Research findings around inter-generational risk-sharing in a collective defined contribution pension scheme

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1 Introduction

Collective defined contribution (CDC) pension schemes are set to become a reality in the UK. As part of a research grant funded by the Institute and Faculty of Actuaries' Actuarial Research Centre, the inter-generational cross-subsidies in a CDC scheme whose design is similar to a defined benefit pension scheme were studied. Such a design is similar to one of the first such CDC schemes to be offered in the UK, the Royal Mail Collective Pension Plan. This latter plan is very important because it is in the vanguard of the CDC pension movement in the UK. It will, for some years, be regarded as a potential model for a UK CDC scheme.

The understanding of the inter-generational cross-subsidies gained from the research grant is set out here. The primary paper setting out the detailed analysis is Donnelly (2022a), with Barajas-Paz and Donnelly (2023) an important, foundational paper for the former. Here, an explanation of how the cross-subsidies arise and recommendations to reduce them, if that was deemed to be appropriate, are set out.

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

2 The studied CDC pension scheme

2.1 The scheme structure

The CDC pension scheme of interest in the project, looks much like a defined benefit pension scheme (Donnelly, 2022a). Contributions are paid at a constant rate of salary at all ages. The contributions are invested in line with a chosen investment strategy. Benefits are accrued as contributions are paid.

The only benefit payable in the studied scheme is a single-life annuity, payable from the retirement age. The benefit accrues annually at a constant fraction of each active member's salary, with each member's salary growing in line with a wage inflation index. In summary, the studied CDC pension scheme could, at first blush, be mistaken for a career-average revalued earnings defined benefit pension scheme.

However, the key difference of the CDC scheme from a defined benefit scheme is in the adjustment of benefits and contributions. In the CDC scheme, the contributions are a fixed percentage of members' salaries and do not change (at least, in the studied setting). The benefits are adjusted regularly so that the scheme's assets are sufficient to fund the benefits. In contrast, in a typical UK defined benefit scheme, the level of accrued benefits change in a known way, usually either in line with a price inflation index or with members' salaries to retirement. It is the contributions which are adjusted to ensure that there are sufficient assets to pay for the benefits.

In the particular CDC scheme studied, the regular adjustment to the benefits is done through the annual pension increases awarded on the accrued benefits. Their calculation are described in the next section. This design choice gives rise to inter-generational cross-subsidies both at each time – between younger and older scheme members - and across time, between generations. These are described below and possible ways of controlling the risk borne by each generation are suggested.

Another inter-generational cross-subsidy comes from the use of a constant rate of benefit accrual. However, this subsidy could be eliminated by using either an age-related benefit accrual or an age-related contribution rate.

2.2 Varying annual pension increases

The aim in the CDC pension scheme is to give price inflation increases on the accrued pension, both before and during retirement. For example, the contribution rate is

calculated by setting the valued annual pension increase equal to the expectation of future price inflation changes.

The key difference from a DB scheme lies in the pension increases awarded annually on accrued pensions. The annual pension increase is chosen to balance the value of assets - which can be observed from their market values – with the 'liabilities', which are valued as the expected value of the discounted projected accrued benefits. This means that the actual level of pension increases awarded may be higher or lower than price inflation.

In the studied scheme, the annual pension increase awarded each year is a constant (rather than being set to a future price inflation curve plus a constant). The constant changes from year to year. To calculate the liabilities at a particular valuation date, the accrued benefits of each member are projected to their payment time using a constant annual pension increase, allowing for the chance of the member to survive to the payment times. The same annual pension increase is used for all members at that valuation date. These projected cashflows are then discounted back to the valuation date, using a suitable set of discount factors, to value the liabilities.

The annual pension increase awarded in a particular year is the one that makes the value of the liabilities, i.e. the value of the discounted projected cashflows in the scheme where the projection factor is the annual pension increase, equal to the market value of assets. No allowance for over- or under-funding relative to a desired pension increase rate is made (the so-called 'funding gates') in this set-up.

