Retirement Eggs and Retirement Baskets

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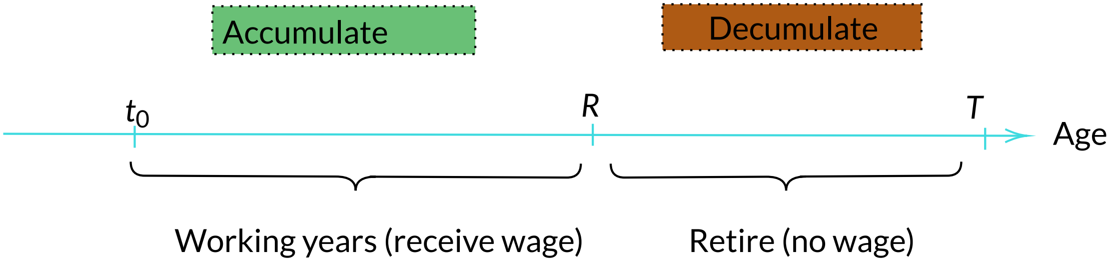
How do people save over their lifetime across their portfolio of assets?

Hump shaped wealth 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 bears increasing weight on old age savings adequacy

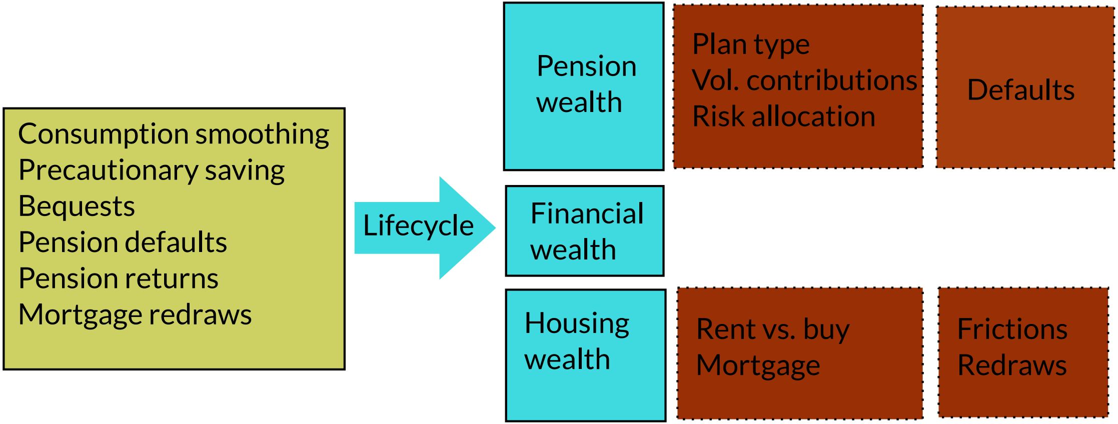
Our research question

How do

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

interact to drive lifetime savings across the main asset classes?

Our eggs and baskets



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 increases 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 findings (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 them from labor income uncertainty

Main finding (cont.)

Pension - housing complementarity

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

Mortgage redraws dampens overall exposure of wealth to wage risk and the need for financial wealth, boosting DC uptake

Technical contribution

- Novel and fast scan method to efficiently compute solutions to higher dimensional optimization problems 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 ‣ UniSuper
2. Reduced form results ‣ Reduced form
3. Structural model and estimation ‣ Go structural
4. Simulated accumulation profiles ‣ Structural fit
5. Counterfactuals and decomposing saving motives ‣ Counterfactuals

Institutional context

UniSuper structure

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
- Portfolio allocation: 15 investment options (risky assets share)
- Job indicators: wage, tenure years, number employers contributing
- Other: 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, wealth, services)
- Demo: marital status, # children, education, health

- 2 waves: 2010 (wave 10) & 2014 (wave 14)
- Match 82% of our full UniSuper sample

Go back

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 analysis

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
- Females and less educated people are more likely to own a home
- Higher earners and more educated people diversify their portfolios more
- Net wealth and the wealth share of own-home invested positively related

Go back

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 chooses

- Voluntary contribution rate v_t (default: 0%)
- Risky assets share r_t for DC funds (default: balanced 70/30)
- To rent or own home
- To adjust home capital (or keep it constant); if adjusting, decides level of housing stock
- Mortgage balance subject to redraws 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

- faces stochastic
  - wage income w_t
  - house and time preferences α_t, β_t
  - rates of return on pension, housing and mortgage assets

