Retirement Eggs and Retirement Baskets

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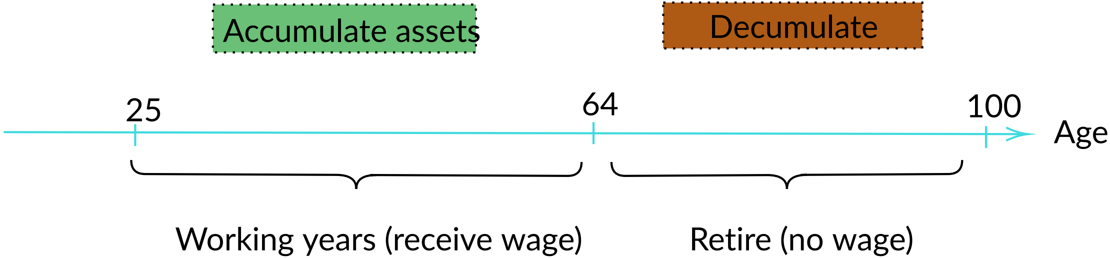
Introduction

How do people save over their lifetime?

Hump shaped accumulation

Standard lifecycle accumulation follows hump shape



Saving motives

Saving motivated by:

- Consumption smoothing (Modogliani, 1986)
- Bequests (Kotlikof and Summers, 1981)
- Precautionary saving (Gounchiars and Parker, 2002; Aiyagari, 1994)

Mediating factors: job tenure & mobility, investment returns, preference heterogeneity, lifetime earning dynamics more generally

From overall wealth levels to portfolio allocation

Significant advantages to accumulating wealth via portfolios with different compositions

Role of private pensions in the provision of retirement income

Worldwide shift from defined benefit (DB) to defined contribution (DC)

Quality of people's portfolios bearing increasing weight on old age savings adequacy

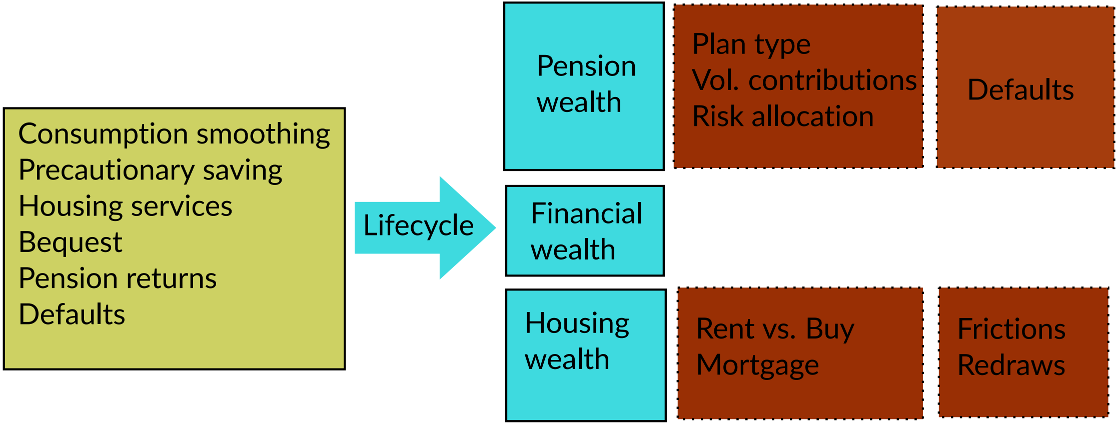
Our research question

How do

1. standard saving motives,
2. pension choices,
3. investment returns,
4. preferences & frictions

interact to drive lifetime savings across all main asset classes?

Retirement eggs and baskets



Policy relevance

Why understand lifecycle asset allocation?

- Adequate welfare programs require adequate understanding of how people accumulate wealth
- Macroeconomic composition of capital in turn affects asset returns, housing prices, rental yields, financial stability (Eckardt et al., 2018)
- Both the micro or macro perspective are relevant

Our paper

- Structural lifecycle model of optimal consumption and portfolio choice
  - housing & financial wealth in safe / risky assets, inside / outside pension plans
  - uninsurable labor income risk and borrowing constraints

- SMM on panel admin data matched with nationally represent. survey data for members of an industry-wide retirement fund

- Run counterfactuals to isolate marginal saving motives effects

Main findings

Consumption smoothing

- Boosts significantly all forms of saving, particularly for females
- Encourages DC plan uptake
- Increases financial and pension wealth after middle years
- Raise early housing wealth

Main findings (cont.)

Bequests

- Boosts pension wealth, slightly reduces financial wealth, *displaces housing*, particularly for females (bequests substitute for consumption)
- Operates on pension wealth almost solely via plan choice:
  - Encourages DC plan uptake (bequests are luxury goods)
  - Females stronger bequest motives induces riskier portfolio
- Increases financial wealth after middle years, with the later boost in non-liquid wealth dampening the effect

Main finding (cont.)

Precautionary saving

- Do not directly add any extra financial or pension wealth
- Mortgage payments have dual role: ‘savings’ and insurance
- Encourages DC plan uptake and indirectly increases pension balances by shielding balances from labor income uncertainty

Main finding (cont.)

