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Optimal Annuity Purchases for Australian Retirees

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Abstract

We develop and simulate a stochastic lifecycle model to investigate optimal annuity purchases at retirement. Retirees can invest in risky assets, purchase fairly priced immediate or deferred lifetime annuities, and are eligible for a targeted safety net pension. We match baseline parameters to current Australian settings and conduct scenario analyses over a wide range of individual preferences and financial market outcomes. Except where individuals need to insure a consumption floor, both immediate and deferred annuity purchases are largely crowded out by the means tested public pension. Welfare losses caused by zero annuitisation are small compared with the losses caused by completely annuitising all savings, particularly if wealth at retirement is low. Decumulation policy should ensure individuals are well-informed of the insurance value of annuities and accommodate diverse choices.

Keywords: life cycle; household finance; longevity risk.

1 Introduction

As workers enter retirement they face the new problem of living without a regular labour income. They must fund ongoing consumption from their personal savings and public pension entitlements. How to manage retirement spending is a problem for a growing number of individuals and for society as a whole. Around three million people in Australia are now aged over 65 years, rising to around eight million by the middle of the century, resulting in a doubling of the age dependency ratio from 20% to 40%. Even allowing for an increase in the eligibility age to 67, spending on the Age Pension is forecast to rise by about one percentage point of GDP, an increase of around one third (The Treasury, 2010). Retirees who spend their personal savings too quickly and draw heavily on the public pension, and retirees who are overly cautious, both create and/or incur welfare losses.

A retiree who knew their remaining lifetime, returns on invested savings and their public pension entitlements could exactly match their financial resources to their consumption plans each year. In reality, plans are made and executed in a haze of uncertainty. Average retirement age is around 62 years, but more than 40% of retirees leave work at an unexpected time and for reasons beyond their control (Australian Bureau of Statistics, 2013b). While life expectancy has increased rapidly over the past century, and people now retiring in their early sixties can expect to live well into their eighties, lifetimes are very uncertain. A female aged 65 in 2012 has about a 50% chance of living to age 89, but a 20% chance of surviving to 95, and a 5% chance of living until 100 (Australian Bureau of Statistics (2013a) and authors' calculations). Many retired Australians keep the exposure to investment risk they had while accumulating savings through defined contribution superannuation funds, managing financial returns volatility in the range of 10-20% p.a. And while the means-tested Age Pension payment makes an income base for around 70% of age-eligible retirees, recent announcements of policy changes to eligibility ages and indexation highlight regulatory risks (Australian Government , 2014)). The risky, long-horizon, multi-dimensional optimization problem that confronts retirees is daunting, especially given the modest financial skills of most (Agnew et al., 2013a).

The economist's favourite remedy for the retirement decumulation problem is a life annuity (Yaari, 1965; Davidoff et al., 2005; Horneff et al., 2008a). Life annuities insure longevity risk, pay regular guaranteed income, and if they are fairly priced, add a mortality credit to the return on the underlying asset. However, purchasing an annuity entails forfeiting capital to the provider, a part of the agreement that is unappealing to individuals who want to leave a bequest, who anticipate a need for liquid wealth to meet uninsured consumption risks or who value exposure to risky asset markets but cannot purchase a variable annuity (Friedman and Warshawsky, 1990; Bernheim, 1991; Turra and Mitchell, 2008; Kingston and Thorp, 2005; Milevsky and Young, 2007). Individuals who receive pension streams from other sources or who enjoy insurance from other household members are also less attracted to annuities (Bernheim, 1991; Dushi and Webb, 2004; Inkmann et al., 2011).

Very few Australian retirees take up the annuity remedy (even partially), and their lack of interest is typical of voluntary annuity markets around the world. The US and Australia, economies that both operate private retirement savings schemes are examples: only around 1% of US 401(k) plan retirees offered a life annuity actually purchase one (Employee Benefits Research Institute (EBRI), 2011) and, until recently, sales of life annuities in Australia stood at just several hundred policies annually in a market with several million retirees (Plan for Life, 2014). Although in recent years slightly more Australian retirees have withdrawn their superannuation through income streams (Australian Prudential Regulation Authority (APRA), 2014), including around 2,000 new life annuity policies sold in 2013-14 (Plan for Life, 2014), still around half of superannuation assets is withdrawn as lump sums, and most of the rest is transferred to phased withdrawal products that have no longevity protection and no upper limit on spending.

Public policy settings around retirement decumulation have varied over time in their relative support for lump sums, phased withdrawal products and life and term annuities. Freedom of choice of benefit type has been a key principle of policy settings, and traditionally lump sums were tax preferred. However, around the time of the introduction of mandatory superannuation arrangements (the Superannuation Guarantee), tax and social security (Age Pension) concessions were introduced for life annuities. Over the 1990s, these were then extended to term annuities and phased withdrawal products. The Simpler Super reforms of 2006-07 abolished all taxes on retirement benefits taken from age 60 and simplified the Age Pension means tests by removing (tax and social security) differences by benefit type (Bateman and Piggott, 2011). In the following year sales of life annuities fell to less than 100 policies across the country. More recently, the 2014 Financial System Inquiry has increased public policy interest in decumulation, with an entire chapter of the Interim Report devoted to 'Retirement Incomes' (Financial System Inquiry, 2014).

While some tax and social security settings favour gradual decumulation over lump sum withdrawals, the income and assets testing of the Age Pension payment creates an incentive to spend wealth faster and hold riskier assets than otherwise (Hulley et al., 2013; Ding, 2013b). This raises the question of whether the best interest of retiring workers, and of society generally, is served by making some annuity purchase compulsory. It also raises the related question of whether a default strategy could or should be introduced to guide decumulation.

We answer these questions by simulating a standard Hyperbolic Absolute Risk Aversion (HARA) model calibrated to Australian settings. The individual reaches retirement with a stock of financial wealth (net of bequests and housing wealth) that must be shared between a fairly priced lifetime annuity and a liquid account that is invested in a well-diversified portfolio of risky assets with a known risk and return distribution. This is a simplified version of the typical choices facing a defined contribution (DC) fund member. We simulate the model and report the optimal allocation decisions over arrays of preferences, returns and endowments. We use a rapid computation method by Carroll (2006) that allows us to cover a wide range of scenarios. To mimic changing financial market conditions, we vary the volatility of risky returns separately from the risk premium, which leads to four scenarios of market performance around the baseline calibration, namely volatile high returns, volatile low returns, stable high returns and stable low returns. Individual heterogeneity is captured by the variation of individual attitudes toward risk, measured by the curvature parameter. Demand for annuities depends on a comparison between mortality credits and the risk premium, and on tastes for risk. Only the most risk-tolerant individuals choose no annuities in this setting, and partial annuitisation is optimal for most.

