

Constructing optimal investment strategies for retirement income by comparing the blending of deferred and immediate annuities with traditional asset classes

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ABSTRACT

Retirement savings in South Africa is dominated by a system of defined contribution provision. Within this system, individuals contribute regularly over their working careers, with the contributions accumulated with returns earned from the selected investment vehicles – the accumulation phase. At and after retirement, individuals start the process of converting their accumulated amount into an income – the decumulation phase.

This paper focuses mainly on the decumulation phase, by comparing various strategies to determine an optimal asset allocation within a goals-based framework. Given that this is an area where limited research and market development has taken place, the specific focus of this paper is on comparing the inclusion of deferred annuities to immediate annuities within an overall investment strategy.

The comparison was done using a model and framework introduced in Anderson & Empedocles (2016) to assess retirement income investment strategies. The model made use of assumptions specific to the South African environment to determine the lifetime spending needs being met and the expected financial reserve upon death using various strategies that include both drawdown accounts with varying asset allocations (or 'living annuities') and guaranteed life annuities. 'Lifetime spending needs being met' is defined as the probability-weighted proportion of income needs being met over a remaining lifetime with 90% confidence. 'Expected financial reserve upon death' is defined as the 50th percentile of the present value of the remaining retirement assets available on the death of the pensioner, adjusted by the present

value of income support provided by dependants during the life of the pensioner in order to meet the pensioner's income needs where it falls short.

A base case for a male aged 65 years and an initial income requirement of 6.44% of retirement capital was modelled. Two alternative scenarios were introduced (i) a lower initial income requirement of 5% of initial retirement capital and (ii) assuming consumption requirements of the retiree increases at 2% above inflation after retirement to reflect an increasing consumption profile. The overall results of all three scenarios were then compared to provide insights into the properties of the blending of deferred annuities as opposed to immediate annuities with traditional asset classes in arriving at an overall investment strategy.

KEYWORDS

Deferred annuities; retirement income frontier; lifetime spending needs being met; expected financial reserve upon death

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1. INTRODUCTION

1.1 Annuities have existed in various forms for thousands of years (Poterba, 2001). For example, Romans sold financial instruments called 'annua' that returned a fixed yearly payment, either for life or a specified period, in return for a lump sum payment. Over time, annuities have increased in complexity to meet the varying needs of retirees (Blanchett, 2014).

1.2 Rusconi (2008) highlights that annuity products vary considerably from country to country. Some are purchased at retirement; some in the form of deferred annuities during the working years.

1.3 A further distinction can be made between annuities purchased at retirement where the income starts immediately (immediate annuities) and an annuity purchased at retirement where the income only starts from a later date (a specific form of deferred annuity purchased at retirement).

1.4 Hence, there are two categories of deferred annuities: those that are purchased during the working years to provide an income at or after retirement, and those that are purchased at retirement with the income starting at a later date.

1.5 Another distinction can be made between deferred annuities that are contingent on a person(s) being alive at a specified date and those that are not.

1.6 The purpose of this paper is to specifically analyse the inclusion of a deferred annuity purchased at retirement, during the decumulation phase, and compare the results to strategies where immediate annuities are blended with other asset classes within a drawdown account. We also limit our investigation to annuities where income payments are contingent on a person being alive at the date of payment.

1.7 The results are aimed at determining the optimal investment strategies providing individuals with an income into retirement. The results can also be used by advisors, benefit consultants or trustees when constructing their default annuity strategies as well as in designing optimal investment strategies for the period of the accumulation phase prior to retirement.

2. OVERVIEW OF LITERATURE ON DEFERRED ANNUITIES

2.1 Deferred annuities provide a form of lifetime protection against both investment risk and longevity risk – the possibility of living longer than expected and running out of money. The literature on the properties of deferred annuities and their inclusion in investment strategies is limited. This section aims to provide an overview of the main studies done although in some cases the conclusions vary.

2.2 In the United States, deferred income annuities, or DIAs as they are termed, have received increased attention over the years from defined contribution plan sponsors, providers, participants, and the government. They are designed to provide guaranteed income for life, but unlike immediate annuities, the benefit payments for DIAs do not begin until some later date.

2.3 Milevsky (2005) was one of the first to note the potential benefit of deferred annuities which he referred to as an Advanced Life Deferred Annuity. Additional research by Pfau (2013) suggests that the inclusion of DIAs in a retirement income strategy results in better retirement outcomes when compared to allocating all retirement savings assets to immediate annuities because it offers more liquidity on the whole (given that a smaller portion of the total strategy is in an illiquid form) and the same longevity protection at advanced ages at less cost.

2.4 Blanchett (2014) noted that while immediate annuities may be slightly more attractive than DIAs at the prices applicable at the time, DIAs may offer significant promise as an efficient form of guaranteed income, especially given the relatively low cost for the longevity hedge when compared to immediate annuities.

2.5 Dus, Maurer and Mitchell (2005) found that delaying annuitisation until age 75 is likely to be most appealing to retirees who wish to maximise payouts while alive. Purchasing the annuity at an even later age (85), promises more bequest potential at the cost of a higher shortfall during the annuitant's lifetime.

2.6 In the study by Gerrard, Haberman, and Vigna (2004) annuitisation is deferred until the age of 75. They consider the optimal investment allocation for an income drawdown plan, until annuitisation occurs at age 75. They compared the deferred approach with complete annuitisation at retirement. Their main result is that for a pensioner with low risk aversion, annuitisation should optimally be deferred.

2.7 Milevsky (2005) used preference-free dominance arguments to develop a framework for attaining the optimal age at which to annuitise, based on USA equity markets. They found that annuitisation prior to the age of 65 to 70 is inferior to a self-annuitisation strategy, even if no bequest motive is present. For retirees willing to accept a minimal level of risk, annuitisation can be delayed even further.

2.8 In the case of the study conducted by Horneff, Maurer and Stamos (2008), gradual annuitisation starts before retirement. They found it to be optimal for households to invest partially in annuities during their working life, and to continue shifting wealth to annuities. Every utility maximising household started to annuitise before 70. Full annuitisation occurred prior to 85, except where a bequest motive was present. Even where a bequest motive was present, the annuity fraction made up 65% of total retirement assets.

2.9 Horneff, Maurer and Stamos (2008) included partial and gradual switching strategies in their study. In the partial switching case the investor has one opportunity to purchase life annuities with a fraction of his or her retirement assets. They found that full and partial switching strategies do not only cause annuitisation to be deferred, but they can also reduce annuitisation. In the gradual switching case, the utility maximising retiree starts to purchase annuities at retirement with 30% of his retirement assets. After retirement he continues to purchase annuities until full annuitisation is reached at 78, unless there is a bequest motive, in which case full annuitisation never occurs.

2.10 Blanchett (2014) highlights that incorporating a DIA into a target-date glide path should have an impact on the equity allocation for the non-DIA portion. DIAs, from a total wealth perspective, are bond-like assets. Similar to a bond, a DIA provides a fixed annual payment.

2.11 In South Africa specifically, Goemans & Ncube (2008) found that deferment of annuitisation was beneficial to annuitants, although any deferment strategy was still inferior to immediate annuitisation.

2.12 The literature therefore has varying and conflicting conclusions. The purpose of this paper is therefore to analyse the inclusion of deferred annuities in an overall investment strategy, within a goals-based framework and is intended to provide a more comprehensive and practical insight to enable better decision-making and

solution design in the South African market. The comparison is therefore done within the retirement income framework as set out in the next section.

3. THE RETIREMENT INCOME FRONTIER

3.1 In order to compare various strategies against these two financial goals, Anderson & Empedocles (2016) constructed a model with the following two measures: 'lifetime spending needs being met' and 'expected financial reserve upon death', each of which represents one of the competing financial goals in retirement.

