care except that provided by the NHS, but conversely these are the people least likely to have a private pension fund and so their demand for annuities would anyway be zero. For richer members of society it is an empirical question regarding how their health needs and reliance on the NHS vis-á-vis private health care interact with their demand for annuities.

A final consideration is the possibility that risky care costs may be used as a hedge against longevity risk. Long-term care needs can be based upon measurable 'Activities of Daily Living' and care/health insurance products are available for individuals who are unable to undertake these activities without assistance. Unfortunately, such care insurance products may also face problems of adverse selection. Spillman, Murtaugh and Warshawsky (2001) propose a possible solution

to this based upon the empirical observation that individuals who need care have shorter life expectancy. Thus, if insurance companies simultaneously sold both an annuity and long-term care insurance they would be selling two insurance products that partially hedged each other.

This would have two important effects: First, in the UK context there are no products which provide an adequate hedge against mortality risks, because life insurance is not usually sold to the people of pension age (the situation is different in the USA). If care insurance provides some sort of hedge then it could buttress the annuity market either for annuity providers or in the reinsurance market by providing some insurance in aggregate annuity risk. Secondly, at the individual level, sales of a combined product would remove adverse selection problems and make both markets more efficient. Based on empirical mortality and care experiences in the USA, Spillman *et al.* (2003) estimate that the cost of providing long-term care insurance and an annuity simultaneously would be three to five per cent less than selling the two products simultaneously and would also result in more purchases. However, given the typical pension fund sizes reported by Stark (2003) it is difficult to believe that there would be a substantial market for care insurance, because most annuitants would have far too small a pension fund to be able to buy care insurance.

5.3 The option value of deferral

An important assumption that we have made up until now is that there is a single interest rate and that this is known. In reality there are a variety of interest rates and many of these are unknown because they are stochastic (such as the return on equity). Consequently, individuals do not just choose to consume or save but must also decide how to allocate their savings (or wealth) between a portfolio of different assets. In Yaari (1965) the choice was simply between investing in a bond or investing in an actuarial note (i.e. a bond whose payment was made conditional on having remained alive). Recently, several papers have asked what would happen if a third asset, equity, were also available.

Milevsky and Young (2002) suggest that this may mean that there is value in deferring annuity purchase. The intuition for this rests on two simple observations:

- The mortality risk for people who have just retired is quite low: typically only one per cent (this can be observed in both the population and annuitant mortality tables in the UK). Therefore, even supposing a one-year actuarial note were available for someone aged 65, the rate of return on it would only be $(1+r)/0.99$, which is clearly hardly any better than the rate of return on a conventional bond of $1 + r$.
- The expected rate of return on equity is much higher than can be explained by risk aversion alone: this phenomenon of the **equity premium puzzle** is well documented both internationally and historically by Dimson, Marsh and Staunton (2002).

An individual aged 65 has the choice of annuitising immediately or waiting one more year and annuitising at aged 66. Since the rate of return on a conventional annuity is almost identical to the rate of return on a bond and since the equity premium is observed to be larger than is necessary to compensate for risk aversion, it follows that the option value of waiting must be positive and that the agent should wait at least one year. Furthermore, the same logic will follow for any individual with a relatively low mortality rate and, therefore, it is worth delaying annuitisation until one is relatively elderly.

A numerical example may help here: suppose that the equity return is seven per cent, the bond return two per cent and hence, the equity premium is five per cent. Suppose also that individuals' attitudes to risk are such that, absent considerations of mortality, they would only require an equity premium of three per cent to be indifferent between equity and bonds. Then it would only be optimal to annuitise when the rate of return on annuities were three per cent, which would happen when:

$$1.04 = \frac{1.02}{p} \Rightarrow p \approx 0.98 \text{ and mortality} \approx 0.02 .$$

Using life tables from the USA, Milevsky and Young (2002) find the optimal ages for annuitising to be 78 for women and 73 for men. The option value of waiting to annuitise at age 65 is 15.3 per cent and 8.9 per cent of total wealth respectively and the probability of doing worse by delaying annuitising rather than annuitising straight away are 0.27 and 0.32. These figures are based on a constant relative risk aversion parameter of 2, and the assumption that the average return on risky assets is 12 per cent (and a 20 per cent standard deviation), compared with an implied six per cent internal rate of return on annuities. It is notable that although there are gains to delaying, the chances of doing worse by following this strategy are quite high.

There is also one slight inconsistency with this approach: The result that individuals would find it optimal to delay annuitising relies upon there being an equity premium which is 'too large'. But the equity premium puzzle exists only within a framework of rational expected utility maximisation. Turning the logic upon its head we could as easily argue that the existence of the equity premium puzzle shows that the theory is itself wrong (at least as a description of behaviour) and it might, therefore, be inappropriate to use expected utility maximisation to calculate the optimal time to annuitise. This clearly raises the question of whether the theory is correct as a description either of actual or optimal behaviour and brings us back to the point that the annuity puzzle is not the only problem with the economic approach to savings behaviour.

A potential solution to the model is that equity-backed annuity products could be made available paying the stochastic rate of return on equity suitably adjusted for mortality. Blake, Cairns and Dowd (2003) consider three types of decumulation

distribution programmes: a purchased life annuity (PLA) at 65, an equity-linked annuity (ELA) with a level annuity purchased at 75, and an equity-linked income drawdown (ELID) with a level annuity purchased at 75. They compare the welfare of a 65 year old male who retires with a pension fund of £100,000 in terms of the discounted lifetime utility from each of the three programmes when he can either annuitise at 65 (the base case of PLA) or use one of the deferred annuitisation options (ELA or ELID) by putting his pension fund into a combination of equities and bonds. They find that for relative risk aversion coefficients of less than 1.25, the best programme is ELA with 100 per cent in equities. For higher risk aversion coefficients the ELA still dominates, but with a greater proportion of the pension fund invested in bonds, until it eventually approaches the PLA. Importantly, the ELA always dominates the drawdown option ELID, but the size of the benefit of the ELA depends on the equity-bond mix. Blake *et al.* compute a cash-equivalent for the dominance of ELA over ELID: a plan member with an RRA of 3.96 would require an extra 25 per cent of wealth in the pension fund for a 75 per cent equities ELID to match the welfare from an ELA.

Blake *et al.* (2003) go on to examine the optimal age at which a plan member should annuitise. They consider the choice of annuitising immediately (PLA), or by employing either the ELA or ELID programme with the optimal equity/bond mix and annuitise at the optimal age between 65 and 85, with compulsory annuitisation at age 85 if voluntary annuitisation has not occurred before.

Comparing ELA and PLA programmes, they find that it is optimal either to annuitise immediately or to wait until age 85, but never to annuitise at some intermediate age, consistent with Merton (1983). Comparing ELID and PLA programmes, they find that the optimal age to annuitise is very sensitive with respect to the degree of risk aversion. At low levels of risk aversion the optimal age to annuitise is 79, close to the Milevsky (1998) rule, that switches at the point that the mortality drag equals the equity premium. Higher levels of risk aversion result in the plan member annuitising earlier.

They also compute the cost of a regulation compelling plan members to annuitise at age 75. A plan member with a low RRA of 0.25 would require an extra 1.6 per cent of their retirement fund to compensate for annuitising at 75 rather than 85, implying that when there is no bequest motive the cost of forced annuitisation is small. Introducing a bequest motive increases the optimal age of annuitisation.

Blake *et al.* (2003) also consider a dynamic stochastic annuitisation optimisation decision, in which the decision to annuitise depends on the performance of the pension fund. They find that a plan member is more likely to defer annuitisation, if their investments have been performing well, and to bring forward the annuitisation, if their investments have been underperforming.

Blake *et al.* summarise the results of the optimal time to annuitise from a number of past studies in Table 5.1.

Table 5.1 Summary of optimal annuitisation decision models

	Model features						
Paper	**Risk aversion**	**Survival credits before annuitisation**	**Type of programme**	**Bequests**	**Asset mix**	**Asset model**	**Results**
Yaari (1965)	Risk-averse	None	ELID	None	Fixed	Deterministic	Annuitise (PLA) immediately
Merton (1983)	Neutral	None	ELID & ELA	None	Fixed	Stochastic	Purchase an annuity immediately; never opt for PLA
Milevsky (1998)	Averse	None	ELID	None	Fixed	Stochastic	Annuitise (PLA) when mortality drag > equity risk premium
Kapur and Orszag (1999)	Neutral	Partial	ELID	None	Dynamic	Stochastic	Gradual annuitisation (PLA) with full annuitisation when mortality drag > equity risk premium
Milevsky and Young (2002)	Neutral	None	ELID	None	Dynamic	Stochastic	Switch to PLA at deterministic time T. ELID before T includes optimised dynamic asset mix. T depends on risk aversion and model parameters
Blake *et al.* (2003) Section 4.6	Neutral	None	ELID	Yes	Fixed	Stochastic	Switch to PLA at a stochastic stopping time T. ELID before T includes optimised static asset mix. T depends on risk aversion and bequest utility

(Source: Table 4 in Blake *et al.*, 2003).

Blake *et al.* (2002) suggest that at higher levels of risk aversion, an individual would annuitise earlier. An interesting question is how risk aversion changes along the life cycle. In the standard life cycle model, Samuelson (1969, 1989) finds that it is optimal to invest a fraction of wealth in risky assets that are independent of age.[48] This is a counter-intuitive result and many pension products have a 'lifestyle' asset allocation (Blake *et al.,* 2005). There are a number of ways around this surprising result, including endogenous labour supply, mean reversion, but also changing degrees of risk aversion along the life-cycle. In experimental work, Barsky *et al.* (1997) find for a sample of over 50s that the relation between relative risk aversion and age has an inverse U shape; whereas Guiso and Paiella (2001) find a positive relation between risk aversion and age.