Optimal allocations are very different from those predicted by the standard model when the Age Pension is present. The agent is either eligible for the Age Pension immediately or can become eligible at a future date, depending on how their total wealth and portfolio allocation interact with the means tests. The Age Pension is an indexed life annuity with payments that are negatively correlated with wealth. It is a substitute for voluntary annuity purchases. Simulation of the extended model with the Age Pension shows that mandatory annuitisation at any level is very costly to low wealth retirees, and would not improve the welfare of richer retirees much. Low wealth retirees are better off holding liquid wealth in a risky asset portfolio that pays the risk premium. This strategy for low wealth households changes only when the household needs to fund a consumption floor exceeding the maximum Age Pension, when the risk premium evaporates, or when asset return volatility and/or risk aversion rise to extremely high levels.

Modest amounts of annuitisation do make medium to high wealth households better off, but the best level of annuitisation will vary with financial conditions and preferences, making it hard to fix a compulsory or default rule. Deferred annuities are more attractive to less well off retirees, because the premiums are lower than immediate annuities. However deferral is very unappealing for wealthier retirees because the delayed payment stream starts around the time that natural decumulation of capital, in conjunction with the means tests, makes individuals eligible for a higher Age Pension payments.

In the next section we outline the model structure, the calibration assumptions and a sketch of the rapid computation method driving the scenarios, followed by the baseline simulation results. In section 3 we describe the Age Pension and show the effects on optimal annuity purchases when social security payments are offered to retirees. Then in section 4 we investigate deferred annuitisation, where retirees pay a premium at retirement for an income stream to begin at age 85, and also review the optimal annuitisation strategy when the retiree has to support a constant consumption habit. The final section discusses some policy implications and concludes.

2 The model

Our aim is to model the annuitisation and consumption decisions of a worker leaving the accumulation stage of a DC retirement savings system. We match the benchmark model parameters to current Australian settings but the basic structure and inference applies to any DC system with a targeted public pension. The model is based on Samuelson (1969), and a discrete time version of Merton (1971), but extended to include partial annuitisation as a single decision at retirement. We allow immediate partial annuitisation, unlike Kingston and Thorp (2005), who model a total, delayed annuitisation later in retirement, and Milevsky and Young (2007), Horneff et al. (2008b) and Horneff et al. (2010), who allow gradual annuitisation. Inkmann et al. (2011) allow agents to choose from bonds, stocks and nominal annuities with life insurance and public pensions in a recursive utility setting for the UK, while Bütler et al. (2011) consider annuitisation with a means tested public pension for Switzerland, but these models are not adapted to the Australian setting.

We assume that people have already made provision for bequests and housing before they decide on annuitisation.[1] Exemption from Age Pension means-testing and the structures of the aged care financing system give older Australians strong incentives to hold onto the the family home, and a majority do (Bradbury, 2008; Cho and Sane, 2013; Spicer et al., 2013) so housing consumption is separate from the model, and housing wealth is treated as an inheritance. Agents in this model also set aside wealth for planned bequests and choose annuities out of net wealth.[2]

[1]We apply the Age Pension means tests only to wealth net of bequests.

[2]Ding et al. (2014) look into the dynamic portfolio implications of 'luxury' bequests and show that retirees who want to leave bequests will put an increasing proportion of their wealth into risky assets later in retirement. They do not model the annuitisation decision.

2.1 Theoretical model of retirement wealth allocation

Consider an individual who reaches retirement with a stock of liquid wealth w which is measured net of housing and the amounts set aside for bequests. At retirement this wealth is shared between a pair of retirement benefit products, forming a portfolio ($p_A \in [0,1], 1 - p_A = p_{\tilde{R}}$), where $p_A w$ is allocated to an immediate life annuity and $p_{\tilde{R}} w$ to a risky investment account with return $\tilde{R}_t$. The chosen portfolio is fixed for the remainder of life, and the only choices made after retirement are consumption and savings.

At the beginning of every period t the return $\tilde{R}_t$ on the risky asset and gross value of investments are realized, the annuity payment, y, and public pension payment, p_t, are received. These sources form the total amount available for consumption at time t:

$$M_t = \tilde{R}_t \left(M_{t-1} - c_{t-1} \right) + y + p_t. \tag{1}$$

The individual then chooses consumption level $c_t = [0, M_t]$, and consumption takes place. At the end of period remaining wealth $M_t - c_t$ is reinvested and the individual's survival is decided. If they survive, the problem is repeated in the next period, $t+1$.

We assume that portfolio allocation p_A is chosen at the instant of retirement, when the individual is alive for certain, and that the first period $t = 1$ starts immediately afterwards. Therefore, the total resources available for consumption at period $t = 1$ include the first annuity payment and are given by $M_1 = p_{\tilde{R}_1} w + y + p_1$.

Let π_t denote the probability of survival from time period t to time period $t+1$. The annuity is fairly priced, so that the annuity payment is increasing in the risk free interest rate, r, and decreasing in the probability of survival, and no additional charges (or loadings) are deducted by the provider:

$$y = \frac{p_A w}{\sum_{t=1}^{T} (1+r)^{1-t} \prod_{\tau=1}^{t-1} \pi_\tau}. \tag{2}$$

The individual plans optimal consumption c_t in every time period until death by performing the maximisation in the Bellman equation

$$V_t(M_t) = \max_{0 \le c_t \le M_t} \left[u(c_t) + \beta \pi_t E V_{t+1} \left(M_{t+1} \right) \right], \tag{3}$$

where $u(c_t)$ is the instantaneous utility of consumption, and next period's total consumable resources M_{t+1} are given by the intertemporal budget constraint (1). The portfolio allocation choice p_A is made so as to maximize the discounted expected lifetime utility at period $t = 1$, which is given by

$$V_1(M_1) = V_1\big((1 - p_A)w + y + p_1\big), \tag{4}$$

where V_1 is the solution of the Bellman equation (3).