3.2 For our purposes, the 'expected financial reserve upon death' is defined as the present value of the remaining retirement assets available on the death of the pensioner, adjusted by the present value of income support provided by dependants while the pensioner is alive in order to meet their income needs at the 50th percentile. The final formula for expected financial reserve upon death is as follows:

$$\text{Expected Financial Reserve upon Death} = \sum_{(T=1)}^{\infty} \left[\frac{[Q(\text{Discounted Total Portfolio}_T)_{0.5} \cdot d_{x+T-1}]}{l_x} \right]$$

where:

$$Q(\text{Discounted Total Portfolio}_T)_{0.5} = \text{50th Percentile outcome of Discounted Total Portfolio}_T$$

$$\text{Discounted Total Portfolio}_T = \frac{\text{PortfolioLA}_T}{\prod_1^T [(1 + R_T) \cdot (1 - \text{Fees})]} + \frac{\text{PortfolioDep}_T}{\prod_1^T [(1 + R_T) \cdot (1 - \text{Fees})]}$$

$$\text{PortfolioLA}_T = \text{Balance of living annuity account at time } T$$

$$\text{PortfolioDep}_T = \text{Accumulated value of borrowings from dependents at time } T$$

$$R_T = \text{Annualised return to time } T$$

$$\text{Fees} = 0.8\% \text{ per annum}$$

3.3 In the model utilised by Anderson & Empedocles (2016), the measurement of 'lifetime spending needs being met' was introduced. This is defined as the longevity-weighted proportion of income needs being met over a full remaining lifetime with 90% confidence. The formula for lifetime spending needs is as follows:

$$\text{Lifetime spending needs met} = \frac{\sum_{T=1}^{\infty} \left[\frac{[Q(\text{Percentage Income Needs}_T)_{0.1} \cdot l_{x+T}]}{l_x} \right]}{\sum_{T=1}^{\infty} \left[\frac{l_{x+T}}{l_x} \right]}$$

where:

$$Q(\text{Percentage Income Needs}_T)_{0.1} =$$

10th Percentile outcome of Percentage Income Needs Met_T

$$\text{Percentage Income Needs Met}_T = \frac{\text{Income}_T}{\text{Spending Requirement}_T}$$

3.4 Within this framework, the optimal strategies provide the highest expected financial reserve upon death for a given level of lifetime spending needs that are met and vice versa.

3.5 The ‘retirement income frontier’ as set out by Anderson & Emedocles (2016) is then the collection of all strategies that are optimal for each level of lifetime spending needs and expected financial reserve upon death.

3.6 In this paper, using the above framework we analyse the impact of including deferred annuities within the investment strategies of a 65-year-old male, to determine whether including deferred annuities within the overall strategy results in more optimal strategies. A base case as well as two alternative scenarios are modelled to determine the effects of varying the income drawdown rate as well as varying consumption needs after retirement.

4. SIMULATION MODEL

4.1 Investment Return Model

4.1.1 The investment returns used in the simulation were sampled from a multi-variate normal distribution X with expected returns μ and covariance matrix ε . When sampling from X , the model produces a simulated asset path return for the number of years required for the simulation. A return matrix of size $N \times M$ is produced. The return assumptions are set out in Section 7.

4.1.2 The formulae relevant to the investment return simulation model are as follows:

Lifespan = mortality table age limit – current age + 1

K = with-profit increase averaging period

N = lifespan + withdrawal period – 1

M = number of asset classes = 7

$$X \sim N_7(\mu, \varepsilon)$$

$$\mu = [E[X_1], E[X_2], \dots, E[X_i]] , \quad i = 1, 2, \dots, 7$$

$$\begin{aligned} &\mu_1 \\ \mu &= \mu_2 \\ &\mu_3 \\ &\mu_4 \\ &\mu_5 \\ &\mu_6 \\ &\mu_7 \end{aligned}$$

$$\varepsilon = [\text{Cov}[X_i, X_j]], \quad i = 1, 2, \dots, 7, \quad j = 1, 2, \dots, 7$$

$$\varepsilon = \begin{bmatrix} \sigma_{11} & \cdots & \sigma_{17} \\ \vdots & \ddots & \vdots \\ \sigma_{17} & \cdots & \sigma_{77} \end{bmatrix}$$

4.1.3 The asset allocations used to model the living annuity portfolios were determined with reference to the optimal portfolio for a given level of risk. In order to determine the optimal portfolios, 500 000 random portfolios were sampled. Constraints were imposed to ensure that all of the portfolios complied with Regulation 28, a South African regulatory requirement applicable to retirement fund portfolios. Using the return and correlation assumptions set out in Section 7, an efficient frontier was created with each portfolio on the efficient frontier representing the portfolio with the greatest return for the given level of risk. Forty portfolios were then selected on this efficient frontier in order to represent a range of portfolios across the risk spectrum. The list of portfolios selected and their asset allocations is set out in Table A.1 of Appendix A.

4.2 With-Profit Annuity Increase Model

4.2.1 A with-profit annuity targeting 100% of inflationary increases was selected. The post-retirement interest rate corresponding to this annuity was 2% per annum.

4.2.2 In our model, we assumed that the aggregate with-profit annuity pool invests in 25% local equity, 60% local bonds, and 15% international equity.

4.2.3 Various formulas are used in practice by insurers to calculate with-profit annuity increases. Our model determined the increases with the following formulae:

$X_{i,j}$ = Return for asset class i , year j of simulation

w_i = %allocation of asset class i in portfolio

$r = w^T \cdot X^T = w_1 \cdot X_{1,j} + w_2 \cdot X_{2,j} + \dots + w_7 \cdot X_{7,j}$, for $j = 1, 2, \dots, N$

r_T = return on with profit investment portfolio during year T

$$WPAInc_T = \frac{\left(\prod_{i=0}^4 (1 + r_{T-i}) \right)^{\frac{1}{5}} - InvFee - CapCharge}{(1 + 2\%)} - 1$$

4.3 Living Annuity Returns Model

Living annuity portfolio returns are calculated as follows:

$W^T \cdot X^T = W_1 \cdot X_{1,j} + W_2 \cdot X_{2,j} + \dots + W_7 \cdot X_{7,j}$, for $j = K, K + 1, \dots, N$

4.4 Lifetime Spending Needs being met Simulation Model

4.4.1 In order to calculate financial needs met, a simulation model was constructed with the formula set out below:

$$Lifetime\ spending\ needs\ met = \frac{\sum_{T=1}^{\infty} \left[\frac{[Q(\text{Percentage Income Needs}_T)_{0.1} \cdot l_{x+T}]}{l_x} \right]}{\sum_{T=1}^{\infty} \left[\frac{l_{x+T}}{l_x} \right]}$$

where:

$Q(\text{Percentage Income Needs}_T)_{0.1} =$

10th Percentile outcome of Percentage Income Needs Met_T

$Percentage\ Income\ Needs\ Met_T = \frac{Income_T}{Spending\ Requirement_T}$

$Spending\ requirement_T = WR \cdot (1 + inflation)^T$

$Income_T = LA_T + D \cdot AW_T$

$AW_T = \text{Income provided by life annuity at time } T$

$= \prod_{K=1}^i (1 + WPAInc_i) \cdot PIA_w \cdot WR, \quad i = 1, 2, \dots, T$

$LA_T = \text{Income provided by living annuity at time } T$

$$= \text{Min} \left(\left(\frac{\max(\text{Spending Requirement}_T - AW_T, 0)}{\text{Portfolio}_{LA}} \right), \text{WRMax} \right) \cdot \text{PortfolioLA}_T$$

