Thought Pieces with The Conexus Institute

How to Approach Quantitative Assessment of Retirement Income Strategies

22 June 2023[1]

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Introduction

A previous Conexus Institute article by Bell and Warren (2022)[2] discussed how retirement income strategies (RIS) offered by superannuation funds might be assessed. It proposed combining a *qualitative checklist* to assess the range of activities that trustees should be undertaking to deliver good member outcomes with *quantitative modelling* where potential outcomes are simulated and evaluated against objectives. Both approaches are necessarily ex ante in nature, and aim to assess the effectiveness by which superannuation fund trustees are assisting retired members to achieve their retirement goals looking forward. This follow-up article outlines how the quantitative assessment may be undertaken, supported by illustrative examples to demonstrate the modelling and its use. We write primarily for trustees and management of superannuation funds, consultants and research houses about how they might assess RIS[3], and not about how RIS

[1] We thank the following for their comments and suggestions: Louise Aracas, Anthony Asher, Shawn Blackmore, Andrew Boal, Danielle Bose, Annika Bradley, Nick Callil, Patrick Clarke, Benedict Davies, Colin Grenfell, Matthew Griffith, David Haynes, Alex Harrison, Jim Hennington. Sam Higgie, Damian Hill, Brad Holzberger, Victor Huang, Stephen Huppert, Ashton Jones, Andrew Long, Ian Lorimer, Scott Manson, Aaron Minney, Joey Moloney, Ruvinda Nanayakkara, Aidan Nguyen, Anthony Saliba, Jon Sedawie, Giacomo Tarantolo, Fintan Thornton, and Nicholas Wilkinson.

[2] "Assessing retirement income strategies… when outcomes are but a promise", found at: https://theconexusinstitute.org.au/wp-content/uploads/2022/12/Assessing-retirement-strategies-Final-20221202-Updated.pdf.

[3] Product providers might also find the modelling approach of interest.

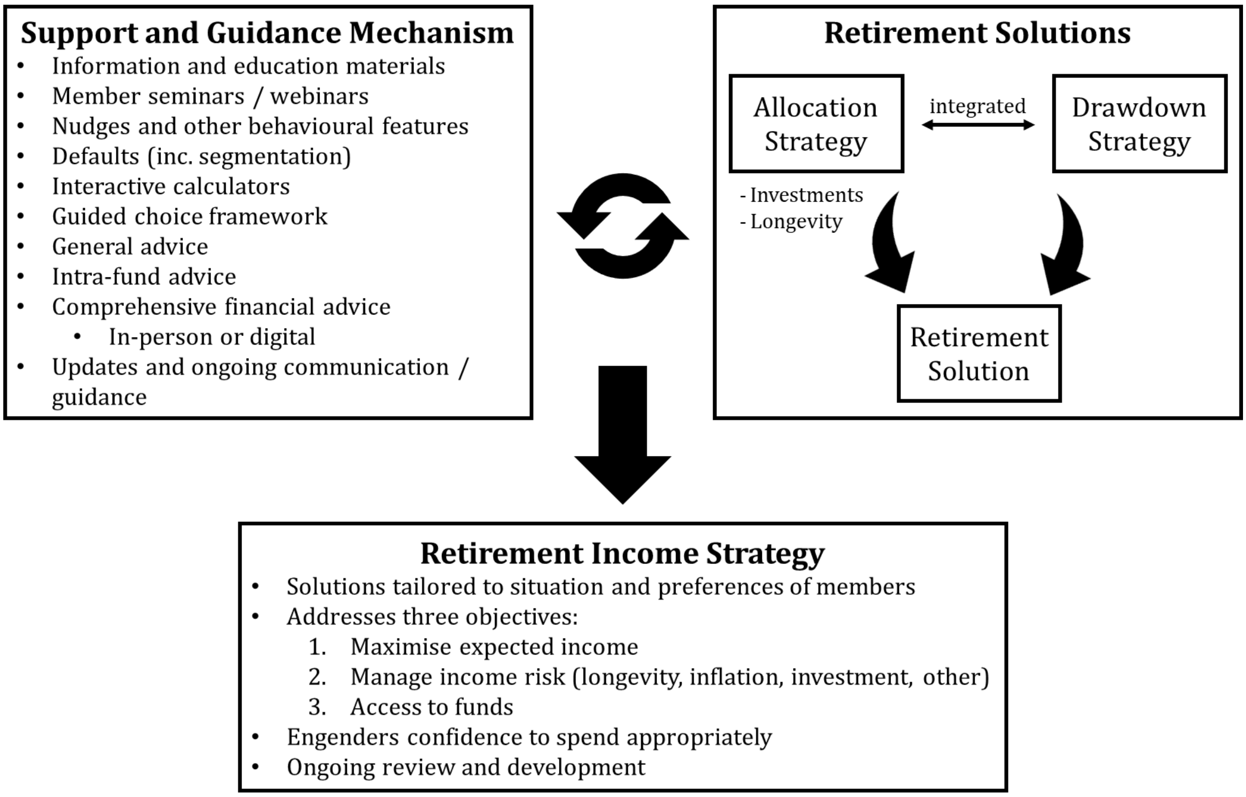
outcomes may be communicated to members[4]. We aim to demonstrate the process rather than recommend particular modelling approaches or retirement solutions.

Our focus is use of quantitative models to assess *retirement solutions* – the financial mechanism through which retirement income is generated by allocating and then drawing down on available assets. We propose three assessment mechanisms: metrics, charts and a summary scorecard. We show how these tools can be used to not only *assess* solutions, but also *understand* the type of outcomes that are delivered and *compare solutions* to assist in design and development. We illustrate how simulated outcomes arising from the modelling can be presented and used, but do not delve into how the outcomes are generated. For readers interested in more technical detail, we refer to the "Primer on Retirement Income Strategy Design and Evaluation" (Butt et al, 2023)[5] co-written by two of the current authors (Khemka and Warren) for the US Society of Actuaries.

Where quantitative modelling fits into RIS assessment

Figure 1 is taken from Bell and Warren (2022). It depicts the two core functional components of RIS – support and guidance mechanisms (left box) and retirement solutions (right box). Quantitative modelling is largely aimed at assessing the solutions under which income streams are generated, which arise from allocating available assets to direct investments and longevity solutions coupled with a drawdown strategy that determines the amount and shape of income extracted over time. Quantitative modelling hence only supports assessment of solutions (i.e. right side of Figure 1), albeit important given that income generation is the primary purpose of any RIS.

Figure 1: Framing key aspects of RIS



[4] The Treasury has investigated and proposed standardised approaches for communicating retirement income strategies to members. The consultation paper is found at: https://treasury.gov.au/sites/default/files/2019-03/181207-FINAL-Retirement-Income-Disclosure-Consultation-Paper.pdf

[5] Primer on Retirement Income Strategy Design and Evaluation | SOA.

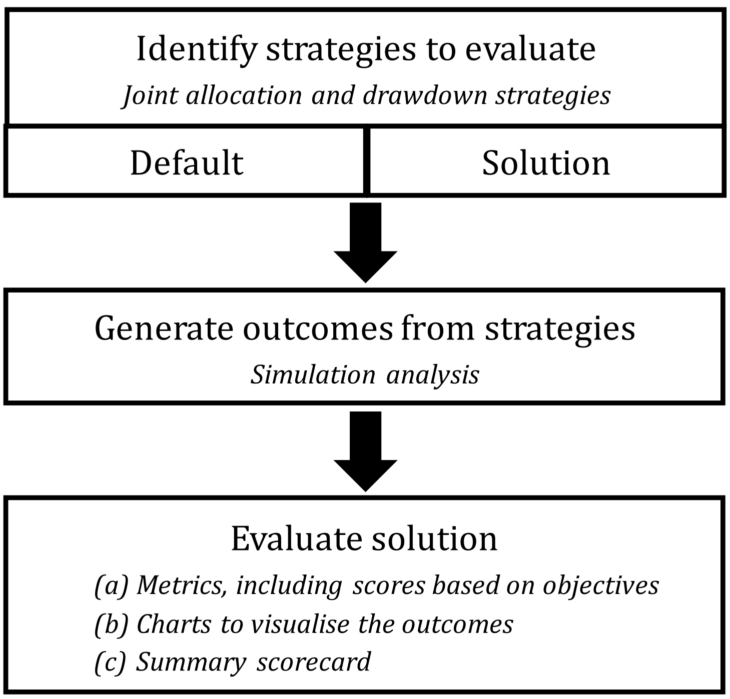
Quantitative modelling enhances RIS assessment through exploring the link between a solution and member financial outcomes in a transparent manner[6]. However, the shortcomings of quantitative modelling also need to be acknowledged. These are outlined in Bell and Warren (2022, see footnote 5 in particular). Basically, the shortcomings boil down to the fact that all models embed assumptions and no model is the source of all truth. Models are imperfect tools, and should be applied carefully including giving consideration to the impact of different assumptions. We briefly touch on addressing the shortcomings of quantitative models in a later section on 'robustness'. We also emphasise the importance of combining quantitative modelling with a checklist approach, noting a checklist can address elements that cannot be captured in quantitative models and hence facilitate a comprehensive assessment.