2.2 Calibration

We set a benchmark by first assuming that individuals have no consumption floor, and so preferences show constant relative risk aversion (CRRA) $u(c_t) = (c_t^{1-\lambda} - 1)/(1 - \lambda)$ with $\lambda = 2.5$ and impatience at $\beta = 0.95$. (We simulate scenarios with a range of risk aversion parameters.)

Annual returns to the risky asset account ($\tilde{R}$) are i.i.d. log-normal, with parameters (μ_i, σ_i). Using historical returns to the most popular (60:40) portfolio for phased withdrawal products as a base, we set the annual expected return and volatility to $E(\tilde{R}) = 0.065$ and $StdDev(\tilde{R}) = 0.10$ implying $\mu_i = 0.059$ and $\sigma_i = 0.094$. At this level, the risk premium over a 2% risk free interest rate is 4.5% p.a.

The immediate life annuity A provides a level real lifetime income stream, fairly priced at a risk-free real interest rate of 2% p.a. and at cohort (25 year improved) survival probabilities π_t (Australian Government Actuary, 2009). Because individuals here buy annuities just once at age 65, we use a constant hazard rate to price them: $\pi_t = 0.953$

for men with life expectancy of 86 years, $\pi_t = 0.959$ for women with life expectancy is 89 years.[3]

Individuals are assumed to reach retirement with at least $5,000 of net wealth to invest. The median superannuation balance for 60-64 year old men in 2011-12 was around $70,000, and was less than $20,000 for women, but average balances were much higher at around $200,000 for men and around half of that for women (ASFA 2014). ABS estimates of average total net wealth for this age group are around $1,266,000. At end 2011 a life annuity with a purchase price of $100,000 provided annual payments of around $6,300. In the current low interest environment the $100,000 purchase price would provide an annual payment of around $5,280 (or just over $4,000 for full inflation protection).

2.3 Solution method

We adopt the following numerical strategy for solving the model and running the simulations. For every set of parameter values defining a scenario, we separately solve the consumption-savings part of the model, and then use a grid search technique to find the optimal portfolio allocation. We use this combination of optimization methods because the stochastic lifecycle model of consumption and saving can be solved by the method of endogenous grid points developed by Carroll (2006) at a very low computational cost. The endogenous grid points method gives (an approximation) of the whole value function $V_1(M_1)$ that can be evaluated at any value of initial wealth w and portfolio weights, allowing for a separate procedure to search for optimal portfolio allocations at different levels of wealth.

In this way, we are able to avoid the more costly nested optimization method, that puts the consumption-savings problem on an inner loop and the optimal allocation problem on an outer loop, and the even more computationally intensive lifecycle formulation with two choice variables. However, because the annuity payment y acts as an exogenous invariant state in the dynamic model of consumption and savings, we discretize the range of possible annuity payment levels and apply the endogenous grid points method repeatedly. We can

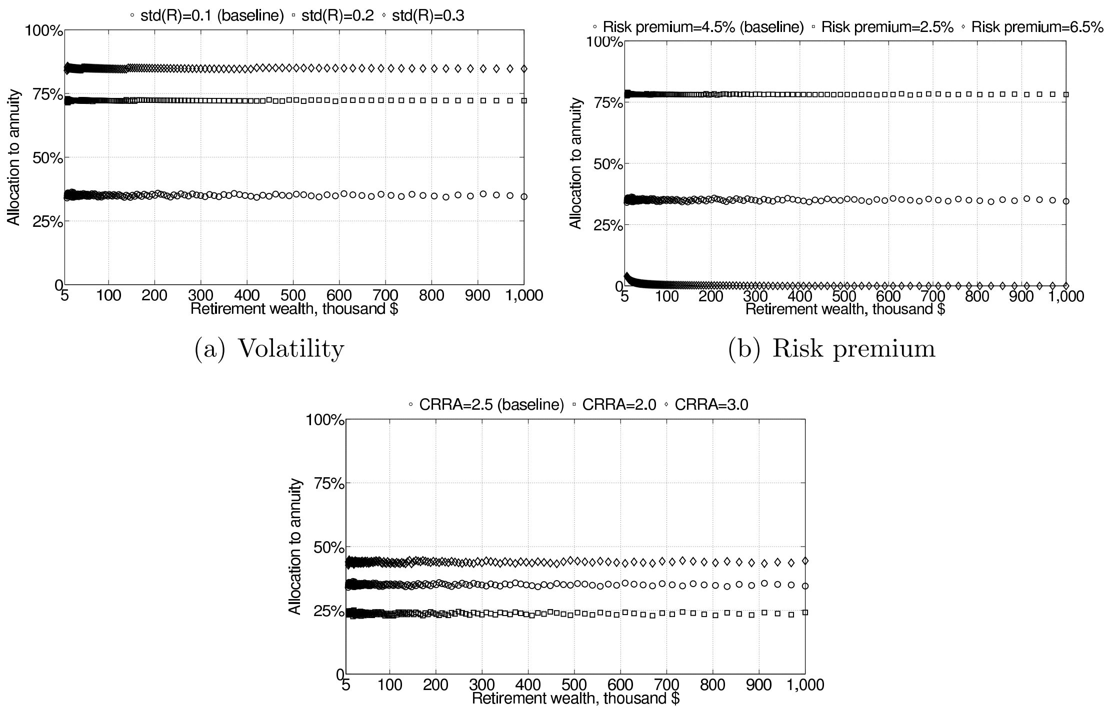
[3]We only report findings based on survival process for men, our findings do not change substantively if we women instead.

then use a solution $V_1(M_1)$ to the consumption-savings model with a particular value of an annuity payment y to compute the expected lifetime utility at different levels of wealth w, in combination with the matching fraction p_A, that is calculated according to equation (2). We use an irregular and sufficiently fine grid over the annuity payments to ensure that for every level of initial wealth at least 250 annuity weights are simulated (necessarily including 0% and 100%), and perform the grid search on these simulated allocations. The end result is an efficient and robust numerical solution method.

