Means-tested Age Pension and Homeownership: Is There a Link?

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Abstract

Empirical studies across some advanced countries show that the homeownership as well as the fraction of household wealth held in housing is greater than the average in Australia. We argue that exemption of the owner-occupied housing from the age-pension means test has a bearing on the propensity of households to invest a greater proportion of their wealth in housing. We examine wealth transitions of households in the 61-64 age bracket using the Household, Income and Labour Dynamics (HILDA) panel data-set and do not find statistically significant evidence of immediate financial wealth draw-down to qualify for the age-pension. We then set up a quantitative general equilibrium lifecycle model with uninsurable labour income risks and dual assets - housing versus financial assets. With reasonable parameter values, the model is able to match some key features of the lifecycle profiles of wealth and homeownership. We conduct counter-factual policy experiments of alternative means-test designs: when the owner-occupied housing is exempt from the assets test, households keep accumulating housing assets well after retirement and over-invest in housing assets by a magnitude of 6% on average during retirement as compared to the case where owner-occupied housing is included.

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1 Introduction

Pension systems in most OECD countries provide for some minimum pension in addition to a targeted pension, as part of their first pillar.[1] One of the advantages of a means-tested pension is that expenditure is restricted to those eligible under the means-tests. At the same time, means-testing is not without its complications. First, there is the issue of identifying people most in need and second, more importantly, targeted pensions can impose large marginal tax rates, especially to those at the margin of eligibility raising concerns that such targeting may engender selection into the group that receives the benefits.[2]

Hubbard, Skinner, and Zeldes (1994, 1995) show that assets tests on various welfare programmes discourage saving by families who view them as a valuable alternative source of income. Most empirical studies since then have focused on perverse incentives on labour supply; incentives on savings and wealth accumulation have been given less attention (Neumark and Powers, 1998, 2000; Powers, 1998). A study by (Gruber and Yelowtiz, 1999) assesses the impact of Medicaid on savings of low-income individuals and finds a highly significant, negative relationship between the generosity of a family's public insurance entitlement and that family's asset holdings. They also find that the effect of Medicaid eligibility is much stronger in the presence of an assets test. One implication of means-testing is that individuals may build into their decision making the possibility of the means tested benefit at the end of their working life and as a result accumulate lower wealth over the life-cycle. Jimnez-Martin and Sanchez-Martin (2007) evaluate the life cycle effects of the minimum pension in Spain and find that the minimum pension increases the opportunity cost of the forgone pension income and eliminates the incentive to work. Sefton, van de Ven, and Weale (2008) conclude that the lightening of the taper rates of the means-test with the replacement of the Minimum Income Guarantee by the Pension Credit in the UK reflects a reasonable compromise across the various distortions by the policy.

In Australia, the age-pension is one of the most important welfare programmes for the elderly. About 2 million (75%) older Australians receive the age-pension (Harmer, 2008). The age-pension payment is calculated under both the income and assets tests. The test that results in the lower rate (or zero) applies. The owner-occupier home is exempt from the means-test and different asset test schedules apply to homeowners and non-homeowners. As of July 2008, a single home-owner could have non-housing assets worth \$171,000 and an income of less than \$138 per fortnight and receive the full pension. The pension is reduced by \$1.5 for every \$1000 above \$171,750 up to \$540,250, the part-pension cut off, beyond which the person ceases to be

[1]In the pensions literature, first pillar stands for basic social security that ensures subsistence needs for all residents of the country. It is usually financed by the State.

[2]Research shows that universal benefits can also crowd-out savings. For example, Kotlikoff, Spivak, and Summers (1982) note that the introduction of social security pensions may lead to an offsetting reduction in private saving if people foresee the state pensions and if they are not constrained in the capital market.

a pensioner. The cut-offs for non homeowners are higher. There are similar cut-offs for the income test, and the pension is reduced by 40 cents in the dollar for income over the full-pension cut-off.

If the age-pension payment provides a replacement rate high enough to offset the annuity that the elderly could buy from the market or allows for the possibility of early withdrawal from the workforce, then the elderly have a high incentive to ensure that their income and wealth stay within the bounds of the respective tests. By impairing wealth holdings, assets test could have adverse implications especially for households who could accumulate assets above the threshold, but do not, for welfare entitlement reasons. The exemption of the owner-occupier home could also lead to a portfolio with a high proportion of housing equity. Residential real estate does comprise more than half of personal wealth in Australia and about half of the elderly claim to have spare capacity in their homes, indicating excess housing services consumption.[3] According to Bradbury (2008) high rates of home-ownership continue into post-retirement years in Australia, while they decline steeply in most other countries. If exemption from the family-home does lead to over-investment in housing, then this is likely to be a source of economic-inefficiency.

This paper uses a panel data set of Household Income and Labour Dynamics (HILDA) to study how the existence of the assets test for the age pension impacts savings decisions of those a few years away from retirement. We pay special attention to non-housing equity as the home is exempt from the assets test. We find that households who go on the age-pension do see an increase in the housing to networth ratios as opposed to those who do not become pensioners. However, we do not find statistically significant evidence of draw-down of non-housing equity prior to retirement in order to qualify for the age-pension.

We then turn our attention to the implications of lifecycle portfolio choice with specific emphasis on nature of the means-tested age pension. We develop an overlapping generations general equilibrium model with explicit tenure choice and life-cycle attributes to determine whether removing or changing the current means-testing age pension scheme would have aggregate and life cycle implications and also what the distributional impacts of making such changes would be. We specifically focus on introducing a constant benefit scheme as well as some possible alternative reforms to the current means-testing scheme such as inclusion of housing assets to the means-testing and lowering the taper ratio. The results from the calibrated model applied to the Australian economy can quantitatively explain some empirical findings on the profile of wealth and homeownership in the aggregate as well as over the life cycle.

Including housing asset into the current means-testing scheme implies that we remove the wedge that distorts household portfolio decision over the lifecycle. In the aggregate, we see a reduction in wealth accumulation and a lower housing to non-housing consumption ratio as well as the

[3] Australian Bureau of Statistics, Household Expenditure Survey, 2004.

fraction of wealth held in housing assets. Lower values in the latter two ratios indicate that average households over-accumulate housing in Australia. Over the life cycle, with inclusion of housing into means-testing, housing profile peaks earlier in age and remains lower than the benchmark scenario, which strengthens our hypothesis that the current means-testing scheme induces households to over-invest in housing. Under the benchmark scenario, households accumulate housing assets until the age of 70-75 with little de-cumulation afterwards. However, when housing is included, housing accumulation peaks earlier around the age of 60-65 and decreases afterwards. Quantitatively, during retirement, compared to the current scheme, the profile of housing assets is lower by a margin of 3% for cohorts aged between 65 and 70, and 7% for cohorts aged between 75 and 85. The average housing asset is around 6% lower during retirement when the means-testing incorporates both financial and housing assets. While the average homeownership remains mostly unchanged due to the fact that the current means-testing scheme already applies different thresholds for homeowners versus renters, changes to the means-testing scheme affects the tenure decision of households aged 60 and above. For households entering into retirement, the period in which homeownership peaks, the average homeownership is around 86.8% when housing is included in the means-testing, which is 3.8% points lower than the benchmark case where means-testing excludes owner-occupied housing assets.

The paper is organised as follows. Section 2 presents a simple two-period model of savings under different means-test design. Section 3 presents a snapshot of aggregate wealth and wealth-transitions of those a few years prior to retirement. In Section 4 we present estimates of wealth draw-down by those in the 61-64 age group. Section 5 presents the general equilibrium life-cycle model, and section 6 the calibration of the model. In Section 7 we show the benchmark results and the results of our policy experiments in Section 8. Sensitivity analysis is presented in Section 9. We conclude in Section 10.

2 Analysing savings dynamics

We consider a simple two-period optimization problem and assume that a household has a utility function of the following form

$$max : log(C_1) + log(H_1) + \beta log(C_2) + \beta log(H_2)$$

s.t.

$$C_1 = Y_1 - A_1 - H_1$$

$$C_2 = Y_2 + (1 + r)A_2 - (1 + r_h)H_2$$

$$Y_2 = \begin{cases} b & \text{if } A_2 \leq Z \\ b - b^a(A_2 - Z) & Z \leq A_2 \leq X \\ 0 & \text{if } A_2 \geq X \end{cases}$$

Here, C_i and H_i indicate non-housing and housing consumption respectively. A_2 indicates non-housing assets in the second period. Second period income Y_2 is equal to a flat amount b if non-housing assets fall below Z, is reduced at a taper rate of b^a for every dollar above the level Z as long as A_2 is less than X and is equal to zero, if A_2 is greater than X. r indicates the rate of return on non-housing assets, and r_h the rate of return on housing.

Solving for the households optimization problem we find that in the case where $A_2 \geq X$, $\frac{C_1}{H_1} = 1$ and $\frac{C_2}{H_2} = 1 + r_f$ and that $\frac{C_2}{C_1} = \beta(1 + r)$. In the case where $A_2 \leq Z$, we find that the trade-off between the non-housing and housing consumption remains the same. There is just a parallel shift in the budget constraint owing to the receipt of benefit b. The household does not face a substitution effect. However in the case where $Z \leq A_2 \leq X$, we find that $\frac{C_2}{C_1} = \beta(1 + r - b^a)$. We find that ratio of second period to first period non housing consumption has fallen.