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 S_t is housing services

- rented at rate $P_t^S = \phi^S P_t$ if not homeowner ($H_t = 0$), or
- given by own housing stock H_t if homeowner ($H_t > 0$)

Bequest

After death, individual values total bequeathable wealth B_t

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

While working, she earns an annual wage y_t

$$\begin{aligned} \ln y_t &= \lambda_0 + \sum_{k=1}^{4} \lambda_k t^k + \sum_{k=1}^{2} \lambda_{4+k} \tau^k + \xi_t, \\ \xi_t &= \phi \xi_{t-1} + u_t, u_t \sim \mathcal{N}\left(0, \sigma_u^2\right) \end{aligned}$$

Pension plan choice

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

    a_t^{DB}=DB component+DC component

    - DB component:

    $$f_t^{ACF}(v_s) \cdot f_t^{LSF}(t) \cdot f^{ASF} \cdot \tau \cdot \bar{y}_t$$

    - DC component:

    $$[\pi_t R_t^r + (1-\pi_t) R_t^s] \cdot \left[a_{t-1}^{DC} + (v_t + (1-\alpha) v_E) y_t\right]$$

  - **DC plan**

    $$a_t^{DC} = [\pi_t R_t^r + (1-\pi_t) R_t^s] \cdot \left[a_{t-1}^{DC} + (v_t + v_S + v_E) y_t\right]$$

- Switching out of default (DB) is costly

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

Asset allocation choice

- 5 allocation options (from 15 available investments) with diff risky:safe composition
  - **Balanced** allocation (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

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

  - **"Low risk - Low return"** allocation

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

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

- Switching out of default (balanced allocation) is costly

$$u_{\pi_t} = \psi + \exp\left(\nu_0^r + \nu_1^r t + \nu_2^r t^2 + \nu_3^r \max\left\{0, \log\left(a_t^{DC}\right)\right\} + \nu_4^r u_p\right)$$

Voluntary contribution choice

- 6 voluntary contribution options
  - **No voluntary contributions**, $v_0 = 0\%$ (default)
  - **Positive voluntary contribution rate** from set $\{v_1, \ldots, v_5\}$
- Switching out of default (no voluntary contributions) is costly

$$u_{v_t} = \psi + \exp\left(\nu_0^v + \nu_2^v \left(t - \nu_1^v\right)^2 + \nu_3^v \max\{0, \log\left(a_t\right)\}\right)$$

Housing

Housing capital accumulates as:

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

Traded by paying a transaction cost $\tau_H P_t H_t$

(Real) Housing price P_t grows at rate r_t^h with mean r^h and shock $\varepsilon_t^h \sim N(0, \sigma^2_{\varepsilon_t^h})$

Mortgages

Mortgages can be taken out at rate $r_t^m = \beta^m r_t^s + \kappa \epsilon_t^d$

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

Costless redraw option even without refinancing but with constraints:

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

(No option to default from repaying mortgages)

Financial wealth

Risk free rate of return r

Go back

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, each period t:

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

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 fast upper envelope scan (FUES) method by Dobrescu and Shanker (2022) to recover optimal solution (high dimensional mixed non-linear 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

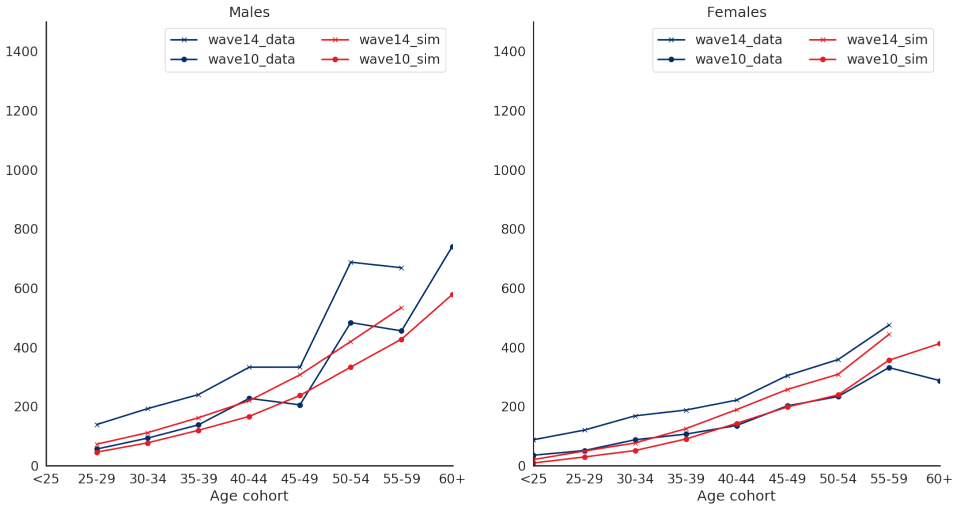
Use SMM: find parameters that generates moments closest to the data

