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Susan Thorp, Hardy Hulley, Rebecca McKibbin, Andreas Pedersen

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Means-tested income support, portfolio choice and decumulation in retirement*

Susan Thorp, Hardy Hulley, Rebecca McKibbin, Andreas Pedersen
University of Technology, Sydney

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Abstract

We investigate the impact of means tested public income transfers on post-retirement decumulation and portfolio choice using theoretical simulations and panel data on Australian Age Pensioners. Means tested public pension payments in Australia have broad coverage and give insight into the incentive responsiveness of well-off, as well as poorer households. Via numerical solutions to a discrete time, finite horizon dynamic programming problem, we simulate the optimal consumption and portfolio allocation strategies for a retired household subject to assets and income tests. Relative to benchmark, means tested households should optimally decumulate faster early in retirement, and choose more risky portfolios. Panel data tests on inferred wealth for pensioner households show evidence of more rapid spending early in retirement. However they also show that better-off households continue to accumulate, even when facing a steeper implicit tax rate on wealth than applies to poorer households. Wealthier households also hold riskier portfolios. Results from tests for Lorenz dominance of the panel wealth distribution show no decrease in wealth inequality over the five years of the study.

Keywords: Retirement wealth, Life-cycle saving, Public pension, Portfolio choice

JEL Classification: D91,E21, G11

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1 Introduction

Retirement savings systems around the world face significant pressures as populations age.[1] Funded individual accumulations, older retirement ages, and means testing of public income transfers have all been proposed as possible ways to alleviate growing demands on government budgets. Here, we investigate the impact of means tested public income transfers on post-retirement decumulation and investment behavior using predictions from a theoretical model and panel data on Australian retirees. Unlike most other developed economies, the Australian retirement incomes system incorporates a means testing regime that extends to around 80% of elderly households, including the wealthiest deciles, and can give insight into the incentive responsiveness of relatively well-off, as well as poorer, households.

One of the fundamental hypotheses of the life cycle model is that agents will save during their working lives and decumulate after they retire, and that those who accumulate at a faster rate will dissave more steeply towards the end of life.[2] However empirical evidence for dissaving by the elderly is inconclusive, with many studies of cross-sectional and panel data concluding that positive or zero saving is common (Alessie et al. 1999, Borsch-Supan 1992, Feinstein and Ho 2000). Among the many reasons offered for this anomaly is that means tested public income support may reduce private saving retirement by eligible and near-eligible households and restrict decumulation after retirement.[3]

While it seems clear that asset testing discourages savings by low-wealth households, the impact of means testing on wealthier households is an open question. Hubbard et al. (1995) treat richer households as unaffected by means tested income support since the welfare loss generated by meeting eligibility requirements exceeds the utility value of the payment. Neumark and Powers (1998, 2000) find impacts on households that are 'likely' to be eligible for the public transfer while Sefton et al. (2008) find responses among lower- to middle-wealth households but not among wealthier groups. Ziliak (2003) argues for savings responses to asset tested transfers among the poor but not among the 'near-poor' or the rich, and Hurst and Ziliak (2004) fail to find any response of 'at-risk' households to reforms designed to encourage saving. By contrast, de Nardi et al. (2006), using a dynamic model with differentiated longevity and potentially large uninsured medical risks, find that the presence of an asset tested consumption floor has

[1] See, for example, Chand and Jaegar (1996), Borsch-Supan et al. (2005), Gruber and Wise (2005), Novy-Marx and Rauh (2008), Commonwealth of Australia (2002).

[2] See Hurd (1990), Browning and Crossley (2001), Dynan et al. (2004) for discussion of the life-cycle model as a representation of retirement decumulation.

[3] Other reasons include: precautionary saving for uninsurable medical risks leading to continued accumulation later in life especially among the rich retired (Gruber and Yelowitz 1999, de Nardi et al. 2006); longevity and time preference differences compounded by different risk aversion to mortality with the rich tending to live longer (Hurd 1990; Hurd et al. 1998); high annuity incomes combining with later life frailty (Borsch-Supan 1992, Alessie et al. 1999); unexpectedly high asset returns, which may appear as persistent savings in short panels ; and the desire to leave a bequest (Hurd 1990, de Nardi et al. 2006).

‘a large effect on the elderly’s saving behavior, including the richest ones.’

How wealthy households respond to means tested income transfers is important for the design of an optimal targeting regime. If a gentle test taper and a relatively low transfer payment mean that richer households do not decrease their saving in order to access income support, the cost of expanding means testing in aggregate may be low, as Sefton et al. (2008) showed for the UK pension system. On the other hand, if income support is relatively unimportant for wealthy retired households, then aggregate welfare might be improved by making extra transfers to the poorer elderly via stricter testing.

Another question that is becoming more pressing as individual retirement savings accounts increase, is the effect of asset allocation on retirement decumulation. Retired households in the US tend to reduce holdings of most asset classes in favor of cash deposits as age increases, and transfers of wealth into these more liquid assets are more likely after the death of a spouse and after health shocks, events which often coincide with lower wealth (Coile and Milligan 2006). Further, if poorer retirees tend to be heavily invested in the family home, they have less access to consumable wealth than is indicated by their relative net worth, but richer households with more financial wealth relative to real estate assets face fewer liquidity restrictions and enjoy a disproportionately greater consumable wealth (Sinai and Souleles 2007). If, for precautionary or liquidity reasons, poorer households choose to store their wealth in low-return, low volatility assets and the family home, whereas wealthier households hold more, and more risky, financial assets, then decumulation may be slower among wealthier households because they can benefit from favorable returns shocks.

Here we contribute to the theoretical and empirical evidence on the effects of means tested payments on the consumption and portfolio choice of retired households. The unique structure of the Australian retirement savings system, with its broadly-targeted basic pension and limited use of annuitization, can give insight into the incentives of means testing up the wealth distribution. Using a standard CRRA utility framework and uncertain investment returns, we solve the dynamic consumption and portfolio allocation problem of the means tested retired household. (We recognize that pre-retirement decisions are almost surely influenced by the pension regulations, but our panel of wealth data is restricted to eligible households over the age of 65, so we limit our study to the behavior of that group.) Simulations show that the prospect of receiving a low-risk, means tested income payment encourages rapid drawdown early in retirement. In addition, the hedging properties of the means tests motivate a risky asset exposure that is optimally higher and more variable than the benchmark portfolio.

We evaluate these predictions using an annual series for the net wealth of Age Pension-receiving households from the Household Income and Labour Dynamics (HILDA) panel. The

HILDA survey does not collect wealth information at each wave, but we can make use of the regulations surrounding the pension along with some restrictions over our sample and calculate annual net worth over 2002-2006 from reported household Age Pension receipts. We estimate annual dissaving rates for groups of households subject to different means tests, and distinguished by bequest and precautionary motives. Further, using data on portfolio allocation from the 2006 HILDA wave, we can compute approximate household-level portfolios and adjust saving rates for transitory shocks. Finally, we test for changes in the Lorenz inequality in the wealth distribution using Barrett et al. (2008) tests.

2 Means tested retirement payments

Most developed economies provide 'first pillar' retirement income support that is means tested and separate from earnings-linked social security payments. US Supplemental Security Income (SSI), for example, ensures a minimum income for those over 65 who fail to qualify for the Old Age, Survivors and Disability Insurance (OASDI) benefit. SSI is not based on work history and apart from some exemptions (such as an individual's home and vehicle, and some minimal income concessions), the payment is strictly means tested across assets and income. Similarly, while recent pension reform in the UK has eased eligibility for the Basic State Pension (BSP) which is based on work history, for those who still do not qualify for the BSP or whose pension payment is low, a safety net is provided by the means tested Pension Credit.

Further, the interaction between state pensions and private wealth is changing as governments and employers encourage saving through personal retirement accounts. In the US, 401(k) coverage is now a substantial component of retirement provision, with contributions to personal accounts the most rapidly growing component of private sector pension contributions since 1980 (Poterba et al. 2007). In the UK, policy reforms also emphasize individual, funded accounts but with centralized collection and administration (Department for Work and Pensions 2006). Plans for private accounts imply less dependence on earnings-linked social security and more on individual wealth holdings, so that means testing, and especially asset testing, of income transfers becomes a stronger influence over life-cycle savings plans.

Unlike the US and the UK, Australia does not have an earnings-linked, public pension system and the Age Pension serves as both a safety net (its original purpose) and as a supplement to individual accumulations (a more recent purpose). Alongside the Age Pension payment, retirees receive income from voluntarily accumulations and mandatory accumulations. Since the introduction of the Superannuation Guarantee in 1992, a compulsory proportion of earnings is paid into individual privately-managed accounts on behalf of employees (currently 9%).

The majority of mandatory accumulations are still small, and while dependence on the public pension is expected to ease as the Superannuation Guarantee system matures, the Australian Government estimates that around 60% of elderly households will still receive a full or part Age Pension payment by the middle of this century. Consequently, pension means tests will interact with population aging and the fiscal burden is forecast to rise (Commonwealth of Australia, 2002).

Further, the effectiveness of the Age Pension as an income supplement and safety net will depend on both the total amount transferred and on how efficiently transfers are distributed among eligible households. Currently, most retired Australians qualify for some income support with around 77% of individuals over the age of 65 (2 million people) receiving all or part of the Age Pension (Harmer 2008). Eligibility depends on age and residency status, and payments are tested over income and assets, but are not dependent on earnings or work history. The payments taper slowly as wealth and income rise: individuals with up to $550 000 and married couples with almost one million dollars of assessable assets (not counting the primary residence) can get some support. As a result, almost 50% of eligible households are in the top half of the national wealth distribution, and close to 14% are in the top wealth quartile. By income measures most pensioners are less well-off, with the large majority in the lowest income quartile, but even so, more than 2% (around 50,000) are in the highest quartile (Kelly 2009).

2.1 Age Pension structure

A single pensioner who owns their own home is paid around 25% of Male Total Average Weekly Earnings (MTAWE) and partnered pensioners receive 83.5% of the single payment each.[4] Compared with OECD countries providing earnings-based retirement incomes, replacement rates based on the Pension alone are low, at 61% of the minimum net wage and 35% of net MTAWE (Harmer 2008). Despite the low replacement, generating a similar stream of income from private savings via commercial income stream products would require a very large accumulation at retirement, in the order of seven times MTAWE (Petrichev and Thorp 2008).