Recap on quantitative modelling for RIS assessment

Bell and Warren (2022) envisaged that the quantitative modelling component would involve assessing simulated outcomes from retirement solutions against assumed objectives for some 'test' member to which the solution might be offered[7]. For instance, the test member could be a representative member for a particular cohort. Assessment of individual solutions might be aggregated into an overall fund level assessment, although we do not address this issue here.

Figure 2 is updated from Bell and Warren (2022), and outlines the ex ante assessment of a retirement solution. The process involves first specifying two strategies (default and the solution), each comprising a joint allocation and drawdown strategy. The default provides a baseline for assessment that might reflect existing practice, e.g. an account-based pension applying minimum drawdown rules. Simulated outcomes are represented by a series of potential retirement income 'paths' under a solution, including Age Pension entitlements.

Figure 2: Quantitative assessment of a retirement solution for a test member



[6] Quantitative modelling could also assist fund trustees with their Strategic Planning and Member Outcomes Assessment under APRA Prudential Standard SPS 515.

[7] The solution should be one that the test member is reasonably likely to be directed to, whether offered by trustees as a comprehensive strategy, or arising under guidance where the member receives a recommendation from (say) a calculator or under advice on how to combine available products and drawdowns.

Simulated outcomes can be evaluated against objectives using three methods:

(i) ***Metrics*** – Metrics should be tailored to objectives (discussed below), and would ideally include an overall 'score' to help gauge the expected benefit a solution delivers over the default (or alternative solutions) based on applying an 'objective function'. The objective function might be a utility function, or selected metrics with a mechanism to trade-off expected income against income risk[8] and perhaps access to funds.

(ii) ***Charts*** – These visualise the distribution of outcomes that a solution delivers.

(iii) ***Summary scorecard*** – This is a high-level overview to convey how effectively a solution addresses the three objectives under the Retirement Income Covenant (RIC) of maximising expected income, managing income risk and providing flexible access to funds.

Bell and Warren (2022) suggest that a useful extension could be to consider an 'optimal' strategy as a point of reference, acknowledging that this strategy would only be optimal under the quantitative model and might be unattainable or undesirable in practice. Optimisation should be used with care, mostly likely to inform retirement solution design while allowing for other considerations such as cost, feasibility, member acceptance, and so on. Quantitative modelling is best viewed as a tool for *conveying potential outcomes* that solutions deliver and for *comparing candidate or 'proposed' solutions* than using it to determine solution design.

Illustrating the quantitative approach: The set-up

To illustrate the use of quantitative modelling, we create two case studies that consider two income objectives – 'income optimisation' and 'income target'. Three candidate retirement solutions are constructed for each case study. Case Study 1 covering income optimisation is presented in the main body; while Case Study 2 covering income target appears in Appendix 2. Presenting two objectives illustrates how measures should be tailored to the assumed objective, i.e. there is no single universal toolkit of measures that should be applied in all circumstances. It also highlights the centrality of assumed objectives to solution design, outcomes and assessment.

We emphasise that the modelling approach presented is constructed to *illustrate the process* of modelling and assessment, and should not be received as a recommendation. There is scope to vary the objectives, modelling methods, input assumptions, measures and presentation. The example solutions, including assumed product features, have been purposefully designed to create points of contrast, including an intentional design flaw in one solution (solution E, see Appendix 2). The solutions as presented should not be taken as suggestions to adopt in practice[9].

Objectives

Assessments should evaluate the degree to which objectives are being achieved, or otherwise. To this end, we consider income and income risk through the lens of the two income objectives while assuming some flexible access to funds (the third objective stated in the RIC) is also desired in both cases. Below is a summary of the key elements of the income target and income optimisation objectives, and how they may relate to the appropriate type of income stream and the metrics required for an assessment. Both objectives are explained in more detail in Butt et al (2023):

- ***Income optimisation*** – This objective assumes that the member desires to maximise the income that is expected to be extracted from their available assets, while managing income risk. The drawdown strategy might entail drawing a variable amount that is 'affordable' given age

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[8] The Australian Government Actuary has proposed a retirement risk metric, see: https://treasury.gov.au/sites/default/files/2019-03/Retirement-Income-Risk-Measure-FINAL-Consultation-1.pdf.
[9] We would expect that solutions offered in practice would be more carefully designed, and take into account considerations such as feasibility of implementation, cost, likely acceptance by members, etc.

and balance, and could be specified as a percentage of balance that varies with age. The minimum drawdown rules broadly align with this objective (although arguably lead to drawing less than an affordable amount), as do the breed of investment-linked annuities (ILAs) now available in the market[10]. Under this objective, the entire distribution of income over time is of interest, and is arguably best portrayed by income percentiles spanning various ages. A power (i.e. risk aversion) utility function as per MDUF[11] might be applied.

- ***Income target*** – This objective assumes that a member desires to sustain some target level of income[12] for as long as they remain alive. It aligns with replacement rates and income standards (e.g. as provided by ASFA and Super Consumers Australia). The baseline drawdown strategy involves drawing enough income from the retirement account to attain the target each period[13]. Risk relates to exhaustion of the balance, in which case income declines to a level underpinned by any guaranteed income streams such as the Age Pension and supplements or lifetime income streams (annuities) that were purchased. Metrics for this objective should communicate the likelihood of sustaining the target to various ages, as well as the decline in income that occurs once the accessible balance is exhausted. A reference dependent (i.e. loss aversion) utility function should be applied, such as proposed under prospect theory.

It is up to trustees to consider what objectives are appropriate for different members. We present just two possible objectives[14], noting that during consultation we observed the use of both. In any event, it may not suffice to apply one single objective across all members, who can vary substantially in the type of income streams they desire.

Finally, analysis of income alone ignores the value that members may place on ***flexible access to funds***, which could arise from a desire for precautionary savings, maintain the ability to respond to changing circumstances and/or perhaps bequest motives[15]. Assessment should hence involve examination of metrics that communicate flexible access to funds, whether it be via the balance remaining in the account-based pension (ABP) or possibly the capacity to extract some capital from a lifetime income product[16]. The metrics should capture how available funds evolve over time, noting that flexible access to funds is also valuable at older ages.

Assessment tools

We present the output under the case studies using a toolkit of measures that illustrates the three assessment methods previously outlined. We anticipate others may apply these assessment methods in their own unique way.

