



DISCUSSION PAPER PI-1011

Back to the Future: A Long Term Solution to
the Occupational Pensions Crisis

Charles Sutcliffe

June 2010

ISSN 1367-580X

The Pensions Institute
Cass Business School
City University
106 Bunhill Row London
EC1Y 8TZ
UNITED KINGDOM

<http://www.pensions-institute.org/>

Back to the Future: A Long Term Solution to the Occupational Pensions Crisis

Charles Sutcliffe*

ABSTRACT

In the UK and elsewhere, defined benefit (DB) schemes are being replaced by defined contribution (DC) schemes. However DC schemes have some substantial weaknesses, and a continuation of current policies will probably lead to another pensions crisis in a few decades. There is an alternative which avoids the major defects of DC schemes. It is proposed that, if UK employers wish to replace their DB schemes, they should do so with something that looks like a career average revalued earnings (CARE) DB scheme to the members, but is funded by single premium deferred annuities (SPDAs) and looks like a DC scheme to the employer. Pension provision is outsourced to specialist providers (insurance companies), with the risk (and the decisions that must be made by members of a DC scheme) managed by insurers, not the employer or members.

Key words:- Deferred annuity, defined benefit, defined contribution, single premium deferred annuity, occupational pension scheme, derisking, two-pension fund separation, crisis.

4 June 2010

* The ICMA Centre, Henley Business School, University of Reading, PO Box 242, Reading RG6 6BA, email c.m.s.sutcliffe@rdg.ac.uk

I wish to thank Adrian Bell, John Board, Peter Casson, Simone Varotto and participants in seminars at both Loughborough and Reading universities for their comments on an earlier draft of this paper.

Back to the Future: A Long Term Solution to the Occupational Pensions Crisis

Occupational pensions are in a state of crisis. In March 2009 90% of defined benefit (DB) schemes in the UK were in deficit, and the aggregate funding position for the 7,400 schemes followed by the Pension Protection Fund (PPF) was a deficit of £242 billion. This very large aggregate deficit is a manifestation of the crisis in DB pensions. The solution that is emerging in the UK to the crisis in occupational pensions is a switch from DB to defined contribution (DC) pension schemes. However, due to problems inherent in their design, this wholesale switch to DC schemes will probably result in another pensions crisis within a few decades. A long term solution to the occupational pensions crisis is needed that is better than a switch to DC schemes. The proposal made here is for the use of single premium deferred annuities (SPDA) by pension schemes. The use of SPDAs enables a DB scheme to effectively replicate a career average revalued earnings (CARE) scheme, with many advantages over a DC scheme, particularly the way in which risks are borne by insurers, as well as having advantages over a final salary DB scheme. The proposal is that, instead of replacing final salary schemes with DC schemes, employers should switch to a CARE scheme based on SPDAs. It means the pension scheme looks like a DC scheme to the employer, but a DB scheme to the members. About sixty years ago the use of deferred annuities by UK occupational pension schemes was widespread. So this proposal represents a return to the past, although with a number of important modifications, and in a different environment.

McCarthy (2005) has shown that when markets are complete and there are no frictions, the design of pension schemes is irrelevant. Employers and employees are concerned only with the net present value of the employees' compensation package. However, in reality, markets are incomplete and frictions exist, making pension design important. Given the presence of real world imperfections, this paper compares alternative pension scheme designs. Section 1 briefly describes the shift from DB to DC schemes, and section 2 presents the shortcomings of DC schemes. Section 3 sets out a long term solution to the occupational pensions crisis using SPDAs, and section 4 describes a simple model for pricing SPDAs. Section 5 has a brief history of deferred annuities, while section 6 contains a summary of the previous literature on the use of SPDAs. Sections 7 and 8 consider the advantages and disadvantages of a pension scheme using SPDAs, and section 9 concludes.

1. The Shift from DB to DC

Since the stock market reached a peak at the end of the last century, UK employers have been increasingly questioning the continuation of their DB schemes. This disenchantment with DB schemes is due to a number of factors (see Board and Sutcliffe, 2007), but the chief reasons are increases in the riskiness of the spread between pension assets and liabilities and in the cost to the

employer¹. In response to these pressures UK companies are replacing their DB schemes with DC schemes. In 2008 only 26% of UK DB schemes remained open to new members (Pension Protection Fund and the Pensions Regulator, 2008), with new (and existing) employees usually offered a recently opened DC scheme instead. In 2007 92% of UK private sector occupational schemes (with only one section) remaining open to new members were DC schemes (Office for National Statistics, 2008). This represents a massive shift in UK occupational pensions from DB to DC.

The UK National Employment Savings Trust (NEST) which begins operation in 2012, is a national DC scheme that requires employers who do not offer a more favourable scheme, to automatically enrol employees in the NEST. It is expected that the NEST will have more than 4 million members. The continuing switch of occupational schemes from DB to DC, coupled with the introduction of the NEST, will create a big expansion in DC scheme membership in the UK such that it will come to dominate occupational pension provision.

2. Problems with DC Schemes

Replacing a DB scheme with a DC scheme transfers various risks and decisions from the employer to scheme members. Investment risk, and the risk of changes in the expected annuity rates at retirement move from the DB scheme to DC scheme members. DC scheme members decide the allocation of their pension pot from a menu of different investments, and on retirement decide when to buy an annuity, and which annuity to purchase. In many schemes they also have to choose their contribution rate (subject to limits). In a DB scheme these decisions fall on either the employer or the scheme. Each of these risks and decisions will now be considered in turn.

A. Risk Shifting. With DC schemes the risks of investment returns, interest rates, inflation, longevity, and much regulatory risk are shifted from the employer to individual scheme members until they retire and buy an annuity. In the UK an annuity must be purchased with at least 75% of the pension pot sometime between retirement and age 75². After the annuity is purchased these risks are borne by the insurer providing the annuity.

A number of studies have investigated the extent to which DC schemes can produce very different

¹ It is argued in sections 5 and 8 below that this disenchantment is due to long-held unrealistic expectations of the risks of DB schemes.

² Since April 2006, instead of annuitization at 75 alternatively secured pensions have been available. They were introduced to help those with a principled religious objection to pooling mortality risk which prevents them from purchasing an annuity.

pensions for the same contributions. Burtless (2009a and 2009b) analysed the replacement rate³ for US DC schemes over the 1872-2008 period. Assuming the DC pension fund was invested in equities, the highest replacement rate (in 1999) was 89%, which is 7.4 times higher than the lowest replacement rate of 12% (in 1920). This represents a very substantial difference in outcomes, illustrating the potential riskiness of DC schemes⁴. Blommestein, Janssen, Kortleve and Yermo (2009) also showed that DC schemes can have a highly variable replacement rate. For UK replacement rates over the 1927-2001 period Burtless (2003) found that the rate for the ninth decile was 2.4 times larger than the rate for the first decile. Blake, Cairns and Dowd (2001) analysed UK data and concluded that “DC plans can be extremely risky relative to a DB benchmark”. This conclusion was also reached by Byrne, Blake, Cairns, and Dowd (2007) from a study of the default funds offered by UK DC schemes, and by Blake (2006). Cannon and Tonks (2009) studied the variability of the fund ratio⁵ for the UK for 1948-2007. They found that with 100% equity investment, the median fund ratio was 17.9, while the ratio for the lowest decile was only 7.3. For an annuity rate⁶ of 0.05, replacement rates⁷ of 89% and 36% are implied, again indicating a wide dispersion of pension outcomes. These studies show that DC schemes have the potential to be very risky, producing substantially different outcomes for the same contributions and asset allocation.

B. Annuity Rate Risk. With a DC scheme the member is exposed to the risk that, due to increases in the expected rates of longevity and inflation, or a decrease in expected interest rates at retirement, actual annuity rates when they retire will be lower than current expectations. In recent years forecasts of longevity have lengthened at an unexpectedly rapid rate, increasing the price of annuities (i.e. lowering the annuity rate). This change in longevity, coupled with a fall in interest rates led to UK annuity rates falling from 16.2% in 1981 to 8.2% in 2002 (Cannon and Tonks, 2004), and by 2010 they had declined further. This reduction in annuity rates greatly reduced the size of the annuities that could be purchased by members of DC schemes with a given size of pension pot to far below what was expected when they joined the scheme.

³ The replacement rate is the annual payment from the annuity purchased by the member at retirement with the DC fund, divided by the member’s final annual salary.

⁴ All the money in a DC scheme could be invested in long term gilts rather than equities, making the DC scheme equivalent to a cash balance scheme where interest on the cash balance is credited at the long term gilt rate (Rappaport, Young, Levell and Blalock, 1997) However, while this would remove investment risk, it still leaves scheme members with longevity, interest rate and inflation risk until they retire. They must also decide the timing and nature of their annuity purchase, and probably their contribution rate.

⁵ The fund ratio is the value of the member’s pension fund at retirement, divided by the member’s final salary.

⁶ The annuity rate is the annual annuity payment divided by the sum of money paid by the annuitant for the annuity.

⁷ The replacement ratio equals the fund ratio multiplied by the annuity rate, which is roughly 0.05. So a replacement rate of 0.6 (i.e. a replacement rate of 60%) implies a fund ratio of 12.

Economic theory suggests that individual employees are unsuitable economic agents for bearing the investment and annuity rate risks during their working lives, and that it is preferable for these risks to be borne by their employer (or an insurer). For each employee their pension often represents one of their largest assets, whose risks they cannot effectively hedge. They lack the knowledge to hedge the risk, and even if they had the requisite understanding, the transactions costs they would face when hedging are prohibitive and instruments to hedge some of the risks are very hard for individuals to access. Their employer (or the insurer providing the SPDAs) is more likely to have access to a knowledge of hedging, and cheap access to the available hedging instruments⁸. A survey by the Association of Consulting Actuaries (ACA, 2009) found that 76% of UK employers thought their employees were uncomfortable bearing the investment, inflation and longevity risks of DC schemes.

C. The Asset Allocation Decision. Usually DC scheme members select the asset allocation of their pension pot. The main determinant of the investment performance of UK and US pension funds has been shown to be asset allocation, rather than stock selection (Blake, Cairns and Dowd, 2001; Lehmann and Timmermann, 1999; Brinson, Hood and Beebower, 1986; Brinson, Singer and Beebower, 1991; Ibbotson and Kaplan, 2000 and Xiong, Ibbotson, Idzorek and Chen, 2010). Members show little interest in this decision, with the vast majority ending up in the default fund. Levy (2009) reports that in 2008 96% of UK DC schemes offered members an investment choice and, where a default fund was offered, 82% of members ended up in the default fund (Byrne, Harrison and Blake, 2007, NAPF, 2009a). Default funds in the UK typically have a high equity content⁹, generating considerable risk and variation in outcomes between different cohorts of members (Byrne, Blake, Cairns and Dowd, 2007). A similar unwillingness to select investments applies in other countries, and in April 2003 92% of new members of the Swedish national DC scheme ended up in the default fund, Cronqvist and Thaler (2004).