The base single pension is recalculated every six months (March and September) to keep up with changes in the CPI and also to ensure that it does not fall below 25% of MTAWE. Pensioners thus hold an option on the general level of wages and prices in the economy such that over the past decade the real pension payment has increased by around 2% p.a., which has been sufficient to maintain or improve relativity with low-income working households (Harmer 2008).

Pensioners are also entitled to allowances for pharmaceuticals, utilities, telephone, rent as-

[4] At July 2008, the single home-owner rate was $546.80 per fortnight, or $14,217 p.a.

sistance and for living in remote areas. They can access a concession card, which, along with providing reduced cost medicines, introduces a range of reductions on state and local government and utilities charges such as reduced transport fares and lower motor vehicle registration. (Table 9 in Appendix A details the current maximum rates and additional federal government allowances for a single pensioner.) Federal allowances alone boost the payment to single home-owning pensioners by around 10%, and since allowances are means tested, but do not taper as assets and earnings increase, they represent a lump sum transfer to every pensioner who achieves eligibility, including the wealthiest.

2.1.1 Means tests

Means tests begin to reduce the pension at fixed levels of income and/or assets with boundaries revised with changes in the CPI. Since the means tests may interact with each other, the pensioner is entitled to the least payment from either test, or zero.

The assets test begins to reduce the payment when financial wealth V_t, reaches an upper asset boundary $A2$ (see Table 1) reducing the annual pension payment by \$39 per thousand increase in wealth until the lower boundary at $A1$ which marks the free asset zone. Under the income test, individuals can receive up to an additional 25% of the base pension payment in private income before payments begin to decrease at 40 cents for each additional dollar.

Since many retirees rely entirely on financial assets for all extra income, regulators 'deem' fixed rates of return for income from financial assets rather then relying on individuals to estimate investment returns for the year ahead. In 2008, for example, financial assets up to a value around \$41 000 were deemed to accrue income at a rate of 4% p.a. and for all financial assets above that value, income was deemed to accrue at 6% p.a. The deeming rules allow us to translate the income test boundaries into an asset test equivalent form ($Y1$ and $Y2$) by assuming that all income comes from financial asset returns. Table 1 details the means tests limits for a single home-owning pensioner that applied in 2006 and 2008. Between these years the assets test taper rate was halved, which explains the large increase in $A2$, whereas the reduction in $Y2$ was caused by an increase in the deemed rates of return on financial assets.[5]

The income test binds earlier than the assets test, at $V = Y1$, but the assets test begins to bind at the point of intersection between the two lines $V_I = \frac{A2(Y1-Y2)-Y2(A1-A2)}{(Y1-Y2)-(A1-A2)}$, becomes the binding constraint until $P(t) = 0$, at $V = A2$. Combining the two constraints gives us the

[5] Some pensioners receive annuity income from defined benefit pensions. Income from these securities is means-tested under the income test on the basis of formulas designed to separate capital draw-down from investment earnings. Annuity income is difficult to identify separately, and also the assessment formulas have been changed several times over the course of our sample. For simplicity we infer the wealth value of annuities by the same method as for other income from other financial assets.

Table 1:
Pension means tests limits, 2006 and 2008.

		$ p.a.	
		2006	2008
Base payment	P_0	12 992	14 217
Income test			
Cut in		3 328	3 588
Cut out		35 809	39 130
Income test - wealth			
Cut in	Y_1	81 920	73 467
Cut out	Y_2	731 530	665 833
Assets test			
Cut in	A_1	161 500	171 750
Cut out	A_2	328 066	540 250

Basic payment and means test limits for a single Age Pensioner who owns their own home. Income test limits are shown in wealth-equivalents by assuming that all income is received from financial assets, and using regulated deeming rates. Source: Centrelink.

current pension payment as a function of wealth at the beginning of period t, $P(V_t)$,

$$P(V_t) = \begin{cases} P_0 + C_0 & if \quad V_t \leq Y1 \\ \frac{-P_0 Y2}{Y1-Y2} + \frac{P_0}{Y1-Y2} V_t + C_0 & if \quad Y1 < V_t \leq V_I \\ \frac{-P_0 A2}{A1-A2} + \frac{P_0}{A1-A2} V_t + C_0 & if \quad V_I < V_t \leq A2 \\ 0 & if \quad A2 < V_t \end{cases} \tag{1}$$

which is piecewise linear, with changing slope at $V = Y1$ and $V = V_I$, a step increase C_0 at eligibility, and a base level payment without allowances of P_0. The combined effect is shown by the lowest section of the intersecting lines in Figure 1.

The rate of taper when computed as the implicit marginal tax rate on wealth, is higher where the asset test rather than the income test is binding, so that means testing is slightly progressive in wealth. Under the assets taper, a tax rate of around 4% applies compared with 2.6% for the income-test taper.

The next section includes this pension structure in a model of post-retirement consumption and portfolio choice.

3 Model

Consider the post-retirement consumption stream and portfolio allocation for an investor with any concave, time-additive utility function. Assume the date of death, T, is known with certainty

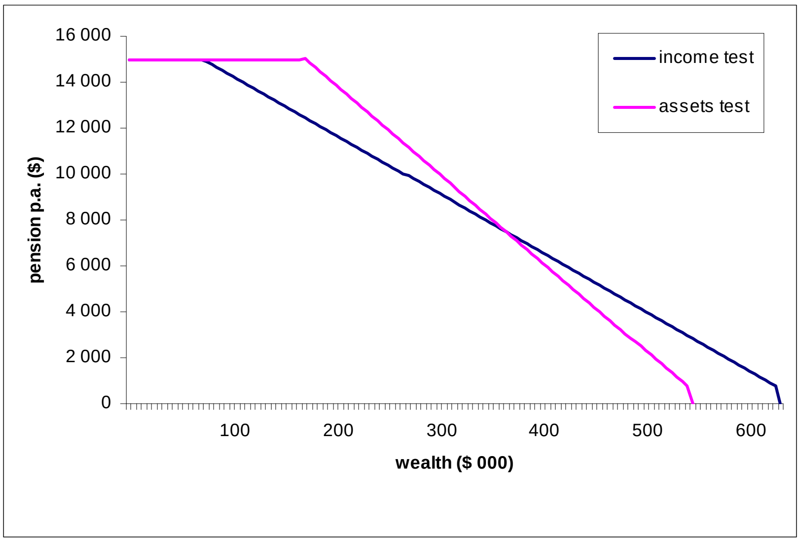


Fig. 1. Age pension means tests, July 2008
Figure graphs basic payment means test tapers at 1 July 2008 for a single, home-owning pensioner receiving the Age Pension, plus pharmaceuticals, utilities and telephone allowances but disregarding one-off bonuses. Cut-in and cut-out levels for assets and income are shown in Table 1. The income test taper assumes that all income is earned from assessable financial assets where returns are deemed at 4% for the first $41 000 of financial wealth and at 6% for the remainder. The pensioner receives whichever payment is least under the assets and incomes tests. Source for regulatory boundaries and deeming rates: Centrelink.

and the investor receives no labor income but is also eligible to receive a means tested government pension. The agent consumes out of wealth, pension payments and investment returns, investing savings each period in one risk-free and one risky asset. In the final period all remaining wealth is consumed, leaving no bequest.

The investor's problem is to maximize utility over retirement by choosing a consumption stream and allocating wealth between the assets

$$\max E\left[\hat{U}(C_0,C_1,...,C_{T-1},V_T)\right] = \max E\left[\sum_{t=0}^{T} U(C,t)\right]. \tag{2}$$

The investor knows S_t = the price of the risky security and the risk-free security at time t , $B_t = B_0(1+r)^t = B_0R^t$ and their pension entitlement, which is a piece-wise linear function of the wealth process V_t,

$$P(V_t) = \begin{cases} P_0 & if \quad V_t \le \bar{V}_1 \\ \alpha_1 + \beta_1 V_t & if \quad \bar{V}_1 < V_t \le \bar{V}_I \\ \alpha_2 + \beta_2 V_t & if \quad \bar{V}_I < V_t \le \bar{V}_3 \\ 0 & if \quad \bar{V}_3 < V_t \end{cases}, \tag{3}$$

and can choose a non-negative monotone increasing predictable consumption strategy $C = (C_t)_{0\leq t\leq T}$ and a predictable trading strategy $\phi = (\phi_t)_{0\leq t\leq T}$ so that associated with each trading-consumption strategy (ϕ, C) is a wealth process $V(\phi, C) = (V(\phi, C))_{0\leq t\leq T}$. All wealth not consumed in a given period is allocated between the risky and risk-free assets but leverage is not permitted, so that

$$I_t := V_t + P(V_t) - C_t = \phi_t S_t + (I_t - \phi_t S_t) B_t, \tag{4}$$

the share of investable wealth allocated to the risky security is

$$\omega_t := \frac{\phi_t S_t}{I_t}, \phi_t \in [0, 1], \tag{5}$$

and next period's gross return to the risky asset is

$$z_t := \frac{S_{t+1}}{S_t},\ z_t\tilde{}\ iid\ (\mu_z, \sigma_z^2). \tag{6}$$

The agent's portfolio return is then

$$Z_t := \omega_t z_t + (1 - \omega_t) R = [\omega_t(z_t - R) + R], \tag{7}$$

and the value of wealth available for consumption in period $t + 1$ is

$$V_{t+1} = [V_t + P(V_t) - C_t] [\omega_t(z_t - R) + R]. \tag{8}$$

Consequently the derived utility of wealth function for period t, can be written as

$$J[V_t, t] \equiv \max_{C,\omega} E_t \left[\sum_{s=t}^{T} U(C, s) \right] \tag{9}$$

with boundary condition

$$J[V_T, T] \equiv U(V_T, T). \tag{10}$$

3.1 Analytical solutions without means tested payments.

When the pension payment is zero, the problem has well-known solutions. (See, for example, Ingersoll 1997.) For log utility, where $U(C, t) = \delta^t \ln(C, t)$, and δ is the constant discount factor, optimal consumption is a time-dependent proportion of current wealth

$$C^* = \frac{1-\delta}{1-\delta^{T-t+1}} V_t, \tag{11}$$

and the optimal portfolio allocation is unaffected by future investment opportunities and current consumption, with the trading strategy controlled by the condition

$$0 = E_t\{\left(\tilde{Z}^*\right)^{-1}(\tilde{z}-R)\}. \tag{12}$$

Similar solutions hold if the agent's preferences are described by $U(C,t) = \frac{\delta^t C^\gamma}{\gamma}$ and the investment opportunity set is constant.

