Asset Decumulation and Risk Management in Retirement

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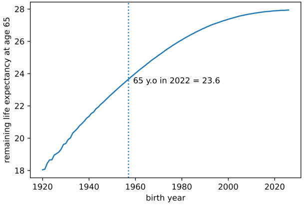
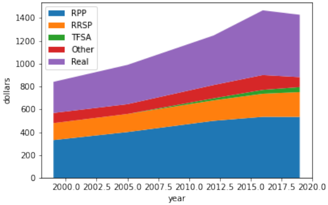
The Outlook has Changed for Retirees

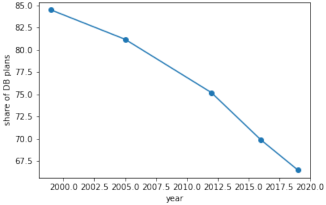
In Canada, retirees



(a) Live longer



(b) Have More Wealth



(c) Have Less DB Cov.

The Problem

Figuring out how to decumulate savings is a hard problem

- time of death is uncertain
- housing and medical (LTC) risks
- Household composition
- Might want to leave something for the kids

Insurance

One can insure, at some cost against risks

- Self-insurance (wealth and housing): Yaari (1965), Abel (1985), Hurd (1989), Hubbard et al. (1995), Palumbo (1999), Ameriks et al. (2011), De Nardi et al. (2010), Lockwood (2018) and McGee (2022)
- Annuities: Inkmann et al. (2011), Lockwood (2012), Hubener et al. (2014), Peijnenburg et al. (2016, 2017), Laitner et al. (2018)
- Long-term care insurance: Brown and Finkelstein (2007), Lockwood (2018), Ameriks et al. (2018), Braun et al. (2019), Boyer et al. (2020a)
- Reverse mortgages: Shan (2011), Nakajima (2012), Shao et al. (2015), Haurin et al. (2016), Nakajima and Telyukova (2017), Shao et al. (2018), and Cocco and Lopes (2020)

Low Awareness and Demand for Insurance

Boyer et al. (2020a) and Boyer et al. (2020b) document low awareness and demand in Canada

Product	Take-up	Intentions
Annuities	12%	13%
LTCI	3%	26%
RMR	1%	7%

But what is the benchmark (how large should take-up be)?

This Paper

- A stated-preference experiment for all three insurance products (LTCI, RMR and annuities)
- A stochastic life-cycle model that is tailored to custom-fit each respondent's situation, preferences and account for household composition, housing and expectations
- A behavioral response mapping that accounts for noise (trembling-hand) and status-quo bias
- Once estimated and filtered, quantitative analysis of asset decumulation and risk management motives
- Is there a demand for bundling?

Model Roadmap

- Demography and Time: Households: i (head), and $j = 1, 2, \ldots, N$ (spouse). Time is denoted $t = 0, 1, 2, \ldots T$ (0 around age 65), Households are composed of singles (denoted i), or of couples (denoted as ij)
- Several Risks:
  - Health evolves over 4 possible states (respondent specific), $s_{it} \in \mathcal{S} = \{G, \ell, L\mathcal{D}\}$. Singles and couples (16 possible health states), $s_{ijt} = (s_{it}, s_{jt})$, heterogeneous beliefs, transition probabilities, $q_{it}^{n}(s, s')$. Details on transitions
  - House Price Dynamics follow CMA specific random walk with heterogeneous beliefs Modelling
  - Out-of-pocket Medical costs depend on health state and CMA specific, $M_{ijt} = M(s_{ijt}), \quad s_{ijt} \in \mathcal{S}^2$
- Resources: Agents have initial financial wealth W_0, a primary residence with value P_0^H, a mortgage D_0, receive annuity income, Y_0 and can borrow using credit card or HELOCs. They can purchase in initial period reverse mortgage, annuities or long-term care insurance.
- Households are Epstein-Zin utility maximizers and have a warm-glow bequest motive

Housing

- Period-t home-owning status of household: $H_t \in \{0, 1\}$ (rent, own). We account for market frictions by incorporating moving costs as well as by ruling out intra-period home repurchases, i.e., a seller must rent for at least one period before purchasing another home (Cocco and Lopes (2020)).
- The household's net housing wealth W_t^H is zero for renters and is otherwise given by house value net of principal and interests on mortgages D_t:

$$W_t^H = H_t \left[P_t^H - D_t(1 + r_d) \right],$$

where r_d is the mortgage rate of interest.