1. ***Table of metrics*** – The table presents metrics designed to provide a high level summary of the main outcomes, including income metrics, remaining balance and a utility-based metric. The latter is denoted 'risk-adjusted income' (RAI), and acts as an overall score for the income being

[10] ILAs are offered by AMP North, Australian Retirement Trust (QSuper), Challenger and Generation Life.
[11] See https://theconexusinstitute.org.au/resources/members-default-utility-function-mduf/.
[12] The target need not be static over time. For instance, it could decline through retirement to recognise lower spending needs at older ages.
[13] The question also arises whether the target might be adjustable under certain circumstances. For instance, downwards to help manage the risk of account exhaustion after a run of poor investment returns; or upwards if available assets well-exceed that needed to sustain the target.
[14] Butt et al (2023) also refers to an 'income floor' objective. This objective might be satisfied by the safety net provided by the Age Pension and various other forms of government support for many Australian retirees. Another possible 'hybrid' objective might be to treat non-discretionary spending as a target to be secured if at all possible and non-discretionary spending as an aspirational goal to be optimised.
[15] Under the assumptions adopted for both case studies, the balance profile proxies for the bequest profile.
[16] We note the role of other assets, including any home equity, in providing access to funds. This is outside the scope of the case studies in this article, but something trustees and researchers should consider.

delivered. RAI reflects the certain (real) income stream that delivers the same utility as the stochastic income stream delivered by the strategy (i.e. it is a certainty equivalent).

2. ***Charts*** – We use two types of charts. *Income layer charts* convey the 'typical' outcome by plotting the composition of median income over the course of retirement, i.e. where income is being sourced. These charts also show median balance to inform the extent to which the solution might deliver flexible access to funds over time. *Income percentile charts* show the distribution of expected income over the full course of retirement[17]. They reveal the downside risk and upside potential in income for each age. It should be borne in mind that the lines on the percentile charts just provide an indication of potential range, and do not represent discrete income paths in themselves, which can be quite variable over time.

3. ***Summary scorecard*** – The scorecard provides a high-level overview to reveal how effectively a solution addresses the three objectives under the RIC. We apply a five-point scale to each RIC objective, and also report RAI as an overarching summary metric accounting for expected income and income risk. While the table and charts provide important detail, a scorecard may be useful for communication purposes, e.g. presentation to senior management or trustees. The weakness of the scorecard is the use of subjective scores that are attempting to balance a range of considerations, such as trading off income variability across any point in time against variability over time[18].

The three methods should be considered in unison to fully assess the suitability of a solution. For instance, the utility-based metric of RAI provides an overall score based on income only[19], and hence glosses over flexible access to funds. Utilising a broader range of metrics and charts fosters a deeper understanding of the type of outcomes that a solution might deliver, including revealing any sources of risk and any evident flaws that may make it unfit for purpose.

Case Study 1 – Income optimisation objective

This section presents the results of the income optimisation analysis, highlighting the relative merits and shortcomings of each solution as emerges from the modelling (bearing in mind the solutions are illustrative examples constructed for contrast). The following section discusses how the modelling might be used in RIS assessment and solution design.

Assumptions

Table 1 sets out the key assumptions for three notional solutions under the income optimisation objective. Appendix 1 contains further information on modelling assumptions, which include that the member is an individual who retires at age 67 with no meaningful assets outside of their superannuation fund. Default solution A reflects the strategy used by many members of investing in an ABP assuming 60/40 weights (i.e. 60% growth, 40% defensive)[20] while following the minimum drawdown rules (MDR). The two proposed solutions incorporate longevity protection by giving access to 'mortality credits'[21], and apply more efficient drawdown rules to boost the extent to which available assets are converted into income. Solution B purchases a life annuity (LA) that delivers $10,000 per annum of (real) guaranteed income absorbing 42% of the balance

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[17] We use percentiles extracted from a series of simulated paths at each age.
[18] For instance, it is unclear that a solution that delivers more variable income year-to-year but supplies a greater chance of avoiding lower income at older ages carries more or less income risk than a solution doing the reverse.
[19] The utility-based metrics also apply survival weightings, such that income occurring later in retirement is down-weighted as being less likely to occur. Butt et al (2023) contains a discussion of the treatment of horizon and the implications, noting that the alternative to survival weighting is modelling over a specific horizon.
[20] The Retirement Income Review of 2020 applied a 58/42 growth/defensive mix in modelling as representative of the typical weighting held by retirees (see page 516 of the Review).
[21] This might be achieved either through pooling members or purchasing from an insurance company.

at retirement. This limits downside in income in conjunction with the Age Pension and supplements. Solution C applies 50% of the balance at retirement to the purchase of an ILA invested in a 60/40 portfolio. For simplicity, we assume that no access to capital is provided through any of the lifetime income streams considered in our case studies.

Under the proposed solutions B and C, the ABP drawdown is based on taking a percentage of the balance as a function of life expectancy and the expected return on the portfolio. This rule is also applied in determining the income that is distributed under the ILA, and broadly reflects the approach used in ILAs that have recently emerged in the market[22].

Table 1: Solutions modelled under Case Study 1 (income optimisation objective)

Solution	A *Default*	B *Proposed*	C *Proposed*
Allocation strategy	ABP 60/40	• LA purchased to secure $10,000 real income • ABP 60/40 remainder	• 50% ILA • 50% ABP • Both 60/40
Drawdown strategy (for ABP)	Minimum drawdown rules	'Affordable' drawdown with reference to expected return and life expectancy given age	

Legend: ABP = account-based pension; LA = life annuity (indexed, i.e. real); ILA = investment-linked annuity

Analysis

Given that income optimisation entails maximising expected income while managing income risk, the choice of metrics aims to convey the level and variability of income over the course of retirement. (By contrast, the focus under an income target objective is the risk of account exhaustion, and how far income falls if it occurs.) Income percentiles across the age range as appearing in Figure 4 below are our main point of emphasis as the most effective way of summarising the entire income distribution. Here median income provides an indication of the typical level of income that might be delivered, while the income levels seen in the lower tail of the distribution reveal income risk and how it evolves with age. Table 2 and Figure 3 broaden out the range of summary metrics by presenting expected income, median income and its layers, guaranteed (i.e. minimum) income, utility in terms of RAI, and median balance.

Table 2 reveals that both expected income and RAI are greater for solution B than the default solution A, and larger yet again for solution C. Median incomes at selected 5-year age gaps are consistently higher for solution C than solution B; and are either above or close to that delivered by default solution A. Further, median income is much more consistent over time for the proposed solutions relative to the default solution A, which reflects the application of an 'affordable' drawdown strategy in place of the MDR used in the default. Solution B generates the highest guaranteed income due to presence of the LA, whereas for guaranteed income for solution A and solution C arises solely from the Age Pension plus supplements. On the other hand, the median balances suggest that default solution A provides the greatest access to funds, although the two proposed solutions still provide reasonable access to funds up until age 90-95.

[22] The drawdown calculations for ILAs vary, with the reference return a key point of differentiation that impacts on the time-pattern of expected income. We refer to the expected return on the assets for simplicity.

Table 2: Metrics for Case Study 1 (Income optimisation solutions)