If we change the benefit structure and include housing wealth in the assets test, we find that $Y_2 = b - b^a(A_2 + H_2 - Z)$ if $Z \leq A_2 + H_2 \leq X$. In this case, we find that $\frac{C_2}{H_2} = (1 + b^a)(1 + r_h)$ and thus is greater than $\frac{C_1}{H_1}$. Comparing the result on $\frac{C_2}{H_2}$ from this case to the one where housing was excluded from the assets test, we find that this ratio is lower than when housing is included in the assets test. This implies that housing is over consumed when it is excluded from the assets test. A detailed derivation is shown in the Appendix.

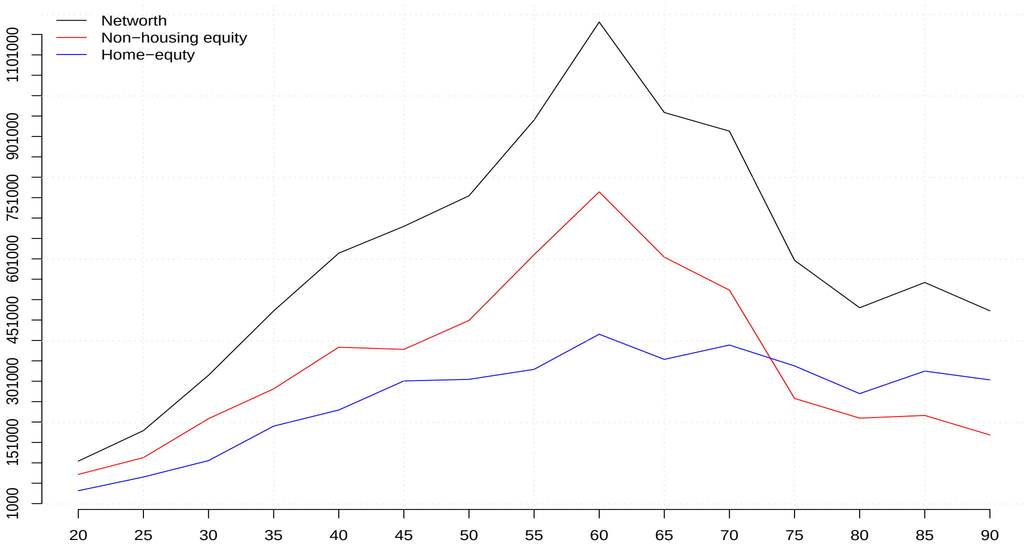
3 Wealth and wealth-transitions in Australia

We examine detailed wealth and wealth transitions of the elderly between 2001-2006 from the Household, Income and Labour Dynamics (HILDA) panel data set from Australia. Detailed wealth estimates of households were collected in the second wave in 2002 and then in the sixth wave in 2006, and we therefore use household data from these two waves (Waves 2 & 6) for our wealth estimates.

We begin by presenting a snapshot of the wealth accumulation across all age groups in Australia in Figure 1. Household age is determined as that of the oldest person in the household. We find that non-housing equity falls starting age 60. Housing equity does not go through the same fall. The drops in wealth may be different for people with different lifetime incomes.

To analyse wealth composition by income, we divide respondents by education category as education is a good proxy for earnings potential and lifetime income. We define School as those

Figure 1 Wealth portfolio by age



who have studied less than or equal to High school, Certificate as those who have some trade qualifications and Graduate as those with a bachelors degree or more. In Table 1 we present median values for total networth and break it up by non-housing and housing wealth.

For the 50-59 age group, we see a sharp drop in non-housing wealth in the school group, but not in the certificate and graduate groups. Housing equity does not see similar drops. At the same time, the school group has the maximum percentage of people out of the labour force at older ages. A peculiar feature of Australian retirement policy, mentioned earlier, is that the access age for drawing down superannuation wealth is 60, thus allowing people to consume out of these resources between 60 and 65 and then accessing the age pension from age 65. Low labour force participation is one indication that this could be an important strategy for the relatively poor.

We expect assets test to have differential impacts on people at different wealth deciles. We first consider the distribution of wealth (between housing and non-housing equity) of those in the 61-64 age group in 2002 and not on the age-pension. We focus on households whose non-housing equity is less than a million dollars as our interest is in observations on the margin of the assets test. We find that in 2002, households with very low non-housing equity have some housing equity. There are a few households with non-housing equity between \$200000 and \$400000 also have high housing equity which falls once again at very high levels of non-housing equity.

We then briefly consider wealth aggregation of those close to the age-pension access age. If

Table 1 Wealth by age and education

	Age						
	< 30	30-39	40-49	50-59	60-64	65-69	70+
	School						
Median networth	46	137	274	440	471	409	337
Median non-housing wealth	26	64	112	205	145	87	54
Median housing wealth	0	25	109	210	252	262	260
Annual income	46	56	58	59	40	27	22
Not working (%)	29	24	23	30	64	88	97
Number of households	108	289	407	411	200	178	620
	Certificate/Dipolma						
Median networth	57	244	418	641	843	768	509
Median non-housing wealth	34	108	137	295	387	314	135
Median housing wealth	0	84	214	295	350	350	300
Annual income	58	64	68	70	60	37	30
Not working (%)	15	12	13	21	52	80	94
Number of households	102	367	614	478	161	144	272
	Graduate						
Median networth	51	305	530	909	1122	856	779
Median non-housing wealth	48	141	259	500	518	455	306
Median housing wealth	0	100	272	350	400	450	350
Annual income	72	75	85	79	53	48	43
Not working (%)	9	15	8	11	44	70	88
Number of households	76	224	251	190	58	44	69

Source: HILDA

residential choice is affected by the assets test rules then we would expect to observe anticipatory behaviour by those approaching pension age.

We present in Table 2 the differences in housing and non-housing to networth ratios amongst those who are not on a pension and are between the age of 61-64 in 2002. This group will have reached the access age for the pension in 2006 and their wealth ratios are observed once again in 2006. One could argue that those who become pensioners have lower wealth to begin with. We therefore look at the two groups separately in 2002, though their pension status is determined only in 2006. We find a rise in the ratio of home wealth to total wealth in the four years of those who become pensioners after they turn 65. This suggests that the exclusion of the family home promotes greater holding of home wealth to begin with.

4 Estimating pre-retirement wealth transitions

We are interested in estimating the impact of the potential receipt of the age-pension on savings behaviour of households. We might expect households to reduce savings if by doing so, they become eligible for the age-pension. We might also expect that households may find it beneficial

Figure 2 Wealth portfolio in 2002

Table 2 Wealth ratios by pension status

	Age 61-64 (2002)		Age 65-69 (2006)	
	P	NP	P	NP
Non-housing equity: Networth				
1 Q	0.29	0.48	0.20	0.48
Median	0.47	0.65	0.43	0.65
3 Q	0.76	0.83	0.69	0.80
Home-equity : Networth				
1 Q	0.23	0.15	0.30	0.19
Median	0.52	0.32	0.56	0.33
3 Q	0.70	0.50	0.79	0.51

Number of households: 237
P: Pensioner; NP: Non-pensioner
Source: HILDA, authors' calculations

to trade-up their owner-occupier homes as the family home is exempt from the assets test.

We expect that these incentives are more relevant to those closer to the eligiblilty age for the age-pension, as not only can these people form better predictions of their post-retirement assets, but also are more likely to pay greater attention to the receipt of the age-pension. We therefore focus on individuals who are between the age of 61 and 64 in 2002, and are not already on an age pension or eligible for one. We only focus on male respondents as women can become eligible for the pension at age 63. We measure savings as the difference between non-housing wealth in 2006 and 2002. Wealth in 2006 is deflated to 2002 levels, using the consumer-price index. Wealth is defined as all financial assets plus non-housing property minus liabilities.

One estimation strategy is to identify households who are likely to be pensioners by 2006 and observe the difference between their savings and of those who are not likely to be pension recipients. However, given that pension receipt is a function of financial resources only (apart from age), predicting pension status is likely to lead to problems of endogeneity. We therefore estimate savings behaviour by dividing househoulds into three categories based on their non-housing wealth in 2002: those whose wealth is already below the full pension threshold, those whose wealth is between the full and part-pension thresholds and those whose wealth is greater than the part-pension thresholds. We expect that the latter two should be drawing-down their non-housing wealth (i.e. saving less) and trading-up their family homes. We focus only on households with wealth less than two million dollars.