Powell and Ansic (1997), Jianakoplos and Bernasek (1998), and Schubert, Brown, Gysler, and Brachinger, (1999) all find that women are more risk averse than men in a number of financial decision making contexts. Haleck and Eisenhauer (2001) find greater relative risk aversion for women and the elderly. An alternative but indirect approach is to examine the share of wealth held in risky assets, and see how it changes along the life cycle. Riley and Chow (1992) find that relative risk aversion decreases with age up to 65, but they then find greater relative risk aversion for the elderly. On the other hand Ameriks and Zeldes (2001) concludes that, after controlling for cohort effects, there is a positive relation between the share of financial portfolios held in risky assets and age. But these studies note that education, income, wealth and age are all correlated, and the relationship may be a function of one of these other variables.

5.4 Social welfare payments

So far we have assumed that at retirement the optimisation problem is to decide how to use a lump sum to finance consumption over several periods. The provision of social welfare payments or the existence of occupational pensions mean that many individuals already have a large proportion of their wealth in the form of an annuity. Indeed the Pensions Commission (2004, p.210) suggests that only those individuals whose labour income exceeds about £25,000 have a significant amount of their total wealth in assets other than their state pension.

Consider an individual who has wealth W_0 and will receive a welfare payment of S in each period of life. We continue to assume that it is impossible to borrow against future income payments, so the budget constraint must now be redrawn as shown in Figure 5.2.

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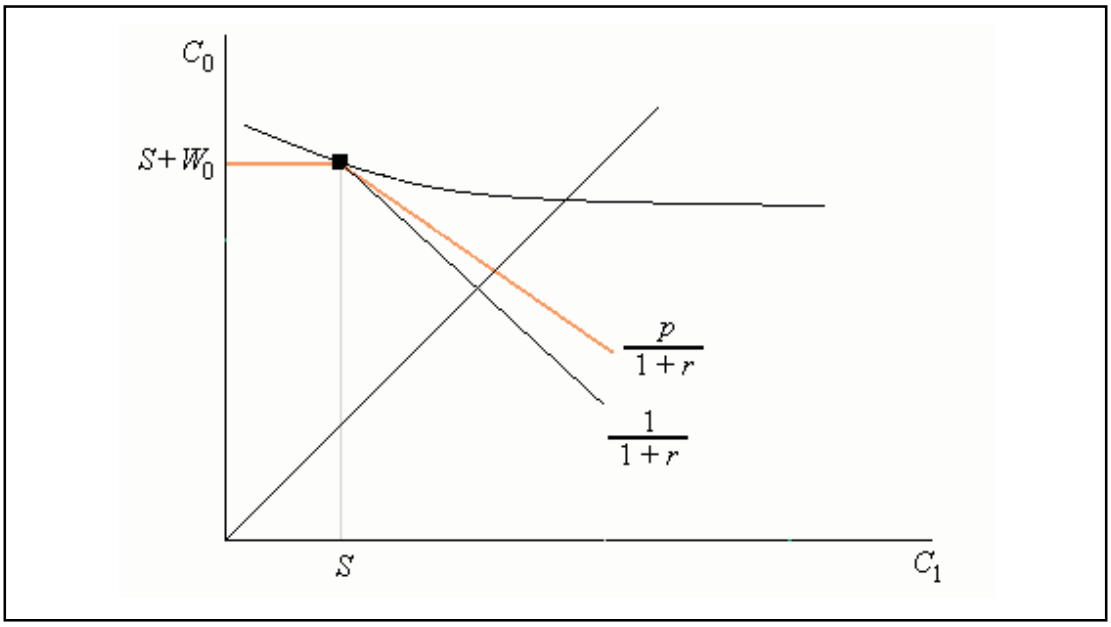
[48] To quantify the importance of risk, economic models have to use a particular model of risk aversion. Samuelson's model uses the Constant Relative Risk Aversion model, which can be contrasted with the Constant Absolute Risk Aversion model. Usually the functional form of the risk aversion is less important than the numerical size of the risk-aversion parameter (a point emphasised by Blake *et al.*, 2005 in their numerical simulations).

Figure 5.2 Annuitising when there are welfare payments

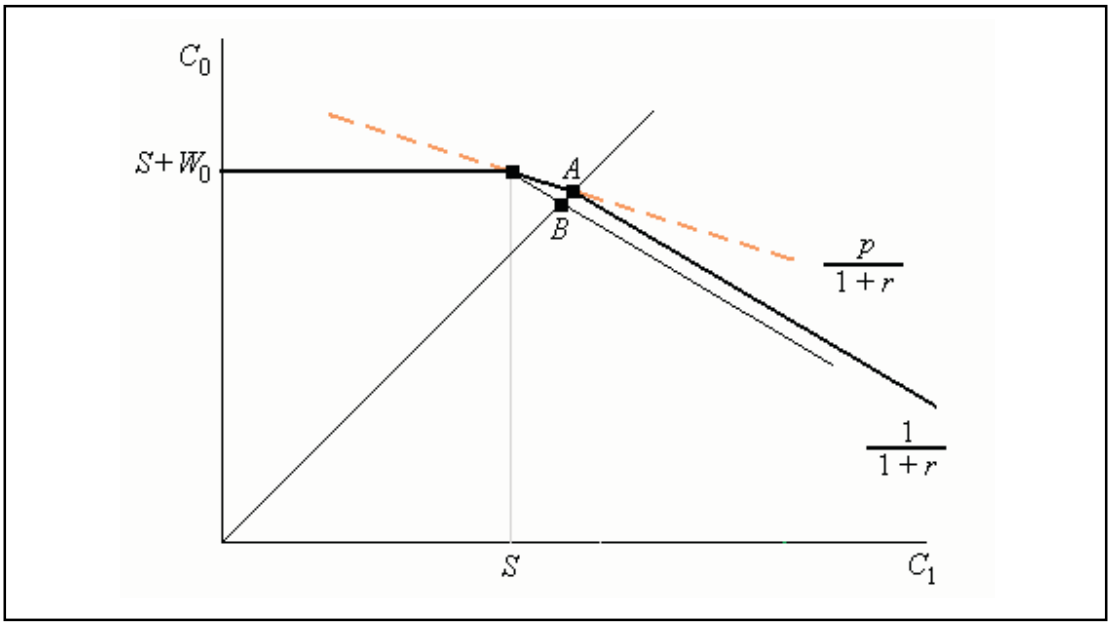


Because the individual is unable to borrow against future income payments there is a kink in the budget constraint and, as illustrated above, this may be the optimal consumption plan. This might be a plausible explanation of why annuity markets are thin; so many individuals' optimal consumption plans are at the kink that hardly any annuities are sold. But it would not explain under-annuitisation, since an individual at the kink consumes all their resources available in period 0 and holds no financial instruments into the second period because the budget constraint using annuities (the orange line) still lies above that using conventional bonds (the black line).

Many individuals, however, reach the point of retirement with very small pension funds so that the magnitude of S relative to W_0 is quite large (The Pensions Commission (2004), reports that only individuals whose labour income is over £25,000 – a sum well above the mean – would have a significant proportion of their wealth outside the state pension on retirement).[49] The budget constraint of individuals such as this is illustrated in Figure 5.3. There are two important kinks: one because individuals cannot borrow against future earnings, the second because they are not able to buy deferred annuities. The resulting budget constraint is shown by the thick black line (the dotted orange line shows the budget constraint that they would face if annuity markets were perfect).

[49] These figures are confirmed by Banks, Emmerson, Oldfield and Tetlow (2005).

Figure 5.3 Annuitisation when social security is the predominant form of an individual's wealth



Clearly individuals who wish to consume $C_0 < S + W_0$ could still purchase an annuity to get to a point such as A: if their optimal consumption plan was $C_1 > C_0$, then they could undertake additional saving using conventional bonds: this still dominates points such as B which are reached by buying conventional bonds alone and not purchasing annuities. However, because S is large relative to W_0, points A and B are relatively close together and so the difference in utility between buying bonds and buying annuities is relatively small and may easily be outweighed by any transactions costs involved in buying an annuity.

In our review of annuity rates in Chapter 4, we presented evidence that annuity rates depend in part upon the size of annuity purchase for small purchases, so purchasing such a small annuity to reach point A might result in obtaining a rate of return little better than on a bond.[50] In our discussion in the section on necessary expenditure, we noted that there might be an option value to saving in bonds because they are more liquid. Any such option value would clearly be more likely to outweigh the benefits of annuitisation over buying bonds the larger were social welfare (or existing pension) payments relative to W_0. This is consistent with the empirical analysis of Brown (2001) discussed already.

[50] In the UK there is also the problem that the means-tested Pension Credit would ensure that the benefit of having a very small annuity would be largely offset by reduced welfare payments.

5.5 Habit formation

We have already discussed the fact that annuitisation makes individuals better off by shifting their budget constraint out, so that the specific functional form of their preferences does not affect the Yaari (1967) result that full annuitisation is optimal when annuity markets are perfect. Davidoff *et al.* (2005) examine this further by considering a more general functional form, namely:

$$U = \sum_{t=65}^{100} \delta^t p_t \frac{\left(c_t / s_t\right)^{1-\gamma}}{1-\gamma}, \qquad s_t = \frac{s_{t-1} + \alpha c_{t-1}}{1+\alpha}. \tag{5.2}$$

This functional form is no longer time additively separable: this can be interpreted as a form of habit formation. The amount of utility that one receives from consumption in period t depends upon how large that consumption is relative to a reference standard of living (which Davidoff *et al.* refer to as a 'habit level'), which itself evolves over time.

The behaviour of an individual with these sort of preferences depends crucially upon the initial habits that an individual has and how large these are relative to y, the individual's level of consumption that could be maintained throughout retirement (analogous to Friedman's permanent income). If the initial habit level is lower than y, then it is clearly possible to have a consumption path which is growing over time, and this is optimal since utility is higher if current consumption is large relative to previous consumption. A more likely scenario is if the habit level is higher than y, in which case a constant level of consumption is not possible. The Pensions Commission (2004) for the UK and Hurd and Rohwedder (2005) for the USA present evidence that consumption expenditure typically falls at the point of retirement and it is usually thought that this fall is larger than can be explained by a reduction in work-related costs and increased availability of discounted prices.