Mortgages Expenses Housing Flows

Budget Constraint

- Household income Y_t: $Y_t = \mathbb{1}^s_{ijt} Y^s_t, \quad s \in \mathcal{A}^2$
- Additional net financial revenues $Z_t = Z_t^{ben} - Z_t^{prem}$ capture net proceeds from time-0 annuity, LTC insurance and RMR choices, and differ across initial and subsequent periods.
- Consumption floor
- Borrowing: HELOC for home-owners and credit card for renters.

Insurance Flows · Transfers · Borrowing Constraint

Preferences and Problem

We assume agents have Epstein-Zin preferences with CES intra-period utility and a warn-glow bequest motive. Utility is given by

$$V_{ijt} = \max \left\{ (1-\beta) u_{ijt}^{1-\varepsilon} + \beta \left[\mathrm{E}_t \sum_{s' \in \mathcal{S}^2} q_{ijt}^1(s,s') V_{ijt+1}^{1-\gamma} \right]^{\frac{1-\varepsilon}{1-\gamma}} \right\}^{\frac{1}{1-\varepsilon}},$$

$$u_{ijt} = \left(\frac{\nu_{ijt}}{n_t} \right) \left[C_t^{1-\rho} + \nu_H H_t^{1-\rho} \right]^{\frac{1}{1-\rho}}$$

$$V_{ijt+1} = b^{\frac{1}{1-\gamma}} X_{t+1}, \quad \text{for } s' = (\mathcal{D}', \mathcal{D}')$$

The respondent picks:

- a state-contingent consumption plan and a decision rule for when to sell the house in the future
- whether or not to purchase insurance

Experiment

We aim to estimate parameters of this model using a stated-choice experiment.

- In May 2019 respondents aged 60 to 70 from the 11 major CMA in Canada
- 1581 households (home owners) with reliable data on balance sheet, income, non-missing data etc.
- We present 12 scenarios with price and benefit information for Annuities, LTCI and RMR. These feature randomization in order to help identify parameters of interest.

Experiment: Annuities

Annuity Intro Screen: We are going to show you some simple annuity products and ask you to rate them. You can assume that the institution offering the annuity will pay the monthly benefit no matter the circumstances. Once you pay the premium, you receive monthly benefits and have nothing else to pay.
Each product has two attributes:
a) a premium you have to pay;
b) a monthly benefit starting next year and lasting until death.
The benefit is adjusted for inflation (indexed).

Two different $W_{i,0}$ repeated twice (20% and 50% of financial wealth W_0). The actuarial premium, by age and sex using yields from CANNEX. The premium shown for each scenario is twice drawn randomly (without replacement) using the following markups τ_A on the actuarial premium (0.5, 0.75, 1.25 and 1.5).

Annuity question: What are the chances, 0% meaning no chance and 100% meaning for sure, that you would purchase this product if it were offered to you by a trusted financial institution within the next year?

Reported probabilities

Table: Choice probabilities by scenario

	Annuities	LTCI	Reverse mortgage
a. Takeup rates and knowledge			
probability buys	0.108	0.174	0.073
probability zero (all scenarios)	0.558	0.392	0.638
knows product	0.269	0.109	0.287
b. Price and benefit (within) elasticities			
Price	-0.584	-0.794	-1.285
Benefit	0.497	0.525	0.143

Model Calibration: Survival Expectations

- We ask respondents (and spouse) a lot of information on their current health. Along with other information (age, education, gender), we use a health dynamics simulator to compute objective survival probabilities of each respondent Boyer et al. (2020a).
- We also ask respondents (and spouse) for their subjective probability of surviving to age 85.
- We calibrate the following health process to match both objective and subjective risks.