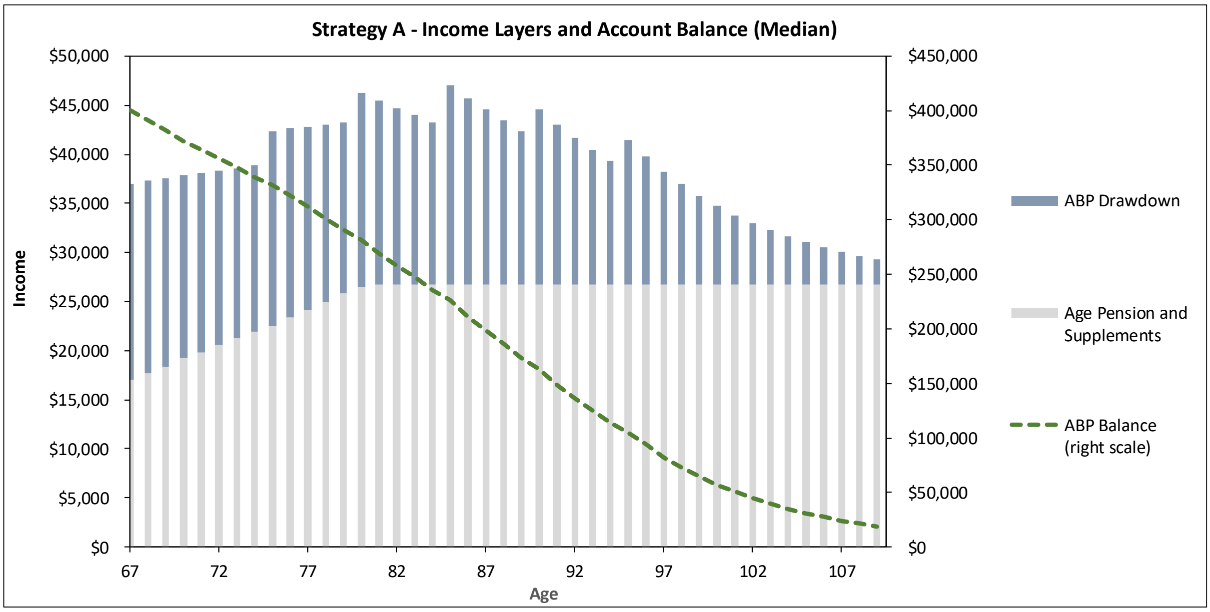
	Strategy A *(Baseline)*	Strategy B	Strategy C
Assumptions About Retiree			
Savings at Retirement (age 65)	$400,000	$400,000	$400,000
Allocation of Savings at Retirement			
Life Annuity (LA), Indexed	-	$169,097 (42%)	-
Investment-Linked Annuity (ILA)	-	-	$200,000 (50%)
Account Based Pension (ABP)	$400,000 (100%)	$230,903 (58%)	$200,000 (50%)
Total	$400,000 (100%)	$400,000 (100%)	$400,000 (100%)
Growth Weighting in ILA			60%
Growth Weighting in ABP	60%	60%	60%
Income streams:			
Age Pension and Supplements	Part-pension initally	Part-pension initally	Close to full pension
Lifetime income stream - LA		$10,000	
Lifetime income stream - ILA, First Year			$14,074
Primary Metrics			
Expected Income#	$40,618	$47,128	$49,626
Guaranteeed Income (Age Pension & Supp. + LA)	$26,689	$36,139	$26,689
Risk-Adjusted Income (Utility-based Metric)#	$39,591	$45,250	$47,637
Median Income			
Age 70 *(Survival probability 96%)*	$36,980	$46,914	$51,270
Age 75 *(Survival probability 87%)*	$37,829	$49,391	$51,008
Age 80 *(Survival probability 74%)*	$41,757	$50,294	$50,317
Age 85 *(Survival probability 54%)*	$44,726	$48,071	$48,949
Age 90 *(Survival probability 30%)*	$47,051	$43,703	$46,569
Age 95 *(Survival probability 11%)*	$44,599	$38,368	$43,242
Age 100 *(Survival probability 3%)*	$41,446	$34,177	$40,675
Age 105 *(Survival probability 0.3%)*	$34,719	$32,260	$39,516
Median Balance in ABP			
Age 70 *(Survival probability 96%)*	$372,396	$273,030	$173,104
Age 75 *(Survival probability 87%)*	$332,246	$202,354	$128,295
Age 80 *(Survival probability 74%)*	$281,235	$133,566	$84,682
Age 85 *(Survival probability 54%)*	$226,248	$73,635	$46,685
Age 90 *(Survival probability 30%)*	$162,820	$30,666	$19,443
Age 95 *(Survival probability 11%)*	$105,410	$8,880	$5,630
Age 100 *(Survival probability 3%)*	$57,358	$1,632	$1,035
Age 105 *(Survival probability 0.3%)*	$31,127	$169	$107

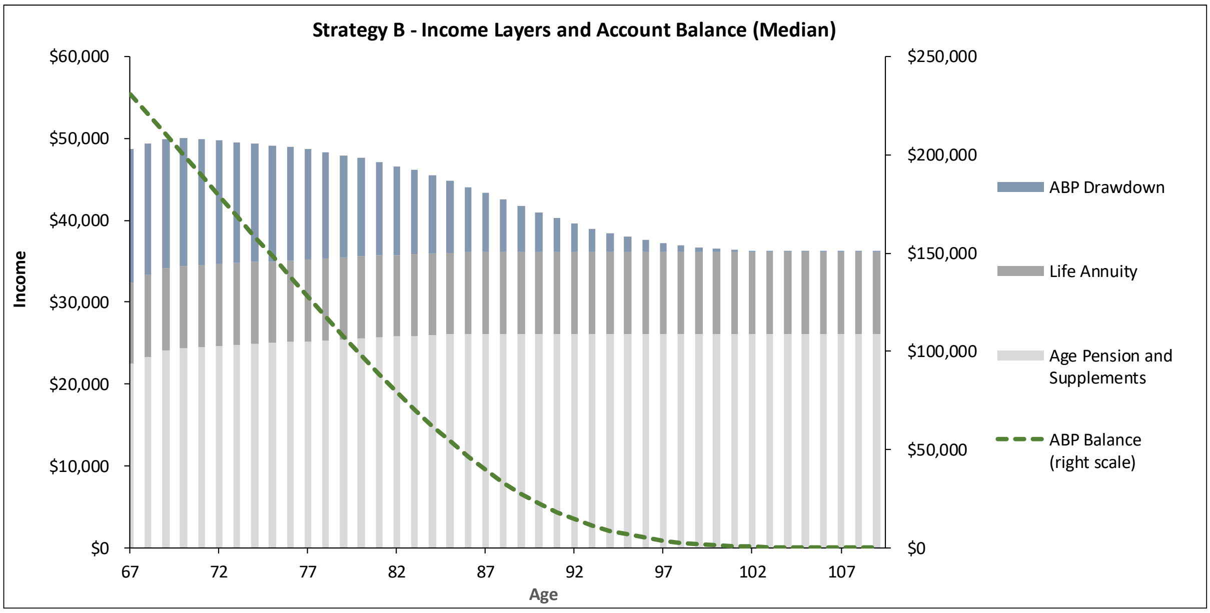
 # Weighted by probability of survival. Use median income as a guide to the central level of income expected at each age.

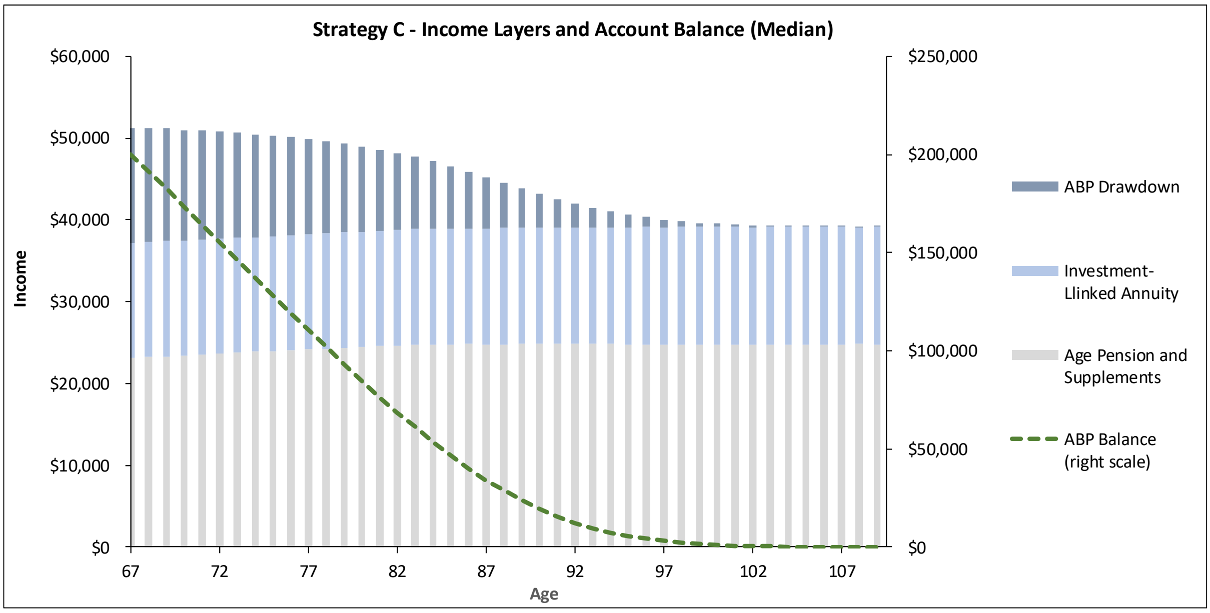
The income layer charts in Figure 3 highlight the relative attractiveness of the income profile of solution C versus the other solutions. Default solution A delivers a hump-shaped and jagged income profile while tending to retain a relatively high balance well into retirement, reflecting the inefficient nature of the MDR. Solution B delivers some degree of income smoothing relative to the default solution A, but not as much as solution C. The latter is able to generate a relatively attractive median income profile as a consequence of combining ongoing investment in growth assets via a 60/40 portfolio with a meaningful amount of mortality credits (given the higher allocation to longevity protection than solution B) and a more efficient drawdown strategy.