Some of those DC scheme members who do make a choice select an unwise asset allocation. Over time scheme members age, their personal circumstances change, and their asset allocation is altered by movements in relative asset prices. Theory suggests that DC scheme members should rebalance their portfolio in response to these changes, but the empirical evidence shows they do not (Agnew, Balduzzi and Sunden, 2003, Ameriks and Zeldes, 2004). Tang, Mitchell, Mottola and Utkus (2009) analysed the asset allocations of one million 401(k) schemes¹⁰ and showed that poor asset allocation by members resulted in an average 20% reduction in the value of their pension pots at retirement. Benartzi and Thaler (2007) discovered a wide range of behavioural biases in the asset allocation

⁸ Hedging is considered further in section 8.

⁹ An NAPF (2009a) study in 2009 found that 71% of UK default funds were invested entirely in equities, while the average equity allocation of default funds was 91%.

¹⁰ 401(k)s are a type of US defined contribution scheme.

and contribution rate decisions made by US members of DC schemes, while an Association of Consulting Actuaries (2009) survey found that 81% of UK employers felt employees were not capable of determining how they should manage their DC funds.

Depending on the investment decisions made by the member, the investment of a DC pension pot can involve substantial charges and fees. The NAPF (2009a) report the average investment management fee for active investment in a multi-asset class fund in 2009 was 58 basis points per year. Over 25 years these charges reduce the size of the final pension pot by about 13%¹¹. This shows that charges and fees have a substantial effect on the size of the final pension pot. The annual investment costs of large DB schemes are about 25 basis points per year (Munnell and Soto, 2007), giving a reduction in the size of a DB fund of about 5.7% after 25 years, which is appreciably lower than for DC schemes.

In addition to inadequate decision making by members, some DC schemes offer members an inefficient menu of possible investments. Elton, Gruber and Blake (2006) analysed the investment choices offered by 401(k) schemes, and discovered that only 53% offered a menu which permitted the formation of an efficient portfolio. After 40 years the average value of the portfolios formed from the inefficient portfolios was 57% lower than would have been the case if an efficient menu had been available. For example, DC schemes may not offer private equity, hedge funds or direct property. So, whether it is due to an inefficient menu of choices offered by the scheme, or sub-optimal decision making by the DC member, DC schemes tend to produce low pension pots with a high level of risk.

D. The Annuity Decision. Since 1978 DC members in the UK have had the right (called the open market option or OMO) to buy their annuity from a supplier other than their pension provider. However, only about half of UK annuitants shop around for a better annuity deal (HM Treasury, 2006), with just 23% actually changing their annuity provider (NAPF, 2009b). Many annuitants have some medical condition which means they could qualify for an impaired life annuity, but do not buy one. Since the price of a standard annuity is over 20% higher than for an impaired life annuity, these pensioners have chosen a poor deal (MGM Advantage, 2009). There is also considerable variation in the price of identical annuities. MGM Advantage (2009) compared prices for standard annuities in the UK and found that a top quartile annuity is 20% cheaper than a bottom quartile annuity. For impaired life annuities, the difference in prices was even larger. This means that some annuitants are making bad annuity choices.

¹¹ Blake (2006, p. 126) reports that over 25 years, the reduction in the final value of the pension pot due to investment charges and fees was 19.0% on average. The lowest reduction was 9.8%, while the highest was 27.8%.

DC pensioners in the UK must annuitize at least 75% of their pension pot at a time of their choosing between retirement and the age of 75. This gives them an American style option to delay annuitization, and this option can be valued using an option pricing model (Milevsky and Young, 2002). In the UK 62% of annuitants buy their annuity on retirement (Taylor, 2004), and only 5% annuitise in their 70's (HM Treasury, 2006). Of the 38% who delay purchasing an annuity, 39% give their lack of need for a pension as their reason for delay, with only 13% waiting to see if annuity rates improve (Taylor, 2004). This suggests that annuitants are not making rational decisions on when to annuitise, as the main factor driving their decision to delay should be annuity rate expectations.

E. The Contribution Rate. In addition to the problems outlined above, the level of contributions to DC schemes is much lower than for DB schemes, and this will greatly amplify a DC pensions crisis. Many DC schemes allow each member to choose their contribution rate, which offers a further area for mistakes by members, i.e. seriously under-contributing. A substantial number of employers tie their contribution rate to that chosen by the member, and so a low member contribution rate often leads to a low employer's contribution rate, exacerbating the problem. In 2007 the average UK employer and member contribution rates for DB schemes were 15.6% and 4.9% respectively, while for DC schemes they were only 6.5% and 2.7% respectively (ONS, 2008). So the total contribution rate for DB schemes was 123% higher than for DC schemes. Choi, Laibson and Madrian (2007) looked at seven 401(k) schemes and found that 30% of older members chose to under-contribute to their pension, even though an arbitrage profit was available from higher contributions, resulting in the loss of up to 6% of their salary each year.

Given these serious problems with DC schemes¹², future experience (possibly destitute pensioners) may lead to the widespread realization that DC schemes are unsuitable. Since companies want to shed the risks inherent in running DB schemes, some alternative entity is needed to bear these risks and take these decisions, other than the members themselves.

3. A Long Term Solution

In order to avoid the problems with DC schemes outlined above, a different scheme design is required. One possibility involves the use of deferred annuities. The proposal is to use SPDAs to create a scheme that looks like a DC scheme to the employer, but a DB scheme to the members. Each year the employer and the employee pay a pension contribution which is some proportion of the member's salary (as for DB and DC schemes). This sum is used to buy a SPDA from an insurer on behalf of the employee. This annuity should offer at least limited price indexation, and

¹² US 401(k) schemes have additional problems: members may invest large amounts of their pension pot in the shares of their employer, members can take cash out of their pension pot, and there is no requirement to annuitize.

preferably provide full indexation. The SPDA will probably be a group annuity, so reducing the adverse selection cost inherent in voluntary annuities. When the employee reaches retirement age the payments under these deferred annuities provide their pension. Once a deferred annuity is purchased, the corresponding portion of the ultimate pension is locked in. As well as providing pensions for employees, SPDAs could also be used by the self-employed and those wishing to top-up their occupational DB or DC pension.

Figure 1 shows that these SPDAs involve a specified investment return (which removes investment risk until retirement), followed by a specified rate for converting the lump sum (or final value of the pension pot) into an annuity (which removes longevity risk, inflation risk and interest rate risk) for the annuitant.

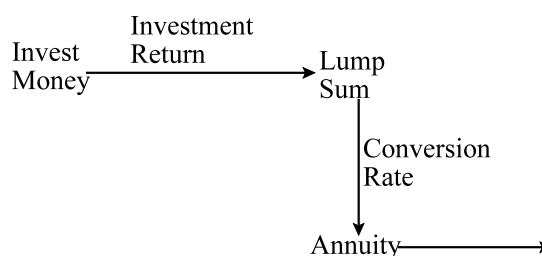


Figure 1: *Single Premium Deferred Annuity*

Although an SPDA-based scheme looks like a DC scheme to the employer, to the members it can be made to look like a final salary DB scheme, a CARE DB scheme or a DC scheme, depending on the revaluation rate for investments (pension contributions) built into the SPDAs. If the contractual rate of return during the investment phase is inflation, then a SPDA scheme resembles a typical CARE scheme, where inflation is usually used as the revaluation rate. If the revaluation rate for investments is final salary, a SPDA-based scheme resembles a final salary scheme. If the revaluation rate is the rate of return on the stock market, it will look like a DC scheme with a fixed annuity rate. Sutcliffe (2010) argues that CARE schemes have many advantages over final salary schemes, making the replication of a CARE scheme an attractive choice. Unless specified otherwise, SPDA-based schemes are assumed to use inflation as the revaluation rate so that a CARE scheme with retail price index revaluation is replicated.

SPDA-based pensions are effectively riskless for both the employer and the members but, given their other assets and liabilities, scheme members may prefer to take some risk in exchange for a higher expected pension. Tobin's two-fund separation result has been applied to pension schemes by Modigliani and Muralidhar (2004) to get two-pension fund separation, as shown in figure 2. In figure 2 R_F is a risk-free pension, such as an SPDA-based scheme, while M corresponds to an investment in the market portfolio, e.g. an all-equity DC scheme. Thus a SPDA-based pension

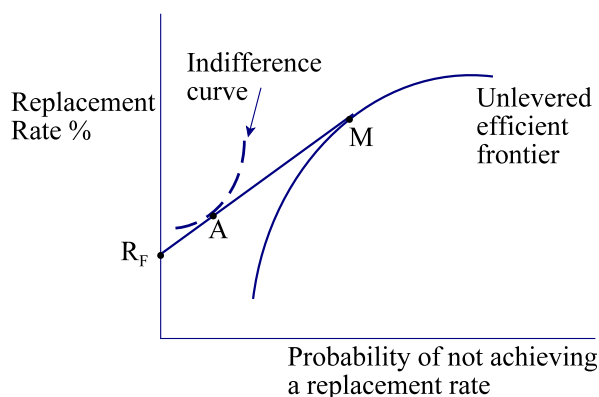


Figure 2: *Two-Pension Fund Separation*

provides the risk-free asset for two-pension fund separation. After allowing for their other assets and liabilities, by varying the proportions of their pension funds in SPDA-based and DC schemes (or investments) each member can achieve their own preferred risk-return trade-off, e.g. point *A* in figure 2. Instead of splitting their pension between two funds to achieve point *A*, some chosen proportion of the SPDAs can use the return on the stock market as their revaluation rate¹³.

The basic SPDA scheme can be modified to include various other benefits to make it look like a typical DB scheme, e.g. death grant, ill health early retirement, dependents benefits, lump sum on retirement, index linking, etc¹⁴. Some of the risks could be transferred to annuitants by offering a bonus related to the returns actually achieved on the pension contributions (or SPDA consideration), and expectations at retirement for longevity, inflation and interest rates. However, the introduction of such option-like features would make the SPDAs more difficult to price and hedge¹⁵, and increase the chances of default by the insurer, e.g. the very severe problems experienced by Equitable Life and the insolvency of eight Japanese life insurers (Davis, 2004). It also makes SPDAs risky for the employer and members. For these reasons a simple SPDA without guarantees and bonuses is proposed. However, there are good reasons for sharing part of the longevity risk with annuitants (see section 8).

Initially, the creation of a small number of immature SPDA-based schemes will have little macro-economic effect, but the widespread adoption of SPDAs by individual schemes will collectively have a number of economic effects. In section 5 it is shown that deferred annuities played a major role in the provision of UK pensions in the middle of the last century, which suggests such a situation is feasible. Competition between insurers could lead to unrealistically low annuity prices, and if pension schemes select the SPDA provider, they have an incentive to choose the cheapest. A number of life insurers in the US have failed, indicating that US annuities have a default risk, and the cheapest SPDA provider may have an above average default risk (Perun, 2007). Such suppliers may not be desired by members, as it is the members who bear the default risk (excepting any

¹³ The theory of compensating wage differentials implies a trade-off between wages and pensions, with employers choosing the riskiness of the pension schemes they offer, in part, to suit the risk-return preferences of their employees. It may be thought there is little employee demand for riskless pensions, such as those based on SPDAs. But pensions form part of each member's portfolio of assets and liabilities, and will be held in combination with risky assets, such as human capital. Only if members do not wish to place any of their wealth in the riskless asset do SPDA-based pensions become redundant. There is also the very widespread evidence of strong member opposition to moving from DB to DC schemes, although in some cases this opposition could be for other reasons.

