Research findings around pooled annuity funds

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1 Introduction

This report summarises the high-level conclusions and recommendations of the research undertaken on pooled annuity funds, under the research programme "Optimising future pension plans: Phase II" funded by the Institute and Faculty of Actuaries' Actuarial Research Centre. More details are found in the associated papers, which are referenced in the report.

There are two primary choices for retirees at retirement in the UK to convert their pension savings into an income stream. The first option is to purchase a life annuity, in which the retiree pays an insurance company for a certain, lifetime income stream. Investment and longevity risk is removed for the retiree through the annuity contract. Inflation risk may also be removed if the retiree buys a suitably inflation-proofed annuity income.

The other choice is to invest in income drawdown. In income drawdown, the retiree's savings are invested and a regular income withdrawn. The retiree must decide how much investment risk to take and for how long they want the income stream to last. Should it last for 15 years? 25 years? In other words, for how long do they expect to live. The income stream received is likely to be uncertain - it may become smaller or larger than anticipated as investment returns fluctuate. The retiree can withdraw an inflation-linked income but they may not have sufficient funds to continue this withdrawal strategy for the duration of their lifetime. In income drawdown, the retiree bears all the risks.

The two choices are extremes: either bear all risks (income drawdown) or (nearly) none of the risk (life annuity). This may be unsatisfactory for some retirees, who think that life annuities are too expensive despite the income certainty. On the other hand, they may find that income drawdown is just too risky and too complicated as decisions needs to be made on investment strategies and when the retiree expects to die.

Pooled annuity funds offer a third option. They have several names and there is currently no standard nomenclature. They may be called group self-annuitisation schemes, pooled pension funds, tontines, variable lifetime annuities, among some of the choices. In this research project,

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these funds are designed primarily to convert retirees' pension savings into a lifetime income. They do this by pooling longevity risk. Taxes, costs and fees are ignored in the research.

Some of the research in the project on pooled annuity fund has focused on answering questions concerning the number of people required to join these funds and how the income volatility changes with the number of participants. The main research findings on these questions are summarised in Section 4. How to offer a joint life income in these funds was determined in the research programme, which has consequences for member communication of what they get from the pooled annuity fund (Section 5). Finally, how to determine an optimal investment strategy for a particular retirement problem was studied, with the high-level lessons given in Section 6.

The motivation for pooled annuity funds is outlined in Section 2. A high-level overview of the operation of pooled annuity funds is given in Section 3. The report concludes in Section 7.

The author expresses their own views here. They do not represent the views of any other party.

2 Motivation for pooled annuity funds

Pooled annuity funds enable retirees to pool their longevity risk with each other. In turn, this allows the retirees to have a lifetime income, that should be fairly stable if a low risk investment strategy is employed. Additionally, it avoids retirees having to guess for how long they will live and either running out of money or having an unnecessarily parsimonious life. These latter problems can arise in income drawdown.

Pooled annuity funds give their participants the main benefit of life annuities - a higher income than they could have alone. They do this by eliminating or significantly reducing idiosyncratic longevity risk. In these funds, the shorter-lived participants subsidise the longer-lived ones. They do this by giving up their residual pension savings to the survivors in the fund upon their death. Their savings are then shared out among the survivors, according to a chosen rule. The consequence of this financial transfer between participants is that a mortality distribution can be used to calculate the income to be paid to retirees, rather than guessing a time of death.

The retirees in the fund continue to bear investment risk. However, less investment risk can be taken compared to income drawdown. This is because the remaining longevity risk is a source of risk. Although it may be relatively small, its existence means that less investment risk can be taken in order to have the same level of risk as in, say, income drawdown. Consequently, retirees are expected to have a higher and longer-paid income than income drawdown, assuming the same investment strategy is followed.

This means, if exactly the same investment strategy was followed in all choices, pooled annuity funds are

- Less risky than income drawdown. Retirees doing income drawdown bear all of their longevity risk. In contrast, in a pooled annuity fund the idiosyncratic element of longevity risk should be virtually eliminated. Note that the remaining element of longevity risk, systematic longevity risk, continues to be borne by the participants in pooled annuity funds, unless there is action taken to mitigate it.