Pension and housing complementarity

- Costless switching out of plan defaults leads to higher pension and housing wealth
- Similar effect from higher pension returns

Technical contribution

- Novel solution method to efficiently solve higher dimensional models with non-convexities

- Monte Carlo gradient free algorithms to perform our estimation on a large compute cluster; contribute to practical scaling of distributed dynamic programming algorithms on high performance computational (HPC) infrastructure

Structure of talk

1. Institutional context, reduced form results
2. Structural model and estimation (briefly)
3. Simulated accumulation profiles
4. Counterfactuals and decomposing saving motives

Institutional context

Pensions in Australia

- Mandatory minimum employer contribution
- Individuals can make additional voluntary contributions
- UniSuper members
  - automatically enrolled in Defined Benefit (DB); can choose Defined Contribution (DC) in 1st year
  - can choose to make voluntary contributions
  - can choose to invest DC funds via several asset allocation options

Table A1. UniSuper plan features

	Mandatory	Default Option	Alternative Options
Enrolment	✓	-	-
Plan type	-	*DB*	*DC (within 1 yr)*
Employer contributions	*17%*	-	-
*Employee contributions**			
Standard rate	-	*7%*	*(Irreversible) Choice to decrease*
Voluntary rate	-	*0%*	*Choice to increase*
Investment options	-	*Balanced*	*Choice of other 14 options*
Insurance	-	*Life and TPD*	*Choice to change cover*

Notes: The table presents the key features of the retirement fund we study. Bold indicates the choice dimensions that we model. Recall all UniSuper members make investment choices as both DB and DC plans have a DC component *An additional choice dimension (that we do not model here) is that employee contributions can be made pre- or post-tax. TPD denotes total & permanent disability.

UniSuper data

UniSuper administrative records:

- Demographics: age, gender
- Plan type and balance: DB/DC
- Contributions: standard, voluntary
- Job indicators: wage, tenure years, number employers contributing
- Risk indicators: supplementary insurance, non-default asset allocation
- 2 waves: Dec. 2010 (wave 10) & Dec. 2014 (wave 14)
- 9,728 individuals (13,022 obs., 5,328 refresher sample in wave 14)

HILDA data

Survey of Household, Income & Labour Dynamics in Australia (HILDA) data :

- Consumption
- Financial wealth
- Housing (prevalence, services, wealth)
- Demo: age, gender, marital status, # children, education, health
- 2 waves: 2010 (wave 10) & 2014 (wave 14)
- Match 82% of our full UniSuper sample

Pension and non-pension wealth characteristics

Panel A.	% of Members	# of Members
Plan type:		
DB	74.71	3,287
DC	25.30	1,113
Is voluntarily contributing	19.43	855
Has supplementary insurance	10.39	457
Is homeowner	86.80	3,819

Pension and non-pension wealth characteristics

Panel B.	Mean	Median
Pension wealth (in $000)	240.36	146.81
Number of employers contributing	0.97	1.00
Number of years contributing	12.69	12.00
Annual wage (estimated, in $000)	87.89	81.34
(DC) share in risky assets	0.63	0.70
Financial wealth (in $000)	434.31	326.10
Housing wealth (in $000)	840.32	660.00
Housing share in total wealth	0.46	0.49
Housing expenses (in $)	8,994.39	1,000.00
Total net wealth (in $000)	1,001.60	803.07

Reduced form results

Reduced form: main findings

- Females have lower balances than males, and invest slightly more aggressively
- People become homeowners relatively early in their working life, and hold higher housing wealth shares as they get older
- Female and less educated sub-samples are both more likely to own a home
- More educated and on higher wages diversify their portfolios more
- Net wealth and the wealth share of own-home invested positively related

Allocation and home decisions

	Risky share	Homeowner	Housing assets share
Age	0.006	-0.512***	0.018***
	(0.003)	(0.083)	(0.003)
Male	-0.019**	-0.166	-0.003
	(0.007)	(0.101)	(0.005)
Low edu.	0.018	2.244***	0.066***
	(0.013)	(0.239)	(0.012)
High edu.	0.011	0.111	-0.022**
	(0.008)	(0.151)	(0.007)
Couple	-0.004	0.637***	-0.035***
	(0.008)	(0.115)	(0.008)
HH size	0.001	0.492***	0.029***
	(0.002)	(0.044)	(0.002)
Good health	0.001	-0.076	-0.021***
	(0.005)	(0.088)	(0.005)
Model fit	0.105	0.431	0.122

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Allocation and home decisions

	Risky share	Homeowner	Housing assets share
Suppl. insurance	0.000	-0.124	-0.015*
	(0.009)	(0.149)	(0.007)
Years of contribution	0.001	0.031**	-0.002***
	(0.001)	(0.010)	(0.000)
Employers	0.017	-0.008	-0.001
	(0.011)	(0.193)	(0.010)
Ln annual wage	0.005	0.622**	-0.053***
	(0.006)	(0.195)	(0.008)
Ln net worth	0.018	-0.433	0.131***
	(0.011)	(0.276)	(0.013)
Ln net worth X Age	-0.000	0.044***	-0.002***
	(0.000)	(0.007)	(0.000)
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Structural model

