

## A market-linked annuity

Authors: Melanie Dunn, Challenger  
Aaron Minney, Challenger

The annuity puzzle has been studied extensively to understand why retirees don't annuitise much of their wealth despite economic theory (Yaari, 1965). One issue that is sometimes mentioned is that traditional lifetime annuities are backed by fixed income investments (because they come with a guarantee). Optimal retirement portfolios typically have some equity exposure. Bengen (1994) suggested retirees have 40%-80% equity exposure in their portfolios.

A potential solution to this is to provide equity-like returns in an annuity structure. The Teachers Insurance and Annuity Association of America (TIAA) has offered the Stock Account annuity, which links income to the equity market, since 1952.<sup>1</sup> Proposals for investment-linked annuities often follow the approach of Horneff et al (2009) in constructing an investment portfolio where the annuity owners periodically redeem units from an underlying portfolio. The number of units is specified in advance. The payments from this structure grow (or fall) in line with the performance of the underlying investment portfolio.

Many commercial annuities do not follow this approach. Equity index annuities in the US provide equity exposure, but they must also provide a minimum return. Consequently, the upside is capped to pay for the downside protections. Investors in these annuities do not necessarily benefit from the expected long-term returns of the underlying equity index.

This paper describes an alternative way to capture market exposure in an annuity. It is now available for Australians to purchase. The market exposure is obtained through derivative structures but, as this paper will show, the payments to a retiree mimic those that would be made from an equivalent investment-linked annuity.<sup>2</sup>

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<sup>1</sup> <https://www.tiaa.org/public/retire/financial-products/annuities/retirement-plan-annuities/cref-accounts>  
access 20 October 2021

<sup>2</sup> Except in respect of franking credits and associated rebates, where relevant.

## An academic view of an investment-linked annuity

An investment-linked annuity is a description of a product that pays an income stream for life, like a lifetime annuity, but is supported by an investment in a portfolio with a higher expected return than risk-free assets. The goal is to be invested in the market, while having an income stream for life. Horneff et al (2007 & 2009) describe such an investment-linked annuity, which they referred to as a variable annuity. The holder of a variable annuity receives payments that increase with the return on the underlying pool of assets for life. In addition, the authors introduce the concept of an Assumed Interest Rate (*AIR*) that has the effect of increasing the initial payment, but reducing the growth in future payments (payments grow at underlying return less *AIR*). This reduction or ‘shrinkage’ is managed by reducing the number of ‘units’ held by the owner of the variable annuity. The number of units held is determined by the investment amount and the price of the underlying units at purchase as:<sup>3</sup>

$$P_x = (1 + \delta) \cdot I_x \cdot \frac{n_x}{(1+AIR)} \sum_{t=1}^T \frac{{}_{x+t}p_x}{(1+AIR)^{t-1}}, \quad (1)$$

Where  $P_x$  is the initial premium amount for the purchase of  $n_x$  units;

$\delta$  is the loading applied to the annuity price

$I_x$  is the price of a unit in the underlying investment at time  $x$ ;

$T$  is the maximum remaining life (reduced from  $\infty$  for computational efficiency);

${}_{x+t}p_x$  is the probability of survival from age  $x$  to age  $x+t$ ; and

*AIR* is the assumed interest rate applied to the variable annuity.

The ratio  $A_x = \frac{P_x}{I_x \cdot n_x}$  is the cost of a unit of investment paying \$1 at time  $x$ .

