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The Optimal Solution to the Retirement Riddle

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Abstract

With an ageing population the question of retirement funding takes on greater importance, both for the retirees that must fund their retirement years and for the policy makers that must balance diminishing resources and intergenerational tension against the living standards of underfunded older generations. In this environment, good retirement planning and decision making is critical for pre-retirees and retirees.

With that in mind, this paper details the findings of research and modelling undertaken to answer the question: What is the optimal retirement solution?

This paper firstly compares the stochastically simulated performance of retirement income products (including account based pensions, annuities and variable annuities) against a range of metrics. Secondly, we discuss the concept of optimal in the context of the allocation of retirement funds and how it can be measured. Thirdly, we examine the optimal allocation to annuities of a typical retirement portfolio.

Keywords – post-retirement, retirement income, stochastic modelling, account based pensions, annuities, income stream, optimum.

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1. BACKGROUND

The Financial System Inquiry (FSI) focussed on defining the objective of our superannuation system. There is widespread support that the objective is to provide income streams in retirement. Pleasingly, and contrary to the popular view that the superannuation system is beset by a lump sum culture, 83% of superannuation assets are in fact converted to an income stream, with only 17% of assets withdrawn as a lump sum[1] (including partial lump sums – see Table 1). Furthermore, those retirees that do take a partial or full lump sum appear to spend it sensibly for the most part[2]. Whilst the vast majority of super assets are converted to an income stream, the percentage by number of customers is much less, with 34% taking all their benefit as a lump sum and 25% taking a partial lump sum.. However, with 57% of lump sums being less than $40,000[3], this again appears to be a rational outcome and, as the system matures, the percentage of super assets converted to an income stream is expected to increase to 96% by 2025[4].

Table 1: Estimated retirement rollovers and benefit payments

	Assets	Members
Lump sum	**16.7%**	**58.9%**
Full lump sum	9.5%	34.2%
Partial lump sum	7.2%	24.7%
Income stream	**83.3%**	**41.1%**
Total	**100%**	**100%**

Hence, the question has evolved from "are Australians taking up income streams?" to "are Australians taking up the *right* income streams?". The FSI didn't think so, making these comments:

- "The lack of a significant market for products with longevity risk protection sets Australia apart from most other developed economies"
- "Superannuation assets are not being efficiently converted into retirement incomes due to a lack of risk pooling and over-reliance on individual account based pensions".

This leads us to consider what income streams are available in Australia. Again, contrary to some commentary, there is a range of retirement income streams available, from traditional immediate annuities through to variable annuities and account based pensions. Further, Mercer has recently announced one of the first group self annuitisation products in Australia. The most significant omission from the suite on offer is deferred lifetime annuities, which face regulatory barriers that Treasury is currently reviewing. Whilst it is fair to say there is an array of products with longevity protection available in Australia, it is also true that such products have not had significant take-up, while a number have been closed.

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[1] Rice Warner, 2015; data to 30 June 2014 and prepared for Colonial First State

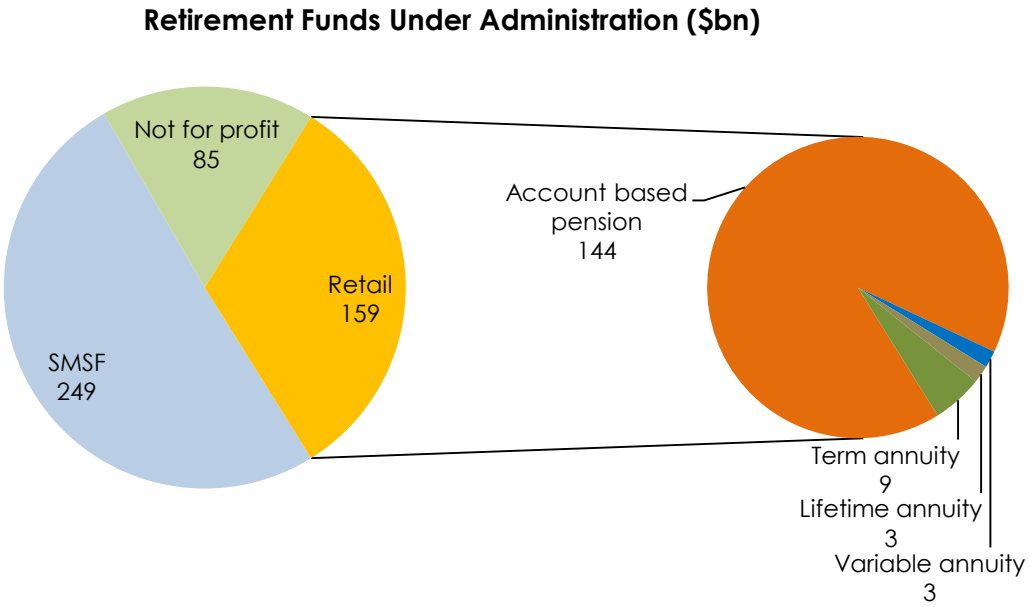
[2] According to the Australian Bureau of Statistics, Retirement and Retirement Intentions 2013, 29% of retires who took lump sums invested it in their own homes (including paying down their mortgage), followed by 20% who reinvested as ordinary money and 12% that paid off debt. Only a combined 22% said they bought a car, paid for a holiday or assisted family.

[3] Australian Bureau of Statistics, Retirement and Retirement Intentions, 2013

[4] Rice Warner, 2015; data to 30 June 2014 and prepared for Colonial First State

Despite the array of available solutions, $144bn of the $159bn retail post-retirement market is invested in account based pensions, with only $12bn invested in term and lifetime annuities[5]. A further $3.6bn[6] is estimated to be held in various account based pension products with capital or income protection (variable annuities). Whilst variable annuity products have enjoyed significant success in the United States, this is largely due to conditions that are not replicated locally: high adviser commissions, often around 7%; favourable tax treatment which is particular to the US; high provider risk, with a number of participants exiting the market after the GFC due to hedging issues in their portfolios. The figure below displays this split of the retail market.

Figure 1: Estimated split of pension assets across industry segments and products



To recap the context so far, the take-up of retirement income solutions is high, and as intended for the mass market: concessional taxation is incentivising income streams, there are a range of products available to manage retirement income needs and risks, and widespread abuse of the system in the form of unwise spending of lump sums, is not evident.

However, some commentators consider that the national preference for account based pensions has introduced significant longevity risk into the post-retirement system. Australian population life expectancy at age 65 is 84 for males and 87 for females[7]. However, according to Mercer, for white collar retirees, the life expectancies are 88 for men and 91 for women. Further, there is a 35% probability that white collar male and female retirees will live to 91 and 93 respectively[8]. This shows that there is a substantial probability that such clients will live into their 90's and financial planners need to plan accordingly. Despite these increasing longevities, only 2-10% of Australian defined contribution (DC) assets are annuitised[9]. This contrasts markedly with Switzerland, Chile, the United Kingdom and Ireland

[5] Plan For Life, June 2014
[6] Rice Warner, 2014
[7] Australian Life Tables 2010-12, Australian Government Actuary
[8] Mercers 2014, based on analysis of public sector pensioners
[9] Pensions Institute, Briefing Paper 66: Freedom and Choice in Pensions

where DC pots are approximately 80%, 70%, 60% and 30% annuitised respectively. Of these markets, although annuitisation of DC savings has only been compulsory in the UK (with the level of annuitisation expected to fall), flexible drawdown products are less attractive. In Switzerland annuity rates are government regulated and generous, in Chile flexible income stream products are expensive whilst annuities are government guaranteed and the Irish market has a significant component of occupational DC schemes that involve some default annuitisation.

A further challenge in the Australian market is the consumer attitudes to investment risk. Qualitative analysis and research conducted for Colonial First State by Strativity Group found that pre-retirees and retirees are inherently conservative, concluding that: "After reaching a 'tipping point', pre-retirees become highly engaged investors and their focus becomes acutely defensive[10]". According to the *Investment Trends Retirement Income Report 2014*, 62% of Australians over 40 favour a low risk defensive asset allocation over growth, and 28% would accept no growth at all rather than any risk of losses[11]. That same report also indicated a significant knowledge and consideration gap, with 39% of pre-retirees aged 40+ reporting they didn't know what income stream product they would use in retirement, 31% said they intended to use an account based pension, 19% would take a full lump sum and only 6% were considering an annuity.

The increasing range of products with longevity protection, increasing longevity and a naturally conservative disposition suggests that Australian retirees could benefit from greater focus by industry and government on longevity protection. The Australian FSI's commentary on the need for greater longevity protection is echoed by overseas regulators. Both the US Department of Labor and the OECD[12] have encouraged the take-up of deferred lifetime annuities in particular. One of the key recommendations coming from the OECD's Roadmap for the Good Design of Defined Contribution Pension Plans was:

"A **combination** of programmed withdrawals with a deferred life annuity that offers protection against inflation could be seen as an appropriate default."

Picking up on this theme of combining products, the Australia FSI made the following observation in relation to Comprehensive Income Products for members' Retirement (CIPRs):

"A **combination** of underlying products would likely be required to provide these features, for example, an account based pension paired with a pooled product that provides longevity risk protection"

Given this back-drop of customer preferences, regulation and global trends, we endeavoured to answer the question "what is the optimal retirement income stream for retirees" in order to inform the Colonial First State product strategy. To avoid restricting our potential solution set, it was important to look not only at the main product categories available, but at combinations of products as well.

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[10] Strativity Group 2013, research conducted for Colonial First State

[11] Investment Trends Retirement Income Report 2014. Excludes those that answered they did not know.

[12] OECD Roadmap for the Good Design of Defined Contribution Pension Plans

The answer to the question of what is the optimal retirement income solution depends critically on two aspects of retirement income projection methodology:

- Allowing for asset volatility by means of stochastic projection as opposed to a deterministic projection; and
- The measures of performance outcomes.

Our approach was initially inspired by some stochastic modelling conducted by David Bell, now CIO at AusCoal Super, indicating that nominal lifetime annuities could offer comparable income replacement rates at a lower level of volatility (compared to a balanced account based pension) and that variable annuities delivered sub-optimal outcomes. He used the after-tax and real replacement rate of pre-retirement income, targeting 70%, as a key outcome measure.

Similarly, other academic research by the University of Sydney and University of Technology Sydney has looked at what combination of products is optimal. In their paper *Optimal Annuity Purchases of Australian Retirees*, Fedor Iskhakov, Susan Thorp and Hazel Bateman used utility functions to analyse what percentage of a person's balance should be allocated to an annuity. The paper includes a chart showing levels of annuitsation for different economic assumptions and different member balances.[13].

Based on this, we set about to build a model to:

- Firstly compare the various retirement products; and
- Secondly, to develop a framework to determine the optimal product selection for an individual.

[13] Choices over life annuities: optimal decisions for Australian Retirees, University of Sydney and University of Technology Sydney

2. ESTABLISHING A BASIS FOR COMPARING RETIREMENT INCOME PRODUCTS

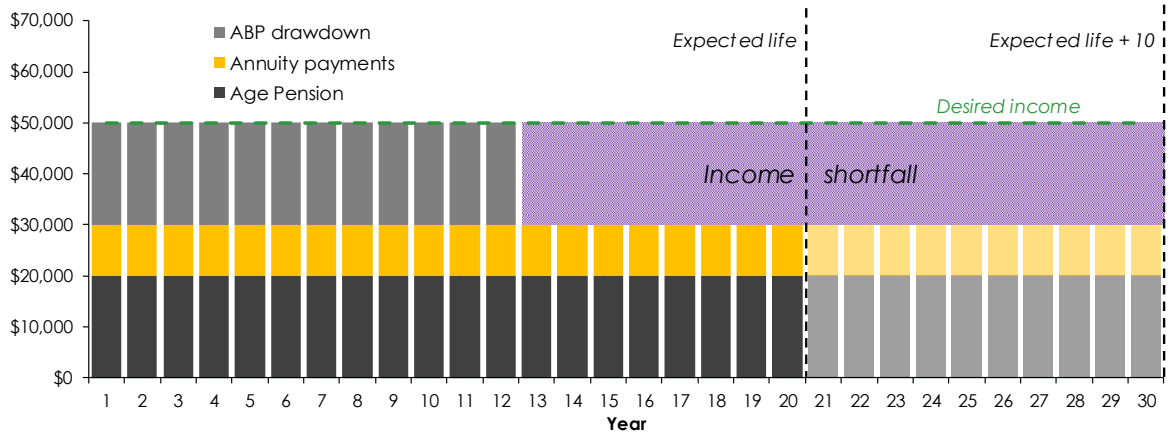
In order to compare retirement income products, and then to seek an optimum retirement income solution, we first need to establish aspects of those products that we believe retirees value the most. Because income, under many products, can be drawn down flexibly, there are many ways to view product outcomes, such as:

- Total income, or net present value (NPV) of income, over life
- The income stream received relative to desired income
- Years relative to lifespan until assets are exhausted
- Inheritance amount at death.