3 Summary of the research findings

3.1 Notional gains and losses against predictions

The pension increases awarded from year to year will rise and fall with scheme experience. This is due to investment returns and mortality experience evolving differently to the assumptions in the contribution and valuation bases. For example, if investment returns are higher than anticipated in those bases, then the pension increases will also be higher than anticipated. This deviation of actual experience from the predicted one results in a series of notional gains (with negative gains representing losses) over time.

Thus the notional gains depend on the predicted experience. It means that the closer that the actual experience turns out to be as predicted, the smaller will be the notional gains. The specifications of the predicted bases - and the specifications will change over time as investment and mortality expectations evolve - matters since money is paid in and out of the scheme. This means that some of the notional gains

are crystallised over time.

For example, if investment returns turn out to be much higher than predicted, then the first generations to join the scheme would get a lower pension in retirement than the later generations to join. This is because the pension increases reflect both the past - the experienced higher investment returns - and the future - the predicted lower investment returns. For the first generations, the future weighs more heavily than the past. Their pension increases are calculated assuming lower investment returns and so they are awarded lower pension increases. Their contributions have not been invested long enough at the higher actual investment returns to compensate for the lower assumed returns. The smaller pension payments made to the first generations mean that more money is kept in the scheme for later generations.

The important point is that predictions of future experience will affect the benefits paid to different generations of members. Clearly, predictions of future experience will always be wrong. It is important to update predictions over time, to reflect the current best estimates of the future. Similarly, contribution rates should be regularly revised to reflect current predictions of the future experience.

The impact of experience not turning out as predicted should be quantified. The inherent risk should be quantified using a suitable of array of risk measures. Expected or median values are not sufficient as measures of risk. For example, an investment strategy with a a higher expected return is usually associated with a higher volatility of returns. Examining only expected returns would not be prudent. Additionally, the impact of experience differing from predictions should be considered for both current and future generations of members in the scheme. This is due to the future generations inheriting the cumulative notional gains of the preceding generations.

Related to this, Donnelly (2022b) shows that in a simple CDC setting that the higher the level of uncertainty about future experience assumed in a stochastic valuation model, the greater the disparity of income between generations. The earliest-joining generations receive less than the later-joining generations. However, this would have to be studied for a more realistic pension scheme to see if the effect is material.

3.2 Notional gains are spread over future lifetimes

The cumulative notional gain arising from the realised experience over the predicted experience is spread over the future lifetime of the scheme membership. The spreading is done through the annual pension increase rate. It manifests itself through the difference between what was expected to be awarded as pension increases and what is actually awarded.

Effectively, the annual pension increase rate is calculated over the average weighted

future lifetime of the scheme membership. Each member's notional liability reflects their own future lifetime in the scheme - through the projection of their current accrued benefit to retirement, allowing for a constant annual pension increase, and the discounting of that benefit to the valuation date. The individual members' liabilities are summed up to give the total scheme notional liability, expressed as a function of the constant annual pension increase rate. This function is equated to the total scheme market value of assets by choosing an appropriate pension increase rate. Thus all the members' lifetimes contribute to the calculated value of the pension increase rate.

The cumulative notional gain could vary a lot from year to year; for example, under a severe fall in the market value of assets. However, by spreading the cost over the lifetime of the scheme's members, members are shielded from any immediate impact of deviations of the scheme experience from that predicted. Consequently, through the spreading of the cost over a long time period, the annual pension increases should vary only by a small amount from year to year.

As an illustration, imagine the market value of assets falls suddenly by 10%. In the studied CDC scheme, this investment loss is amortised over the lifetime of the scheme's current membership, by decreasing the annual pension increase rate. Perhaps the pension increase rate was expected to be 3% per annum, just prior to the decline in the asset value. Afterwards, the pension increase may reduce to 2.5% per annum. Thus while the collective value of the assets has fallen by 10%, the members' accrued benefit is still increasing, albeit at a lower rate. The recognition of the majority of the decline in the asset value has been pushed into the future. The accrued benefit is expected to increase each year by 0.5% per annum less. However, if the market value of assets recover, then the pension increase should increase to back up to its previous level.