In such a case an unconstrained optimum would have levels of consumption expenditure that were high initially but falling steadily over time. Since per period utility is a concave function of consumption relative to habit, the optimum is achieved by smoothing this ratio.

Davidoff *et al.* (2005) then calculate the optimal consumption path under a variety of scenarios. The one which is relevant for our discussion here is the proportion of wealth that would be annuitised if the only annuity product that was available were a constant real annuity. The results of this exercise are reported in Table 5.2.

Table 5.2 Optimal annuitisation with habit formation in preferences

Model	Alpha	s_0/y	Discount rate	Amount of wealth annuitised %
1	-	-	0.03	100
2	1	1	0.03	100
3	1	0.5	0.03	100
4	1	2	0.03	90
5	1	2	0.1	75

Source: Davidoff *et al.* (2005, p.29).

These simulations all suggest that the rational amount of annuitisation is very high, but of course take no account of the issues of health care and welfare payments raised above. Taking the basic state pension as about £3,500 per year for a single male, the present value of this asset is about £43,000, only slightly higher than the average private personal pension fund of £40,000. This suggests that if preferences were characterised by the parameters in case 5 in the above table, then the individual would only wish to annuitise a further £21,500 of their financial wealth, or 54 per cent.

5.6 Behavioural factors

Our discussion so far has assumed that agents are rational utility-maximising agents with risk-averse preferences. These are very standard assumptions which have been used widely within the economics literature for much of the post-war period. More recently, economists have become aware that these assumptions may be inadequate descriptions of actual behaviour and current research is more devoted to the insights that can be learned from economic psychology (Rabin, 1998). Much of this research suggests that actual behaviour is frequently irrational and that departures from rationality are both consistent across a range of behaviours and reliably correlated with other factors. Some recent work on behavioural economics and pension provision has been collected in Mitchell and Utkus (2004).

5.6.1 Cumulative prospect theory and loss aversion

There is a considerable body of evidence to suggest that the expected utility hypothesis with risk aversion does not fully explain economic behaviour.[51] One well-known problem is that risk-averse individuals would always purchase fair insurance

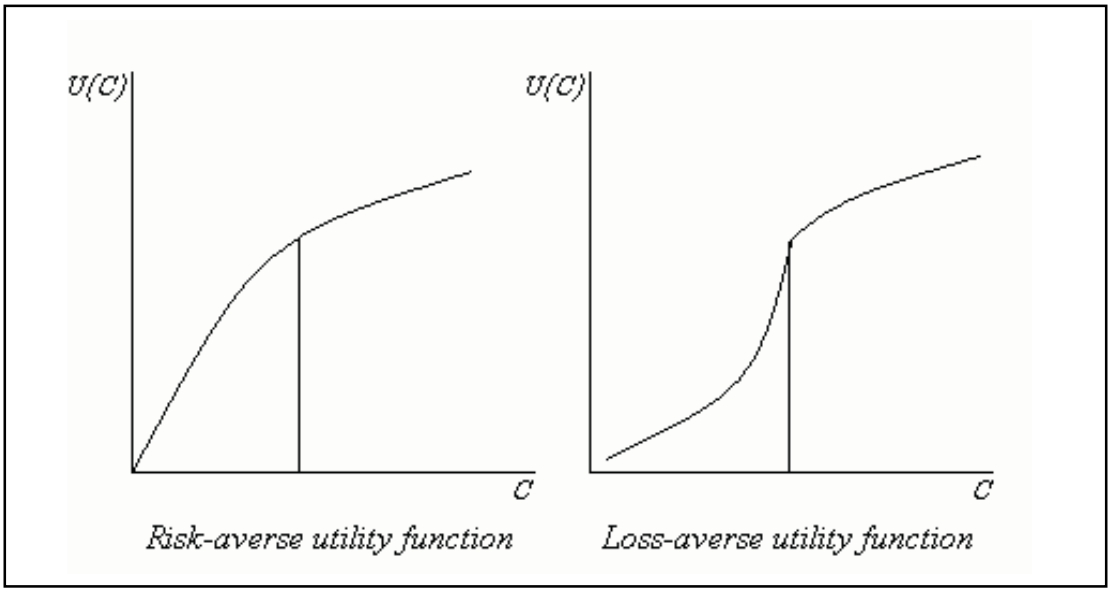
[51] The Kahneman-Tversky approach assumes that loss aversion is a better characterisation of behaviour than risk aversion. Plott and Zeiler (2005) argue that these results are due to faulty experiment design and that with appropriate design behaviour appears to be better characterised by risk aversion. Of course, this provides incidental support that framing effects are important.

and avoid fair gambles, but it is frequently observed that agents do purchase unfair gambles: that they simultaneously purchase insurance suggests that they cannot be risk-loving. Kahneman and Tversky (1979) have suggested that agents' behaviour is modelled better by **loss aversion** than **risk aversion**. In this theoretical framework, there is a reference or endowment point, which can often be understood as the initial position, and utility depends upon whether the agent's position improves or worsens in comparison with this reference point. Gains over the reference point yield increased utility at a diminishing rate, consistent with standard **risk aversion**. Losses compared with the reference point yield lower utility, but there are two important differences with **risk aversion**:

- there is diminishing disutility to losses, resulting in the utility function being risk-loving for outcomes lower than the reference point; and
- the marginal disutility to a very small loss is strictly greater than the marginal utility gain to a very small gain, resulting in a kink at the reference point.

These preferences are illustrated in Figure 5.4.

Figure 5.4 Contrasting risk- and loss-aversion



An example of these preferences is as follows: an agent who initially has £110 and then loses £100 will be less happy than an agent who initially has £90 and then receives an extra £10, even though both end up with the same sum of £100.

The replacement of risk aversion with loss aversion need not suggest a departure from rationality *per se*, since there is no necessary inconsistency with these preferences. However, it does raise the question of what is to be taken as the reference point and how the reference point is determined and changes over time. But Kahneman and Tversky (1992) do also include a component of explicit irrationality by assuming that individuals falsely perceive probabilities, noting that

empirically individuals tend to overestimate the probability of low probability events and underestimate the probability of high probability events. Therefore instead of calculating the mathematical expected utility, they calculate a weighted utility metric, where the weights are functions of the probabilities but with these biases built in.

To put this in context, we show how this could be applied to the two-period scenario that we have discussed already. Consider an individual whose reference point is to consume without purchasing an annuity: this is clearly appropriate in the voluntary purchase market, if less so in the compulsory purchase market. For simplicity we also assume that $\delta = (1+r)^{-1}$, so that the individual prefers to divide their consumption equally between the two periods. In this case the reference level of consumption would be $W_0 / 2$. Furthermore assume that p, the probability of living into period 1, is relatively high and write the weights in the loss aversion theory as $\xi \in (0,1)$:

(5.3)
$$\begin{array}{cccc} p & & 1-p & \\ \xi & < & p & \text{and} \quad 1-\xi > 1-p \end{array}$$

Then the optimisation problem with standard preferences is:

(5.4)
$$\max \left\{ u(C_0) + p u(C_1) \right\} \quad u' > 0; u'' < 0$$

and the optimisation problem is:

$$\max \left\{ v(C_0) + \xi v(C_1) \right\}$$

$$C > W_0 / 2 \Rightarrow \begin{cases} v'(C) > 0 \\ v''(C) < 0 \end{cases}$$

(5.5)
$$C < W_0 / 2 \Rightarrow \begin{cases} v'(C) > 0 \\ v''(C) > 0 \\ \lim\limits_{C \to W_0/2} v'(C) < \lim\limits_{C \to W_0/2} v'(C) \end{cases}$$

where the utility maximisation is subject to the relevant budget constraint in both cases. The indifference curve now has a kink where it crosses the 45 degree line and this characterisation violates the assumptions made by Davidoff *et al.* (2005), but this does not ensure that the individual would not prefer to be fully annuitised. Indeed, the presence of the kink would appear to make it more likely that the optimal solution would be to put all of their wealth into an annuity.

The only application of loss aversion to the annuity market that we can find is Holmer (2003), who contrasts his results with those in an earlier version of Davidoff *et al.* (2005). However, Holmer's analysis concentrates on the effects of stochastic interest rates and his paper is, thus, more easily compared to that of Milevsky and

Young (2002). Unlike Milevsky, who calculates the optimal time to annuitise (given 100 per cent annuitisation), Holmer calculates the optimal annuitisation given that this is done immediately (at the point of retirement). His results are summarised below, which show the percentage of wealth that should be put into a joint-life annuity for a married couple. The parameterisation of the loss-aversion model are taken from Tversky and Kahneman (1992), whereas that for the risk-averse model is based on a reasonable measure of risk aversion (usually thought to be a bit greater than unity).

Table 5.3 Summary of Holmer's (2003) results on optimal annuitisation

Money's worth of annuity %	Expected utility model (risk aversion), CRRA, $\gamma = 2$ %	Cumulative prospect theory (loss-aversion) %
100	71	16
85	30	0

These results suggest that individuals whose behaviour is characterised by loss-aversion are less likely to annuitise, although it is clear that all of the results in Table 5.3 rely upon the existence of an excessive equity premium as we explained above in our discussion of Milevsky and would anyway be moot if equity-based annuity products were available.

This area is clearly one for further research. However, one important consideration is whether Holmer's characterisation of the reference point is correct; since one of the concerns that many people voice over annuitising is the possibility that they might die before receiving back their capital, perhaps the reference point is not the continuous stream of consumption that forms the reference point but instead the capital sum. Historically one could partially insure against dying soon by purchasing an annuity with a guarantee period and newer annuity products that allow for the possibility of a guarantee to pay at least the capital sum. In the context of the Tversky and Kahneman (1992) approach sketched above, two things are worth noting:

- the probability of dying very soon after purchasing an annuity (and hence getting very little apparent benefit) is very low, but this probability is likely to be overestimated; conversely the significant probability of out-living one's means if one doesn't annuitise is underestimated; and
- the gain to annuitising compared with holding bonds will give a small utility benefit, while the 'loss' of dying early may have a large utility loss.