The outcomes to a retiree under these measures will also depend on interactions with the Age Pension, and will vary according to asset returns and lifespan from retirement, both of which are uncertain. It is therefore necessary to consider multiple measures in multiple scenarios, and also consider the variability of outcomes. The resulting maze of multiple views of multiple outcomes across a variety of product combinations makes it challenging to make meaningful comparisons and draw firm conclusions. Our approach to navigating these challenges was to fix some of the variability, carefully select outcomes to focus on, and examine those outcomes and the remaining variability.

In a typical retirement situation, a retiree will receive the Age Pension, plus any annuity income, and then draw down an amount from an account based pension (ABP) to reach their desired income. Once the account based pension is exhausted the retiree's income will fall. This is shown in the following diagram. For ease of illustration, all amounts are assumed to inflate, differences between average weekly earnings (AWE) and inflation (CPI) are ignored, and the inflation adjusted amounts are shown.

Figure 2: Inflation-adjusted depiction of retirement income over a projection period



In order to sidestep some of the potential variability in our analysis we performed comparisons as if the retiree's lifespan were known, together with illustrations of shorter or longer lifespans. We illustrated lifespans as:

- the time from retirement to expected life of the individual (EL),
- ten years after life expectancy (EL + 10) and, sometimes
- ten years less than life expectancy (EL - 10)

An alternative would have been to use a stochastic mortality model and to illustrate percentiles of financial outcomes driven by this and asset variability. However we felt that this complicated rather than assisted the ease of communicating results.

In the subsequent sections of this paper we have illustrated financial outcomes, using the above framework, under stochastic asset returns, for different product combinations. The summary measures of product performance that we examined are:

Table 2: Measures of product performance

Measure	Definition	Relevance
NPV of lifetime income (Section 4)	The discounted value of all future income payments and any inheritance amounts from the selected retirement income product	Summary measure of total value delivered (at different percentiles of asset performance and for different lifespans assumed)
Desired income attainability (Section 4)	Total income received over the retiree lifespan divided by total desired income over the same period, excluding any inheritance	A direct summary measure of the achievement of the income goal (at different percentiles of asset performance and for different lifespans assumed)
Utility of the payment stream produced (Section 5)	A convex function of the income received at any point in time	Summarising the benefit, for assumed lifespans, of the range of potential asset market outcomes
Depth and duration of "income misses" (Section 6)	Depth refers to the desired income less the actual received income. Duration refers to the length of time where the desired income is not being received.	Provides richer information about the number of retirement years with depleted income, and the severity of the income reduction

3. PRODUCTS EXAMINED AND MODEL USED

The products examined

The products that we initially examined were account based pensions, immediate lifetime annuities, variable annuities and two hybrid products (one being a 75:25 retirement funds mix of account based pension and immediate lifetime annuity and the other being a 75:25 retirement funds mix of account based pension and deferred lifetime annuity). We assumed the immediate lifetime annuity and deferred lifetime annuity to be priced using the same model and mortality assumptions.

Table 3: List of retirement income products that were compared

Product	Reference code
Account based pension	ABP
Immediate lifetime annuity (CPI-indexed)	LA
Variable annuity	VA
75% account based pension + 25% immediate lifetime annuity	ABP + LA
75% account based pension + 25% deferred lifetime annuity	ABP + DA

The products modelled do not represent actual products belonging to any one provider, yet their fees and benefits have been calibrated to existing products in their product cohort in the current Australian market at the time this analysis was performed. See Appendix C for the assumptions behind the products modelled. The income drawdown rates modelled for each product are a result of the design of the products except the account based pension which provides more flexibility. For this, we have assumed that income is drawn down in line with the desired total income specified for a particular retiree profile until the assets are exhausted. Desired income is assumed to be indexed with average weekly earnings (AWE).

The model used

To properly investigate the range of outcomes produced by each retirement income product we have used a stochastic projection model. Assets are assumed to grow according to a lognormal distribution. This requires assumptions for expected returns, volatilities and correlations for the asset classes. A more detailed description of the asset model used, as well as these assumptions is provided in Appendix A.

Two important assumptions required for our comparison of products are the discount rate used for any net present value (NPV) calculations and the process by which annuity rates are set.

The discount rate used is assumed to be the expected return on fixed income assets to reflect the opportunity cost of investing a particular amount of money.
The (indexed) annuity rates are determined by using a pricing model allowing for expected annuitant mortality and assuming a level of inflation equal to the expected inflation (CPI) for the assumed interest rate environment. An input is required for the investment return for the assets backing the annuity. This is provided in Appendix C for reference.

4. PRODUCT COMPARISON RESULTS

Comparison A - NPV of lifetime income

For the first comparison of products, we look at income received over the projection period, or time horizon. To provide an equitable comparison we:

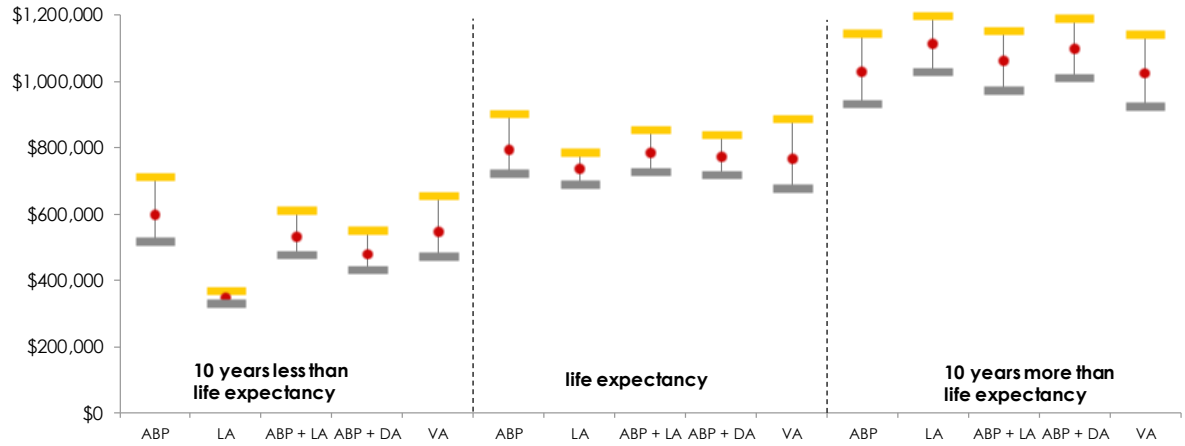
- look at the NPV of all income payments provided (rather than just adding them); and
- include an inheritance amount on death for products that provide a residual capital value – in this case the account based pension and variable annuity.

The income included in the calculations is:

- The Age Pension;
- Income on any annuity portion; and
- An amount of drawn down from the account based pension to attain, in total, the desired income for the retiree.

The following output is for a newly-retired 67 year old male who wants a desired level of income of $43,000 and has superannuation balance at retirement of $400,000. Each candlestick depicts the 10th, 50th and 90th percentiles for a particular product and time horizon.

Figure 3: Comparison of NPV of income plus inheritance



This assists us in visualising the median outcome and ranges of outcomes from the alternative products, at an "average" lifespan and alternatives. The results are intuitive and our observations can be summarised as:

Average payouts over an average lifespan are similar

At the expected life time horizon, the median outcome across the products is comparable. This seems reasonable as each product is, broadly speaking, returning initial capital plus investment earnings after fees or charges. It might seem surprising that the account based pension does not provide significantly higher "average" returns than an annuity, as we have assumed higher mean returns for the more growth oriented (riskier) asset mix. However this can be explained by the difference between mean and median outcomes, which is explored further in Appendix B.

Those who live longer receive more, especially with annuities

The NPV of income increases with the time horizon for all products, largely because the Age Pension is received for longer, and it does so even more for annuity products as the payments under these contracts also match the retiree's lifespan.

Variability of payout differs greatly by product

The account based pension and variable annuity demonstrate the largest variability of outcomes, due to their greater exposure to risky assets. The lifetime annuity has minimal variability.

Greater annuitisation means payout varies more with lifespan

As expected, the lifetime annuity performs well for the longer life expectancies, and not so well if the person dies ten years before life expectancy. The account based pension plus deferred lifetime annuity hybrid is the next most protected against longevity, followed by the variable annuity and account based pension plus lifetime annuity hybrid.

Comparison B – Desired income attainability

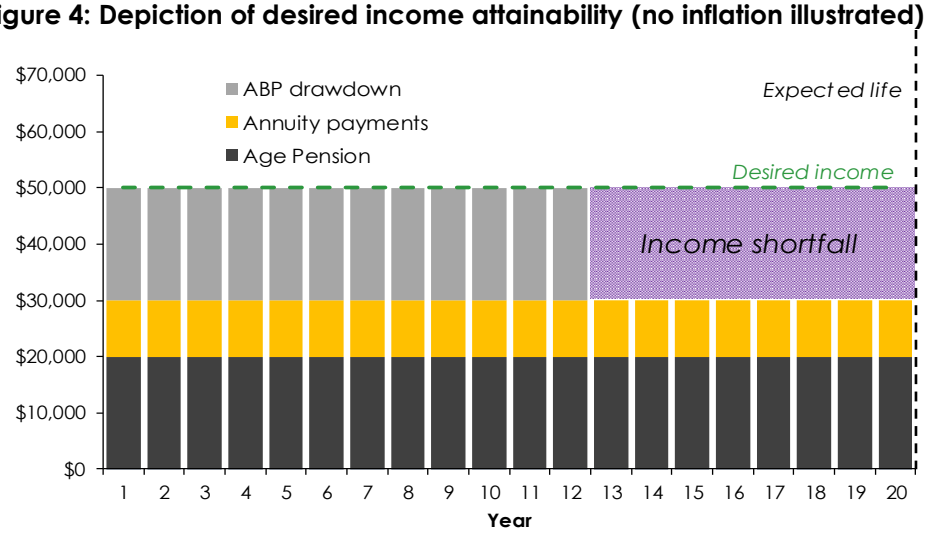
Using the same visualisation as the previous comparison, we now examine "desired income attainability", defined as the ratio between the actual income (again including the Age Pension) received by the retiree to their desired income, this time ignoring any amount left for inheritance at the presumed date of death.

As an example of this measure, if a retiree desired $50,000 per annum and received exactly $50,000 per annum up until their expected life of 20 years, this would equate to a desired income attainability of 100%. Similarly, the same retiree who received $50,000 per annum in all but the last 8 years, in which they received $30,000 per annum, would have a desired income attainability of

$$\frac{50{,}000 \times 12 + 30{,}000 \times 8}{50{,}000 \times 20} = 84\%$$

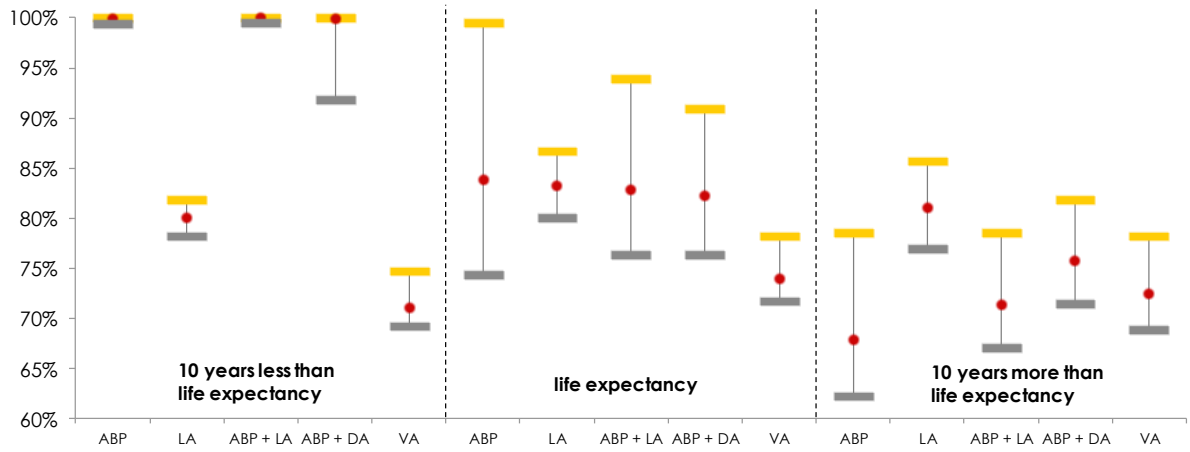
This example is illustrated below in Figure 4 below, where the shortfall area represents 16% (being 100% minus the desired income attainability of 84%) of the total area bounded by the desired income and the expected life.

Figure 4: Depiction of desired income attainability (no inflation illustrated)



The example above is for one particular combination of market scenario, product and time horizon. We can produce the desired income attainability metrics for several combinations of these dimensions to produce the chart below. Again, each candlestick depicts the 10th, 50th and 90th percentiles for a particular product and time horizon. The results are for the same example as above.