- Expected to pay a higher income than income drawdown. The higher expected income is due to the additional return that survivors in the pooled annuity fund get from shorter-lived participants. Of course this means that if a retiree dies, they give up their pension savings to the rest of the pool. This trade-off is the same as that in life annuities (where the pension savings are 'given up' at the time of purchase) and defined benefit pension schemes, in which pensioners are not allowed to leave the scheme after their pension is in payment.

- More risky than conventional life annuities. Retirees who purchase a conventional life annuity bear no longevity risk and no investment risk. While participants in a pooled annuity fund eliminate the idiosyncratic element of longevity risk, they continue to bear the systematic element of longevity risk and the investment risk.
- Expected to pay a higher income than a conventional life annuity. Since the removal of investment and longevity risk in a life annuity comes generally at a cost, the income from a pooled annuity fund is expected to be higher than that from a conventional life annuity.

Overall, pooled annuity funds lie between income drawdown and life annuities in terms of risk. They may be suitable for people for whom life annuities are too risk-averse but income drawdown is too risky.

In the next section, the operation of a pooled annuity fund is outlined.

3 Operation of pooled annuity funds

In a single cohort fund, a group of people join the pooled annuity fund at time 0. No other entrants are allowed to join after time 0. Each participant can be different from any other: different age, different expectations of future lifetime, have different amounts of pension savings.

Analysing a single cohort fund is instructive for two reasons. The first is that single cohort funds may exist in practice, perhaps due to legal restrictions on a particular structure or to fall within a certain regulatory regime. Therefore, a study of how many people in a single cohort are required to pool longevity risk is useful in itself. Second, it helps to explain why open funds provide better pooling, and what is likely to happen when an open fund closes to new entrants.

The single cohort fund studied first in the research programme is one in which the participants are the same age and join with the same amount of pension savings. They each face the same distribution of future lifetime. Additionally, they invest their pension savings using the same investment strategy. This is a fund which is highly amenable to analysis. Understanding it leads to a better understanding of the heterogeneous case, in which participants have different ages and pension savings, which was also studied in the research programme.

3.1 Operation of a single cohort pooled annuity fund

A simple pooled annuity fund was primarily studied, since it enables longevity pooling to be analysed in isolation. In practice, there are likely be additional features offered, such as a joint life benefit (Donnelly and Zhang, 2023) and a death benefit (Bernhardt and Donnelly, 2019; Donnelly, 2022). There may be a minimum guaranteed income or full or partial guarantees on the longevity and investment risk (Donnelly and Young, 2017).

The operation of a pooled annuity fund, when there is only a single cohort, is described below. It assumes that the only benefit offered is a single life annuity. The inclusion of a joint life annuity was detailed in Donnelly and Zhang (2023) and an innovative death benefit in Bernhardt and Donnelly (2019) and Donnelly (2022).

It is assumed that the fund operates annually, with annual income payments to the participants and an annual crediting of investment returns and longevity credits to their pension savings. However, it could be done monthly, quarter-yearly or at some other regular interval.

3.1.1 The initial income

The level annual income expected to be paid to the initial group of participants over their future lifetime is calculated when they join. This is done by dividing their pension savings by the expected present value of a single life annuity paying £1 per annum annually in advance.

The first income payment paid out to the participants, called the 'initial income', is the result of the calculation. If everything turned out as expected then the survivors in the fund would receive the initial income for the remainder of their lifetime. However, as discussed below, this is unlikely to be the case and the income will vary from year to year.

The income payment made to the participants is deducted from their pension savings. The residual pension savings are then invested in line with a chosen investment strategy.

3.1.2 Longevity credit

At the end of the first year, the accumulated savings of those who have died are shared out among the survivors. In this case, since survivors have the same characteristics, they receive an equal share of the savings of those who have died.

This money, called a longevity credit, is added to the survivors' accumulated pension savings. The more deaths that have occurred, the more money that is shared out and hence the greater the longevity credit received by the survivors. Additionally, the investment returns achieved are added to the participants' pension savings.

3.1.3 Re-calculation of the income

Once the longevity credits and investment returns are received on the survivors' pension savings, the level annual income expected to be paid to the survivors from the end of the first year onwards is calculated. Once again, the result of the calculation is deducted from their pension savings and paid out to the survivors.

