Australian retirees’ preferences between consumption, government pension, bequest and housing

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Abstract

This paper models the financial preferences of Australian retirees with a life-cycle utility model, incorporating Australia’s age pension means testing, bequest motive and housing decision. The model has a semi-analytical solution and its parameters are calibrated to the ABS data of household expenditure survey and survey of income and housing. The calibrated model reasonably explains the financial behavior of surveyed households.

JEL classification: D14, G11, G23. Keywords: life-cycle model, utility, bequests, housing, age pension, financial planning, dynamic programming.

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1 Summary

Life-cycle utility helps to model people’s financial behavior\(^2\). These models can be applied in many practice areas including post-retirement financial planning\(^4\), pension product design\(^6\) and the evaluation of public policy changes\(^5\). Current applications of these models in Australia, however, adopt many parameter values from overseas studies\(^6\). The retirement income system in Australia differs to most other developed economies, incorporates complicated means testing rules\(^7\) and covers around 80% of elderly households in Australia.

This paper develops a life-cycle utility model incorporates Australia’s age pension means testing, bequest motive and housing decision. A semi-analytical solution\(^8\) enables the utility parameters to be effectively calibrated to ABS data of household expenditure survey and survey of income and housing. Hence the model provides a suitable reference point.

The calibrated model reasonably explains the financial behavior of surveyed households, this can be illustrated in Fig.1 as an example, which plots of the average value of family home as percentage of total wealth, against age and wealth percentiles, for the original data of couple households, and the model outputs:

\(^2\)This dates back to Samuelson (1969), Merton (1971) and Yaari (1965), amongst others
\(^3\)One example of professional financial planning software developed using the utility model is ESPPlanner, see Koltlikoff (2008). The program had received positives reviews in Turner and Witte (2009)
\(^4\)One example is the Vanguard’s Managed Payout Funds based on the researches of Americks et al. (2011)
\(^5\)Kudrna and Woodland (2009) analysed the effects of possible age pension policy changes with a general equilibrium model including household behaviors; Oliver and Dixon (2010) developed an utility approach to model the behavioral responses to public policy changes for the Australian Treasury.
\(^6\)for e.g. Bateman et al. (2007), Kudrna and Woodland (2009), Cho and Sane (2009), and Thorp et.al. (2012) etc.
\(^7\)Australia’s age pension payment is subject to two means tests: the assets test and the income test; which reduce the pension entitlement when the income and/or asset of the household increase. The actual pension payment is the lesser of the entitlements under the asset test and income test. The payment is also bounded, such that it cannot be negative or exceed the maximum pension rate. Many details in the means testing rules can affect retiree’s financial decisions, for example, the value of family home is exempted form the asset assessable under the asset tests, creating incentives for the household to allocate a higher amount of wealth in their family home. The detail of Australia’s age pension system can be found on the centrelink website: http://www.centrelink.gov.au/internet/internet.nsf/payments/age_pension.htm
\(^8\)As an extension to the methodology presented in Ding et al. (2012) and Ding (2012)
The result of this paper suggest that the high concentration of wealth in the family home is affected by the Age pension. First, the high level of age pension payments are well above the calibrated level of subsistence consumption, indicating that households in low wealth bands do not need much wealth outside of their family home to fund their retirement consumptions; Second, the age pension asset test implies that it is optimal for middle to high wealth bands to allocate wealth in their family home to receive higher age pension payments.

2 Literature Review

In recent years, substantial research has been focused on study people’s behavior in the post-retirement phase. Some of the major findings in the previous literature are as follows:

1. **Expenditure in the post-retirement phase generally decreases with age.** Rice and Higgins (2009) suggest that there are 3 different phases in retirement, with different consumption and health care expenditure needed in each phase. A US study by Bernicke (2005), identified significant spending declines in every major category except health care as people age. According to his research, the difference between the expenditure of US people age 65-74 and 75+ is 26.4%. Australian researches by Clare (2011) and Higgins and Roberts (2011) shows similar declines but of a smaller magnitude. The decline in expenditure can be due to declining health (Yogo 2011) or less resources allocated to advanced ages due to the uncertainty that one may not live
2. **Most middle and wealthy households decumulate wealth very slowly**. Many Australian and international studies find that positive or zero saving during retirement is common. Empirical modeling of Thorp et al. (2012) on the data of Household Income and Labor Dynamics (HILDA), shows that Australian households decumulate slower than is optimal. Although poorer households decumulate at around 5% p.a. on average, some wealthy households add around 3% p.a. to wealth, even when facing a steeper implicit tax rate due to age-pension means testing.

3. **Concentration of wealth in the family home**. For many Australian retirees, the family home and contents are their only capital asset and their only income comes from superannuation, insurances or government pensions (Olsberg and Winter 2005). And empirical studies across some advanced countries show that the homeownership, as well as the proportion of household wealth in the family home, is greater than average in Australia (Cho and Sane 2009).

These characteristics are also found in the ABS data used in this paper as shown in Section 3 of this paper. Two factors may contribute to these observations:

- **Bequest motive and precautionary savings**. According to Lawrence and Goodnow (2011), there is evidence of Australian parents’ commitments to making bequests to their children, however it is difficult to distinguish it from the motive of precautionary savings, as in a world of risk, bequest may be accidental instead of intended. According to Olsberg and Winter (2005), the desire to bequeath assets to the next generation seems to be significantly diminishing. When investigating housing arrangements for the elderly, they found that 74% of people see family home as something of value which one can pass on to ones’ family, however 75% of people at the same time agree that they can sell it or borrow against it to provide for needs in old age.

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9These researches did not include long-term-care expenses, which can be significant when people ages and moves into an aged care facility; The data used did not surveyed people who lives in age care facilities either. Greenwald (2012) shows that about 60% of retirees in US are very or somewhat concerned about having enough money to pay for adequate health care and long-term care. According to Arthur (2011), the cost of government funded aged care in Australia can be up to $70,000 per year. Although only 20% of retirees use care facilities in Australia, this cost can be considered a significant financial risk for retirees.