The income percentile charts in Figure 4 reveal a fuller picture that confirms the relative attraction of solution C. Figure 4 shows that solution C delivers the widest range of income outcomes, but still performs comparably in the lower tail of the income distribution while offering a better prospect of much higher income. Thus it provides greater expected income with only a moderate increase in income risk versus solution B as captured by the magnitude of downside to income appearing in the lower tail. There are two caveats on the attractiveness of solution C. First, it might be unsuitable for a member with high aversion to volatility of income over time, although it is still arguably superior to default solution A on this front. Second, a solution that offers a higher level of guaranteed income might be more suitable for retirees who are not willing to take any chance that income might fall towards that supported by the Age Pension and supplements.

Figure 3: Income layers for Case Study 1 (Income optimisation solutions)







<u>Figure 4</u>: Income percentiles for Case Study 1 (Income optimisation solutions)

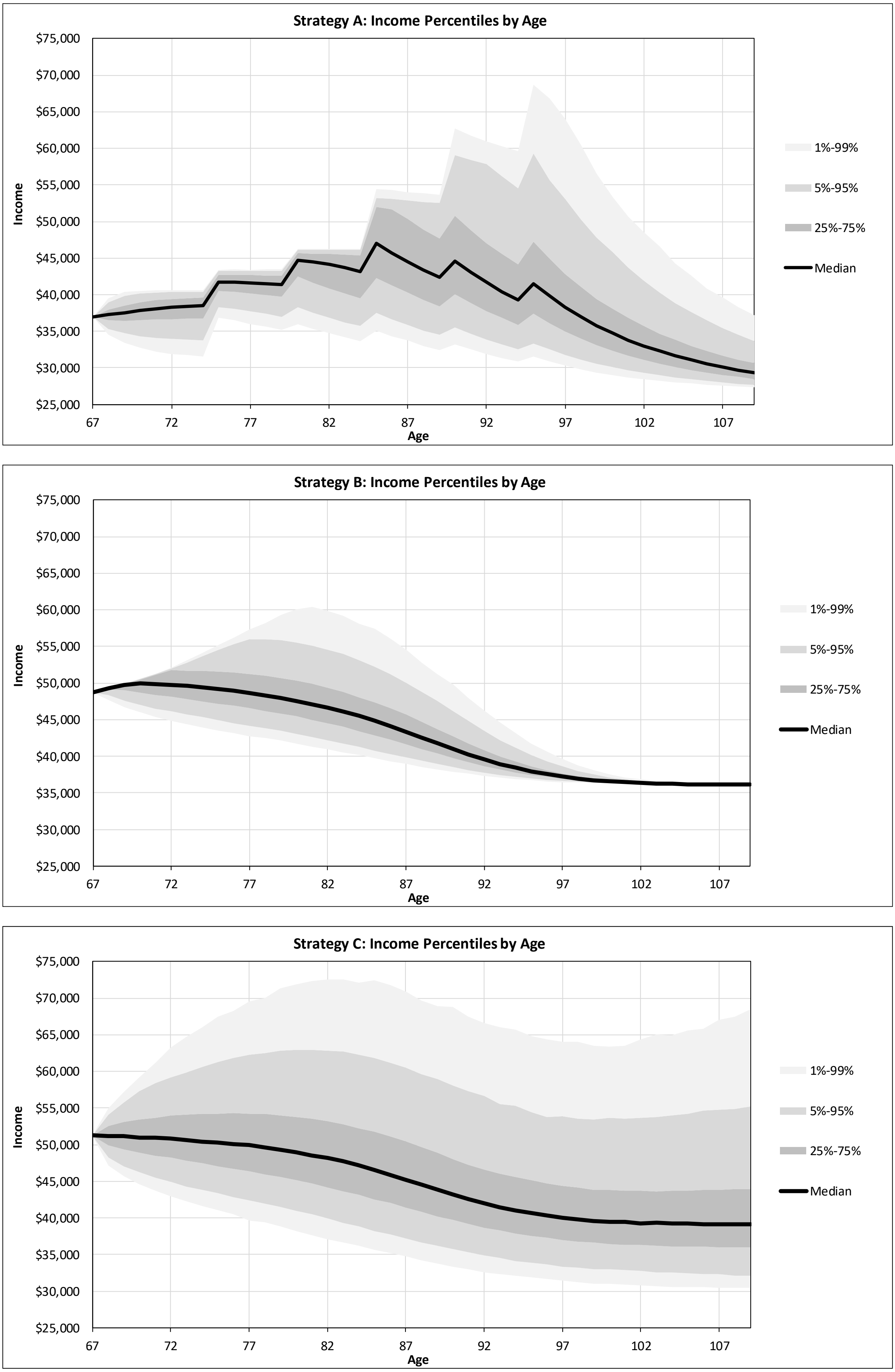


Table 3 presents our summary scorecard[23]. As well as reporting RAI, a score of between one and five under each RIC objective is awarded based on a subjective evaluation informed by the metrics and charts appearing above. The 'expected income' scores reflect the likely level of income over the course of retirement, including giving some credit for upside. 'Income risk exposure' scores consider the potential downside in income. Finally, 'access to funds' is evaluated based on how long the retiree is likely to be able to access a meaningful ABP balance if the need arises.

Default strategy A is afforded the lowest scores on expected income and income risk, but the highest score on access to funds. These scores are a consequence of the inefficiency of the MDR in converting assets into income and the absence of any longevity insurance. Solution B scores lower than solution C on expected income but higher on income risk exposure. The main point of difference is that solution C maintains a higher exposure to growth assets, which provide potential for higher income but increased exposure to investment and hence income risk including more volatile income streams. Both proposed solutions score similarly on access to funds.

Table 3: Summary scorecard for Case Study 1 (Income optimisation solutions)

Solution	**A** ***Default***	**B** ***Proposed***	**C** ***Proposed***
Allocation Strategy	100% ABP	42% LA 58% ABP	50% ILA 50% ABP
Drawdown Strategy	MDR	Affordable	Affordable
Risk-Adjusted Income	$39,591	$46,537	$47,637
RIC Objective Rankings			
Expected Income	2	3	4
Income Risk Exposure	3	5	4
Access to Funds	5	4	4

Legend: *1. Very Poor* *2. Poor* *3. Satisfactory* *4. Good* *5. Excellent*

Solution C emerges as most attractive overall as it provides a reasonable balance across all three RIC objectives and the highest RAI. Nevertheless, solution B is close behind on the assessment measures. Which of the two proposed solutions is more suitable may depend on the relative weight placed on prospects for higher income versus limiting the downside in income to more than the Age Pension plus supplements. While the proposed solutions improve on default solution A, there is also room for further improvement in them both.

Application

This section discusses how quantitative modelling can be applied to solution assessment and solution design and development, while drawing on the two case studies for illustration.

Solution assessment

Assessment of solutions might address two primary questions:

1. Does the solution clearly improve on the default?
2. Are there any aspects to suggest that the solution may be unsuitable for the members to which it is likely to be offered?

[23] Others might wish to form their own summary scorecard, for instance: conveying additional information; using a different scaling system, e.g. rankings, or an alternative combined score such as a weighted average of rankings. The scoring system might also be formalised, e.g. rescaling and aggregating existing quantitative measures.