Table 3 Descriptive statistics of our estimation sample

	Estimate	Standard error
Mean savings	145	58
Education		
Graduate	10%	2.3
Diploma	45%	4.2
High school or less	45%	4.2
Family type		
Couple family	59%	4.5
Lone person	15%	2.8
Others	25%	4.2
Health problem		
Respondent	44%	4.2
Partner	23%	4.2
Labour force status		
Working	44%	4.25
Not working, but in the labour force	44%	4.0
Not working, not in the labour force	13%	3.2
Partners labour force status		
Working	28%	3.9
Not working, but in the labour force	45%	4.1
Not working, not in the labour force	27%	3.6
Mean other assets (2002)	354	32
Households with assets		
Below full pension threshold	48%	4.4
Between full and part-pension threshold	22%	3.7
Greater than part-pension threshold	30%	3.8
Number of observations	171	

Demographic variables in the analysis include type of household (lone-person or couple), education (graduate, diploma or high-school and less), health of the respondent and partner, labour-force participation of the respondent and partner (working, out of the labour force, or not working but not out of the labour-force) and home-ownership status. Descriptive statistics of our variables are presented in Table 3.

Results from our estimation are presented in Table 4. Individuals with a diploma or a high school education save less than gradutes, significant at the 1% level. Having a spouse in the labour force adds to savings. Households with assets between the full and part pension thresholds and assets greater than part pension thresholds actually have lower savings than households with assets lower than the full pension cut-offs. At the same time, these households have greater savings in the family home. While both results are not significant at the 10% level, the signs are what we would expect if households were dissaving non-housing wealth and focusing on housing wealth.

Table 4 Estimation results

	Non-housing savings	Housing savings
Constant	14.67***	14.12***
	(0.08)	(0.48)
Health prob.	-0.032	0.28
	(0.031)	(0.25)
Partner health prob.	-0.01	0.11
	(0.031)	(0.12)
Lone person	-0.005	-0.13
	(0.46)	(0.16)
Other	-0.009	0.13
	(0.052)	(0.16)
Diploma	-0.12***	-0.11
	(0.054)	(0.14)
High school or less	-0.13**	0.18
	(0.06)	(0.20)
In the labour force	0.034	-0.205
	(0.039)	(0.202)
Not in the labour force	0.038	0.19
	(0.039)	(0.19)
Spouse in the labour force	0.058*	-0.51
	(0.035)	(0.45)
Spouse not in the labour force	0.054	0.001
	(0.046)	(0.096)
Non-housing wealth	-0.004	-0.074
	(0.06)	(0.077)
Assets between FP and PP cut-offs	-0.019	0.625
	(0.029)	(0.595)
Assets greater than PP cut-offs	-0.066	0.771
	(0.044)	(0.713)
Homeowner	0.046	
	(0.026)	
R^2	0.11	0.09
N	164	164

Our estimation strategy treats wealth in 2002 as exogenous. One could argue that this is not really the case as households build into their life-cycle the possibility of the receipt of the age-pension and accumulate lower wealth to begin with. We present a lifecycle model to explore this in Section 5.

5 Benchmark Model

We consider a general equilibrium overlapping generations model populated by *ex ante* heterogenous agents. We explicitly model the tenure decision where individuals who wish to purchase a home must meet a down-payment requirement and pay a transaction cost that is proportional to the size of the house. Houses also have a minimum size.

5.1 Demographics

Each model period is calibrated to correspond to five years. Agents or households actively enter into working life at 20 (denoted as $j = 1$ in the model)[4] and live until 80 (denoted as $J = 13$), when he/she dies for certain. All agents enter their working life with zero financial asset and some positive transfers. Initially, an exogenous fraction o of the agents enter as homeowners with housing asset equal to minimum housing size, and the remaining *1-o* as renters. Agent work and receive earnings until the age of mandatory retirement denoted as j^*. Following each period after retirement, agents face a positive probability of dying. This is denoted by ν_j, which is the exogenously given survival probability at age $j + 1$ conditional on being alive at age j. The unconditional survival probability for an agent aged j is thus given by $\prod_{t=1}^{j} \nu_t$. Since death is certain after age J, $\nu_J = 0$. Upon death, household's net worth is seized away by the government and evenly re-distributed to all working households as transfers, T.

5.2 Technology

There is a representative firm producing an aggregate output good Y under the aggregate production function using aggregate capital stock K and aggregate labor input L:

$$Y = F(K, L) \tag{1}$$

The aggregate output can be either consumed or invested into business capital or housing capital. Let I^k and I^h denote the aggregate investment in business capital and housing capital, respectively. The aggregate resource constraint is:

$$Y = C + I^k + I^h + \Pi \tag{2}$$

[4] Age is indexed with subscript j and time is indexed with subscript t.

where C denotes aggregate consumption of non-housing goods and Π denotes the transaction costs incurred from the housing transactions. In addition, the business capital and the housing capital depreciate at a rate δ^k and δ^h, respectively.

5.3 Preferences

Agents derive utility from consumption of non-housing goods, c, and from the flow of services from housing stock, h, as well as from bequests, q, left upon death. Assuming agents derive utility from leaving a bequest (or 'warm glow' bequest motive) is a simple way to incorporate bequests into the model without introducing the complexities of strategies between parents and children. The service flow from housing, $f(h)$, is proportional to the housing stock, h. Following the set up by Platania and Schlagenhauf (2002) and Ortalo-Magné and Rady (2006), we assume that the utility derived from housing is higher for a homeowner than for a renter[5]. That is, renters ($I = 0$) will only derive a fraction $\lambda < 1$ of utility compared to a homeowner ($I = 1$) who has the same housing stock.

In order to capture the utility premium for homeownership, the utility function slightly differs from the standard CRRA type with homothetic aggregator between consumption of non-housing goods and housing services, given as follows:

$$U(c, f(h)) = \omega \frac{c^{1-\sigma_1}}{1-\sigma_1} + (1-\omega)\left[I \frac{f(h)^{1-\sigma_2}}{1-\sigma_2} + (1-I)\frac{(\lambda f(h))^{1-\sigma_2}}{1-\sigma_2} \right] \tag{3}$$

The parameter ω measures the relative importance of non-housing consumption to housing expenditures, and σ_1 and σ_2 are the curvature parameters with respect to non-housing and housing consumption[6]

As for the utility derived from leaving bequests, q, we incorporate a nonhomothetic bequest motive and follow the specification by De Nardi (2004) denoted as:

$$\varphi(q) = \varphi_1 \left[1 + \frac{q}{\varphi_2} \right]^{1-\sigma_2}$$

The term φ_1 reflects the parent's concern about leaving bequests to children, while φ_2 measures the extent to which bequest is a luxury good. The curvature parameter σ_2 is chosen to be

[5] Glaeser and Shapiro (2002) discuss the positive externalities of homeownership over renting in detail. Poterba (1992) details various tax benefits such as home mortgage interest deductions and tax deductions on the capital gains from selling the house. In addition, higher utility premium for homeowners incorporate the fact that housing can be used as an investment asset with possible capital gains, which is an aspect of housing the model abstracts from.

[6] The standard CRRA type commonly used in the literature is given as $U(c, f(h)) = \frac{\left[c^{\omega} f(h)^{1-\omega}\right]^{1-\sigma}}{1-\sigma}$. In the appendix, we discuss our justification for our choice of functional form with respect to the role of the utility premium as well as the ratio of housing services to non-housing consumption.

identical to the one chosen for housing consumption[7]. The remaining bequests are fully taxed by the government. Finally, the lifetime utility function can then be written as[8]:

$$E\left\{\sum_{j=1}^{J}\beta^{j-1}(\prod_{t=1}^{j}\nu_{t-1})[U(c_j,f(h_j))+(1-\nu_j)\varphi(q_j)]\right\}$$

5.4 Income Dynamics

Agents enter into the lifecycle either as a renter or a homeowner. Renters have zero financial or housing assets, whereas homeowners have zero financial assets but positive housing assets. During each period prior to the mandatory retirement age denoted as j^*, agents are endowed with one unit of time which they supply inelastically. Agents also face the same exogenous age-efficiency profile, ϵ_j, during their working years. This profile is estimated from the data and recovers the fact that productive ability changes over the life cycle. Each unit of effective labor is paid the wage rate w. Workers are also subject to stochastic shocks to their productivity level. These shocks are represented by a finite-state Markov process defined on $(Y, \mathcal{B}(Y))$ and characterized by a transition function Q_y, where $Y \subset R_{++}$ and $\mathcal{B}(Y)$ Borel algebra on Y. This Markov process is the same for all households. The total productivity of a worker of age j is given by the product of the workers' stochastic productivity in that period and the workers' deterministic efficiency index at the same age: $y_j\epsilon_j$. Working agents also pay taxes on their labor income. Upon retirement, households receive social security benefit for households aged j is denoted by:

$$b_j \quad = \quad \max\{0, \bar{b} + b_1(a_j - \bar{a})\} \tag{4}$$

where $\bar{b}$ is the replacement ratio for households with assets lower than the cut-off level of $\bar{a}$ and $b_1(< 0)$ is the taper ratio above the threshold cut-off. In addition, when the household dies and leaves bequests, the government collects the bequests and re-distributes equally to working households as transfers.