10For detailed references on this topic see Thorp et al. (2012)
• **Australia’s age pension.** It is a significant part of the retirement income for the majority of Australian retirees. According to Rothman (2012), currently around 80% of Australian population age above 65 receive a full or part pension. Thorp et al. (2012) show that the age-pension buffers retired households against shocks to wealth and may influence decumulation and portfolio allocations in retirement. Cho and Sane (2009) shows with their model that it is optimal for households to over-invest in housing when the value of family home is exempted from the asset test.

Many Australian and international studies have used life-cycle utility models to model the financial behaviors and preferences of households post-retirement. For example, Bateman et al. (2007) applied the life cycle model to the post-retirement problem for Australian retirees and illustrated the optimal behaviors assuming a subsistence level of consumption. The model is extended in Ding (2012), with a method to solve the life cycle model, taking into account Australia’s age-pension means testing. Lockwood (2011, 2012) investigated the life cycle model treating bequests as luxury goods, and Ding et al. (2012) solved this model and show that as a luxury good, the planned bequest drops following a negative wealth shock, and optimal allocation in to risky asset increases with age in the presence of luxury bequests. Americks (2011) calibrated a utility model to US data and identified separate parameters for bequest and precautionary saving motives.

This paper extends the life cycle models developed in the previous researches, incorporating Australia’s age pension means testing, bequest motive and housing decision. The model parameters are calibrated to ABS data of household expenditure survey and survey of income and housing. Previous studies of Australia adopt overseas parameter values.

Note life annuities and other insurance products are not considered in this paper. Evans and Sherris (2009) pointed out that there is not enough awareness of longevity protection products amongst Australian retirees. Ding (2011) finds that there is very little incentive for Australian retirees to purchase life annuities, given the current market price.
3 Data Analysis

The data used in this paper is the ABS data of household expenditure survey (HES) and survey of income and housing (SIH). The survey period is 2009 to 2010. I look at people above the age of 55 and not in the labor force. These include survey results of 2856 single households and 2652 couple households. The household characteristic looked at in this paper are as follows: Gender; Age; Total wealth, Value of family home net of mortgage; Yearly Household Expenditures; Whether any of the family member has disability or is a DVA pensioner, and the amount of social security payments entitled.

3.1 Wealth and Expenditure

Table 1 summarizes the average wealth of Single and Couples households for different age groups.

<table>
<thead>
<tr>
<th>Age</th>
<th>Single</th>
<th>Couple</th>
</tr>
</thead>
<tbody>
<tr>
<td>55-59</td>
<td>$320,900</td>
<td>$923,500</td>
</tr>
<tr>
<td>60-64</td>
<td>$348,900</td>
<td>$924,100</td>
</tr>
<tr>
<td>65-69</td>
<td>$453,900</td>
<td>$742,800</td>
</tr>
<tr>
<td>70-74</td>
<td>$353,500</td>
<td>$697,300</td>
</tr>
<tr>
<td>75-79</td>
<td>$428,700</td>
<td>$660,200</td>
</tr>
<tr>
<td>80+</td>
<td>$447,100</td>
<td>$674,800</td>
</tr>
</tbody>
</table>

Table 1: Average total wealth by age group

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11 This paper excludes samples of all other household types
12 Includes the value of family home but excludes the value of vehicle and household contents
13 Mortgage Repayments excluded, while both rental expenditure and rental income are included. Note that the expenditure data are only available for 1861 single households and 1662 couple households, because everyone included in the HES is also included in the SIH, but not vice-versa. Furthermore, 14 outliers have been excluded and treated as missing data where: 1, the yearly expenditure is less than $3,000. 2. the net yearly expenditure (net of social security income) is greater than half of the total household wealth and three times the maximum age pension rate. I believe these households either has unreported wealth or unreported expenditure.
14 If the person has disability or is a DVA pensioner, I assume he/she is qualified for the public pension, if not, he/she is assumed to be qualified for the public pension from age 65
15 For the social security payment, 207 records have been excluded and treated as missing data, where the household does not receive any pension payments while being entitled to significant pension payments according to its reported wealth and expenditure.
16 Value of wealth include the value of the family home. Couples are placed into age groups according to the age of the older partner.
There is not an obvious trend for wealth declines during retirement, suggesting a slow rate of decumulation consistent with the findings in Thorp et al. (2012). Also, we can observe big differences in wealth before and after age 65 for couple households. This suggest significant amount of wealth may be dissipated during early retirement. Although this observation may be distorted by the cohort effect, if the younger age cohorts are richer. These can be further supported by the pattern of average yearly expenditures by age group and wealth percentiles, as illustrated in Table 2 for couple households:

<table>
<thead>
<tr>
<th>Wealth</th>
<th>10th</th>
<th>20th</th>
<th>30th</th>
<th>40th</th>
<th>50th</th>
<th>60th</th>
<th>70th</th>
<th>80th</th>
<th>90th</th>
<th>100th</th>
</tr>
</thead>
<tbody>
<tr>
<td>Couple</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>55-59</td>
<td>28</td>
<td>19</td>
<td>42</td>
<td>40</td>
<td>38</td>
<td>46</td>
<td>37</td>
<td>53</td>
<td>51</td>
<td>92</td>
</tr>
<tr>
<td>60-64</td>
<td>42</td>
<td>38</td>
<td>37</td>
<td>36</td>
<td>34</td>
<td>50</td>
<td>60</td>
<td>68</td>
<td>76</td>
<td></td>
</tr>
<tr>
<td>65-69</td>
<td>33</td>
<td>43</td>
<td>36</td>
<td>37</td>
<td>43</td>
<td>42</td>
<td>36</td>
<td>46</td>
<td>77</td>
<td>79</td>
</tr>
<tr>
<td>70-74</td>
<td>32</td>
<td>33</td>
<td>33</td>
<td>30</td>
<td>30</td>
<td>36</td>
<td>34</td>
<td>35</td>
<td>48</td>
<td>76</td>
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<tr>
<td>75-79</td>
<td>28</td>
<td>27</td>
<td>32</td>
<td>29</td>
<td>33</td>
<td>32</td>
<td>36</td>
<td>30</td>
<td>42</td>
<td>60</td>
</tr>
<tr>
<td>80+</td>
<td>29</td>
<td>27</td>
<td>29</td>
<td>28</td>
<td>31</td>
<td>29</td>
<td>33</td>
<td>38</td>
<td>38</td>
<td>40</td>
</tr>
</tbody>
</table>

Table 2: Couple data, Expenditure (‘000) by age and wealth percentiles

Although the data is not of the best quality, the expenditure patterns from Table 2 can be summarized as follows:

- There is not much difference in the expenditure of household with little wealth compared to middle households. This is likely due to the fact that middle households have most of their wealth locked in the family home hence a big proportion of their consumption comes from age pension, just like households in the low wealth bands.