$\text{PortfolioLA}_T = \text{living annuity balance at time } T$

$$= \text{PortfolioLA}_{T-1} \cdot (1 + R_T) \cdot (1 - \text{InvFee}) - LA_T$$

$$\text{PortfolioLA}_0 = \max(1 - PA_j, 0.000000000001)$$

$s : LA = \text{Living annuity}, Dep = \text{Dependency portfolio}$

$PIA_W = \text{Percentage of income annuitised with with-profit annuity}$

$WR = \text{Income required as \% of initial retirement capital}$

$D = 0 \text{ where } T < N$

$= 1 \text{ where } T \geq N$

$N = \text{period over which annuity is deferred}$

$= 10 \text{ for deferred annuity at age 65 years with income starting at age 75 years}$

$= 20 \text{ for deferred annuity at age 65 years with income starting at age 85 years}$

$\text{WRMax} = \text{Maximum allowable living annuity drawdown rate of 17.5\% of capital}$

$a_x^r = \text{with profit annuity rate deferred for period } N \text{ for pensioner aged } x$

$$PA_j = PIA_j \cdot WR \cdot a_x^r, j = W \text{ or } I, \text{ if } PA_j > 1, PA_j = \left(\frac{1}{PA_j} \right)$$

4.4.2 In the above simulation, allowance was made for years in which the income provided by the with-profit annuity exceeds the spending requirements for year T . In scenarios in which this occurs, the difference between the spending requirement and income requirement is reinvested in the retirement savings component of the simulation.

4.4.3 For the drawdown account, a drawdown limit of 17.5% of the capital was applied to be consistent with South African legislation at the time of writing. No explicit

allowance was made for the minimum of 2.5% applicable in South Africa since this did not apply and hence had no impact on any of the scenarios tested in this paper.

5. MEMBER PROFILE AND ANNUITIES

TABLE 1 Descriptions of abbreviations used for illustrations

Abbreviation	Description
LSN/LSNM	Lifetime spending needs/met
EFR	Expected financial reserve
Institutional or institutional fee	Fee assumption of 0.8% per annum
LA	Living annuity
WP or WPA	With-profit annuity (immediate)
WP75 or WPA75	With-profit annuity purchased at retirement age 65 years (income deferred with first payment from age 75 years)
WP85 or WPA85	With-profit annuity purchased at retirement age 65 years (income deferred with first payment from age 85 years)

5.1 Table 2 sets out the member profiles that were modelled.

TABLE 2 Member profiles for illustration of results

Profile	Gender	Single/Joint life	Spouse's age	Spouse's pension
1	Male	Single	N/A	N/A

5.2 The initial income requirement was expressed as a percentage of initial retirement capital and assumed to increase with inflation. The base initial income requirement modelled was 6.44% of initial retirement capital, to be consistent with the previous study by Anderson & Empedocles (2016). An alternative initial income requirement of 5% of initial retirement capital was also introduced to illustrate the impact on the results, given that in general industry practice is to use a 5% drawdown rate as a general rule of thumb when advising individuals and structuring retirement income strategies.

TABLE 3 Initial income requirement scenarios for each member profile

Initial income as a % of initial retirement capital
5%
6.44%

5.3 Various income annuitisation strategies were tested, ranging from 0% to 100% of initial income annuitised in increments of 5%. A maximum of 21 annuitisation strategies were therefore modelled. A limit to the amount of initial income annuitised

was introduced, corresponding to the level at which the cost of securing the initial income equals the amount of retirement capital available.

5.4 Level, fixed escalating and inflation-linked annuities were not included. Level annuities do not provide any inflation protection. The level of protection offered by fixed escalating annuities depends on future inflation. Higher actual inflation will result in fixed escalating annuities providing lower protection. Lower inflation will result in fixed escalating annuities providing higher protection. Since there is no natural link between the annual increases and actual inflation, these annuities were not included any further. Inflation-linked annuities were not included given that the previous study by Anderson & Empedocles (2016) demonstrated that their inclusion is sub-optimal given their high cost.

5.5 The only annuities included in our modelling were those with increases that have some implicit measure of inflation protection in which increases are expected to vary with inflation over time (with-profit annuities targeting increases of 100% of inflation).

5.6 The income payment commencement of the with-profit annuities was varied to include immediate and deferred versions. The immediate annuity income starts from age 65 years whereas the two deferred annuities are purchased at age 65 years with their income commencing from age 75 years and age 85 years respectively.

5.7 Living annuity strategies provided within a retirement fund at institutionally-negotiated fees were included.

5.8 Various living annuity asset allocations were modelled. From these, an efficient frontier was created and 40 portfolios were selected from the efficient frontier, each representing a portfolio with the greatest return for a given level of risk. In selecting the portfolios, Regulation 28, a South African regulatory requirement applicable to retirement fund portfolios, was imposed given the desire for the framework to be utilised by retirement funds in constructing their default annuity strategies. The detailed asset allocation for each of these portfolios is set out in Table A.1 of Appendix A.

6. MODELLING ASSUMPTIONS

6.1 Mortality was assumed to follow the PA(90) table with a downwards age adjustment of three years for males. No explicit allowance was made for mortality improvements.

6.2 For our purposes, annuity rates are defined as the present value of the real income stream of R1 per annum on the terms (either immediate or deferred) specified by the type of annuity. Immediate and deferred with-profit annuity rates targeting increases of 100% were utilised. These were calibrated with an adjustment so that the calculated immediate annuity rate is equivalent to a market rate provided by Just Retirement

Life (Pty) Ltd and utilised in Anderson & Empedocles (2016). The same calibration adjustment was used when determining the deferred annuity rates. The annuity rates are shown in Table 4.

6.3 Institutional investment management fees for living annuities (negotiated on a group basis) and with-profit annuities were assumed to be 0.8% per annum.

TABLE 4 Annuity rates for various retiree profiles

Gender	Single/Joint	Immediate with-profit annuity rate	With-profit deferred annuity rate (income starts at age 75 years)	With-profit deferred annuity rate (income starts at age 85 years)
Male	Single	11.62	4.69	0.94

6.4 No assumption was included for advisor charges. Capital charges for the with-profit annuities were assumed to be 1% per annum. Investment returns were simulated using the model set out in Section 4, and 10 000 simulations were run. Inflation was assumed to be 6% per annum.

6.5 Annual real returns were assumed to be normally distributed (Table 5). A covariance matrix (Table 6) was constructed based on historical monthly returns from an internal company database dating back to 1 July 1987. Allowance was made for current market conditions given that future returns are expected to be lower than those observed in the past. The real return assumptions were compared for reasonableness to best-practice assumptions of one of the largest asset consulting houses in South Africa.

TABLE 5 Expected real returns on asset classes

Asset class	Local				International		
	Equity	Property	Bonds	Money market	Equity	Bonds	Cash
Real return	5.50%	4.50%	2.50%	1.00%	4.50%	1.50%	0.50%

7. FULL RESULTS: BASE CASE

This section sets out the results for Member Profile 1 using the base case assumptions set out earlier. For the purposes of this section the following strategies were compared:

- **Institutional: LA and WPA** living annuity strategies at institutional fees with various asset allocations, as well as annuitising initial income in increments of 5% from 0% to 100% using with-profit annuities with income payments starting from age 65 years.

TABLE 6 Covariance matrix for various asset classes

	Local				International		
	Equity	Property	Bonds	Money market	Equity	Bonds	Cash
Local equity	3.70%	1.11%	0.42%	−0.01%	1.47%	−0.30%	−0.29%
Local property	1.11%	3.21%	0.59%	0.00%	0.13%	−0.57%	−0.62%
Local bonds	0.42%	0.59%	0.67%	0.02%	−0.21%	−0.34%	−0.45%
Local money market	−0.01%	0.00%	0.02%	0.01%	0.00%	0.00%	0.00%
International equity	1.47%	0.13%	−0.21%	0.00%	2.67%	1.04%	1.12%
International bonds	−0.30%	−0.57%	−0.34%	0.00%	1.04%	1.73%	1.68%
International cash	−0.29%	−0.62%	−0.45%	0.00%	1.12%	1.68%	2.03%

- **Institutional: LA and WPA75** living annuity strategies at institutional fees with various asset allocations, as well as annuitising initial income in increments of 5% from 0% to 100% using deferred with-profit annuities purchased at age 65 years with income payments starting from age 75 years.
- **Institutional: LA and WPA85** living annuity strategies at institutional fees with various asset allocations, as well as annuitising initial income in increments of 5% from 0% to 100% using deferred with-profit annuities purchased at age 65 years with income payments starting from age 75 years.