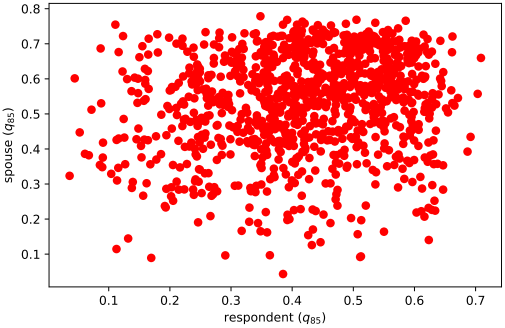
$$q_{it}(s,s') = \Pr_t\left[s_{it+1} = s' \mid s_{it} = s\right] = \frac{\exp\left[\alpha_i(s')\,t + \delta_i(s,s')\right]}{\sum_{s'\in\mathcal{S}} \exp\left[\alpha_i(s')\,t + \delta_i(s,s')\right]}$$

where we allow, $\delta_i(s,\mathcal{D}) = \tilde{\delta}_i(s,\mathcal{D}) + \xi$ for $s \in (G,\ell,L)$ to capture survival beliefs.

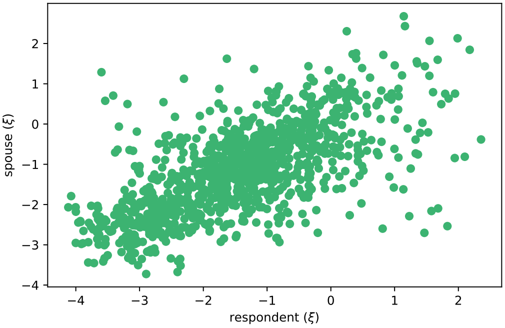
Joint Distribution of Survival Risks

Respondents (and spouse) optimistic.

Figure: Objective and Subjective Survival Beliefs Distributions



(a) Objective



(b) Subjective

House Price Expectations

Objective Risks:

- We use data from Teranet on historical house price indices by census metropolitan area (CMA) for the period 1991 to 2017 to compute annual real growth rates g and volatility σ.
- We test for and do not reject the null of no unit root for ϵ_t using an Augmented Dicky Fuller (ADF) test, for 10 out of the 11 CMAs (Ottawa being the exception).
- Overall, we find heterogeneity in average growth rates over the recent period (2010-2017), with Toronto and Vancouver house prices increasing at a rate of 6.4% and 6.2% per year respectively compared to much more modest growth in Montreal (1.4%) and Calgary or Edmonton (respectively 0.7% and -0.01%) respectively.

house price modelling

Subjective Expectations

- The cumulative change in house prices (percent terms) after T years, $\Delta^T p_t^H = p_{t+T}^H - p_t^H$ is approximately normally distributed with mean $g_{T,c} = Tg_c$ and standard deviation $\sigma_{T,c} = \sqrt{T}\sigma_c$.
- The probability that the cumulative return after 10 years is lower than some threshold p is given by

$$\Pr(\Delta^T p^H < p) = \Phi\left(\frac{p - \mu_i g_{T,c}}{\zeta_i \sigma_{T,c}}\right)$$

- In question Q23 of the survey, respondents report J analogs of these probabilities, $l_{i,j}$, at thresholds $(p_1, ...p_J)$. For each threshold, we set the following restriction:

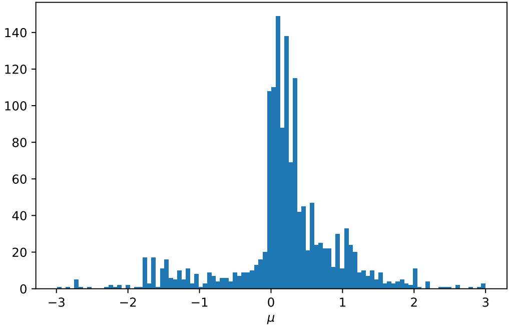
$$l_{i,j} - \Phi\left(\frac{p_j - \mu_i g_{T,c}}{\zeta_i \sigma_{T,c}}\right) = 0$$

  Denote by $L_i(\mu_i, \zeta_i)$ the set of J such restrictions.
- We use a minimum distance estimator to estimate (μ_i, ζ_i) for each respondents,