Interestingly, Chen (2003) suggests that the psychological barriers due to loss-aversion to buying long-term care insurance might be partially overcome through bundling the insurance with an annuity, thus providing a psychological rationale to complement the same suggestion by Spillman, Mautaugh and Warshawsky (2003).

5.6.2 Additional psychological considerations

We have found relatively few explicit applications of the psychological literature to the market for annuities (for example, there is only one paper on 'pensions' in the entire 25 year history of the *Journal of Economic Psychology*). Therefore, in this section we shall briefly review some of the concepts that seem most relevant.

Framing Effects occur when individuals' behaviour depends not upon the choices available but upon the way in which they are presented. The Pensions Commission (2004) notes that in the USA employees are much more likely to be a member of a 401(k) scheme if they have to opt out than they are if they have to opt in, although this is not a pure framing effect, since employees have to exert different amounts of effort in the different cases.

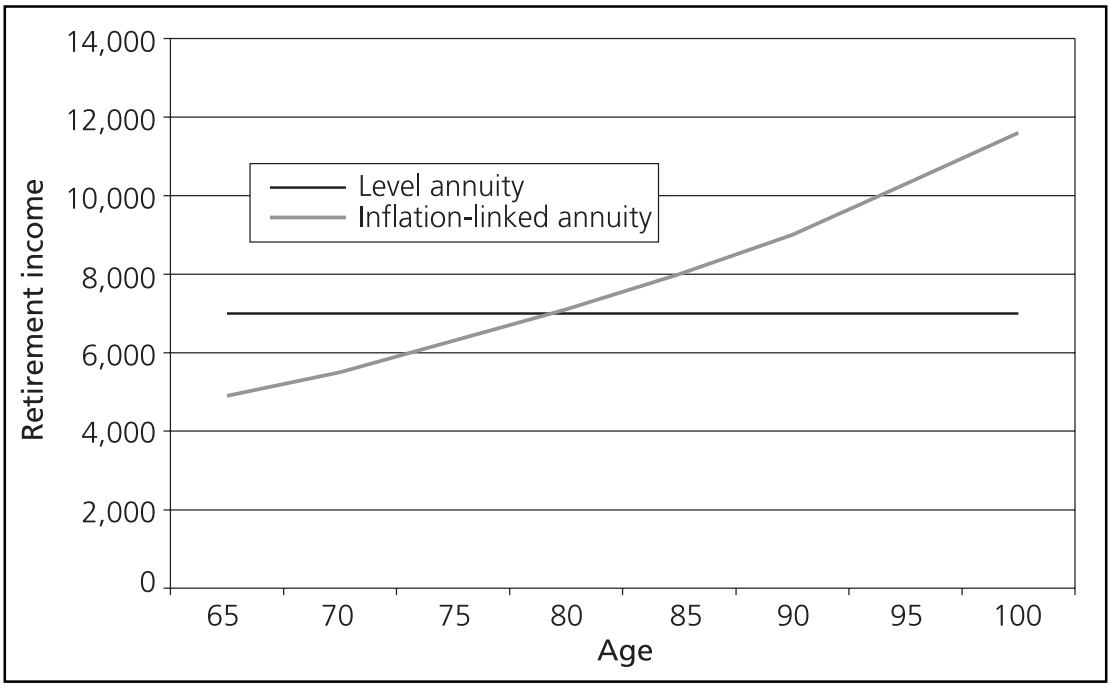
A UK example is the difference between Defined Benefit (DB) and Defined Contribution (DC) schemes. Members of DB schemes who receive a pension and a tax-free lump sum are not agitating to be given their entire pension benefits as a lump sum, but members of DC schemes who are required to annuitise their pension fund do appear to resent the annuitisation requirement. Again this is not a pure framing effect, but it does appear that being given explicit information about the size of the pension fund biases individuals from wanting a pension. This clearly relates to our discussion of how to characterise reference or endowment points under the heading of loss-aversion.

The Pension Research Forum (2004) finds evidence of a pure framing effect when it comes to purchasing different types of annuity. Their research is based on a sample of about 5,000 workers in large corporations (the latter being customers of Watson-Wyatt). Respondents were asked whether, at age 65, they would prefer an annuity that paid a constant £7,000 per year or one that was initially £4,900, but rose in line with inflation. The sample was split into two parts: both groups received exactly the same textual question, but one group was shown a table of numbers and the other a graph (approximate copies are shown in Table 5.4 and Figure 5.5). Of the group that was shown the table, 65 per cent chose the level annuity and 26 per cent the inflation-linked, whereas of those shown the graph the figures were 48 per cent and 41 per cent respectively. These discrepancies are due to the visual impact that the different forms of presentation have.

Table 5.4 Group A

Age	Level annuity	Inflation-linked annuity
65	7,000	4,900
70	7,000	5,500
75	7,000	6,300
80	7,000	7,100
85	7,000	8,000
90	7,000	9,000
95	7,000	10,300
100	7,000	11,600

Figure 5.5 Group B



Other framing effects occur when the range of options is increased. For example, the choice between two options, A and B, may be affected by whether a third option C is also available. The Pensions Commission (2004) cites the Benartzi and Thaler (2001) result that the percentage people invest in equity is determined by the proportion of equity funds in the choice set. Another possibility is that people prefer to avoid extremes: while agents may choose A over B (and A may be objectively superior to B), if an alternative C is added so that B is intermediate between A and C, then the most likely choice is B, because it is more 'average'. The number of choices also matters with a greater variety leading to more confusion, potential worry and greater likelihood of avoiding any decision at all.[52]

Overconfidence is now often cited as a possible reason for financial behaviour among professional investors, especially during times of bubbles. Individuals systematically overestimate their own individual ability: even professionals who believe in the efficient markets hypothesis also believe that they will (uniquely) be able to beat the market. Among pensioners who wish to control their own pension funds rather than hand them over to an insurance company this could be a major barrier to annuitisation. This might particularly affect the Self-Invested Personal Pensions (SIPPs) market.

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[52] Schwartz (2003) argues that agents would be happier at the point of decision if they had fewer choices and attempted merely to satisfice (i.e. aim for some easily achievable target level of utility) rather than maximise (i.e. aim for the maximum possible level of utility); in addition the presence of fewer choices would lead to less delay in decision making.

Conclusion. The theoretical literature has been able to find scenarios where less than full annuitisation is optimal, but the underlying intuition that annuitisation expands the budget set still stands. Perhaps the most convincing cases for not annuitising are the:

- fact that better returns can be earned on equity than on bonds, which can be resolved by allowing people to buy equity-based annuities; and
- possibility of adverse selection, which may be alleviated by bundling annuities with long-term care.

In both cases there is a potential solution based on more sophisticated annuity products, but these might only be appropriate for relatively wealthy individuals and might be difficult for many consumers to understand.

Instead, it appears likely that psychological explanations, many of which could be characterised as irrational behaviour, may underlie much of the unwillingness to annuitise. Combined with a general ignorance about how annuity products work, this creates major challenges to designing appropriate policy – it is not clear how to maximise welfare if people's happiness is determined as much by psychological considerations as by financial well-being.

6 Supply of annuities

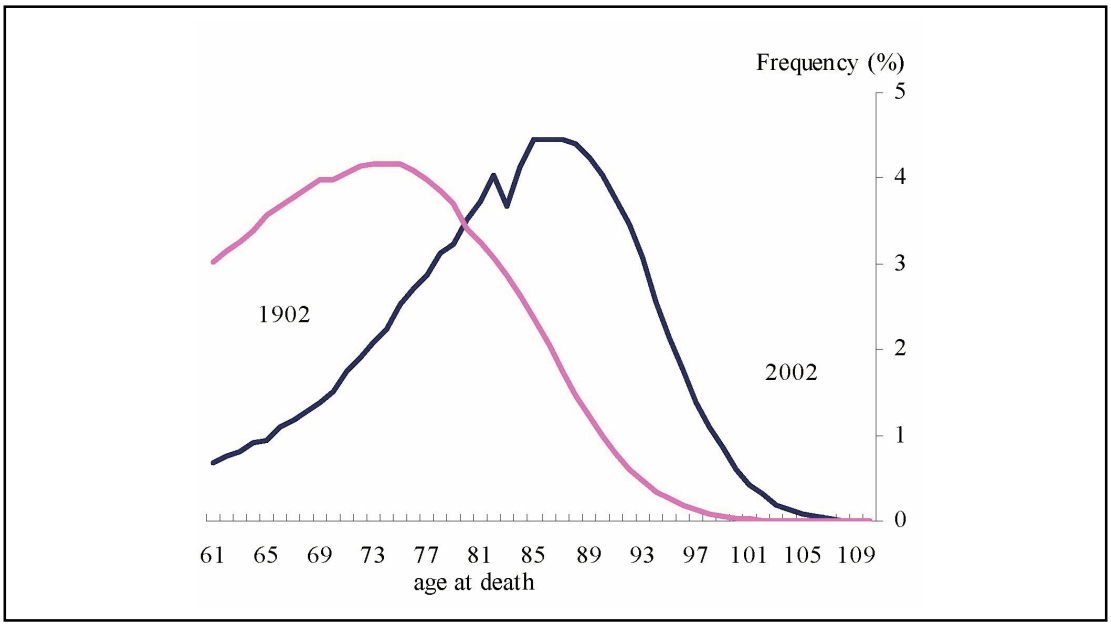
Stark (2003) suggests that the projected demand for annuities, will be constrained by the capacity of the annuity supply. The purpose of this section is to understand the factors that determine the supply of annuities. Current annuities are almost invariably bond-backed products: life assurers use bonds (government bonds, corporate bonds and mortgages) as an 'input' and produce annuities as an 'output': the value added provided by the life assurers is the conversion of these financial instruments into mortality-contingent income streams for individuals. Clearly, two issues of importance are the supply of bonds and the way that life assurers deal with cohort longevity risk. Another important issue is the small number of annuity providers, potentially leading to abuse of monopoly power, but also meaning that the failure of any individual annuity provider would have an impact on a very large number of pensioners. For both these reasons, the small number of providers requires appropriate regulation and we shall consider the recent changes to the regulatory framework for insurers in the UK.