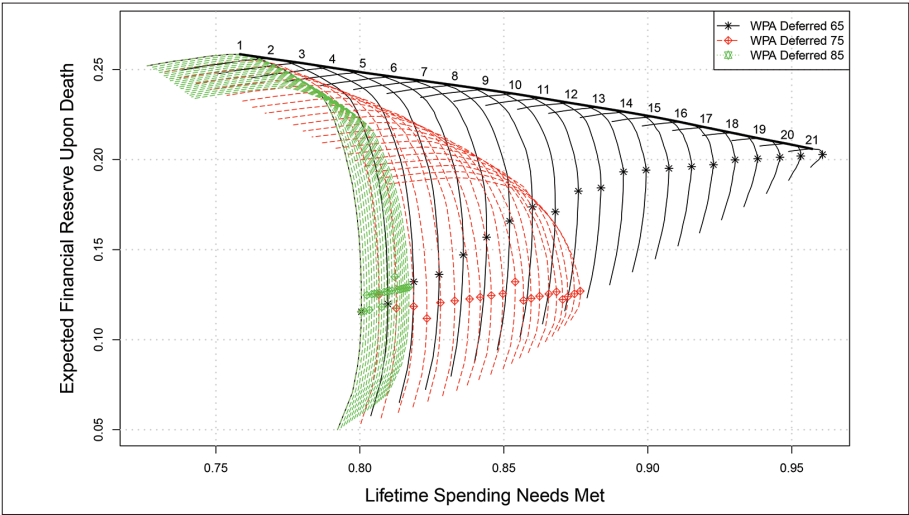


FIGURE 1 Retirement income frontiers: Member Profile 1, combinations of living annuity, immediate and deferred with-profit annuities, institutional fee, 6.44% initial income requirement

TABLE 7 Summary of strategies for points on the retirement income frontier that maximise LSN for a given percentage of initial income annuitised: Member Profile 1, institutional fees, 6.44% initial income requirement

Retirement income frontier number	% of initial income annuitised	% of portfolio in WPA	% of portfolio in deferred WPA	% of portfolio in LA	Point at which LSNM is maximised	Corresponding EFR	Living annuity portfolio	Growth allocation
1	0%	0%	0%	100%	80.05%	11.55%	6	18%
2	5.00%	4%	0%	96%	80.97%	11.98%	6	18%
3	10.00%	8%	0%	92%	81.87%	13.22%	7	20%
4	15.00%	11%	0%	89%	82.75%	13.62%	7	20%
5	20.00%	15%	0%	85%	83.59%	14.71%	8	22%
6	25.00%	19%	0%	81%	84.40%	15.69%	9	25%
7	30.00%	23%	0%	77%	85.20%	16.59%	10	27%
8	35.00%	26%	0%	74%	86.00%	17.38%	11	29%
9	40.00%	30%	0%	70%	86.79%	17.10%	10	27%
10	45.00%	34%	0%	66%	87.59%	18.25%	12	32%
11	50.00%	38%	0%	62%	88.37%	18.43%	12	32%
12	55.00%	41%	0%	59%	89.16%	19.32%	14	36%
13	60.00%	45%	0%	55%	89.94%	19.42%	14	36%
14	65.00%	49%	0%	51%	90.74%	19.51%	14	36%
15	70.00%	53%	0%	47%	91.52%	19.61%	14	36%
16	75.00%	56%	0%	44%	92.28%	19.71%	14	36%
17	80.00%	60%	0%	40%	93.03%	19.99%	15	39%
18	85.00%	64%	0%	36%	93.82%	20.05%	15	39%
19	90.00%	68%	0%	32%	94.59%	20.13%	15	39%
20	95.00%	71%	0%	29%	95.31%	20.20%	15	39%
21	100.00%	75%	0%	25%	96.07%	20.28%	15	39%

TABLE 8 Summary of strategies for points on the retirement income frontier that maximise EFR for a given percentage of initial income annuitised: Member Profile 1, institutional fees, 6.44% initial income requirement

Retirement income frontier number	% of initial income annuitised	% of portfolio in WPA	Portfolio in deferred WPA	% of portfolio in LA	Point at which EFR is maximised	Corresponding LSM	Living annuity portfolio	Growth allocation
1	0%	0%	0%	100%	26%	76%	34	90%
2	5%	4%	0%	96%	26%	77%	34	90%
3	10%	8%	0%	92%	25%	78%	34	90%
4	15%	11%	0%	89%	25%	79%	34	90%
5	20%	15%	0%	85%	25%	80%	34	90%
6	25%	19%	0%	81%	25%	81%	34	90%
7	30%	23%	0%	77%	24%	82%	34	90%
8	35%	26%	0%	74%	24%	83%	34	90%
9	40%	30%	0%	70%	24%	84%	34	90%
10	45%	34%	0%	66%	24%	85%	34	90%
11	50%	38%	0%	62%	23%	86%	34	90%
12	55%	41%	0%	59%	23%	87%	34	90%
13	60%	45%	0%	55%	23%	88%	34	90%
14	65%	49%	0%	51%	23%	89%	34	90%
15	70%	53%	0%	47%	22%	90%	34	90%
16	75%	56%	0%	44%	22%	91%	34	90%
17	80%	60%	0%	40%	22%	92%	34	90%
18	85%	64%	0%	36%	21%	93%	34	90%
19	90%	68%	0%	32%	21%	94%	34	90%
20	95%	71%	0%	29%	21%	95%	33	89%
21	100%	75%	0%	25%	21%	96%	33	89%

TABLE 9 Optimal strategic asset allocation for various objectives: Member Profile 1, 6.44% initial income requirement

Objective	Maximise LSN annuitising no more than 15% of initial capital	Maximise LSN annuitising no more than 30% of initial capital	LA strategy with highest LSN	Maximise LSN	Maximise EFR	Maximise EFR with LSN at least 90%	Maximise EFR with LSN at least 80%	Maximise EFR with LSN at least 70%
% of initial income annuitised	50%	100%	0%	100%	0%	70%	20%	0%
% of portfolio annuitised	15%	30%	0%	75%	0%	53%	15%	0%
Life annuity utilised	WPA75	WPA75	None	WPA	None	None	None	None
Living annuity portfolio	6	4	6	15	34	34	34	34
Living annuity growth allocation	18%	13%*	18%	39%	90%	90%	90%	90%
LSN	85%	87%	80%	96%	75%	90%	80%	70%
EFR	13%	13%	12%	20%	26%	22%	25%	26%

8. FULL RESULTS: LOWER INCOME REQUIREMENTS

This section sets out the results for Member Profile 1 using the base case assumptions set out earlier, but with the income requirements reduced to 5% of the initial capital.