3.2 Numerical solutions with means tested payments

When the pension is described by equation (3), the consumption path depends on pension tapers and future consumption

$$0 = (C_t^*)^{\gamma-1} - \delta E_t \left\{ a_{t+1}^{\gamma-1} \left[V_{t+1} + P\left(V_{t+1}\right)\right]^{\gamma-1} \left(1 + \frac{\partial P}{\partial V_{t+1}}\right) Z_t \right\}, \tag{13}$$

where $a_{t+1}$is next period's optimal consumption/wealth ratio. (See derivation in Appendix B.) The proportion invested in the risky asset depends on expected returns, the pension taper and future consumption

$$E_t \left\{ a_{t+1}^{\gamma-1} \left[V_{t+1} + P\left(V_{t+1}\right)\right]^{\gamma-1} \left(1 + \frac{\partial P}{\partial V_{t+1}}\right) (z_t - R) \right\} = 0. \tag{14}$$

Since the value function is unknown, analytical solutions are not available and we use numerical methods. We establish a grid of values for wealth, the state variable, in each period, and search for optimal consumption and risky asset investment proportions at each point in the grid in each period. Using Gaussian Quadrature to compute the value function for a given consumption and investment strategy, we then use numerical optimization to maximize the value function across all consumption and investment strategies at each point on the grid, then interpolate to construct an approximate representation of the value function.

3.2.1 Parameterization

The examples set out below are representative of a few special cases and are designed to show how the pension causes the control variables to deviate from benchmark, rather than to closely match observed paths. We assume preferences are described by log utility and that model parameters are fixed and known with certainty. Low rates of risk aversion are supported by micro studies of life-cycle consumption behavior (Attanasio et al. 1999, Gourinchas and Parker 2002). The real annual risk-free rate of return is set at $R = 1.03$, the return to the risky asset at $E(z) = \mu_z = e^{\mu} = 1.0408$ with a standard deviation $st.dev.[z] = e^{\mu}\left(e^{\sigma^2} - 1\right)^{1/2} = 0.21$. This unusually low equity premium we choose to allow for interior solutions to the portfolio allocation path. (Since the portfolio is constrained to the $[0, 1]$ interval to reflect the borrowing constraints of the elderly and risk aversion is low, the optimal solution is at the boundary for typical choices of the equity premium.) We set the subjective discount factor to 0.97 for the purposes of illustration, though much higher and more variable rates are supported by some studies (Attanasio et al. 1999, Alan and Browning 2006). The means tests constraints used in the simulation are set out in Table 1.

3.2.2 Simulation results and discussion

Figure 2 graphs the optimal consumption path and consumption to wealth ratio over a 20 year horizon, assuming that the risky asset pays its expected return in each year and initial financial wealth is \$500 000. Slightly linearly increasing spending paths are optimal when there is no pension (solid line). The dotted line is optimal consumption under the 2006 pension rules, when the overall value of the payment was marginally lower (close to \$13 000) and the implicit tax rate over wealth was twice as high under the asset test compared with the 2008 pension. Under the 2006 test, consumption increases until wealth reaches the cut-out level for the asset test, $A2$, which is reached around age 71, then declines over the steeper taper to the point of intersection between the income and asset tapers, V_I, around age 75, then flattens over the gentler taper. Under the 2008 test, consumption decreases smoothly from high initial levels since the steep taper applies from $t = 0$. It is clear that the means tests create incentives to reduce early-retirement wealth at a faster rate than is optimal under the no-pension benchmark.

Consumption to wealth ratios are higher over the whole of retirement under the means tested payment (Figure 3), even at times when the actual amount being contributed by the pension is relatively small.

Figure 4 shows the impact of the tapers on drawdown rates from another perspective. Under the 2006 tests, the steeper assets test taper applies when wealth is \$330 000, the flatter income taper applies from \$188 000, and the maximum amount of pension is always paid when wealth falls below \$82 000. If we set initial wealth close to each of these crucial levels, optimal drawdown rates follow different paths. The wealthiest household ($V(0) =$ \$300 000) is subject to the faster taper and draws-down steeply (6%) early in retirement, then gradually decreases that rate to

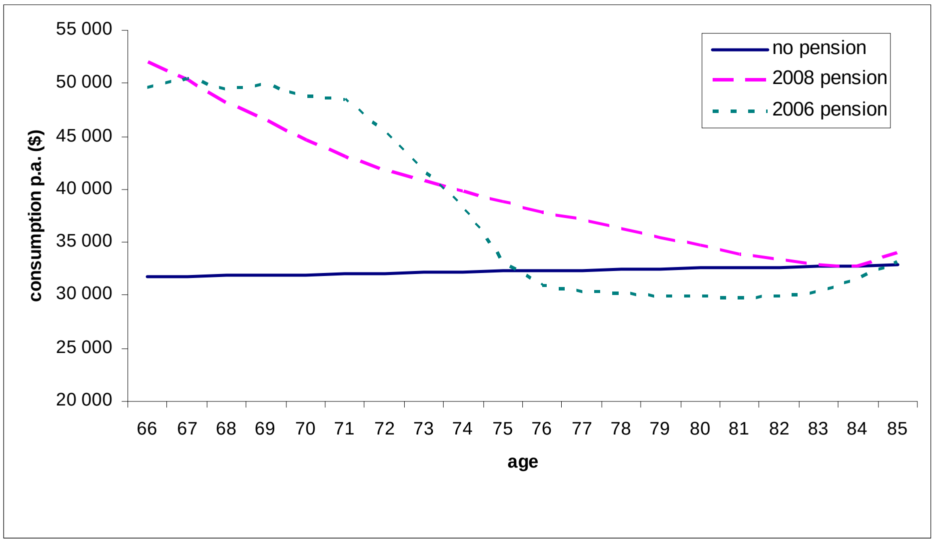


Fig. 2. Simulated consumption paths

Figure graphs simulated consumption paths over 20 years for single retiree with intial wealth of \$500 000, log utility preferences, and assuming that the risky asset pays expected return in each year. The constant discount rate is 0.97 p.a. Pension regulations are set out in Table 1.

around 2%, finally increasing the spending rate near the terminal date. The household on the flatter income taper ($V(0) = \$190\ 000$) begins to drawdown at 2% p.a., consuming faster than the household receiving the full pension and not subject to any taper ($V(0) = \$100\ 000$), but much less quickly than the richer household. In effect, implicit tax rates encourage different rates of wealth reduction by all households depending on their accumulation at retirement, whereas the rate of change in wealth under the benchmark (equation 11) is the same at all initial savings levels.

Few studies have looked into the impact of pension streams on portfolio allocation. This is a particularly interesting question for Australian retirees, the majority of whom do not annuitize at retirement but continue to hold individual investment accounts both inside and outside the superannuation system,[6] and the issue has international significance for pension regulators who are overseeing the transition to individual accounts from public or private defined benefit pension schemes. The Age Pension is a low-volatility real annuity stream with a payoff that is negatively correlated with the risky asset because of the means tests. Pension entitlement therefore creates a substitute for the risk-free asset, a hedge against other risks to wealth, encourages higher risk exposure by beneficiaries, and transfers risk from individuals to the public sector. Given these incentives, we expect the simulations to show a higher initial risky-asset weight, declining as the retiree's entitlement to future payments decreases. Two additional influences apply: first,

[6]Tax concessions continue to apply to accumulations kept in superannuation accounts after retirement, but regulations control spending rates to minimum annual levels which vary with age. (See Bateman and Thorp 2008.)

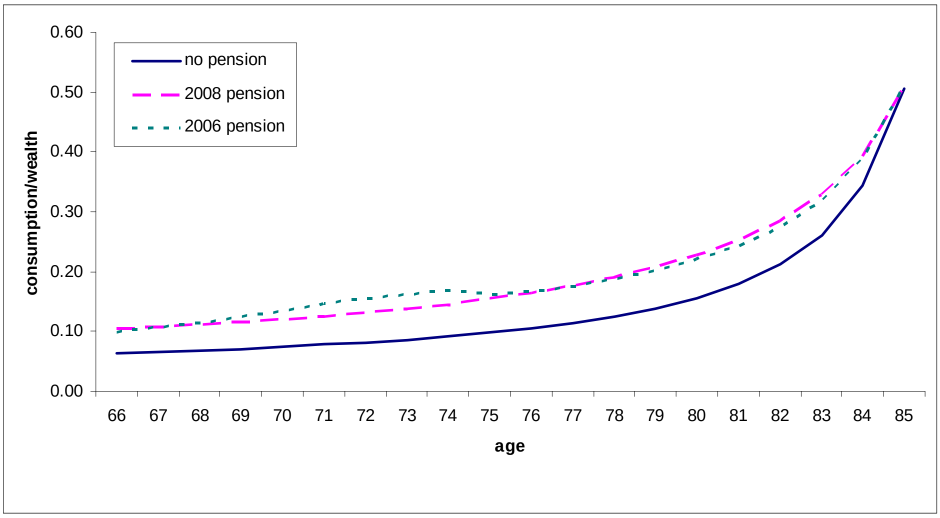


Fig. 3. Consumption to wealth ratios
Figure graphs simulated consumption/wealth ratios over 20 years for single retiree with intial wealth of $500 000, log utility preferences, and assuming that the risky asset pays expected return in each year. The constant discount rate is 0.97 p.a. Pension regulations are set out in Table 1.

the net present value of future pension payments declines with age, and secondly, the size of the negative correlation between wealth and the pension depends on the steepness of the operating means test taper.

Figure 5 shows that the optimal allocation to the risky asset is much higher when the steeper assets-taper applies, then declines in the region of the flatter taper, but still always exceeds the baseline allocation. (The optimal allocation without the pension is 25:75 risky to risk-free asset at all wealth levels for our parameter choice.) Overall, individuals will choose a much higher exposure to risk, declining towards the end of life when future entitlements are decreasing.

Simulations of optimal choices under the Age Pension support higher consumption to wealth ratios over the early and middle years of retirement and consequently much higher levels of dissaving. In addition, the consumption insurance supplied by the hedging property of the payment stream induces higher allocations to the risky asset until later ages.

In the next section we review the wealth and asset choice of Age Pension households in the HILDA panel survey and compare them to the predictions of the simulation.