Increased demand for long-dated government debt by insurance companies who have issued annuities and wish to match the duration of their assets and liabilities, coincides with a reduction in the size of the UK's national debt through a series of budget surpluses or very small deficits. This has led to very high prices of long-dated government debt and relatively low yields, to the point where the yield curve is now downward sloping at the long end. According to this 'preferred-habitat' view of the term structure, there is a major distortion of all long-term interest rates that has a corresponding effect on annuity prices. The preferred habitat theories rely on there being poor substitute assets in which to invest. We will assess this feature of the annuities market by considering the substitutes for long-term UK government bonds such as high quality corporate bonds, international bonds and mortgages and the effects of the Debt Management Office's (DMO) issue of ultra-long 4¼ per cent Treasury Gilt 2055, auctioned on 26 May 2005.

Turning to longevity risk, Figure 6.1 shows the distribution of female survival probabilities by age at two points in time. Clearly there has been a huge shift in the distribution between 1902 and 2002, which would have been difficult to predict in 1902. Insurance companies efficiently insure individuals against the idiosyncratic

risk, but also bear the risk of mis-predicting the overall position of the distribution. The Continuous Mortality Investigation Bureau analyses the mortality experience of pensioners and produces quadrennial reports and less frequent tables of predictions of future mortality. Analysis of the Bureau's regular reports shows that predicting cohort mortality is difficult (Cannon, 2005). An important risk is who ultimately bears this cohort longevity risk.

Figure 6.1 Female mortality after age 60, England and Wales, 1902 and 2002



The regulatory framework for insurance companies has changed considerably from January 2005 as the Financial Services Authority (FSA) has implemented risk-based measures for company solvency standards. These new regulations, in part influenced by the Equitable Life debacle, anticipate likely EU-wide regulations under Solvency 2. We shall consider the implications of the new regulatory framework for annuity markets.

Cannon and Tonks (2004b) have documented the declining number of annuity providers over the last 50 years, although the money's worth calculations of Cannon and Tonks (2004a) discussed already suggest that this has had no impact on prices. We now turn to examine recent evidence on the market shares of life assurers writing annuity contracts.

6.1 Market shares of annuity business

Annuities are provided by insurance companies, and are a heavily regulated industry. From the annual returns submitted by insurance companies to the FSA, we can obtain information on the market share of the main companies. Table 6.1 reports information from Form 47 of the FSA annual returns for 2004. It shows the

number of annuity contracts sold in 2004, the total premiums received by the insurance company reflecting new business generated in 2004, and the annual payments made on existing annuity contracts which is a measure of existing business, or more correctly, obligations that relates to business conducted historically. It can be seen that the Prudential dominates the annuities market, in terms of existing payments (49 per cent of the market), and in terms of new business (57 per cent), so that the Prudential's dominance in the annuities market appears to be growing. The other major players in the market are: Legal and General, Norwich Union, and Friends Provident. Legal and General's annuity business appears to be shrinking.

Table 6.1 New business of selected insurance companies in 2004

Analysis of FSA returns year ended 2004

New ordinary UK long-term business (Form 47)	Annuity rate (2005) for £20,000 Male %	Rank by annuity rate	Market share %	Average premium £	Total premiums £m
AXA/Sun Life (both companies)			2.2	23,448	185
Canada Life Ltd	6.96	1=	7.1	49,831	591
Clerical Medical	6.54	9			
Friends Provident Pensions Ltd	6.96	1=	7.8	9,279	648
Legal and General	6.84	4=	12.3	44,754	1,015
MGM Life Assurance Ltd			0.3	22,750	22
Norwich Union Annuity Ltd	6.84	4=	7.7	53,041	636
Prudential (both Annuities and Retirement Income)	6.96	1=	40.6	27,287	3,360
Reliance Mutual	6.00	10	0.3	35,315	29
Resolution Group			2.4	20,007	200
Royal London Mutual Insurance Society Ltd (Scot Life)			2.0	12,836	169
Scottish Equitable	6.60	8	5.9	24,766	492
Scottish Widows Annuities Ltd	6.84	4=	6.6	16,224	543
Standard Life	6.72	7	4.7	12,440	387
Total of these companies				**27,075**	**8,277**

Source: FSA insurance returns.

Cannon and Tonks (2004b) report that the number of annuity providers quoting annuity prices has fallen substantially over the last 40 years: as recently as 1970 almost 100 companies' annuity rates were quoted in the trade magazine *The Policy* while the current number of companies quoting annuity rates on the FSA web-site is about 20 and some of these are specialist providers.[53] The five-firm concentration

[53] B&CE Insurance Ltd only sells annuities to people who have worked in the construction industry and the NFU only to farmers. Partnership Insurance specialises in impaired lives annuities.

ratio is over 70 per cent, and given this high degree of market concentration, it is perhaps surprising that the money's worth calculations in Chapter 3 suggested no evidence of monopoly profits in the voluntary annuities market. Although it does write a small amount of new business, Resolution Group is a firm specialising in the consolidation of closed life funds (Britannic, Phoenix, Royal & Sun Alliance, Sun Alliance & London, Swiss Life). There have been two new entrants to the market in recent years, suggesting that there are no significant barriers to entry: The Pension Annuity Friendly Society started business in 1995, demutualising to become Partnership Assurance in 2005; Just Retirement started business in 2004. Although these two annuity providers are small, they are backed with capital from larger companies.[54] The small number of active annuity providers in the UK could be beneficial due to the potential advantages of economies of scale, especially through more effective risk-pooling, but the near constancy of the money's worth over a period of increased concentration suggests that this consideration is also unimportant. Cardinale, Findlater and Orszag (2002) compare annuity markets across a number of countries. They note that the UK's annuity market is the largest in the world, and that in most other countries annuity markets are small. In the countries surveyed annuity providers are typically life assurers, though in some European countries these are part of the larger bancassurance groups. They note that Australian and German annuity markets are less concentrated than those in France and the UK, though they note that in every country there has been a trend towards greater consolidation over time.

6.2 Regulation of annuity providers

Traditionally, industries are candidates for regulation, when there is one of the following three situations: first, consumer asymmetric information (leading to the possibility of market breakdown); secondly, externalities present mean that the actions of one supplier may spill over onto other producers; or thirdly, if there is the possibility of the abuse of market power. As Davies (2004) notes, the supply of annuities is heavily regulated, because all three of these situations apply. Annuity providers are regulated in three ways: firstly in terms of the way information is provided to consumers (FSA); secondly through the design of products which are acceptable to the Her Majesty's Revenue and Customs (HMRC) (since pension contributions benefit from tax deductions) and the Department of Work and Pensions (DWP) (through 'protected rights' obligations) and thirdly by solvency regulation of the annuity provider in terms of reserves and capital adequacy (FSA). In fact the first and third of these regulations, are statutory objectives of the UK's FSA. The first falls within the FSA's remit of promoting public understanding of the financial system, and the third relates to the FSA's obligation to secure an appropriate degree of protection for consumers.

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[54] Partnership Assurance is backed by Phoenix Equity Partners and HBOS; Just Retirement by Langholm Capital Partners, Hannover Re and Robeco.

As we have already discussed, annuities are complex financial products, the characteristics of which are not easily understood by consumers, so that like 'treatment goods', it is only long after the event of purchase (approximately if the annuitant lives for longer than their life expectancy) that annuitants appreciate the benefit of an annuity product. As the Equitable Life case illustrates, assumptions made by one annuity supplier can impact on the rest of the industry. Finally, as Table 6.1 shows the industry is highly concentrated, and although we have documented no abuse of monopoly power in the relatively small purchased life annuity market, the evidence on the pricing in the compulsory annuity market is less well-documented. Indeed, the government introduced the open market option in 2002, which requires that personal pension providers must inform the upcoming pensioners, that they have the right to annuities with an alternative annuity provider. As we have discussed in Chapter 3, Stark (2003) notes that a third of annuitants exercise this option.

Annuity holders are protected from insurance company insolvency by reserving and capital adequacy requirements. Daykin (2001, 2004) outlines a number of issues in reserving for annuities. He notes that reserving may be carried out for a number of different reasons: a) to support the sound and prudential management of the insurer; b) to ensure that the insurer's accounts give true and fair picture of its assets and liabilities; and c) to provide information for tax authorities. As we note below, these reasons may not be in conflict: the FSA (2005) recognises that if an insurer's accounts give an accurate picture of its asset-liability mix, then this will ensure that the market will provide the discipline that the insurer practices the appropriate level of prudential management.

Capital requirements for insurance companies, and specifically for annuities (Article 2), are covered by the European Union Directive 2002/83/EC concerning life assurance, Article 28, which states that the required solvency margin should be equal to the sum of a *'four per cent fraction of the mathematical provisions relating to direct business* [net of reinsurance]...[plus]*...for policies on which the capital at risk is not a negative figure, a 0.3 per cent fraction of such capital underwritten'* (paragraph 2a, 2b). In addition, Article 29 states that *'One third of the required solvency margin as specified in Article 28 shall constitute the guarantee fund. This fund shall consist of the items listed in article 27 (2), (3)...The guarantee fund may not be less than a minimum of Euros 3million'* (Article 29 paragraphs 1 and 2).