5.5 Housing and Tenure Choice

In every period, households decide whether to become a renter or a homeowner. A renter has the option to continue renting or to buy a house and become a homeowner. If the renter of age j decides to rent in the next period, a rental payment of p is paid per unit of housing service $f(h_{j+1})$, as well as a deposit, which is ι fraction of rental housing stock h_{j+1} is paid to the rental agency. The latter is returned to the renter with risk-free interest, r. The renter

[7]If $\sigma_1 > \sigma_2$, then increases in income will be spend disproportionately more on housing and bequests.
[8]Here, $\nu_0 = 1$

may also decide to become a homeowner and purchase a house with size h_{j+1}. By purchasing owner-occupied housing, the household pays a transaction cost proportional to the new housing property, $\phi^b h_{j+1}$. We assume that h_j is a measure of the size of the house which is proportional to its value (larger houses are more valuable).

We assume that the housing capital is not perfectly divisible, as we introduce a minimum size, $\underline{H}$, for owner-occupied housing, as was introduced in Gervais (2002) and Cocco (2005), among others. The constraint on minimum housing size is as follows:

$$h_j \quad \geq \quad \underline{H} \quad \forall j. \tag{5}$$

For renters, there is no such lower bound on the size of the rental property. A homeowner, on the other hand, can decide whether to keep the house or to sell and move. Homeowners also pay a maintenance cost equal to the level of depreciation, δ^h, in the period during which the house was owner-occupied. If the household sells the house, he can decide to buy a different-sized house or become a renter. Selling the house incurs a transaction cost equivalent to $\phi^s h_j$ and buying a new house incurs a transaction cost amounting to $\phi^b h_{j+1}$. In addition, the house can be used as collateral for homeowners to borrow up to a fraction, κ, of next period's housing value. As such, κ is the loan-to-value (LTV) ratio, and $1-\kappa$ is commonly known as the down payment ratio. The collateral constraint for household of age j is as follows:

$$a_{j+1} \quad \geq \quad -\kappa h_{j+1} \quad \forall j \tag{6}$$

where a_{j+1} is the financial net worth.

5.5.1 Rental Agency

The rental market in the economy is operated by a rental agency. Following Gervais (2002), this rental agency is a two-period lived institution which in the first period takes deposits from the homeowners, D_t, and buys rental properties denoted as S_t. Unlike business capital, which requires one period time-to-build constraint, the residential capital can be rented immediately upon purchase. The rental agency can instantly provide housing service to renters, receive rental payments, $pf(S_t)$, as well as rental deposits, ιS_t. In the next period, the agency earns interests on both the rental payments and the rental deposits. The agency uses its proceeds to pay for the depreciation costs of the rental properties and pay interest on the deposit. At the end of the second period, the existing institution sells the undepreciated part of the residential stock to a new institution. The problem of this rental agency is formulated as follows:

$$(7) \qquad \max_{S_t, D_t} \quad (1+r)(pf(S_t) + \iota S_t) - (1+r)\iota S_t - \delta^h S_t - rD_t$$
$$\text{subject to}$$
$$S_t \leq D_t$$

For this maximization problem to be well defined, the following no-arbitrage condition needs to be satisfied in a stationary equilibrium with constant prices:

$$(8) \qquad (1+r)p = \delta^h + r \qquad \text{or} \qquad p = \frac{\delta^h + r}{1+r}$$

Here, p denotes the price paid per unit of rental service flow. In addition, given the interest rate and the depreciation rate, the price of a rental unit is uniquely determined, as the derivation of this rental price comes from equating the marginal rate of substitution between housing and non-housing consumption to the user-cost for housing service.

5.6 The Household's Recursive Problem

This subsection describes the recursive problem faced by the households in different states. The state space is a set $x = \{j, h, a, I, y\}$, where j is the age of the household, h is the stock of housing, a is the financial net worth carried from the previous period, I is the tenure status of the household in the current period, and y is the exogenous productivity process.

In every period, working households receive labor earnings net of social security payroll taxes, $(1-\tau)w\epsilon y$. If the households are retired, on the other hand, they receive pension benefits b. We use the indicator I^w to distinguish working ($I^w = 1$) versus retired ($I^w = 0$) households.

Given the housing tenure status, homeowners decide whether to stay in the current property, move to a different sized property, or become renters, whereas renters decide to stay as renters or become homeowners. Incorporating the tenure decision, the value function for a household depends on the tenure choice decision made in the next period, where V^c, V^k, V^r are, respectively, the value functions of changing the house or becoming a homeowner, keeping the house, and renting next period:

$$(9) \qquad V(x) = \max\left\{V^c(x), V^k(x), V^r(x)\right\}$$

5.6.1 Homeowner changing the house or renter buying a house: V^c, $I' = 1$

In the beginning of period, homeowners have a position on the housing capital net of maintenance costs and transaction costs for selling, $(1 - \delta^h - \phi^s)h$. Renters receive the security deposit paid in the last period with an interest payment, $(1+r)\iota h$. Households also receive realized riskfree returns on their financial assets. Given the available resources, the household then chooses consumption of non-housing goods, c, next period financial net worth, a', and buys a new house with transaction costs, $(1+\phi^b)h'$. In the case that the retired households do not survive until the next period, all their assets (housing and financial) are left as a bequest. If the household chooses to stay as a homeowner, the minimum housing size constraint holds, and the household can borrow up to a certain fraction of the value of the house, with the house as collateral. The problem for homeowners changing their housing size or renters buying a house can be formed recursively as follows:

$$\begin{aligned}
V^c(j,h,a,I,y) &= \max_{c,h',a'} \; [U(c,f(h)) + \nu\beta E(V(j+1,h',a',I'=1,y')) + (1-\nu)\varphi(q)] \\
&\text{subject to} \\
c + a' + (1+\phi^b)h' &\leq I^w\{(1-\tau)\omega\epsilon y + T\} + (1-I^w)b_j + (1+r)a + (1-I)(1+r)\iota h + I(1-\delta^h-\phi^s)h \\
(10) \qquad c &\geq 0 \\
(11) \qquad q &= a' + h' \\
\text{and} \quad & (5),(6)
\end{aligned}$$

5.6.2 Homeowner maintaining existing house: V^k, $(I, I') = (1,1)$

In the beginning of period, homeowners have a position on the housing capital net of maintenance costs, $(1-\delta^h)h$, and receive financial net worth with realized riskfree returns, $(1+r)a$. Given the available resources, the household then chooses consumption of non-housing goods, c, next period financial net worth, a', and maintains the same housing size ($h' = h$).

$$\begin{aligned}
V^k(j,h,a,I=1,y) &= \max_{c,h',a'} \; [U(c,f(h)) + \nu\beta E(V(j+1,h'=h,a',I'=1,y')) + (1-\nu)\varphi(q)] \\
&\text{subject to} \\
c + a' + h' &\leq I^w\{(1-\tau)\omega\epsilon y + T\} + (1-I^w)b_j + (1+r)a + (1-\delta^h)h \\
\text{and} \quad & (5),(6),(10),(11)
\end{aligned}$$

5.6.3 Becoming a renter: V^c, $I' = 0$

In the beginning of period, homeowners have a position on the housing capital net of maintenance costs and transaction costs for selling, while renters receive the security deposit paid in the last period with interest payment. The household then chooses consumption of non-housing goods, c, next period financial net worth, a', pays rent, which is priced at p per unit of rental service flow $f(h')$, and pays security deposit which is ι fraction of the housing stock, $\iota h'$[9]. As the household

[9] The notion of a security deposit is used to keep track of the housing stock which will be a state variable.

becomes a renter, the household cannot to borrow.

$$
\begin{aligned}
V^c(j,h,a,I,y) &= \max_{c,h',a'} \; [U(c,f(h)) + \nu\beta E(V(j+1,h',a',I'=0,y')) + (1-\nu)\varphi(q)] \\
\text{subject to} & \\
c + a' + pf(h') + \iota h' &\leq I^w\{(1-\tau)\omega\epsilon y + T\} + (1-I^w)b_j + (1+r)a + (1-I)(1+r)\iota h + I(1-\delta^h-\phi^s)h \\
c, a' &\geq 0 \\
q &= a' + \iota h'
\end{aligned}
$$

5.7 Definition of a stationary equilibrium

A stationary equilibrium is given by a set of government policy arrangements $\{\tau, b, T\}$; a set of prices $\{p, r, w\}$; value functions $V(x)$; and allocations $c(x), a'(x), h'(x)$; a time-invariant distribution of agents over the state variables $x = \{j, h, a, I, y\}$, $m^*(x)$; and aggregate quantities $\{Y, C, H, K, L, S, D\}$ such that given prices and the government policies:

(i) the functions $V(x), c(x), a'(x), h'(x)$ solve the maximization problem of the households given in section (5.6).

(ii) factor prices are equal to their marginal products:

(iii) government policies satisfy:

$$
\int_{j<j^*} \tau w L \, m^*(dx) = \int_{j\geq j^*} b_j \, m^*(dx)
$$

(iv) $\{S, D\}$ solves the rental agency's problem given in (7).

(v) m^* is the invariant distribution of households over the state variables.