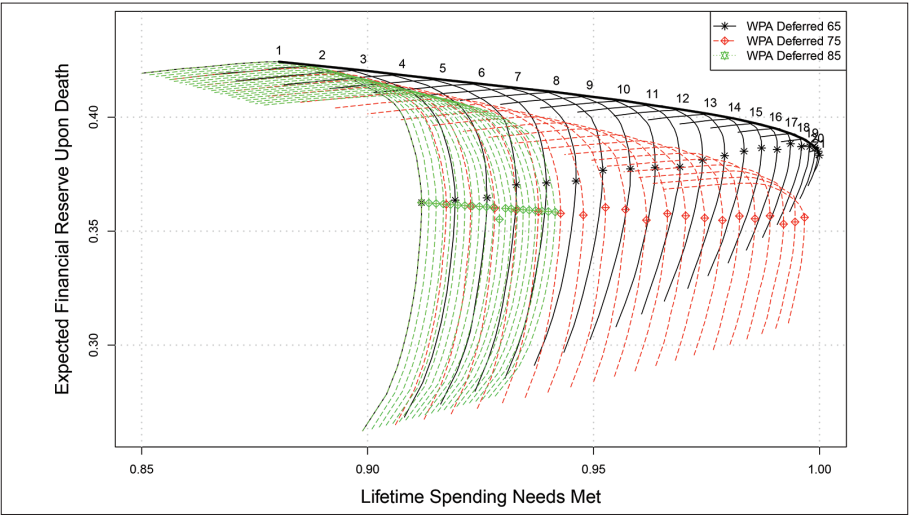


FIGURE 2 Retirement income frontiers: Member Profile 1, combinations of living annuity, immediate and deferred with-profit annuities, institutional fee, 5% initial income requirement

TABLE 10 Summary of strategies for points on the retirement income frontier that maximise LSN for a given percentage of initial income annuitised: Member Profile 1, institutional fees, 5% initial income requirement

Retirement income frontier number	% of initial income annuitised	% of portfolio in WPA	% of portfolio in deferred WPA	% of portfolio in LA	Point at which LSNM is maximised	Corresponding EFR	Living annuity portfolio	Growth allocation
1	0%	0%	0%	100%	91.19%	36.25%	14	36%
2	5.00%	3%	0%	97%	91.94%	36.36%	14	36%
3	10.00%	6%	0%	94%	92.64%	36.46%	14	36%
4	15.00%	9%	0%	91%	93.29%	37.03%	15	39%
5	20.00%	12%	0%	88%	93.96%	37.12%	15	39%
6	25.00%	15%	0%	85%	94.61%	37.20%	15	39%
7	30.00%	18%	0%	82%	95.21%	37.67%	16	41%
8	35.00%	20%	0%	80%	95.82%	37.73%	16	41%
9	40.00%	23%	0%	77%	96.36%	37.78%	16	41%
10	45.00%	26%	0%	74%	96.91%	37.82%	16	41%
11	50.00%	29%	0%	71%	97.41%	38.12%	17	44%
12	55.00%	32%	0%	68%	97.90%	38.31%	18	45%
13	60.00%	35%	0%	65%	98.33%	38.50%	19	48%
14	65.00%	38%	0%	62%	98.72%	38.65%	20	50%
15	70.00%	40%	0%	60%	99.06%	38.61%	20	50%
16	75.00%	43%	0%	57%	99.36%	38.58%	23	60%
17	80.00%	47%	0%	53%	99.60%	38.87%	23	60%
18	85.00%	50%	0%	50%	99.78%	38.87%	25	67%
19	90.00%	53%	0%	47%	99.90%	38.65%	27	74%
20	95.00%	56%	0%	44%	99.97%	38.50%	28	77%
21	100.00%	58%	0%	42%	99.99%	38.33%	29	79%

TABLE 11 Summary of strategies for points on the retirement income frontier that maximise EFR for a given percentage of initial income annuitised: Member Profile 1, institutional fees, 5% initial income requirement

Retirement income frontier number	% of initial income annuitised	% of portfolio in WPA	% of portfolio in deferred WPA	% of portfolio in LA	Point at which EFR is maximised	Corresponding LSN	Living annuity portfolio	Growth allocation
1	0%	0%	0%	100%	42.43%	88.04%	34	90%
2	5.00%	3%	0%	97%	42.23%	89.00%	34	90%
3	10.00%	6%	0%	94%	42.05%	89.91%	34	90%
4	15.00%	9%	0%	91%	41.84%	90.77%	34	90%
5	20.00%	12%	0%	88%	41.64%	91.66%	34	90%
6	25.00%	15%	0%	85%	41.45%	92.53%	34	90%
7	30.00%	18%	0%	82%	41.28%	93.33%	34	90%
8	35.00%	20%	0%	80%	41.10%	94.18%	34	90%
9	40.00%	23%	0%	77%	40.91%	94.91%	34	90%
10	45.00%	26%	0%	74%	40.72%	95.66%	34	90%
11	50.00%	29%	0%	71%	40.52%	96.30%	34	90%
12	55.00%	32%	0%	68%	40.33%	96.97%	34	90%
13	60.00%	35%	0%	65%	40.13%	97.58%	34	90%
14	65.00%	38%	0%	62%	39.94%	98.11%	34	90%
15	70.00%	40%	0%	60%	39.73%	98.59%	34	90%
16	75.00%	43%	0%	57%	39.50%	99.03%	34	90%
17	80.00%	47%	0%	53%	39.27%	99.37%	34	90%
18	85.00%	50%	0%	50%	39.04%	99.64%	34	90%
19	90.00%	53%	0%	47%	38.80%	99.83%	34	90%
20	95.00%	56%	0%	44%	38.57%	99.95%	33	89%
21	100.00%	58%	0%	42%	38.35%	99.99%	33	89%

TABLE 12 Optimal strategic asset allocation for various objectives: Member Profile 1, 5% initial income requirement

Objective	Maximise LSN annuitising no more than 15% of initial capital	Maximise LSN annuitising no more than 30% of initial capital	LA strategy with highest LSN	Maximise LSN	Maximise EFR	Maximise EFR with LSN at least 90%	Maximise EFR with LSN at least 80%	Maximise EFR with LSN at least 70%
% of initial income annuitised	60%	100%	0%	100%	0%	15%	0%	0%
% of portfolio annuitised	14%	23%	0%	58%	0%	9%	0%	0%
Life annuity utilised	WPA75	WPA75	None	WPA	None	WPA	None	None
Living annuity portfolio	15	19	14	29	34	34	34	34
Living annuity growth allocation	39%	48%	36%	79%	90%	90%	90%	90%
LSN	97%	99%	91%	100%	88%	90%	88%	88%
EFR	36%	36%	36%	38%	42%	42%	42%	42%

9. FULL RESULTS: ADJUSTED SPENDING PATTERN IN RETIREMENT

9.1 The base case results models income requirements that increase with inflation.

9.2 Expenditure patterns throughout the retirement years of individuals in South Africa are not well researched and understood. Butler and van Zyl (2012a) analysed income adequacy at retirement and the various factors impacting income adequacy at the point of retirement. The spending patterns after retirement are less well understood.

9.3 Even internationally the expenditure patterns of pensioners are not well understood and the findings seem to vary.

9.4 Some studies in Australia suggest that household expenditure systematically decreases at the time of retirement (the ‘retirement consumption puzzle’) (Hurd & Rohwedder 2008). Other research has suggested that expenditure levels in Australia may be characterised by a ‘retirement spending smile’. In this case, expenditure levels decrease in the early years of retirement as retirees become less active, before increasing in later years as healthcare expenses increase.

9.5 Research conducted by the Australian Centre for Financial Studies in 2016 suggested that expenditure patterns are likely to differ across retirees, depending on lifestyle, household structure, and non-monetary resources. A key finding from this research which analysed the Household Income and Labour Dynamics in Australia (HILDA) data is that expenditure does in fact not appear to decline through retirement (or exhibit the ‘retirement spending smile’). Instead, income looks relatively constant throughout retirement.