The UK's FSA makes clear in FSA (2005) that *'It is widely recognised that the existing capital requirements for insurance companies as set out by the European Directives are inadequate and not sufficiently risk-sensitive'* (paragraph 3.5, page 19).

The EU's Solvency 2 programme is intended to apply to the insurance industry, the regulatory approach adopted in the Basel 2 reforms for the banking industry. Basel 2, consists of three regulatory pillars. The first pillar consists of risk responsive capital requirements; the second pillar consists of additional capital requirements imposed by the regulator following individual company risk assessments; and pillar 3 relates

to disclosures to ensure market disciplines can operate. However, the timetable for Solvency 2 has fallen behind and is not expected to be implemented until 2009. In the meantime the FSA has recognised the shortcomings of the existing EU insurance directives, and has proceeded with its own risk-based solvency requirements, in part anticipating the likely Solvency 2 rules. Muir and Waller (2003, p.2) note that the reason for the FSA's need to implement reforms in advance of a European-wide approach, relates to a number of events in the UK's insurance industry, including the closure of Equitable Life, the Sandler Review of Medium and Long-term savings in the UK, a number of high profile compliance failings, and the fall in equity values after 2000.

The new capital requirement reforms outlined in FSA (2005) came into effect from January 2005, and apply the principles enshrined in the proposed Solvency 2. These are based on a 'twin-peaks approach' risk-sensitive regime for with-profit insurance companies: a regulatory peak and a realistic peak. Both of these peaks constitute Pillar 1 of the regulatory regime. Under the FSA's Integrated Prudential Sourcebook (PRU 2.1) an insurance company must maintain capital resources no less than its Minimum Capital Requirement (MCR), which follows on directly from the EU Directive (four per cent reserves), and is equal to its base capital resources requirement, of Euros 3million (which, starting from the review date of 20 September 2005, increases annually by the European Index of consumer prices from 20 March 2002) (PRU 2.1.27). In addition, life firms that have with-profits liabilities in excess of £500million, must make realistic assessments of their risk-based capital to satisfy the realistic peak, referred to as the resilience capital requirement which arises from market risk for equities, real estate and fixed income securities (PRU 4.2.11). The realistic peak requirements only apply to firms that write significant with-profits business, so that annuities that are written in separate non-profit funds would not be required to comply with the realistic peak, but annuity business written in funds that included significant with-profit business would have to comply.

Furthermore, under Pillar 2 of the new regime, firms must carry out individual risk assessments, relating to other types of risk (group, operational, insurance (including longevity), credit, and liquidity risks) based on stress and scenario testing, to determine whether they need to hold additional capital. The need to hold additional reserves to satisfy the Pillar 2 requirements depends on the views of the senior management of the company and private discussions with the regulator, and since 2002 firms and the FSA have been preparing for the new system. The FSA also intends that a company's realistic balance sheets will be published, to allow the market to discipline companies, in line with Pillar 3.

It seems appropriate that the risk of annuities be assessed on an individual firm basis, since the risks for insurance companies selling annuities, will be offset by the sales of life insurance by the same company that will act as a natural hedge against longevity risk.

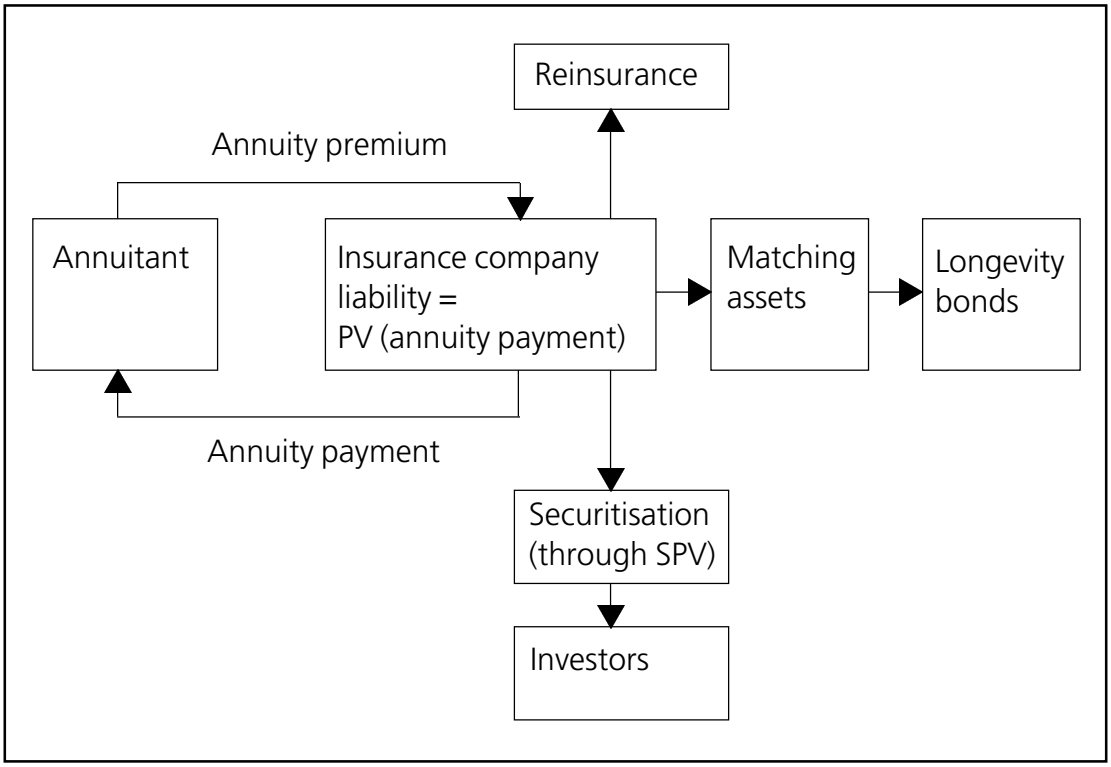
Prudent management of reserves is important, and imprudent management can have catastrophic consequences as illustrated by the Penrose (2004) report into the Equitable Life case. Equitable Life is the UK's oldest life assurer and during the 1970s and 1980s had offered deferred guaranteed annuities (strictly speaking the option to buy an annuity at a guaranteed rate) to individuals who saved through an Equitable Life personal pension. However, the company appeared to have made no charge for these guarantees nor made any attempt to set aside reserves to cover the cost of the guarantees. These options were out-of-the-money at the time they were made, because nominal interest rates were high during these periods, but as interest rates fell during the 1990s, the guaranteed annuities moved into the money. Other companies who had also offered these guaranteed annuities undertook prudential management in a number of ways: reserving, capping and reinsurance. However, Equitable Life sought to manage these liabilities by paying out smaller terminal bonuses on the with-profits personal pensions to those policyholders with guarantees than those without (to the detriment of the policy holders with guarantees). In the event the Law Lords ruled that this discrimination was illegal, and as a mutual insurer, all policyholders were liable for the guaranteed annuities. In the event, the non-guaranteed policyholders received reduced terminal bonuses to honour the guarantees. This made non-guaranteed policies uncompetitive, and the fund was closed to new members in 2001. This case illustrates the importance of sound and prudential financial management and the role of reserving.

6.3 Managing the annuity liabilities: longevity risk

The cash flows in an annuity contract between the insurance companies who supply or write annuities, and the annuitants who purchase them, are illustrated in Figure 6.2. In return for an annuity premium, the insurance company agrees to pay the annuitant a regular annuity payment until death. The insurance company then has a liability to the annuitant, and may protect or offset this liability in a number of ways. The standard investment would be for the premium received from the annuitant in an asset. Insurance companies operate an annuity portfolio, and given the characteristics of the annuitants in the portfolio, are able to estimate the likely future annuity pay-outs from the portfolio.

Prudential risk management dictates that the insurer will invest the pool of annuity premium proceeds in assets whose pay-outs and risk profile closely match the pool of expected future annuity pay-outs in order to minimize the risk to the insurance company that it will not be able to fund the annuity contract. Long-term government bonds are one such asset, though James and Song (2000) note one possibility for the documented high money's worth of annuities is that annuity providers may have been investing in riskier securities such as corporate bonds. An ideal matching asset would be a longevity bond (Blake 1998, 2002; Dowd, 2002).

Figure 6.2 Relationship between annuitant, life assurer and underlying assets



A longevity bond is a long-term bond whose coupon payments depend on an index of population mortality, so that the coupon payments increase in line with the number of lives surviving. For example, a fixed coupon payment could be multiplied by the percentage of the reference population still alive at each anniversary. Although the advantages to an insurance company from purchasing a longevity bond, are that the cash flows provides a close match to the liabilities of the insurer, there are some disadvantages: First, the mortality experience of the pool of annuitants held by the insurer may be different from that of the reference population; secondly although a longevity bond may provide a hedge against interest rate movements, it may not be as liquid as a government bond; and thirdly the credit risk of the issuer of the bond might make it riskier than a government bond.

In November 2004 the European Investment Bank announced its intention to issue a 25 year longevity bond. The annual coupon payments on the bond are determined by the number of lives in the English and Welsh male population reaching age 65 in 2003 and then surviving to each subsequent year. Coupon payments decrease in line with the number of lives surviving, as estimated by the Office of National Statistics. The bond issue of £500million was arranged by BNP Paribas, and was reinsured with PartnerRE, who assumed the longevity risk. As of the summer of 2005, this bond had still not been fully issued, and there were news reports that potential customers of the bond, such as insurance companies, had been reluctant to purchase it. The DMO (2005) reports that as part of its consultation exercise with

the pensions industry in 2004, it had considered the issuance of longevity bond, however, it reports that the consultation exercise displayed *'very limited interest in gilts structured in an annuity format. Concerns were expressed about the potential illiquidity of such instruments and it was felt that annuities would be of interest to particular individual investors rather than of generic widespread interest. The Government therefore decided that it would not issue conventional or index-linked annuity type gilts in 2005-06 or in the near future'* (p. 22).