The loading ( $\delta$ ) represents a cost to manage the annuity. A fully efficient annuity would have no loading, so the goal is to construct a market-linked annuity with a low  $\delta$ . For convenience we can consider  $A_x$  for the case when  $\delta = 0$  and simplify the formula by moving the  $(1+AIR)$  denominator back into the sum:

$$A_x = \sum_{t=1}^T \frac{{}_{x+t}p_x}{(1+AIR)^t}. \quad (2)$$

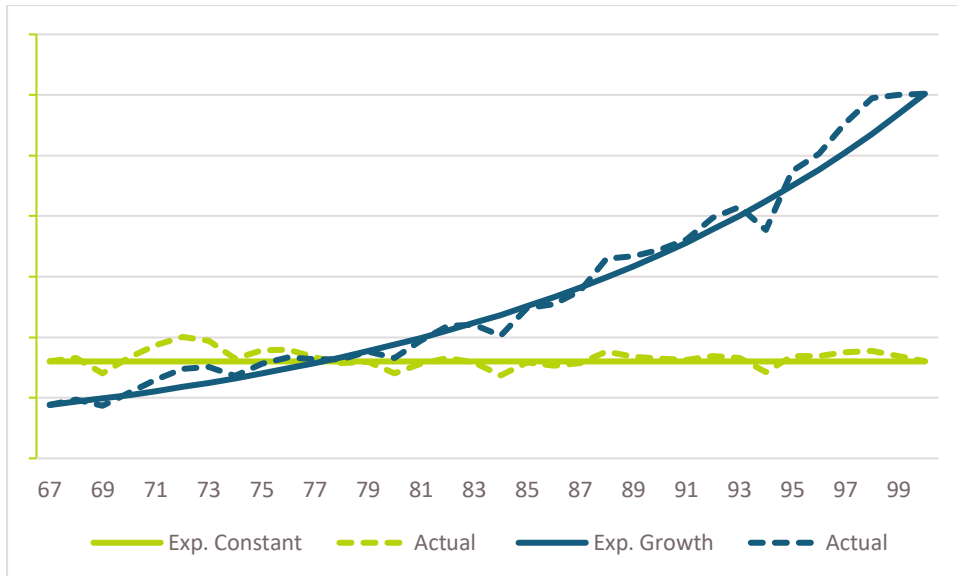
This is a useful representation of a generalised annuity price. If we set the *AIR* to be the risk-free rate of return (in each period), (2) provides the standard annuity formula for a traditional lifetime annuity (assuming payment at the end of the year). It should also be clear that the *AIR* is an arbitrary assumption in the construction of the variable annuity. While a different *AIR* will result in a different payoff structure, the value of any efficient variable annuity will be the same. All that changes is the starting payment and the growth of payments over time.

Figure 1 highlights how this trade-off works. If the *AIR* is set to match the expected return of the investment, the payments are expected to be constant. This is shown by the green lines in Figure 1. The unbroken line is the (constant) payment while the dashed lines represent actual payments

<sup>3</sup> The notation here differs from Horneff (2009) but the form has been maintained.

based on the underlying returns. This example is constructed to match actual to expected returns (geometric average) to age 100. The blue lines represent the payments when the AIR is set to zero, so the payments provide growth. In this case the payments will start lower but then rise with the actual investment performance over time.

Figure 1: Potential cash flow profiles



*Indicative calculations only. Underlying returns used average 6% p.a. with volatility of 10%.*