- There is not much difference in the expenditure of different ages groups, for households in the low to middle wealth bands. This could be due to a subsistence consumption requirement for all households in all age bands, which is consistent with the consumption floor argument as in Bateman et al (2007).

- For wealthy household, their expenditure clearly decrease as age increases for households in the same wealth band, this support the assumption that utility from consumption decreases as age increases due to health declines, which is consistent with Higgins and Robinson (2011), and provide some evidence for the 3 phases of retirement as proposed in Rice and Higgins (2009).
• There are definitely saving motives, as the data illustrate that most middle and wealthy households spend much less than they can afford. This can also be illustrated in Fig 2, which plots the average yearly expenditure for couple households as a percentage of estimated lifetime wealth, defined as current wealth plus estimated value of future age pension entitlements.\footnote{Estimated lifetime wealth $\bar{W}_n = W_n + e_n \times P_n$, where $W_n$ is the current wealth for the $n$th retiree, $e_n$ is his/her life expectancy (joint life expectancy if couple) and $P_n$ is the maximum age pension payment for this Person/Couple. Table 6 in Appendix B gives the average estimated lifetime wealth by age and wealth percentiles.}

Data for single households exhibit the same characteristics, illustrated in Table 8 and Fig 8 in Appendix B. From Fig 4 we see that most households are spending less than 4\% of their estimated lifetime wealth. Researches by Bengen (1994) and Cooley et al. (1998) find that 4\% is the sustainable level of withdrawal rate, hence most Australian retirees are saving,\footnote{Specially if we assume a major proportion of people agrees that home equity can be utilized to provide for needs in old age according to Olsberg and Winter (2005)} reinforcing the findings in Thorp et al. (2012). We can also conclude that wealthier households has more wealth saved outside of the family home, as they spend as little as the middle households in percentage terms while allocating a

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{Fig2.png}
\caption{Expenditure as \% of estimated lifetime wealth, Couple data}
\end{figure}
3.1 Wealth and Expenditure

A smaller proportion of wealth is allocated to the family home.

Table 3 and Fig 3 summarize the average value of family home as a percentage of current wealth for couple households, by age group and wealth percentiles:

<table>
<thead>
<tr>
<th>Wealth</th>
<th>10th</th>
<th>20th</th>
<th>30th</th>
<th>40th</th>
<th>50th</th>
<th>60th</th>
<th>70th</th>
<th>80th</th>
<th>90th</th>
<th>100th</th>
</tr>
</thead>
<tbody>
<tr>
<td>Couple</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>55-59</td>
<td>24%</td>
<td>78%</td>
<td>97%</td>
<td>96%</td>
<td>73%</td>
<td>35%</td>
<td>67%</td>
<td>58%</td>
<td>45%</td>
<td>50%</td>
</tr>
<tr>
<td>60-64</td>
<td>16%</td>
<td>74%</td>
<td>89%</td>
<td>84%</td>
<td>74%</td>
<td>74%</td>
<td>67%</td>
<td>52%</td>
<td>52%</td>
<td>39%</td>
</tr>
<tr>
<td>65-69</td>
<td>11%</td>
<td>82%</td>
<td>88%</td>
<td>87%</td>
<td>78%</td>
<td>75%</td>
<td>67%</td>
<td>63%</td>
<td>53%</td>
<td>42%</td>
</tr>
<tr>
<td>70-74</td>
<td>6%</td>
<td>83%</td>
<td>81%</td>
<td>90%</td>
<td>84%</td>
<td>81%</td>
<td>77%</td>
<td>68%</td>
<td>54%</td>
<td>40%</td>
</tr>
<tr>
<td>75-79</td>
<td>12%</td>
<td>84%</td>
<td>86%</td>
<td>85%</td>
<td>80%</td>
<td>85%</td>
<td>80%</td>
<td>71%</td>
<td>67%</td>
<td>39%</td>
</tr>
<tr>
<td>80+</td>
<td>3%</td>
<td>73%</td>
<td>87%</td>
<td>87%</td>
<td>83%</td>
<td>84%</td>
<td>76%</td>
<td>73%</td>
<td>66%</td>
<td>43%</td>
</tr>
</tbody>
</table>

Table 3: Couple data, Value of family home as % of total wealth, by age and wealth percentiles

Fig 3: % of wealth in family home, Couple data

Single household data exhibit similar characteristics, illustrated by Fig 4:

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19 Table 5 in Appendix B gives the average wealth for each of the wealth percentiles.
Fig 4: % of wealth in family home, Single data

From Fig 3 and Fig 4 we can observe the following:

- A household is unlikely to be homeowner if its wealth is less than a certain threshold, for both single and couple households. This may be due to that households in the low wealth band, would have difficulties to obtain a loan and unlikely to be able to afford upfront instalment to purchase a property; it can also be due to that for them it may be better to receive government rental assistance instead of owning a house. We can see that less single households are homeowners, which is not surprising as single households have in average, lower wealth than couple households.

- For households in the middle wealth bands, majority of their wealth are in the family home. This is consistent with previous studies (eg. Cho and Sane 2009), on the high wealth weighting towards the family home of Australian households.

- The proportion of wealth in family home then decreases as the households become wealthier. This suggest that saving in liquid wealth only happens when household wealth is above a certain threshold, hence can be considered as a luxury good. This is consistent with the assumption of luxury bequests, as in Ding et al. (2012), De Nardi (2004) and Lockwood (2011, 2012).