9.6 Asher et al. (2015) state that the standard assumptions in the lifecycle literature are for complete continuity, usually with an expectation of returns greater than the rate of discount, which then imply deferment of consumption. This is consistent with results reported in Frederick et al. (2002) of a general preference to prefer increasing patterns of consumption to declining ones.

9.7 Beshears et al. (2011) also confirms that benefits in retirement should not be decreasing in real terms.

9.8 The above findings are fundamental to the design of income products, suggesting they should aim to deliver at least a stable (inflation adjusted) income for the length of retirement.

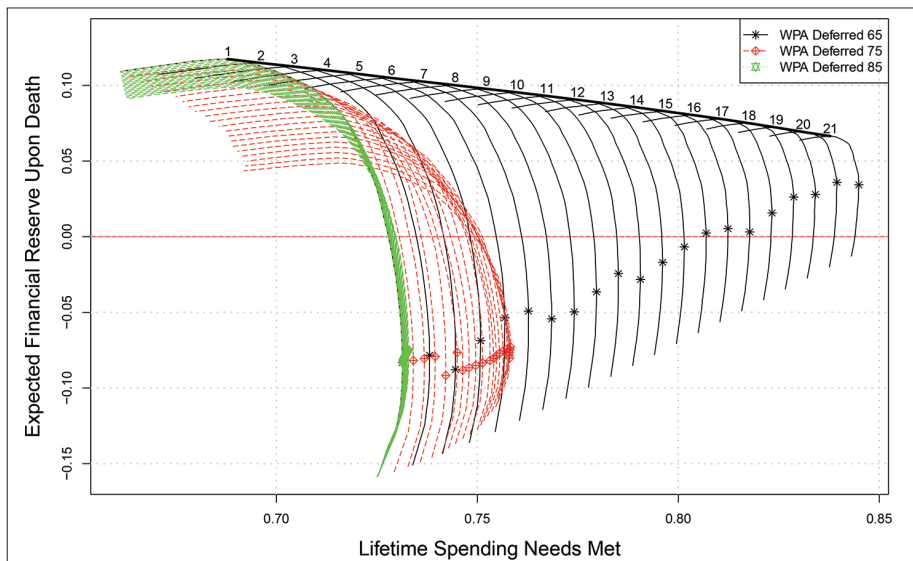


FIGURE 3 Retirement income frontiers: Member Profile 1, combinations of living annuity, immediate and deferred with-profit annuities, institutional fee, 6.44% initial income requirement

9.9 In order to do some sensitivity analysis of the results to changing spending patterns, in particular allowing for higher inflation in retirement due to healthcare costs, we have modelled a specific scenario where the spending needs are modelled to increase with inflation +2% per annum. Further, more in-depth analysis of spending needs should be undertaken. We only include this scenario in this paper to test the overall findings.

TABLE 13 Summary of strategies for points on the retirement income frontier that maximise LSN for a given percentage of initial income annuitised: Member Profile 1, institutional fees, 6.44% initial income requirement

Retirement income frontier number	% of initial income annuitised	% of portfolio in WPA	% of portfolio in deferred WPA	% of portfolio in LA	Point at which LSNM is maximised	Corresponding EFR	Living annuity portfolio	Growth allocation
1	0%	0%	0%	100%	73.14%	-0.08%	5	16%
2	5.00%	4%	0%	96%	73.81%	-0.08%	5	16%
3	10.00%	8%	0%	92%	74.46%	-0.09%	4	13%
4	15.00%	11%	0%	89%	75.08%	-0.07%	5	16%
5	20.00%	15%	0%	85%	75.69%	-0.05%	6	18%
6	25.00%	19%	0%	81%	76.27%	-0.05%	6	18%
7	30.00%	23%	0%	77%	76.85%	-0.05%	5	16%
8	35.00%	26%	0%	74%	77.41%	-0.05%	5	16%
9	40.00%	30%	0%	70%	77.97%	-0.04%	6	18%
10	45.00%	34%	0%	66%	78.51%	-0.02%	7	20%
11	50.00%	38%	0%	62%	79.06%	-0.03%	6	18%
12	55.00%	41%	0%	59%	79.62%	-0.02%	7	20%
13	60.00%	45%	0%	55%	80.15%	-0.01%	8	23%
14	65.00%	49%	0%	51%	80.69%	0.00%	9	25%
15	70.00%	53%	0%	47%	81.24%	0.01%	9	25%
16	75.00%	56%	0%	44%	81.78%	0.00%	8	23%
17	80.00%	60%	0%	40%	82.33%	0.02%	10	27%
18	85.00%	64%	0%	36%	82.87%	0.03%	12	32%
19	90.00%	68%	0%	32%	83.41%	0.03%	12	32%
20	95.00%	71%	0%	29%	83.95%	0.04%	14	36%
21	100.00%	75%	0%	25%	84.49%	0.03%	13	34%

TABLE 14 Summary of strategies for points on the retirement income frontier that maximise EFR for a given percentage of initial income annuitised: Member Profile 1, institutional fees, 6.44% initial income requirement

Retirement income frontier number	% of initial income annuitised	% of portfolio in WPA	% of portfolio in deferred WPA	% of portfolio in LA	Point at which EFR is maximised	Corresponding LSN	Living annuity portfolio	Growth allocation
1	0%	0%	0%	100%	11.74%	68.79%	34	90%
2	5.00%	4%	0%	96%	11.48%	69.62%	34	90%
3	10.00%	8%	0%	92%	11.24%	70.45%	34	90%
4	15.00%	11%	0%	89%	11.00%	71.26%	34	90%
5	20.00%	15%	0%	85%	10.75%	72.06%	34	90%
6	25.00%	19%	0%	81%	10.49%	72.87%	34	90%
7	30.00%	23%	0%	77%	10.24%	73.67%	34	90%
8	35.00%	26%	0%	74%	10.01%	74.45%	34	90%
9	40.00%	30%	0%	70%	9.77%	75.23%	34	90%
10	45.00%	34%	0%	66%	9.54%	75.99%	34	90%
11	50.00%	38%	0%	62%	9.30%	76.73%	34	90%
12	55.00%	41%	0%	59%	9.05%	77.49%	34	90%
13	60.00%	45%	0%	55%	8.80%	78.23%	34	90%
14	65.00%	49%	0%	51%	8.54%	78.96%	34	90%
15	70.00%	53%	0%	47%	8.29%	79.68%	34	90%
16	75.00%	56%	0%	44%	8.03%	80.39%	34	90%
17	80.00%	60%	0%	40%	7.77%	81.08%	34	90%
18	85.00%	64%	0%	36%	7.50%	81.75%	34	90%
19	90.00%	68%	0%	32%	7.21%	82.43%	34	90%
20	95.00%	71%	0%	29%	6.92%	83.11%	34	90%
21	100.00%	75%	0%	25%	6.65%	83.78%	34	90%

TABLE 15 Optimal strategic asset allocation for various objectives: Member Profile 1, 6.44% initial income requirement

Objective	Maximise LSN annuitising no more than 15% of initial capital	Maximise LSN annuitising no more than 30% of initial capital	LA strategy with highest LSN	Maximise LSN	Maximise EFR	Maximise EFR with LSN at least 90%	Maximise EFR with LSN at least 80%	Maximise EFR with LSN at least 70%
% of initial income annuitised	20%	40%	0%	100%	0%	Not possible	75%	10%
% of portfolio annuitised	15%	30%	0%	75%	0%	Not possible	56%	8%
Life annuity utilised	WPA	WPA	None	WPA	None	Not possible	WPA	WPA
Living annuity portfolio	6	6	5	13	34	Not possible	34	34
Living annuity growth allocation	18%	18%	16%	34%	90%	Not possible	90%	90%
LSN	76%	78%	73%	84%	69%	Not possible	80%	70%
EFR	-0.05%	-0.04%	-0.08%	0.03%	12%	Not possible	8%	11%

10. DISCUSSION OF RESULTS

10.1 Introducing / blending immediate or deferred life annuities into post-retirement investment strategies improves the levels of lifetime spending needs being met for given levels of expected financial reserve upon death, compared to strategies focussed purely on traditional asset classes such as equities, bonds and cash. This is a result of the benefit of mortality credits as well as the immediate and deferred with-profit annuity providing an annual income stream where volatility of the underlying returns are smoothed over a 5-year period using the annuity insurer's balance sheet.