### A consumer view of the market-linked annuity

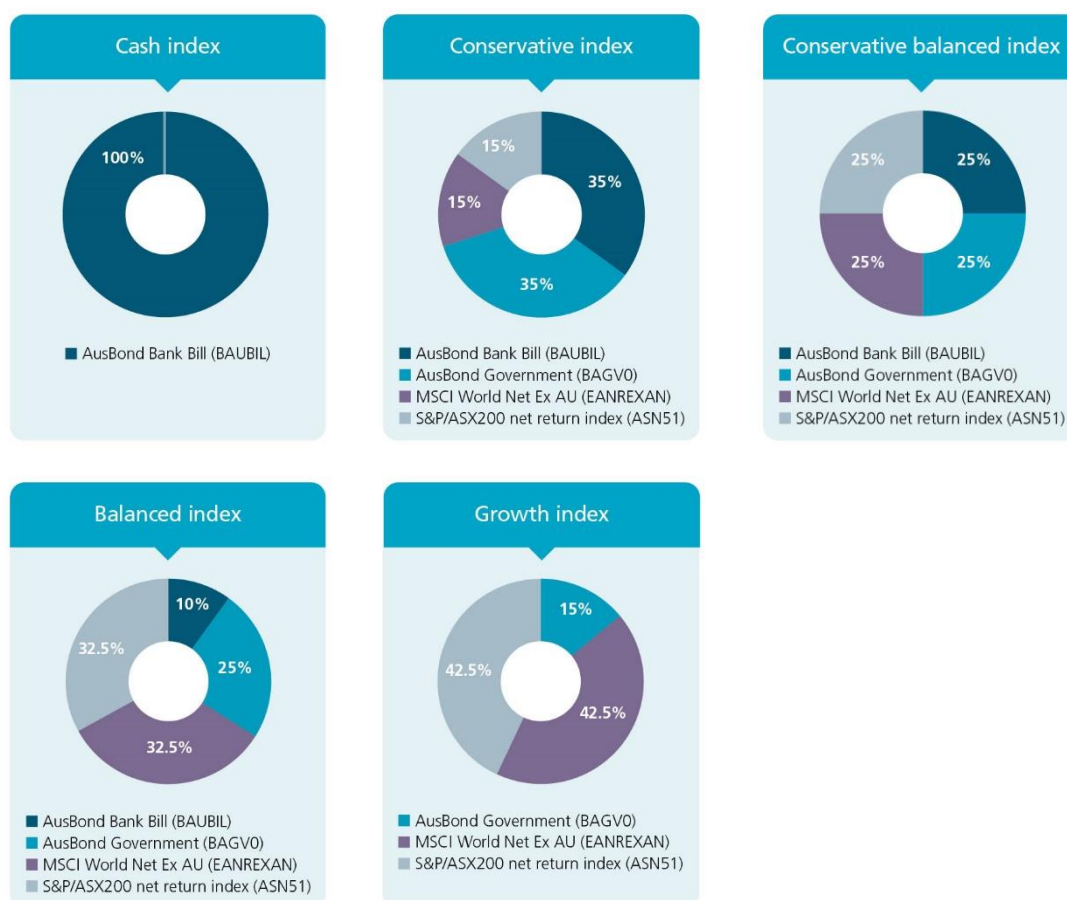
The market-linked annuity (**MLA**) currently available from Challenger is one where payments grow with the full market return.<sup>4</sup> That is the  $A/R = 0$ .

The MLA is similar to a traditional CPI-linked annuity from the point of view of the (retiree) consumer. In exchange for an initial payment, the consumer will receive a series of (monthly) payments for as long as they live. The first payment is set on the purchase date of the MLA. This amount is paid for the first year. Payments in the subsequent year are based on the change in the market index linked to the annuity. This mechanism is the same as CPI-linked payments, but the market index will be more volatile with the returns expected, on average, to be higher than the CPI, but a negative return will result in lower income payments in the subsequent year.

The MLA has a range of pre-packaged exposures to suit a variety of retiree risk profiles. The asset allocation exposures for each of these profiles are provided in Figure 2. Initial payment rates are set at the same level for each option.

<sup>4</sup> More information on the MLA offered by Challenger Limited can be found here: <https://www.challenger.com.au/adviser/products/lifetime-annuities/market-linked-payments>

Figure 2: Asset exposure options for the market-linked annuity



### Balancing longevity risk and market exposure

The Challenger MLA provides retirees with exposure to 100% of the underlying market index but with payments that will last for life. This will manage all longevity risk, but the market risk is retained by the retiree. They enjoy 100% of the upside but will also endure 100% of any downside. This new product completes the cross-tabulation of market and longevity risks.

Retirees need to manage both the longevity risk and market risk in their retirement income portfolio. In simple terms, these risks can either be retained, or hedged. This results in four options for a retirement income portfolio:

	Longevity Risk	Market Risk
Account-based pension	Retained	Retained
Traditional lifetime annuity	Hedged	Hedged
Term deposit / bond ladder	Retained	Hedged
Market-linked annuity	Hedged	Retained

As an investment option that hedges longevity risk exposure, while providing the long-term returns from market exposure, the MLA is well-placed as an innovative superannuation income stream to assist super fund members in retirement.