4 Wealth profile of Age Pensioners

4.1 HILDA wealth survey data

HILDA is an annual panel survey of 7682 households begun in 2001 and designed to be representative of the Australian population. Members of households forming the permanent component of the sample are interviewed in every (annual) wave of the survey unless they move overseas,

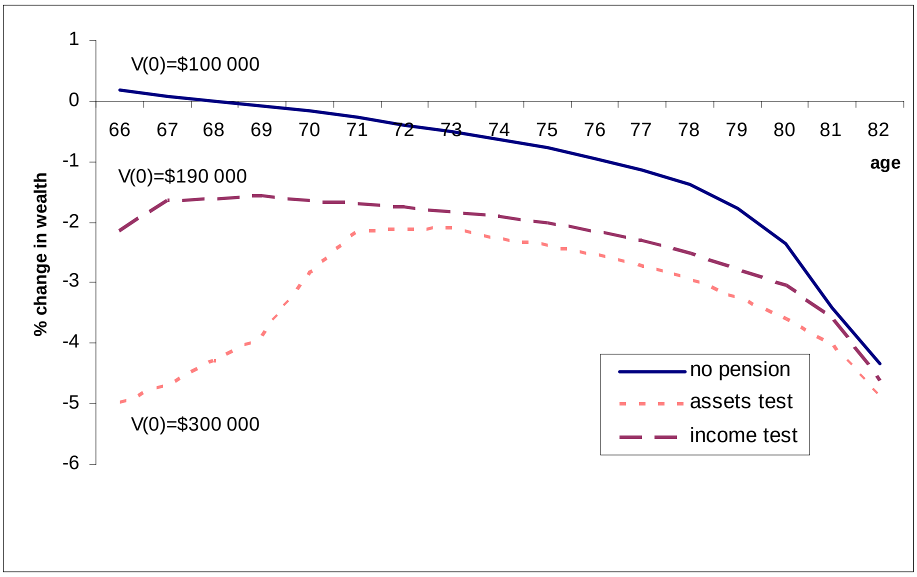


Fig. 4. Spending rates under asset and income tapers

Figure graphs simulated optimal dissaving ratios over 20 years for single retiree at different initial wealth levels, log utility preferences, and assuming that the risky asset pays expected return in each year. The constant discount rate is 0.97 p.a. Pension regulations are set out in Table 1.

die or attrit. The majority of the survey is conducted via face-to-face interview with all persons over the age of 15 or a household representative, but for most results discussed below, households are made up of single or couple retirees without children. Information on attitudes and some sensitive subjects is collected from a self-completion questionnaire. To protect confidentiality some variables have be top coded while others have been aggregated but these changes are not an issue for our analysis. HILDA surveys in 2002 and 2006 included questions on household wealth and portfolio data; here we concentrate on results from the 2006 survey.

4.1.1 Wealth and asset holdings of age pensioners

Age Pension households reported total assets below that for the general population in the 2006 survey. The full sample (here 5253 households) and Age Pension sample (796 households) distributions of total assets are graphed in Figure 6a (log scale) as the average level of total assets for each 20-percentile band. Both distributions are right-skewed. The median full-sample household has total assets close to $371 000 and a net worth of $284 000,[7] whereas the median Age Pension household has around $300 000 in total assets.

Households approaching retirement (45-65 year old household heads) have more financial assets[8] than households with heads older than 65 years (Figure 6b). Households with heads

[7] We exclude households with negative net worth, which is the reason that the graph begins at the 7th percentile.

[8] Financial assets include bank accounts, insurances, equity investments and superannuation, but exclude vehicles, real estate, collectibles and private businesses.

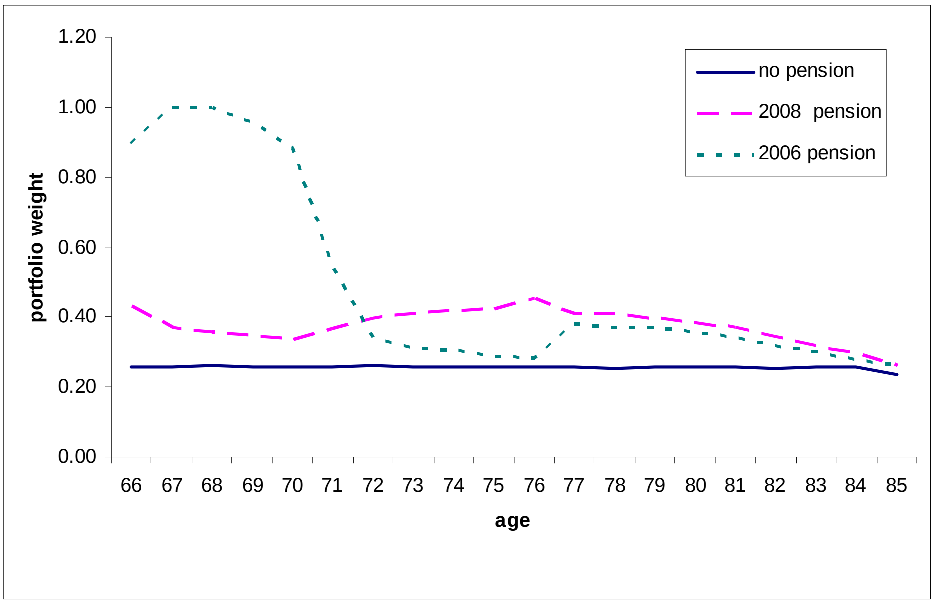


Fig. 5. Allocation to risky asset as a proportion of total investable wealth
Figure graphs simulated optimal allocation to the risky asset for single retiree with initial wealth of $500 000, log utility preferences, and assuming that the risky asset pays expected return in each year. The constant discount rate is 0.97 p.a. Pension regulations are set out in Table 1.

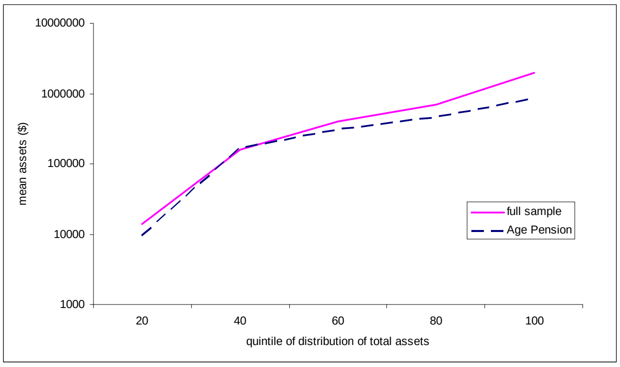
over 65 years and who receive the Age Pension have still less. This decrease across ages could be consistent with some drawdown of savings after retirement (although we are not controlling for cohort effects) and with targeted Pension eligibility. The median household in the 45-65 years group holds nearly three times more financial assets than the median 65+ household and almost five times more than the median Age Pension household. (The amounts are $163 000 in financial assets for the full sample, compared with $62 000 for all over-65 years households and $35 000 for the subset of Age Pensioners.) In the highest quintiles these differences moderate so that the financially richest over 65s hold about 90% of the financial assets of the richest of the 45-65 years group, whereas the highest Age Pension wealth quintile has one quarter the financial assets of the richest pre-retirement households.[9]

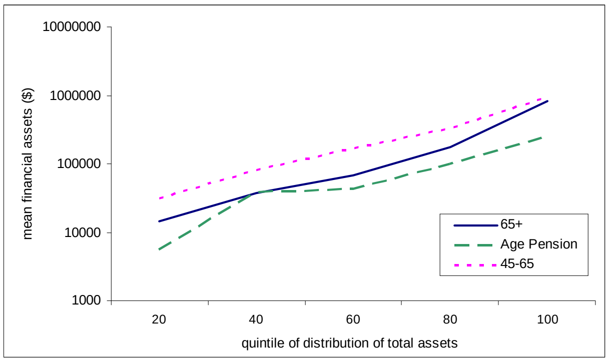
Low levels of financial assets compared with total assets shows that housing assets and consumer durables are the majority of wealth for the median household and that the financial assets buffer is especially small for Age Pensioners.

Asset class participation data indicate that households in the lowest quintile of the full sample wealth distribution (Figure 7a) hold their assets as bank accounts, vehicles and superannuation, but do not enter the property market or hold equities directly, although many poorer households will hold equities indirectly via superannuation accounts.[10] Age Pensioner house-

[9]Mean financial assets in the highest quintiles are $934 000, $826 000 and $246 000 respectively.

[10]Equity participation tends to be higher at lower wealth quintiles in Australia than in many other developed economies because default superannuation accounts typically allocate 70% to growth assets comprised of property





a. Total assets **b. Financial assets**

Fig. 6. Total and financial assets of surveyed households, HILDA 2006.

Fig. 6a: We stack all reporting households (5253 households) and the subset of households reporting receipt of the Age Pension (795 households whose heads answer 'yes' to PQ F12a : 'Do you currently receive the Age Pension from the Australian federal government?' i.e. FBNCAP=1) by FHWASSET DV: Household Total Assets ($), select the 20%, 40%, 60% and 80% quantiles and graph averages of each quintile. Fig 6b: We stack all reporting households (5253 households), households with head over 65 years (1116) and households reporting receipt of the Age Pension (795) by FHWFIN, select the 20%, 40%, 60% and 80% quantiles and graph averages of each quintile. FHWFIN is DV: Household Financial Assets ($), the sum of household equity investments (FHWEQINV), cash investments (FHWCAIN), trusts (FHWTRUST), own bank accounts (FHWOBANK), joint bank accounts (FHWJBANK), children's bank accounts (FHWCBANK), redeemable insurance policies (FHWINSUR), retirees superannuation (FHWSUPRT), and non-retirees superannuation (FHWSUPWK)

holds (Figure 7b) are more likely to hold property at lower quintiles, show lower rates of vehicle ownership and much lower rates of superannuation participation. Rates of superannuation participation average above 60% for all quintiles in the full survey, whereas for Age Pensioners, it is only the top 20% of households with high rates of participation. Lower participation in the retirement savings system by Age Pensioners reflects the relatively recent introduction of the Superannuation Guarantee in 1992 but also the preference of Australian retirees for taking lump sum retirement accumulations out of the superannuation system at preservation age.

Figure 8a shows the gross proportional allocation of Age Pension household portfolios by asset class. Pensioners keep a low proportion of their total assets as liquid and tradeable financial securities, and also relatively little wealth in superannuation accounts, but hold the majority of their wealth in property. In terms of non-property assets, we can see from Figure 8b that exposure to risk is rising in wealth quintile for pensioner households, with a much higher average allocation in the highest wealth quintile to equities and trusts, and superannuation (which is typically at least 70% in growth assets).