Figure 5: Comparison of desired income attainability



While it is using the same underlying information as the NPV chart, this comparison accentuates the differences in income received between the products. Our observations are summarised as follows:

Focus on the income goal has high visual impact

This measure provides a view more closely linked to the retirement goal of income generation, and would likely have more impact than the NPV measure above to many individuals in understanding the potential range of outcomes.

At average lifespans we clearly see the risk reward trade-off

At the expected life time horizon we see the variability in desired income attainability for the account based products, which is due to the underlying asset class investments providing variability in when the account balance will be depleted. However, for this example, the account based pension is still expected to perform well much of the time, with the median outcome delivering 84% of the desired level of income.

Those who live longer receive more, and with more certainty, if they annuitise

At the EL + 10 time horizon the account based products spend longer with depleted asset balances so this measure is again lower. Unsurprisingly the immediate lifetime annuity provides a relatively known and steady income (some variability arises from the Age Pension and indexation), and produces the best outcomes at the longest time horizon. The performance of the "partially" annuitised hybrids lies between the account based pension and the lifetime annuity. Conversely retirees may not be satisfied that during their active retirement years they are only receiving 80% of their desired level of income and, if they live less than an average lifespan, are likely to be better off not annuitising.

Variable annuities are not flattered by these metrics

The variable annuity in this example performs reasonably well at the EL + 10 horizon but relatively poorly for both the EL-10 and EL time horizons. The shorter term performance is impacted by our assumption that the drawdown is limited to the product payment rate. Over the longer term, the higher fees impact asset balances and account longevity, limiting its upside, but guaranteed income levels provide some downside protection. In some specific scenarios with strong early asset growth but subsequent declines, the variable annuity will be the strongest performer. However these scenarios are not sufficient in number to tip this analysis in favour of variable annuities.

5. SEARCHING FOR THE OPTIMAL PRODUCT

In the previous sections we compared different products or combinations. Our results of those comparisons provided motivation to explore product combinations of various proportions of account based pension and immediate lifetime annuity. While a 25% proportion invested in an annuity appears promising, we would like to determine a basis for suggesting an optimal proportion for particular retirement balance and desired income combinations. As before this optimum might consider:

1. Total income, or NPV of income, over life
2. The income stream received relative to desired income
3. Years relative to lifespan until assets are exhausted
4. Inheritance amount at death

In addition we believe there is also a benefit to having:

5. Least volatility in the outcomes above (all other things equal); and
6. Access to liquidity.

The multiple dimensions of outcome present a problem for optimisation – we need some way to trade these off against each other and produce a summary outcome that we can use to rank the products, or combinations of products.

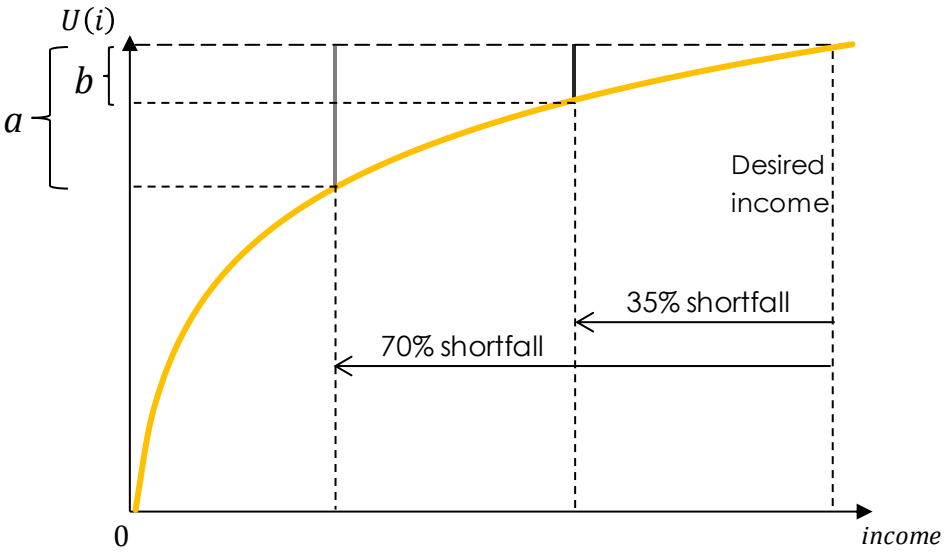
In an attempt to reduce the dimensions to something that would allow us to explore optima we decided to:

- Represent our first two criteria by focusing on any shortfall in income versus the set "desired income"
- Account for our third and fourth criteria by considering this shortfall up until the retiree's expected life and considering any inheritance available at the end of this time horizon.
- Capture volatility by presenting outcomes based on various percentiles of market performance (as we did in sections 5 and 6)
- Limit annuity allocations to 50% of any superannuation balance to ensure that liquidity is available in at least the initial years of retirement.

Although we have now reduced the dimensionality of the problem somewhat, we still have an issue; we have no way of determining whether an account based pension providing a retiree's desired income for 10 years and nothing thereafter is better than an annuity providing for 50% of the retiree's desired income for 20 years (for example). To address this, we could consider using a one-size-fits-all utility function.

The utility function considered in this context reflects the view that individuals generally experience decreasing marginal utility in relation to income. What this means is that a given individual would value the first dollar they receive more than the second, the second more than the third and so on. This is illustrated in the chart below.

Figure 6: Example income utility function



Here we can see that although the marginal benefit – that is, the incremental increase in utility with each dollar of income – is higher at the lower levels of income. We have used this to represent our belief that a retiree would rather fall short of their desired income by 35% for two years rather than fall short by 70% for one year. In the above diagram, this inequality may be expressed as $a > 2b$.

Using a utility curve provides a means by which we may compare different income scenarios. However, we are still left with three key issues:

1. Different retirees will have different trade-offs based on their own preferences and these preferences are not readily accessible to us, so a one-size-fits-all solution may lead to inappropriate conclusions
2. A utility function would present considerable challenges to being easily communicated by financial advisers to their clients
3. Even if the concept of utility were more easily understood, retirees anecdotally prefer concrete examples such as impacts of stress tests on their financial assets, as opposed to academic concepts such as utility

The results of the calculations that we performed with sample utility curves, while interesting, raised as many questions about the appropriate curve as they provided insight to an "optimal" product mix. We therefore concluded, considering also the issues above, not to further pursue the use of a utility function.

We did, however, believe that the trade-offs we explained with the utility concept are relevant and the challenge remained to carefully present these trade-offs in a way which could be easily understood and could facilitate a meaningful adviser discussion to assist retirees make an informed decision about how to receive their retirement income. We quickly found that, with so many dimensions, it is difficult to concisely present and contrast outcomes for different products, or combinations or products. The problems in assuming trade-offs translated into problems presenting this information in a meaningful way. The following section suggests how these trade-offs might be presented.

6. OPTIMAL ANNUITY ALLOCATION FOR INDIVIDUALS

In the Section 4 we compared different products or combinations. Our results of those comparisons provided motivation to explore product combinations of various proportions of account based pension and immediate lifetime annuity. This is because, while deferred lifetime annuities appear to have promise, they are not readily available in the Australian marketplace and are unlikely to be available without changes to the tax rules. Furthermore, the performance of the variable annuities at the EL and EL - 10 time horizons relative to the account based pension led us to exclude them from the optimisation analysis.

We proceeded similarly to how we had previously, by:

- Representing our income criteria by focusing on any shortfall in income versus the set "desired income" for expected life
- Considering this shortfall up until the retiree's expected life, disregarding subsequent years, but also illustrating any assets remaining which would be available for inheritance
- Retaining a stochastic model to produce a range of scenarios and illustrating the 10th, 50th and 90th percentiles

To illustrate the outcome for different outlooks of "expected life" we repeated the exercise for lifespans which exceeded and fell short of the statistical expectation by 10 years.

For the calculations in the remainder of this section, we have made the following assumptions:

- All fixed costs are paid upfront
- That an annuity would form part of a retiree's defensive asset mix so that we would invest the account based pension more heavily in growth assets as we increase our annuity allocation. We have assumed that a 0% annuity allocation would lead to a 60:40 account based pension, a 25% annuity allocation would lead to a 70:30 invested account based pension and that a 50% annuity would lead to a 80:20 invested account based pension.
- As in sections 5 and 6, the product combinations we explored are varying proportions of account based pension and annuity. As retirees typically prefer to retain some liquidity, we have not illustrated annuity proportions above 50%.
- That the economic environment is similar to the current low inflation environment.

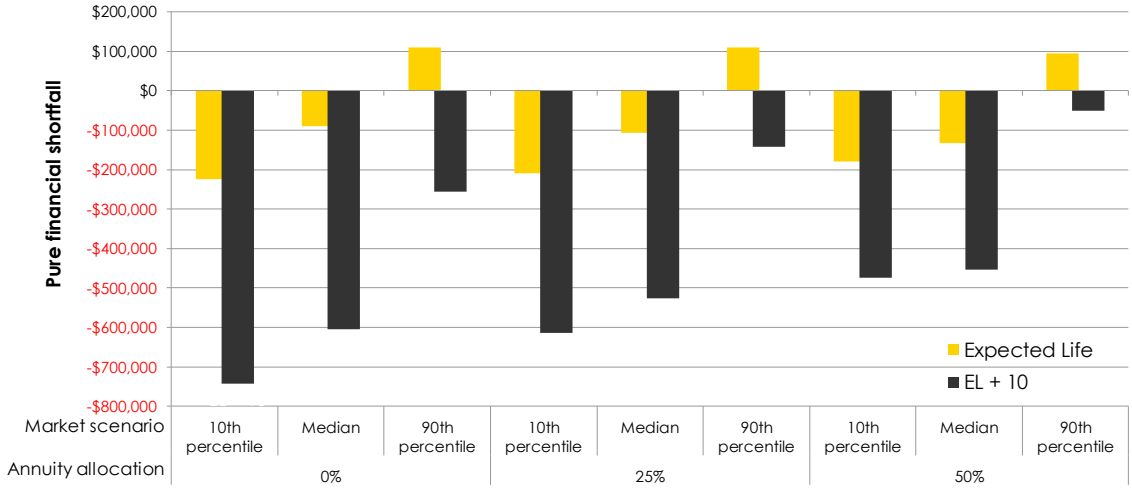
We performed the analysis on several retiree profiles which are provided in the table below. This section comments on results for profile 2. For all other results, see Appendix D.

Table 4: List of retiree profiles that were analysed

Profile	Family Status	Gender	Account balance	Desired income
1	Single	Male	$200,000	$30,000
2	Single	Male	$400,000	$43,000[14]
3	Single	Male	$600,000	$43,000[15]
4	Single	Male	$1,000,000	$58,000
5	Couple	Male and female	$250,000	$40,000
6	Couple	Male and female	$500,000	$58,000[15]
7	Couple	Male and female	$700,000	$58,000[16]
8	Couple	Male and female	$1,200,000	$73,000

Our first step in this optimisation analysis was to revisit the concept of shortfall (Figure 2) – which is the cumulative, non-discounted sum of monthly income "misses" (desired income minus actual income) over the projection period. In addition, we add any potential inheritance if there is any account balance remaining at the end of the projection period. So, a negative amount represents a shortfall and a positive amount represents an inheritance amount. The results below are for a single male aged 67 with an account balance of $400,000 and a drawdown rate of $43,000 per annum (profile 2).

Figure 7: Potential inheritance or income shortfall



Outcomes differ greatly depending on the market scenario

In the figure above we can see how the levels of total shortfall over the retiree lifespan vary depending on the market scenario (as represented by the different percentiles) and annuity allocation used. For example, as expected, we see that a pure account based pension (0% annuity allocation) experiences fewer shortfalls in both the EL and EL + 10 cases as the market scenario improves.

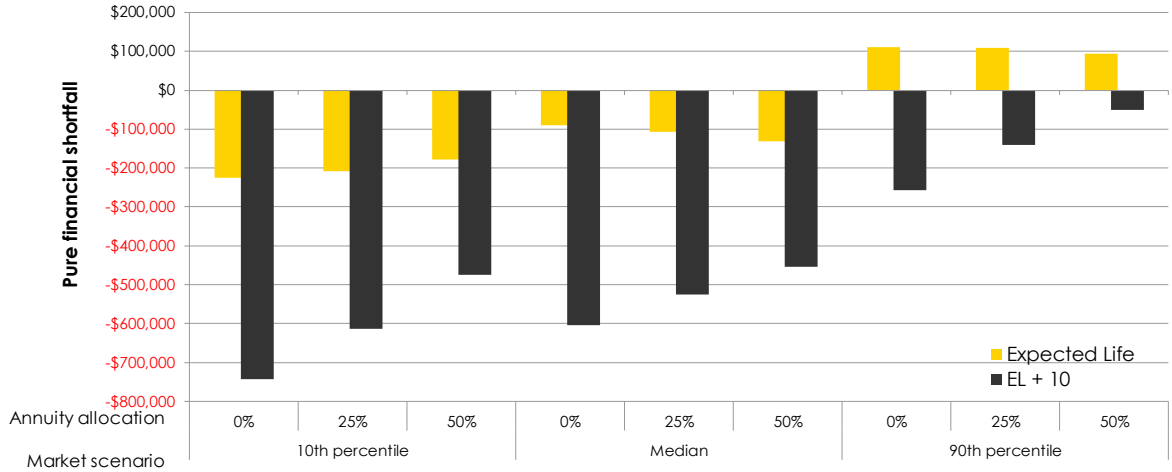
Viewing the same data in a different order can highlight certain stories

Viewing this same information in a different order allows us to more easily notice other trends to come from this modelling. Below is the same graph as above, but with the order of the columns changed so that each set of three column-pairs

[14] This level is approximately equal to the ASFA Comfortable income level for individuals. This represents the annual income needed by Australians to fund a comfortable standard of living in retirement, as estimated by ASFA.
[15] This level is approximately equal to the ASFA Comfortable income level for couples.