20 A simple way to model these factors is to assume a minimum house size as in Coco (2005), which is the same for both single and couple households.
• The proportion of wealth in the family home is similar between people in different age groups. This suggests the utility from housing is age independent, unlike utility from consumption, following health declines, one spends more time at home.

4 Model

Based the data analysis and related literatures, I propose the following utility model of the post-retirement preferences, of Australian households.

Retirees derive utility from consumption of non-housing goods and the flow of services from housing stock, as well as from bequests. Consider a single pensioner who makes a one off decision to allocate \( H \) dollars in the family home at retirement, and makes contingent plans for consumption rate \( C(t) \) and proportionate investments \( \omega(t) \) in risky assets, up to a certain age \( T \), while aiming to leave a non-housing bequest \( B(T) \) at the end of the planning period. Her objective is to maximize expected utility:

\[
\max E \left[ \sum_{t=x}^{T} v^t \left( \frac{(C_t - \bar{C})^\gamma}{\gamma} + \frac{(\psi H)^\gamma}{\gamma} \right) + v^T \theta^{1-\gamma}(\theta_0 + B_T)^\gamma \right],
\]

subject to the budget constraints,

\[
W_{t+1} = [W_t + P_t - C_t][\omega_t \tilde{z} + (1 - \omega_t)R],
\]

\[
W_x = W_x - H,
\]

\[
0 \leq H \leq \max(W_x - \bar{W}, 0),
\]

\[
B(T) \geq 0.
\]

The notation is:

• \( E \), expectations operator

• \( x \), current age of the retiree

• \( T \), age of the retiree at the end of the planning period, this paper assumes \( T = 100 \)

• \( v \), utility parameter denoting the retiree’s time preference\(^{21}\)

\(^{21}\)Note the notation \( v^t \) is used to be consistent with Ding(2012b), it would be more reasonable to
• $C_t = D_t + P_t$, Consumption at age $t$, consist of drawdown from wealth $D_t$ and age pension entitlement $P_t$.

• $P_t$, age pension entitlement at age $t$, which is a function of drawdown $D_t$ and wealth $W$.

• $\bar{C}$, nonnegative utility parameter with the interpretation of 'subsistence' or 'protected' or 'habitual' consumption.

• $\gamma$, utility parameter denoting the degree of risk aversion.

• $\bar{P}_t$, probability of someone currently age $\bar{x}$ survives to age $t$, this paper use $\bar{x} = 55$.

• $H$, value of the family home.

• $\psi$, utility parameter denoting the retiree’s preference for Housing.

• $B_T = W_T + P_T - C_T$, liquid wealth at the end of period $T$.

• $\theta$, utility parameter denoting the retiree’s preference between consumptions and bequest.

replace it with $\psi^{1-x}$, however this simplification does not affect the results.

22 For detail of Australian age pension means testing, see Ding (2012).

23 This can be considered a necessity in the sense that its elasticity of demand with respect to wealth is zero, for detail see Bateman et al. (2007) and Ding, Kingston and Purcal (2012).

24 Various studies (e.g. Bernick (2005), Yogo (2009), Higgins and Robinson (2009), amongst others) had point out that retiree’s consumption generally decrease with age due to declining health. Survival rates are used here to approximate this decrease of marginal utility of consumption due to declining health when retiree ages. I assume that people are completely healthy before age 55, and their health then declines with age. It is not applied to Housing and bequest utilities, as these are assumed to not be affected by health statues. Note I assume the retiree make financial plans up to age ”T” certain, a more realistic assumption is to take into account longevity risk such that the retiree are not certain how long she will live. Unfortunately this assumption cannot be applied in this paper, as it requires the mortality rate to be considered in the bequest function, in which case the model cannot be solved analytically.

25 This paper assumes the value of family home increase in line with inflation.

26 $\psi$ can be considered as the value of services as proportion to housing stock. This setting is similar to Cho and Sane (2009), which also modeled housing utility as additively separable from consumption utilities. Other researches including Coco (2005) and Yogo (2009), modeled housing utility as a multiplicative component, in which case the model cannot be solved analytically.

27 The optimal bequest decision in a simpler model included in Americks (2011) Appendix A, is to leave bequest equal to $(c - a)$ per year for $\theta$ years (assume $C$ is constant, $\bar{C} = 0$ and no age pension). $\theta = \phi/(1 - \phi)$ can also be seen as transform a utility parameter $\phi \in (0, 1)$ that has the interpretation of ”the marginal propensity to bequeath in a one-period problem of allocating wealth between consumption and an immediate bequest”. For detail see Lockwood (2012) and Ding et al. (2012).
### 4.1 Homeowner or Renter

Australia’s age pension means testing treats homeowner and renters differently. To model people’s decision of whether to be a homeowner or a renter, I assume the follows:

- For a renter, the derived utility from housing is also \( \left( \frac{\psi H}{\gamma} \right)^\gamma \), same as if she is a homeowner, where \( H \) is the optimal value of the family home assuming she chooses to be a homeowner.

- The renter incurs rental expenses equal \( \varrho H \), which is a form of subsistence consumption on top of \( \bar{C} \). Here \( \varrho = 4\% \) is the amount of rent required as proportion.

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28. \( a \) has the interpretation of the "threshold consumption level below which, under the conditions of certainty or with full, fair insurance, people do not leave bequests" (Lockwood 2012), see also Americks (2011), De Nardi (2004) and Carroll (2000).

29. If someone’s total wealth is less than $40,000, she do not purchase a house. If someone’s total wealth is greater than $40,000, she do not purchase an expensive house that will leave her with less than $40,000 liquid wealth. This assumption is required for the model to be consistent with the low home-ownership amongst households with low wealth, without this liquidity constraint, it is optimal for these household to allocate all wealth into family home, as age pension is enough to cover their consumption requirement. The value of $40,000 is chosen as the value most consistent with the data of low wealth households. This assumption is similar to assuming a minimum house size as in Coco (2005).

30. Under the age pension means testing rules, for every dollar of non-housing wealth above a threshold, the age pension entitlement will be reduced by 0.039 dollars, this threshold is lower for homeowners compared to renters.