Model outline

An individual faces the following lifetime dynamics

- starts working at age t_0
- survives from one year to the next with survival probability s_t
- retires (and withdraws UniSuper balance) at age $R = 65$
- lives to a maximum age $T = 100$
- chooses DB/DC in the 1st year (default: DB)

Model outline

Each year, a surviving individual faces the following shocks

- Stochastic wage income w_t
- Stochastic house preferences α_t
- Stochastic discount rates β_t
- Stochastic rates of return on pension, housing and mortgage assets

Model outline

Each year, a surviving individual chooses

- Voluntary contribution rate v_t (default: 0%): discrete choice
- Risky assets share r_t for DC funds (default: balanced 70/30): discrete choice
- To rent or own home
- To adjust home capital (or keeps stock constant); if adjusting, decides level of housing stock
- Mortgage balance subject to redraw and collateral constraints
- Liquid savings that earn a risk free rate of return

Model outline

Each year, a surviving individual

- consumes non-durable goods and enjoys housing services from housing stock or rented home

Within period utility

While alive, within-period utility function:

$$u(C_t, S_t) = \frac{\left[(1-\alpha_t)c_t^{\rho} + \alpha_t {S_t}^{\rho}\right]^{\frac{1-\gamma}{\rho}} - 1}{1-\gamma}$$

where H_{t+1} is housing capital and $S_t = H_{t+1}$ if $H_{t+1} > 0$

If $H_{t+1} >= 0$, S_t can be rented at a constant proportion ϕ^R of the house price P_t

Bequest

After death, individual values total bequeathable wealth a_t^B

$$b(a_t^B) = \theta \frac{\left(a_t^B + k\right)^{1-\gamma}}{1-\gamma}$$

While working, she earns an annual wage w_t

$$\begin{aligned} \ln w_t &= \lambda_0 + \sum_{k=1}^{4} \lambda_k t^k + \sum_{k=1}^{2} \lambda_{4+k} \tau^k + \xi_t, \\ \xi_t &= \phi_w \xi_{t-1} + \epsilon_t^w, \ \epsilon_t^w \sim \mathcal{N}\left(0, \sigma_w^2\right) \end{aligned}$$

Pension plan choice

- 2 pension plan options
  - **DB plan** (default)

    a_t^{DB}=DB component+DC component
    - DB component:
    $$f_t^{ACF}(v_s)\cdot f_t^{LSF}(t)\cdot f^{ASF}\cdot\tau\cdot\overline{w}_t$$
    - DC component:
    $$(1+r_t)\cdot\left[a_{t-1}^{DC}+(v_t+(1-\alpha)\,v_E)\,w_t\right]$$
  - **DC plan**
    $$a_t^{DC}=(1+r_t)\cdot\left[a_{t-1}^{DC}+(v_t+v_S+v_E)\,w_t\right]$$
- Switching out of default (DB) is costly

$$u_p=\exp\left(\nu_0^p+\nu_1^p t+\nu_2^p t^2\right)$$

Asset allocation choice

- 5 asset allocation Options. Convex points of
  - **Balanced** allocation option (default)

$$\ln r_t^d = r^d + \varepsilon_t^d, \text{ with } \varepsilon_t^d \sim N(0, \sigma^2_{\varepsilon_t^d})$$

  - **“High risk - High return”** allocation option

$$\ln r_t^h = r^h + h\varepsilon_t^d$$

  - **“Low risk - Low return”** allocation option

$$\ln r_t^l = r^l + l\varepsilon_t^d$$

    with $r^h > r^d > r^l$ and $h > 1$, $l < 1$

- Switching out of default (balanced) is costly

$$u_{inv} = \exp\left(\nu_0^{inv} + \nu_1^{inv} t + \nu_2^{inv} t^2 + \nu_3^{inv} \max\left\{0, \log\left(a_{t,dc}^{DB/DC}\right)\right\}\right)$$

Voluntary contribution choice

- Choose voluntary contributions from 5 points
  - **No vol. contributions**, $v_0 = 0$ (default)
  - **Positive voluntary contribution rate** from set $\{v_1, \ldots, v_5\}$
- Switching out of default (no vol. contributions) is costly

$$u_v = \nu_0^{vc} + \nu_2^{vc}\left(t - \nu_1^{vc}\right)^2 + \nu_3^{vc}\max\{0, \log\left(a_t\right)\}$$

Housing

Housing capital accumulates as:

$$H_{t+1} = (1-\delta)H_t + h_t$$

If $h_t \neq 0$, then non-convex house price adjustment cost paid $P_t \tau_H H_{t+1}$

(Real) Housing price P_t grows at rate r_t^h with mean r^h and i.i.d shock each period

Mortgages

Mortgages can be taken out at rate r_t^m where r_t^m follows AR(1)

Collateral constraint $m_{t+1} \leq (1 - \phi^C) H_{t+1}$

Costless redraw option even without re-financing but with constraints:

- $m_t \geq 0$
- $(1 + r_m) m_t - m_{t+1} \leq \iota$

No option to default from repaying mortgages

Financial wealth

Risk free rate of return r

Decision making

1st stage: DB vs. DC

$$V_{t_0}\left(X_{t_0}\right)=\underset{DB/DC}{Max}\left\{V_{t_0}\left(X_{t_0}|DB\right)+\zeta_{DB},\, V_{t_0}\left(X_{t_0}|DC\right)-u_p+\zeta_{DC}\right\}$$

2nd stage:

$$\begin{aligned}\tilde{V}_t\left(X_t\right) &= \max_{c_t,h_{t+1},S_t,m_{t+1},a_{t+1}} u\left(c_t,S_t\right)+\\ &\quad +\beta E_t\left[s_t V_{t+1}\left(X_{t+1}\right)+\left(1-s_t\right)b\left(a_{t+1}+a_{t+1}^{(DB/DC)}\right)\right]\\ &\quad -u_{inv}\cdot\mathbf{1}\left\{r_t\neq r^d\right\}+\zeta_{r_t}--u_{vc}\cdot\mathbf{1}\left\{v_t\neq 0\right\}\end{aligned}$$

Solution method

Problem is non-convex, implies standard FOCs not sufficient

Traditionally, use ‘pure’ numerical optimization tools (i.e., iteratively apply grid search or Newton’s method to the value function)

Dimensionality of model makes pure numerical optimization too costly

- 6 exogenous states, 5 endogenous states
- 5×10^8 grid points per period
- with standard methods, computation time 1-2 days / model
- with non-convex method, computation time 30 min / model

We use sufficient FOC & SOC by Shanker et. al. (2022) to characterize Euler equations (high dimensional mixed integer programming)

Estimation

Calibrate parameters available in the data/ literature

- Interest rates, redraw and collateral constraints, housing adj. costs, rental rates

Estimate (27) parameters including:

- Preferences (housing, bequest, intertemporal elasticity, time)
- Switching cost parameters

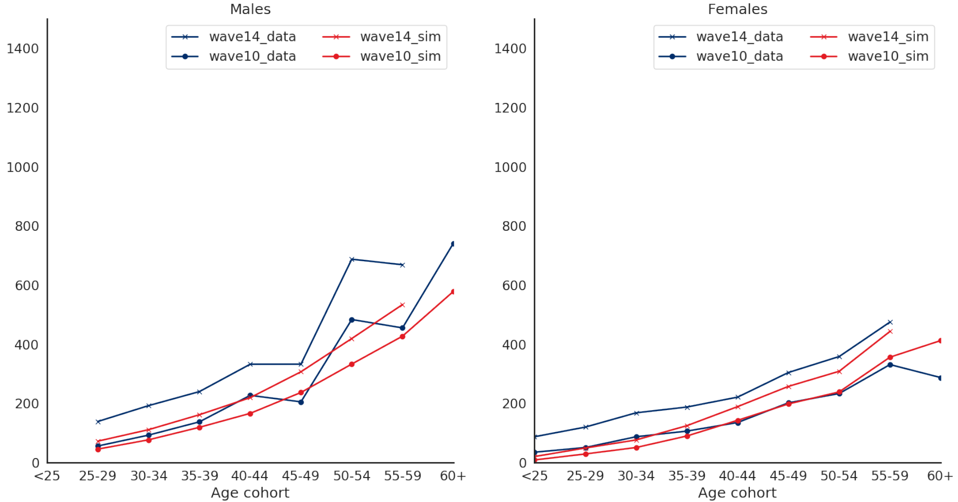
Use SMM: find parameters that generates moments closest to the data

Parallelize Cross Entropy Method on 20,000 CPU cores on AU National Computational Infrastructure; takes approx. 5-10 hours (*c.f. 2-3 years with standard iterative methods*)

Structural results

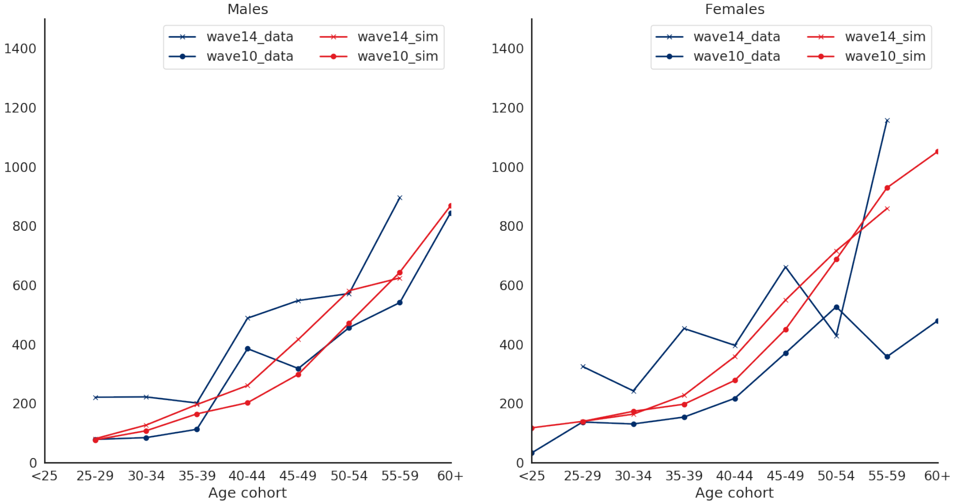
Simulated profiles

Figure: Mean pension wealth (DB+DC) by cohort (thousands of $)