10.2 By implication, strategies where the annuitisation decision is delayed until the later years in retirement would be even more sub-optimal within the retirement income framework. Although individuals may prefer delaying annuitisation, and in terms of behavioural biases this would be more palatable, such advice is sub-optimal. Instead, advice and solutions provided at retirement should encourage earlier annuitisation, by blending immediate annuities with traditional asset classes as early as possible and

then revisiting this decision regularly to annuitise more of the retirement capital over time until an optimal blend is achieved given the individual retiree's goals.

10.3 During the decumulation phase with no constraints on the amount of initial capital annuitised, an immediate annuity has the greatest impact on improving lifetime spending needs met and is more favourable than a deferred annuity bought at age 65 years (with income commencement being deferred to a later date). The two reasons explaining this are:

10.3.1 The impact of mortality credits are greater with immediate annuitisation (where the benefit of mortality credits apply to all instalments of the income stream purchased from age 65 years) compared to that of deferred annuities. Although the deferred annuity is purchased at age 65 years, the mortality credit benefits are only realised in relation to the value of the income instalments that are purchased from age 75 years onwards and not in relation to the value of the income payments before age 75 years (where these payments are then funded from the balance of the investment strategy without the benefit of mortality credits accruing on survival to that payment date). Whilst the mortality credit benefits for each of the income payments between ages 65 and 75 years are smaller, they are still positive.

10.3.2 Where immediate annuitisation is used, less reliance is placed on the balance of the capital for income and hence the sequence of returns risk is better managed on the balance of the strategy. In this instance, the immediate annuity provides a regular income stream where the underlying volatility is smoothed over a 5-year period using the insurer's balance sheet (which includes an implicitly modelled guarantee that income can't reduce in nominal terms). With a strategy incorporating a deferred annuity, the full income requirements from age 65 years to 75 years (or 85 years depending on the deferment period) are taken from the remaining drawdown account (which has been reduced to purchase the deferred annuity with income payments only commencing from either age 75 or 85 years). Given that the tenth percentile is used as the risk measure for lifetime-spending needs, the sequence of returns risk is more significant and amplified with a strategy requiring more income to be drawn down from the remaining drawdown account.

10.4 Blending with immediate annuities allows more growth assets to be allocated to the balance of the strategy. The benefit is lower where deferred annuities are used as a result of the income during the deferment period needing to be paid from the remaining living annuity. Where deferred annuities are used, a lower growth allocation for the remaining assets is found to be optimal to manage the sequence of returns risk. Hence, utilising immediate annuities – in particular a with-profit annuity where the underlying assets can be invested in growth assets – as an alternative to bonds or cash, allows greater growth allocation to be used in the balance of the investment strategy.

10.5 Where a constraint of 30% or 15% of the initial capital used to annuitise is imposed, deferred annuitisation to age 75 years produces the most optimal lifetime spending needs met result. Although this result does not appear on the retirement income frontier itself, it indicates that where individuals are well funded for retirement and have a desire to limit the amount of initial capital placed into an illiquid annuity, in these instances deferred annuitisation produces the greatest lifetime spending needs met. However, it should be pointed out that other strategies blending living and immediate annuities are more optimal without this constraint, producing a greater expected financial reserve for the same level of spending needs met. Hence, imposing such a constraint does result in a less optimal strategy that would otherwise be the case.

10.6 Where individuals are less well funded for retirement, blending of living and immediate annuities is more favourable even where constraints are imposed in terms of the amount of initial capital to annuitise.

10.7 Therefore, it is only when a constraint is imposed on the amount of initial retirement savings to annuitise (which could be based on an individual's preference), that deferred annuities apply in some circumstances. This is particularly so at some of the lower level of initial drawdown levels and depends on the extent on the constraint being imposed (the more restrictive the constraint, the more likely a deferred annuity being more optimal all else being equal). The points at which this applies depends on the retiree's age, gender and the cost of securing the desired income based on his/her expected mortality.

10.8 Where consumption in retirement increases, immediate annuitisation is still found to be more optimal overall. This is even the case even where constraints are imposed on the initial amount to annuitise. This can be explained given that an increasing income is drawn in the initial years of retirement, resulting in the sequence of returns risk being further exacerbated given that we are measuring the 10th percentile of the lifetime spending needs met as a risk measure. It can also be explained given that an increasing amount is drawn from a drawdown account, leading to a lower expected financial reserve value at more advanced ages where the probability of dying is higher. Consumption needs at advanced ages would need to increase substantially (and in a step-wise fashion) for deferred annuities to be considered appropriate relative to immediate annuitisation.

10.9 Although a limited number of initial drawdown strategies were modelled, the overall finding that, where no constraints are applied, immediate annuities are more optimal (in respect of the retirement income frontier framework) would apply for all initial income withdrawal strategies.

10.10 Where the objective is to provide a sustainable income, a higher level of expected financial reserve is achieved by incrementally annuitising more of the initial income. This is the case where immediate or deferred annuities are used with an income requirement of 6.44% of initial capital. However, where income requirements reduce, the effect is only present where immediate annuities are used incrementally. This is an important finding, since although the cost of a deferred annuity appears lower in comparison to an immediate annuity, and for this reason individuals (in particular those that are more funded for retirement) prefer living annuities or using some capital to purchase deferred annuities, the results show that within the retirement income frontier framework introducing immediate annuities incrementally is superior in generating a greater expected financial reserve, thus improving legacy potential.

10.11 For each level of spending needs met, the level of expected financial reserve can be increased by increasing the allocation to either immediate or deferred with-profit annuities and, at the same time, increasing the allocation-to-growth assets within the living annuity strategy. In other words, as more of the initial income is secured with either an immediate or deferred with-profit annuity, greater investment risk can be taken on the living annuity strategy to increase the expected financial reserve without impacting on the level of spending needs met negatively. The effect is greater where immediate annuitisation is used compared to deferred annuities, given that more of the sequence of returns risk is managed. This can be observed by the 'tails' at the top of the graphs being more pronounced for the deferred annuity simulations – indicating that at the high levels of growth asset allocations the expected financial reserves start to reduce after reaching a peak.

10.12 Given that the modelling is done using relative real-returns on various asset classes, the findings remain valid for different levels of inflation environments.

10.13 This paper focussed on the results in respect of a male retiree aged 65 years. The overall high level findings as set out in this section are however valid for female retirees as well.

10.14 The apparent anomaly in column 2 of Table 9, where lower growth asset allocation is observed is a result of sampling from the simulations. A larger number of simulations are expected to smooth out the results, yielding a growth asset allocation closer to 18%.

11. LIMITATIONS

11.1 Mortality assumptions are based on age and gender and do not take other individual factors into account (for example, health, socio-economic status etc.). Further work can be done on the implications of this and to enhance the model further.

11.2 The mortality assumptions used are deterministic. This could be addressed by incorporating stochastic mortality assumptions. It is expected that this could provide further insight into the value of inflation-linked annuities, which comprise the 'risk free' asset class that reduces both investment and mortality risk at retirement. However, given the large difference between the with-profit and inflation-linked annuity results, it is anticipated that a significant difference between actual and assumed mortality would need to be experienced before inflation-linked annuities could provide better value in terms of the framework.