31. A more realistic assumption would be that, if someone can obtain higher utility renting, that would reflect in a higher consumption as well as a higher derived utility from housing. However this a relatively minor issue, yet would greatly complicate the calculations.
of the property value $H^{32}$.

- The renter cannot leave the family home as a bequest, hence her threshold of liquid bequest is lower than $\theta a$ by the amount of $H$.

The objective function of a renter can therefore be expressed as:

$$\max E \left[ \sum_{t=2}^{T} v^t \left( tP_x \left( \frac{(C - \bar{C} - \varrho H)^\gamma}{\gamma} + \frac{(\psi H)^\gamma}{\gamma} \right) + v^T \theta^{1-\gamma} \left( \frac{(\theta a - H + B_T)^\gamma}{\gamma} \right) \right] \right], \quad (6)$$

subject to the budget constraints Eq(2) and:

$$W_x = W_x. \quad (7)$$

The solution of Eq (6) is the same as the solution of Eq(1) without the housing decision, given in Appendix A, except with $\bar{C}$ replaced by $\bar{C} + \varrho H$ and $\theta a$ replaced by $\theta a - H$. To find someone’s decision between being a homeowner or a renter, I first find the optimal value of $H$ assuming she is a homeowner, then find the optimal decisions under Eq(6) given $H$, assuming she is a renter. We then compare the optimal utilities between the case of renting or owing a home$^{33}$.

### 4.2 Couples

The utility function assumed for a couple households is the same as the single households, however it is reasonable to assume the health decline of both partners affect the marginal utility of the household, this is supported by the data analysis, which shows significantly higher spending for couple households during early years of retirement.

Hence the survival probability $tP_x$ is replaced by the joint survival probability $(P_{x\cup y})$ for couple households, to approximate the effect of lower utility from consumption in later age due to health declines.

---

$^{32}$This is calculated as the average weekly housing cost (according to ABS 2011 Census Data), divided by the average value of houses (according to ABS survey of Income and Housing 2009-2010, adjusted with inflation as the two surveys are of different years).

$^{33}$Note this decision is insignificant, as the result indicates that the decision of owning a home dominates the decision for renting for nearly every households in the sample.
5 Calibration

We calibrate the model by choosing the utility parameters to minimize the sum of squared error between the data and the model output on: 1. household expenditure in the year of survey; 2. age pension received in that year. 3. the value of family home. This can be expressed as follows:

$$\min SSE = \sum_{n=1}^{N} \left( \frac{(\hat{C}_n - C_n)}{W_n} e_n I_n \right)^2 + \left( \frac{(\hat{P}_n - P_n)}{W_n} e_n I_n^2 \right)^2 + \left( \frac{(\hat{H}_n - H_n)}{W_n} \right)^2,$$

where $N$ is the sample size (2856 single households and 2652 couple households). All errors are standardized by the estimated lifetime wealth $\bar{W}_n$. Errors on current expenditure and age pension are weighted by expected year of remaining life $e_n$, and $I_n$ and $I_n^2$ are indicators which takes value 0 if the expenditure/social security data is missing for this person and 1 otherwise. On average, the 3 items (consumption, age pension and housing) have roughly equal weights in the equation.

Six utility parameters are calibrated separately for singles and couples, namely $v$, parameter denoting the retiree’s time preference; $\gamma$, parameter denoting the degree of risk aversion; $\bar{C}$, parameter denoting the consumption floor; $\psi$, parameter denoting retiree’s preference for housing utility; $\theta$, parameter denoting preference for bequest and $a$, parameter denoting the degree of non-housing bequest as a luxury good.\textsuperscript{34}

Current age $x$, wealth $W_x$ and disability statues are given by the data. Other parameters of the model are economic assumptions given as follows: inflation rate 4.5%\textsuperscript{35}, real risk free return $R = 1%$; parameters for risky asset return $\nu = 0.225$ and $\sigma = 0.14$; and the age pension parameters used are as published by Centrelink in December 2009.\textsuperscript{36}

\textsuperscript{34}The model is calibrated as follows to ensure global optimization: in the 1st step, 4 possible values are assigned for each parameter, and I calculate the SSE for all $6^4$ possible set of parameters. in the 2nd step, 10 set of parameters are selected based on the result of the 1st step, I then further optimize the parameters with the Nelder-Mead Simplex Method, using each of the 10 sets of parameters as initial inputs. The result reported here is the set of parameter with the lowest SSE after the fine-tuning.

\textsuperscript{35}Australia’s age pension payment is indexed to Male Full Time Average Earnings, which average 4.5%, hence I set the inflation to 4.5% to avoid changing the age pension parameters during the calculation. Once the result are calculated, it can be easily adjusted to other inflation rate assumptions.

\textsuperscript{36}The average age pension rate in December 2009 is about $17,500 for singles and $26,100 for couples combined. The risk free return follows the 3 month bank bill rate published by Reserve Bank of Australia. And the risky asset return are calibrated from the historical returns of ASX All Ordinary Index. For details see Ding(2011) Appendix B.
5.1 Results

The optimal set of calibrated parameters are shown in the following table:\(^{37}\)

<table>
<thead>
<tr>
<th></th>
<th>(v)</th>
<th>(\gamma)</th>
<th>(\bar{C})</th>
<th>(\psi)</th>
<th>(\theta)</th>
<th>(a)</th>
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</thead>
<tbody>
<tr>
<td>Single</td>
<td>0.99</td>
<td>-3</td>
<td>$10,000</td>
<td>3.2%</td>
<td>21.7</td>
<td>$14,000</td>
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<tr>
<td>Couple</td>
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<td>-3</td>
<td>$18,000</td>
<td>4.8%</td>
<td>21.7</td>
<td>$21,000</td>
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</tbody>
</table>

Table 4: Calibrated utility parameters

Appendix B plots the output of the model compared to the original data, compare Figs 9,10,11,12 to Figs 2,3,4,8 we see that the calibrated model provides a reasonable fit to the data.