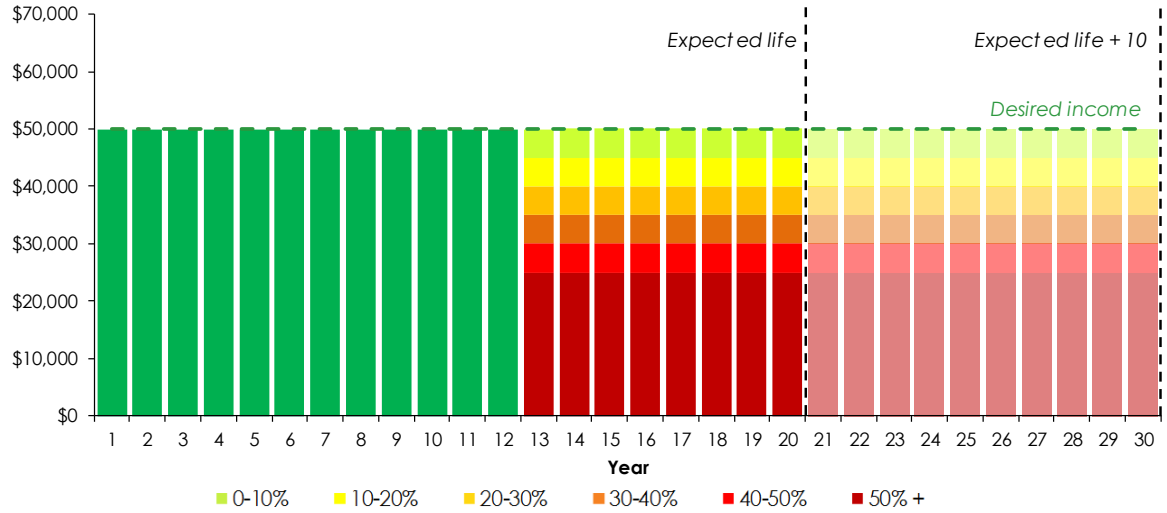
represents the impact of increasing the portfolio annuity allocation within a particular market scenario. This re-ordering makes it clear that in a strong market scenario up to expected life, a 50% annuity allocation does not produce the best outcome and so a retiree with an optimistic outlook on the economy may elect to not annuitise at all. Conversely, a risk averse retiree may annuitse 50% of their portfolio to minimise their shortfall in the event that either market performance is poor or they outlive their expected life, or both.

Figure 8: Potential inheritance or income shortfall (re-ordered)



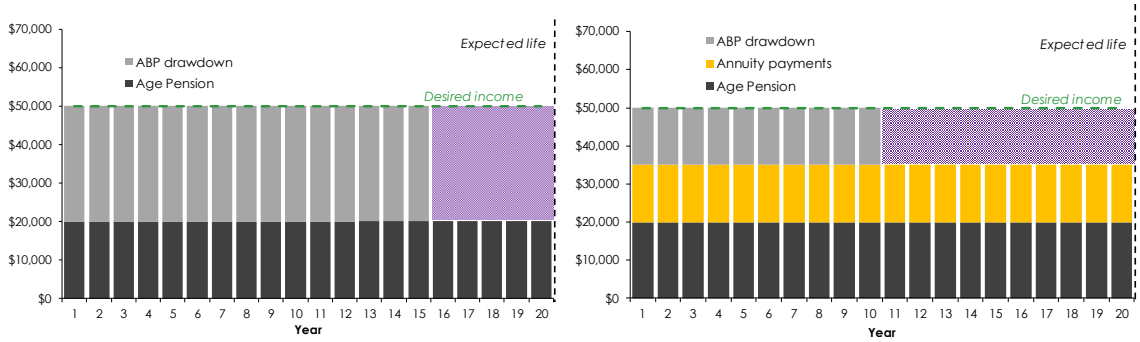
What is missing from this aggregate level picture is the depth and duration of the income shortfall. While the shortfall outcomes at expected life can sometimes be similar for different levels of annuitisation, the depth and duration will differ. In order to present this trade-off between depth and duration of shortfall we assigned a different colour on the chart for a different degree of shortfall, as per the following guide. This presents enough information to inform retirees of the reality of a deep fall in income on account exhaustion, to allow them to compare this against the potential for asset outperformance.

Figure 9: Inflation adjusted income, showing various shortfall levels



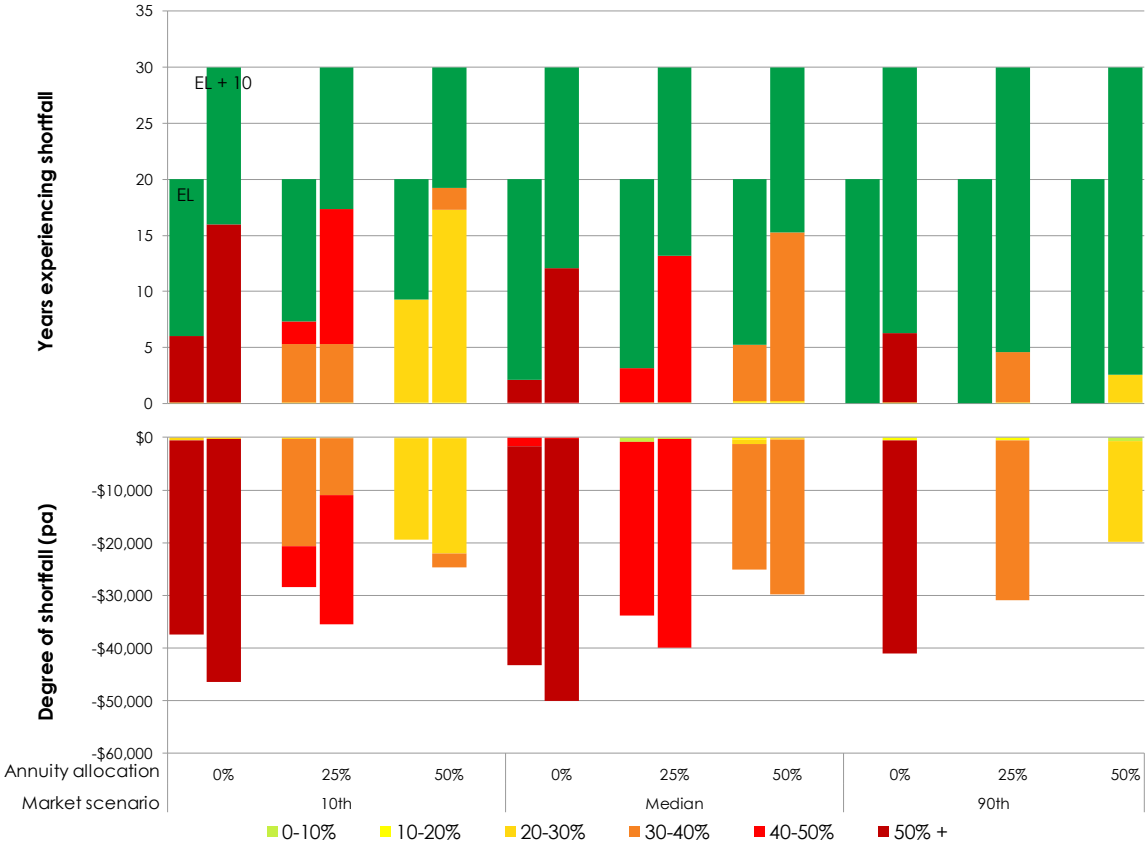
Using this scheme we can present the difference between 0% and 50% annuitisation, in a median market outcome by contrasting these two charts:

Figure 10: Comparison of income shortfall profiles with 0% and 50% annuitisation, respectively



To illustrate, side by side, a greater range of product combinations and economic outcomes, we have used this colour scheme in the following summary chart. The top section of the chart displays the proportion of years that the retiree's desired income is provided for by their chosen product combination. Where there is a period of shortfall, the level of this shortfall is indicated by the colour coding above. Each pair of columns presents this information for the EL and EL + 10 time horizons as introduced in our analysis earlier. The bottom section of the chart shows the average levels of shortfall per annum (provided there was a shortfall) over the given time horizon.

Figure 11: Indicating duration and depth of income shortfall



There is a trade-off between more income in the short term versus more income in the long term

Examining first the median outcomes at expected life, what we see is that, unsurprisingly, by choosing more or less annuitisation we are making a trade-off between a long shortfall and a deep shortfall. However if our intuition about retirees' utility is right then the information around the depth of shortfall should lead some towards more annuitisation. This visualisation of the results for poor market outcomes or longer survival makes, as did Figure 8, more annuitisation appear attractive. This visualisation further amplifies this message by showing relatively few additional years of shortfall, and with significantly less shortfall.

The modelling indicates that an allocation to annuities of up to 50% will, for some retirees, be appropriate and can deliver superior retirement outcomes. However, applying mathematical models to real world client scenarios requires consideration by advisers and their clients of criteria including risk aversion, liquidity needs, health and longevity, expected Age Pension entitlements and income expectations, among others.

7. SUMMARY AND CONCLUSION

Solving the retirement riddle is not easy. To establish the optimal retirement income solution, we first had to establish the features that retirees find valuable. This allowed us to construct measures on which we could compare the performance of retirement income solutions. Since the universe of retirement income solutions is large, we limited our analysis to a set of the most common products, as well as certain combinations of those products.

To investigate the range of outcomes produced by each retirement income solution, we developed a stochastic projection model. We then investigated the performance measures under various economic scenarios and retiree lifespans. The results showed that, as expected, all products – with the exception of the variable annuity – performed similarly in average economic markets, in the base life expectancy scenario. However, account based pensions, which are the most common form of retirement income solution currently, exhibit poorer performance than any of the annuity products when the retiree exceeds their expected life by ten years. The results also showed that combinations of account based pension and lifetime annuity can deliver attractive outcomes. The results for deferred annuities are particularly appealing, confirming that they will be a welcome component of the retirement toolkit.

Based on these results, and the current lack of availability of deferred lifetime annuities, we decided to further investigate the retirement income solution of part account based pension, part lifetime annuity. This still provided us with many dimensions to present and so we considered using a utility function to reduce the dimensionality of the problem. Unfortunately utility functions have their own issues and instead of using one to bypass meaningful financial adviser conversations with retirees about the various trade-offs, we believe there is benefit in presenting these trade-offs in meaningful ways to assist those conversations.

We constructed shortfall charts which display the time experiencing shortfall and the actual dollar value of the shortfall to be expected over the retiree's life. These charts provide insights that may not be available to retirees contemplating incorporating annuities into their retirement income solution. The results show that partial annuitisation, if the benefits are well-presented, may appeal to retirees who are risk averse.

Keeping this in mind, as well as the recent Murray Inquiry's recommendation for all superannuation trustees to offer Comprehensive Income Products for members' Retirement (CIPRs), we believe that this kind of analysis will prove valuable over the next phase of Australia's retirement income landscape.

APPENDIX A – MODEL AND ASSUMPTIONS

We have constructed an asset model to assist us in the analysis and comparison of the various retirement income options. This appendix summarises the methodology and assumptions we have used in our analysis.

Asset Model

We have used a Monte Carlo simulation model to project the performance of future economic variables which are then used in a range of product and asset allocation scenarios. The model enables simulation of the following economic variables:

- Consumer Price Index (CPI)
- Average Weekly Earnings (AWE)
- Cash Rate
- Fixed Income
- Domestic Equity
- International Equity
- Listed Property

The model comprises expected levels and returns of each of these variables, as well as their possible variation and interaction. The expectation and variation of each of the variables is based primarily on economic fundamentals; however in setting these assumptions we do also consider historical experience. The interaction between the variables has been estimated using observed historical levels and returns. Further, we have assumed all continuous time changes in variables are normally distributed and their joint distribution is characterised by a Gaussian copula. This results in lognormal distributions of asset values.

Expected asset returns

The table below presents our expected levels/returns for each of the above variables. These are continuously compoundable returns expressed on an annual basis.