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

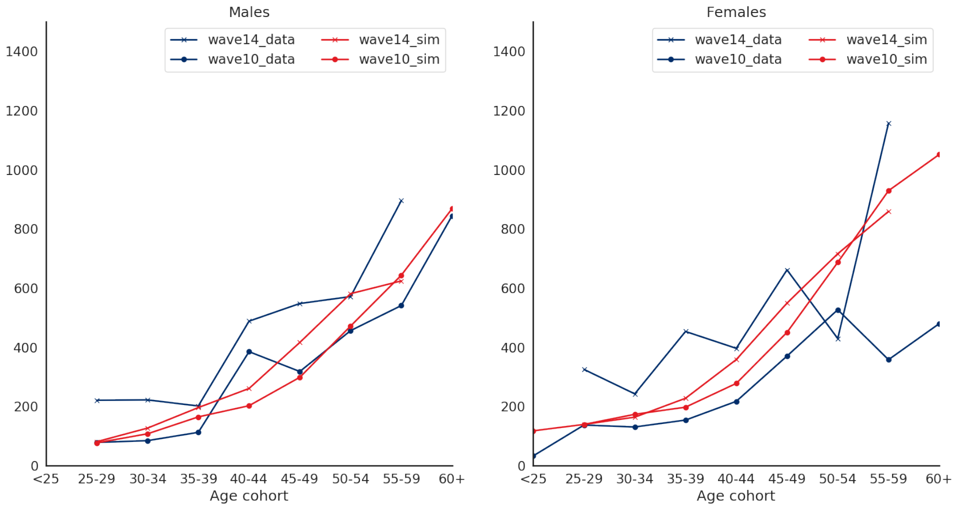
Simulated profiles

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



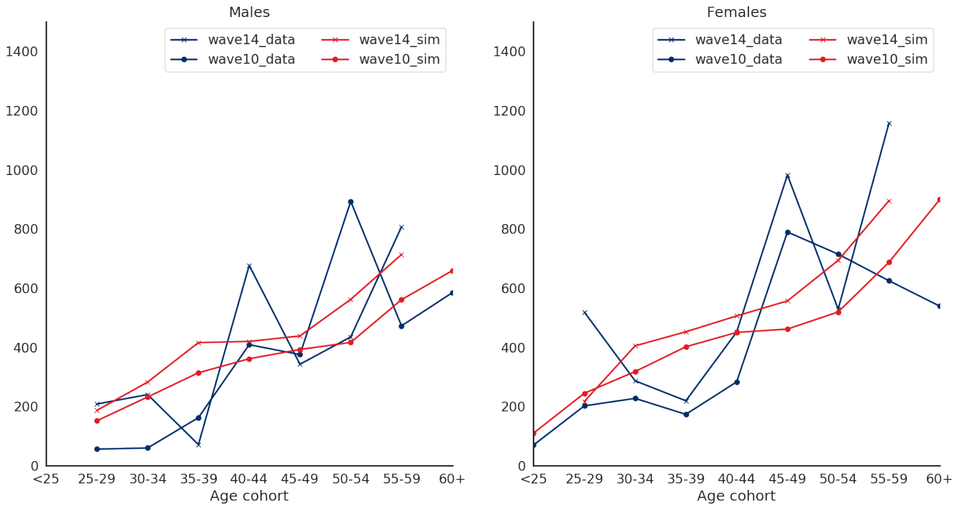
Simulated profiles

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



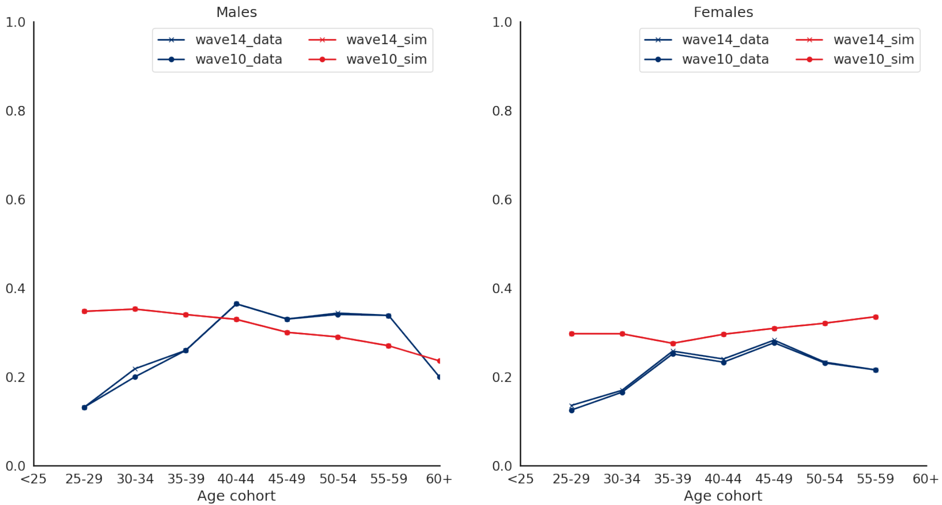
Simulated profiles

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



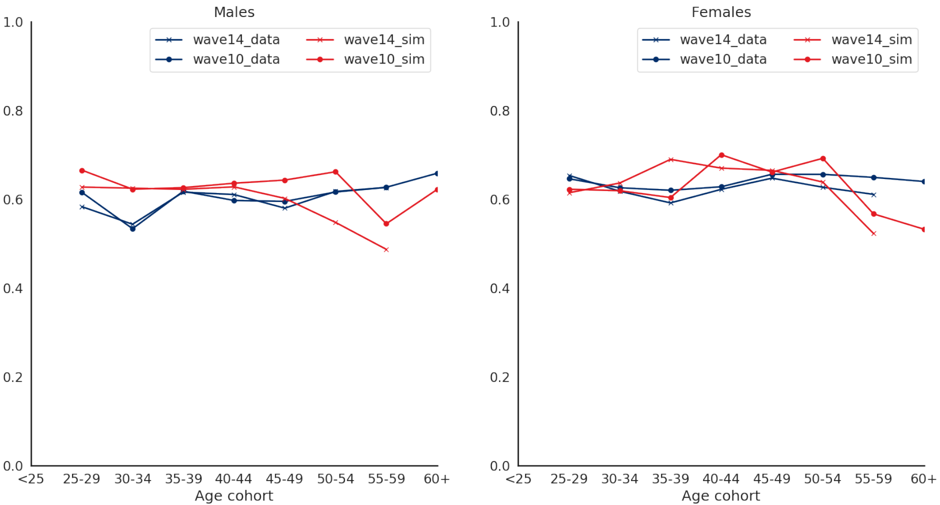
Simulated profiles

Figure: Share of members choosing DC plans by cohort