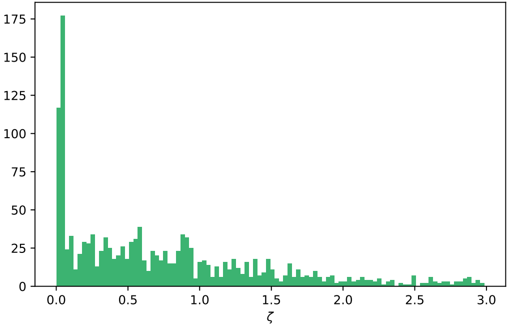
$$(\hat{\mu}_i, \hat{\zeta}_i) = \arg\min_{\mu_i, \zeta_i} L_i(\mu_i, \zeta_i)' L_i(\mu_i, \zeta_i).$$

House Price Expectations

Figure: Distribution of House Price Growth and Volatility Shifter Estimates



(a) Mean growth shifter



(b) Standard deviation shifter

Preference Shifters

We use a set of preference questions to capture preference types. We recode reported answers on Likert scales into binary variables. This introduces heterogeneity in $(\varepsilon, \gamma, b, \nu_h)$.

We ask the following in addition to a standard subjective risk aversion question:

> Q24 Do you agree with the following statements? (Answers: 5 Strongly Agree; 4 Agree; 3 Disagree; 2 Strongly Disagree; 1 Don't know)
> (1) Parents should set aside money to leave to their children or heirs once they die, even when it means somewhat sacrificing their own comfort in retirement
> (2) A house is an asset that should only be sold in case of financial hardship
> (3) I prefer to live well but for fewer years than to live long and have to sacrifice my quality of life

Distribution of Shifters

Estimation

- Each respondent, indexed $i = 1, ..., N$
- Scenarios $k = 1, ..., K$, three-dimensional tuple for the prices $\mathbf{P}_{i,k} = (P^A_{i,k}, P^L_{i,k}, \pi^R_{i,k})$ and for benefits $\mathbf{B}_{i,k} = (b^A_{i,k}, b^L_{i,k}, L_{0,i,k})$ in annuities, LTC insurance and reverse mortgage products.
- $j(k)$ maps to the product type $\{A, L, R\}$ featured in scenario k.
- Each agent i reports probabilities $p_{i,k} \in [0, 1]$ of purchasing product k, relative to the benchmark case $\boldsymbol{B}_{i,0} = (0, 0, 0)$ and $\boldsymbol{P}_{i,0} = (0, 0, 0)$ of no participation in the three products.

Experience Utility

For given parameters θ solve $N \times K$ times for values

$$V_{i,k}(\theta) \equiv V(\boldsymbol{X}_i, \boldsymbol{P}_{i,k}, \boldsymbol{B}_{i,k}, \theta). \tag{1}$$

Define

$$\tilde{V}_{i,k}(\theta) = V_{i,k}(\theta) - V_{i,0}(\theta) \tag{2}$$

This is experience utility gain from purchasing a product

Decision utility

We account for behavioral considerations by specifying instead that agents purchase product k if

$$-\delta^*_{i,j(k)} + \tilde{V}_{i,k}(\theta) + \upsilon_{i,k} > 0, \tag{3}$$

With a logistic assumption on $\upsilon_{i,k}$ we get

$$p_{i,k}(\theta) = \frac{\exp(-\delta_{i,j(k)} + \lambda_{\upsilon,j(k)}\tilde{V}_{i,k}(\theta))}{1 + \exp(-\delta_{i,j(k)} + \lambda_{\upsilon,j(k)}\tilde{V}_{i,k}(\theta))}. \tag{4}$$

Estimator

Concentrated fixed effect NLS estimator:

- Transform $p_{i,k}(\theta)$:

$$g_{i,k} = \log \frac{p_{i,k}}{1 - p_{i,k}} = \delta_{i,j(k)} + \lambda_{\upsilon,j(k)} \tilde{V}_{i,k}(\theta). \tag{5}$$

- Within difference, for a given product, eliminates $\delta_{i,j(k)}$
- For given θ, can estimate $\lambda_{\upsilon,j(k)}$ by OLS. Avoids numerical search jointly with θ.
- allow λ_υ to vary by product type (A, L, R) and also by whether or not respondents know the product based on their responses (if they respond that they know the product *a lot*).
- Estimate θ by NLS.
- Clustered standard errors (at respondent level)
- Over 20 000 DP problems to solve at each iterations...