### How does the Market-Linked Annuity work?

The MLA consists of two components. One is like a traditional lifetime annuity. The other is an overlay that swaps the future payments for payments that grow with a specified market index (as a diversified portfolio). This structure is equivalent to the investment-linked annuity described above that invests directly in the portfolio. At any point in time, the overlay hedges all future income payments for the exposure to the underlying market. The future payments mimic the investment-linked annuity with  $AIR = 0$ . The comparison can be seen mathematically by valuing the series of payments that will be received by the retiree. These payments are expected to grow in line with the returns ( $r_t$ ) from the market portfolio. The present value of these payments should be discounted by a risk-adjusted return. The arbitrage-free condition is that the discount rate equals the expected return.<sup>5</sup> The present value for a series of payments from a base of  $S_0$  will be:

$$\sum_{t=1}^T \frac{S_0 \cdot x+t p_x (1+E(r_t))^t}{(1+E(r_t))^t} \quad (3)$$

The payment at the end of the first year in this example will be  $S_0 \cdot (1+r_1)$ . On simplification, it is clear that this becomes the equivalent of equation (2) with  $AIR=0$ :

$$\sum_{t=1}^T S_0 \cdot x+t p_x \quad (4)$$

The cost of an initial \$1 payment is independent of the underlying market so the value,  $S_0$ , will depend on only the sum invested and the underlying mortality table.

### The impact of a hurdle rate- variations in the AIR

The trade-off between starting payments (as shown in Figure YYY) for different  $AIR$  can be calculated for a given mortality table. There is no requirement for the  $AIR$  to be the expected return of the investment (which can vary over time). The starting payment is not affected by the underlying investment. It is the future payments that will be affected.

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<sup>5</sup> This condition is why a \$100,000 portfolio of equities is worth the same as \$100,000 in the bank despite higher expected returns.

Consider the ALT15-17 with 25-year mortality improvement factors from the Australian Government Actuary.<sup>6</sup> The starting payments (rounded to nearest \$100) from a \$100,000 investment by a 67-year-old (in 2021) for a range of different AIRs:

AIR	Male, 67	Female, 67
0%	\$5,000	\$4,500
1%	\$5,600	\$5,100
2%	\$6,300	\$5,800
3%	\$7,000	\$6,500
4%	\$7,700	\$7,200
5%	\$8,500	\$7,900
6%	\$9,300	\$8,700
10%	\$12,600	\$12,100

The trade-off in this table provides an equivalence among fairly-priced options with the same assumed mortality table. In practice, adverse selection will reduce the starting payments. The mortality table assumed in the pricing of any product that is not compulsory needs to assume lighter mortality than the general population. The Actuaries Institute (2018) has attempted to estimate this mortality table for the Australian population.

A \$100,000 investment could purchase any of the above payment profiles.

### A behavioural basis for setting $AIR=0$ in the MLA

It is widely accepted that people do not annuitise as much of their wealth that economic theory implies they should - known as the annuity puzzle. Some of the potential reasons for this include the behaviour of retirees. Initial testing with financial advisers raised a concern that it might be difficult to explain to their clients why the income increased by less than the market. In particular, following a year where returns were positive but small and lower than the  $AIR$  hurdle (say 5%), it might be difficult to explain why the payments fell (2%) when markets rose (3%). The simplicity of a direct link between returns and growth in the payments was a factor in setting the  $AIR=0$  in the Challenger MLA. The payments to the owner of the annuity will rise (or fall) in a direct relationship with the market returns.