Table 5: Expectations of economic assumptions

Variable	Annual growth/return
CPI	2.5%
AWE	3.5%
Cash rate	4.2%
Fixed income	5.1%
Australian equity	7.8%
Listed Property	7.8%
International equity	8.2%

Covariance structure

The expected returns presented above provide an average around which the quantities will vary. That variation is expressed as volatility (standard deviation of returns) with correlation parameters for each pair of variables.

Table 6: Asset class volatilities

Variable	Volatility
CPI	1.6%
AWE	2.9%
Cash rate	0.4%
Fixed income	3.5%
Australian equity	13.6%
Listed Property	18.4%
International equity	16.3%

Table 7: Asset class correlation matrix

Variable	CPI	AWE	Cash	Fixed Income	Aus Equity	Listed Property	Int'l Equity
CPI	100%	10%	10%	-7%	-4%	0%	-8%
AWE	10%	100%	3%	6%	-11%	0%	-2%
Cash rate	10%	3%	100%	27%	-12%	-17%	-15%
Fixed Income	-7%	6%	27%	100%	-9%	2%	-19%
Aus Equity	-4%	-11%	-12%	-9%	100%	53%	75%
Listed Property	0%	0%	-17%	2%	53%	100%	45%
Int'l Equity	-8%	-2%	-15%	-19%	75%	45%	100%

Expected life

The expected life assumption is critical to the analysis as it represents the time horizon over which the various retirement income solutions are compared. For this assumption, we have chosen a mortality basis that we believe to be representative of the proportion of the population that are most inclined to purchase annuities – white collar retirees. This is heavier than the mortality basis we have used to price the annuities. See Appendix C for more details.

Table 8: Calculated expected lives under a white collar mortality basis

Profile	Expected life
Male aged 67	87
Male and female aged 67	93 (last survivor)

APPENDIX B – MEAN VERSUS MEDIAN OUTCOMES IN A STOCHASTIC PROJECTION

It is common for past asset returns to be analysed to make inferences about future likely returns, and for average past returns to be used as a basis for both deterministic projections as well as to calibrate the mean outcome for stochastic projections. In analysing the range of outcomes of a stochastic projection, one has a range of summary measures that can be used to describe outcomes, including mean and median outcomes. In the context of investing, or drawing down a lump sum, these measures have the following meanings. The median is the amount of dollars expected to be received (or the minimum time the investment is expected to last) 50% of the time. The mean has a more subtle interpretation. If the investment was repeated many times, over consecutive time periods, and the relevant measures recorded, the mean estimates the arithmetic average of these outcomes. In the context of investing retirement savings to provide an income for life, it seems more natural to focus on the median outcome, as investors cannot repeat their retirement and take a long run average. Gaining an appreciation of more extreme outcomes will add to this picture.

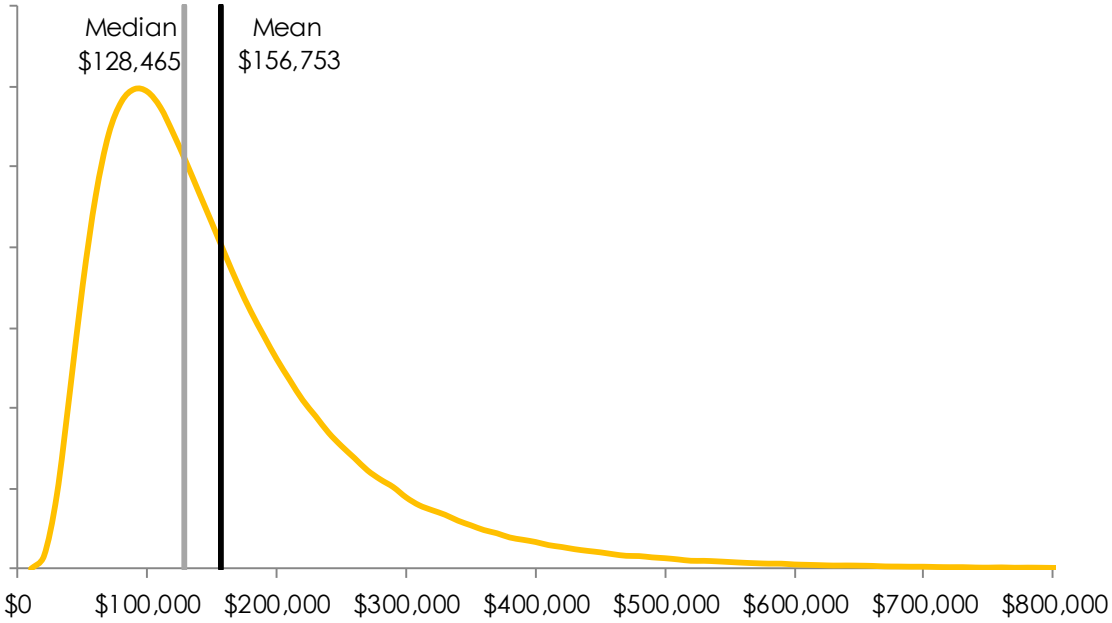
Since the distributions of investment proceeds are strongly skewed to the right, the median will be less than the mean. An interesting corollary of this is that a deterministic projection, using average returns will produce the mean outcome of the stochastic projection, which exceeds the median and runs the risk of being misunderstood in terms of its likelihood of being achieved, as this will be less than 50%. In this appendix, we explore these differences between mean and median in the context of our model.

In our stochastic model, asset prices in an account based pension are assumed to follow a lognormal distribution[16]. A common property of the lognormal distribution is that the mean is $e^{\mu+\frac{1}{2}\sigma^2}$ whilst the median is e^{μ}, where μ and σ represent the mean and standard deviation of the underlying normal distribution of continuous time asset returns. This means that an asset stochastically projected with a lognormal distribution will experience a distribution of outcomes where the mean will be greater than median by a factor of $e^{\frac{1}{2}\sigma^2}$. As for the trivial case of $\sigma = 0$, this represents a deterministic projection whereby the median outcome will, of course, be equal to the mean.

Let us first look at the distribution of asset values after ten years given a starting value of $100,000. As expected, the mean is larger than the median due to the fat tail outcomes pushing up the average.

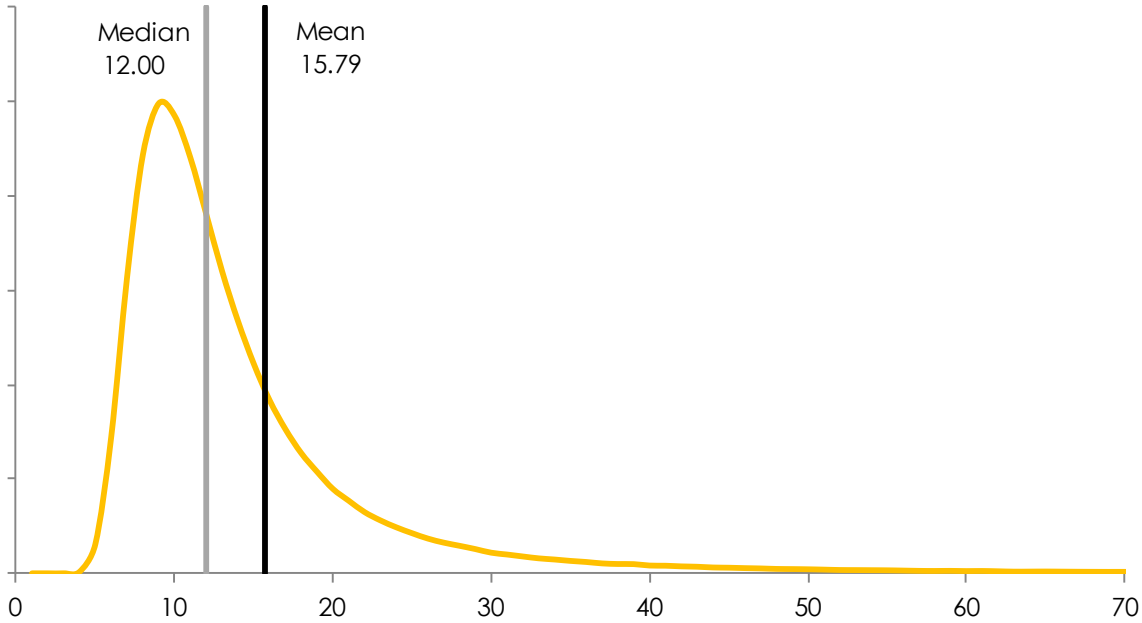
[16] Although we are aware of the limitations of this distribution, it is commonly used in industry to value equity derivatives

Figure 12: Lump sum of $100,000 accumulated for 10 years



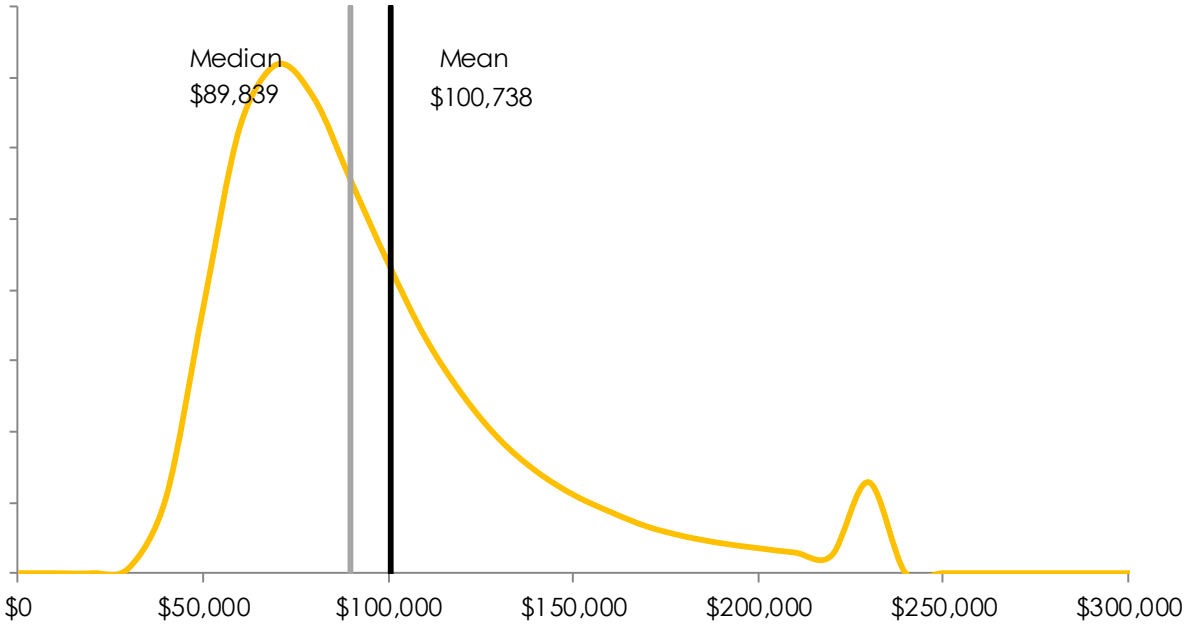
Now we will extend the first example, assuming an annual drawdown amount of $10,000 and we will investigate the distribution of years to account balance exhaustion. Again we see a fat-tailed distribution and, even though it is not necessarily lognormal this time, we again see the mean proving to be larger than the median.

Figure 13: Distribution of years to account balance exhaustion



Finally we observe the distribution of the NPV of the drawdown amounts described above. For the purpose of this analysis, we limited the projection period to 80 years. Again we see the median smaller than the mean.

Figure 14: Distribution of NPVs of drawdowns from $100,000 balance at $10,000 pa



In summary, the implication of this phenomenon is two-fold:

1. Deterministic models, although sometimes useful for their simplicity, do not incorporate asset volatility and therefore care should be used communicating results from such models as they are likely to exceed median outcomes, and are likely to be achieved less than 50% of the time.
2. Even though larger return assumptions may be used for account based pensions than annuities, a comparison of median scenarios may not necessarily favour the account based pension due to their higher volatility and the median being smaller than the mean by $e^{\frac{1}{2}\sigma^2}$.

APPENDIX C – PRODUCT ASSUMPTIONS

This section details the various assumptions made in the projection model for the following products or combinations of products:

- Account based pension
- Lifetime annuity
- Variable annuity
- Account based pension + deferred lifetime annuity
- Account based pension + immediate lifetime annuity

Account based pension

In our model, the account based pension invests the initial dollar amount available for investment into a fund with an asset allocation as set out in Table 9 below. Income is drawn from the fund in accordance with the retiree's income requirements and subject to the Government-specified minimum annual payments for superannuation income streams. The assets are assumed to be continuously rebalanced so that the allocations below are always observed.

Asset allocations

Table 9: Account based pension asset allocations depending on annuity proportion

Asset class	0% Annuity Allocation	25% Annuity Allocation	50% Annuity Allocation
Cash	6.0%	4.5%	3.0%
Fixed Income	34.0%	25.5%	17.0%
Australian Equity	24.0%	28.0%	32.0%
Listed Property	15.0%	17.5%	20.0%
International Equity	21.0%	24.5%	28.0%

Fees

The table below summarises the current fee structure under the account based pension product.