As Figure 6.2 illustrates, an alternative to an insurance company investing the proceeds of the annuity premiums in assets, would be to sub-underwrite some of the annuity risks through reinsurance, or to reinsure through securitisation in which a Special Purpose Vehicle (SPV) purchases the reinsurance from the insurance company and in turn issues mortality bonds to outside investors. The difference between a mortality bond and a longevity bond is that with a mortality bond the coupon payments **decrease** if the survival of the reference population increases, whereas with a longevity bond the coupon payments **increase** with the survival of the reference population

The classic paper on reinsurance is Borsch (1962), which explains that reinsurance is concerned with the transfer of risk. Companies in the reinsurance market deal with other insurance companies to redistribute risk that each company has accepted by its direct underwriting for the public: companies that gain from these risk transfers pay cash compensation to the companies that take on the risk. The Borsch model starts by assuming that insurers take on insurance contracts with the general public, and that the risks insured by these contracts are **independent** of each other. In the reinsurance market these companies can trade with other insurance companies (reinsurers) to redistribute these insurance claims. Borsch demonstrates that the optimal arrangement is for the insurance companies to place all of their insurance portfolios in a central pool, in order to spread the risks as widely as possible, and then agree on a sharing rule as to how payments of the claims against the pool should be divided up. Borsch shows that a reinsurance price exists which equates supply and demand for insurance contracts between insurers, but that the resulting outcome is not Pareto efficient. He suggests that reinsurance can be better characterised by cooperative bargaining, which corresponds to how much reinsurance is conducted. An important assumption in Borsch's work is that the individual insurance claims are independent, leading to the result that pooling all risks is optimal. Powers and Shubik (2001, 2005) consider a reinsurance market with a non-cooperative bargaining equilibrium and show that if the number of primary insurers is large then the optimal number of reinsurers is approximately the square root of the number of primary insurers. They also note that an analogous 'fourth-root-rule' applies to markets for retrocession (the reinsurance of reinsurance).

An alternative form of reinsurance is securitisation. In this case the original insurer purchases reinsurance of the annuity payments from a SPV, who in return for the reinsurance premium, agrees to make reinsurance payments to the insurer, in the event that the survival of a reference population is higher than expected. The SPV

then issues mortality bonds (Lin and Cox, 2004), to outside investors, whose coupon payments or terminal face value is a decreasing function of the survival probability of the reference population. The SPV will use the proceeds from the mortality bonds to purchase similar structured government bonds. But because the mortality bonds are risky, the investor will pay less for them than similar structured government bonds whose pay-outs are not conditioned on survival probabilities. The SPV will use the proceeds from the reinsurance premiums to offset the difference in the price that it receives for the mortality bond and the price it pays for the government bond. Cox, Pedersen and Fairchild (2000) note that these arrangements for mortality bonds are very similar to those for catastrophe bonds in which there is an active market. They argue that, catastrophe bonds are popular, since catastrophe risks are uncorrelated with stock and traditional bond markets, so that an investor who adds catastrophe bonds to their portfolio improves their investment opportunities.

Cox and Lin (2004) cite Swiss Re who issued a bond in 2003 based on the mortality index of the general population of the US, UK, France, Italy and Switzerland. The term of the bond was three years; issued at a price of $400million; paying LIBOR plus 135 basis points. If the mortality index exceeds 130 percent of the 2002 level, the principal is reduced. Cox and Lin (2004) note that these payments are increasing in the survival rates (since they are decreasing in mortality rates) since Swiss Re were issuing a bond that insured against rises in mortality (due famine/plague/disease) which is the opposite of an SPV that wished to issue a mortality bond to insure against longevity risk, but Cox and Lin suggest there will be investors who are willing to bear the risk of increased longevity. One obvious set of investors are life assurers, whose payouts will reduce as survival rates increase, but if cohort survival probabilities have low correlation with stock and bond returns, then any investor ought to be willing to hold such assets as part of a diversified portfolio.

A critical issue in the reinsurance of annuity risks, whether by a reinsurer or through securitisation, is who bears the longevity risk. The Pension Commission Interim Report (2004) notes that there are different types of longevity risk: First, 'Specific longevity risk post-retirement' of an individual relates to the individual who at retirement does not know their exact length of life. Second 'average cohort longevity risk post-retirement' which means that there is uncertainty as to the length of life of the cohort of persons retiring. These first two risks are typically absorbed by the pension provider, whether a Defined Benefit (DB) pension scheme or an insurance company for Defined Contribution (DC) schemes. The third type of longevity risk is 'Long-term average longevity risks pre-retirement', which relates to the fact that projections of life expectancy for the current employed who will retire in the future is very uncertain. This risk is borne by DB scheme providers and by the government when they agree to a pension contract which will apply to the current working population. However, in DC schemes individuals bear this risk, through changing annuity rates. It is likely that individuals in DC schemes as they approach retirement will need to make a decision as to whether there is sufficient savings in their DC scheme to provide an income in retirement. If not they will need to work longer. The Pension Commission Final report (2005, page 174) emphasises that pre-

retirement longevity risk of a particular cohort should be borne by that generation of individuals through longer working lives.

Stark (2003) and Wadsworth (2005) express concern that the insurance industry and the reinsurance industry does not have the capacity to absorb cohort longevity risk. Wadsworth (2005) suggests that although reinsurance is common in other sectors of the insurance industry, reinsurers seem reluctant to sub-underwrite annuity business, presumably because reinsurers are not able to diversify the 'average cohort longevity risk' between the pool of insurers. King (2004) notes that for average cohort (or collective) longevity risks, the burden of unexpectedly high longevity for a particular cohort should be spread over as many generations as possible, and this provides a potential role for government to share risks across generations, since the private sector may be unable to provide these risk-sharing contracts. If the government is unwilling to underwrite this cohort longevity risk through issuing longevity bonds, or if neither reinsurers nor individual investors are unwilling to bear this cohort longevity risk, then the only people who can bear this risk are the pensioners themselves. This could be achieved either by premiums rising to the point where reinsurers or investors are willing to enter the market or by annuity payments being linked to cohort mortality. This would mean that pensioners' annuities insured them only against the idiosyncratic mortality risk and not the cohort mortality risk.

Daykin (2004) points out that there are a number of risks faced by insurers of annuities, including expenses and operational risk; liquidity risk, market risk, credit risk, underwriting risk, liability risk and asset/liability mismatch risk; but that the two main risks faced by an annuity provider are longevity risk and interest rate risk. Wadsworth (2005) also argues that the two important issues in the supply of annuities, are the development of markets to pool longevity risk, and constraints on the supply of long duration government bonds which relates to interest rate risk. We have already discussed the issues around longevity risk and now turn to interest rate risk.

6.4 Interest rate risk and bond markets

Interest rate risk is the risk that interest rates will change to leave the present value of the assets less than the present value of the liabilities. As we have already mentioned in Figure 6.1, insurance companies may remove this risk by exactly matching the risk profile of the assets with the risk profile of the liabilities. In practice insurance companies use a combination of existing long, medium and short government bonds, and other financial instruments including swaps and other derivatives to immunize the portfolio of liabilities against interest rate risk.

Wadsworth (2005) suggests that insurance companies, and occupational pension schemes, would prefer to hold long-term government bonds to match the long-term nature of their annuity liabilities. Table 6.2 shows the term structure of government and corporate bonds held by Norwich Union. It can be seen that 74 per cent of these securities are dated above 15 years.

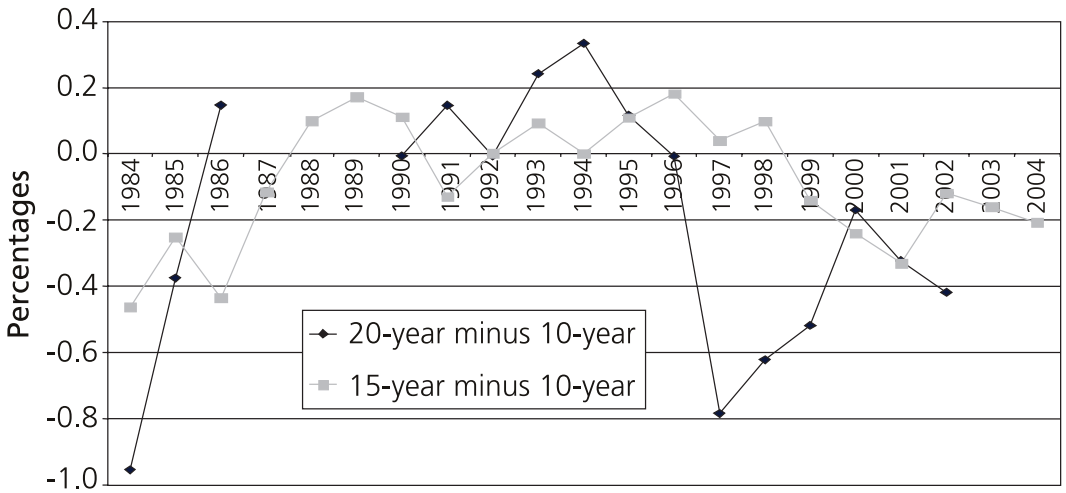
Table 6.2 Analysis of term holdings for Norwich Union

	Fixed interest approved	Variable interest approved	Percentage of total approved securities	Other fixed interest	Other variable interest	Percentage of other securities
<1	10,340		1	3,524		0
1-5	43,066	1,026	3	93,111		3
5-10	312,033	519	23	288,525		9
10-15	194,801	266	14	443,287		14
15-20	116,406	1,219	9	767,403		25
20-25	131,512		10	518,015		17
>25	468,974	314	35	717,006		23
Irredeemable	74,142		5	272,905		9
Total	**1,351,274**	**3,344**		**3,103,776**	**0**	**4,458,394**

Source: FSA return 2004.