2.4 Optimal annuitisation without the Age Pension

Annuities insure retirees against outliving their incomes but usually pay out at a rate below the risk premium, even after mortality credits. Retirees make a trade-off between the liquid high return, high risk phased withdrawal account and the illiquid, lower return, inexhaustible annuity. Conventional life cycle models treat individuals as risk neutral over mortality uncertainty but risk averse over consumption uncertainty. As a result, more risk averse individuals discount the risk premium more and value certainty over future consumption more, and annuitise more of their wealth. The general theoretical result favouring complete annuitisation depends on the risk premium being low relative to annuity payouts.

In Figure 1, each panel compares the benchmark annuitisation level (for males) with two alternative scenarios. With no Age Pension payment, a constant investment opportunity set and CRRA preferences, the optimal purchase of annuities is the same for any level of wealth. At relative risk aversion of $\lambda = 2.5$, a risk premium of 4.5% p.a. and volatility of 10% p.a., men optimally spend about 38% of their wealth on annuities. Panel 1(a) shows how the optimal annuitisation increases non-linearly with the volatility of the risky investment, so that a ten percentage point increase raises annuity purchases to nearly 75% of retirement wealth. By contrast, raising the risk premium by two percentage points (Panel 1(b)) makes annuitisation completely unappealing. At benchmark settings for other parameters, risk aversion would need to increase to extremely high levels to warrant full annuitisation (Panel 1(c)).



(a) Volatility

(b) Risk premium

(c) Risk aversion

Figure 1: Optimal annuitisation without Age Pension

Annuities appeal to retirees when the annuity pays a high income compared with the risky investment account, if retirees strongly value smooth consumption, and if uninsurable wealth shocks are relatively low. In the absence of the public pension, and setting aside uninsurable shocks, these simulations show that most Australian retirees would want to use a substantial share of their savings net of housing and bequests to purchase annuities but would also benefit from continued exposure to risky returns. These results could support a default (opt-out) annuitisation of around one third of fungible retirement wealth.

3 The Age Pension

The Age Pension is very similar to an inflation-indexed annuity offered by a commercial provider, with a few important differences. Means tests target the Age Pension payment to people who meet the age and residency requirements and whose income and assets are below the thresholds. Targets are not very tight, and the current settings mean that around 70% of age-eligible residents get at least a part pension (Department of Families, Housing, Community Services and Indigenous Affairs, 2013). The Department of Social Services review and adjust payments to changes in the pensioners' circumstances every two weeks, so unlike a commercial annuity, the Age Pension payment cushions changes in other sources of income and assets. Means-tests thresholds are adjusted to changes in the price level, and payments are indexed to prices and/or earnings twice each year. Age Pension payments are maintained at 27.7% of male average weekly earnings or adjusted for increases in the CPI or the Pensioner and Beneficiaries Cost of Living Index (PBCI), whichever is the higher.

If the retiree earns no labour income, the Age Pension benefit p_t depends on the end of previous period's wealth $A_{t-1} = (M_{t-1} - c_{t-1})$ and annuity income y in the current period. The Age Pension benefit p_t is

$$p_t(M_t) \quad = \quad max\left(0, FP - max\left(IT_t, AT_t\right)\right), \tag{5}$$

where FP is the maximum payment, assumed constant in the model, and IT_t and AT_t are reductions due to the income and asset tests respectively. In this analysis, we set the maximum annual payment to 2010 levels at \$18,961.80 for single pensioners.

The income test reduces the maximum payment by 50% of every dollar received above a the income threshold ($\bar{IT}$). Different sources of income (I) are treated differently under the income test: returns to financial investments are "deemed" at a fixed progressive rate, while incomes from long term income stream products (including annuities) are reduced by returns of capital. The asset test reduces the maximum pension by 3.9% for every dollar in assets above a certain threshold ($\bar{AT}$). For the purposes of this test, financial assets are assessed at their market value, and income stream products are assessed at their residual value. The exact formulas for income and asset tests are:

$$IT_t = max\left\{0,\, 0.5\left(I_t - \bar{IT}\right)\right\},$$

$$I_t = DR_2 A_{t-1} - \left(DR_2 - DR_1\right) min\left\{A_{t-1},\, \bar{DR}\right\} + \left(y - \frac{p_A w}{LE_1}\right),$$

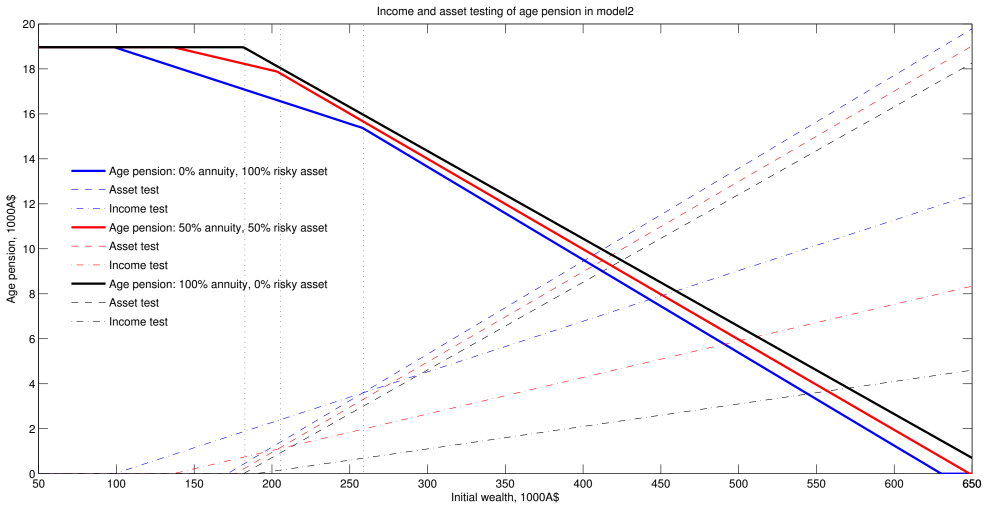


Figure 2: Age pension benefits and means testing for single home owners

where for simplicity we are treating investable wealth as financial investments and LE_1 is life expectancy at time $t = 1$. Deeming rates at are set to 2010 levels, $DR_1 = 3\%$ and $DR_2 = 4.5\%$, $\bar{IT} = 43,200.00A\$$, $\bar{DR} = 3,796.00A\$$.