Age Pension means tests exclude the family home and this exclusion, along with other tax advantages for owner-occupied housing, partly explain the concentration of pensioner wealth in housing assets. And while the majority of Age Pension households do not invest their financial

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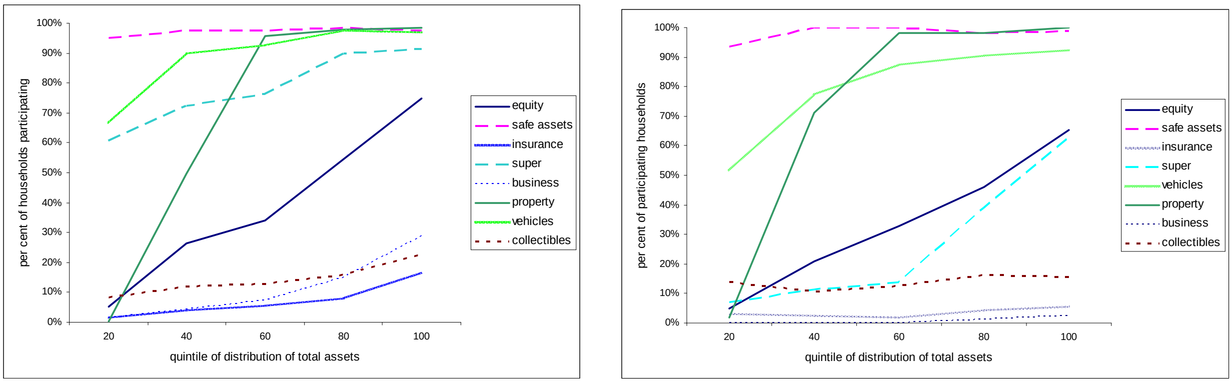
and local and international equities.



a. All households. **b. Age Pension households.**

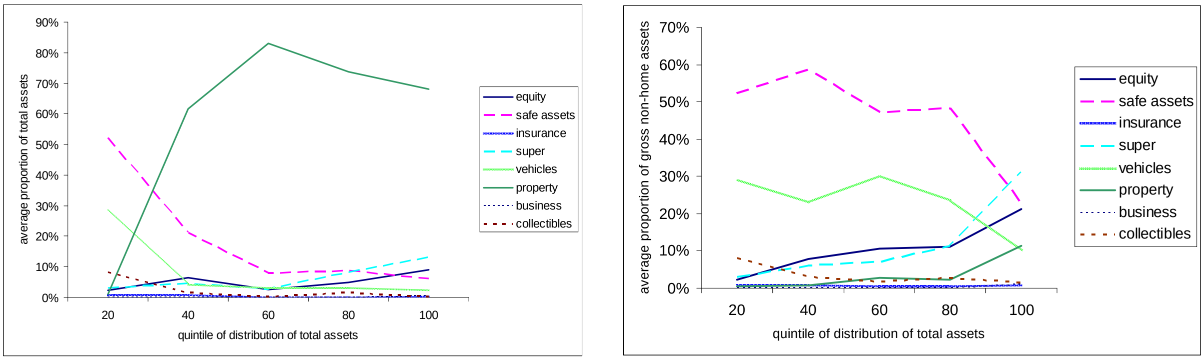
Fig. 7. Household participation by asset class, HILDA 2006

Fig. 7a: Graphs the percentage of all households in each total asset quintile (see Fig. 6a.) with non-zero reported balances in each of the following categories: Public equity: FHWEQINV (Total shares, managed funds, and property trusts for the household) +FHWTRUST (Total household wealth in trust funds (including children's trust funds); Safe assets: FHWTBANK (Sum of individual level bank accounts (FHWOBANK), individual level joint bank accounts (FHWJBANK) and household level children's bank accounts (FHWCBANK) + FHWCAIN (Government bonds, corporate bonds, debentures, certificates of deposit, and mortgage backed securities owned by the household.); Insurance: FHWINSUR redeemable insurance policies; Superannuation: FHWSUPER retirees superannuation (FHWSUPRT) + non-retirees superannuation (FHWSUPWK); Vehicles: FHWVECH The sum of the value of transport vehicles (cars, vans, motorbikes, tucks, utilities), recreational vehicles (boats, caravans, campervans, jet skis, trail bikes) and tractors, planes, helicopters and other vehicles at the household level.; Property: FHWTPVAL Sum of home value (FHWHMVAL) and other property value (FHWOPVAL) at the household level. Does not include home contents.; Business: FHWBUSVA Business / farm assets owed by the household. Excludes assets owed by individuals outside the household.; Collectibles: FHWCOLL Total of substantial assets such as antiques, works of art, and collectibles for the household. **Fig. 7b**: Graphs the percentage of Age Pension households in each total asset quintile (see Fig. 6a.) with non-zero reported balances in each of the categories described for Figure 7a.

wealth in growth assets, even within the retirement savings system, the wealthiest 20% keep around 70% in equities, trusts and property. Other data on portfolio choice by Australian retirees confirm this continuing taste for growth asset exposure by post-retirement investors (Thorp et al. 2007).

4.2 Inferred wealth data

While the HILDA survey has only two waves of wealth data, for a subset of Age Pension households we can use the means testing rules to infer a value for wealth at every wave in the survey. Single and couple Age Pensioners who own their homes and do not participate in the workforce must earn income largely from asset returns and annuities. We select two samples of households from the HILDA panel, one of single and one of couple households: household members describe themselves as fully retired from paid work, over the age of 64 in the 2002



a. All assets **b. Non-home assets**

Fig. 8. Portfolio share by asset class, Age Pension households, HILDA 2006

Fig.8a: Graphs the average percentage by quintile of Age Pension households' total assets FHWASSET allocated to each of the categories described for Fig. 7a. **Fig. 8b**: Graphs the average percentage by quintile of Age Pension households' total assets FHWASSET less the value of the home, FHWHMVAL, allocated to each of the categories described for Fig. 7a. but where property is other property, FHWOPVAL only.

wave of the survey, owning their own home and receiving an Age Pension in every wave of the survey. Single pensioners must live alone and have lived alone through all waves of the survey, and likewise couples must be living together. We study households that meet these criteria in each wave from 2002-2006 creating a balanced panel sample of 136 single-person households, and 109 couple households.

As long as a household is not getting the maximum Age Pension payment their implied wealth is

$$V_t = \min\left\{(P_t - C_0)\frac{Y1 - Y2}{P_0} - Y2, (P_t - C_0)\frac{A1 - A2}{P_0} - A2\right\}.^{11} \qquad (15)$$

We treat the Age Pension payment amount reported by households as including allowances as well as the basic payment: we assume that all households received telephone and pharmaceuticals allowances, and utilities allowances during 2005 and 2006, but not rent assistance (households own their own homes), and not remote area allowance. We also include the lump-sum 'one-off' bonus paid to pensioners in 2006.

During our sample, the means test taper rates vary slightly from year to year due to changes in deemed rates of return on financial assets, so that the reduction in pension per additional

[11] There are two possible sources of mis-measurement: First, if the household is getting the maximum payment then we know that their wealth is less than Y1, but we cannot infer its actual level. In our sample, very few reported payments equal the maximum and for those that do we project the income taper slightly back into the maximum payment region as an approximation to wealth. Second, there are sources of means-tested income that are not generated from financial assets, including from property investments or from annuity streams. To the extent that any realized rates of return from these assets differ from the deemed rate of return, we will mismeasure the true wealth of the household. On the other hand, we are effectively estimating their net present financial-wealth-equivalent value by backing out an approximate stock value from the income flow.

dollar wealth under the income test was 1.6 cents in 2002 and 2003, and 2 cents over 2004-2006. The assets test taper reduced the annual pension payment by a constant 7.8 cents for each additional dollar assets over the whole sample.[12]

4.2.1 Features of the inferred-wealth panel

The majority of the Age Pensioners in our sub-sample are single and of low education, their median age is 76 years, and more than 65% are female, characteristics matching up pretty well to the whole population of pensioners (Harmer 2008). A large minority report fair or poor health (Table 2).

Table 2:
Household characteristics of Age Pensioners, 2006

variable	**mean**
age (years)	76.5
married (%)	44.7
single male (%)	12.2
single female (%)	43.1
high school is highest degree (%)	5.7
college degree (%)	4.1
post high school qualification (non-college) (%)	25.2
did not complete high school (%)	64.6
fair or poor health	40.9
annual expenditure on medicines, prescriptions and pharmaceuticals ($)	361

Demographic characteristics of sub-sample of HILDA Age Pensioners used to create the wealth panel. Household members must describe themselves as fully retired from paid work, over the age of 64 in the 2002 wave of the survey, owning their own home and receiving an Age Pension in every wave of the survey. Single pensioners must live alone and have lived alone through all waves of the survey, and likewise couples must be living together. Total sample is 136 single-person and 109 couple households.

The median value of real inferred wealth decreases between 2002-2006 whereas the means rise (Table 3), with increasing positive skewness in the distributions. Standard deviations also increase over the sample, suggesting that some households are accumulating while the majority are decumulating. Estimated models of decumulation rates in the next section aim to break down these patterns by households types and savings motives.

[12] We thank David Tellis from the Australian Treasury for the following sources for historical boundaries and limits:

Rates of Pension - July 1909 to Present Date http://www.facsia.gov.au/guides_acts/ssg/ssguide-5/ssguide-5.2/ssguide-5.2.2/ssguide-5.2.2.10.html

Additional Payments - April 1943 to Present Date http://www.facsia.gov.au/guides_acts/ssg/ssguide-5/ssguide-5.2/ssguide-5.2.2/ssguide-5.2.2.20.html

Historical Age & Invalid (Disability Support) Pension Income & Assets Limits
http://www.facsia.gov.au/guides_acts/ssg/ssguide-4/ssguide-4.10/ssguide-4.10.3.html

Historical deeming rates & thresholds
http://www.facs.gov.au/guides_acts/ssg/ssguide-4/ssguide-4.4/ssguide-4.4.1/ssguide-4.4.1.20.html

Table 3:
Real wealth of single and couple pensioner households ($ 000).

	2002	2003	2004	2005	2006
couples					
mean	216.70	217.54	202.63	203.32	220.02
median	202.02	200.60	173.28	161.38	195.72
std dev	66.08	64.30	77.64	88.94	86.70
singles					
mean	132.00	134.28	119.29	128.52	134.49
median	115.43	118.54	94.06	100.29	105.57
std dev	51.34	50.15	56.54	60.07	64.69

Annual summary statistics for inferred wealth, where nominal inferred values are deflated by the CPI to create real values. Wealth is measured as $V_t = \min\left\{(P_t - C_0)\frac{Y1-Y2}{P_0} - Y2, (P_t - C_0)\frac{A1-A2}{P_0} - A2\right\}$ using the testing boundaries $(Y1, Y2, A1, A2)$ and deeming rules current for the survey year, and reported Age Pension receipts less allowances $(P_t - C_0)$ from HILDA. Single-person and couple households must meet the characteristics described in notes to Table 2.