Assessing the degree of improvement offered by a solution can be confronted with mixed indications across metrics, and will likely involve trade-offs between the three RIC objectives. In Case Study 1 (income optimisation example) as above, the proposed non-default solutions both improve on the default. The same emerges under Case Study 2 (income target objective, Appendix 2). However, improvements over the default do not occur across all dimensions. For example, solutions B and C both led to a worsening in flexible access to funds relative to default solution A. In Case Study 2, the target income solutions vary in the shape of their income profile. Default solution D and solution F provide a high likelihood of attaining the target until age 80, but an increasing probability of not doing so later in retirement. Meanwhile, solution E brings considerable risk of failing to sustain the income target between ages 77-84, but guarantees the target later in retirement due to the presence of a deferred life annuity (DLA). While the utility-based metric RIA offers an overarching measure that balances expected income and income risk, it says nothing about flexible access to funds. Inevitably an element of judgement will be required in assessing the extent to which a solution improves on the default.

Solution E in Case Study 2 provides an example of a solution containing an aspect suggesting that it may be unsuitable for the member type for which it is designed. The solution delivers a significant probability of failing to sustain the target between age 77 and age 84, i.e. prior to DLA income cutting in. This aspect seems at odds with a target income objective and the promise to members that it implies. Another example of an unsuitable solution might be one that is fully invested in an annuity that offers no flexible access to funds … unless the solution was specifically designed and offered to members with no requirement for access to funds due to (say) having substantial funds outside of superannuation.

Solution design and development

Quantitative modelling links solution design and development through to member outcomes, and in doing so elevates the status of retirement income as a key deliverable. (The Peter Drucker adage "what gets measured gets managed" comes to mind.) Quantitative modelling can inform design and development in three ways:

1. **Comparing candidate solutions** – Quantitative modelling can inform solution selection by providing a means to compare candidate solutions. For example, solution C above (and solution F in Case Study 2) emerge as tentative winners based on the modelling. Nevertheless, it is envisaged that the quantitative modelling results would be one of many factors considered in solution design, which might include business considerations and potential member acceptance and behaviours. For a discussion of these matters, see Butt et al (2023).

2. **Identifying shortcomings** – Quantitative modelling can help reveal any shortcomings of a solution so they might be addressed. The example of the potential 'income hole' between age 77 and age 84 under strategy E is a clear flag of a problem to fix, perhaps through lowering the income target being offered or winding back the DLA allocation. Quantitative modelling can highlight situations where income risk is higher than the member type might be willing to bear, say because the guaranteed income is insufficient relative to some minimal acceptable income level. Quantitative modelling may also help identify situations where the balance remains too high throughout retirement thus suggesting inefficient conversion of assets into income, such as under default strategy A. Or where access to funds is inadequate, such as solution E under which the ABP balance is highly likely to be exhausted early in retirement.

3. **Investigating design improvements** – Quantitative modelling can assist to develop solutions by providing a vehicle to investigate how design changes impact on member outcomes. For instance, modelling might be used to gauge the potential member benefit from adjusting cohort definitions, adding investment building blocks or finessing the drawdown strategy. Estimating an 'optimal' strategy might inform the development process by indicating directions to pursue in making adjustments. For instance, our examples point to the improvements that can arise

by adding longevity protection through access to mortality credits, while suggesting that this might be achieved without sacrificing expected income. Our analysis also hints at the potential to improve member outcomes through better designed drawdown strategies.

Those involved in solution design may want to have more detail in their models than we present.

Robustness

Establishing the robustness of model-based assessments of retirement solutions is important, especially where the quantitative assessment operates a key input into decisions regarding the suitability of a solution. Potential areas to investigate are listed below.

- **Member assumptions** – Assessing solutions based on their suitability for representative test members leaves solution suitability decisions exposed to the risk of mis-specifying the member type. Investigations might consider the potential impact of omitted member characteristics. For example, the robustness of a solution that is designed without consideration for homeownership might be gauged by assessing its suitability for homeowners and renters. Another focus area might be the risk of offering solutions to members who differ from the representative test member. For example, a solution that is designed assuming a member balance of (say) $400,000 that is offered to members with a balance between $300,000 and $500,000 might also be assessed at both ends of the balance range.
- **Modelling and parameter choices** – Critical modelling and parameter choices should be identified with the aim of testing robustness of assessments to those choices. For instance, robustness might be examined to objective formulation, projection horizon, availability and features of investments or products, investment returns, mortality assumptions, and so on.
- **Scenario analysis / stress testing** – It may be helpful to 'stress test' solutions under certain scenarios. For example, solutions might be assessed to ensure that relatively acceptable outcomes are delivered under a GFC re-run, persistently high inflation, or changes to the Age Pension or taxation rules. In doing so, care should be taken not to anchor too heavily on particular scenarios, e.g. assessing solutions largely on their ability to protect against a GFC re-run. Good practice would be to apply such tests across member types and ages.

Concluding comments

We have demonstrated how quantitative modelling is a useful tool for understanding and assessing the outcomes delivered by retirement solutions, and informing solution design and development. We have highlighted the power of stochastic models, noting that deterministic models reveal little about income risk and hence do not address the second RIC objective. Fund trustees and other industry players such as consultants and research houses should ensure that they have access to the capability to undertake quantitative assessment of the type presented here. Larger organisations might employ staff with the skills to build the required support systems to undertake the analysis in-house. Small-medium sized funds might outsource the modelling in whole or part. We emphasise that effective RIS assessment will ultimately involve exercising judgement. This extends to the need to interpret the output from quantitative modelling, given the complex trade-offs involved and the absence of any single comprehensive measure that can satisfactorily summarise all the elements required of a suitable retirement solution.

Bell and Warren (2022) saw RIS assessment as a learning process that will evolve over time. The same applies to the quantitative component, entailing ongoing review and continual improvement of the models and the analysis – especially in light of the difficulty of capturing all relevant features given the complexity of retirement. We trust that this article helps lay some foundations which are extended upon by others.

Appendix 1: Modelling assumptions

Member attributes:

- Retires at age 67 with $400,000 balance
- Single male
- Mortality rates from Australian Government Actuary without mortality improvements. 2015-2017 tables, see https://aga.gov.au/publications/life-tables/australian-life-tables-2015-17
- Access to Age Pension and supplements
- Homeowner
- No other assets outside of superannuation (apart perhaps from a minimal amount of precautionary savings that are not included in the modelling)
- Utility function (i.e. preferences)
  - Power utility for income optimisation; prospect theory function for income target
  - Low risk appetite as applied in Butt et al (2023), i.e. risk aversion of five for income optimisation; Blake et al. (2013)[24] parameters for income target
  - No time preference
  - Survival weights applied
  - No bequest term

Real return assumptions:

Continuously compounded	Growth Portfolio	Defensive Portfolio	Fees	60/40 Portfolio
Expected real return (mean)	5.5%*	1.0%	0.85%	2.85%
Standard deviation	15.0%	4.0%		9.1%

** Based on 4% risk premium in excess of defensive portfolio, with 0.5% added for franking credits. Growth and defensive portfolios are uncorrelated.*

Age Pension:

Start age = 67
Eligibility rules as at September 2022
Maximum Age Pension: $936.80 (fortnightly)
Supplements: minimum $40.70, maximum $75.60; energy supplement $14.10
Asset test threshold: $280,000. Reduce by $3 for every $1,000 above the threshold
Income test threshold: $190,000. Reduce by 50% for every $1 of income
Deeming break point: $56,400. Deeming rates 0.25% low, 2.25% high (updated at 21 Dec 2022)
Rules applied for incorporation of lifetime income steams (annuities) into income and asset tests

Longevity products:

Discount rate for LA and DLA = 1% real
LA starts at age 67, DLA at age 85
Reference return for ILA equals expected return on investments, i.e. 2.85% real
Zero loadings
All longevity products are assumed to provide no access to capital

Modelling notes:

Analysis undertaken in real terms.
Income target, LA, DLA and Age Pension[25] and supplements assumed indexed to inflation (CPI)

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[24] Includes a risk aversion coefficient of 4.5, curvature parameters of 0.44 on gains and 0.88 on losses. See Blake, D., Wright, D. and Zhang, Y. (2013). Target-driven investing: Optimal investment strategies in defined contribution pension plans under loss aversion. *Journal of Economic Dynamics and Control*, 37(1), pp.195-209.