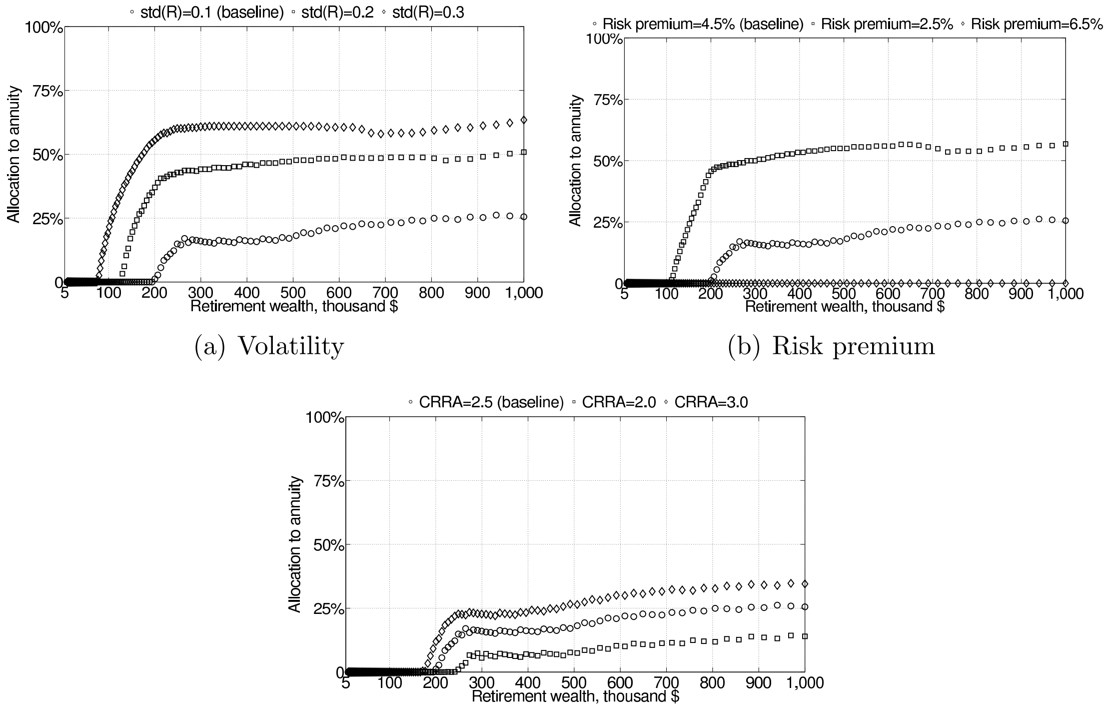
$$AT_t = max\left\{0,\ 0.039\left(\tilde{R}A_{t-1} + p_A w \cdot max\left\{0,\ \left(1 - \frac{t}{LE_1}\right)\right\} - \bar{AT}\right)\right\},$$

where $\bar{AT} = 181,750.00A\$$ p.a. for singles.

If the retiree does not annuitise at all ($y = 0$), at wealth of around $\$100,000$ the income test taper begins to reduce the pension payment at an implicit tax rate of 50%, then from around $\$260,000$ the asset test taper reduces payments more steeply. Because the annuity provides lower assessable income (under the income test) and is counted at a fraction of its purchase price (under the asset test), allocating more retirement wealth to the annuity shifts both income and asset test tapers to the right, resulting in higher pension payments for a given amount of initial wealth. (See Figure 3.)

3.1 Optimal annuitisation with the Age Pension

Retirees who can access the means tested pension will reduce other annuity purchases and keep their portfolio settings as close to the ideal (Figure 1) as possible. Figure 3



(a) Volatility

(b) Risk premium

(c) Risk aversion

Figure 3: Optimal annuitisation with Age Pension

shows the same scenarios but now with Age Pension entitlements included. Because the means tests apply to levels of wealth, the optimal purchases change as wealth increases, and the differences in the taper rates between the income and assets tests cause uneven slopes.

For low wealth retirees, the Age Pension completely crowds out voluntary annuity purchases, even when risky asset volatility is 30% p.a. or the risk premium falls to 2.5% p.a. For the scenarios presented here, it is never optimal for retirees with wealth below the current median male retirement accumulation of $\$70,000$ to buy annuities. So around half of current males retirees would have accumulations too low to justify any annuity purchases. The same holds for a far larger proportion of females, first because women accumulate less wealth then men on average and because annuities are more expensive at female mortality rates.

The Age Pension crowds out annuitisation to some degree in all scenarios at all wealth levels. Rational retirees anticipate that they if they live long enough, they will eventually spend down their own savings to the point where they become eligible for some future

Age Pension payment, and so everyone annuitises less at retirement. This generally lower purchase applies even though the means tests favour annuities over the risky asset investment.

Retirees with higher wealth do better with some annuitisation. For the benchmark settings, some annuitisation becomes attractive when retirement wealth reaches nearly $\$200,000$ and climbs to a maximum of 25% of retirement wealth at around $\$800,000$. If the risk premium falls to 2.5% or if volatility increases, allocations above 50% are optimal. Considering the optimal annuitisation level as a function of wealth, we see that after the initial rise, the optimal path flattens because of the implicit income insurance cover of the means tests tapers, then rises again as higher wealth makes the retiree ineligible for any pension payment. The slight decline in the optimal level of annuitisation at higher wealth levels is caused by the discontinuity in the means tests at the point of pension eligibility, and the favourable treatment they give annuities. Figure 3 shows how people will start to get a small pension at wealth around $\$700,000$ and the tapers move a little rightwards when more annuities are purchased. So just below the eligibility point optimal annuitisation is slightly higher than just above it.

3.2 Compensating variation calculations with Age Pension

Low wealth retirees are much worse off if they are forced to fully annuitise their savings: at benchmark parameter settings, retirees with $\$50,000$ of wealth would need around 28% additional retirement wealth to maintain their utility at the optimal level (compensating variation). Table 1 sets out compensating variations at a range of retirement wealth levels, comparing zero or full annuitisation with the optimal paths shown in Figure 3. In all the scenarios analysed here, retirees with accumulations at current median to average levels are better off with zero annuitisation, and the compensation needed for full annuitisation is around 20%.