11.3 The simulation model essentially operationalises a utility-based approach to converting savings into income by weighting the results of the lifetime spending needs by the probability of survival. This may, however, result in insufficient protection for longevity at more advanced ages as the model favours income in the earlier years of retirement compared to income in the more advanced years in retirement in cases in which retirement capital is limited. That said, it must be recognised that individuals generally have limited resources available. A utility-based approach is considered the best way to ensure that an individual's available resources can be appropriately prioritised when converting capital to income. More work can be done to address and explore this.

11.4 In creating the model, we did not run simulations for with-profit annuities at higher or lower post-retirement interest rates. More work can be undertaken in this area since this may improve lifetime spending needs being met for individuals with higher initial income requirements.

11.5 The model makes use of a specific smoothing formula for the with-profits annuity, but other formulas can also be used. It was felt, given that the 10th percentile outcomes of the lifetime spending needs being met are measured, that this may not make a significant difference for our purposes. However, this is an area that requires further work to determine if different with-profit formulae may lead to significantly different lifetime spending needs being met or expected financial reserves upon death.

11.6 The desired income and breadline income were assumed to be equal. This was to simplify the process in practice, given that it may be a difficult or highly subjective process for individuals to determine a minimum level of income. Further work can be done on this in order to introduce certain minimum income requirements and the impact thereof on the results.

11.7 The simulations are sensitive to the assumptions used. Alternative assumption sets can be used to determine their impact. However, we do not believe that the overall findings and insights would be impacted materially. We also ensured that the key assumptions are broadly aligned to those currently being used by practitioners. Further work can be done to test the sensitivity of the results in more detail.

12 CONCLUSION

12.1 Over the last number of years, greater focus has been placed on the provision of advice and solutions to retirees during the decumulation phase.

12.2 This paper compared the blending of immediate and deferred annuities with other traditional asset classes to arrive at optimal investment strategies at retirement.

12.3 The findings can be used by advisors and solution providers to construct optimal investment strategies at retirement to individual retirees, depending on given and relative preferences. It can also be used by benefit consultants and trustees when deciding on their design of their default annuity strategies.

12.4 It is anticipated that the findings and their application will have implications for advice and how solutions are provided in the retirement fund industry and lead to improvements in the quality of advice and solutions provided. In particular, advice and solutions provided at retirement should encourage earlier annuitisation, by blending immediate annuities with traditional asset classes as early as possible and then revisiting this decision regularly to annuitise more of the retirement capital over time until an optimal blend is achieved given the individual retiree's goals.

12.5 We suggest that further research be undertaken to specifically explore the inclusion of deferred annuities within the accumulation phase, where individuals approaching retirement can secure deferred annuities with income payments starting from retirement age. Whilst we have not specifically explored this aspect in this paper, we expect that their inclusion as a building block in the accumulation phase can result in more optimal outcomes during retirement for a significant proportion of retirees and further enhance retirement outcomes.

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APPENDIX A

TABLE A.1 sets out the detailed asset allocation for each of the 40 living annuity portfolios included in the simulation model.

TABLE A.1 Living annuity portfolio asset allocation

Portfolio	Local equity	Local property	Local bonds	Local money market	International equity	International bonds	International cash	Total equity	Total growth
1	0.74%	0.95%	0.37%	96.24%	0.66%	1.04%	0.00%	1.40%	2.35%
2	1.59%	2.23%	4.90%	86.53%	3.13%	1.62%	0.00%	4.72%	6.95%
3	2.22%	3.19%	8.30%	79.25%	4.99%	2.06%	0.00%	7.21%	10.40%
4	2.64%	3.83%	10.56%	74.39%	6.22%	2.35%	0.00%	8.87%	12.70%
5	3.17%	4.63%	13.39%	68.32%	7.77%	2.71%	0.00%	10.94%	15.57%
6	3.59%	5.27%	15.66%	63.47%	9.01%	3.00%	0.00%	12.60%	17.87%
7	4.02%	5.91%	17.93%	58.61%	10.24%	3.29%	0.00%	14.26%	20.17%
8	4.44%	6.55%	20.19%	53.76%	11.48%	3.58%	0.00%	15.92%	22.47%
9	4.86%	7.19%	22.46%	48.90%	12.72%	3.88%	0.00%	17.58%	24.76%
10	5.28%	7.83%	24.72%	44.05%	13.95%	4.17%	0.00%	19.23%	27.06%
11	5.70%	8.47%	26.99%	39.19%	15.19%	4.46%	0.00%	20.89%	29.36%
12	6.13%	9.11%	29.26%	34.34%	16.43%	4.75%	0.00%	22.55%	31.66%
13	6.55%	9.75%	31.52%	29.48%	17.66%	5.04%	0.00%	24.21%	33.96%
14	6.97%	10.39%	33.79%	24.63%	18.90%	5.33%	0.00%	25.87%	36.26%
15	7.64%	11.06%	35.88%	20.42%	19.94%	5.06%	0.00%	27.58%	38.64%
16	8.55%	11.78%	37.79%	16.88%	20.77%	4.23%	0.00%	29.33%	41.11%
17	9.47%	12.50%	39.70%	13.33%	21.61%	3.39%	0.00%	31.08%	43.58%
18	10.15%	13.04%	41.13%	10.67%	22.24%	2.76%	0.00%	32.39%	45.43%
19	11.07%	13.76%	43.04%	7.13%	23.07%	1.93%	0.00%	34.14%	47.91%
20	11.98%	14.48%	44.95%	3.58%	23.91%	1.09%	0.00%	35.90%	50.38%
21	12.67%	15.02%	46.39%	0.92%	24.54%	0.46%	0.00%	37.21%	52.23%
22	14.71%	16.58%	43.71%	0.00%	25.00%	0.00%	0.00%	39.71%	56.29%
23	16.73%	18.05%	40.22%	0.00%	25.00%	0.00%	0.00%	41.73%	59.78%
24	18.76%	19.52%	36.72%	0.00%	25.00%	0.00%	0.00%	43.76%	63.28%
25	20.78%	20.99%	33.23%	0.00%	25.00%	0.00%	0.00%	45.78%	66.77%

26	22.80%	22.46%	29.74%	0.00%	25.00%	0.00%	0.00%	47.80%	70.26%
27	24.82%	23.93%	26.24%	0.00%	25.00%	0.00%	0.00%	49.82%	73.76%
28	27.11%	25.00%	22.89%	0.00%	25.00%	0.00%	0.00%	52.11%	77.11%
29	29.12%	25.00%	20.88%	0.00%	25.00%	0.00%	0.00%	54.12%	79.12%
30	32.12%	25.00%	17.88%	0.00%	25.00%	0.00%	0.00%	57.12%	82.12%
31	35.12%	25.00%	14.88%	0.00%	25.00%	0.00%	0.00%	60.12%	85.12%
32	37.12%	25.00%	12.88%	0.00%	25.00%	0.00%	0.00%	62.12%	87.12%
33	39.12%	25.00%	10.88%	0.00%	25.00%	0.00%	0.00%	64.12%	89.12%
34	43.38%	22.44%	10.00%	0.00%	24.19%	0.00%	0.00%	67.56%	90.00%
35	46.38%	21.27%	10.00%	0.00%	22.35%	0.00%	0.00%	68.73%	90.00%
36	52.39%	18.94%	10.00%	0.00%	18.67%	0.00%	0.00%	71.06%	90.00%
37	55.39%	17.77%	10.00%	0.00%	16.84%	0.00%	0.00%	72.23%	90.00%
38	58.39%	16.61%	10.00%	0.00%	15.00%	0.00%	0.00%	73.39%	90.00%
39	61.39%	15.44%	10.00%	0.00%	13.16%	0.00%	0.00%	74.56%	90.00%
40	67.40%	15.00%	10.00%	0.00%	7.60%	0.00%	0.00%	75.00%	90.00%