¹⁴ In fleshing out the details of SPDA-based schemes, minor conflicts with existing regulations need to be avoided.

¹⁵ For details of the pricing and hedging of guaranteed annuity rates see Van Haastrecht, Plat and Pelsser (2009), Ballotta and Haberman (2003, 2004, 2006), Biffis and Millossovich (2006) and Pelsser (2003).

industry-wide compensation scheme). However, UK insurers are highly regulated to prevent failure, with a compensation scheme to cover defaults. In addition, members may require higher wages or pensions to compensate for an increased default risk, so reducing or removing the incentive for employers to choose low-cost, high-risk SPDA providers, if regulators allow such providers to emerge.

Another likely consequence of the widespread use of SPDAs is an increase in the size of insurers operating in the UK, probably making some of them ‘too big to fail’. However, UK insurers are heavily regulated and have a good record of not defaulting on their liabilities, while DB sponsors are much more likely to fail. In addition, the PPF currently insures 90% of UK DB liabilities, and so these liabilities may be viewed as already carried by an organization that is ‘too big to fail’.

The final aggregate effect of a growth in SPDA-based pensions concerns the type of assets in which the pension fund is invested. Insurers usually match their annuity liabilities by investing largely in bonds. So a switch from DC (and DB) schemes to SPDAs would reduce the demand for equities, and increase the demand by UK pension schemes for gilts and corporate bonds¹⁶. Applying the Modigliani-Miller result to the entire UK corporate sector, and assuming a closed economy, this switch in investments would cause a rise in equity returns and a fall in interest rates, but no change in the overall cost of capital for UK companies (Exley, 2005)¹⁷. Over time the average gearing of UK companies is likely to rise, increasing the probability of failure during recessions, while the higher gearing may also affect the way companies are managed, as suggested by Jensen and Meckling (1976). The rise in demand for gilts, coupled with a fall in corporate bond rates would probably be accompanied by a fall in gilt rates, so reducing the government’s cost of borrowing.

The magnitude of these changes in the allocation of pension fund assets on equity and bond returns depends on the relevant price elasticities. These changes may be modest because UK and foreign asset markets are highly integrated. For example, in December 2006 40% by value of UK shares was owned by foreign investors (National Statistics, 2007). The UK equity market has successfully accommodated considerable changes in the proportion of UK equities owned by UK pension schemes. Until the 1940s UK pension funds invested most of their money in government bonds (Sutcliffe, 2005). In 1963 the proportion in UK equities was only 6.4%, and by 1992 it had quintupled to 32.4%, but by the end of 2006 it had fallen by 60% to 12.7% (National Statistics, 2007). There is also considerable cross-section variation between European countries in their pension fund asset allocations. For example, in 2009 only 6% of German pension fund assets were

¹⁶ In 2009, the average large UK DB scheme had 28% of its assets in UK equities, 26% in foreign equities, 39% in domestic government debt and corporate bonds and 1% in foreign bonds, Mercer (2009).

¹⁷ Davis (1995, p. 243) has argued that the cost of capital will rise because international bond markets are more integrated than international equity markets.

invested in domestic equity, while 83% were in domestic bonds, Mercer (2009). These facts suggest that the UK capital market could successfully accommodate a gradual move of pension assets out of UK equities and into bonds (both domestic and foreign, sovereign and corporate).

4. Pricing SPDAs

In a competitive market, the price of an immediate annuity on a single life paid with a single premium is given by equation (1).

$$V_{xI} = \sum_{i=1}^n \frac{A \cdot P_{xi}}{(1+r)^i} \quad (1)$$

where V_{xI} is the current price of the annuity, i is the number of years since the annuity began payment, r is the rate of interest (assuming for simplicity a flat yield curve), A is the annual payment under the annuity, n is a number greater than the remaining years of life of the annuitant, and P_{xi} is the probability that an annuitant aged x when the annuity begins payment survives for at least i years.

For the corresponding deferred annuity, the probabilities used to value the annuity are based on expectations at the time the SPDA is sold, not when the annuitant retires and the annuity comes into payment. It also incorporates the investment of the purchase price of the SPDA during the deferral period at the contractual revaluation rate (e).

$$V_{xD} = \frac{1}{(1+e)^m} \left[\sum_{i=1}^n \frac{A \cdot P_{(x+m)i}}{(1+r)^i} \right] P_{xm} \quad (2)$$

where m is the number of years for which the SPDA is deferred, and P_{xm} is the probability of the annuitant surviving the deferral period (assuming that if the annuitant dies during the deferral period there is no payout).

Equations (1) and (2) assume that both real interest rates and the mortality table are deterministic. However, in reality, both interest rates and mortality are stochastic and this complicates the pricing problem. The effects of allowing for stochastic mortality and interest rates on SPDA pricing have been studied by Dowd, Blake and Cairns (2008), Toplek (2007) and Post (2009).

Changes in longevity, inflation, interest rate and investment return expectations during a member's working life affect the price of SPDAs to be purchased for them in future years. This is similar to DB pensions, where future accrual rates can be changed, although this is seldom done. Insurers will probably vary the price of SPDAs from year to year as expectations change. Reducing the accrual rate for a DB scheme often leads to strong opposition from scheme members and threats of strike

action. Variations in the accrual rate for SPDAs will be less contentious, as changes (both up and down) will be generated by the market, not the employer. This represents a modest degree of risk sharing between the pension provider and the member, relative to a DB scheme. It can be viewed as a form of pound cost averaging, as the member buys their annuity at approximately the average expected annuity rate during their working life, not the actual rate at retirement. It also means that, if there is a steady increase in longevity expectations, the cost is shared between the member and the insurer.

Some previous authors have assumed that an initial agreement is reached with the insurer which specifies the price of subsequent SPDAs, thereby offering a guaranteed accrual rate. In which case, the annuitant has a lapse option and, if interest rates rise or expected longevity shortens, this option may move into the money (Nielsen and Zenios, 1996, Asay, Bouyoucos and Marciano, 1992). The complication of this embedded option does not apply to SPDAs where the annuity rate is revised each year, as suggested here.

5. The Development of Deferred Annuities

Deferred annuities have a long history, having been sold in the UK for at least a quarter of a millennium. A sale of deferred annuities was proposed in 1739, while between 1766 and 1771 eleven insurers were formed in the UK to sell deferred annuities (Lewin, 2003). By 1952 about a quarter of UK life assurance business took the form of deferred annuities (Ogborn and Wallas, 1955). Group insured pension schemes using deferred annuities probably appeared in the UK in the early 1920s, and by the later 1920s they were being widely marketed (Butt, 1984, Supple, 1970, pp. 435-6). This market expanded during the 1930s and 1940s, and grew by 14.5% per year between 1951 and 1955 (Johnston and Murphy, 1957).

After the 1960s the size of the UK market in group deferred annuities decreased, and at the turn of the millennium various authors described this market as small. Booth et al (1998) noted that group deferred annuity contracts had become rare in the UK, while Blake (1999) stated that this market was “extremely thin”. The Actuarial Education Company (2002) thought there may be difficulties in finding a deferred annuity supplier for a large group of members on competitive terms in the UK and, while non-profit deferred annuities could be purchased by schemes, this was rare.

However, in recent years the market for deferred annuities in the UK has increased in size. When a DB scheme is wound-up, the rights of active members can be discharged by the purchase of deferred annuities from an insurer on behalf of the affected members¹⁸. This buy-out market was a duopoly, with most of the business coming from scheme wind-ups. But since 2006 new

¹⁸ For example, section 74(3c) of the Pensions Act 1995. Since 2005 only schemes which have not entered the PPF have purchased annuities on wind-up.

companies have entered this market, and by 2009 eleven companies were offering bulk insured pensions solutions in the UK (Association of British Insurers, 2009). These companies have targeted the new market of employers who wish to dispose of part or all of their DB scheme via group annuities. The proposal in this paper to use SPDAs is similar to a pension buy-out in which an insurer provides SPDAs to the active and deferred members of a DB scheme, and immediate annuities to pensioners, in return for the transfer of the scheme's assets and probably a payment by the employer. By the end of 2008 UK buy-outs covered half a million members and £22 billion of assets under management, (Association of British Insurers, 2009).

Light can be shed on whether a substantial market in SPDAs will develop in the UK by looking at the reasons for the decline in this business from the high levels reached in the 1950s and 1960s. From the mid-1950s onwards competition from DB schemes was strong, particularly among large companies who had the staff and resources to run their own schemes (Hannah, 1986). This led to group deferred annuities being increasingly concentrated in small and medium sized companies. Hymans (1950) argued that in the 1950s the costs of running DB schemes were substantially lower than the costs included in the annuity prices charged by insurers, so reducing the relative cost of DB schemes¹⁹. By 1950 a quarter of all employees were in the public or local government sectors, and pension schemes for these sectors were very largely DB, limiting the market for SPDA-based schemes (Hannah, 1986). The terms and conditions of DB schemes are usually under the control of the employer, and can be altered (at least for future accruals) to suit changing business needs and circumstances. The terms of group deferred annuities in the 1950s and 1960s tended to be under the control of the insurers, who usually offered only standard terms and conditions (Hymans, 1950)²⁰. Consulting actuaries extolled the virtues of DB schemes, possibly because DB schemes create work for consulting actuaries, while insurers handle their own actuarial work (Hannah, 1986).

Early leavers from DB schemes usually had just their own contributions returned, sometimes with accrued interest; while their employer retained all the employer's contributions, together with the investment returns on this sum (Hymans, 1950, Owen, 1952-3, Polman, 1939, Turner, 1931). In most cases, rather than retaining a deferred annuity, early leavers from such schemes also had their own contributions, and maybe the accrued interest, returned. Typically the employer received back 90% of the employer's contributions in respect of an early leaver, with the remaining 10% being retained by the insurer (Polman, 1939). If the employer had a high labour turnover this 10%

¹⁹ Presumably this comparison involves DB schemes that had actually been set up, mostly by large companies; and excludes small companies where the costs of a DB scheme would probably have been higher.

²⁰ Some schemes in the 1920's and 1930's were tailored to meet the employer's requirements (Butt, 1984).

retention increased the cost of using group deferred annuities, relative to a DB scheme.

In 1950 the Prudential Assurance Company, a leading provider of group deferred annuities to UK companies, decided to cease selling these annuities on a non-profit basis, and to sell only the new product of group deferred annuities with-profits. This switch has been attributed to the exposure of insurers to interest rate and longevity risk over very long periods which were difficult to hedge, and because annuity prices were high (i.e. annuity rates were low), due to low interest rates (Dennett, 1998, Layborn, 1952). Many other providers of group deferred annuities also switched to with-profits deferred annuities. In 1928 the insurers supplying group pension schemes had formed an 'inner circle' to fix prices (Butt, 1984), and the switch to with-profits deferred annuities weakened this price fixing, leading to greater competition, higher selling costs, lower prices and smaller profits for insurers (Hannah, 1986). The introduction of with-profits annuities also created risk for the employer and members with schemes based on such deferred annuities, removing an important advantage of deferred annuities over DB schemes.