4.3 Panel estimation

Here we estimate the average percentage decrease in wealth over 2002-2006 for households from our sample using panel estimation. Saving is proxied by the change in the log of inferred real household net worth (excluding changes in the value of the family home) each period. If we treat the pension as a linear function of wealth, we can write the difference equation for real (optimized) wealth in equation (8) in log differences as

$$\tilde{s}_t = \tilde{v}_t - v_{t-1} = \ln\left[1 + p_t - c_t\right] + \ln Z_{t-1} := d + \tilde{r}. \tag{16}$$

where v_{t-1} is the log of stock of wealth in period $t-1$, p_t is the proportion of current wealth received as the Age Pension payment, c_t is the proportion of current wealth consumed and Z_{t-1} is the stochastic real gross return on investment.

However we may need to deal with transitory income shocks, especially since our sample covers only four years of changes in wealth. Households relying on earnings from financial assets receive transitory income in the form of unexpected variation in investment returns. Hence we might write expected savings s_t^* as

$$s_t^* = v_t^* - v_{t-1} = d + \bar{r} \tag{17}$$

where $\bar{r}$ is the expected component of returns income such that $\tilde{r} = \bar{r} + \varepsilon$, $\varepsilon \,\tilde{}\, iid\left(0, \sigma^2\right)$. A complete adjustment would be to remove the entire component of the transitory shock to get:

$$s_t^* = v_t^* - v_{t-1} = v_t - v_{t-1} - \varepsilon = d + \bar{r}. \tag{18}$$

4.3.1 Savings subject to taper, health, bequests precaution and age.

We estimate feasible generalized least squares models of 136 single and 109 couple households over four years as separate and combined samples. Pre-testing of the data failed to reject the null of no fixed effects, and random effects estimation was not possible because the estimated variance of the individual random error was negative. We did find significant first-order serial correlation over the four-year sample, so the results are from a Prais-Winsten (PW) feasible GLS estimation based on Baltagi (2005, ch5) where the correlation coefficient is estimated by the method of Baltagi and Li (1997). We estimate the following equation after pre-multiplying all data by the (PW) transformation matrix

$$\tilde{s}_{it} = \alpha + \beta D_{a,it} + \sum_j \delta_j D_{j,it} + \sum_j \gamma_k D_{j,it} D_{a,it} + e_{it} \tag{19}$$

where $D_{a,it}$ is an indicator for asset-test taper for household i in period t and $D_{j,it}$ are indicators for general saving intentions, precautionary motives, bequest motives, health, expected health, and newly retired (age<70). (Definitions and data sources for $D_{j,it}$ are set out in Appendix C.) Table 4 reports the estimated coefficients and p-values for the best models.

Single-person households with less wealth, whose pension payment is subject to the flatter income taper, drawdown their savings at around 4% p.a. in real terms, and those who are newly retired and/or in poor health spend much faster at 8-11% p.a. By contrast, wealthier asset taper pensioners who are not newly retired are likely to be saving close to 4% p.a., or as much as 8% if in poor health, perhaps as a precaution against future medical or nursing home expenses, or because frailty limits his or her lifestyle. (Wealthier households are more likely to access private medical services.)

Couples are more likely to be saving for the benefit of children or other relatives (probably including partners) with significantly positive estimated coefficients on the bequest indicator. The bequest motive raises the annual saving rate of asset-taper couples to 15% p.a., and moderates the dissaving of income taper couples to 5.6%. Newly-retired couple households on the income taper do not spend down significantly faster, but asset taper couples do. The combined sample estimates show that expected health is also marginally relevant, causing income taper households to save and asset taper households to spend faster.

Both income and asset-taper households spend faster earlier in retirement consistent with

Table 4:
FGLS estimation results.

dependent variable:	log change in real wealth		
p-values in italics	**single**	**couple**	**combined**
constant	-0.036	-0.082	-0.052
	0.010	*0.000*	*0.000*
asset taper	0.081	0.121	0.125
	0.000	*0.000*	*0.000*
newly retired	-0.041		-0.028
	0.024		*0.030*
newly retired×asset taper		-0.053	
		0.072	
bequest		0.026	
		0.613	
bequest×asset taper		0.087	
		0.084	
health	-0.028		-0.027
	0.111		*0.051*
health ×asset taper	0.079		
	0.046		
expected health			0.024
			0.105
expected health ×asset taper			-0.054
			0.062

Table shows feasible generalized least squares estimation of the log change in real inferred wealth 2002-2006 for single-person and couple pensioner households. Data are transformed for first-order serial correlation using the Prais-Winsten transformation described in Baltagi (2005, chapter 5) using the estimate of the serial correlation coefficient in Baltagi and Li (1997). Explanatory variables are indicators for the current means test taper applying to the households (asset taper), household head is less than 70 years of age in 2002 (newly retired); household says they save to help children or other relatives (bequest); at least one household member describes current health as fair or poor (health); at least one household member expects their health to get worse (expected health). Indicator variables for general savings intentions and precautionary savings were not relevant.

the predictions of the theoretical model, but contrary to theory, households on the steeper taper accumulated over this sample, rather than decumulating more rapidly. Significantly higher rates of accumulation, despite a higher implicit tax rate on wealth, apply when we control for poor health and bequests, suggesting that the tapers themselves are not driving more rapid spending, whereas the prospect of more years of future higher pensions may be encouraging the younger-retired to deplete their accumulations.

4.3.2 Savings adjusted for transitory investment income

The table below shows the average portfolio allocation for pensioners who are bound by the income taper and for those bound by the asset taper. There is very little difference between the average portfolio allocations of the poorer (income taper) and wealthier (assets taper) groups, although the distributions are very diffuse, incorporating a wide array of portfolio structures. In 2006, only 62 households in the combined sample are on the asset test taper compared with 184 on the income taper. Poorer households hold more wealth in consumer durables such as vehicles and collectibles compared with wealthier ones, and we know from Fig. 8 that higher weights to growth assets are more evident at the top of the wealth distribution.

Table 5:
Pensioner household portfolio allocation 2006 and average return, 2002-2006.

income taper	% of portfolio					average
	equity	super	property	other	safe	return
mean	13.6	14.6	7.1	25.7	39.0	6.0
median	0	0	0	12.2	25.9	6.5
std dev	24.5	25.7	24.4	30.5	34.0	2.6
skewness	1.717	1.548	3.383	1.323	0.465	-0.711
asset taper						
mean	14.7	15.6	0	23.1	46.6	6.3
median	0	0	0	6.4	43.4	6.6
std dev	27.1	29.4	0	31.5	34.1	2.8
skewness	1.57	1.62	0	1.45	0.15	-0.771

We compute asset class weights by household using the 2006 HILDA wealth survey, and then generate an annual household-level portfolio return using expected (historical average). Details of portfolio and returns computations are set out in Appendix D.

Since some transitory income is saved, it is possibly that our short sample might be affected by returns shocks. Using the surveyed 2006 portfolio allocations for each household we compute portfolio returns shocks for each year by computing household-level allocations to cash and bank deposits, superannuation and insurance, equities and trusts (including businesses), property and consumer durables, then combining these with estimated mean-deviations of asset class returns. Appendix D describes the computation of the portfolio returns shocks and details data sources. When we deflate wealth by these returns shock we find that the mean return surprise was slightly smaller and less negatively skewed for wealthier households over this sample period (Table 6).

Given the size and sign of shocks it is not surprising that the estimated equations for decumulation are substantially unchanged. We still find that less wealthy households subject to the lower implicit tax rate of the income taper dissave more rapidly, and that wealthier households generally save, despite paying a higher implicit wealth tax. The means test tapers do appear to encourage a faster rate of decumulation early in retirement (Table 7).

Table 6:
Household portfolio transitory shocks: summary statistics, 2002-2006.

	income taper	**asset taper**
mean	-0.022	-0.020
median	-0.016	-0.017
max	0.140	0.117
min	-0.317	-0.290
std	0.060	0.054
skewness	-2.45	-2.211

We compute asset class weights by household using the 2006 HILDA wealth survey, and then generate an annual household-level portfolio return shock as the deviation of realized return from expected (historical average). Details of portfolio and returns computations are set out in Appendix D.

4.3.3 Test for changes in wealth equality: Lorenz dominance

Means tests are designed to target payments to the most needy, and are partly justified by the view that the Age Pension is a safety net for the elderly poor. We compare the wealth equality properties of the inferred wealth distribution over time using tests for Lorenz dominance developed by Barrett et al. (2008). Tests are pairwise comparisons of the empirical Lorenz curves in two (usually adjacent) years and inference is based on bootstrap simulation of the test statistics adapted to the panel characteristics of the data.[13]

We first test to see if the wealth distribution in year one dominates that in year two: $H_0^1 : L_2 \leq L_1$ against $H_1^1 : L_2 > L_1$, and then reverse the test: $H_0^2 : L_1 \leq L_2$ against $H_1^2 : L_1 > L_2$. If there is a unique ordering so that L_1 dominates L_2 and L_2 fails to dominate L_1 then we conclude that the wealth distribution in year one Lorenz dominates that for year two. Increasing equality might show up as a sequence of dominance relations that move through time, with later years dominating early ones. The table below shows the results of this test for our pooled sample of single and couple households where couple wealth is scaled by $\sqrt{2}$.

Wealth inequality is not decreased over the period 2002-2006, rather the 2002 wealth distribution Lorenz dominates 2006. Year by year comparisons show that the only decrease in inequality occurred between 2003 and 2002, which may be partly due to the effects of portfolio allocations, since 2003 was a year of large negative returns on risky assets, whereas strongly positive returns were recorded in 2005-2006. These results are consistent with the estimated continued accumulation patterns of wealthier households combined with the dissaving of poorer households.