For wealthier individuals who get less Age Pension, being forced to annuitise too much is less costly than for poorer retirees, but still worse than having no chance to annuitise. At benchmark parameter settings, the compensation needed by wealthier

Table 1: Compensating variations for zero and full immediate annuitisation: $1000*s* of initial wealth

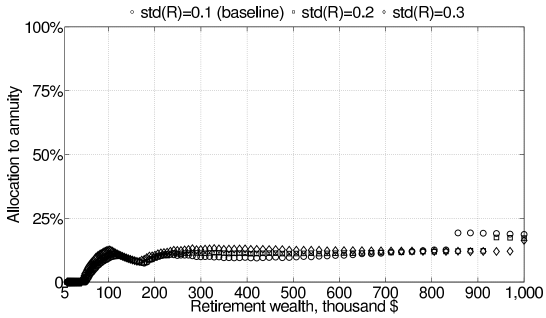
Wealth ($1000s)	50	125	250	500	1000
Zero annuitisation					
Benchmark	0.00	0.00	0.70	3.98	15.49
$std(\tilde{R}) = 0.2$ p.a.	0.00	0.00	15.10	57.91	154.69
$std(\tilde{R}) = 0.3$ p.a.	0.00	3.96	50.82	174.71	471.76
Risk premium = 2.5% p.a.	0.00	0.14	18.04	56.27	129.54
Risk premium = 6.5% p.a.	0.00	0.00	0.00	0.00	0.00
RRA $\lambda = 2.0$	0.00	0.00	0.02	0.68	4.28
RRA $\lambda = 3.0$	0.00	0.00	2.11	9.27	30.70
Full annuitisation					
Benchmark	13.75	23.50	34.75	78.43	117.39
$std(\tilde{R}) = 0.2$ p.a.	13.39	17.48	24.93	61.74	87.78
$std(\tilde{R}) = 0.3$ p.a.	12.88	13.74	19.28	52.54	66.89
Risk premium = 2.5% p.a.	12.34	13.39	18.88	52.86	74.42
Risk premium = 6.5% p.a.	16.35	36.48	66.86	139.55	224.29
RRA $\lambda = 2.0$	13.60	24.71	38.42	87.88	133.69
RRA $\lambda = 3.0$	13.89	22.40	32.07	71.71	106.18

Notes: Table reports compensating variations in $1000*s* of retirement net wealth for forcing allocations to zero or full annuitisation for 65 year old male single home owning retirees who may be eligible for the Age Pension. Benchmark settings are $\lambda = 2.5$, $\beta = 0.95$, $E(\tilde{R}) = 0.065$ p.a., and $StdDev(\tilde{R}) = 0.10$ p.a. Annuities are fairly priced at a risk free interest rate of 2% p.a. and 65 year old male survival probability $\pi_t = 0.953$.

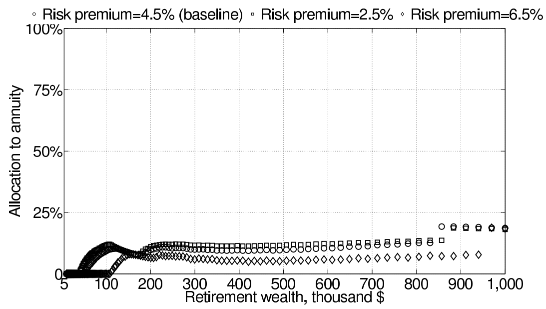
retirees ($\$500,000 - \$1m$) for full annuitisation is around 15% of retirement wealth, and still much higher than for zero annuitisation at 1%. However changing the outlook for the risky asset can reverse this result: at $20 - 30\%$ volatility, or at a risk premium at 2.5%, the benefits of a guaranteed income with longevity insurance outweigh the benefits of a higher return. At this wealth range, the marginal benefits of annuitising are sensitive to the investment outlook. High loadings on annuity prices would quickly eliminate the benefits of purchasing them, but financial market pessimism would make them very attractive.

4 Extensions

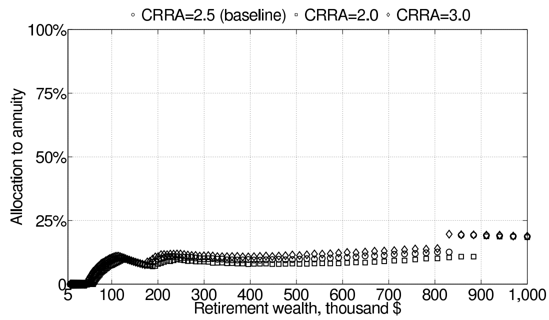
Deferred annuities are often proposed as the ideal solution to increasing longevity in DC systems because they insure consumption at later ages at lower cost (Horneff et al., 2010;



(a) Volatility



(b) Risk premium



(c) Risk aversion

Figure 4: Optimal deferred annuitisation with Age Pension

Gong and Webb, 2010): we now conduct the equivalent scenario analysis for an annuity that can be purchased at age 65 to begin paying income at age 85. In addition, so far we have assumed that that retirees have no subsistence consumption level, but conventional advice to retirees is often framed in terms of a pyramid of spending needs, with a base of essentials, so we also introduce a consumption floor and rerun the scenario analysis.

4.1 Optimal deferred annuitisation with the Age Pension

Retiring members of DC systems are often justifiably worried about running out of uninsured private savings before the end of life and facing a permanently lower income. Deferred annuities have some appealing features that can help with this concern. First, the premiums are lower than immediate annuities because survival prospects are lower over the later payout phase and also because there is a positive probability the insured will die before the payment stream starts, boosting mortality credits to the surviving members of the pool. Second, the payout arrives at the time when phased withdrawal account balances are likely to be exhausted but health or aged care costs are starting to rise. For these reasons, policy makers sometimes propose compulsory deferred annuitisation as a more palatable alternative to compulsory immediate annuitisation. However in the Australian setting, payments from the Age Pension also increase as personal savings decline at older ages, so the deferred annuity income arrives alongside increasing government support. Scenario analysis shows that this latter effect dominates the more attractive pricing for most wealth levels.