After the Second World War, George Ross Goobey promoted the cult of the equity for pension schemes, and there was an expansion of equity investment by DB schemes to enable employers to benefit from the equity risk premium (Sutcliffe, 2005). Insurers had a strong self-interest in setting group deferred annuity prices at realistic levels, but DB schemes had considerable scope to offer unrealistically high benefits (Hannah, 1986). This was possible because DB schemes are permitted to continue operating with a substantial deficit, and had considerable latitude in valuing their assets and liabilities, allowing them to choose the size of their deficit or surplus from within wide limits. This situation allowed employers with DB schemes to offer attractive benefits to employees, and hope that in the long run the equity risk premium would fund their generous pensions promise²¹. These features helped DB schemes continue operating when investment returns were poor. Due to high post-war inflation, the performance of group deferred annuities was seen as poor because they were generally not index linked, giving them a low replacement rate (Hymans, 1950, Booth et al, 1998). DB schemes with equity investment were able to offer pensions based on final salaries that were expected to, at least, match inflation.

Having examined the factors that led to the decline in the usage of SPDAs, the issue is whether these negative factors remain important, and whether they will prevent SPDAs from staging a recovery. Competition from DB schemes has ceased and they are being closed not opened, while consulting actuaries are no longer pushing DB schemes. The cult of the equity and the ability of DB schemes to offer the employer a bet on equity prices has taken a severe knock, with the full risks of DB and DC schemes being better appreciated. Despite lobbying by employers, in 1980 it became

²¹ DB schemes have been said to have some of the characteristics of a Ponzi scheme, as the contributions of active members can be used to pay the pensions of retired members (Vermeulen, 2009).

compulsory for all UK schemes to preserve the pension rights of early leavers; that is, to create deferred pensions up-rated by limited price indexation, Hannah (1986). So the penalty for leaving a DB scheme early has been much reduced, while that for leaving an SPDA-based scheme early no longer exists, as members can retain their SPDAs. Therefore the employer still receives a benefit when a member leaves a DB scheme early²², but no benefit for early leavers from DC or SPDA-based schemes.

For large schemes the terms and conditions of SPDAs should now be open to negotiation, rather than offered on a take-it-or-leave-it basis²³. Some near insolvencies of insurers caused by with-profits annuities have demonstrated the disadvantages of this form of annuity, making non-profit SPDAs (as proposed in this paper) more attractive. Modern SPDAs that offer an inflation indexed revaluation rate have become available, removing inflation risk. With the widespread use of computerized systems, the administrative costs of providing deferred annuities should now be broadly similar to those for a DB scheme. With developments in financial markets the ability of insurers to hedge their annuity risks has improved (see section 8). The only areas where DB schemes remain invulnerable are the public and local government sectors. So it appears that circumstances generally have changed to favour SPDAs, and that they can be adapted to modern conditions, making them once again an attractive way of creating a pension scheme²⁴.

Although the market in SPDAs in the UK is currently fairly small, there are some notable examples of provision elsewhere. For example, in Denmark half of Danish pension contributions are used to buy deferred annuities (Andersen and Skjodt, 2007). These are usually group deferred annuities with a preset minimum conversion rate (i.e. a guaranteed annuity rate or GAR). If mortality, interest rates or investment returns are higher than expected the annuitant receives a bonus payment. Since about 1980 deferred annuities have been sold in the US as a tax-advantaged savings vehicle for individuals, and are seldom held to maturity (Shankar, 2005). By 2005 most annuities sold in the USA were deferred, with SPDAs being the most popular annuity product. In 1996 few new group deferred annuities were issued in the US, but many such agreements remained in force, having been sold in earlier years, McGill et al (1996). Belgium also has an important market in deferred annuities, while more modest deferred annuity markets exist in Germany, the Netherlands, Switzerland and Singapore, amongst others (Rusconi, 2008).

²² Salaries generally increase faster than inflation, and so employers gain from the difference between the rate of salary increase and the rate of limited price indexation (capped at either 5% or 2.5%).

²³ For example, the terms of pension buyouts are carefully tailored to the needs of the employer, Monk (2009).

²⁴ Sections 7 and 8 below contain a comparison of the current advantages and disadvantages of using SPDAs.

5. Previous Literature

In a seminal contribution, Yaari (1965) showed that, given various assumptions, complete annuitization is optimal for all consumers. This result depends on consumers having access to deferred, as well as immediate annuities (Cannon and Tonks, 2008, Davidoff, Brown and Diamond, 2005). Therefore, in theory, deferred annuities play a key role in enabling consumers to maximise their inter-temporal utility. The purchase of SPDAs has previously been suggested for a variety of reasons:- (a) benefitting from the mortality discount²⁵, (b) providing longevity insurance to pensioners, (c) reducing the cost of adverse selection²⁶, and (d) reducing the variance of the cost of an annuity by pound cost averaging due to the incremental purchase of SPDAs. It has also been suggested that the presence of behavioural biases increases the attractiveness of SPDAs, relative to immediate annuities (Hu and Scott, 2007).

Bateman, Doyle and Piggott (2002) proposed buying a deferred annuity at retirement that begins payment in late old age, e.g. 80 or 85 (called a “longevity annuity”)²⁷. Dus, Maurer and Mitchell (2005) also suggested buying a longevity annuity as this provides longevity insurance at a low cost. Scott (2008) argued that, for consumers who do not fully annuitize at retirement, the purchase of a longevity annuity is very likely to be superior to the purchase of an immediate annuity. Scott, Watson and Hu (2006, 2007, 2009) also showed that buying a longevity annuity gives consumers a higher utility than is available from purchasing an immediate annuity on retirement. Antolin (2008) argued that the purchase of longevity annuities should be mandatory, while Turner (2008) proposed that US Social Security should provide an index-linked longevity annuity to low income pensioners when they reach the age of 82.

Brugiavini (1993) suggested the incremental purchase of SPDAs throughout a person’s working life, in preference to buying an immediate annuity on retirement. Since adverse selection increases with the age of the annuitant, this strategy reduces the cost of buying an annuity. Sheshinski (2003) showed that a sequence of SPDAs gives higher utility than buying a single immediate annuity on retirement. This is because the annuitant may die during the deferral period, leading to a better price for SPDAs than for immediate annuities due to an increase in the mortality discount. Milevsky and Young (2007) proposed the incremental purchase of annuities (deferred if purchased before

²⁵ The mortality discount is the reduction in the price of an annuity, relative to the cost of purchasing bonds to give the same annual payment, due to the probability of death each year of the annuitant and cessation of the annuity payments. The higher is the probability of death at a young age, the greater is the mortality discount.

²⁶ Adverse selection in this context refers to the fact that consumers who are more likely to live for a long time tend to choose to buy annuities, Finkelstein and Poterba (2004).

²⁷ From 2005 MetLife, Hartford and the New York Life Insurance Company have been selling longevity annuities in the US (Antolin, 2008).

retirement) of any size at any time of life; or what they called “anything, anytime annuities”. Horneff, Maurer and Stamos (2008) suggested starting to buy deferred annuities at age 40, and continuing to buy them until full annuitization is reached at age 74, while Horneff, Maurer and Rogalla (2010) found it optimal to start buying deferred annuities from around 40 years of age across a range of circumstances.

Milevsky (2005) and Gong and Webb (2010) examined the incremental purchase at a relatively young age of an index-linked deferred annuity which does not commence payment until the annuitant reaches an advanced age, such as 80, 85 or 90 (a longevity annuity, but purchased incrementally). There would be no payout if the annuitant died before the annuity commenced, with the resulting savings reducing the price of these annuities (the mortality discount). Burtless (2002) and Blake (1999, 2008) suggested buying a sequence of annuities during the five or so years before retirement, rather than waiting until retirement, thereby reducing the variance of annuity rates - a form of pound cost averaging. Alier and Vitas (2001) examined this idea and, using US data from 1871 to 1995, found this strategy reduced the standard deviation of the replacement rate by 25%. Soares and Warshawsky (2004) also found it reduced the volatility of the annuity rate.

These studies have examined using SPDAs as an alternative to immediate annuities, while the present paper proposes using SPDAs to create a pension scheme. A number of previous authors have proposed using SPDAs to create a pension scheme, including Merton (1983) who suggested a funded state DC scheme based on SPDAs for the USA. Contributions would be a fixed proportion of each member’s consumption, with the price of the SPDAs indexed to aggregate per capita consumption. Contributions would be invested by the government in a well diversified portfolio of securities. Boskin, Kotlikoff and Shoven (1988) suggested that US social security be restructured with the social security tax paid by a worker each year used to accrue an index-linked annuity for that individual. These deferred annuities would be payable from retirement. Past accruals would be locked in, but the annuity rate for new contributions would vary from year to year, depending on experience. While largely unfunded, this scheme bears strong similarities to the proposal in this paper. Bodie and Treussard (2007) suggested investment in deferred real annuities by members of US DC schemes.

Nugée (2005) proposed that the UK Treasury should offer deferred annuities, preferably index-linked, which could be bought by members of DC schemes. This would effectively give them an SPDA-based scheme. Similarly, a NAPF (2009a) survey suggested that DC pension pots could be invested in deferred annuities. Byrne and Blake (2009) proposed that members of the NEST be offered a default fund that switches into deferred annuities as the chosen retirement date approaches. If implemented, this would result in a very considerable increase in the size of the UK

deferred annuity market.

7. Benefits of Using SPDAs

a. Relative to DC and DB Schemes. The use of SPDAs offers two important advantages over both DC and DB schemes. First, once an SPDA is purchased the investment risk, longevity risk, interest rate risk and inflation risk are borne by the insurer. There is no salary risk as a SPDA-based pension is not determined by the final salary (unless final salary is used as the revaluation rate), while regulatory risk is borne largely by the insurer and the members. If inflation is used as the SPDA revaluation rate, instead of the pension varying with final salary, a pension based on SPDAs is fixed in real terms when each year's deferred annuity is purchased. This makes such a pension highly predictable in real terms. Therefore, with a SPDA-based scheme the employer bears virtually no risk, and nor do the members²⁸. In contrast, as argued in section 2, the terminal value of a DC pensions pot is highly variable, and so is the resulting replacement rate, while members of most DB schemes get a pension which is a specified proportion of their final salary, and so their pension varies with their final salary. Table 1 summarises who bears most of the risk during the stages of a member's life for different types of scheme.