The average weighted lifetime of the scheme membership will change over time. This could be due to an ageing membership or where life expectancies are adjusted. In the case that the lifetime falls, there is a shorter time period over which to amortise the 10% investment gain. Consequently, the annual pension increase rate will rise as the lifetime falls.

3.3 Pension smoothing through lifetime spreading

Spreading notional gains over the future lifetime of the scheme membership means that the volatility due to scheme experience translates into a lower volatility in the accrued benefits. A benefit accrued in a particular year by a particular member will be granted a pension increase each year. This annual pension increase should not usually vary much over time, due to the spreading of gains over the scheme membership's lifetime.

This is the source of 'pension smoothing' effect, under which the accrued benefits increase steadily over each member's lifetime with only small fluctuations. Pension smoothing allows members to predict better their income in retirement. In turn, it allows them to plan better for their retirement so that they can make decisions in good time. For example, whether to continue working in retirement or to save more towards their retirement.

Note that the level of volatility in the accrued benefits depends on the age of the scheme members. For example, as a scheme moves from being a young scheme to a mature one, the membership becomes older. There is a shorter time until benefits are paid or until they cease being paid. In that case, the scheme's average weighted lifetime will gradually fall over time. In turn, this means that there is a shorter time period over which to amortise the notional gains. Consequently, the annual pension increase rate will become more volatile. This is because it must be larger in magnitude to spread the gains over the shorter lifetimes, compared to a scheme with a more youthful membership.

Looking at the development of the studied CDC pension scheme over time, a clear picture emerges (Donnelly, 2022a). The standard deviation of the accrued benefits increase steadily for each successive generation joining the scheme, as the scheme moves from being a new scheme to a mature scheme. As it matures, the average weighted lifetime decreases. When the scheme reaches maturity – a steady state in which new entrants balance with exits – the standard deviation is increasing only slightly (the standard deviation is not constant due to the cumulative notional gains passed from generation to generation, which is discussed below). When the scheme closes to new entrants, the standard deviation of the accrued benefits starts to climb steadily as the average weighted lifetime declines even further . It continues rising until the last generations exit the scheme. Overall, the standard deviation of the accrued benefits is lowest for the first generations to join and highest for the last generations to join. (The values are calculated at the inception time of the scheme, conditional only on the information available at the inception time.)

Alternatives to lifetime spreading

There are other ways of amortising the notional gains. They could be spread over an even longer time period, by including generations who have not yet joined the scheme. This is likely to result in even lower volatility in the annual pension increase rate awarded from year to year. However, it is unlikely to be appealing in an occupational pension scheme setting.

At another extreme, notional gains could be immediately recognised, by adjusting

the level of accrued benefits up or down accordingly. Such an approach means no pension smoothing and not much investment risk-sharing across generations (Barajas-Paz and Donnelly, 2023). Since the resultant scheme performs similarly to a defined contribution pension scheme, it is not attractive from a pension smoothing point of view.

A potential approach may be to spread notional gains over a fixed time period, for example 10 years. This should mean that the standard deviation of the accrued benefits would be fairly similar across the generations of members, who join the scheme at different times. WIth this approach, the amortisation period would be decoupled from the membership profile of the scheme. On the other hand, there may be more volatility in the accrued benefits compared to lifetime spreading. This would be the case when the fixed time period was shorter than the average weighted lifetime in the scheme, which would occur during the retirement period of the very last generations in the scheme.

3.4 Transferring risk from the old to the young

Awarding the same pension increase to current members of the scheme has another consequence. It results in investment risk-sharing at each point in time, between the younger and older members in the scheme. This is a one way transfer, from the older members to the younger members.