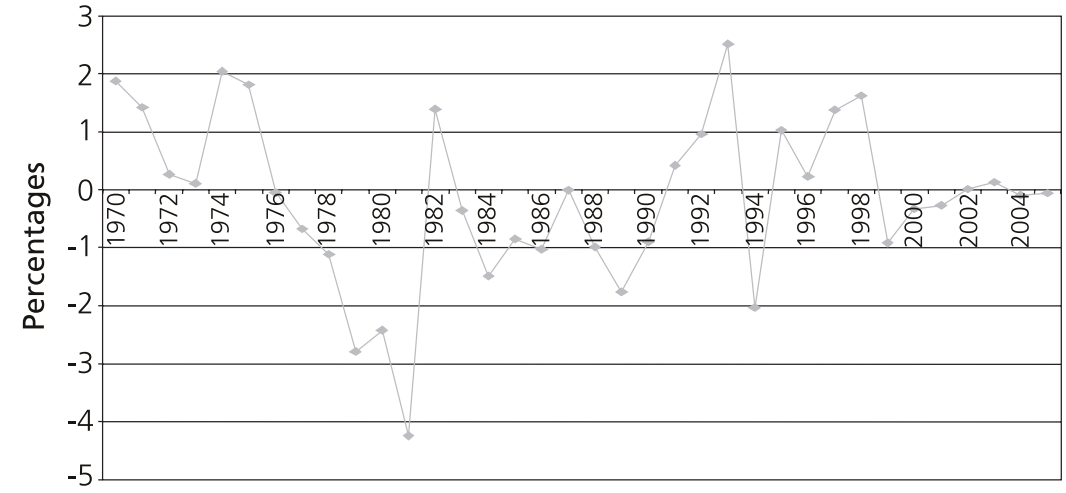
Figure 6.3 shows the yield spread on 20-minus-ten-year government bonds, and 15-minus-ten-year bonds from 1984-2004, and it can be seen that since the late 1990s the yield spread has been negative, suggesting that the term structure is 'humped'. Figure 6.4 shows the yield spread on irredeemable consols minus ten year bonds, and again this illustrates that the yield spread is variable, but over the last five years has been negative. This data would be consistent with institutional investors (or some investors) desiring to hold long-term bonds, but there being insufficient supply. According to the DMO (2005) the UK Government's debt management policy objective is: *'to minimise over the long term, the costs of meeting the Government's financing needs, taking into account risk, whilst ensuring that debt management policy is consistent with the aims of monetary policy'* (p. 11). It achieves this objective and arrives at its issuance plans each year by taking into account: (i) the Government appetite for risk (both nominal and real in each year); (ii) the shape of the yield curves (nominal and real) and the expected effect of issuance policy; (iii) investors' demand for gilts; and (iv) cash management requirement for Treasury Bills and other short-term debt instruments. In 2004/05 the planned split of gilt sales totaled £48billion, and these were split between: short conventional gilts (31 per cent); medium conventional gilts (21 per cent); long conventional gilts (30 per cent) and index-linked gilts (16 per cent). Following calls from the pensions industry during 2004 for the government to issue more and longer debt, the DMO via the National Association of Pension Funds consulted with participants in the pensions industry, and in his 2005 Budget speech, the Chancellor of the Exchequer announced that the Government would issue conventional gilts with maturities of up to 50 years from May 2005 onwards.

Figure 6.2 Spreads between real bond yields of different maturities



Source: Bank of England

Figure 6.3 Spreads between nominal consol yield and ten-year bond yield



Source: National Statistics Office

Wadsworth (2005) argues that there are insufficient long-term government and corporate bonds available to satisfy the potential demand by insurance companies and occupational pension schemes. Table 6.3 shows that the outstanding quantities of long-term government and corporate bonds are small relative to the potential demand for annuities (based on total pension scheme assets).

Table 6.3 Summary data on volumes of long bonds and mortgages

	Estimated market values at 30 September 2004 (£billion)
Gilts (15+)	
- conventional	82*
- price indexed	38*
Non-gilts (investment grade/15 years +)	
- conventional	90*
- price indexed	8*
Mortgages (balances outstanding)	850
Occupational Pension Scheme Assets	750*
Annuity reserves (excluding investment linked)	80

Source: Wadsworth (2005).

There are a number of other alternatives to long-term government bonds: corporate bonds, overseas bonds and mortgage backed securities. However, Wadsworth (2005) reports a survey by Watson Wyatt of company treasurers which finds there is no desire by company treasurers to issue long-term index linked bonds. Overseas bonds carry currency risk and one of the largest potential issuers, the US Treasury, stopped issuing bonds dated for more than ten years in 2001, resulting in a shortage of longer-dated debt in the USA (Bank for International Settlements, 2001). Elsewhere in the Eurozone, government bond issues are also more frequent in the short and medium segment. European governments do issue some long-term issues, but they constitute a limited share of total issuance.

According to Holmans, Karley and Whitehead (2003), there has been a strong growth in the securitisation of mortgages since 1998. Table 6.3 also shows the quantity of mortgages outstanding in the UK. However, a potential problem with mortgages as an asset for insurance companies is that most UK residential mortgages are variable interest, with the holder of the mortgage suffering the potential of prepayment risk when interest rates fall.

In order to establish the actual portfolio allocation of annuity providers we reproduce in Table 6.4, the balance sheet of one major annuity provider taken from the FSA returns. It can be seen that most of Norwich Union's assets are in Mortgages, Approved and Other Fixed Interest securities: most of these mortgages are fixed rate commercial mortgages rather than residential mortgages. However, we should emphasise that the Norwich Union is relatively unusual amongst annuity providers in placing such a high proportion of its reserves in mortgages.

Table 6.4 Assets for insurance business of Norwich Union, 2004

	Value	% of assets	Yield %
Assets: Non-index-linked (Form 48)			
Land and buildings	3,088	0.02	8.71
Approved fixed interest	1,351,274	9.62	4.77
Other fixed interest	3,103,776	22.10	5.85
Approved variable interest	3,344	0.02	1.65
Other variable interest	0	0.00	
Equity	0	0.00	
Loans secured by mortgages	8,062,335	57.40	6.37
Other income producing assets	126,169	0.90	5.5
Other assets	686,198	4.89	0
Total non-index-linked	13,336,184	94.95	5.75
Assets: Index-linked (Form 56/1)			
Corporate index-linked bonds	443,041	3.15	
Land and buildings	54,064	0.38	
Derivatives	-5,043	-0.04	
Govt/Public index-linked bonds	217,367	1.55	
Total index-linked	709,429	5.05	
Total assets	**14,045,613**		
Liabilities (stock of annuities written) (Form 51)			
UK non-linked net total	11,415,134		
Overseas	361,400		
UK linked	438,773		
Reinsurance	709,429		
Total liabilities	**12,924,736**		

Source: 2004 FSA returns, tables 48, 51 and 56.

7 Conclusions

We have provided a survey of the UK annuity market, set against a background of increased demand for compulsory-purchase annuities, as increasing numbers of people with defined-contribution pensions retire, and the shift from defined-benefit to defined-contribution pensions continues. The proposed changes to the compulsory annuities market after A-day (April 2006) will result in a slight weakening of the compulsory annuitisation requirement at the higher pension end of the annuity market, as income drawdown alternatives are widened, and also at the lower wealth end where individuals with small pensions can take all their pension as a lump sum. Individuals with a personal pension fund in the range £15,000 to £100,000 will still be required to annuitise their wealth post A-day.

We examined the factors that determine annuity prices and showed that the price of annuities depends on: interest rates, projections of life expectancy, size of the pension fund, type of annuity and the annuity providers' mark-up. The market for annuities appears to function satisfactorily; there is no evidence of monopoly pricing of annuities and the providers have absorbed substantial growth in annuity demand, with sales tripling over the period 1991 to 2004.

The seminal paper by Yaari (1965) that demonstrates the welfare benefits of annuitising one's wealth to insure against longevity risk, sits uncomfortably with the fact that voluntary annuity markets are small. We considered a range of factors that could explain this puzzle. These included: bequests, habit formation, existence of state pension benefits, means testing, selection effects, deferred annuitisation and behavioural aspects. All of these factors may provide reasons why demand for relatively inflexible annuity products is low.

We also examined the supply of annuities, and noted that annuity markets are highly regulated. Typically, life assurers write annuity contracts, and invest the annuity premiums in matching assets. There are two sets of risks that the annuity providers face with respect to the availability of matching assets: interest rate risk, because the duration of the assets is typically less than the liabilities, and cohort longevity risk. Cohort longevity risk is the risk that a future and subsequent cohorts of individuals will benefit from a significant increase in longevity, and annuity providers will then be required to honour the annuity contracts that have become unprofitable.

In summary there are a number of issues that policymakers need to be aware of:

- The number of annuity providers has fallen significantly over the last 50 years; there are currently fewer than twenty annuity providers writing new business, but one firm (the Prudential) accounts for 40 per cent of this market. Despite this, there is no evidence of abuse of market power.
- The small number of providers also means that the cohort longevity risk is highly concentrated in a small number of firms, and there is a question whether these providers have the capacity to absorb the extra risk associated with increased annuity demand. If this limited number of firms were not able to bear the total longevity risk, mechanisms would need to be found for this risk to be held elsewhere. Possible candidates are:
  - individual investors or other financial institutions, who would hold mortality bonds (issued by reinsurers) in a diversified portfolio;
  - the government, or other bond issuers, by issuing longevity bonds; and
  - the annuity holders themselves, by making the annuity payments conditional on cohort survival rates.
- Annuity providers would be better able to minimise the risks of an asset-liability mismatch by the availability of more long-term government bonds. The Debt Management Office's (DMO's) new issue of longer-term gilts has addressed this problem to some extent.
- Demand for voluntary annuities is low, and this appears to be due to a combination of rational reasons due to the inflexible nature of existing annuity products, and a misunderstanding of the nature of mortality drag. Better explanations of the annuity products may reduce this second type of annuity aversion.

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