Type of Scheme	Working	Retirement
Defined Benefit	Employer	Employer
Defined Contribution	Member	Insurer
SPDA	Insurer	Insurer

Table 1: Risk Bearing For Different Types of Scheme

Second, employers are often fairly small companies, probably operating in an economic sector that does not involve any special expertise in pensions and fund management. Most trustees (who are usually employees of the company) also lack this expertise. Yet thousands of such companies supply annuities via their DB schemes. In contrast, a small number of large insurers focus on the supply of annuities, enjoying considerable economies of scale and low transactions costs, together with close regulation. They are specialists in the management of financial risk and have greater knowledge and access to expertise than individuals or DB and DC schemes. These advantages should enable them to do a better job of managing scheme assets and liabilities than achieved by DB and DC schemes. DC schemes usually require the member to choose the asset allocation and contribution rate, and then which annuity to buy and when, and the evidence is that members often do a poor job when making these choices (see section 2).

²⁸ Members face a risk of changes in the price of future SPDAs, and some regulatory risk. It is suggested in section 8 below that it may be sensible for members to share some of their age cohort's longevity risk.

b. Relative to DC Schemes. SPDAs are superior to DC schemes because they offer the possibility of inter-generational risk-sharing, as do DB schemes. Insurers providing SPDAs may suffer losses on those retiring this year, but have made a profit on those who retired ten years ago resulting in an inter-generational transfer. The risks borne by members in DC schemes are not shared with other members, and so inter-generational and intra-generational risk sharing and transfers are not part of such schemes.

c. Relative to DB Schemes. SPDAs are preferable to DB schemes in a number of ways. First, SPDA-based pensions have the same portability as DC pensions. As a result there is no problem for members in changing employer as each member takes their deferred annuities with them. Second, subject to the constraints of a group scheme, individual members can customize their deferred annuities, e.g. full index linking, a 5 or 10 year guarantee period, joint life, impaired life, etc. While such customization is possible for DC scheme members, DB schemes usually offer a standard set of benefits to all members. Third, the published accounts of the employer are not impacted by pension surpluses or deficits when SPDAs (or DC schemes) are used. Deficits and surpluses on DB schemes affect the employer's published accounts, making firms unhappy about this volatility, which is unconnected with their business operations.

Fourth, while there is default risk with SPDAs, it is default by the insurer, not the employer²⁹. This avoids the risk of a double hit to members of simultaneously losing their job and their DB pension when their employer is wound-up³⁰. Insurers are less likely to default than most employers and “in almost all scenarios an FSA-regulated insurer provides more security than the sponsoring employer”, Jones, Hunter and Herbert (2009). This increases the attractiveness of group deferred annuities to employees, compared with DB schemes, Hannah (1986). To diversify the risk of default, the SPDAs could be purchased from a range of insurers. While it is acceptable for DB schemes to operate with a substantial deficit³¹, insurers must always have sufficient assets to cover all their liabilities and hold the required capital reserves, so reducing the chances of default. DC schemes cannot default. Fifth, there is no liability for schemes using SPDAs to pay the PPF levy on DB schemes. However, there is a Financial Services Compensation Scheme (FSCS) levy on insurers, and if the insurer defaults, the FSCS will cover 90% of the liability. Compensation from the PPF for DB schemes is capped, while compensation from the FSCS is unlimited.

²⁹ The members could be given a claim on their employer if the insurer defaults.

³⁰ The Pension Protection Fund (PPF) protects 90% of the pensions of active DB members, subject to a cap of about £30,000 per annum. However, the PPF is an insurer that lacks a government guarantee, and its insolvency, or a lowering of the rate of compensation it provides, is a distinct possibility (Blake, Cotter and Dowd, 2007).

³¹ If the deficit of a DB pension scheme becomes very large, the Pensions Regulator can require the scheme to produce a recovery plan.

Sixth, insurers can pool the longevity risks from many members who have different employers and occupations, so reducing their risk of default. DB schemes typically cover either a single employer, or a single industry making their members more homogeneous, which reduces the diversification of actuarial risks. Small DB schemes are susceptible to shocks, such as the death of a highly paid member triggering the payment of a large death benefit. Such actuarial risks are diversified away by large DB schemes, and to an even greater extent by insurers. The use of SPDAs by small schemes removes such risks. Seventh, early leavers from final salary schemes often have their deferred pension up-rated by limited price indexation, not final salary, generating a loss for members which does not occur for early leavers from DC or SPDA-based schemes³². Finally, the accrual rate in a SPDA-based scheme adapts from year to year in response to changed investment and annuity rate expectations in a way that is unlikely to generate industrial unrest. This may not be the case for DB schemes, while DC schemes do not have an accrual rate.

8. Disadvantages of Using SPDAs

a. Hedging. The Actuarial Education Company (2002) reported that the prices for non-profit deferred annuities are unattractive because the insurer is exposed to longevity, inflation and interest rate risk over 50 or 60 years. However, the investment and annuity rate risk of SPDAs can be reduced by hedging. Interest rate risk can be hedged by holding long positions in fixed interest securities (including interest rate swaps)³³, and stock market exposure can be hedged using a range of instruments. Although index-linked gilts have been available in the UK since 1981, the quantity available meets only a tiny fraction of demand. If the UK government fails to respond to increased demand by issuing sufficient index-linked gilts, insurers can make greater use of OTC inflation swaps.

Few securities are currently available for hedging longevity risk, and there may be concern over the ability of insurers to hedge the longevity risks inherent in the SPDAs to fund an increased proportion of UK pension schemes. Their life assurance business provides insurers with an

³² In the US accrued benefits for early leavers are not up-rated, generating a larger gain for employers with DB schemes (Schrager, 2009).

³³ The British government first issued consols, which have no redemption date and so are perpetuities, in 1751. Until the 1950s 100 year bond issues were common, but between 1954 and 1993 there were none. Since then the market in long term debt has revived with 100 year corporate bonds such as those issued by IBM, Walt Disney, Coca Cola, Ford, BellSouth Telecommunications, ABN Amro, Reliance Group, Tenaga Nasional and Apache; while Safra Republic Holdings issued a 1,000 year bond. The World Bank and the governments of the UK, France and China have recently issued 50 year sovereign debt, and Belgium and Denmark have outstanding 50 year bonds (Blommestein, 2007)

operational hedge for at least some of this longevity risk (although this involves basis risk)³⁴. There are two types of longevity risk, analogous to the systematic and non-systematic risks of the CAPM. Insurers sell many thousands of annuities, and so diversify away the non-systematic risk that the longevity of any particular annuitant deviates from the longevity given by the mortality table for their age cohort. However, the systematic risk that the average longevity of a cohort born in a particular year is higher or lower than expected from the mortality table cannot be diversified away. The concentration of this systematic risk with insurers should enable them to stimulate the development of instruments to improve their hedging opportunities, e.g. longevity, mortality and survivor bonds, swaps or forwards and life securitization (Blake, Cairns and Dowd, 2008)³⁵. Any remaining risks are diversified across the insurance company's shareholders (or policyholders), rather than falling on members or their employer.

Another approach to dealing with age cohort (or systematic) longevity risk is for some of this risk to be assumed by members. The systematic longevity risk can be further disaggregated into (a) the longevity of an age cohort expected shortly before their retirement, relative to the longevity expected when they purchased each of their SPDAs; and (b) the remaining age cohort risk, (i.e. the extent to which the age cohort longevity expectations shortly before retirement prove incorrect). Some of this first type of age cohort risk can be transferred to members, while the remaining age cohort risk remains with the insurer. If a cohort's expected longevity increases during their employment this may lead to a rise in their retirement age. Many company DB schemes have recently increased their retirement age in response to rising longevity, as have many state schemes³⁶.

³⁴ For 542 US insurers, Cox and Lin (2007) found that hedging their annuity business with an equivalent value of life insurance business lowered their annuity prices by 2.4%.

³⁵ A market in longevity swaps is emerging. In April 2007 Friends Provident transferred the longevity risk of 78,000 annuities worth £1.7 billion to Swiss Re in exchange for an undisclosed payment; while in March 2009 Norwich Union entered into a swap with Partner Re which transferred the longevity risk of Norwich Union annuities worth £475 million to Partner Re. Then in June and October 2009 Babcock International completed two longevity swaps with a term of 50 years worth a total of £850 million with Credit Suisse for two of its pension schemes (Jones, Hunter and Herbert, 2009). A third longevity swap with Credit Suisse worth £300 million for Babcock's largest scheme was completed in December 2009. In July 2009 the RSA Insurance Group insured the longevity risk of £1.9 billion of its pension liabilities with Rothesay Life (Goldman Sachs), while in December 2009 the Royal County of Berkshire entered into a longevity swap worth £750 million with Swiss Re. BMW (UK) agreed a longevity swap worth almost £3 billion with Abbey Life (Deutsche Bank) and Paternoster in February 2010. In the first quarter of 2010 Legal and General, UBS, Morgan Stanley and Munich Re announced they were willing to supply longevity swaps, and JP Morgan, Lucida, and the Pension Insurance Corporation are also seeking customers. Six companies reinsuring the risk of longevity swaps - Hannover Re, Swiss Re, Partner Re, Munich Re, Pacific Life Re and the Reinsurance Group of America (Lane, Clark and Peacock, 2010).

³⁶ An alternative to delaying the retirement age is a longevity adjustment factor which reduces the pension, rather than delaying the date from which it is paid. Such factors are used by some corporate and state schemes (e.g. John Lewis, BAE Systems, Sweden, Finland, Italy, Switzerland and Denmark).

Therefore some of the increased longevity of a cohort is absorbed by an increase in the length of their working life, with a smaller increase in the period spent in retirement³⁷. If the start date for each cohort's SPDAs is postponed until their delayed retirement date, the increase in the number of years for which their SPDAs are paid will be less than the increase in their expected longevity. The magnitude of the age cohort risk borne by insurers now depends on the accuracy with which the retirement age for each cohort is revised in line with changing longevity expectations. Although they start to receive their annuity payments later, scheme members still receive the same real income per year in retirement as initially agreed, supplemented by income from the extra SPDAs they purchase during their additional years of employment³⁸.

The pension risks to be replaced by SPDA-based schemes already exist in DC and DB schemes. DB schemes have issued roughly £1,000 billion of what are effectively deferred annuities, indexed to final salaries, while DC schemes have about £450 billion of assets, and insurers have approximately £125 billion of annuity liabilities (Pension Protection Fund and the Pensions Regulator, 2008). The proposal is for the very gradual transfer of these risks to insurers via the introduction and slow growth of SPDA-based schemes. For example, the new schemes introduced to replace closed DB schemes could be SPDA-based. Since the total quantity of the risks to be hedged is largely unchanged, the amount of unhedged risk will not be reduced by a switch to SPDAs, and will almost certainly be increased.

b. Value for Money. The use of SPDAs will probably produce smaller expected pensions than either DB or DC schemes for the same level of contributions. However, such comparisons must allow for differences in risk. In final salary schemes each member's promised pension is a specified percentage of their final salary, and the obligation to pay this pension falls on the employer using the proceeds from investing the contributions. Therefore, in DB schemes the equity risk premium is largely a matter for the employer. DB schemes under-estimated the cost of their pensions promise because they expected to earn a substantial risk premium from investing the pension fund in risky assets, which did not materialise. They also under-estimated improvements in longevity and the cost of increases in the regulatory burden. Due to these inaccurate expectations, previous pension promises were too optimistic, and in future DB pensions promises will be lower. Using the market price of risk, the cost of bearing each risk should be roughly equal to the associated risk premium.