(vi) all markets clear.

$$
\begin{aligned}
K &= \int a \;\, m^*(dx) - D \\
H &= \int h \;\, m^*(dx) - S \\
L &= \int \epsilon y \;\, m^*(dx) \\
S &= \int_{I=0} h \;\, m^*(dx) \\
S &= D \\
Y &= C + \delta^k K + \delta^h H + \delta^h S + \Pi \;\text{ where }\; \Pi = (\phi^s + \phi^b)H
\end{aligned}
$$

6 Calibration

The set of parameters will be divided into those that can be estimated independently of the model or are based on the estimates provided by other literature and data, and those that are chosen such that the predictions generated by the model can match a given set of targets. All parameters were adjusted to the five year span that each period in the model represents. For the first group of calibrated parameters, Table 5 lists the parameters provided by other literature and data.

Regarding the preference parameters, while standard CRRA type utility function assumes that $\sigma_1 = \sigma_2$, it is not consistent with the data evidence that income increases are more likely to be consumed in housing as opposed to consumption. Different values for σ_1 and σ_2 could take into account the non-linearity of housing to non-housing consumption ratio. A similar approach has been taken in Chambers, Garriga, and Schlagenhauf (2008) to match the observed ratio of housing to non-housing consumption goods as income grows. We take $\sigma_1 = 2$, which falls in the range commonly used in the macroeconomics literature (1-3), and $\sigma_2 = 1.5$ to take into account the non-linearity of non-housing consumption to housing consumption and bequest.

For the bequest parameters, ϕ_1 and ϕ_2, the values are taken from De Nardi (2004), which matches the wealth distribution in the United States. For λ, which measures the degree of households' preference for homeownership over renting, we choose a value of 0.6, similar to the value used in Platania and Schlagenhauf (2002). For all the preference parameters, we conduct sensitivity analyses to test the robustness of our choice of parameter values.

In the aggregate production function, we use the national accounts data for periods 1960 to 2007 to find the share of income attributed to physical capital, α, at 26.4%, while the annual depreciation rate of the capital stock and the housing stock are 10.3% and 6.1%, respectively. For the transaction cost parameters, ϕ^s and ϕ^b, I assume the selling and buying transaction costs to be 6% and 2% of the property value, respectively, which are reasonable values chosen in the housing literature. We take the average loan-to-value ratio,κ, to be 75%. The implied average down-payment requirement is 25 percent, which is consistent with the number used in Chiuri and Jappelli (2003).

The logarithm of the stochastic productivity process is assumed to be an AR(1) following Huggett (1996).

$$\ln y_t = \rho \ln y_{t-1} + \mu_t \tag{12}$$

The disturbance term μ_t is normally distributed with mean zero and variance σ_y^2. The persistence parameter ρ is taken from De Nardi (2004), while the variance σ_y^2 is chosen to match

Table 5 Parameter Definition and Values

	PREFERENCE	
σ_1	Risk-aversion coefficient (non-housing)	2
σ_2	Risk-aversion coefficient (housing & bequest)	1.5
ϕ_1	Bequest parameter	-9.5
ϕ_2	Bequest parameter	11.6
λ	Utility premium	0.6
	TECHNOLOGY	
α	Capital income share	0.264
δ^h	Housing depreciation rate	6.1%
δ^k	Business capital depreciation rate	10.3%
ϕ^s	Selling transaction cost	6%
ϕ^b	Buying transaction cost	2%
κ	Loan-to-value ratio	75%
	STOCHASTIC PROCESS	
ρ	Persistence of income process	0.85
σ_y^2	Innovation of income process	0.35
	DEMOGRAPHICS	
j^*	Retirement age	65
ν_j	Survival probability	ASB Life Table
ϵ_j	Age-efficiency profile	Hansen (1993)
o	Homeownership ratio for 20-25 year old	14%
τ	Payroll tax rate	21.1%

the Gini coefficient for earnings[10]. The productivity shocks are discretized into a four-state Markov chain according to Tauchen and Hussey (1991), with the shocks taking values given by $\{0.3253, 0.6877, 1.4541, 3.0742\}$, and the transition matrix Q_y given by:

$$\left\{ \begin{array}{cccc} 0.6217 & 0.3029 & 0.0702 & 0.0052 \\ 0.2585 & 0.4255 & 0.2618 & 0.0542 \\ 0.0542 & 0.2618 & 0.4255 & 0.2585 \\ 0.0052 & 0.0702 & 0.3029 & 0.6217 \end{array} \right\}$$

For retirement benefits, we use the Centrelink 2007 data to set the maximum annual age pension benefit to be \$23,754. For homeowners, every additional dollar above the threshold asset level of \$243,000 reduces the pension benefit by 3.87 cents, while for renters, the threshold asset level is \$368,000. For homeowners with assets above \$856,000 and renters with assets above \$981,000, there is no pension benefit. Equations 13 and 14 summarize the age pension plan for homeowners and renters with all units normalized by the annual average household labor earnings set at \$30,000, which is around 60% of the average household income (\$50,659) in the 2002 HILDA survey. Since we assume that the government balances its budget, the resulting payroll tax rate on working households is endogenously determined at 21.1%.

$$b = \begin{cases} 0.79 & \text{if } a \leq 8.1 \\ 0.79 - 0.0387(a - 8.1) & \text{if } 8.1 \leq a \leq 28.5 \\ 0 & \text{if } a \geq 28.5 \end{cases} \tag{13}$$

$$b = \begin{cases} 0.79 & \text{if } a \leq 12.3 \\ 0.79 - 0.0387(a - 12.3) & \text{if } 12.3 \leq a \leq 32.7 \\ 0 & \text{if } a \geq 32.7 \end{cases} \tag{14}$$

For demographics, the deterministic age-efficiency profile ϵ_j, is calculated from the estimate of the mean age-income profile from Hansen (1993). For lifetime uncertainty, the conditional survival probabilities for the retired households aged 65 and above are taken from the Australian Bureau of Statistics Life Table 2003-2005. We take exogenously the fraction of homeowners for the households entering into the life cycle at 14%, taken from HILDA 2002 data.

The next three parameters are jointly chosen such that the predictions generated by the model can match a given set of aggregate ratios as shown in Table 6. First we take the discount factor, β, to match the capital-output ratio, which is 3.25 averaged over the period 1960-2007. Here, capital is defined as the sum of physical and housing capital. The physical capital stock is the sum of private and government non-residential fixed assets and inventories, while the housing capital

[10]The model implied Gini coefficient for earnings is 0.419, which is very close to 0.42 taken from OECD 'Levels and trends in the Gini coefficient of market income inequality among the working-age population' (http://www.oecd.org/dataoecd/48/9/34483698.pdf)

stock comprises residential fixed assets. Output is defined as the gross domestic product minus the expenditure on housing services. The second target ratio is the aggregate homeownership ratio, which for Australia, the average homeownership ratio is around 68%. We use the minimum housing size parameter, $\underline{H}$, to match the aggregate homeownership ratio[11]. The implied value for the minimum housing size is 0.95 times the average labor income. The third target ratio is the ratio of housing stock to non-housing consumption expenditure in the National Accounts data. Non-housing consumption expenditure is defined as the sum of personal consumption expenditure, excluding the expenditure on housing services, and government expenditure. In the model, the ratio corresponds to $\frac{H}{C}$, which is 1.332. We use the preference parameter ω, which is the weight of housing to non-housing consumption in the utility function, to match this target ratio.

Table 6 Parameters to Match Target Ratios

Parameters	Definition	Value
β	Discount factor	0.954
$\underline{H}$	Minimum housing size	0.95
ω	Share of non-housing consumption	0.93

7 Benchmark Results

In this section, the results from the benchmark simulation are presented and the fit of the model is evaluated along the dimensions not specifically matched by model construction such as age-wealth profile and wealth distribution. The aggregate statistics of the benchmark simulation as well as the empirical counterparts for Australia are presented in Table 7. The benchmark simulation well matches the aggregate data in terms of the capital output ratio, homeownership ratio, and ratio of housing to non-housing consumption well. The model also gives the ratio for the fraction of total wealth held in housing ($\frac{H}{H+K}$)to be 34%, which is close to the data counterpart of 30%.

7.1 Aggregate and Life Cycle Profiles

We also construct the life cycle profiles of net worth, wealth portfolio (housing vs. financial assets) and homeownership for an average household from the simulation. The net worth is defined as the sum of the financial net worth, housing asset, and transfers. Figure 3 and Figure 4 depict the profile of assets and homeownership rates over the life cycle, respectively. With a

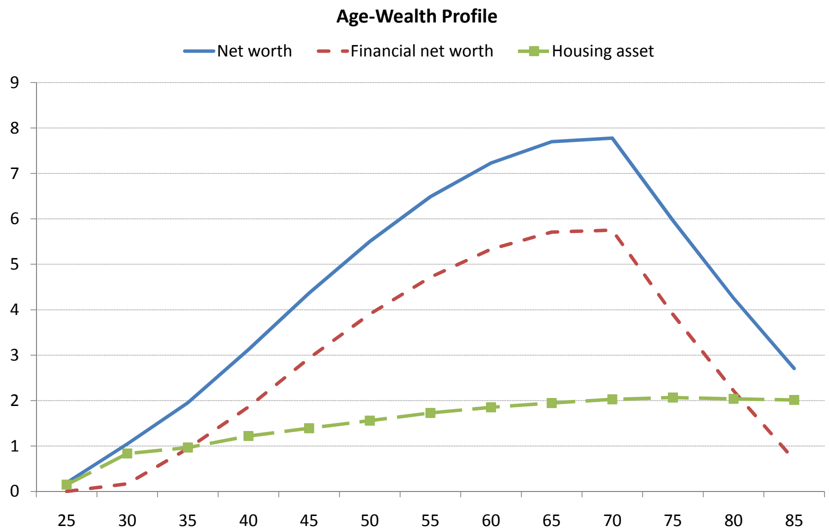
[11]Here, the unit of normalization is the average labor income.