[13] The empirical Lorenz curves are piecewise linear functions beginning at zero and ending at one. For a sample j of wealth observations for n_j individuals, $\left\{V_i^j\right\}_{i=1}^{n_j}$ given by $v_1 < v_2 < ... < v_{n_j^*}$ where $n_j^* < n_j$ and sample mean $\bar{\mu}$, and where the proportion of wealth observations in the sample at each value v_i is $\hat{\pi}_j$, the empirical Lorenz curve joins the points $\left(\sum_{k=1}^{j-1} \frac{\hat{\pi}_k v_k}{\bar{\mu}}, \sum_{k=1}^{j} \frac{\hat{\pi}_k v_k}{\bar{\mu}}\right)$ with straight lines (Barrett et al. 2008).

Table 7:
FGLS estimation results, adjusted for returns surprise.

dependent variable:	log change in real deflated wealth		
p-values in italics	**single**	**couple**	**combined**
constant	-0.039	-0.138	-0.066
	0.007	*0.000*	*0.000*
asset taper	0.069	0.129	0.104
	0.005	*0.000*	*0.000*
newly retired	-0.048		-0.046
	0.013		*0.018*
newly retired×asset taper		-0.060	0.007
		0.104	*0.693*
bequest		0.023	
		0.720	
bequest×asset taper		0.099	
		0.100	
health	-0.029		-0.041
	0.111		*0.037*
health ×asset taper	0.099		0.041
	0.019		*0.303*
expected health			0.027
			0.134
expected health ×asset taper			-0.079
			0.049

See estimation notes for Table 4. Dependent variable here is adjusted for transitory shocks to investment returns by household. We compute asset class weights by household using the 2006 HILDA wealth survey, and then generate an annual household-level portfolio return shock as the deviation of realized return from expected (historical average). We deduct the transitory shock from nominal wealth then deflate using the CPI. Details of portfolio and returns computations are set out in Appendix D.

5 Conclusions

Overall, we confirm results of earlier studies that wealthier households do not decumulate rapidly in retirement, and we go further by showing that this tendency to zero dissaving or accumulation holds when wealthier households face a steeper implicit tax rate on wealth than applies to poorer households. Hence we demonstrate not only that dissaving rates among the wealthy are lower, they are lower under a steeper, active means test. Our findings suggest that whatever encourages wealthier households to save more after retirement, also dominates the saving disincentives of the assets means tests even after controlling for bequest motives and health.

We conclude that Australian Age Pensioners decumulate during retirement on average if they are less wealthy, but that more wealthy households, despite being subject to the incentives of a stricter means test for pension payments, continue to accumulate. Portfolio choice appears to have been one driver of wealthy household accumulations. While strong conclusions are difficult to draw in small samples, we find some evidence that all households subject to the

Table 8:
Lorenz dominance tests of wealth distribution

F_1	F_2	H_0^1	H_0^2
year		p-value	
2002	2003	0.803	**0.030**
2003	2004	**0.000**	0.754
2004	2005	0.059	0.897
2005	2006	0.290	0.210
2002	2006	**0.000**	0.974

Results of Barrett et al. (2008) tests for Lorenz dominance of the distribution of inferred wealth for Age Pension single-person and couple households, where couple wealth is scaled by $\sqrt{2}$. Bold p-values show where the wealth distribution in year j dominates the distribution in year i but the reverse dominance relation is rejected. Tests are based on bootstrap simulation of the test statistic which allows for the panel nature of the data.

pension taper decumulate faster early in retirement, consistent with theory, and that higher risky asset allocations are associated with higher wealth, also consistent with our theoretical model. However there is little evidence for the view that the means tests create increasing equality in the wealth distribution over time.

Appendix A: Age Pension payments and allowances

Table 9:
Payments and allowances for Single Age Pensioners

Age Pension and Related Benefits	Regular Payment	Annual value	Adjustment
Age pension payment	\$547 fortnightly	\$14217	max(CPI, 0.25×MTAWE)
Pharmaceuticals allowance	\$6 fortnightly	\$151	CPI
Rent assistance	\$107 fortnightly	\$2782	CPI
Telephone allowance	\$22 quarterly	\$88	CPI
Utilities allowance	\$125 semi-annually	\$500	CPI
Remote area allowance	\$18 fortnightly	\$473	by legislation
Senior Bonus payments		\$500	one-off payments
Pensioner Concession Card	Access to Pharmaceutical Benefits Scheme plus reductions for state and local government charges e.g. water and property rates, energy bills, public transport fares, motor vehicles registration		

Note: Table shows basic payment and allowance schedules for a single Age Pensioner as at 1 July 2008. Partnered pensioners receive 83.5% of the single rate basic payment. Source: Harmer (2008).

Appendix B: Derivation of policy functions

The consumer's problem is to maximize utility from retirement until the end of life by choosing consumption C_t and risky asset investment ω_t subject to the wealth and pension processes described by equations (8) and (3), so that derived utility of wealth is

$$J\left[V_t, t\right] \equiv \max_{C,\omega} E_t \left[\sum_{s=t}^{T} U(C, s)\right]$$

with boundary condition

$$J\left[V_T, T\right] \equiv U(V_T, T).$$

Beginning with the second last period,

$$J\left[V_{T-1}, T-1\right] = \max_{C,w} U(C_{T-1}, T-1) + E_{T-1}[U(V_T, T)]. \tag{A-1}$$

The first order conditions in the controls C and ω are:

$$0 = U_C(C^*_{T-1}, T-1) - E_{T-1}\{U_{V_T}\left[\omega^*_{T-1}\left(z_{T-1} - R\right) + R\right]\} \tag{A-2}$$

$$0 = E_{T-1}\{U_{V_T}\left(z_{T-1} - R\right)\}. \tag{A-3}$$

Using the definition of Z_t, and I_t,and the first order conditions, we can write:

$$E_{T-1}(U_{V_T} z_{T-1}) = RE_{T-1}(U_{V_T}) \tag{A-4}$$

and also

$$U_C = \omega^*_{T-1} E_{T-1}(U_{V_T} z_{T-1}) + (1 - \omega^*_{T-1}) RE_{T-1}(U_{V_T}) \tag{A-5}$$

so that at the optimum,

$$U_C = RE_{T-1}(U_{V_T}). \tag{A-6}$$

With two years to go, the investor solves

$$J(V, T-2) = \max U(C, T-2) + E_{T-2}[J(V_{T-1}, T-1)]. \tag{A-7}$$

By substituting optimal C^* and ω^*into the original problem, and differentiating with respect to wealth, we can derive the envelope condition. Recalling the wealth equation,

$$\begin{aligned} J_{V_{T-1}} &= U_C \frac{\partial C^*}{\partial V_{T-1}} + E_{T-1}\{U_{V_T}[Z^*(1 + \frac{\partial P}{\partial V_{T-1}} - \frac{\partial C^*}{\partial V_{T-1}}) + (\tilde{z} - R) I^* \frac{\partial \omega^*}{\partial V_{T-1}}]\} \\ J_{V_{T-1}} &= [U_C - E_{T-1}(U_{V_T} \tilde{Z}^*)] \frac{\partial C^*}{\partial V_{T-1}} + I^* \frac{\partial \omega^*}{\partial V_{T-1}} E_{T-1}[U_{V_T}(\tilde{z} - R)] \\ &+ E_{T-1}\left(U_{V_T} Z^*\right) \frac{\partial P}{\partial V_{T-1}} + E_{T-1}\left(U_{V_T} Z^*\right). \end{aligned} \tag{A-8}$$

The first two terms in this expression are zero at the optimum, which results in the envelope condition:

$$J_{V_{T-1}} = E_{T-1}\left(U_{V_T} Z^*\right)(1 + \frac{\partial P}{\partial V_{T-1}}) = U_C(1 + \frac{\partial P}{\partial V_{T-1}}). \tag{A-9}$$

This envelope condition differs from the standard problem by the effect of the partial derivative of the pension with respect to current period wealth. The value of the partial derivative depends on where the agent finds themselves in pension-wealth space. If the agent is in the highest wealth region $\bar{V}_3 < V_t$, the pension payment is a constant zero and the partial derivative is zero. In the next two lower wealth regions $\bar{V}_I < V_t \leq \bar{V}_3$ and $\bar{V}_1 < V_t \leq \bar{V}_I$, the pension reduces linearly in wealth, and $\frac{\partial P}{\partial V_{T-1}} = \beta_i$ is a negative constant. In the final region $V_t \leq \bar{V}_1$, the agent receives the fixed full pension payment P_0 and the partial derivative is again zero.

If the agent's preferences are described by $U(C,t) = \frac{\delta^t C^\gamma}{\gamma}$, as for the conventional CRRA investor, in the final period the consumption decision is given by

$$U_C = E_{T-1}[U_{V_T} Z_{T-1}], \tag{A-10}$$

and since $U_C = \delta^{T-1} C_{T-1}^{\gamma-1}$ and $U(C_T) = U(V_T) = \delta^T \frac{((V_{T-1}+P(V_{T-1})-C_{T-1})Z_{T-1})^{\gamma}}{\gamma}$, we can write (A-10) as

$$\delta^{T-1} C_{T-1}^{\gamma-1} = E_{T-1}[\delta^T (V_{T-1} + P(V_{T-1}) - C_{T-1})^{\gamma-1} (Z_{T-1})^{\gamma-1} Z_{T-1}],$$

and rearranging for C_{T-1},

$$\begin{aligned} C_{T-1} &= [V_{T-1} + P(V_{T-1})] \left[1 + (\delta E_{T-1}[(Z_{T-1})^{\gamma}])^{\frac{1}{1-\gamma}}\right]^{-1} \\ C_{T-1} &= a_{T-1} [V_{T-1} + P(V_{T-1})] \\ a_{T-1} &:= \left[1 + (\delta E_{T-1}[(Z_{T-1})^{\gamma}])^{\frac{1}{1-\gamma}}\right]^{-1}. \end{aligned} \tag{A-11}$$

The trading strategy is derived from the first order condition for ω,

$$\begin{aligned} E_{T-1}[U_{V_T} z_{T-1}] &= R E_{T-1}[U_{V_T}] \\ E_{T-1}\left[\delta^T (I_{T-1})^{\gamma-1} (Z_{T-1})^{\gamma-1} z_{T-1}\right] &= R E_{T-1}\left[\delta^T (I_{T-1})^{\gamma-1} (Z_{T-1})^{\gamma-1}\right] \\ E_{T-1}[(Z_{T-1})^{\gamma-1} z_{T-1}] &= R E_{T-1}[(Z_{T-1})^{\gamma-1}]. \end{aligned} \tag{A-12}$$

and we note that the optimal portfolio weights are independent of current consumption at $t = T-1$.