Parameter Estimates

Table: Non-linear least squares estimates

Parameter	Point estimate	Std. Err.
	a. Base preference	
ε	0.233	0.009
Δ_ε	-0.167	0.024
γ	0.439	0.022
Δ_γ	0.292	0.051
	b. Housing and state-dependence	
ρ	0.877	0.039
$\nu_{c,2}$	0.172	0.019
$\nu_{c,3}$	0.073	0.008
ν_h	0.220	0.421
$\Delta_{\nu h}$	0.009	0.463
	c. Bequests	
b	0.045	0.054
Δ_b	0.124	0.059
	d. Info content utility gradients	
$\lambda_{\upsilon,A(0)}$	0.008	0.006
$\lambda_{\upsilon,A(1)}$	0.007	0.008
$\lambda_{\upsilon,L(0)}$	0.095	0.015
$\lambda_{\upsilon,L(1)}$	0.099	0.016
$\lambda_{\upsilon,R(0)}$	0.010	0.003
$\lambda_{\upsilon,R(1)}$	0.017	0.002
within SSE	7980.57	

Comparison with other studies

Table: Comparison with other preference parameter estimates/calibration

	a. Base preferences			b. Housing		c. Bequests
	Discount	Risk avers.	EIS	ElaS	H-share	Share
Parameter	β	γ	$1/\varepsilon$	$1/\rho$	ν_h	$\tilde{b}$
This paper	0.970	(0.439,0.731)	(4.290,15.15)	1.141	(0.220,0.229)	(0.005,0.042)
CL-20	0.970		0.333	1.250	0.382	0.289
PT-19	0.950	3.780	0.340	1.493	1.000	1.000
L-18	0.975	4.600				0.017
NT-17	0.906	2.006		1.000	0.208	0.050
ILM-11	0.990	5.000	0.500			0.639
DFJ-10	0.970	3.660				0.053

- Andersen et al. (2018, Tab. 1) disentangle risk aversion from EIS and find RRA of 0.45 and EIS of 2.85.
- Boyer et al. (2022, Tab. 1, panel d) report a RRA value (s.d.) of 0.41 (0.91) in a Canadian experiment.

Take-up

Table: Take-up data, estimated and pure model-based

	a. Data	b. Estimated	c. Model-based
ANN	0.115	0.089	0.292
LTCI	0.179	0.157	0.373
RMR	0.080	0.061	0.400

Notes: Mean take-up probability for each product-type; (a) data; (b) predicted using the estimates default-bias $\hat{\delta}_{i,j}$ and noise $\hat{\lambda}_{\upsilon,j}$; (c) predicted by only the life-cycle model utility gradients obtained by setting $\delta_{i,j} = 0$ and $\lambda_{\upsilon,j} = \infty$. Calculated as averages over all scenarios for each product type.

Simulated Decumulation Decumulation Motives

Optimal Risk Management

We run a series of counterfactuals to understand low optimal take-up in the scenarios presented.

Table: Counter-factual optimal take-up of risk management products

Counter-factual	ANN	LTCI	RMR
Baseline	0.294	0.380	0.395
1. No health-dep. margin. utility	0.339	0.438	0.306
2. No subj. survival expectations	0.192	0.197	0.434
3. No subj. house price expectations	0.278	0.390	0.140
4. Constant house prices	0.287	0.361	0.743
5. No resource floor	0.301	0.350	0.341
6. No bequest motive	0.288	0.348	0.420

Pricing

Is the pricing fair in the scenarios given risks observed? We compute respondent-specific fair prices.