[25] We have assumed that the Age Pension is indexed to the CPI rather than average weekly earnings to generate more coherent outcomes, noting that accumulating the Age Pension at a positive real growth rate over multiple decades can lead to it tending to dominate the delivery of real income later in retirement.

Appendix 2: Case Study 2 – Income target objective

Assumptions

Table A2.1 sets out the key assumptions for the three solutions examined under the income target objective. The assumed income target of $47,771[26] is based on a replacement rate equal to 70% of disposable income for an individual with pre-retirement income prior to the superannuation guarantee and personal tax (including the Medicare levy) equal to average full-time ordinary-time earnings of $93,907 per annum (November 2022). All solutions assume that sufficient income is drawn from the ABP to reach the target until the balance is exhausted (or as required under the MDR), after which income falls to the Age Pension plus any lifetime income streams. Default solution D assumes the entire balance is invested in an ABP with 60/40 weights. The proposed solutions invest in two types of lifetime income streams, with the remainder in the 60/40 ABP. Solution E purchases an indexed (i.e. real) DLA that guarantees the target for life from age 85. Solution F invests 50% of the balance at retirement in an ILA that also invests in a 60/40 portfolio. This is the same asset allocation as solution C combined with a different drawdown strategy.

Table A2.1: Solutions modelled under Case Study 2 (Income target objective)

Objective	**Income Target = $47,771 per annum** *70% replacement rate with reference to average weekly earnings (full-time ordinary-time) of $93,907 less 12% superannuation guarantee and personal tax*		
Solution	**D** ***Default***	**E** ***Proposed***	**F** ***Proposed***
Allocation strategy	ABP 60/40	• DLA secures target from age 85 (with Age Pension) • ABP 60/40 remainder	• 50% ILA • 50% ABP • Both 60/40
Drawdown strategy (for ABP)	Draw sufficient income to attain target until balance is exhausted		

Legend: ABP = account-based pension; DLA = deferred life annuity (indexed); ILA = investment-linked annuity

Analysis

Table A2.2 presents the metrics for the three solutions under the income target objective. The focus is the likelihood of sustaining the target to various ages, as well as the decline in income that occurs once the ABP balance is exhausted. The first group of metrics reveal the risk of failing to sustain the assumed income target due to the ABP being exhausted. The 'expected age of ABP exhaustion' indicates that the ABP is projected to last to an average age of 88 under the default solution D, an age of 81 under solution E and an age of 93 under solution F. The 'probability of shortfall versus the income target' provides further colour, albeit in 5-year intervals. It reveals that solution E has a 0% probability of not sustaining the target until age 75 and from age 85 (when the DLA begins to make payments), but a 30% probability of failing to do so at age 80. Closer examination reveals that the probability of solution E not sustaining the target exceeds 0% between age 77 and age 84. Meanwhile, the probability of not sustaining the target exceeds zero for default solution D from age 81 and for solution F from age 79. Solution F delivers a lower probability of shortfall than solution D at all but age 80.

'Guaranteed income' reveals the minimum level to which income can fall, and hence provides a gauge of the magnitude of potential shortfall to supplement the metrics on probability of shortfall.

[26] This compares with the ASFA comfortable retirement standard for September 2022 of $48,266 for retires aged 65-84. It sits between the Super Consumers Australia income standards for retirees aged 65-69 of $38,000 medium and $55,000 high.

All three solutions deliver minimum income equal to the Age Pension plus supplements until age 84. From age 85, solution E delivers minimum income equal to the income target as payments from the DLA kick in. Thus solution E is superior from the perspective of guaranteeing the target from age 85 through until death, although it does not do so in the years before age 85.

The utility-based metric of RAI places an overall score on these income outcomes. Solution F generates the highest RAI of $47,096, versus $46,233 for solution E and $46,198 for default solution D. It thus suggests that solution F is superior on balance in terms of limiting the potential to fall short of the target over the entire course of retirement.

Finally, the median balance in the ABP reveals that solution F commences with the lowest ABP, but is able to sustain some balance for longer than solution D and solution E. Solution E also runs down the balance relatively quickly as it uses ABP drawdowns to sustain the target until the DLA kicks in. Thus solution F comes out as preferred from the perspective of providing flexible access to funds for a longer period of time, with a median balance of $44,499 still evident at age 90[27].

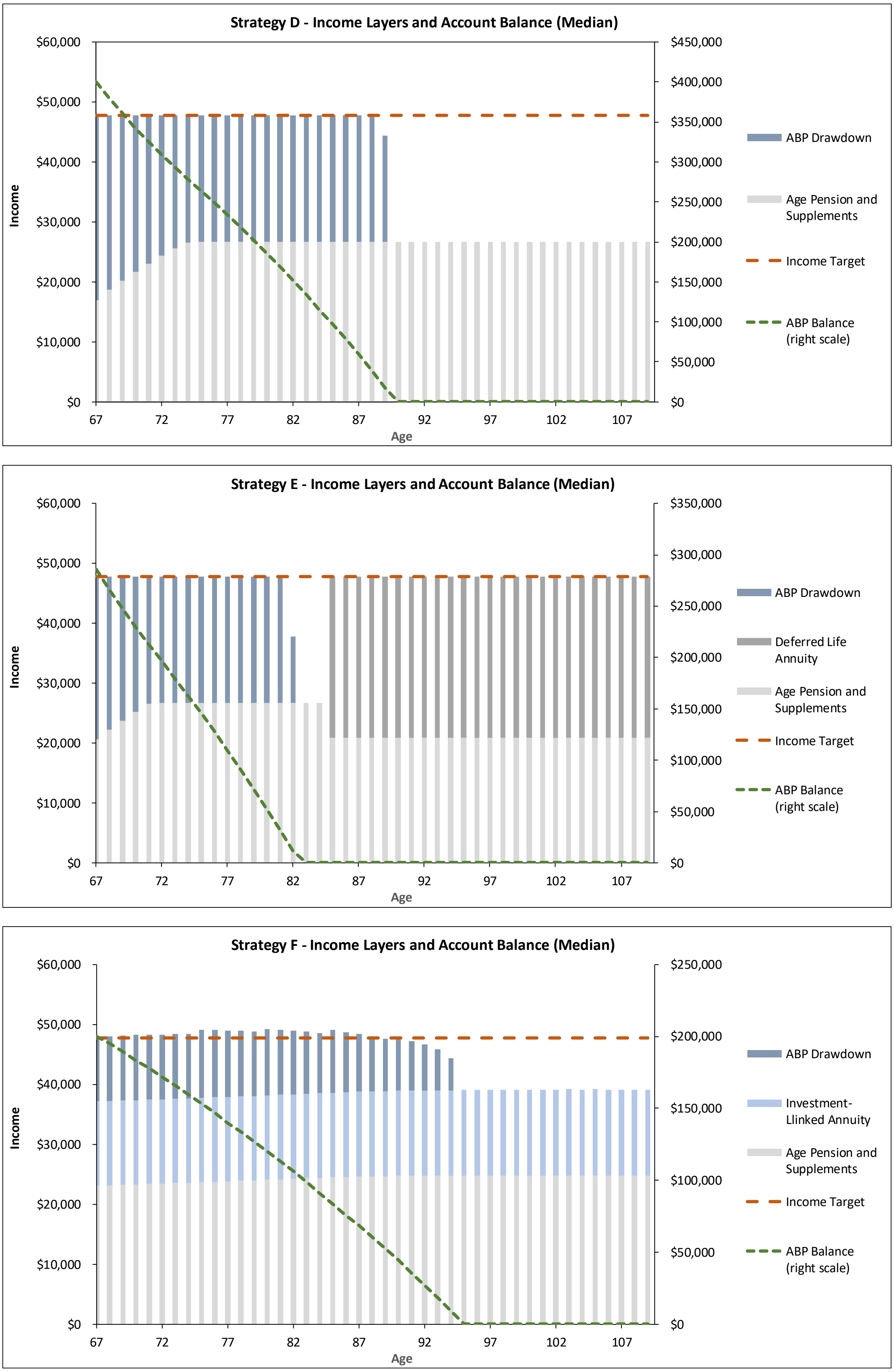
Table A2.2: Metrics for Case Study 2 (Income target solutions)