Optimal allocation levels in Figure 4 show that access to the Age Pension crowds out deferred annuitisation more than immediate annuitisation in general. Retirees with savings above $\$100,000$ optimally allocate only around 10% of wealth to the deferred annuity, with little variation as investment returns, volatility and risk preferences change. The deferred annuity mutes the impact of parameter variation across all scenarios.

However we see two important differences between deferred and immediate annuitisation. First, lower wealth retirees demand some deferred annuities where they wanted no immediate annuities. The more attractive pricing of the deferred annuity creates demand among low wealth households even when the risk premium rises to 6.5%. Second, the cheaper price induces individuals of all wealth levels to purchase some annuities at the higher risk premium where there was no demand for the immediate annuity. Compensating variation calculations in Table 2 confirm these observations: the absence of a deferred annuity market reduces the welfare of retirees with $\$50,000 - \$125,000$ of wealth at retirement by small, but positive, amounts, where the absence of an immediate annuity market made no difference to them.

This analysis confirms that lower wealth retirees in Australia would be better off if they could purchase a deferred annuity at fair prices. The lack of a market in deferred annuities hurts poorer retirees more than the lack of a deep immediate annuity market.

Table 2: Compensating variations for zero deferred annuitisation: \$1000s of initial wealth

Wealth (\$1000s)	50	125	250	500	1000
Benchmark	0.00	2.10	12.77	23.90	64.34
$std(\tilde{R}) = 0.2$ p.a.	0.01	3.54	16.40	43.75	110.62
$std(\tilde{R}) = 0.3$ p.a.	0.06	5.28	21.98	67.40	177.143
Risk premium = 2.5% p.a.	0.09	4.17	19.85	46.39	119.55
Risk premium = 6.5% p.a.	0.00	0.25	6.19	6.99	13.97
RRA $\lambda = 2.0$	0.00	1.37	10.39	17.56	42.72
RRA $\lambda = 3.0$	0.01	2.79	15.14	30.87	84.80

Notes: Table reports compensating variations in \$1000s of retirement net wealth for forcing allocations to zero or full deferred annuitisation for 65 year old male single home owning retirees who may be eligible for the Age Pension and who can purchase a fairly priced 20 year deferred annuity. Benchmark settings are $\lambda = 2.5$, $\beta = 0.95$, $E(\tilde{R}) = 0.065$ p.a., and $StdDev(\tilde{R}) = 0.10$ p.a. Annuities are fairly priced at a risk free interest rate of 2% p.a. and 85 year old male survival probability $\pi_t = 0.953$.

4.2 Optimal annuitisation with minimum consumption

We now extend our analysis by generalising the utility function from CRRA to hyperbolic absolute risk aversion (HARA), or a linear risk tolerance function.[4] We model a fixed consumption floor, or a constant habit. As Kingston and Thorp (2005, p. 226) note: "Insofar as the habit paradigm constitutes a useful characterization of any phase of the life-cycle, surely retirement is that phase." It is common for financial planners to ask about a client's minimum consumption requirements as a base for assessing the adequacy of retirement savings and as a guide to portfolio structure.

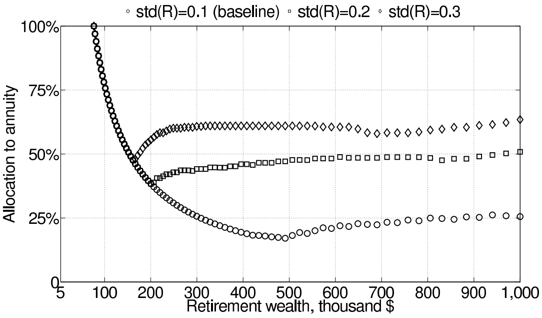
Building on work by Saunders et al. (2005) the Association of Superannuation Funds of Australia (ASFA) publish "modest" and "comfortable" retirement standards.[5] We set the modest ASFA standard (\$23,363) for a healthy, single home-owning retiree as the consumption floor in the utility function.[6]

Because the marginal disutility of consumption under the floor approaches infinity, the optimal portfolio allocation in habit models protects the consumption floor by setting aside an escrow fund in risk-free assets (Ingersoll, 1987). Retirees in this model must buy

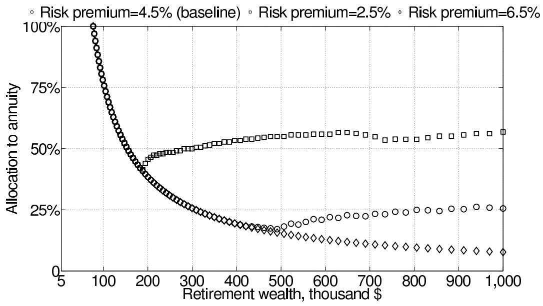
[4]The continuous time version of the HARA was developed by Merton (1971). When the curvature parameter is equal to one we get the generalized logarithmic utility model (GLUM)(Litzenberger and Rubinstein, 1976). The annuitisation decision in this setting is analysed in Kingston and Thorp (2005).

[5]The estimate of spending includes communications, private health insurance, energy, clothing, basic household goods and services, transport, and some basic costs of leisure such as social club membership (The Association of Superannuation Funds of Australia, 2014).

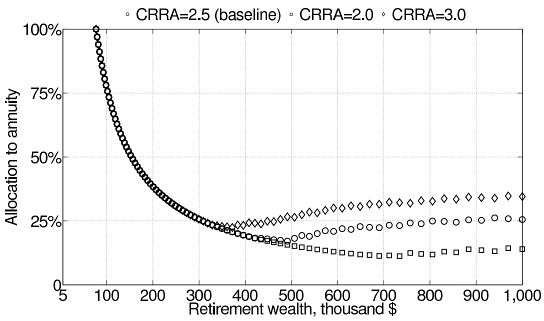
[6]Ding (2013a) estimate a much lower subsistence level for single Australian retirees at \$10,000.



(a) Volatility



(b) Risk premium



(c) Risk aversion

Figure 5: Optimal annuitisation with consumption floor and Age Pension

annuities to cover the floor because no other risk-free asset is offered to them. Even if a riskless bond could be held, agents here would prefer the annuity because of the mortality credits it pays over the risk free rate of interest. In real markets, agents can follow a constant proportion portfolio insurance strategy to protect the consumption floor and receive the risk premium (Kingston, 1989).