There are additional features to the MLA that reflect the behaviour of retirees and their money. This includes a death benefit for an extended period after purchase. Following the capital access schedule of an Innovative Retirement Income Stream<sup>7</sup>, a death benefit equal to the purchase price is paid for up to half the life expectancy of the retiree. For a 67-year-old male, this means the death benefit up to age 76 is 100% of the purchase price (and to age 77 for females). The ability to access the capital for an extended period in retirement also alleviates concerns that retirees want some flexibility in case their situation changes. Reducing this concern increases the potential take-up of the product.

<sup>6</sup> Australian Life Tables 2015-17, Australian Government Actuary <https://aga.gov.au/publications/life-tables/australian-life-tables-2015-17>

<sup>7</sup> 4.9.3.35 Means test assessment of asset-tested income streams (lifetime) | Social Security Guide ([dss.gov.au](https://dss.gov.au))

A desire for greater control is met by providing the option to adjust the market exposure. Retirees can switch between the different market-linked options on each anniversary of their purchase.

### **Reducing the $\delta$ -load in a market-linked annuity**

The  $\delta$  factor in equation (1) reflects an inefficiency in an investment-linked annuity. To maximise the payoff to a retiree, the goal should be to minimise the  $\delta$  in the annuity. Aside from historical commissions (which are no longer payable in Australia) the main driver of the load is the cost of capital for the annuity provider. The MLA construct reduces the capital requirement by using a total return swap (TRS) that matches the exposure of the underlying payments.

In the Australian equity sector, this means forgoing franking credits, which are not available through derivative exposure. There is also a small withholding tax loss with the equity index returns. Offsetting this is an investment advantage from the approach in the underlying portfolio that can provide a return above the index with the TRS swap. The underlying portfolio is able to capture some of the illiquidity premium by investing to match the cash flows of the future annuity payments. This can provide a return at a margin over the swap rate. Pricing in the total return swap (TRS) market reflects the liquid nature of the assets of the counterparties, so the illiquidity premium is able to remain attached to the annuity payments, even after the TRS introduces the market exposure.

### **How can a Market-Linked Annuity be used in a retirement portfolio**

The following case study highlights how an MLA can provide for a better outcome in retirement.

Consider a single male retiree aged 67 with \$500,000 in superannuation savings and \$20,000 in personal assets. His superannuation savings are invested in an account-based pension (ABP) with 50% in growth assets and 50% in defensive assets and he is targeting a retirement spend equal to the ASFA comfortable retirement standard<sup>8</sup> of \$44,818 increasing annually with price inflation.

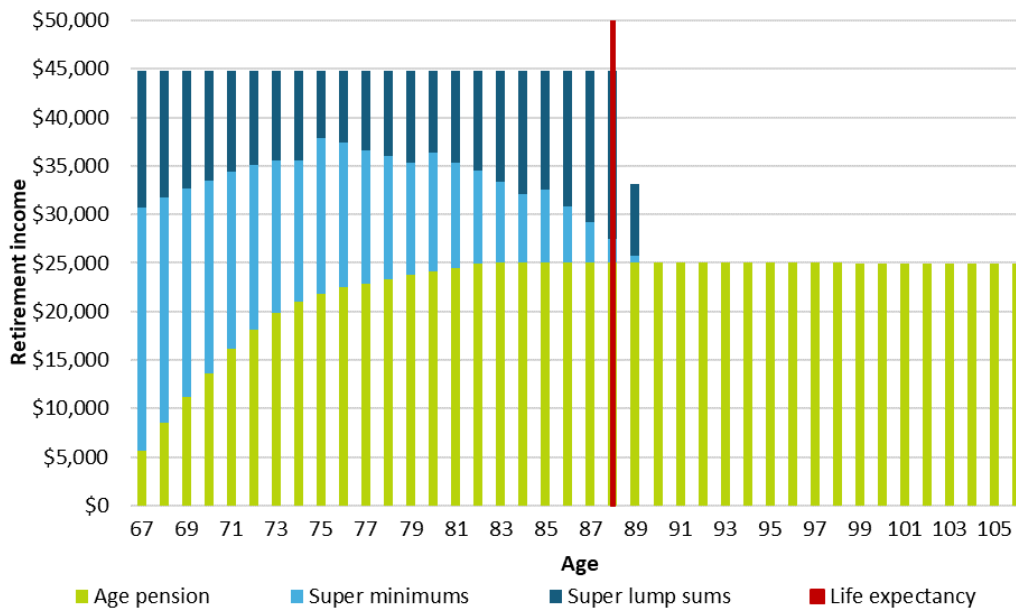
Analysing this retirement plan over 2,000 simulations of retirement<sup>9</sup> it is found that this retiree could afford this target lifestyle for his life expectancy of 21 years nearly two thirds of the time (64% chance). If he survived just 3 years longer this reduces to just over a third (35% chance). Once his ABP runs out he would need to rely solely on the Age Pension or income over the remainder of retirement. Figure 3 shows how he might typically expect income to last to age 89.