If members can flex their retirement date, whether the longevity adjustment factor leads to a pension decrease or an increase in the default retirement age makes little difference (Lindell, 2004).

³⁷ It is possible the period in retirement could decrease if the retirement age is increased by more than the actual increase in cohort longevity.

³⁸ Since the SPDAs come into payment later, the insurers are able to invest the SPDA contributions for longer.

The cost of DB and DC pensions should include the cost of the various risks, making the total cost of a DB scheme to the employer broadly similar to that faced by an insurer providing SPDAs³⁹. Since the insurer will probably have slightly lower costs than a DB scheme due to their greater expertise, economies of scale and hedging possibilities, a SPDA-based pension may be cheaper than a fully costed DB scheme⁴⁰.

For DC schemes, the equity risk premium is received by the member. DC schemes should offer a higher expected return than a SPDA-based scheme for the same contributions because the member is bearing the equity and annuity rate risks. When allowance is made for the cost of bearing these risks, the risk-adjusted expected return on a DC scheme will probably be below that for a SPDA-based scheme. This is because, due to its hedging capabilities and diversification among shareholders (or policyholders), the insurer will probably have a lower cost for bearing risk than individual scheme members. In addition, since many DC members make poor decisions when allocating their assets, buying an annuity, and selecting a contribution rate, the expected return from a DC scheme may well be inferior to that of a SPDA-based scheme (see section 2).

DB and DC schemes only appear to offer better value than SPDA-based schemes when no allowance is made for the risks undertaken by such schemes. Once these risks are added to the costs of DB and DC schemes, their value for money is broadly similar to that of SPDA-based schemes.

c. Solvency. Insurers are more tightly regulated than pension schemes. They must always be solvent, while DB pension schemes can continue operating with a substantial deficit. In addition, insurers must comply with the prudential regulations in the Financial Services Authority handbook requiring them to hold capital reserves. As non-profit business, SPDAs affect the size the regulatory peak in pillar 1 and the individual capital assessment in pillar 2 of the solvency requirements. Holding this additional regulatory capital increases the cost of annuities, including the immediate annuities associated with DC schemes, while the forthcoming introduction of Solvency II by the European Union (CEIOPS) is expected to further increase the costs of providing both deferred and immediate annuities⁴¹.

If these solvency requirements efficiently reduce risk, all they do is require insurers to adopt a

³⁹ The issue of regulatory capital is considered below.

⁴⁰ In a study using UK annuity data, Bauer and Weber (2008) conclude that longevity risk appears to be overpriced. They suggest that, as insurers become more familiar with pricing longevity risk, its price will drop.

⁴¹ Blake, Boardman, Cairns and Dowd (2009) have suggested that, if a market in longevity risk develops and longevity risk can be marked to market, it may be possible to avoid some of the costs of Solvency II.

lower-risk higher-cost strategy. The risks of insolvency are now priced (via the cost of the regulatory capital), with the company and its customers given greater protection against the risk of insurance company insolvency. Without solvency rules they would face lower explicit costs, but higher risks. The solvency rules merely make explicit the cost of the additional insurance company insolvency risk created by the sale of annuities⁴². If DB schemes are also required to comply with Solvency II, this would level the regulatory playing field between DB schemes and insurers⁴³.

An alternative to insurers acting as risk-removing intermediaries via SPDAs, is for DB schemes themselves to remove most of the risks inherent in offering a CARE scheme by instituting a do-it-yourself derisking strategy to replicate an SPDA-based scheme. This can be done by DB schemes hedging the inflation, interest rate, longevity and investment risks. It has the advantage that pension schemes are not subject to insurance company solvency rules. Campion (2010) reports that in 2010 65% of UK DB pension schemes had taken steps to reduce their risks, while 73% intended to take further steps to reduce their risks, with 34% considering using longevity swaps.

d. Relative to DB. There is a wide range of ways in which SPDA-based schemes are at a disadvantage to DB schemes. First, DB schemes are a convenient tool for managing early retirement, with the costs of granting additional accrued years falling on the pension scheme, while with DC and SPDA-based schemes the costs immediately fall on the employer as additional contributions. Second, DB schemes can be designed to encourage retirement at a particular age (Ippolito, 1986, Kotlikoff and Wise, 1987), although a compulsory retirement age provides an upper limit for all types of scheme. Third, an insurer (unless it is a mutual) builds a profit margin into the price of its SPDAs, and also charges for its marketing expenses, while DB schemes are not-for-profit organizations and do not incur marketing expenses. The annuities purchased with a DC pension pot also include a charge for profit and marketing expenses, while the accumulation phase of DC schemes involves investment via vehicles which charge for marketing costs and profit.

Fourth, the employer can choose to underfund a DB scheme. Underfunding offers the employer the benefits of borrowing from the scheme (Cooper and Ross, 2001, Datta, Iskandar-Datta and Zychowicz, 1996) and bonding scheme members to the long term success of the company (Ippolito, 1985, 1986). However, the creation of the PPF has largely removed the bonding benefit, and the remaining benefits may be offset by the need for employers with underfunded DB schemes to offer

⁴² A switch to SPDA-based schemes results in a positive cash flow into insurers until the annuities come into payment, while very little capital is required to hedge the SPDAs if swaps (interest, inflation, equity and longevity) are used.

⁴³ In recent years DB pensions have moved from being a discretionary promise to more like a legally binding contract, as are annuities, (Donaldson, 2007). Therefore, it is possible both will be subject to the same solvency requirements.

higher wages. Fifth, overfunding a DB scheme offers the employer a tax-free investment. However, there are legal restrictions on such overfunding, and it is hard for the employer to recover the money from the scheme.

Sixth, the terms and conditions of a DB scheme can usually be set and altered by the employer to suit their changing business needs. SPDAs are purchased from an insurer, and so are less susceptible to customization and adaption. However, with computerized systems, it should be possible to offer customized SPDAs for large schemes. Seventh, as for DC schemes, the size of the pension differs by gender due to the different longevity of males and females built into annuity rates in the UK⁴⁴. Such a gender distinction is not usually the case for DB schemes. Eighth, because SPDA annuity rates may vary over time, different cohorts of members could receive differently sized annuities for the same contributions, which is not the case for DB schemes (assuming no changes in the accrual rate, retirement age, employees' contribution rate etc.). This inter-temporal inequality applies in a much more extreme manner to DC pensions than to SPDA-based schemes, as detailed in section 2. Finally, if the revaluation rate implicit in the SPDAs is inflation, a SPDA-based pension scheme (like a DC scheme) does not encourage hard work or reward low discounters⁴⁵ because no pension loss is suffered by early leavers. Final salary schemes penalise early leavers because they revalue their accrued benefits by inflation (possibly capped at 5% or 2.5%), not salary increases.

Despite these advantages of DB schemes, large numbers of employers are choosing to terminate DB schemes in favour of DC schemes. Therefore, corporate behaviour reveals that the advantages of DB schemes, relative to DC and SPDA schemes, are not sufficient to outweigh the attractions of DC and SPDA-based schemes.

9. Conclusions

In the UK and elsewhere, DB schemes are being replaced by DC schemes. However DC schemes have some substantial weaknesses, and a continuation of current policies will probably lead to another pensions crisis in a few decades. There is an alternative which avoids the major defects of DC schemes by looking like a DC scheme to the employer, and a DB scheme to members. A SPDA-based scheme offers only modest advantages over a CARE DB scheme with a strong covenant. So the target group for SPDA-based pensions is employers planning to switch from DB

⁴⁴ There is a requirement that there be no gender discrimination in the pricing of protected rights annuities. However these annuities must be for a joint life, and so discriminate between married and single annuitants.

⁴⁵ Low discounters are people who discount at market rates, while high discounters use substantially higher rates.

to DC. If UK employers wish to replace their DB schemes, they should do so with something that looks like a CARE DB scheme to the members, but is funded by SPDAs. Some of these SPDAs may be revalued using stock market returns, rather than inflation to allow members to achieve their desired risk-return trade-off via two pension-fund separation. Pension provision is outsourced to specialist providers (insurers), with all the risk (and the decisions that must be made by members of a DC scheme) managed by insurers, not the employer or members.

The use of deferred annuities was widespread in the UK as a way of creating occupational pension schemes, but has greatly reduced since the 1950s and 1960s. In recent years circumstances and perceptions have changed to favour SPDAs, relative to DC and DB schemes. The principal problem in using SPDA-based schemes is their higher cost, due to their lower risk (e.g. investing primarily in bonds not equities, hedging annuity rate risk, the effects of Solvency II). If desired, the costs of Solvency II can be avoided by DB schemes replicating SPDAs via do-it-yourself derisking. A move to SPDA-based schemes will take a considerable time as members gradually build up accrued benefits in newly created SPDA-based schemes. This long adjustment period will provide the opportunity for insurers and financial markets to slowly readapt to providing a proportion of occupational pensions using SPDAs.

References

- ACA (2009) ACA Survey Finds Close to Nine Out of Ten Defined Benefit Schemes Now Closed, But Widespread Unease With the Present Pension Alternative, Association of Consulting Actuaries, News release, 1 September.
- Actuarial Education Company (2002) *ActEd Study Materials: 2002 Examinations*, Subject 304, Course Notes, Actuarial Education Company, Oxford.
- Agnew, J. Balduzzi, P. and Sundén, A. (2003) Portfolio Choice and Trading in a Large 401(k) Plan, *American Economic Review*, vol. 93, no. 1, March, pp. 193-215.
- Alier, M. and Vittas, D. (2001) Personal Pension Plans and Stock Market Volatility. In *New Ideas About Old Age Security: Towards Sustainable Pension Systems in the 21st Century*, edited by R. Holzman and J. Stiglitz, World Bank Publications,
- Ameriks, J. and Zeldes, S.P. (2004) How Do Household Portfolio Shares Vary With Age?, Working paper, Columbia University.
- Andersen, C. and Skjoldt, P. (2007) Pension Institutions and Annuities in Denmark, Policy Research Working Paper 4437, The World Bank, December.
- Antolin, P. (2008) Policy Options for the Payout Phase, OECD Working Papers on Insurance and Private Pensions, no. 25, OECD, September.
- Asay, M.R., Bouyoucos, P.J. and Marciano, A.M. (1992) An Economic Approach to Valuation of Single Premium Deferred Annuities. In *Financial Optimization* edited by S.A. Zenios, Cambridge University Press, pp. 101-135.
- Association of British Insurers (2009) *Defined Benefit Pensions: Information for Trustees About the Bulk Insured Pensions Business*, ABI, April.
- Ballotta, L. and Haberman, S. (2003) Valuation of Guaranteed Annuity Conversion Options, *Insurance: Mathematics and Economics*, vol. 33, no. 1, August, pp. 87-108.
- Ballotta, L. and Haberman, S. (2004) Guaranteed Annuity Conversion Options and their Valuation. In *Developing and Annuity Market in Europe*, edited by E. Fornero and E. Luciano, Edward Elgar, pp. 168-199.