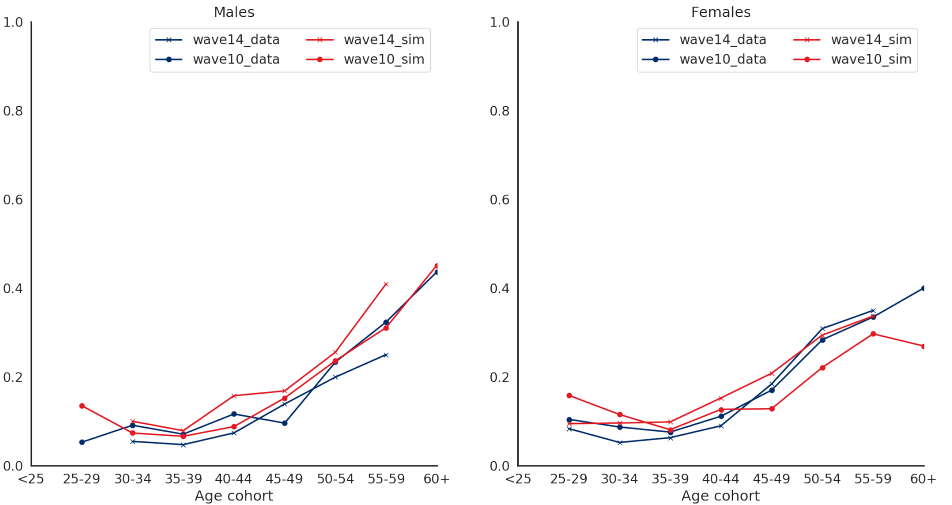
Simulated profiles

Figure: Mean risky assets share by cohort



Simulated profiles

Figure: Share of members voluntarily contributing by cohort



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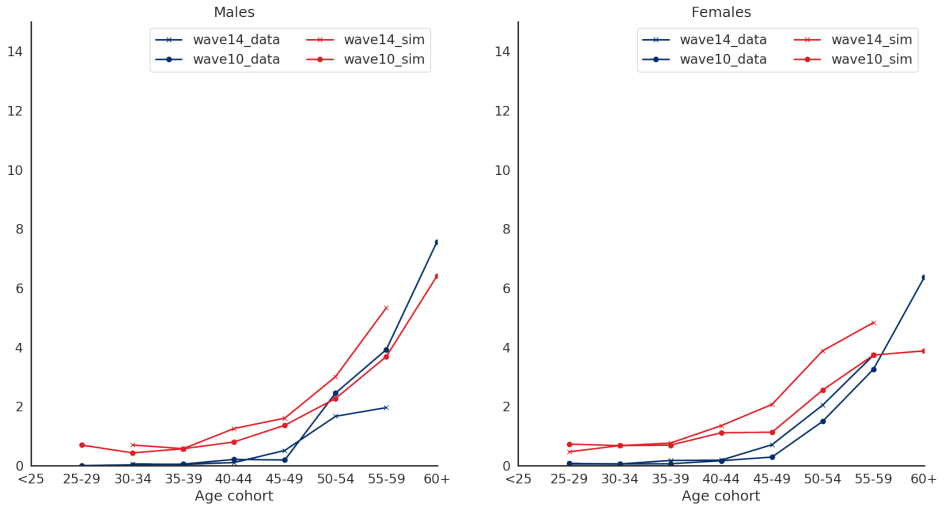
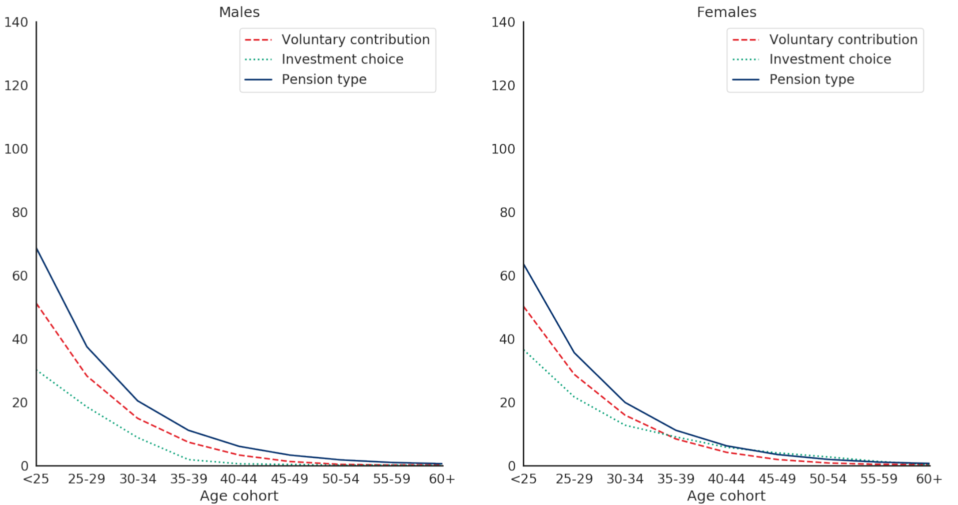


Plan switching costs

Figure: Mean switching costs by cohort (thousands of $) ▸ Go back



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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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