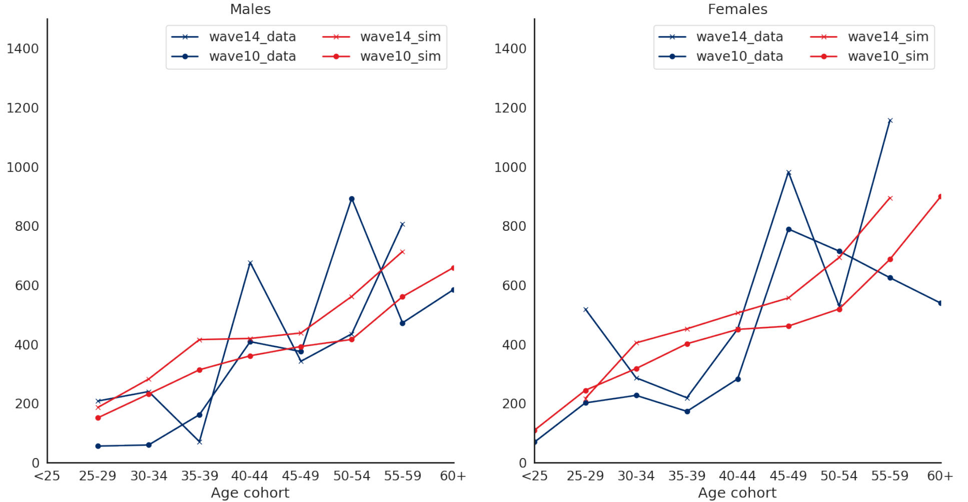
Simulated profiles

Figure: Mean financial wealth by cohort (thousands of $)



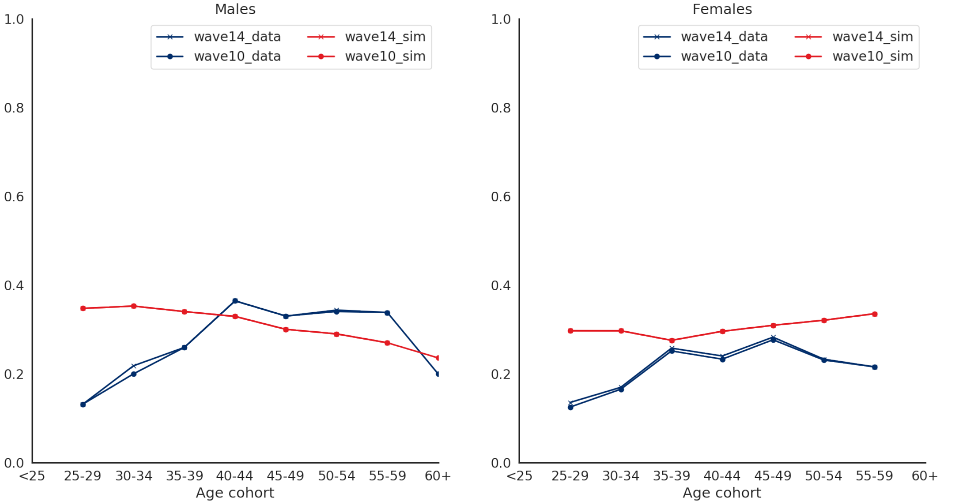
Simulated profiles

Figure: Mean housing wealth by cohort (thousands of $)