- Ballotta, L. and Haberman, S. (2006) The Fair Valuation Problem of Guaranteed Annuity Options: The Stochastic Mortality Environment Case, *Insurance: Mathematics and Economics*, vol. 38, no. 1, February, pp. 195-214.
- Bateman, H., Doyle, S. and Piggott, J. (2002) Private Mandatory Retirement Provision. In *Social Security Reform in Advanced Countries: Evaluating Pension Finance*, edited by T. Ihori and T. Tachibanaki, Routledge, pp. 81-112.
- Bauer, D. and Weber, F. (2008) Assessing Investment and Longevity Risks Within Immediate Annuities, *Asia-Pacific Journal of Risk and Insurance*, vol. 3, no. 1, pp. 89-111.
- Benartzi, S. and Thaler, R.H. (2007) Heuristics and Biases in Retirement Savings Behaviour, *Journal of Economic Perspectives*, vol. 21, no. 3, Summer, pp. 81-104.
- Biffis, E. and Millossovich, P. (2006) The Fair Value of Guaranteed Annuity Options, *Scandinavian Actuarial Journal*, vol. 2006, no. 1, pp. 23-41.
- Blake, D. (1999) Annuity Markets: Problems and Solutions, *Geneva Papers on Risk and Insurance*, vol. 24, no. 3, July, pp. 358-375.
- Blake, D. (2006) *Pension Finance*, John Wiley and Sons.
- Blake, D. (2008) It is All Back to Front: Critical Issues in the Design of Defined Contribution Pension Plans. In *Frontiers in Pension Finance*, edited by D. Broeders, S. Eijffinger and A. Houben, Edward Elgar, pp. 99-164.
- Blake, D., Boardman, T., Cairns, A. and Dowd, K. (2009) Taking the Long View, *Life and Pensions*, April, pp. 32-34.
- Blake, D., Cairns, A.J.G. and Dowd, K. (2001) Pensionmetrics: Stochastic Pension Plan Design and Value at Risk During the Accumulation Phase, *Insurance: Mathematics and Economics*, vol. 29, no. 2, October, pp. 187-215.
- Blake, D., Cairns, A.J.G. and Dowd, K. (2008) The Birth of the Life Market, *Asia-Pacific Journal of Risk and Insurance*, vol. 3, no. 1, pp. 6-36.
- Blake, D., Cotter, J. and Dowd, K. (2007) Financial Risks and the Pension Protection Fund: Can It Survive Them?, *Pensions: An International Journal*, vol. 12, no. 3, June, pp. 109-130.
- Blake, D., Lehmann, B.N. and Timmermann, A. (1999) Asset Allocation Dynamics and Pension Fund Performance, *Journal of Business*, vol. 72, no. 4, October, pp. 429-461.
- Blommestein, H.J. (2007) Pension Funds and the Evolving Market for (Ultra-)Long Government Bonds, *Pensions: An International Journal*, vol. 12, no. 4, September, pp. 175-184.
- Blommestein, H.J., Janssen, P., Kortleve, N. and Yermo, J. (2009) Evaluating the Design of Private Pension Plans: Costs and Benefits of Risk-Sharing, OECD Working Papers on Insurance and Private Pensions, no. 34, OECD, March.
- Board, J.L.G. and Sutcliffe, C.M.S. (2007) Joined-Up Pensions Policy in the UK: An Asset-Liability Model for Simultaneously Determining the Asset Allocation and Contribution Rate. In *Handbook of Asset and Liability Management*, edited by Stavros A. Zenios and William T. Ziemba, North Holland Handbooks in Finance, Elsevier Science B.V., vol. 2, pp. 1029-1067.
- Bodie, Z. and Treussard, J. (2007) Making Investment Choices as Simple as Possible, but Not Simpler, *Financial Analysts Journal*, vol. 63, no. 3, May, pp. 42-47.
- Booth, P., Chadburn, R., Cooper, D., Haberman, S. and James, D. (1998) *Modern Actuarial Theory and Practice*, Chapman and Hall.
- Boskin, M.J., Kotlikoff, L.J. and Shoven, J.B. (1988) Personal Security Accounts: A Proposal for Fundamental Social Security Reform. In *Social Security and Private Pensions: Providing for Retirement in the Twenty-First Century*, edited by S.M. Wachter, Lexington Books, pp. 179-208.
- Brinson, G.P., Hood, L.R. and Beebower, G.L. (1986) Determinants of Portfolio Performance, *Financial Analysts Journal*, vol. 42, no. 4, July-August, pp. 39-44.
- Brinson, G.P., Singer, B.D. and Beebower, G.L. (1991) Determinants of Portfolio Performance II: An Update, *Financial Analysts Journal*, vol. 47, no. 3, May-June, pp. 40-48.
- Brugiavini, A. (1993) Uncertainty Resolution and the Timing of Annuity Purchases, *Journal of Public Economics*, vol. 50, no. 1, January, pp. 31-62.
- Burtless, G. (2002) Social Security Privatization and Financial Market Risk: Lessons from US Financial History. In *Social Security Reform in Advanced Countries: Evaluating Pension Finance*, edited by

- T. Ithori and T. Tachibanaki, Routledge, pp. 52-80.
- Burtless, G. (2003) What Do We Know About the Risk of Individual Account Pensions? Evidence from Industrial Countries, *American Economic Review*, vol. 93, no. 2, May, pp. 354-359.
- Burtless, G. (2009a) Financial Market Turbulence and Social Security Reform. In *Pensions, Social Security and the Privatization of Risk*, edited by M.A. Orenstein, Columbia University Press, pp. 72-85.
- Burtless (2009b) Lessons of the Financial Crisis for the Design of National Pension Schemes, CESifo Working Paper no. 2735, July.
- Butt, J. (1984) Life Assurance in War and Depression: the Standard Life Assurance Company and its Environment, 1914-39. In *The Historian and the Business of Insurance*, edited by O.M. Westall, Manchester University Press, pp. 155-172.
- Byrne, A. and Blake, D. (2009) The Best Way to Invest Personal Accounts, *The Financial Times*, 24 August.
- Byrne, A., Blake, D., Cairns, A. and Dowd, K. (2007) Default Funds in UK Defined Contribution Plans, *Financial Analysts Journal*, vol. 63, no. 4, July-August, pp. 40-51.
- Byrne, A., Harrison, D. and Blake, D. (2007) *Dealing With the Reluctant Investor: Innovation and Governance in DC Pension Investment*, The Pensions Institute, April.
- Campion, B. (2010) Engaged Investor/Pension Corporation Trustee Survey 2010, The Future of Pension Schemes, *Engaged Investor*, May, pp. 1-4.
- Cannon, E. and Tonks, I. (2004) UK Annuity Price Series 1957-2002, *Financial History Review*, vol. 11, no. 2, pp. 165-196.
- Cannon, E. and Tonks, I. (2008) *Annuity Markets*, Oxford University Press.
- Cannon, E. and Tonks, I. (2009) The Value and Risk of Defined Contribution Pension Schemes: International Evidence, Working paper, University of Exeter Business School, no. 09/03.
- Choi, J.J., Laibson, D. and Madrian, B.C. (2007) \$100 Bills on the Sidewalk: Sub-optimal Investment in 401(k) Plans, Working Paper, Yale University, no. 08-05, December.
- Cooper, R. and Ross, T.W. (2001) Pensions: Theories of Underfunding, *Labour Economics*, vol. 8, no. 6, December 2001, pp. 667-689.
- Cox, S.H. and Lin, Y. (2007) Natural Hedging of Life and Annuity Mortality Risks, *North American Actuarial Journal*, vol. 11, no. 3, July, pp. 1-15.
- Cronqvist, H. and Thaler, R.H. (2004) Design Choices in Privatized Social-Security Systems: Learning from the Swedish Experience, *American Economic Review*, vol. 94, no. 2, May, pp. 424-428.
- Datta, S., Iskandar-Datta, M.E. and Zychowicz, E.J. (1996) Managerial Self-Interest, Pension Financial Slack and Corporate Pension Funding, *The Financial Review*, vol. 31, no. 4, November, pp. 695-720.
- Davidoff, T., Brown, J.R. and Diamond, P.A. (2005) Annuities and Individual Welfare, *American Economic Review*, vol. 95, no. 5, December, pp. 1573-1590.
- Davis, E.P. (1995) *Pension Funds: Retirement-Income Security and Capital Markets - An International Perspective*, Oxford University Press.
- Davis, E.P. (2004) Issues in the Regulation of Annuities Markets. In *Developing an Annuity Market in Europe*, edited by E. Fornero and E. Luciano, Edward Elgar, pp. 49-92.
- Dennett, L. (1998) *A Sense of Security: 150 Years of Prudential*, Granta Editions.
- Donaldson, K. (2007) The Emergence of an Alternative Buy-Out Market. In *Pension Scheme Deficits: Practical Solutions*, Globe Law and Business, pp. 197-209.
- Dowd, K., Blake, D. and Cairns, A.J.G. (2008) The Distribution of Future Annuity Prices Under Interest Rate and Longevity Risks, Discussion paper PI-0823, The Pensions Institute, August.
- Dus, I., Maurer, R. and Mitchell, O.S. (2005) Betting on Death and Capital Markets in Retirement: A Shortfall Risk Analysis of Life Annuities Versus Phased Withdrawal Plans, *Financial Services Review*, vol. 14, no. 3, Fall, pp. 169-196.
- Elton, E.J., Gruber, M.J. and Blake, C.R. (2006) The Adequacy of Investment Choices Offered by 401(k) Plans, *Journal of Public Economics*, vol. 90, nos. 6-7, August, pp. 1299-1314.
- Exley, C.J. (2005) Pension Funds and the UK Economy, *North American Actuarial Journal*, vol. 9, no. 1, January, pp. 73-87.
- Finkelstein, A. and Poterba, J. (2004) Adverse Selection in Insurance Markets: Policyholder Evidence from