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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			
			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
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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

Counterfactual scenarios

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Saving motives decomposition

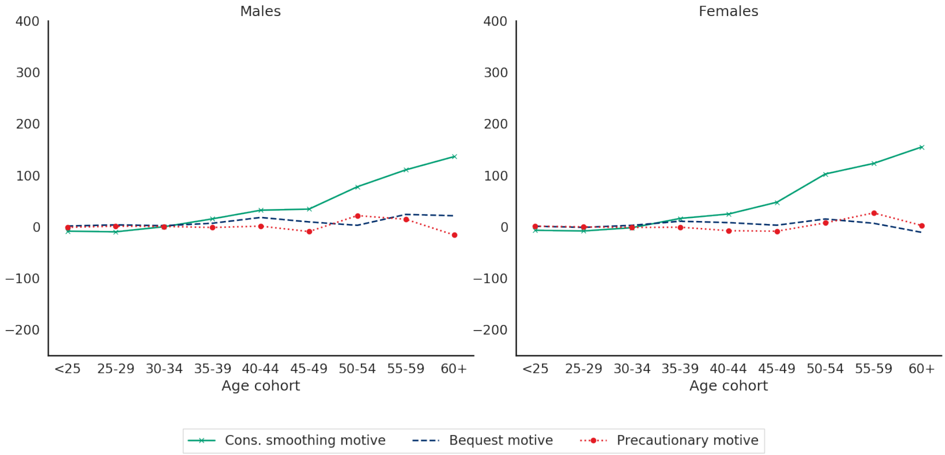
Directly isolate the impact of saving motives on lifetime wealth allocation