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<sup>8</sup> ASFA Retirement Standard June quarter 2021

<sup>9</sup> Illustrations completed using Challenger's retirement income model allowing for Age Pension means tests and target spend of \$44,818 p.a. increasing annually with inflation. Lifetime income strategy uses Challenger Lifetime Annuity Flexible Income (Market-linked payments) with conservative balanced payment option, pricing as at 9 November 2021. 2,000 simulations of asset class data provided by Willis Towers Watson, average return net of fees over 40yrs ABP growth 5.3% p.a. (including franking credits) and ABP defensive 1.6% p.a. and conservative balanced payment option 4.3%p.a.

Figure 3: Income profile for 67-year-old male- Median outcome for ABP alone

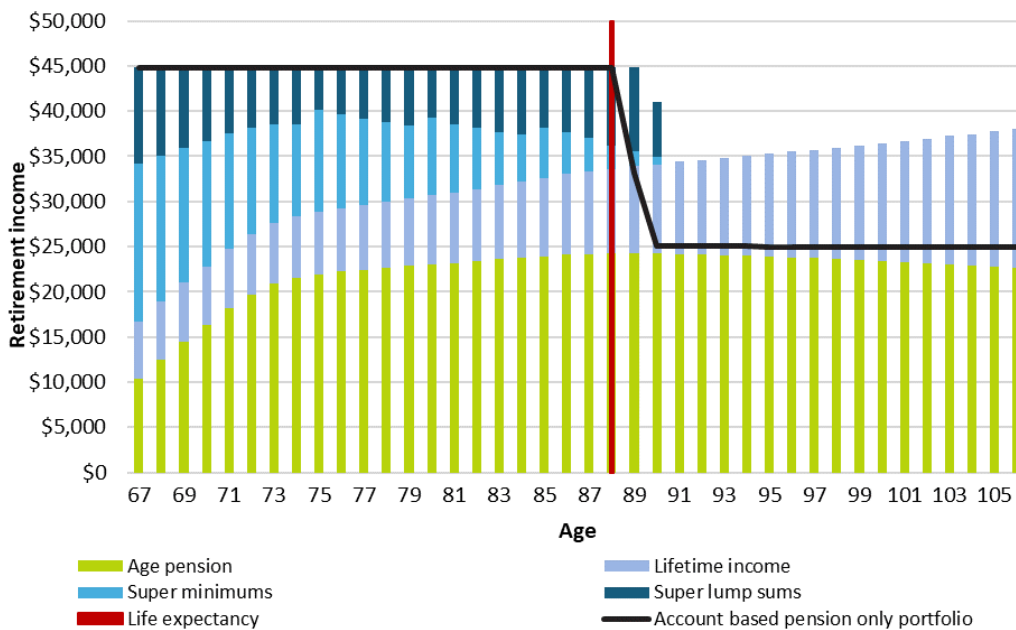


Source: Challenger

This strategy provides little longevity protection and the retiree might need to reduce his spending to have confidence his target lifestyle would last for as long as he lives.