The calculation basis of the income payments is dynamic, being updated to reflect changes in the anticipated mortality distribution and investment returns. This means that if the survivors were anticipated to live longer than assumed at the outset, then the income payments would fall as the pension savings would need to last for a longer time. This is unlike a conventional life annuity, where the income payments never change.

Thus the income paid out to the survivors in the pooled annuity fund will vary from year to year for several reasons. It will vary with the accumulated pension savings, which change due to investment returns and deaths among the participants. It will also vary due to a changes in the predictions of both the mortality distribution and investment returns, which are reflected in annuity value used in the income calculation.

At the end of each subsequent year, the process is repeated. The residual pension savings of those who have died over the year are shared out among the survivors as a longevity credit. The income to be paid out to them is re-calculated, allowing for any changes in the calculation basis.

3.2 Similar operation for other pooled annuity funds

Although described for a single cohort fund, the operation is broadly the same for pooled annuity funds in which participants have different characteristics to one another or funds which are open to new members and so pool longevity risk across cohorts.

One difference is that the income calculated for each participant is based on the mortality distribution of that participant (i.e. an individualised approach). This means that members are

paid an income that is expected to be supported by their pension savings for the rest of their life, allowing for continued participation in the pooled annuity fund. As above, when investment returns and deaths do not occur as expected then the income will vary from year to year.

Another difference from the homogeneous single cohort fund is that the distribution of the savings of those who have died is not an 'equal share to each survivor' approach. Note that the longevity credit is paid to those who shared their longevity risk over the year and who survived to the end of the year. The longevity credit reflects the amount of each survivor's residual pension savings and their chance of mortality over the last year.

4 Number of participants to adequately pool longevity risk

One of the research strands undertaken in the project was to investigate how many participants are needed to adequately pool longevity risk and how this affects the income paid out to participants. Investment risk was deliberately excluded which means that annual investment return rates were held constant.

This was studied first in the context of a single cohort pooled annuity fund in the absence of systematic longevity risk when all initial participants are independent and identical copies of each other (Bernhardt and Donnelly, 2021a,b). The impact of a heterogeneous membership was studied in Donnelly (2022) and Donnelly (2023b). Systematic longevity risk was included in the model used in Donnelly (2022).

4.1 Research findings on number of participants

The overall conclusions in this research strand are that

- A pooled annuity fund should be kept open to new members, to improve longevity pooling (Donnelly, 2022). In general, the more people pooling longevity risk together, the more certainty about the amount and frequency of the longevity credits. Certainty is ideal when the goal is to pay a fairly constant income to participants.
- To have sufficient longevity pooling in an open fund:
  - When new entrants have very similar characteristics, such as they join at the same age with the same amount of money and face the same future distribution of deaths, then about 100 people are needed to join an open fund each year (Donnelly, 2022).
  - When new entrants have moderately different characteristics, then 150-200 people are needed to join an open fund each year. The more heterogeneous is the population of new entrants, the greater the number of participants needed to pool longevity risk (Donnelly, 2023b).
- To have sufficient longevity pooling in a single cohort fund:
  - When the members of the single cohort have very similar characteristics, such as they join at the same age with the same amount of money and face the same future distribution of deaths, then about 2 000 people are needed to join the fund (Bernhardt and Donnelly, 2021a,b).
  - When the members of the single cohort have moderately different characteristics, then 3 000-4 000 people are needed to join the single cohort. The more heterogeneous is the population of new entrants, the greater the number of participants needed to pool longevity risk (Donnelly, 2023b).

- At some point in a single cohort's lifetime, pooling fails. This occurs when there are too few survivors to pool longevity risk. The time at which this occurs depends on the mortality distribution of the participants. If the goal of the pooled annuity fund is to pay a fairly constant income to participants then risk management or risk removal is required for the longest-lived survivors; the consideration of the latter is outside the scope of the research programme.

In the next section, the explanation for why an open fund is preferred to a closed fund is given. The impact of systematic longevity risk is described in the following section.

4.2 Why an open fund improves longevity pooling

An open pooled annuity fund is one which is open to new members. Every year, new people can join and can pool their longevity risk with the existing members. In contrast, a closed fund no longer accepts new members. A simple example of a closed pooled annuity fund is the single cohort one.