Table 7 Aggregate Statistics for Benchmark Simulation

	Benchmark Simulation	Data
Capital Output Ratio ($\frac{H+K}{Y}$)	3.26	3.25
Homeownership Ratio	68.3%	68%
Housing to Non-housing Consumption ($\frac{H}{C}$)	1.325	1.332

bequest motive, the model is able to generate sufficient wealth (and financial assets) at advanced ages, which matches the data counterpart shown in Figure 1. The model also captures the profile of the housing assets observed in the data with rapid accumulation early in life and almost no downsizing after retirement. The former is attributed to the role of housing as collateral whereas the latter is explained by the existence of transaction costs and the fact that some older households take on reverse mortgage and assume debts. For the age profile of homeownership, the model replicates the hump-shaped profile of homeownership over the life cycle.

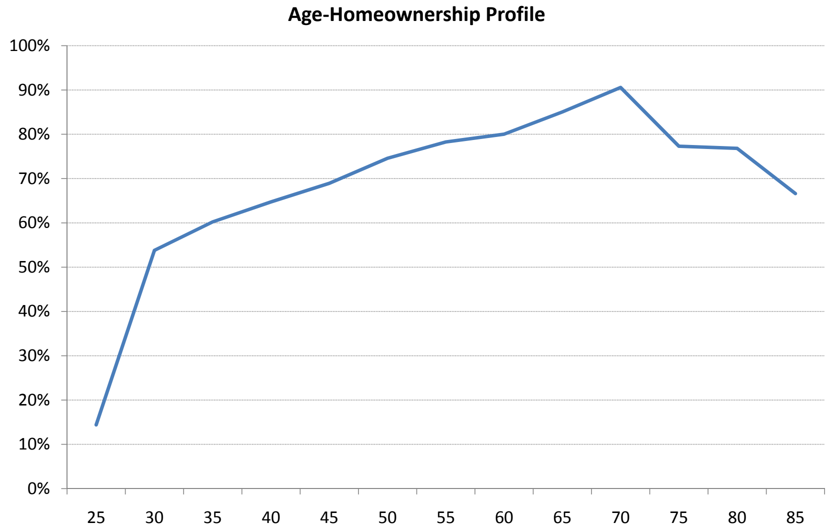
Figure 3 Life Cycle Profile of Assets



7.2 Distribution of Wealth

In this section, we look at the model implied summary statistics on the distribution of wealth summarized in Table 8. The model produces an exact match of the data counterpart in terms of the Gini coefficient of net worth. As for the skewness of the wealth distribution, while the model does not produce sufficient heterogeneity in the upper tail of the distribution, it matches well in the wealth held by the top 20% and the bottom 50% of the distribution as well as the interquartile ratio. The fact that the model produces a well-fitted distribution of wealth comes

Figure 4 Life Cycle Profile of Homeownership



from the idiosyncratic shocks to productivity during the working life as well as introducing a bequest motive during retirement.

Table 8 Percentage wealth held by different percentiles and Gini coefficients

Percentile	Benchmark Simulation	HILDA 2002
Top 5%	23%	31%
Top 10%	40%	45%
Top 20%	63%	63%
Bottom 50%	7%	9%
Gini - Net worth	60.7	61
Interquartile ratio ($\frac{75}{25}$)	8.72	9.6

8 Policy Experiments

In this section we consider the effect of changing the age pension benefit plan. First, we explore the possibility of including housing asset as part of the means-testing scheme. We look at the case where we apply the same taper rate on both financial and housing assets ($b_2 = b_1$) and another case where we apply a lower taper rate on housing ($|b_2| < |b_1|$) than on financial assets. We also look at the case of lowering the taper rate to 1.5% to reflect the recent policy changes to the age pension benefit, effective March 2009. Second, we look at the case of eliminating the means-testing scheme and providing a constant pension benefit to retired households. To keep the revenue-neutrality condition, we look at one scenario where the payroll tax rate is kept at the same rate as the benchmark case (21.1%), and another scenario where the level of pension benefit is fixed to the benchmark level (79% of average household labor income).

8.1 Reforming the Means-Testing

We first look at the implication of including housing assets to the current means-testing scheme and keeping the current pension benefit level. One option is to take the taper rate on housing asset to be identical to the financial asset ($b_1 = b_2$), while the other option is to apply the taper rate on housing to be half the rate on financial asset ($|b_2| = 0.5 \times |b_1|$). Another interesting option is to keep the current means-testing scheme but lower the taper rate to 1.5% to reflect the recent policy changes to the age pension benefit effective March 2009. We assume that the government adjusts the payroll tax rates to keep its revenue neutrality. The changes in the aggregate statistics as well as the interest rate are reported in Table 9.

Table 9 Reforming the Means-Testing - Aggregate Statistics

	Benchmark	$b_1 = b_2$	$\lvert b_2\rvert = 0.5 \times \lvert b_1\rvert$	Lower taper rate
$\frac{K+H}{Y}$	3.26	3.23	3.24	3.29
Homeownership ratio	68.3	68.9	68.4	68.3
$\frac{H}{C}$	1.33	1.307	1.315	1.312
$\frac{H}{K+H}$	34.1%	34.0%	34.0%	33.4%
r	3.4%	3.5%	3.5%	3.3%
τ	21.1%	20.8%	20.9%	21.2%

From Table 9, we see that the aggregate implications of changes to the current means-testing pension scheme are not large. Including housing assets into the means-testing reduces overall wealth accumulation and lowers housing to non-housing consumption ratio. As exemption of housing into means-testing acted as a wedge on the portfolio choice between financial and housing assets, the fraction of wealth held in housing decreases. As the pension benefit level decreases, the payroll tax rate is also reduced. For lowering the taper rate from 3.9% to 1.5%, we see higher wealth accumulation associated with a lower interest rate. As pension benefit is higher for partial pensioners, the payroll tax rates must rise to keep the government revenues neutral. Homeownership remains mostly unchanged due to the fact that the current means-testing scheme already applies different threshold for homeowners versus renters. Lowering the taper rate on the current scheme provides larger pension benefit to the retirees and increases the wealth accumulation in the economy. Lower taper rate on the financial assets also provide an incentive to hold more financial assets, thus reducing the fraction of wealth held in housing assets. This is shown by a decrease in both the ratio of housing to non-housing consumption as well as the fraction of total wealth held in housing.

We also report how the lifecycle profiles of wealth and homeownership in Figures 5 to 7. Figure 6 compares how the accumulation of housing assets change when we include housing into the means-testing scheme. With inclusion of housing into means-testing, we note that the housing profile peaks earlier and remains lower than the benchmark scenario, which implies that the current means-testing scheme induces households to over-accumulate housing. Under the benchmark scenario, households accumulate housing assets until the age of 70-75 with little de-cumulation afterwards. However, when housing is included, the housing accumulation peaks earlier around the age of 60-65 and decreases afterwards. During retirement, compared to when housing is not included (as in the current system), the profile of housing assets is lower by a margin of 3% for cohorts aged between 65 and 70 to 7% for cohorts aged between 75 and 85. On average, the average housing asset is around 6% lower during retirement when the means-testing incorporates both financial and housing assets. Changes to the means-testing scheme also affects the tenure decision of households aged 60 and above. For households entering into retirement, the period in which homeownership peaks, the average homeownership is around 86.8% when housing is included in the means-testing. This is 3.8% points lower than the benchmark case where means-testing excludes owner-occupied housing assets.