Parameters in Table 4 can be explained as follows:

- \(v\) implies that Australian households value receiving $1 (current dollar) in one years time to be the same as receiving $v now. The calibrated value for single households is the same as the real risk free rate, however the value for couple households is higher.\(^{38}\)

- \(\gamma\) denotes the degree of risk aversion. A high value of \(\gamma\) implies that consumption paths are smoother, and the retiree would allocate less into risky assets.\(^{39}\) The value of \(\gamma = -3\) denotes a relatively high degree of risk aversion, although within the range of values suggested by previous literatures.\(^{40}\)

- \(\bar{C}\) denote the subsistence consumption level. The fitted parameter suggest the level of consumption floors for single and couple households are close to the payment rate of Newstart Allowance in Australia, which seems reasonable as a level of consumption for absolute necessities.

\(^{37}\)These parameters have been rounded, and some are assumed to be the same for single and couple households, when the calibrated values are very similar.

\(^{38}\)This may suggest the time preference are different for Single and Couple households. However although mortality rate had been included in the model to approximate the effect of lower utility from consumption in later ages due to health declines, the higher discount rate for couples here may be due to the fact that approximating the effect of health declines for couples, using the joint survival rate as assumed for couples in Section 4.2, is not the best assumption.

\(^{39}\)In a one-period asset allocation problem, given the return of risky and risk-free asset assumed in this paper, the retiree will allocate 19% of wealth in to risky asset, compared to 64% if their utility function is assumed to be log form (when \(\gamma = 0\))

\(^{40}\)for a discussion on the value of risk aversion parameter, see for e.g. Americks et.al. (2011)
5.1 Results

- $\psi$ denotes flow of utility (or can be interpreted as a rate of return) from housing stocks; the calibrated parameters suggest that same value of house would derive more utility for couples than singles, which seems reasonable as there are two people in a couple household. The calibrated values of 3.2% and 4.2% seems reasonable as it is consistent with the current rental cost of 4% in Australia, as assumed in Section 4.1.

- $\theta = \phi/(1 - \phi)$, gives $\phi = 0.956$ which denote the preference between consumption and saving. While $a$ implies that, a household is unlikely to have savings in liquid wealth if it cannot afford annual consumption of at least $\bar{C} + a$. The calibrated value of these two parameters are consistent with previous US studies. The high value of $a$ seems reasonable here as in Australia most bequests are in the form of the family home. Therefore liquid bequests are expected to be luxuries.

The calibrated parameters indicates that there is no specific preferences for housing amongst Australian households, since the calibrated flow of utility from housing is consistent with market rental cost. The high concentration of wealth in the family home is most likely affected by the age pension. First, the high level of age pension payments are well above the calibrated consumption floors, indicating that households in low wealth bands do not need much wealth outside of their family home to fund their retirement consumption. Second, the age pension asset test implies that it is optimal for middle to high wealth bands to allocate wealth in their family home, to receive higher pension payments.

Although the parameters reported here are the ones that provide the best fitted results, these parameters suffers from identification problems similar to the ones reported in Americks et.al. (2011). For example: the smoothness of consumption between ages (hence the level of current consumption to be calibrated), can be affected by either $v$ (preference for higher consumption earlier), $\gamma$ (penalty for higher consumption in a particular period than average) or $\bar{C}$ (the required base level of consumption every period). In fact, the parameters $v = 0.99$ and $\gamma = -2.5$ for couple households, result in very similar model outputs, compared to the results when assuming $v = 0.98$ and $\gamma = -3$, as reported above.

41 According to Lockwood (2012), US literatures disagree with each other on the degree of bequest motives with value of $\phi$ range from 0.88 to 1, and $a$ range from $5,300 to $48,400, for e.g. Lockwood (2012) found a $\phi = 0.93$ and $a = $20,400, while Americks et.al. (2011) suggest $\phi = 0.98$ and $a = $7,300.
5.2 Numerical examples

The following two numerical examples are given to illustrate optimal financial decisions under the calibrated model:

1. Household A: Single female age 77, with total wealth $320,000.

2. Household B: Couple, male age 77, female age 72, with total wealth $1,933,000.

The model output indicates that the optimal allocation of wealth in family home is $280,000 for household A, 88% of her total wealth; and $829,000 for household B, 43% of their total wealth.

Fig 5 illustrate the consumption path for these two households:

In both households, consumption decreases with age, and the rate of decrease becomes faster at higher ages, due to health declines. Household A is a relatively poorer household and Age pension payments contribute to a major part of her retirement consumptions, note the model implies that at higher ages, Household A would consume less than the age pension payments. Household B is a relatively wealthy household,
however even at their level of wealth, they would still be eligible for age pension payments at higher ages.

Fig 6 illustrates the path of liquid wealth (net of family home) for these two households:

![Wealth path graph]

At the end of the planning period (age 100), household A is expected to have no asset outside of the family home, while household B is expected to have $495,600. Note the wealth of Household A become negative at around age 89, this is due to the model only imposes restriction that terminal wealth cannot be negative, yet Household A is allowed to have higher consumption and negative wealth at younger ages, and this shortfall is then made up by consuming less than the age pension payments.

Fig 7 illustrates the estimated optimal investment path for Household B; for Household A, it is optimal to allocate nearly all liquid wealth into risky assets, this is because majority of her consumption requirement can be funded by age pension. As it is a risk-free source of income for life, she does not need further risk-free assets.
Fig 7: optimal path of risky asset allocations.

From Fig 7, we see that for Household B the optimal allocation in risky assets slightly increases at early ages and then decreases. Two factors contribute to this pattern, with opposing effect. First, the existing of luxury bequests implies a higher allocation into risky asset as the household ages. It provides a buffer for investment risks, and this buffer is more significant at later ages, when there are less future consumption requirement to consider. However at the same time, the existing of the age pension implies a lower risky allocation as the household ages. Future age pension payments also provides a buffer for investment risks; this buffer diminishes as the household approaches the end.