Donnelly (2022) shows that pooling longevity risk matters most at older ages. In other words, it is important to have lots of people in the fund to allow older participants to adequately pool their longevity risk. If there are not enough people in the fund, then longevity credits become highly volatile for the older members, and consequently the income paid to them will become highly volatile too.

When participants are young, the gains from longevity credits are small and adequate pooling of longevity risk matters less. As they age, the longevity credits become an increasingly large part of the overall return on their pension savings. Pooling matters more as participants age because the longevity credits are proportional to the participants' chance of dying, which increases as the participants get older.

Consider first a single cohort fund which has just started. Suppose it has 3 000 members. Initially, there are many people in the fund with whom to pool longevity risk. The longevity credit received by each participant should be close to their expected longevity credit.

However, as time goes on, there are fewer members left alive. The longevity credit becomes increasingly volatile and the income paid to the survivors – assuming it is adjusted annually – also becomes increasingly volatile. At some point, there are not enough other people with whom to pool their longevity risk and pooling starts to fail. The time at which this occurs can be calculated using the results in Bernhardt and Donnelly (2021a).

The longevity credit becomes increasingly volatile for two reasons. It increases with the participant's chance of dying and it increases as the number of members goes down. With fewer and fewer survivors in the scheme, and the chance of dying increasing for those survivors, the increase is volatility is accelerated.

Consider another fund which has recently opened, and which accepts new entrants at their retirement time. Suppose that there is a steady flow of new entrants, of 200 per year. Initially, there are few people in the fund with whom to pool longevity risk. At this time, the expected longevity credit is small, as the chance of dying is small. The actual longevity credit received will fluctuate around the expected longevity credit, but with a relatively low volatility.

As new members join over time, there are more and more people in the fund. The number of new entrants outweighs the number of deaths until some membership steady state is reached. The oldest people in this open fund pool their longevity risk with many people. They do not need younger people *per se* to join, they just need more people to join the fund – of any age – so that

there are sufficient numbers with whom to adequately pool their longevity risk. They avoid the lack of pooling experienced by the longest-lived single cohort participants.

This is why an open fund is preferable to a closed fund. There is a natural increase in the volatility of the longevity credits as participants age. By having a flow of new members into the fund, this volatility is reduced compared to the closed fund.

In the next section, the impact of systematic longevity risk on the fund is described.

4.3 Systematic longevity risk

Systematic longevity risk is the risk that longevity risk has been mis-estimated. It is one of the two elements of longevity risk: systematic longevity risk and idiosyncratic longevity risk. Systematic longevity risk can not be eliminated by adding more people to the fund, unlike idiosyncratic longevity risk.

Systematic longevity risk manifests itself through the income payments being different to what was expected. Suppose participants live longer than expected, compared to the case that the chosen mortality distribution was correct. Their income would have been calculated assuming that they would die earlier than is actually the case. Thus they would be paid a higher income than if their longevity risk was correctly estimated. This means that their pension savings are depleted faster.

In turn, there is less money paid out as longevity credits to the survivors, since the pension savings released by deaths are smaller than they should have been. The pension savings of the survivors are increased by less and hence the income paid out to them declines.

How significant are these effects will depend on the extent to which longevity risk has been mis-estimated. As noted above, the income paid out to the participants is re-calculated every year with updated assumptions. This means that the income can be adjusted for changes in the estimations of longevity risk, to reduce the impact of longevity risk.

Systematic longevity risk was studied in Donnelly (2022), in the context of an open pooled annuity fund. It allows for the income to be adjusted for changes in the estimations of longevity risk. Recall that the initial income is the first income paid to a participant when they join the fund. In this fund, the income will change from year to year. As investment return rates are a constant 2% per annum in the study, there is no investment risk taken and so changes in the income arise solely from longevity risk. Further suppose that 100 people join the fund every year, joining at age 65 years old and bringing the same amount of pension savings of £100. With this number of joiners, idiosyncratic longevity risk is greatly reduced and so only systematic longevity risk remains as a significant risk while the fund remains open to new members.