Awarding the same pension increase means that the younger members have a more volatile value of their accrued pension, and a more volatile projected pension. This is due to younger members having a longer time until their pension payments are made. Returning to the illustrative example of a 10% fall in the asset value, the pension increase rate might have dropped to only 2.8% if there were only young members in the scheme. In a scheme populated only by older members, the pension increase rate might have reduced to 2% reflecting their shorter future lifetime in the scheme and hence shorter time over which to amortize the fall in the asset value. By comparison, the pension increase rate calculated fell from 3% to 2.5%.

As those younger members age, the volatility reduces. This is an additional source of protection for older members against volatility in their accrued pension. It is another driver of pension smoothing in the CDC pension scheme.

The proposal to spread notional gains over a fixed time period would impact on the level of volatility experienced by the members in the scheme. Sharing more of the notional gains in each year, would increase the volatility of the accrued benefits. In turn, this would increase the volatility of the younger members' benefits. The impact of this increased volatility should be considered carefully, particularly in schemes from

which a high proportion of members withdraw at relatively young ages.

3.5 Inter-generational risk-sharing

Now turn to risk-sharing across generations of members who join at different times and whose scheme membership may not even overlap. Risk-sharing across time requires that notional gains are not immediately recognised and paid for by the generation under whom they arise. This certainly happens by spreading the gains over the scheme's lifetime. It means that a newly joining generation inherits the cumulative notional gains of past and existing scheme members. In turn, the new generation bears some of the financial consequences of their predecessors. They pass the rest onto the next generation.

Over time, this means that there is a wide range of possible benefit payments to members, with the range increasing as the scheme becomes older. It explains why the standard deviation of the accrued benefit continues to rise over time. It contributes to the slightly increasing standard deviation observed even when the scheme is in a steady-state, with new entrants balancing against exits (Donnelly, 2022a).

The time period over which notional gains are amortised is important. It determines how much of the gains is borne by the generation under whom it emerged, and how much is passed onto later generations. The longer the time period, the more that is passed on.

For the last generations in the scheme, there is no incoming generation to whom they can pass the notional gains. Instead, they bear the cumulative notional gains on their own. These residual gains are amortised over a continually decreasing lifetime as the scheme membership ages and no new members join. This results in the standard deviation of the accrued benefit steeply increasing over time, for these last generations.

Controlling the level of investment risk-sharing

Shortening the time period over which notional gains are amortised would reduce the build-up of risk in the scheme over time. It would mean that more of the notional gains are borne by the generations under whom the gains arose. In the studied CDC scheme, the amortisation period is the average weighted lifetime of the scheme membership. In general, the average weighted lifetime should reduce over time as the scheme membership ages. In turn, this leads to increasing risk borne by successive generations in the scheme due to (i) notional gains being amortised over an increasingly shorter time period; (ii) the cumulative notional gains arising from previous generations being passed on to the last generations. The cumulative gains are also amortised over the

shortening lifetime.

It is difficult to see a design choice within the studied CDC scheme structure that avoids *any* build-up of risk over time. In an inter-generational risk-sharing pension scheme, risk is by definition passed on to new generations joining the scheme. It is the *quid pro quo* for pension smoothing while retaining the ability to take investment risk.

Accepting that transferring risk from generation to generation is an integral part of the studied scheme, then a criticism is that the amount of risk passed on is not controlled. This matters since each successive generation bears more and more risk, in terms of a greater range of possible outcomes.

In theory, there is no limit on how much notional gain can be passed on (recalling that a negative gain is a loss) in this scheme. This is because there is no ring-fenced buffer account, where a buffer account is a collectively owned account. In some risk-sharing schemes, members maintain their own accounts and then have access to a buffer account. They contribute to or withdraw from the buffer account according to the actual experience.

Instead, in the studied CDC pension scheme, the entire scheme asset value is collectively owned. Current members have a claim on a known share of the scheme's assets, at each point in time, as expressed through the value of their notional liability relative to the other scheme members. There is no minimum guarantee on the amount of pension and there are no ring-fenced pension savings for each individual.