Table: Distribution of fair prices

Product	count	mean	std	min	25%	50%	75%	max
ANN	1581	16.946	2.868	6.041	14.854	17.014	19.173	23.441
LTCI	1581	0.101	0.084	0.040	0.062	0.079	0.105	1.592
RMR	1581	0.000	0.001	0.000	0.000	0.000	0.000	0.012

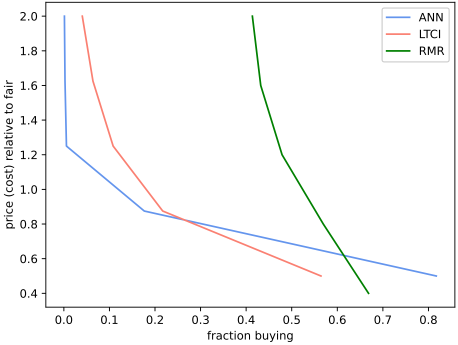
ANN and LTCI Fair Pricing RMR Fair Pricing

Optimal Demand

Prices in scenarios lower for ANN and LTCI, more expensive for RMR.

Comparison with Scenarios

Figure: Demand Curves for Risk Management Products



Bundling

The purchase of each risk management product is considered in isolation. Is there a demand for bundling? Interesting combinations:

- Annuities + Reverse mortgage: This allows to extract home equity and receive it as an annuity to protect against longevity risk.
- Annuities + LTCI: Allows for a state-dependent annuity where the benefit is larger when in poor health. Protects against longevity and health risk.
- RMR and LTCI: The reverse mortgage can help finance premiums for liquidity constrained households.

Bundling

We compare demand for each product individually when the choice set is constrained and when products can be purchased jointly. We allow for extensive and intensive margin (how much to purchase).

Table: Demand for bundling: Pick-up rates

ANN	LTCI	RMR	Joint	Independent
a. Distribution of take-ups				
No	No	No	0.366	0.372
		Yes	0.398	0.421
	Yes	No	0.083	0.078
		Yes	0.054	0.074
Yes	No	No	0.021	0.021
		Yes	0.055	0.016
	Yes	No	0.006	0.008
		Yes	0.016	0.009
b. Total take-ups				
ANN			0.098	0.055
LTCI			0.160	0.169
RMR			0.523	0.521

Conclusion

- Asset decumulation in retirement is complex. Risk management goes hand-in-hand with the speed at which assets are used to finance consumption.
- We estimate a benchmark model of asset decumulation and risk management in retirement from hypothetical choice situations households face.
- Our contribution lies in the identification of preferences from experimental data while accounting for the various complexities households face.
- For estimation, we outfit the optimal choice model with a behavioral apparatous which allows to match choices from the model to choices expressed in the experiment. This allows us to account for status-quo bias as well as noise considerations in hypothetical choice situations.

Conclusion

- Estimates of the model reveal a strong desire on the part of households to substitute consumption intertemporally, modest levels of risk aversion, a decreasing marginal utility of consumption with poor health and a relatively weak preference for bequests.
- Our estimates imply that optimal take-up of fairly priced risk management products is much larger than observed take-ups in the experiment. However, optimal take-up is far from 100% for each products.
- A number of factors play a role in these results.
  - For annuities, existing replacement income from retirement programs appears to generate a relatively low optimal demand for additional annuities.
  - For long-term care insurance, one important factor appears to be the declining marginal utility of consumption with poor health.
  - For reverse mortgages, house price expectations appear to be important.
- Of the three products, the model generates the highest optimal demand for reverse mortgages. There appears to be a high demand in the model for extracting home equity to finance near term consumption as well as the purchase of annuities.

Health Risks

▸▸ Back to roadmap

- States: $\mathcal{A} = \{G, \ell, L\}$, resp. good health, low and high limitations in activities of daily living (ADL) and $\mathcal{D}$ denote death. Observable health status of agent i's is $s_{it} \in \mathcal{S} = \{\mathcal{A}, \mathcal{D}\}$, with $\mathbb{1}^s_{it} = \mathbb{1}(s_{it} = s \in \mathcal{S})$.
- The individual health statuses s_{it} are Markovian, with exogenous, age-dependent 4×4 transition matrices denoted:

$$q^n_{it}(s, s') = \Pr_t\left[s_{it+n} = s' \mid s_{it} = s\right], \quad (s, s') \in \mathcal{S}^2$$

$$\mathbf{q}^n_{it} = \left[q^n_{it}(s, s')\right]_{(s,s')\in\mathcal{S}^2} = \prod_{k=0}^{n-1} \mathbf{q}^1_{it+k}, \quad n = 1, 2, \ldots T - t.$$

- For couples,

$$q^n_{ijt}(s, s') = \Pr_t\left[s_{ijt+n} = s' \mid s_{ijt} = s\right]$$

$$\mathbf{q}^n_{ijt} = \left[q^n_{ijt}(s, s')\right]_{(s,s')\in\mathcal{S}^2\times\mathcal{S}^2} = \mathbf{q}^n_{it} \otimes \mathbf{q}^n_{jt}.$$

- Medical expenses are denoted $M_{ijt} = M(s_{ijt}), \quad s_{ijt} \in \mathcal{S}^2$.