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)

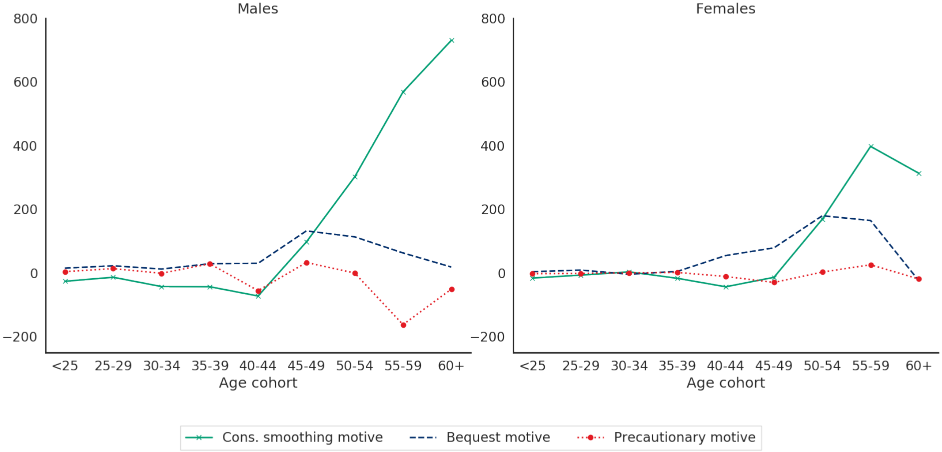
Saving motives decomposition

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



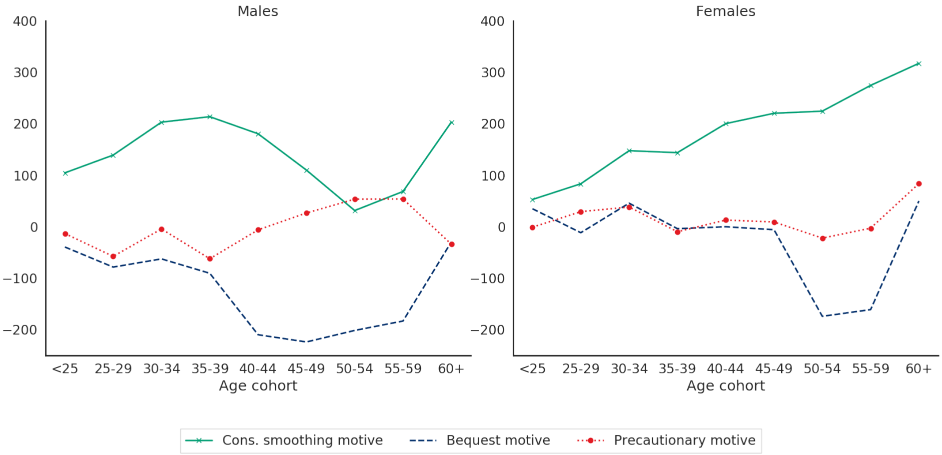
Saving motives decomposition

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



Saving motives decomposition

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



So... main findings

1. Consumption smoothing: key role in driving (post-40) pension & financial wealth, (early) housing wealth
2. Bequests: limited direct role, affect plan choice, financial boost that displaces housing in mid years
3. Precautionary savings: limited role, affect plan choice, drives savings but not directly
4. Housing and pensions act as complements

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

Final remarks

- Pension plan structure has a significant impact on overall asset composition
- Policies encouraging retirement savings (with withdraws only available in later life) can boost housing
- Housing not always looking like a plausible ‘substitute’ for pensions
- Consumption smoothing is key for savings overall and across assets
- Bequest (dis)incentives have little impact on overall savings but affect plan choices
- Mortgage redraws can dampen precautionary saving motives via added liquidity