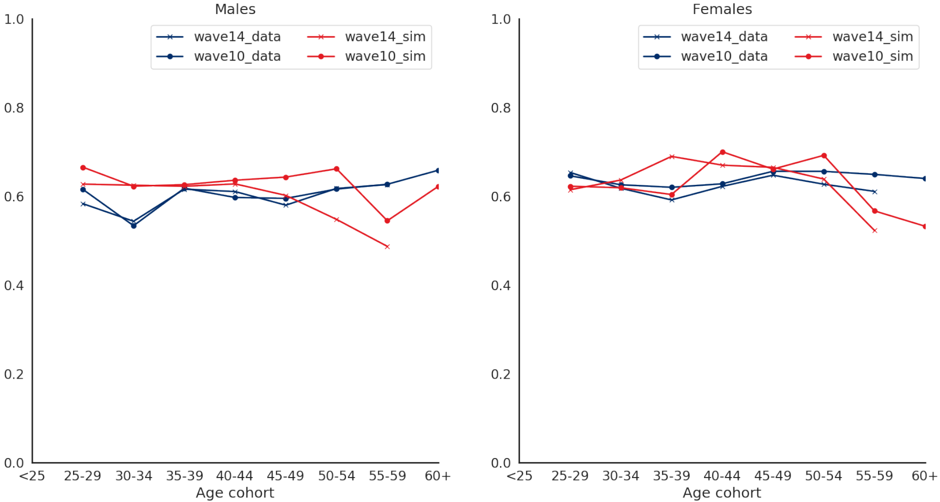
Simulated profiles

Figure: Share of members choosing DC plans by cohort



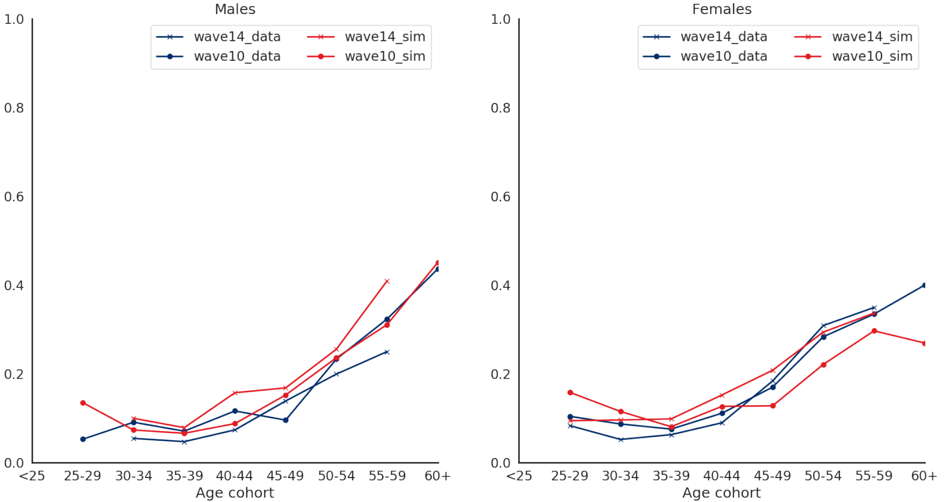
Simulated profiles

Figure: Mean risky assets share by cohort



Simulated profiles

Figure: Share of members voluntarily contributing by cohort



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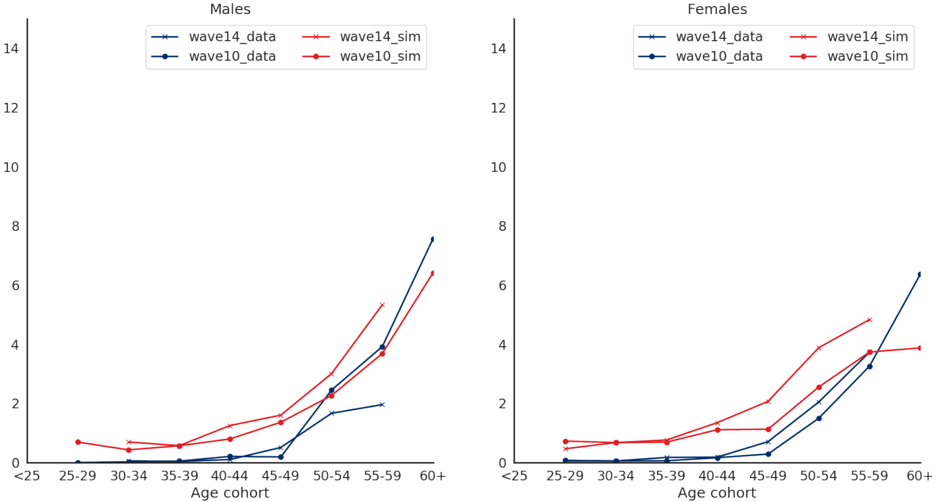

Estimation results

		Males		Females	
		Estimates	S.E.	Estimates	S.E.
CRRA	γ	3.617	0.098	3.261	0.016
Housing share	$\overline{\alpha}$	0.512	0.013	0.494	.0144
	ρ_α	0.817	0.029	0.797	0.041
	$\sigma_{\alpha\epsilon_t}$	0.023	0.002	0.023	.001
CES parameter	ρ	0.244	0.023	0.326	0.024
Bequest	$\ln(\theta)$	8.367	0.075	9.652	0.093
Time discount	$\overline{\beta}$	0.918	0.012	0.901	0.019
	ρ_β	0.843	0.021	0.801	0.045
	$\sigma_{\beta\epsilon_t}$	0.025	0.001	0.034	0.012

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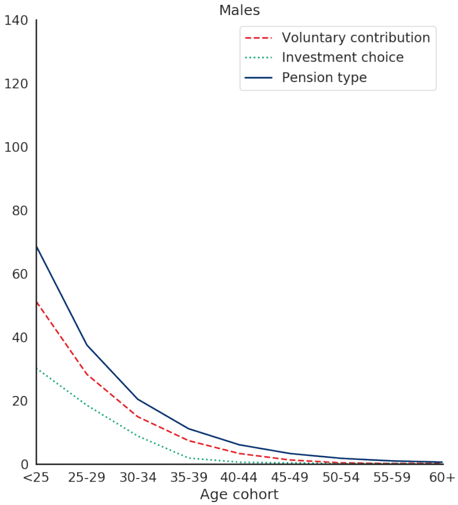
Estimation results