6 Conclusion

This paper extends the utility models considered in Ding (2012) and Ding et al. (2012), and further includes housing decisions, in addition to age pension and bequest motives. The model parameters are calibrated to the ABS data of household expenditure survey and survey of income and housing. The model is realistic enough to be calibrated to empirical data, as it takes consumption and housing decision, bequest motive and the age pension system into account, yet the model has a semi-analytical solution, which make the calibration feasible. The parameters calibrated indicate that Australian retirees have a relatively high preference for consumption now versus consumption in the future, a high degree of risk aversion, and a strong saving motive (except for poorer

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42 For detail see Ding, Kingston and Purcal (2012)
43 There are two reasons, future age pension payments are risk-free hence crowds out allocation in risk-free assets, furthermore if the household suffers a lose in their investment, they will be entitled to higher age pension under the asset test.
These calibrated model parameters is a valuable reference for further researches into the retirement problems. The calibrated model in Ding (2012b) is expected to have applications in a wide areas including post-retirement financial planning, pension product design and the evaluation of public policy changes in Australia.

This research has a number of limitations. The calibrated parameters suffer from identification problem, such that various set of parameters can provide very similar outputs. Americks et al. (2011) deal with identification problems by incorporating additional survey data. Future extensions to this paper can integrate other data and surveys into the study (the HILDA survey for example).

I assume a single utility function with a particular set of parameters is applicable for every Australian retiree. This assumes people’s behavior depends only on age, wealth, gender and marital status. In reality no two people can be identical, and the SIH data shows that there is higher level of variability for people in the same age and wealth band. Future research could incorporate other explanatory variables, eg. education levels.

Future research could also improve the flexibility of the utility functions, or find fast numerical methods to incorporate more flexible assumptions.

44 This can be illustrated as in Fig 13 in Appendix B, we can see that the house values modeled only explains a small part of variability of the value of family homes in the data.
References


REFERENCES


REFERENCES


Appendix A: Model Solution

First assume the value of family home $H$ is given, and $W_x = W_x - H$, maximizing Eq(1) is the same as:

$$\max E \left[ \sum_{t=2}^{T} v^t \left( t P_x \frac{(C_t - \bar{C})^\gamma}{\gamma} \right) + v^T \theta^{1-\gamma} \frac{(\theta a + B_T)^\gamma}{\gamma} \right], \quad (9)$$

The solution for Eq(9) subject to Eq(2), can be summarized as in Proposition 1. For detail of the proves and notations used, see Ding (2012) and Ding et al. (2012).

**Proposition 1.** Consider three time points $k_1 \leq k_2 \leq k_3$, where:

- $k_1$ is the age when the pensioner start receiving asset test pension.
- $k_2$ is the age when the pensioner start receiving income test pension.
- $k_3$ is the age when the pensioner start receiving full pension.

At any time $t$, define: $\hat{k}_i = \min(\max(k_i, t, A_p), T + 1)$ for all $i = 1$ to $3$, where $A_p$ is the qualifying age for Age Pension. The optimal decision rule for drawdown $D_t^*$, is:

$$D_t^* = \alpha_t \hat{W}_t - \hat{P}_t,$$

in which:

$$\hat{W}_t = W_t + \xi_{k_1} R^{t-k_1} - \bar{C} \frac{R - R^{t-k_1+1}}{R - 1},$$

$$\xi_{k_1} = \xi_{k_2} [R(1 - \omega_a)]^{k_1-k_2} + R(P_m + L_a \omega_a - \bar{C}) \frac{1 - [R(1 - \omega_a)]^{k_1-k_2}}{R(1 - \omega_a) - 1},$$

$$\xi_{k_2} = \frac{P_m + L_i \omega_i - \bar{C}}{1 - \omega_i} R^{k_2-k_3+1} - \frac{L_i \omega_i}{1 - \omega_i} (1 + I)^{x-k_2} \frac{R(1 + I) - (R(1 + I))^{k_2-k_3+1}}{R(1 + I) - 1},$$

$$\quad + R^{k_2-k_3} (P_m - \bar{C}) \frac{R - R^{k_3-T}}{R - 1} + R^{k_3-T} \theta a.$$
\[
\hat{P}_t = \begin{cases} 
-\bar{C} \\
\omega_a \left( \xi_{k_2} [R(1-\omega_a)]^{t-k_2} + R(\mathcal{P}_m + L_a\omega_a - \bar{C}) \frac{1-[R(1-\omega_a)]^{t-k_2+1}}{R(1-\omega_a)-1} \right) \\
+(\mathcal{P}_m + L_a\omega_a - \bar{C})/(1-\omega_a) \\
(\mathcal{P}_m + (E_i(t) + L_i\omega_i - \bar{C})/(1-\omega_i) \\
\mathcal{P}_m - \bar{C}
\end{cases}
\]

for \( t < \hat{k}_1 \); \( \hat{k}_1 \leq t < \hat{k}_2 \); \( \hat{k}_2 \leq t < \hat{k}_3 \); \( t \geq \hat{k}_3 \).

\[
\alpha_t = \begin{cases} 
\hat{\alpha}_t + \omega_a(1-\hat{\alpha}_t) & \text{for } \hat{k}_1 \leq t \leq \hat{k}_2 - 1; \\
\hat{\alpha}_t & \text{for all other } t;
\end{cases}
\]

and \( \hat{\alpha}_t \) can be found recursively such that:

\[
\hat{\alpha}_t = \begin{cases} 
\beta_a \mu_t \hat{\alpha}_{t+1}/(1 + \beta_a \mu_t \hat{\alpha}_{t+1}) & \text{for } \hat{k}_1 - 1 \leq t \leq \hat{k}_2 - 2; \\
\beta_i^{-1} \mu_t \hat{\alpha}_{t+1}/(1 + \beta_i^{-1} \mu_t \hat{\alpha}_{t+1}) & \text{for } t = \hat{k}_2 - 1 \\
\beta_i \mu_t \hat{\alpha}_{t+1}/(1 + \beta_i \mu_t \hat{\alpha}_{t+1}) & \text{for } t = \hat{k}_3 - 1; \\
\mu_t \hat{\alpha}_{t+1}/(1 + \mu_t \hat{\alpha}_{t+1}) & \text{for all other } t
\end{cases}
\]

with the terminal condition:

\[
\hat{\alpha}_T = \frac{\theta^{-1}(TP_x)^{\frac{1}{\gamma}}}{1 + \theta^{-1}(TP_x)^{\frac{1}{\gamma}}},
\]

where:

\[
\beta_i = (1 - \omega_i)^{\frac{1}{\gamma}}, \\
\beta_a = (1 - \omega_a)^{\frac{1}{\gamma}}, \\
\mu_t = \left( P_t v_E[(\hat{Z}^*)^\gamma] \right)^{\frac{1}{\gamma}}, \\
\hat{Z}^* = \hat{\omega}^* \hat{z} + (1 - \hat{\omega}^*) R.
\]