Table 10: Account based pension fee structure

Fee	Amount
Ongoing account fee	1.0%

Lifetime annuity

The lifetime annuity is modelled as a traditional lifetime annuity that pays a certain amount (indexed to CPI) per annum for the lifetime of the purchaser, with no guarantee period and therefore no capital return on death. This amount is determined based on the initial outlay used to purchase the annuity as well as the customer's age and sex. This calculation is performed within the model using mortality tables to calculate an actuarially fair annuity rate, subject to assumptions about the customer's family situation, the insurer's expense and profit margins (exclusive of the advisor fee) and tax.

Annuity pricing assumptions

The net of expenses and profit margin internal rate of return (IRR) used in the annuity calculations is 3.69%. Note that this is not the annuity rate, since that varies depending on the individual and the type of annuity purchased. For example, a 67 year old male with $500,000 to invest would receive $29,291 per annum (first year) from a CPI-indexed immediate lifetime annuity. The resulting annuity rates were consistent at the time of our calculations, after allowing for differences in bond returns between our model and the economy, with rates available in the market.

Mortality assumptions

The mortality tables and mortality improvement assumptions used in the annuity calculations lead to the following expected lives for the two retiree types investigated:

Table 11: Calculated expected lives under the annuity mortality basis

Profile	Expected life
Male aged 67	88
Male and female aged 67	96 (last survivor)

Variable annuity

The variable annuity modelled is much like an account based pension in which the initial dollar amount available for investment is placed into a fund with a specified asset allocation (Defensive, Moderate, Growth). However the retiree has no control over the income drawn out of the account balance, as this is fixed at purchase, subject to the rules below:

Table 12: Age pension payment rates

Age at issue	Payment rate (pa % of protected income base over the life of the VA)
Under 65	4%
65 and over	5%

The dollar amount of income received per annum may change depending on the Government-specified minimum annual payments for super income streams.
The dollar amount may also increase due to ratcheting or decrease due to SIS minimum payments requiring higher than planned income payments being made.

Ratcheting

The percentage listed in Table 12 above is applied to the protected income base. The protected income base is initially set equal to the account balance and is redefined every year. If the account balance is higher than the protected income base at the end of a particular year, the protected income base is reset to be equal to the account balance. In this way, the retiree is rewarded for strong economic performance within their fund. This ratcheting feature is paid for by a guarantee fee, which we have assumed to be 2.00% pa for a 60/40 portfolio.

Asset allocations

Table 13: Variable annuity asset allocations

Asset class	Allocation
Cash	6.0%
Fixed Income	34.0%
Australian Equity	24.0%
Listed Property	15.0%
International Equity	21.0%

Fees

The table below summarises the current fee structure under the variable annuity product.

Table 14: Variable annuity fee structure

Account balance	Fee
First $200,000	0.40% pa
Next $600,000	0.25% pa
Over $800,000	0.20% pa

Plus:

- Investment fee: 0.80% pa
- Guarantee fee: 2.00% pa
- Spouse benefit: 0.90% pa

Account based pension + deferred annuity (75:25)

This product splits the initial amount available for investment between the account based pension and the deferred annuity products. The proportion invested in the account based pension is drawn down such that the customer's desired income is met until account balance depletion. The remainder is invested into a deferred annuity product which has a deferment period equal to the expected exhaustion of the account based pension.

The cost of the deferred annuity is determined using the same model as the immediate annuity, including the assumptions that it would be available in a zero tax environment, which is currently not the case in Australia.

Account based pension + lifetime annuity (75:25)

This product splits the initial amount available for investment between the account based pension and the lifetime annuity products. The proportion invested in the account based pension is drawn down such that the customer's desired income is met until account balance depletion. The remainder is invested into an indexed lifetime annuity product.

APPENDIX D – ANNUITY ALLOCATION OUTPUT

In section 6 of this paper we used several charts to visualize the financial shortfall, or surplus, against retirement goals for some sample retiree profiles. In this appendix we include those charts for a wider range of profiles as set out in the following table.

Table 15: List of retiree profiles that were analysed

Profile	Family Status	Gender	Account balance	Desired income
1	Single	Male	$200,000	$30,000
2	Single	Male	$400,000	$43,000
3	Single	Male	$600,000	$43,000
4	Single	Male	$1,000,000	$58,000
5	Couple	Male and female	$250,000	$40,000
6	Couple	Male and female	$500,000	$58,000
7	Couple	Male and female	$700,000	$58,000
8	Couple	Male and female	$1,200,000	$73,000

Figure 15

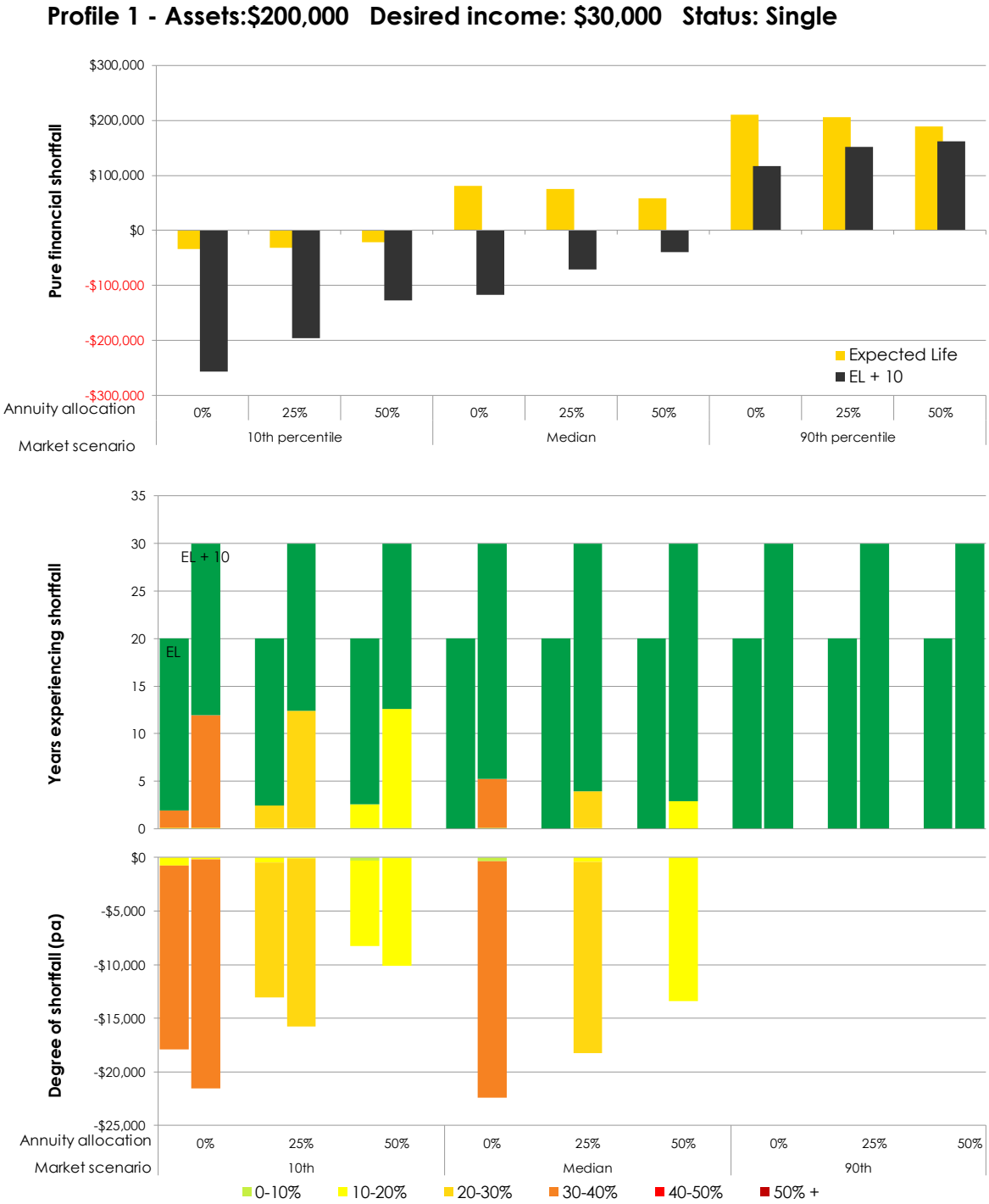

Profile 1 - Assets:$200,000 Desired income: $30,000 Status: Single
Pure financial shortfall
$300,000
$200,000
$100,000
$0
-$100,000
-$200,000
-$300,000
Expected Life
EL + 10
Annuity allocation
0%
25%
50%
Market scenario
10th percentile
Median
90th percentile
Years experiencing shortfall
35
30
25
20
15
10
5
0
EL + 10
EL
Degree of shortfall (pa)
$0
-$5,000
-$10,000
-$15,000
-$20,000
-$25,000
Annuity allocation
Market scenario
10th
Median
90th
0-10%
10-20%
20-30%
30-40%
40-50%
50% +

Figure 16

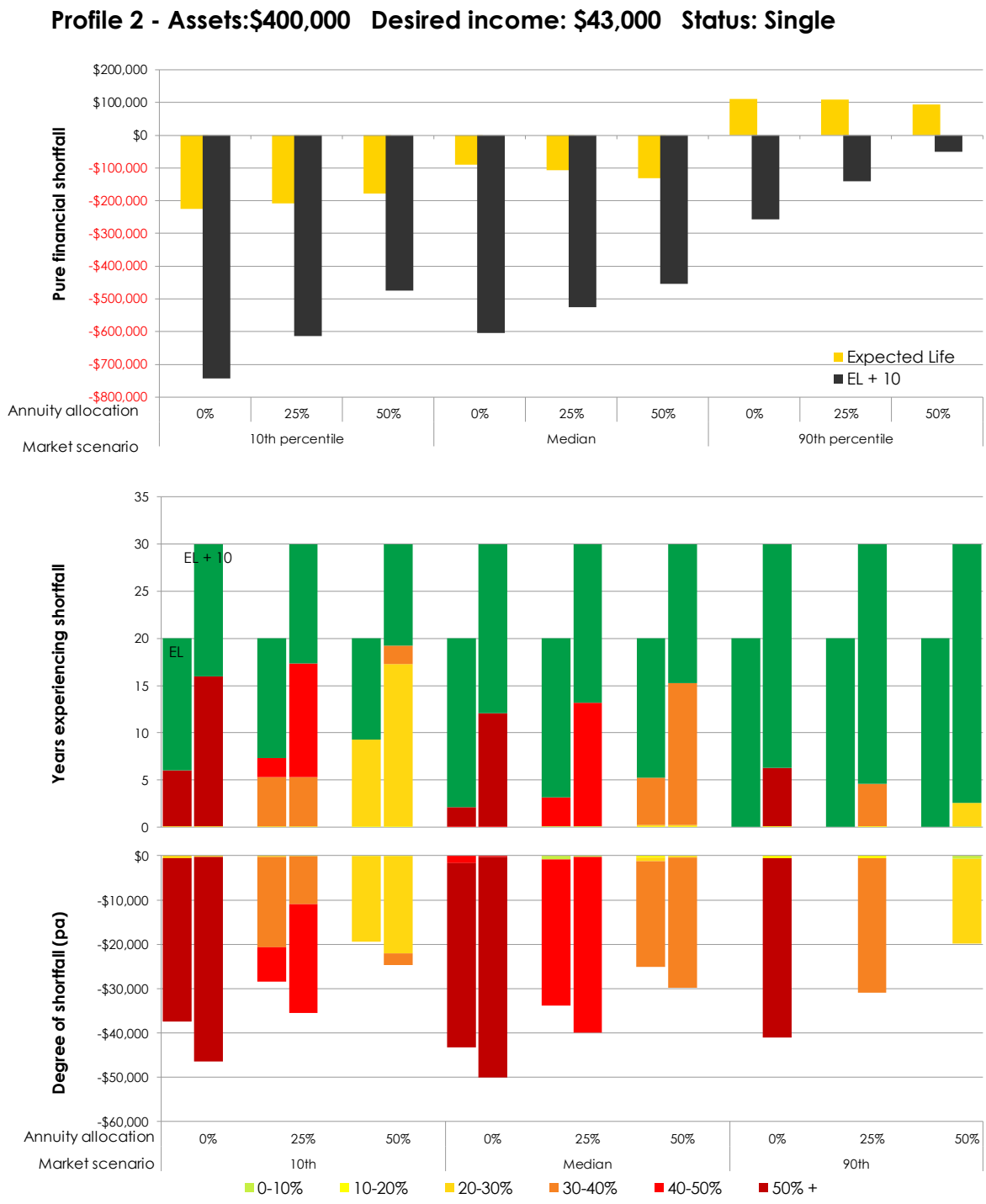

Profile 2 - Assets:$400,000 Desired income: $43,000 Status: Single
Pure financial shortfall
$200,000
$100,000
$0
-$100,000
-$200,000
-$300,000
-$400,000
-$500,000
-$600,000
-$700,000
-$800,000
Expected Life
EL + 10
Annuity allocation
0%
25%
50%
0%
25%
50%
0%
25%
50%
Market scenario
10th percentile
Median
90th percentile
Years experiencing shortfall
35
30
25
20
15
10
5
0
EL + 10
EL
Degree of shortfall (pa)
$0
-$10,000
-$20,000
-$30,000
-$40,000
-$50,000
-$60,000
Annuity allocation
0%
25%
50%
0%
25%
50%
0%
25%
50%
Market scenario
10th
Median
90th
0-10%
10-20%
20-30%
30-40%
40-50%
50% +