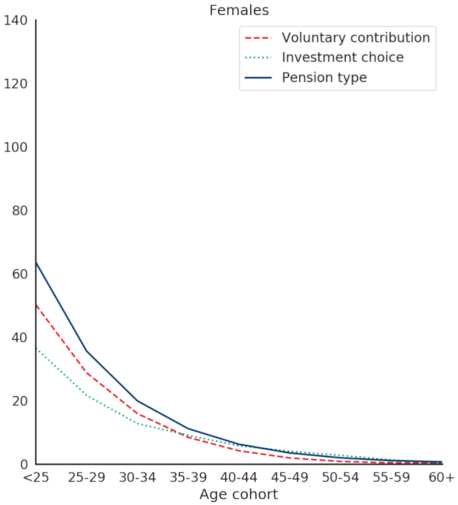
		Males		Females	
		Estimates	S.E.	Estimates	S.E.
Switching costs:					
Voluntary	ν_0^V	-0.689	0.011	0.655	0.022
contribution	ν_1^V	59.721	0.015	59.249	0.034
	ν_2^V	0.096	0.001	0.093	0.002
	ν_3^V	-0.360	0.032	-0.564	0.020
	$\sigma_V^{DB} \times 10^3$	1.530	0.001	1.202	.001
	$\sigma_V^{DC} \times 10^5$	0.503	0.001	1.041	0.001

Estimation results

		Males		Females	
		Estimates	S.E.	Estimates	S.E.
Asset allocation	ν_0^r	4.710	0.081	3.271	0.013
	ν_1^r	0.244	0.013	-0.101	0.029
	ν_2^r	-0.410	0.011	-0.330	0.071
	ν_3^r	0.162	0.002	0.360	0.016
	ν_4^r	0.081	0.002	0.051	0.021
	$\sigma_r^{DB} \times 10^3$	3.022	0.001	0.621	0.002
	$\sigma_r^{DC} \times 10^3$	1.351	0.001	0.564	0.001
Plan	ν_0^p	-0.321	0.089	-0.651	0.075
	ν_1^p	-1.893	0.052	-0.124	0.042
	ν_2^p	-1.017	0.018	-0.672	0.016
	σ_p	0.557	0.043	0.424	0.055
Default preference	$\ln(\psi)$	-7.234	0.067	1.481	0.057

Plan switching costs





Counterfactuals

Counterfactual scenarios

	Opting into DC plans	Opting to contribute	Risky assets share	Pension wealth	Non-pension wealth:	Financial wealth	Housing wealth
	% of members		%	% change from baseline			
			Panel A. Males				
Baseline	35.392	21.216	59.514	-	-	-	-
No cons. smooth.	32.169	20.009	61.241	-34.764	-19.325	-43.457	-6.339
No bequests	32.798	17.497	65.824	-33.139	0.095	-19.423	16.232
No prec. savings	28.940	21.232	63.671	-33.723	18.730	39.796	7.394
No switching costs	41.185	73.098	48.711	67.946	14.850	-0.046	22.866
Higher R^r	42.644	23.026	61.851	24.477	9.686	9.962	9.537
No redraw	23.967	20.887	60.434	-10.597	35.382	34.423	-1.592

Counterfactual scenarios

	Opting into DC plans	Opting to contribute	Risky assets share	Pension wealth	Non-pension wealth:	Financial wealth	Housing wealth
	% of members		%	% change from baseline			
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Counterfactual scenarios

	Opting into DC plans	Opting to contribute	Risky assets share	Pension wealth	Non-pension wealth:	Financial wealth	Housing wealth
	% of members		%	% change from baseline			
			Panel B. Females				
Baseline	32.619	21.968	61.731	-	-	-	-
No cons. smoothing	29.402	21.871	64.918	-24.542	-44.947	-49.072	-40.873
No bequests	30.040	20.996	54.329	-23.242	2.355	-20.567	26.459
No prec. savings	25.042	25.450	63.690	-13.588	5.017	0.033	9.941
No switching costs	35.447	55.007	52.522	55.989	-0.667	-6.035	4.637
Higher R^r	35.022	23.680	62.538	25.295	1.036	3.082	0.986
No redraw	23.967	19.661	62.233	-15.677	15.276	27.346	-10.789

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Saving motives decomposition

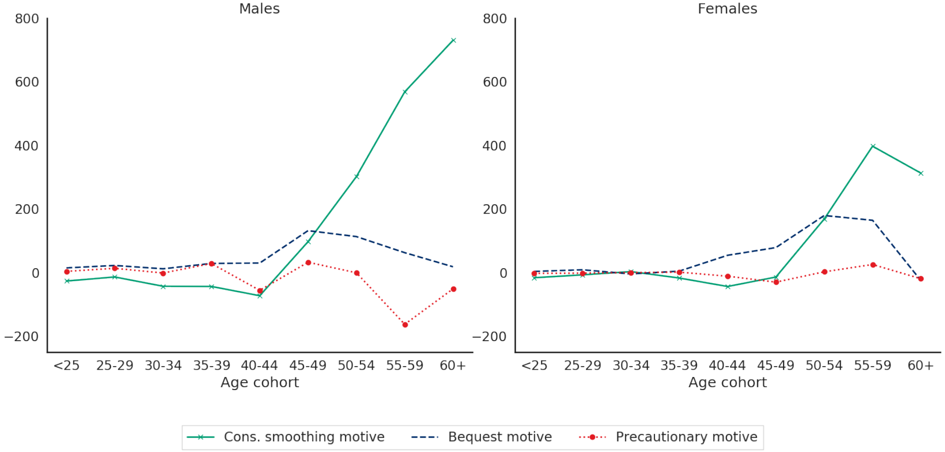
Directly isolate the impact of saving motives on lifetime wealth allocation