- the UK Annuity Market, *Journal of Political Economy*, vol. 112, no. 1, February, pp. 483-208.
- Gong, G. and Webb, A. (2010) Evaluating the Advanced Life Deferred Annuity - An Annuity People Might Actually Buy, *Insurance: Mathematics and Economics*, vol. 46, no. 1, February, pp. 210-221.
- Hannah, L. (1986) *Inventing Retirement: The Development of Occupational Pensions in Britain*, Cambridge University Press.
- HM Treasury (2006) *The Annuities Market*, HM Treasury, December.
- Horneff, W., Maurer, R. and Rogalla, R. (2010) Dynamic Portfolio Choice with Deferred Annuities, *Journal of Banking and Finance*, forthcoming.
- Horneff, W.J., Maurer, R.H. and Stamos, M.Z. (2008) Life-Cycle Asset Allocation with Annuity Markets, *Journal of Economic Dynamics and Control*, vol. 32, no. 11, November, pp. 3590-3612.
- Hu, W.Y. and Scott, J.S. (2007) Behavioural Obstacles in the Annuity Market, *Financial Analysts Journal*, vol. 63, no. 6, November-December, pp. 71-82.
- Hymans, J.C.S. (1950) Pension Schemes II: Private Fund or Insured Scheme?, *The Accountant*, vol. 123, no. 3965, 16th December, pp. 607-609.
- Ibbotson, R.G. and Kaplan, P.D. (2000) Does Asset Allocation Policy Explain 40, 90 or 100 Percent of Performance?, *Financial Analysts Journal*, vol. 56, no. 1, January-February, pp. 26-33.
- Ippolito, R.A. (1985) The Economic Function of Underfunded Pension Plans, *Journal of Law and Economics*, vol. 28, no. 3, October, pp. 611-651.
- Ippolito, R.A. (1986) *Pensions, Economics and Public Policy*, Pension Research Council, University of Pennsylvania, Dow Jones-Irwin.
- Jensen, J.C. and Meckling, W.H. (1976) Theory of the Firm, Managerial Behaviour, Agency Costs and Ownership Structures, *Journal of Financial Economics*, vol. 3, no. 4, October, pp. 305-360.
- Johnston, J. and Murphy, G.W. (1957) The Growth of Life Assurance in UK Since 1880, *The Manchester School of Economic and Social Studies*, vol. 25, no. 2, May, pp. 107-182.
- Jones, R., Hunter, M. and Herbert, O. (2009) *The False Dawn: An Update on the UK Bulk Buy-Out Market and Other De-risking Solutions*, Punter Southall Transaction Services.
- Kotlikoff, L.J. and Wise, D.A. (1987) The Incentive Effects of Private Pension Plans. In *Issues in Pension Economics* edited by Z. Bodie, J.B. Shoven and D.A. Wise, University of Chicago Press, pp. 283-339.
- Lane, Clark and Peacock (2010) *Pension Buyouts 2010: Buy-outs, Buy-ins and Longevity Hedging*, Lane, Clark and Peacock, May.
- Laybourn, T.A.E. (1952) New Thoughts on Pension and Group Schemes, *Journal of the Insurance Institute of London*, vol. 40, pp. 81-91.
- Levy, S. (2009) *Occupational Pension Schemes Annual Report 2008*, Office for National Statistics, No. 16.
- Lewin, C.G. (2003) *Pensions and Insurance Before 1800: A Social History*, Tuckwell Press.
- Lindell, C. (2004) Longevity is Increasing - What About the Retirement Age?, Finnish Centre for Pensions, Working Paper no. 6.
- McCarthy, D. (2005) *The Optimal Allocation of Pension Risks in Employment Contracts*, Research Report 272, Department for Work and Pensions.
- McGill, D.M., Brown, K.N., Haley, J.J. and Schieber, S.J. (1996) *Fundamentals of Private Pensions*, University of Pennsylvania Press, Seventh edition.
- Mercer (2009) *Asset Allocation Survey 2009*, Mercer, London.
- Merton, R.C. (1983) On Consumption Indexed Public Pension Plans. In *Financial Aspects of the United States Pension System*, edited by Z. Bodie and J.B. Shoven, University of Chicago Press, pp. 259-289.
- MGM Advantage (2009) Launch of MGM Advantage Annuity Index Reveals Average Difference of 22% Between Standard and Enhanced Annuities, <http://www.mgmadvantage.com/homepage/media-centre/press-releases/press-release-14.html>
- Milevsky, M.A. (2005) Real Longevity Insurance with a Deductible: Introduction to Advanced Life Delayed Annuities (ALDA), *North American Actuarial Journal*, vol. 9, no. 4, pp. 109-122.
- Milevsky, M.A. and Young, V.R. (2002) Optimal Asset Allocation and the Real Option to Delay Annuitization: It's Not Now-or-Never, Working paper, York University, April.
- Milevsky, M.A. and Young, V.R. (2007) Annuitization and Asset Allocation, *Journal of Economic*

- Dynamics and Control*, vol. 31, no. 9, September, pp. 3138-3177.
- Modigliani, F. and Muralidhar, A. (2004) *Rethinking Pensions Reform*, Cambridge University Press.
- Monk, A.H.B. (2009) Pension Buyouts: What Can We Learn from the UK Experience, Centre for Retirement Research at Boston College Working paper CRR WP 2009-19, September.
- Munnell, A.H. and Soto, M. (2007) State and Local Pensions Are Different From Private Plans, Centre for Retirement Research, Boston College.
- NAPF (2009a) *DC Default Funds: Today and Tomorrow: An Analysis of Current Practice and Thoughts on the Future*, National Association of Pension Funds, October.
- NAPF (2009b) *A Review of Retirement Information for DC Members*, National Association of Pension Funds, October.
- National Statistics (2007) *Share Ownership: A Report on Ownership of UK Shares as at 31st December 2006*, HMSO.
- Nielsen, S.S. and Zenios, S.A. (1996) A Stochastic Programming Model for Funding Single Premium Deferred Annuities, *Mathematical Programming*, vol. 75, no. 2, November, pp. 177-200.
- Nugée, J. (2005) A New Solution for Pensions, *Pensions Management*, September.
- Office for National Statistics (2008) *Occupational Pension Schemes Annual Report 2007*, No. 15, ONS.
- Ogborn, M.E. and Wallas, G.E. (1955) Deferred Annuities With Participation in Profits, *Journal of the Institute of Actuaries*, vol. 81, pp. 261-299.
- Owen, A.S. (1952-53) Pension Schemes and Funds: The Problem of Transfers of Employment, *Journal of the Insurance Institute of London*, vol. 41, pp. 7-37. Reprinted in *Superannuation*, no. 10, October 1954.
- Pelsser, A. (2003) Pricing and Hedging Guaranteed Annuity Options Via Static Option Replication, *Insurance: Mathematics and Economics*, vol. 33, no. 2, October, pp. 283-296.
- Pension Protection Fund and the Pensions Regulator (2008) *The Purple Book: DB Pensions Universe Risk Profile 2008*, Pension Protection Fund and the Pensions Regulator.
- Perun, P. (2007). Putting Annuities Back into Savings Plans. In *Employee Pensions: Policies, Problems and Possibilities*, edited by T. Ghilarducci and C.E. Weller, Labour and Employment Relations Association, pp. 143-162.
- Polman, M.C. (1939) Group Life and Pension Schemes Including Valuation Problems, *Journal of the Institute of Actuaries Students Society*, vol. 5, pp. 122-136.
- Post, T. (2009) Individual Welfare Gains from Deferred Life-Annuities Under Stochastic Lee-Carter Mortality, Working paper, Humbolt University of Berlin, July.
- Rappaport, A.M., Young, M.L., Levell, C.A. and Blalock, B.A. (1997) Cash Balance Pension Schemes. In *Positioning Pensions for the Twenty-First Century*, edited by M.S. Gordon, O.S. Mitchell and M.M. Twinney, University of Pennsylvania Press, pp. 29-44.
- Rusconi, R. (2008) National Annuity Markets: Features and Implications, OECD Working Papers on Insurance and Private Pensions, no. 24, OECD, September.
- Schrager, A. (2009) The Decline of Defined Benefit Plans and Job Tenure, *Journal of Pension Economics and Finance*, vol. 8, no. 3, July, pp. 259-290.
- Scott, J.S. (2008) The Longevity Annuity: An Annuity for Everyone?, *Financial Analysts Journal*, vol. 64, no. 1, January-February, pp. 40-48.
- Scott, J.S., Watson, J.G. and Hu, W.Y. (2006) Efficient Annuitization with Delayed Payout Annuities, Working paper, Financial Engines Inc.
- Scott, J.S., Watson, J.G. and Hu, W.Y. (2007) Efficient Annuitization: Optimal Strategies for Hedging Mortality Risk, Pension Research Council Working Paper, WP2007-09.
- Scott, J.S., Watson, J.G. and Hu, W.Y. (2009) What Makes a Better Annuity?, Pension Research Council Working Paper WP2009-03, March.
- Shankar, N. (2005) A Strategic Analysis of the US Life Insurance Industry: Part 1 Customers, Part 2 Products, *The Actuary Magazine*, April/May and June/July.
- Sheshinski, E. (2003) Annuities and Retirement. In *Assets, Beliefs and Equilibria in Economic Dynamics*, edited by C.D. Aliprantis, K.J. Arrow, P. Hammond, F. Kubler, H.M. Wu and N.C. Yannelis, Springer, 2003, pp. 27-54.
- Soares, C. and Warshawsky, M. (2004) Annuity Risk: Volatility and Inflation Exposure in Payments from

- Immediate Life Annuities. In *Developing an Annuity Market in Europe*, edited by E. Fornero and E. Luciano, Edward Elgar, pp. 93-111.
- Supple, B. (1970) *The Royal Exchange Assurance: A History of British Insurance 1720-1970*, Cambridge University Press.
- Sutcliffe, C.M.S. (2005) The Cult of the Equity for Pension Funds: Should it Get the Boot?, *Journal of Pension Economics and Finance*, vol. 4, no. 1, March, pp. 57-85.
- Sutcliffe, C.M.S. (2010) Should Defined Benefit Pension Schemes be Career Average or Final Salary? In *Optimizing the Ageing, Retirement and Pensions Dilemma*, edited by Marida Bertocchi, Sandra Schwartz and William Ziemba, Wiley, pp. 227-257.
- Tang, N., Mitchell, O.S., Mottola, G.R. and Utkus, S.P. (2009) The Efficiency of Sponsor and Participant Portfolio Choices in 401(k) Plans, Pension Research Council Working Paper WP2009-08, August.
- Taylor, R. (2004) The Economics of Annuities, *Geneva Papers on Risk and Insurance*, vol. 29, no. 1, January, pp. 115-127.
- Toplek, D. (2007) Deferred Annuity Contracts Under Stochastic Mortality and Interest Rates: Pricing and Model Risk Assessment, Working paper, University of St Gallen, no. 41, May.
- Turner, J.A. (2008) Longevity Insurance: Strengthening Social Security at Advanced Ages, Pension Policy Centre, Working paper, November.
- Turner, N.C. (1931) Group Insurance and Group Pension Schemes, *Journal of the Institute of Actuaries Students' Society*, vol. 3, pp. 327-337.
- Van Haastrecht, A., Plat, R. and Pelsser, A. (2009) Valuation of Guaranteed Annuity Options Using a Stochastic Volatility Model for Equity Prices, Working Paper, Netspar & University of Amsterdam.
- Vermeulen, L. (2009) Needed: A New Species of Retirement Plan, *The Financial Times*, 5th October.
- Xiong, J.X., Ibbotson, R.G., Idzorek, T.M. and Chen, P. (2010) The Equal Importance of Asset Allocation and Active Management, *Financial Analysts Journal*, vol. 66, no. 2, March-April, pp. 22-30.
- Yaari, M. (1965) Uncertain Lifetime, Life Insurance and the Theory of the Consumer, *Review of Economic Studies*, vol. 32, no. 2, April, pp. 137-150.