Figure 17

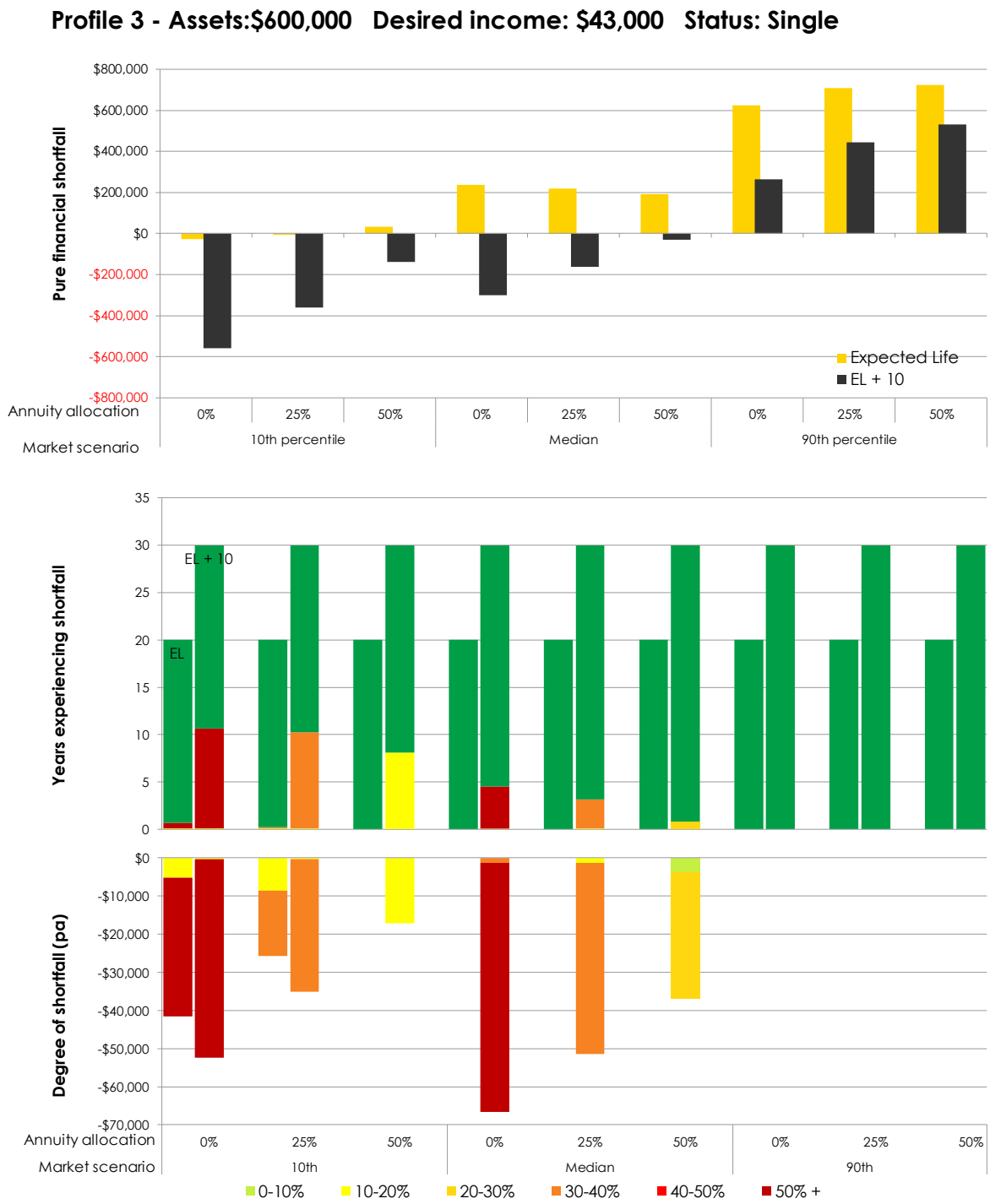

Profile 3 - Assets:$600,000 Desired income: $43,000 Status: Single
Pure financial shortfall
$800,000
$600,000
$400,000
$200,000
$0
-$200,000
-$400,000
-$600,000
-$800,000
Expected Life
EL + 10
Annuity allocation
0%
25%
50%
Market scenario
10th percentile
Median
90th percentile
Years experiencing shortfall
35
30
25
20
15
10
5
0
EL + 10
EL
Degree of shortfall (pa)
$0
-$10,000
-$20,000
-$30,000
-$40,000
-$50,000
-$60,000
-$70,000
10th
0-10%
10-20%
20-30%
30-40%
40-50%
50% +