Examine motives profiles with plan prevalence fixed at its baseline levels

Interpretation: the marginal effect of each saving motive on each major asset class (Gourinchas and Parker, 2002; Cagetti, 2003; Pashchenko and Porapakkarm, 2020)

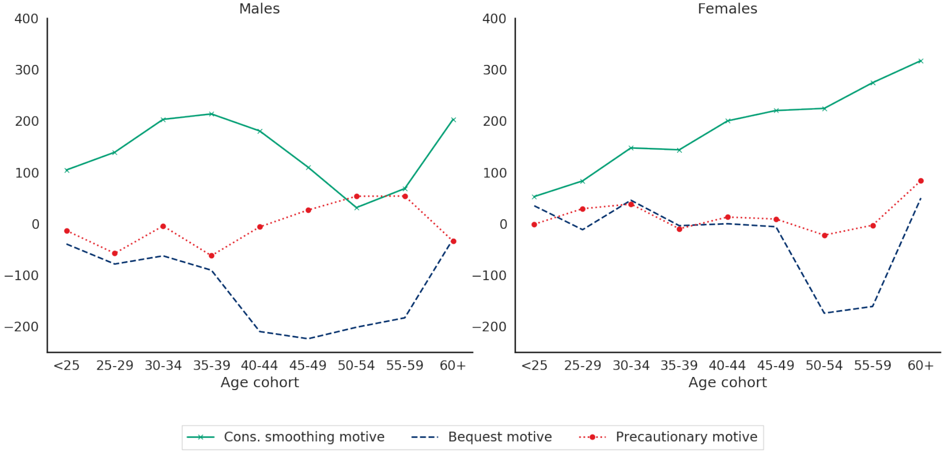
Saving motives decomposition

Figure: Additional financial wealth by cohort (thousands of $)



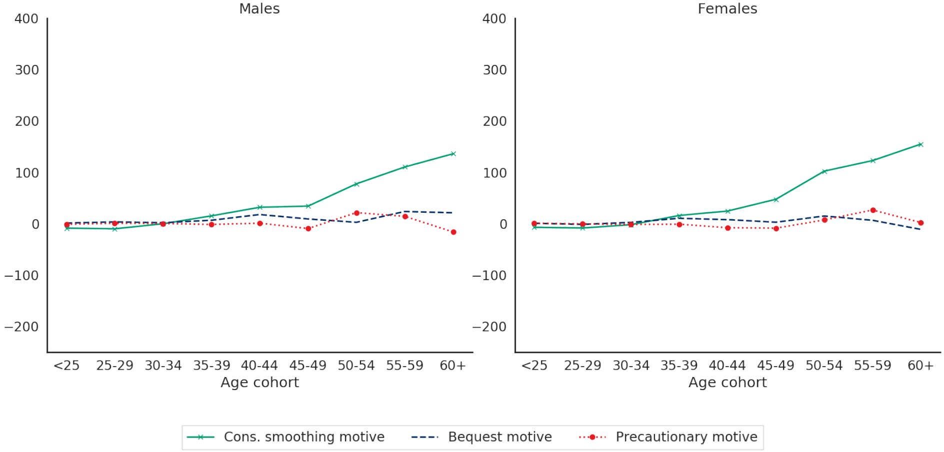
Saving motives decomposition

Figure: Additional housing wealth by cohort (thousands of $)



Saving motives decomposition

Figure: Additional pension wealth by cohort (thousands of $)



Housing pension complementarity

Housing adjustment has a fixed cost; individuals accumulate housing early

Housing consumption locked in by decisions during early years

A young homeowner will thus consider both what they wish to consume immediately, and what they anticipate consuming in their later life (and even post-retirement)

With higher pension returns, younger individuals anticipate lower marginal utility of consumption after (close to) retirement, thus increasing housing wealth in earlier years

Conclusion

Recap of main findings

1. Consumption smoothing: key role in driving financial and early real wealth
2. Bequests: limited direct role, affect plan choice, displaces housing in mid years
3. Precautionary savings: affects plan choice, drives savings but not directly
4. Housing and pensions act as complements

Final remarks

- Policies encouraging pension saving (with withdraws only available in later life) can boost housing
- Plan structure has a significant impact on overall asset composition
- Bequest (dis)incentives have little impact on overall savings but affect plan choices
- Housing not always looking like a plausible ‘substitute’ for pensions (see Hungary)
- Mortgage redraw options can dampen precautionary saving motives via added liquidity