If this retiree allocated 30% of his superannuation savings to an MLA which matches his desired 50:50 risk profile, this could improve his confidence of spending at his target lifestyle. This strategy would also provide an income for life on top of any Age Pension entitlement for as long as he lives, even once superannuation savings are exhausted. As can be seen in Figure 4, when and MLA is incorporated, he might expect the income from the ABP to last to age 90 but there will still be income from the MLA when this runs out.

Figure 4: Income profile for 67-year-old male- Median outcome for ABP + MLA



Source: Challenger



Using this strategy, the retiree could afford his target lifestyle for his life expectancy with a similar level of confidence (65% chance). If he survived just 3 years longer, his confidence increases to around fifty percent (48%), providing significantly higher confidence his target income will last. Further, once his ABP does run out, he would have an income for life on top of any Age Pension for income over the remainder of retirement.

The strategy is also found to be robust to market performance:

Figure 5a: 10<sup>th</sup> percentile income outcomes

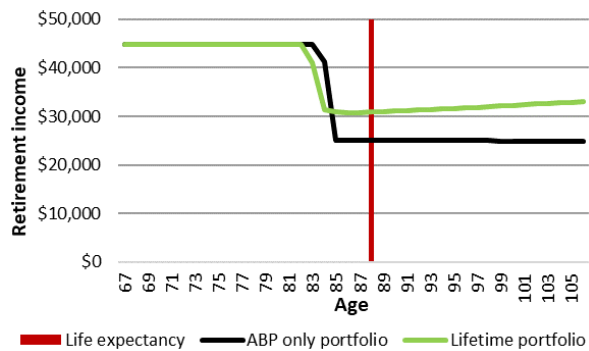
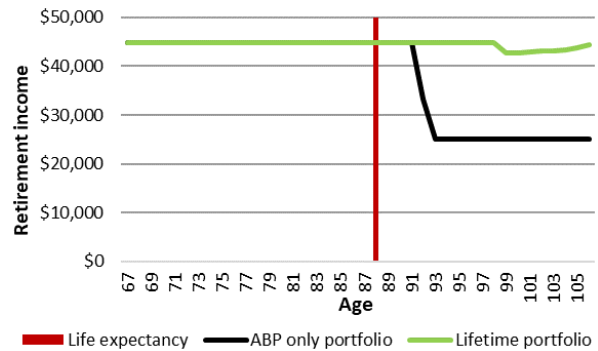


Figure 5b: 90<sup>th</sup> percentile income outcomes



Source: Challenger

Looking at the bottom 10<sup>th</sup> percentile outcomes in each year in Figure 5a, the target lifestyle will not last as long but it might be achieved for a year longer with the ABP alone. However, the income floor once the ABP does run out is much higher with the MLA portfolio, even under poor market outcomes. At the top 10<sup>th</sup> percentile outcome in each year, the target lifestyle can be maintained for life in the MLA portfolio even though it would stop at age 93 with an ABP alone.

### Concluding remarks

A new market-linked annuity is available for Australian retirees. This enables older Australians to secure an income stream for life that maintains exposure to investment markets. Used as part of a diversified portfolio, the MLA can lead to better financial outcomes in retirement.

## References

Actuaries Institute 2018, *Exploring Retiree Mortality*, Actuaries Institute December 2018.  
<https://actuaries.asn.au/Library/Opinion/2018/AIExploringRetireeMortalityFINAL.pdf>

Bengen, W., 1994, "Determining Withdrawal Rates Using Historical Data". *Journal of Financial Planning* 7, 4 (October): 171–180.

Horneff, W., R. Maurer, O. Mitchell, and M. Stamos, 2007, "Money in Motion: Dynamic Portfolio Choice in Retirement," *Discussion paper, NBER* No. 12942.

Horneff, W., R. Maurer, O. Mitchell, M. Stamos, 2009. "Asset allocation and location over the life cycle with investment-linked survival-contingent payouts." *Journal of Banking and Finance* 33 (9), 1688–1699.

Yaari, M., 1965, "Uncertain Lifetime, Life Insurance, and the Theory of the Consumer" *Review of Economic Studies*, 32, 137-150

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