One suggestion would be set risk targets or risk budgets, which would consider the distribution of the pensions paid to both current and future members of the scheme. These pension levels could be summarised via the projected funding level. The risk targets should include a measurement of risk, with a simple example being the standard deviation of the funding level. The risk measure should be projected over time, to capture the risk faced by current and future generations in the scheme. Some quantification of risk is required, over and above the current funding level. For example, the current funding level doesn't take into account the variable outcomes possible under the current investment strategy.

Once the risk appetite is determined across the different generations in the scheme, an appropriate, dynamic investment strategy would be the primary means of achieving it. Ideally, this would avoid passing on excessive levels of notional gains to later generations to join the scheme.

3.6 Subsidies to the first generations to join

The last cross-subsidy identified in Donnelly (2022a) is due to a constant rate of benefit accrual. The latter is financially fair on a lifetime basis in a defined benefit scheme:

the expected present value of the lifetime contributions equals the expected present value of the lifetime benefits. However, it is not financially fair on an accrued basis: the expected present value of a single contribution is not equal to the expected present value of the corresponding accrued benefit. This is because the constant contribution rate is an average rate, which is expected to be sufficient to cover the value of the benefits over the lifetime of the member. However, it is too high at younger ages and too low at older ages compared to the value of the benefits accrued by each contribution considered in isolation.

The lack of financial fairness on an accrued basis causes an anomaly due to the annual pension increase calculation. Consider the first members in the scheme, when they are no existing assets. If these members are young, then the contributions paid are generally too high relative to the value of the accrued benefits. At the end of the first year, the first annual pension increase is unexpectedly high as it tries to raise the value of the accrued benefits to the value of the accumulated contributions.

This gives rise to a subsidy for the first-joining members in the scheme, assuming that the first-joining members are – on average – sufficiently young. The subsidy is paid for by the later-joining members. It means that, even if all assumptions are borne out in practice, the first generations end up with a higher pension than expected. Correspondingly, the later generations end up paying for it and themselves get a lower pension than expected. The reverse could happen if a sufficiently old membership were the first joiners to the scheme.

If this effect was considered undesirable, then it could be mitigated by using either an age-related contribution rate or an age-related benefit accrual. It is likely that the age-related benefit accrual would be the more attractive option, where members contiue to pay contributions at a constant rate of salary but accrue a larger proportion of their benefits at younger ages.

4 Conclusion

There are several inter-generational cross-subsidies arising in the studied CDC scheme which have been identified by the research undertaken (Barajas-Paz and Donnelly, 2023; Donnelly, 2022a). These are:

- Risk sharing across time, among different generations of the scheme membership. This is a consequence of notional gains and losses being spread over the future lifetime of the current scheme membership.
- Cross-subsidy at each point in time, transferred to the current generation of

younger members from the current generation of older members.

- Cross-subsidy from the first generations in the scheme to the later generations. If the first generations are relatively young, then they will be subsidised by the later generations. If they are relatively old, then the first generations provide a subsidy to the later generations. This cross-subsidy can be mitigated through an age-related contribution rate or age-related benefit accrual.

These highlight that the risks faced by each generation in the scheme are not the same, in terms of what their eventual pension payments will be. It can be seen in Donnelly (2022a) that the risk faced by each successive generation in the scheme increases over time, where risk is measured in terms of their standard deviation of pension payments at retirement.

It is suggested that spreading notional gains and losses over a fixed time period may help to equalise the risk faced by each generation. This would come at the cost of the pension becoming more volatile. Therefore, it should be considered what is the desired trade-off between risk and pension smoothing.

Setting a risk budget or risk target should be considered. Risk is passed from the current generations to the future ones - it is not possible to share it with past generations. Consequently, risk will continue to grow with each successive generation. For this reason, the risk passed on should be measured and controlled, to reduce the chance that later generations bear excessive amounts of risk.

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