Figure 5 Life Cycle Profile of Assets

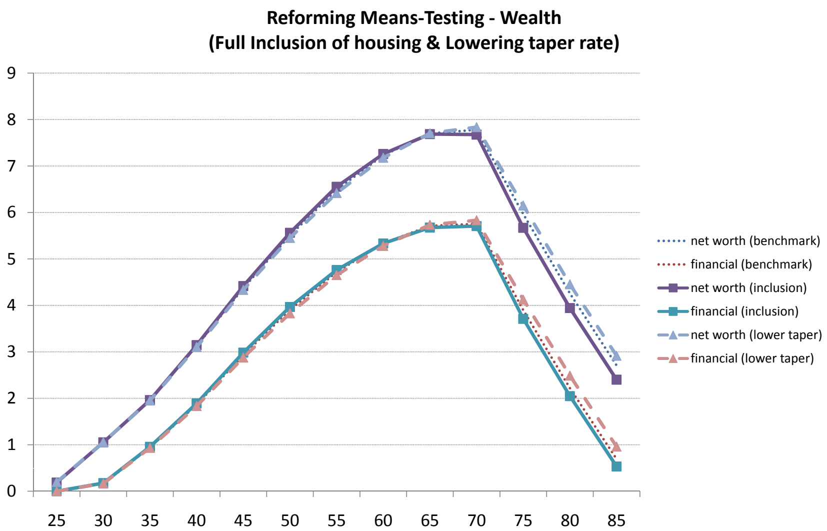


Figure 6 Life Cycle Profile of Housing

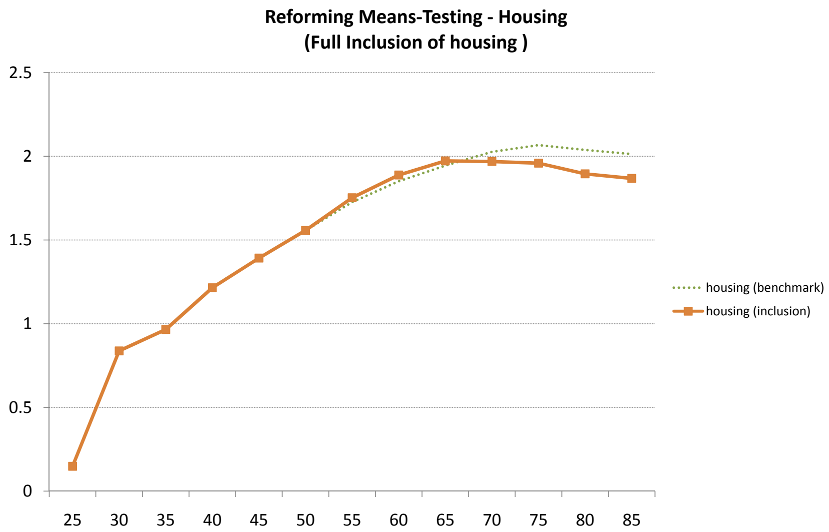
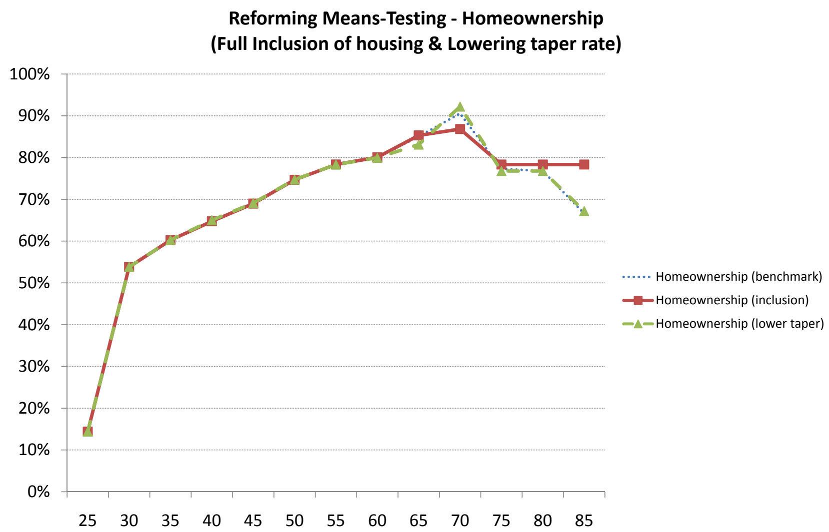


Figure 7 Life Cycle Profile of Homeownership



8.2 Constant pension benefit

We also explore possible implications of eliminating the current means-testing scheme with a constant pension benefit scheme. One option for the government is to provide full benefit (79% of average household earnings) to all retired households and adjust payroll tax rates to fund the pension scheme (labelled as 'tax-adjusted'). The resulting payroll tax rate is 21.9%, which is 0.8% points higher than the benchmark case. The other option for the government is to fix the payroll tax rate to the benchmark level at 21.1% and adjust the constant benefit level (labelled as 'benefit adjusted'). This results in the constant benefit level to be 76.1% of average household earnings, which is 2.9% points lower than the benchmark full benefit level. The changes in the aggregate statistics as well as the interest rate are reported in Table 10. Whether the tax is adjusted or the benefit is adjusted to keep the tax rate fixed, we note introducing a constant benefit scheme increases the overall wealth accumulation associated with a lower interest rate, increases homeownership, lowers the fraction of housing to non-housing consumption, and the fraction of housing in the total wealth.

Table 10 Constant pension benefit

	Benchmark	Tax-adjusted	Benefit-adjusted
$\frac{K+H}{Y}$	3.26	3.34	3.36
Homeownership ratio	68.3	70.9	69.3
$\frac{H}{C}$	1.33	1.32	1.31
$\frac{H}{K+H}$	34.1%	32.3%	32.3%
r	3.4%	3.0%	2.9%

We also report how the lifecycle profiles of wealth and homeownership are affected for the average household as shown in Figure 8 and 9.

Figure 8 Life Cycle Profile of Assets

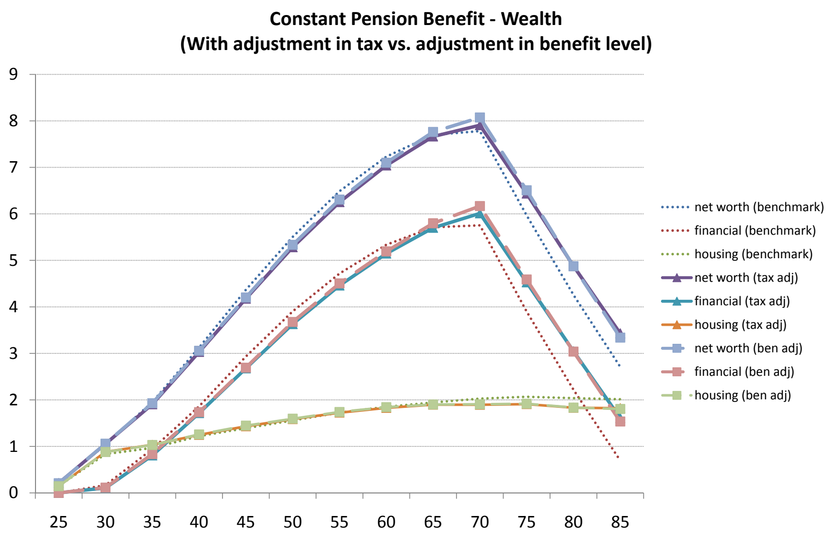
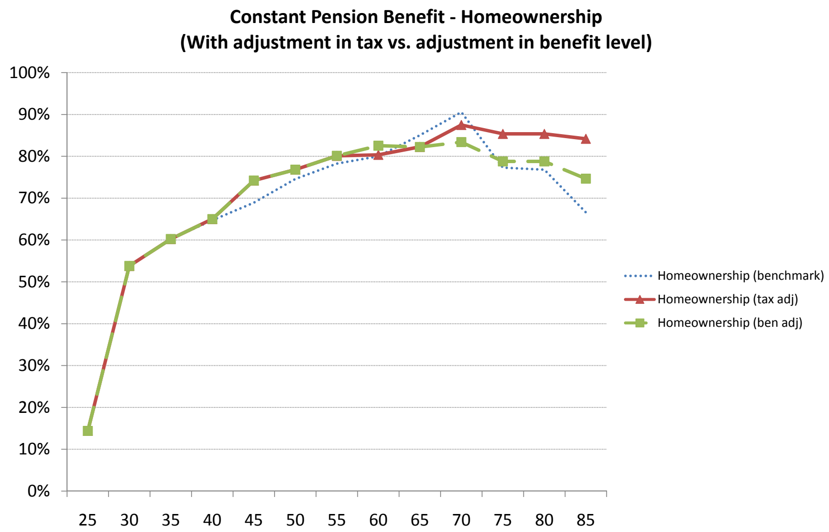


Figure 9 Life Cycle Profile of Homeownership



9 Sensitivity Analysis

In this section, the robustness of the main findings in the benchmark economy to the choice of key parameters are scrutinized. We specifically look at the utility premium parameter for homeownership (λ), bequest parameters (ϕ_1, ϕ_2), and the relative risk aversion parameters (γ_1, γ_2), and how the benchmark results would change to the different choice of these individual parameter values. Other calibrated parameters are kept fixed to the benchmark experiment.

9.1 Homeownership premium - λ

In this section, we vary λ between 0.4 and 0.8. (Benchmark is 0.6) Since λ governs the degree in which households prefers homeownership to renting, a lower value of λ implies higher benefit for homeownership over renting. While this utility premium parameter does not affect the overall wealth level in the economy, it affects the aggregate homeownership ratio as well as the ratio of housing to non-housing consumption, which is shown in Table 11. On average, a 1 percentage point increase in λ lowers the homeownership ratio by 0.45% points as well as lowering the housing to non-housing consumption ratio by 0.45.