Donnelly (2022) shows that, while the fund remains open, the income paid to a participant from age 65 years to age 90 years is unlikely to fall by more than 10% of the initial income (with a probability of 13% of falling by 10% or more) and highly unlikely to fall by more than 20% of the initial income (with a probability of 1% of falling by 10% or more). These probabilities of falling increase when the time period is extended by 5 years, to consider the income paid from age 65 years to age 95 years (probability of 20% of falling by 10% or more and probability of 2% of falling by 10% or more).

In the study done by Donnelly (2022), fluctuations in the income are caused by the updating of the annuity values used to calculate the income paid out. With this regular updating of assumptions, systematic longevity risk is spread among the current members and is not passed wholesale onto the next generations of members to join. Within the study, there is little inter-generational risk-sharing.

Indeed, the largest fluctuations in the study are on the last members to join the fund and, in particular, the longest-lived among them. For these members, there are not enough other people in the fund with whom to pool their longevity risk. It is idiosyncratic longevity risk which dominates for these last participants in the fund.

5 Joint life income

Another strand of the research on pooled annuity funds showed how to construct a joint life income, using the longevity credit approach (Donnelly and Zhang, 2023). On a practical note, the construction leads to a recommendation of member communication.

Suppose a participant chooses a joint life income of £5 000 per annum. This means that, while the participant survives, it is expected that £5 000 will be paid each year (of course, this amount will vary from year to year). If the participant dies and their partner is still alive, the payment continues at £5 000 per annum to the surviving partner.

The value of paying £5 000 per annum to a joint life is higher than paying £5 000 per annum to a single life. The reason is that the income on a joint life may continue to the partner, if the participant dies. This means that, if the participant dies and their partner survives them, some of their pension savings are given up to the other pooled annuity fund participants.

Thus the participant's pension savings would suffer a drop in value upon the death of the participant, to an amount that is just enough to pay a single life annuity to their surviving partner. It is likely that the surviving partner would be unhappy to see a drop in their pension savings, even though it is fully actuarially justified.

This leads to the recommendation that the benefits of joining the pooled annuity fund are expressed in terms of the income received and not in terms of the residual pension savings.

6 Income targets at older ages

The last part of the research on pooled annuity funds examined how to invest to meet a particular investment objective (Donnelly, 2023a). The goal was to have security of income at age 75 years, with the retiree willing to take investment risk between retiring at age 65 years and securing a lifetime income at age 75 years. The retiree joined a pooled annuity fund at age 65 years and stayed a member.

Using a quadratic loss function, it was shown that an optimal investment strategy exhibited two features. It took less investment risk, the closer the retiree was to age 75 years. It was also a dynamic investment strategy, taking more investment risk if it was further from meeting its objectives.

The optimal investment strategy outperformed both a constant proportion and a decreasing proportion investment strategy, within a simple investment model. The message is that participants in the fund may get a better outcome through a dynamic investment strategy, which is suitably risk-adjusted over their lifetime.

7 Conclusion

Pooled annuity funds offer a third option at retirement, between life annuities and income drawdown. They may be attractive for retirees for whom life annuities are too expensive yet income drawdown is too complicated and requires bearing too much risk.

The research programme has investigated some fundamental questions about pooled annuity funds. It has shown that the number of participants required to join such a fund can be numbered in the hundreds rather than thousands (Section 4.1). It is better to have a fund that is open to new members on a continuous basis. If the fund is closed to new members or run on a single cohort basis, then longevity pooling should be sufficient for many, many years. However, for the longest-lived survivors, longevity pooling will be insufficient and risk mitigation strategies should be put in place to avoid them having a highly volatile income stream.

The research programme has also proposed new design features. It has shown how a bequest feature could be added, by diverting some of the longevity credits to an account that is paid to the participant's estate upon their death (Bernhardt and Donnelly, 2019). It is shown in Donnelly (2022) how to calculate how much income to pay to the participants when they have the bequest feature, and that the number of participants required is the same as if the bequest feature was not present.

How to structure a joint life income has also been detailed (Donnelly and Zhang, 2023). The desire to offer a joint life income to participants leads to the benefits of the fund being expressed as an income rather than as the amount of pension savings attributed to each participant.

Finally, the choice of investment strategy is a highly important one, to offer a suitable product to retirees. The work in the programme on this topic suggests that a dynamic strategy, which adjusts its risk profile over time, may out-perform more standard strategies.

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