To find a general form for $J(V,t)$ we begin with the envelope condition:

$$J_{V_{T-1}} = U_C(1 + \frac{\partial P}{\partial V_{T-1}}) = \delta^{T-1} \{a_{T-1} [V_{T-1} + P(V_{T-1})]\}^{\gamma-1} (1 + \frac{\partial P}{\partial V_{T-1}}) \tag{A-13}$$

Integrating this up over V,

$$J(V, T-1) = \delta^{T-1} a_{T-1}^{\gamma-1} \left[\int [V_{T-1} + P(V_{T-1})]^{\gamma-1} \left(1 + \frac{\partial P}{\partial V_{T-1}}\right) dV\right]. \tag{A-14}$$

At this point we use the result that $P(V_{T-1})$ is piece-wise linear so that $\frac{\partial P}{\partial V_{T-1}}$ is either zero or a constant depending on the region of V_{T-1}, so we can write

$$J(V, T-1) = \delta^{T-1} a_{T-1}^{\gamma-1} \left(1 + \frac{\partial P}{\partial V_{T-1}}\right) \left[\int [V_{T-1} + P(V_{T-1})]^{\gamma-1} dV\right]. \tag{A-15}$$

Again using the result that $\frac{\partial P}{\partial V_{T-1}}$ is either zero or a constant, we can write the solution to the integral as

$$\begin{aligned}
J(V,T-1) &= \delta^{T-1}a_{T-1}^{\gamma-1}\left(1+\frac{\partial P}{\partial V_{T-1}}\right)\frac{\left[V_{T-1}+P\left(V_{T-1}\right)\right]^{\gamma}}{\gamma\left(1+\frac{\partial P}{\partial V_{T-1}}\right)}+k \\
&= \delta^{T-1}a_{T-1}^{\gamma-1}\frac{\left[V_{T-1}+P\left(V_{T-1}\right)\right]^{\gamma}}{\gamma}+k. \qquad \text{(A-16)}
\end{aligned}$$

Now solve this problem for time $T-2$.

$$\begin{aligned}
J(V_{T-2},T-2) &= \max_{C,\omega} U(C,T-2)+E_{T-2}\{J(V_{T-1},T-1)\} \\
&= \frac{\delta^{T-2}C^{\gamma}}{\gamma}+\frac{\delta^{T-1}}{\gamma}E_{T-2}\left\{\left[V_{T-1}+P\left(V_{T-1}\right)\right]^{\gamma}a_{T-1}^{\gamma-1}\right\} \\
&= \frac{\delta^{T-2}\left(C_{T-2}\right)^{\gamma}}{\gamma} \\
&\quad +\frac{\delta^{T-1}}{\gamma}E_{T-2}\left\{\left[\begin{array}{c}\left(V_{T-2}+P\left(V_{T-2}\right)-C_{T-2}\right)Z_{T-2} \\ +P\left(\left(V_{T-2}+P\left(V_{T-2}\right)-C_{T-2}\right)Z_{T-2}\right)\end{array}\right]^{\gamma}a_{T-1}^{\gamma-1}\right\}. \qquad \text{(A-17)}
\end{aligned}$$

Firstly taking the partial derivative with respect to consumption gives

$$\frac{\partial J}{\partial C_{T-2}}=\delta^{T-2}\left(C_{T-2}\right)^{\gamma-1}-\delta^{T-1}E_{T-2}\left\{a_{T-1}^{\gamma-1}\left[V_{T-1}+P\left(V_{T-1}\right)\right]^{\gamma-1}\left(1+\frac{\partial P}{\partial V_{T-1}}\right)Z_{T-2}\right\}, \qquad \text{(A-18)}$$

so the solution for the consumption strategy at time $T-2$ will be the (strictly positive) root of the equation

$$0=\left(C_{T-2}^{*}\right)^{\gamma-1}-\delta E_{T-2}\left\{a_{T-1}^{\gamma-1}\left[V_{T-1}+P\left(V_{T-1}\right)\right]^{\gamma-1}\left(1+\frac{\partial P}{\partial V_{T-1}}\right)Z_{T-2}\right\}, \qquad \text{(A-19)}$$

noting that consumption depends on current and future investment opportunities through Z_{T-2} and a_{T-1}.

If we define a_t using a feedback rule over the optimized value of consumption so that $a_t := \frac{C_t^*}{[V_t+P(V_t)]}$, then we can write the general first order condition for consumption at time t as

$$0=\left(C_t^{*}\right)^{\gamma-1}-\delta E_t\left\{a_{t+1}^{\gamma-1}\left[V_{t+1}+P\left(V_{t+1}\right)\right]^{\gamma-1}\left(1+\frac{\partial P}{\partial V_{t+1}}\right)Z_t\right\}. \qquad \text{(A-20)}$$

The optimal portfolio is:

$$
\begin{aligned}
\frac{\partial J(V,T-1)}{\partial \omega_{T-2}} &= \frac{\delta^{T-1}}{\gamma} E_{T-2}\left\{ \frac{\partial}{\partial \omega_{T-2}} \left[\begin{array}{c} I_{T-2}\left[\omega_{T-2}\left(z_{T-2}-R\right)+R\right] \\ +P\left(I_{T-2}\left[\omega_{T-2}\left(z_{T-2}-R\right)+R\right]\right) \end{array} \right]^{\gamma} a_{T-1}^{\gamma-1} \right\} \\
&= \delta^{T-1} E_{T-2}\left\{ a_{T-1}^{\gamma-1}\left[V_{T-1}+P\left(V_{T-1}\right)\right]^{\gamma-1}\left(1+\frac{\partial P}{\partial V_{T-1}}\right) I_{T-2}\left(z_{T-2}-R\right)\right\}.
\end{aligned} \tag{A-21}
$$

Setting this expression equal to zero gives

$$
E_{T-2}\left\{ a_{T-1}^{\gamma-1}\left[V_{T-1}+P\left(V_{T-1}\right)\right]^{\gamma-1}\left(1+\frac{\partial P}{\partial V_{T-1}}\right)\left(z_{T-2}-R\right)\right\}=0 \tag{A-22}
$$

$$
\begin{aligned}
& E_{T-2}\left\{ a_{T-1}^{\gamma-1}\left[I_{T-2}^{*}Z_{T-2}^{*}+P\left(I_{T-2}^{*}Z_{T-2}^{*}\right)\right]^{\gamma-1}\left(1+\frac{\partial P}{\partial I_{T-2}^{*}Z_{T-2}^{*}}\right) z_{T-2}\right\} \\
= \; & RE_{T-2}\left\{ a_{T-1}^{\gamma-1}\left[I_{T-2}^{*}Z_{T-2}^{*}+P\left(I_{T-2}^{*}Z_{T-2}^{*}\right)\right]^{\gamma-1}\left(1+\frac{\partial P}{\partial I_{T-2}^{*}Z_{T-2}^{*}}\right)\right\}.
\end{aligned} \tag{A-23}
$$

The optimal trading strategy $\omega\left(\phi\right)$ therefore depends on future investment opportunities via a_{T-1} and the current consumption strategy via I_{T-2}^{*}.

Appendix C: Definitions of panel survey indicator variables

health = 1 if at least one household member reports general health as 'fair' or 'poor', and zero if 'good', 'very good', 'excellent' or declined to comment.

expected health = 1 if at least one household member answers true to 'I expect my health to get worse'.

savings = 1 if household answers the question 'Which of the following statements comes closest to describing your (and your family's) savings habits?' as

- Save whatever is leftover - no regular plan
- Spend regular income save other income
- Save regularly by putting money aside each month

precautionary = 1 if the household answers yes to at least one of the following questions in the 2002 wave: 'Which of the following comes closest to describing your (and your family's) current reason for saving? 1. For emergencies/in case of unemployment or illness and/or 2. Medical/dental expenses.

bequest = 1 if the household answers yes to at least one of the following question in the 2002 wave: 'Which of the following comes closest to describing your (and your family's) current reason for saving? 1. Education for children and grandchildren and/or 2. To help children or other relatives.

Appendix D: Portfolio construction and returns calculation

Household portfolios, returns and returns surprises.

To adjust for transitory shocks to household wealth we construct wealth measures for each household for each year. We begin with the raw data underlying Figure 8b from which we calculate the portfolio weights in 2006 for the categories:

- Equity: public equity + business
- Superannuation: superannuation + insurance
- Property: adjusted property series excluding the value of the family home
- Other: vehicles + collectibles
- Safe assets

This will create a vector of portfolio weights summing to one for each Age Pension household for 2006. Next we use these weights to compute a household specific transitory shock series for each of the survey years 2002-2006, assuming that the 2006 weights were also true for the preceding years in the sample.

We compute expected returns as the annualized average of quarterly returns to representative benchmark indices for December 1989 to December 2006. Returns for each portfolio component are calculated as follows:

- Equity: returns are a weighted average of Australian and international equity indices,

  $$0.3 Aust.Equity + 0.7 Int.Equity$$

  where the Australian equity return is from the DataStream Australian Total Market Returns index (TOTMKAU) and the International Equity return is from the MSCI AC World EX AU (AUD)

- Property: returns to DataStream S&P/ASX 300 Property price index, (ASG3PTZ)

- Other: Value of Household sector Consumer Durables from Reserve Bank of Australia Bulletin Historical Table B20, adjusted for transactions. Return is computed as change in the (residual) valuation effect. (Available from the authors on request).

- Safe assets: returns to DataStream UBS Australian Bank Bills, all maturities, total returns index, (ABNKBLI)

- Superannuation: Returns to superannuation and insurance are computed as a weighted average of underlying benchmark returns using the portfolio weights of the default superannuation portfolio as reported in APRA INSIGHT 2007(2) Table 14, June 2004. The return is

$$0.437 Aust.Equity + 0.228 Int.Equity + 0.178 Aust.Bonds + 0.078 Property + 0.079 Cash$$

  where the indices for each asset class are those described above and where the bond return is the UBS Australian composite bond index, total returns (ACIALLM).

The annualized average return and the annual deviation from that expected return are set out in Table 10 below

Table 10:
Expected returns and transitory shocks by asset class, 2002-2006.

	Equity	Super	Property	Safe Assets	Other
			shock % p.a.		
2002	-3.92	-4.24	-0.93	-0.56	-1.97
2003	-10.40	-10.43	-0.74	-1.94	3.46
2004	-33.12	-25.10	-4.12	-2.00	-0.18
2005	9.55	2.91	0.17	-1.86	-2.02
2006	11.46	5.23	12.42	-1.13	-1.89
			expected return % p.a.		
	9.65	10.25	6.51	6.73	0.46

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