9.2 Bequest parameters - ϕ_1, ϕ_2

Bequest motive plays a strong role in the accumulation of wealth during retirement and the fact that households do not decumulate all their wealth by the end of their lifecycle. We look at the

Table 11 Sensitivity Analysis - λ

λ	Homeownership ratio	$\frac{H}{C}$
0.40	80.1%	1.44
0.44	78.5%	1.43
0.48	75.8%	1.40
0.52	74.9%	1.39
0.56	72.9%	1.37
0.60	68.3%	1.33
0.64	67.5%	1.31
0.68	66.9%	1.30
0.72	64.4%	1.29
0.76	63.2%	1.27
0.80	63.5%	1.27

case of no bequest motive ($\phi_1 = 0$), different degrees of bequest strength ($\phi_1 = -5, -15$), as well as different degrees in which bequest is considered as a luxury good ($\phi_2 = 5, 15$). As expected, lower bequest motive produces a faster decumulation of wealth during retirement, resulting in a lower capital-output ratio, homeownership ratio, and the fraction of housing to non-housing consumption ratio. As for the age profile of wealth, bequest motive plays a large role in the level of retirement wealth. Compared to the benchmark case ($\phi_1 = -9.5$, $\phi_2 = 11.6$), the retirement wealth under no bequest motive is lower by a margin of 13%. Bequest parameters also play a role in the homeownership ratio over the lifecycle. In the case of no bequest motive, the absence of transfer to younger household implies a lower transition from renting to homeownership. For age groups of 20-35, the homeownership is lower than the benchmark scenario by a margin of 13 percentage points. In addition, a lower level of retirement wealth implies lower homeownership level, with the homeownership ratio decreasing by a margin of 8 percentage points compared to the benchmark case. We provide aggregate statistics as well as life cycle profiles of wealth and homeownership in Table 12.

9.3 Risk aversion parameters - γ_1, γ_2

γ_1 and γ_2 governs the curvature of the profiles of the non-housing and housing consumption, as well as bequest. We look at three different possible combination of the preference parameters. (Benchmark is $\gamma_1 = 2$, $\gamma_2 = 1.5$, where γ_2 is applied to housing expenditure as well as bequest function.)

First, we lower the curvature parameter for non-housing consumption from 2 to 1.5. This results in a lower wealth accumulation as well as lower ratio of housing to non-housing consumption. For the life cycle profile of homeownership, homeownership no longer shows a hump shaped

Table 12 Sensitivity Analysis - ϕ_1, ϕ_2

	Benchmark	$\phi_1 = 0$	$\phi_1 = -5$	$\phi_1 = -15$	$\phi_2 = 5$	$\phi_2 = 15$
$\frac{K+H}{Y}$	3.26	3.12	3.17	3.42	3.47	3.22
Homeownership ratio	68.3	59.8	60.6	74.0	73.2	60.5
$\frac{H}{C}$	1.33	1.25	1.27	1.40	1.40	1.27
Average Wealth						
20-35	1.06	1.12	1.12	1.07	1.03	1.12
35-50	4.33	4.47	4.43	4.13	4.04	4.41
50-65	7.14	7.17	7.17	7.09	7.09	7.24
65-85	5.18	4.53	4.78	5.86	6.11	5.03
Average Homeownership						
20-35	42.8	29.4	31.0	42.8	42.8	31.0
35-50	69.4	63.9	64.2	79.2	80.7	64.2
50-65	81.1	74.1	74.4	92.4	85.8	74.5
65-85	77.8	69.5	70.5	79.9	81.9	70.1

pattern but an increases over the life cycle. Second, we raise the curvature parameter for housing consumption from 1.5 to 2, which results in higher wealth accumulation as well as an increase in overall homeownership ratio and the fraction of housing to non-housing consumption. Finally, while the curvature parameter for the bequest function was chosen to be the same as the parameter for housing expenditure (γ_2), we look at the case when the curvature parameter for the bequest function takes the same value as the parameter for non-housing expenditure (γ_1). This results in higher wealth accumulation but lower homeownership ratio in the aggregate. Higher capital output ratio is attributed to the increase in the average retirement wealth.

10 Conclusion

It is important to note that the model abstracts from several important issues. In terms of modelling housing market, the model abstracts from housing price fluctuations, which has an impact on the size of the debt leverage as well as the distribution of wealth, as well as various preferential tax treatment of owner-occupied housing, such as the untaxed nature of imputed rent and capital gains tax provisions. As for the means-testing, the current system also incorporates income levels, which we have abstracted in the current paper, which might have implications on our results. We leave these issues for future extensions in the research frontier.

TO BE CONCLUDED

Table 13 Sensitivity Analysis - γ_1, γ_2

	Benchmark	$\gamma_1 = 1.5$	$\gamma_2 = 2$	$\gamma_q = 2$
$\frac{K+H}{Y}$	3.26	3.04	3.47	3.49
Homeownership ratio	68.3	66.7	84.3	64.6
$\frac{H}{C}$	1.33	1.19	1.73	1.35
Average Wealth				
20-35	1.06	1.04	1.18	1.09
35-50	4.33	4.10	4.46	4.17
50-65	7.14	6.80	7.37	7.23
65-85	5.18	4.73	5.51	6.22
Average Homeownership				
20-35	42.8	40.8	50.6	40.8
35-50	69.4	67.0	91.9	67.0
50-65	81.1	78.0	98.0	76.8
65-85	77.8	78.8	94.6	72.3

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Appendix

Optimal Consumption Ratios under different social security rules

This section looks at how the optimal consumption of housing and non-housing goods would change under the different social security rules. Here, the social security benefit rule is denoted by $b_t = b_1 + b_2 a_t + b_3 h_t$, and we look at three possible situations as shown below:

1. Constant benefit scheme: $b_1 > 0$, $b_2 = b_3 = 0$.
2. Means-testing on total assets: $b_1 > 0$, $b_2 = b_3 < 0$.
3. Means-testing on financial assets: $b_1 > 0$, $b_2 < 0$, $b_3 = 0$.

Consider the case of retired homeowners changing the housing next period $(t+1)$ (corresponding to the value function V_c). For simplicity, I assume that there is no transaction cost. Using the functional form for the instantaneous utility function and the 'warm-glow' bequest function, the household problem can be written as follows:

$$\max_{c_t, h_{t+1}, a_{t+1}} \quad E\left\{\sum_{t=1}^{T} \beta^{t-1}(\prod_{j=1}^{t} s_{j-1})[U(c_t, f(h_t)) + (1-s_j)\varphi(q_{t+1})]\right\}$$

subject to

$$\begin{aligned} c_t + a_{t+1} + h_{t+1} &\leq b_t + (1+r_t)a_t + (1-\delta^h)h_t \\ c_t &\geq 0 \\ a_{t+1} &\geq -\kappa h_{t+1} \\ q_{t+1} &= a_{t+1} + h_{t+1} \\ h_{t+1} &\geq \underline{H} \\ f(h_t) &= I_t h_t + (1-I_t)\lambda h_t \\ b_t &= b_1 + b_2 a_t + b_3 h_t \end{aligned} \tag{15}$$

Since the household is retired, there is no stochastic shocks to productivity. Assuming interior solution and taking first order conditions with respect to c_t, c_{t+1}, a_{t+1} and h_{t+1}, gives the following equations:

$$
\begin{array}{llll}
(16) & c_t & : & \beta^t (c_t^{1-\omega} h_t^{\omega})^{-\gamma} h_t^{\omega} (1-\omega) c_t^{-\omega} = \mu_t \\
(17) & c_{t+1} & : & s_t \beta^{t+1} (c_{t+1}^{1-\omega} h_{t+1}^{\omega})^{-\gamma} h_{t+1}^{\omega} (1-\omega) c_{t+1}^{-\omega} = \mu_{t+1} \\
(18) & a_{t+1} & : & (1-s_t)\varphi'(q_{t+1}) - \mu_t + (1 + r_{t+1} + b_2)\mu_{t+1} = 0 \\
(19) & h_{t+1} & : & s_t \beta^{t+1} (c_{t+1}^{1-\omega} h_{t+1}^{\omega})^{-\gamma} h_{t+1}^{\omega-1} \omega c_{t+1}^{1-\omega} + (1-s_t)\varphi'(q_{t+1}) - \mu_t + (1 - \delta^h + b_3)\mu_{t+1} = 0
\end{array}
$$

Proposition 1. *Housing service consumption is higher under Plan 2 (means-testing on financial asset only) than other social security plans.*

Proof. Re-arranging the first order conditions, we get

$$
\frac{h_{t+1}}{c_{t+1}} = \frac{1-\omega}{\omega} \frac{1}{r + \delta^h + b_2 - b_3}
$$

Under the constant benefit (plan 1), $b_2 = b_3 = 0$ and under the means-testing on total assets (plan 3), $b_2 = b_3$. Thus, the right hand side of the equation collapses to $\frac{1-\omega}{\omega}\frac{1}{r+\delta^h}$. However, when social security benefit depends on the level of financial assets only, then $b_3 = 0$ while $b_2 < 0$. This leads to $\frac{1-\omega}{\omega}\frac{1}{r+\delta^h-b_2}$. Since $b_2 < 0$, the relative housing consumption will be higher under this social security scheme. $\square$