	Strategy D *(Baseline)*	Strategy E	Strategy F
Assumptions About Retiree			
Income Target	$47,771	$47,771	$47,771
Savings at Retirement (age 65)	$400,000	$400,000	$400,000
Allocation of Savings at Retirement			
Deferred Life Annuity (DLA) from Age 85, Indexed	-	$114,166 (29%)	-
Investment-Linked Annuity (ILA)	-	-	$200,000 (50%)
Account Based Pension (ABP)	$400,000 (100%)	$285,835 (71%)	$200,000 (50%)
Total	$400,000 (100%)	$400,000 (100%)	$400,000 (100%)
Growth Weighting in ILA			60%
Growth Weighting in ABP	60%	60%	60%
Income streams:			
Age Pension and Supplements	Part-pension initally	Part-pension initally	Close to full pension
Lifetime income stream - DLA from Age 85		$26,886	
Lifetime income stream - ILA, First Year			$14,074
Primary Metrics			
Expected Age of ABP Exhaustion	88	81	93
Probability of Shortfall vs. Income Target			
Age 70 *(Survival probability 96%)*	0%	0%	0%
Age 75 *(Survival probability 87%)*	0%	0%	0%
Age 80 *(Survival probability 74%)*	1%	30%	4%
Age 85 *(Survival probability 54%)*	22%	0%	20%
Age 90 *(Survival probability 30%)*	58%	0%	38%
Age 95 *(Survival probability 11%)*	80%	0%	53%
Age 100 *(Survival probability 3%)*	93%	0%	64%
Age 105 *(Survival probability 0.3%)*	99%	0%	74%
Guaranteeed Income (Age Pension & Supp. + DLA)	$26,689	$47,771	$26,689
Risk-Adjusted Income (Utility-based Metric)#	$46,198	$46,223	$47,096
Median Balance in ABP			
Age 70 *(Survival probability 96%)*	$341,900	$229,366	$183,451
Age 75 *(Survival probability 87%)*	$263,548	$145,437	$153,435
Age 80 *(Survival probability 74%)*	$186,029	$51,893	$120,206
Age 85 *(Survival probability 54%)*	$97,255	-	$83,679
Age 90 *(Survival probability 30%)*	-	-	$44,499
Age 95 *(Survival probability 11%)*	-	-	-
Age 100 *(Survival probability 3%)*	-	-	-
Age 105 *(Survival probability 0.3%)*	-	-	-

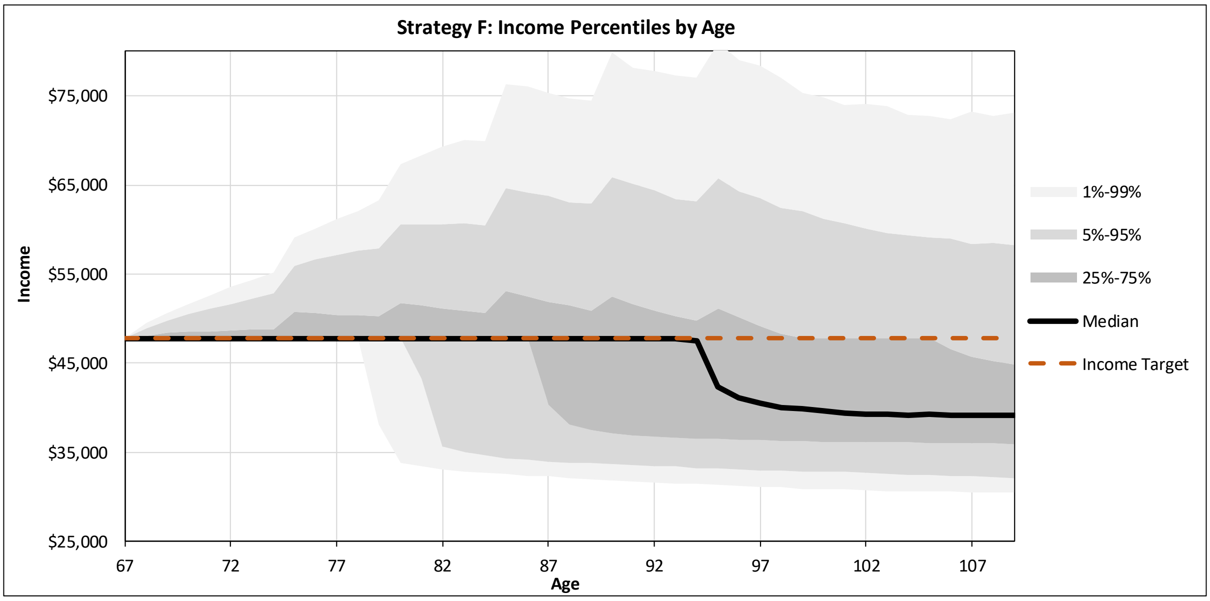
 # Weighted by probability of survival.

[27] Median balance falls to zero at age 95 for solution F, versus age 90 and 83 for default solutions D and E.

Figure A2.1: Income layers for Case Study 2 (Income target solutions)



<u>Figure A2.2</u>: Income percentiles for Case Study 2 (Income target solutions)



Charts of income layers in Figure A2.1 and income percentiles in Figure A2.2 provide further insight into the sources and distribution of income over time. Both chart sets underline the fact that default solution D leads to a knife-edge decline in income from the target to the Age Pension plus supplements at some stage from age 80. The potential for Solution E to deliver a knife-edge but transitory decline in income between age 77 and age 84 is clearly evident. Solution F delivers a wide potential income range, with both upside and downside versus the target. The downside is limited relative to default solution D as the ILA continues to generate some income. A key point of contrast between the two proposed solutions relates to the risk of falling short of the target. This risk emerges for solution E only between ages 77 and age 84, while for solution F it emerges from around age 80 then increases with time.

Table A2.3 presents our summary scorecard. On expected income, default solution D is given a score of 2 as income is likely to toggle all the way down from the target to the Age Pension plus supplements at some stage, which reduces expected income. Solution E scores a 4 as it sustains the income target through most of retirement. Solution F is also given a score of 4, in this case balancing the potential upside the against downside in income, noting that income typically remains above the Age Pension plus supplements. On income risk exposure, default solution D is given a score of 2 because income is likely to drop sharply to the Age Pension and supplements at some point while the retiree is still alive. Both solution E and solution F are given scores of 3 as both can lead to declines in income albeit less than under solution D. Notable considerations are the potential income 'hole' between age 77-84 for solution E, whereas solution F tends to deliver the risk of income declines later in retirement to levels that remain above the Age Pension and supplements. Finally, access to funds is scored based on how long a meaningful balance is likely to be retained in the ABP.

Table A2.3: Summary scorecard for Case Study 2 (Income target solutions)

Solution	**D** ***Default***	**E** ***Proposed***	**F** ***Proposed***
Allocation Strategy	100% ABP	29% DLA 71% ABP	50% ILA 50% ABP
Drawdown Strategy	Draw-to-target	Draw-to-target	Draw-to-target
Risk-Adjusted Income	$46,198	$46,223	$47,096
RIC Objective Scores (1-5)			
Expected Income	2	4	4
Income Risk Exposure	2	3	3
Access to Funds	3	2	4

Legend: *1. Very Poor* *2. Poor* *3. Satisfactory* *4. Good* *5. Excellent*

In summary, solution F comes out as relatively attractive considering the range of metrics including utility scores, the distribution of income over time and reasonable flexible access to funds. It also emerges as either equally or more attractive than the other two strategies on all three RIS objectives. While solution F is assessed as the more attractive of the three solutions, much hinges on the view of the differing pattern of income risk over time between solution E and solution F. Similar to the income optimisation analysis, there is room for improvement in both proposed solutions.