The optimal proportion of wealth to be allocated to risky asset at time \( t \) after consumption, \( \omega_t^* \), can be found as:

\[
\omega_t^* = \hat{\omega}^* \cdot \frac{\hat{W}_t - D_t^* - \hat{P}_t}{\hat{W}_t - D_t^*},
\]
where $\hat{\omega}^*$ is the solution to the following equation:

$$E[(\hat{\omega} \tilde{z} + (1 - \hat{\omega})R)^{\gamma - 1}(\tilde{z} - R)] = 0.$$  

The expected value of Eq(9) at time $t$ under the optimal decisions, can be written as:

$$J(W_t, t) = v^t P_x (1 - \omega_t)^\gamma \alpha^\gamma_1 \frac{\tilde{W}_t^\gamma}{\gamma}$$

(10)

$$\omega_t = \begin{cases} 
\omega_a & \text{for } k_1 \leq t < k_2; \\
\omega_i & \text{for } k_2 \leq t < k_3; \\
0 & \text{for all other } t;
\end{cases}$$

Where $P_m$ denote the annual payment under the maximum pension rate, $L_a$ denotes the asset test limit and $\omega_a$ the asset test reduction rate, $E_i(t)$ denotes the amount of pensioner’s income that is deductable at age $t$, $L_i$ the income test limit and $\omega_i$ the income test reduction rate, $e_x$ denote the expected years of remaining life of the pensioner and $I$ the inflation rate.

Ding (2012) Appendix A shows a method of estimating $k_1$, $k_2$ and $k_3$. Following Merton (1971), under the assumption that risky asset return $\tilde{z}$ is log-normally distributed with parameters $\nu$ and $\sigma$, we can write:

$$\hat{\omega}^* = \frac{\nu - \ln(R)}{\sigma^2(1 - \gamma)};$$

and

$$\ln(\mu_t) = \frac{\ln((P_t v)^{-1}) - \gamma \left[ \frac{(1 - \ln(R))^2}{2\sigma^2(1 - \gamma)} + \ln(R) \right]}{1 - \gamma}.$$  

Now consider the pensioner’s decision at retirement to allocate $H$ dollar into the family home, given Eq(10) and Eq(3), Eq(1) can be written as:

$$J(W_x, x) = v^x P_x (1 - \omega_x)^\gamma \alpha^\gamma_2 \frac{h(W_x - H)^\gamma}{\gamma} + \sum_{t=x}^{T} v^t (\psi H)^\gamma,$$

(11)
where $h(W) = \hat{W}$. Differentiating Eq(11) we have:

$$v_x^x P_x(1 - \varpi_x)\gamma \alpha_2^{\gamma - 1} h(W_x - H)^{\gamma - 1}(-\xi' - 1) + \sum_{t=x}^{T} v_t^t \psi^\gamma H^{\gamma - 1} = 0, \quad (12)$$

$$\xi' = R^{x-k_1} [R(1-\varpi_a)]^{k_1-k_2} \varpi_i e_x(1-\varpi_i)(1+I)^{x-k_2} \frac{R(1+I) - (R(1+I))^{k_2-k_3+1}}{R(1+I) - 1}.$$

Solve Eq(12) we can find the optimal amount of $H$ for single pensioners as:

$$H^* = \frac{\vartheta h(W_x)}{1 + (\xi' + 1)\vartheta}, \quad (13)$$

$$\vartheta = \left[ \frac{v_x^x P_x(1 - \varpi_x)\gamma \alpha_2^{\gamma - 1}(\xi' + 1)}{\psi^\gamma \sum_{s=0}^{T-x} v_s^s} \right]^{\frac{1}{\gamma - 1}}.$$

One challenge of the model is that we need to ensure $B(T) > 0$, else retiree with wealth below a certain threshold may have negative wealth at time $T$. Ding et al. (2012) dealt with this problem by replicating a put option, the value of which at time $T$ would be $-B(T)$ if $B(T) < 0$ and zero otherwise. The solution however would be much more complicated with age pension taken into account and requires numerical method to be implemented in practice. In this paper, the decision is approximated as follows: I calculate the value of consumption assuming $B(T) = 0$ and if it is smaller than our original case, it indicates that in the original case the retiree’s saving is negative, we then use the results assuming $B(T) = 0$. This approximation gives very similar results as the method in Ding et al. (2012) in most situations, except a retiree with moderate level of wealth may allocate more wealth into risky asset than ideal.

46 refer to Fig.2 in Ding and Kingston (2012)
Appendix B: Additional Tables and Figures

Table 5: Average wealth ($'000) of each wealth percentiles for Couple and Single data

<table>
<thead>
<tr>
<th>Wealth</th>
<th>10th</th>
<th>20th</th>
<th>30th</th>
<th>40th</th>
<th>50th</th>
<th>60th</th>
<th>70th</th>
<th>80th</th>
<th>90th</th>
<th>100th</th>
</tr>
</thead>
<tbody>
<tr>
<td>Couple</td>
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<td>322</td>
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<td>456</td>
<td>530</td>
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Table 6: Average of estimated lifetime wealth ($'000) of each wealth percentiles by age

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Table 7: Single data, Value of family home as % of total wealth, by age and wealth percentiles

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<th>80th</th>
<th>90th</th>
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Table 8: Single data, Expenditure ($'000) by age and wealth percentiles

Fig 8: Expenditure as % of estimated life time wealth, Single data
Fig 9: % of wealth in family home, Model output, Couple households

Fig 10: % of wealth in family home, Model output, Single households
Fig 11: Expenditure as % of estimated lifetime wealth, Couple output

Fig 12: Expenditure as % of estimated lifetime wealth, Single output
Fig 13: Value of family home by Household net wealth, Data and Model outputs, Couple Households