Agents in our model can choose their allocation once, at retirement, so they purchase a life annuity in an amount at least large enough to protect the difference between the maximum Age Pension entitlement and their consumption floor. For a retiree on the full pension, this gap is approximately $\$4,400$ p.a. and individuals with wealth below $\$75,000$ cannot insure the modest consumption level. The habit model has no solution for these individuals. The combination of the annuity guarantee and the income insurance provided by the Age Pension tapers means that they always have at least enough income to fund the consumption floor.

Figure 5 shows the dramatic difference a consumption floor makes to annuitisation levels at lower wealth. Around $\$75,000$ is used to purchase annuities when individuals

Table 3: Compensating variations for full annuitisation with minimum 'modest' consumption: \$1000s of initial wealth

Wealth (\$1000s)	50	125	250	500	1000
Benchmark	-	13.39	33.83	78.43	117.39
$std(\tilde{R}) = 0.2$ p.a.	-	13.10	24.93	61.74	87.78
$std(\tilde{R}) = 0.3$ p.a.	-	12.67	19.28	52.54	66.89
Risk premium = 2.5% p.a.	-	12.03	18.88	52.86	74.42
Risk premium = 6.5% p.a.	-	15.91	54.46	127.89	216.14
RRA $\lambda = 2.0$	-	13.24	36.11	87.40	133.69
RRA $\lambda = 3.0$	-	13.54	31.79	71.71	106.19

Notes: Table reports compensating variations in \$1000s of retirement net wealth for forcing allocations to full immediate annuitisation for 65 year old male single home owning retirees who may be eligible for the Age Pension and who has a constant consumption habit of \$$23,363$ p.a. Benchmark settings are $\lambda = 2.5$, $\beta = 0.95$, $E(\tilde{R}) = 0.065$ p.a., and $StdDev(\tilde{R}) = 0.10$ p.a. Annuities are fairly priced at a risk free interest rate of 2% p.a. and 65 year old male survival probability $\pi_t = 953$.

are entitled to the full pension, gradually tapering off as minimum consumption declines as a proportion of wealth. The cost of not being able to insure the consumption floor by purchasing zero annuities is infinite so Table 3 reports compensating variations for full annuitisation only. For lower wealth individuals, these are higher than when no consumption floor was included in the utility function, but for higher wealth individuals, compensating variations are still around 10-15% of initial wealth.

5 Discussion and conclusions

Retirees optimally balance the Age Pension with voluntary annuitisation: the higher their anticipated pension entitlement, the lower their demand for annuities. As long as the risk premium on alternative investments is positive and risk aversion is moderate, low wealth retirees will not want to voluntarily annuitise. Retirees with accumulations above the current average for retiring men of around \$$200,000$ are better off with some voluntary annuitisation, and as the Superannuation Guarantee matures, an increasing proportion of older Australians will move into this group.

Being forced to fully annuitise and being unable to annuitise at all both make retirees worse off, but the effects are felt by different groups, delineated mainly by wealth rather than preferences. On one hand, compulsion would be very costly for less wealthy retirees who already receive the Age Pension, forcing them into safe, low return, longevity insured income streams where the marginal improvement in welfare does not compensate for the risky higher investment returns they have to forego. On the other hand, wealthier retirees need access to longevity insurance well above the government's provision, and not having a private annuity market would be costly to them. The loss of this insurance to well-off individuals is much more marked if the outlook for investment returns is less optimistic.

The fact that the Age Pension is targeted to poorer elderly has implications for risk pooling in annuity markets. Studies of longevity have described the "mortality gradient", where survival prospects rise with wealth, as a robust regularity across different populations (Deaton, 2002; Meara et al., 2008; Pijoan-Mas et al., 2013; Turrell and Mathers, 2001). Our analysis shows that even when mortality is assumed to be the same for all wealth groups, means testing concentrates private demand for annuities among the better off. In reality, these individuals will also live significantly longer on average than those with less wealth, inducing annuity providers to adjust prices upwards.

At present, Australian tax and social security regulations do not support a market for deferred annuities and policy makers and other stakeholders are discussing regulatory changes to that would allow more even treatment of longevity insured income streams. Our modelling shows that a fairly priced deferred annuity would probably be attractive to lower wealth retirees by offering longevity insurance at a lower premium than an immediate annuity. However the Age Pension crowds out the late payment stream offered by deferred annuities for wealthier people because they would probably begin to receive income from the government towards the end of their decumulation around the same time as the deferred annuity payment. Developing a deep market in deferred annuities is likely to be challenging if the Age Pension payments and means testing stay as they are.

Immediate annuitisation is most valuable for retirees protecting a consumption habit, especially for those who have smaller accumulations. However, a policy of compulsory annuitisation is problematic even here, since consumption habits will vary from person to person: forcing low wealth retirees to buy annuities that they do not need makes them a lot worse off. Alternative policy settings such as a default annuity or the re-installment of incentives to take annuities are similarly problematic. There is strong evidence that people stick with defaults (Madrian and Shea, 2001), including those for whom the default is inappropriate (Bateman et al., 2014a), while incentives may not be taken-up by those who could benefit.

It can be argued that regulators need to make annuitisation compulsory to stop imprudent spending by retirees but empirical studies present a very different view. Studies using Australian panel data show that the speed of decumulation by retirees is fairly slow, and susceptible to changes in financial market conditions (Spicer et al., 2013; Lim-Applegate et al., 2005). Very slow spending could be a self-insurance strategy adopted by retirees who do not annuitise. Exposure to investment risk can also be lessened by annuity purchases. While income streams can give guidance and structure to retirees' budgets and can moderate the speed of spending, it seems that the more important benefits of annuitisation are likely to come from the insurance features of the contract.

Unfortunately, Australian retirees have scant knowledge of income stream product features. Fewer than 10% of middle aged Australians surveyed (Bateman et al., 2014b) understood the guaranteed income and longevity insurance features of a lifetime annuity. The fact that most people understand very little about these products, have misconceptions about their retirement and survival prospects, and typically do not plan ahead (Agnew et al., 2013c,b), mean that education and advice should have priority over compulsion and be central to annuity defaults or incentives.

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