Figure 18

Profile 4 - Assets:$1,000,000 Desired income: $58,000 Status: Single

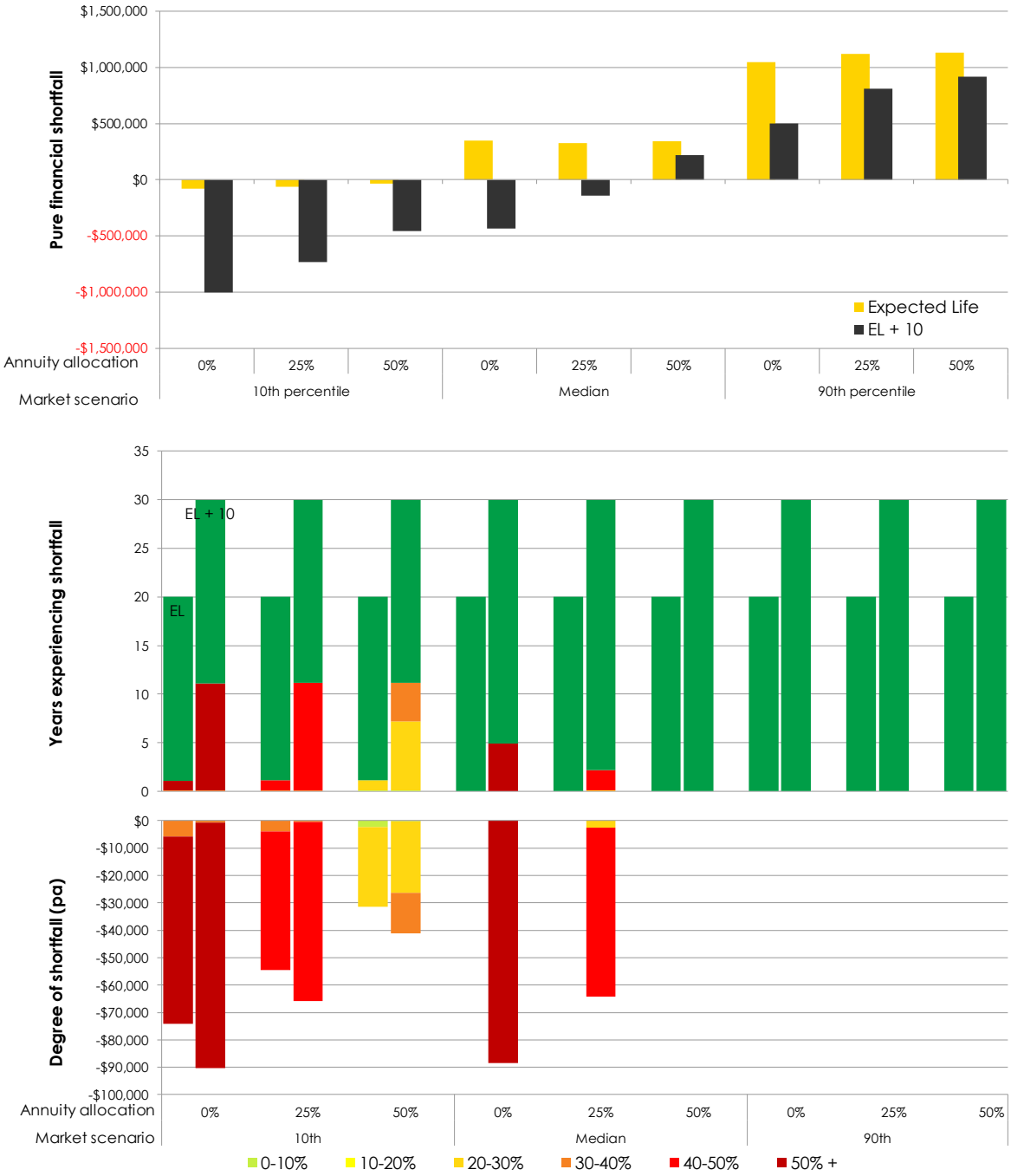


Figure 19

Profile 5 - Assets:$250,000 Desired income: $40,000 Status: Couple

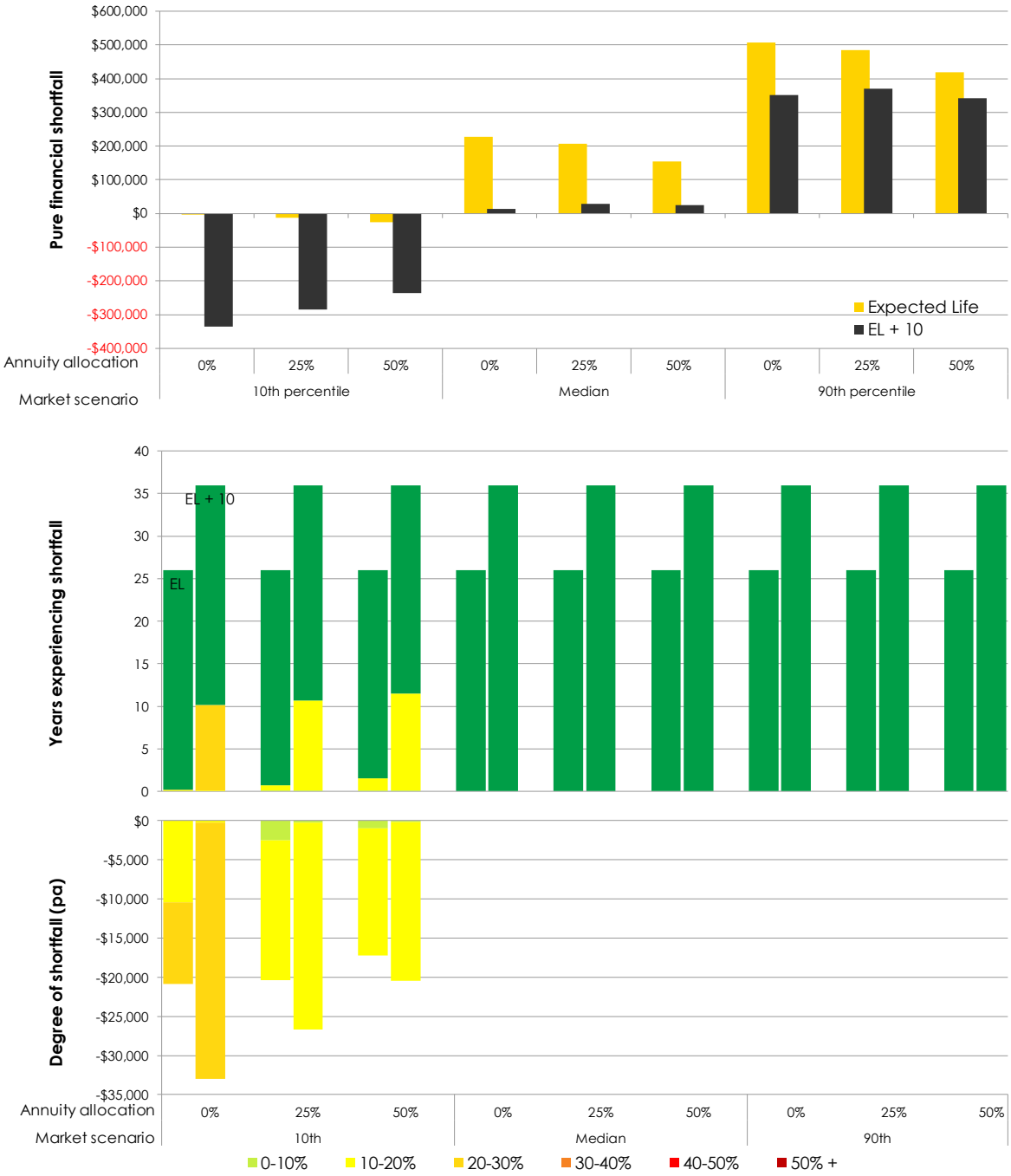


Figure 20

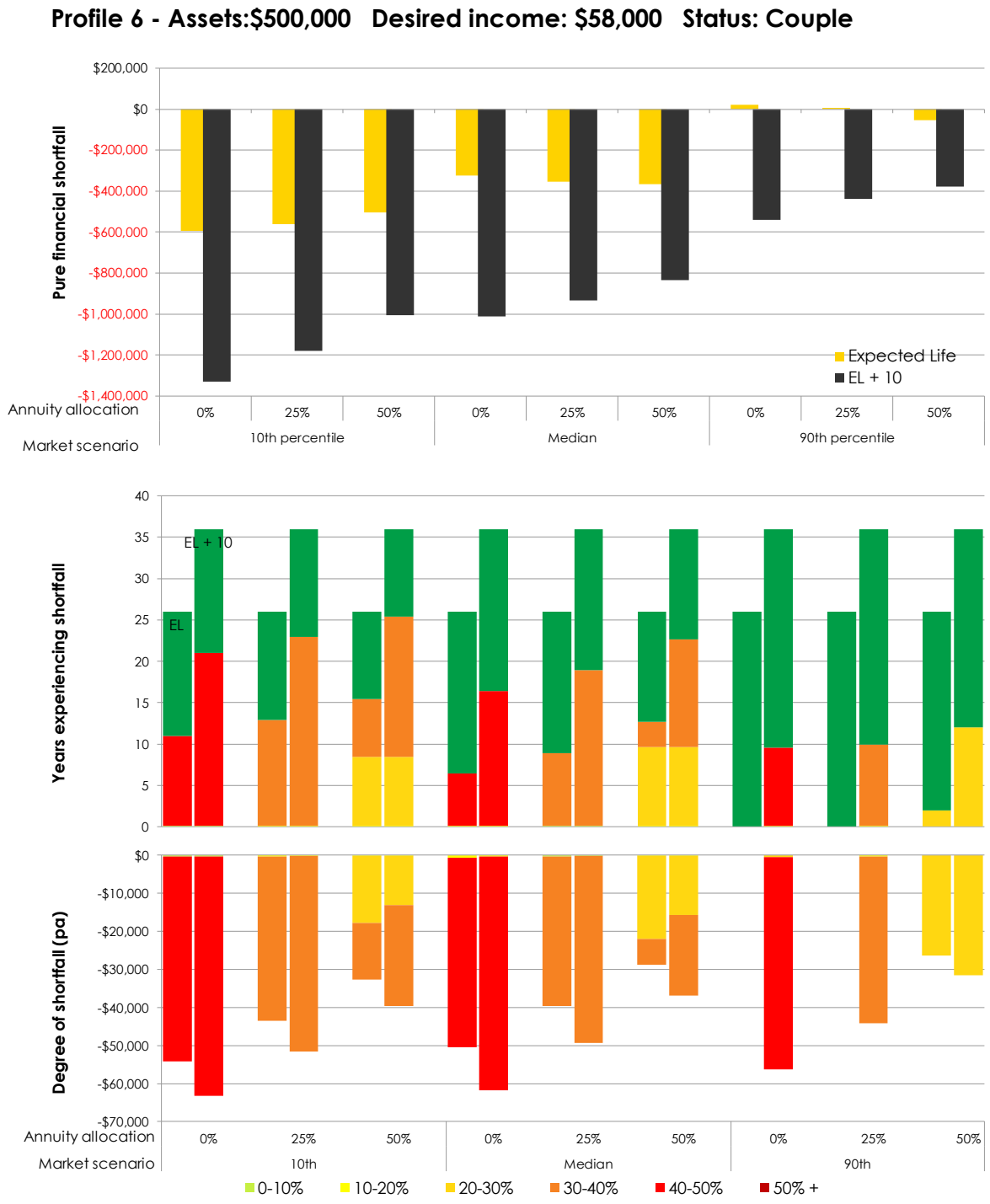

Profile 6 - Assets:$500,000 Desired income: $58,000 Status: Couple
Pure financial shortfall
$200,000
$0
-$200,000
-$400,000
-$600,000
-$800,000
-$1,000,000
-$1,200,000
-$1,400,000
Expected Life
EL + 10
Annuity allocation
0%
25%
50%
Market scenario
10th percentile
Median
90th percentile
Years experiencing shortfall
40
35
30
25
20
15
10
5
0
EL + 10
EL
Degree of shortfall (pa)
$0
-$10,000
-$20,000
-$30,000
-$40,000
-$50,000
-$60,000
-$70,000
10th
0-10%
10-20%
20-30%
30-40%
40-50%
50% +

Figure 21

Profile 7 - Assets:$700,000 Desired income: $58,000 Status: Couple

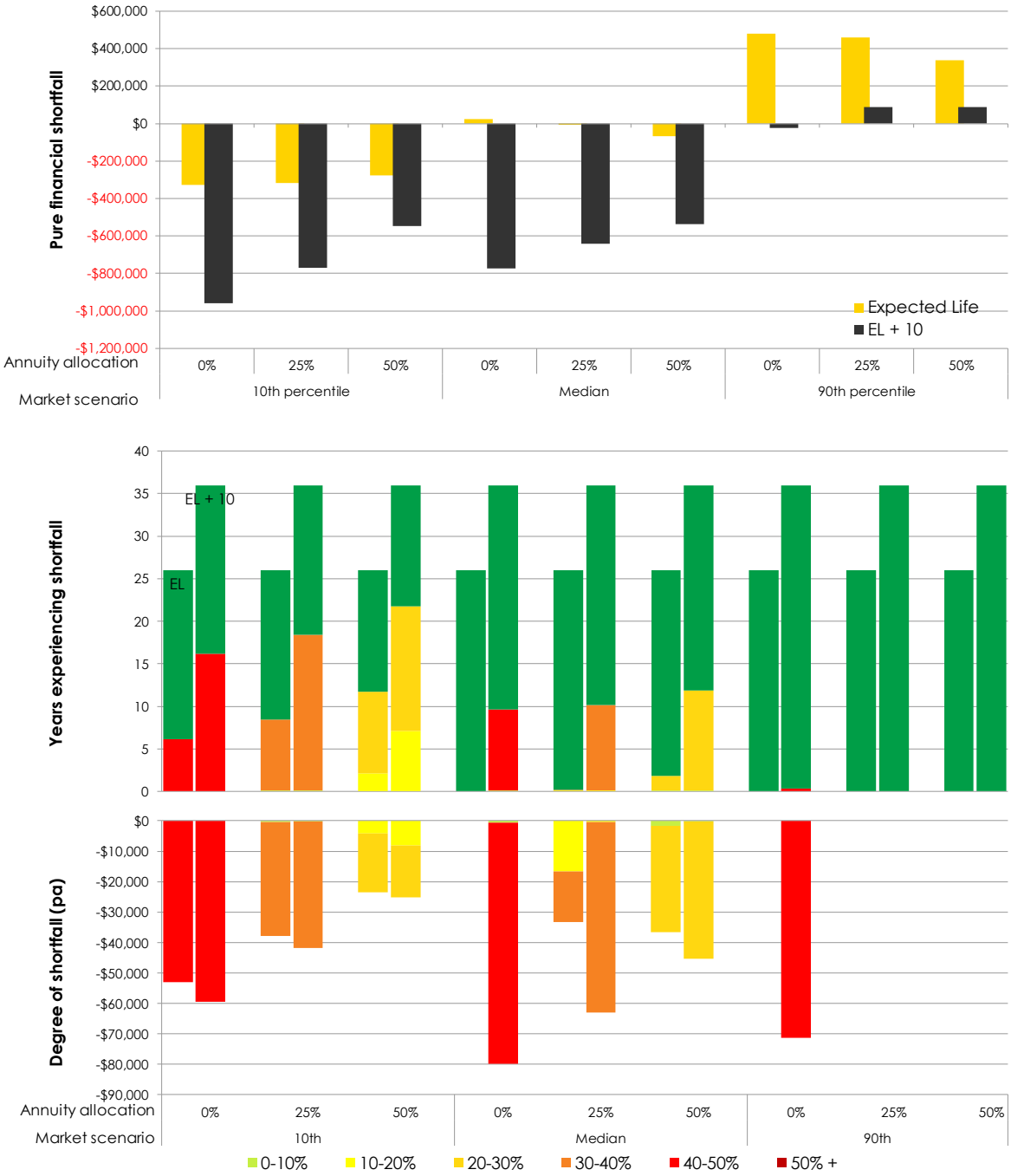
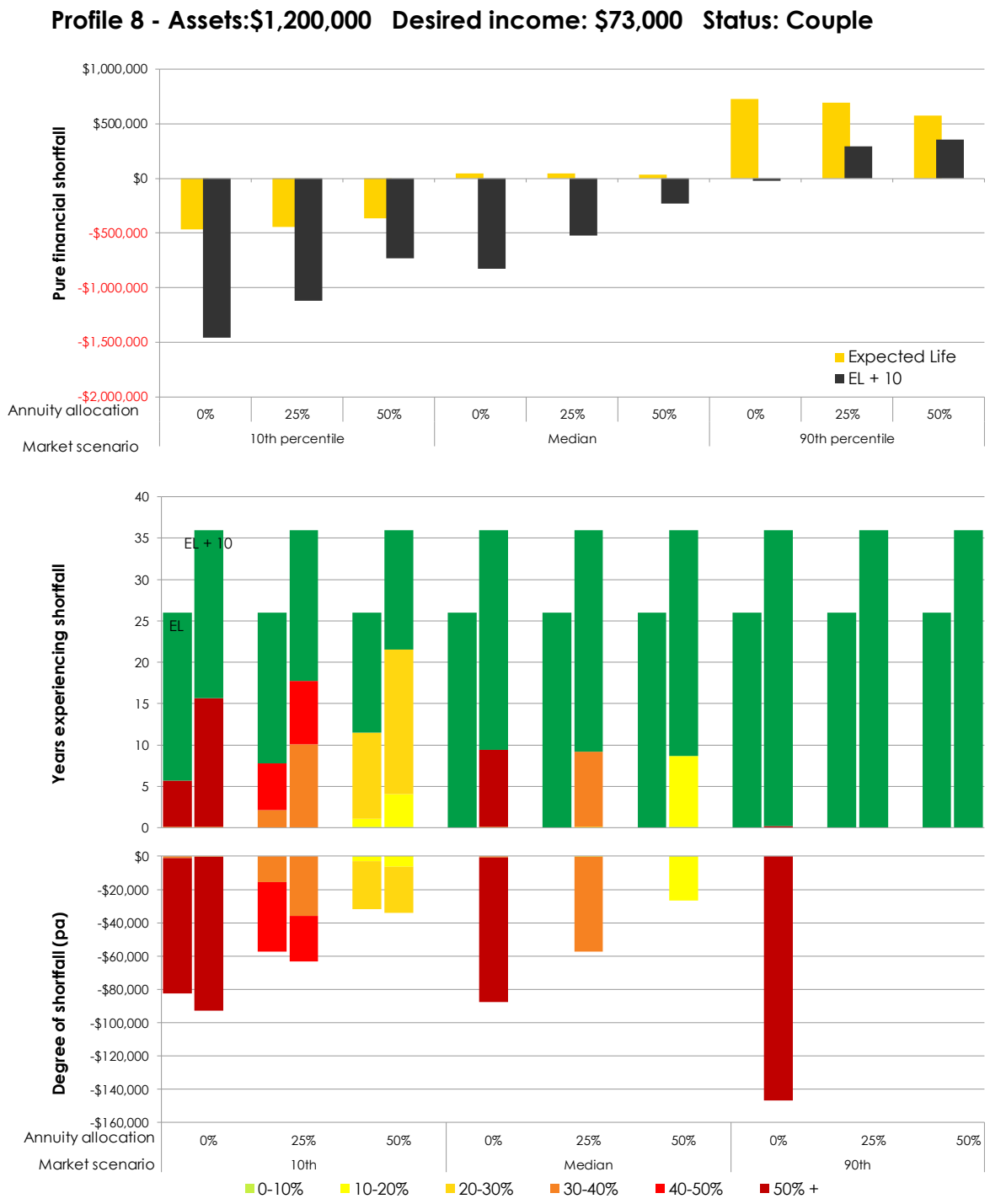


Figure 22


Profile 8 - Assets:$1,200,000 Desired income: $73,000 Status: Couple
Pure financial shortfall
$1,000,000
$500,000
$0
-$500,000
-$1,000,000
-$1,500,000
-$2,000,000
Expected Life
EL + 10
Annuity allocation
0%
25%
50%
Market scenario
10th percentile
Median
90th percentile
Years experiencing shortfall
40
35
30
25
20
15
10
5
0
EL + 10
EL
Degree of shortfall (pa)
$0
-$20,000
-$40,000
-$60,000
-$80,000
-$100,000
-$120,000
-$140,000
-$160,000
10th
Median
90th
0-10%
10-20%
20-30%
30-40%
40-50%
50% +

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