House Price Risk

Back to roadmap

Let $p_t^H \equiv \log(P_t^H)$ denote log home-owning prices P_t^H and let P_t^r denote rental prices, jointly distributed as:

$$p_t^H = g + p_{t-1}^H + \epsilon_t \tag{6a}$$

$$\epsilon_t \sim \mathrm{NID}(0, \sigma^2) \tag{6b}$$

$$P_t^r = \phi P_t^H, \quad \phi \in (0, 1) \tag{6c}$$

We will allow for subjective beliefs to impact this process.

Mortgages

Back to housing We follow Gorea and Midrigan (2018) by modeling mortgages as perpetuals with falling coupons. Specifically, the next-period mortgage value D_{t+1} cannot exceed $\xi^D \in (0,1)$ of outstanding mortgages for continuing owners, i.e. $(H_t, H_{t+1}) = (1,1)$, or a share $\omega^D \in (0,1)$ of house value for new mortgages, i.e. $(H_t, H_{t+1}) = (0,1)$:

$$D_{t+1} \leq \left[\xi^D H_t D_t + (1 - H_t)\omega^D P_t^H\right] H_{t+1}.$$

We will henceforth assume that the constraint is binding, i.e. conditional upon housing statuses (H_t, H_{t+1}), new mortgages D_{t+1} are not a choice variable. Equivalently, the household cannot adjust repayment on outstanding mortgages, and must disburse $(1 - \omega^D)$ of new house purchases as collateral.

Housing Expenses

Back to housing Finally, housing (C_t^H) and moving (MC_t) expenses – incurred only upon a change in housing status – are given as:

$$
\begin{aligned}
C_t^H &= (1 - H_{t+1})\, P_t^r + H_{t+1} P_t^H - D_{t+1}, \\
MC_t &= H_t (1 - H_{t+1}) MC_t^s + (1 - H_t) H_{t+1} MC_t^b, \\
MC_t^k &= \tau_0^k + \tau_1^k P_t^H, \quad k = s, b
\end{aligned}
$$

where τ_0^k, τ_1^k are fixed and proportional costs paid out as moving expenses that may differ for sellers and buyers.

Housing Flows

Back to housing

Table: Home-related statuses, wealth, mortgages, and expenses

	Statuses (H_t, H_{t+1})			
	Renter $(0,0)$	Buyer $(0,1)$	Seller $(1,0)$	Owner $(1,1)$
W_t^H	0	0	$P_t^H - D_t(1+r_d)$	$P_t^H - D_t(1+r_d)$
D_{t+1}	0	$\omega^D P_t^H$	0	$\xi^D D_t$
C_t^H	P_t^r	$(1-\omega^D)P_t^H$	P_t^r	$P_t^H - \xi^D D_t$
MC_t	0	$\tau_0^b + \tau_1^b P_t^H$	$\tau_0^s + \tau_1^s P_t^H$	0
$W_t^H - C_t^H$ $-MC_t$	$-P_t^r$	$-\tau_0^b - (1-\omega^D+\tau_1^b)P_t^H$	$-\tau_0^s + (1-\tau_1^s)P_t^H$ $-D_t(1+r_d) - P_t^r$	$-D_t(1-\xi^D+r_d)$

Net Proceeds from Insurance

Back to Budget Constraint

Table: Net financial revenues

Item	$t = 0$	$t \geq 1$
Z_t^{ben}	$H_t H_{t+1} L_0$	$b^A + \mathbb{1}_{it}^L b^L$
Z_t^{prem}	$P_i^A b^A + P_i^L b^L$	$(\mathbb{1}_{it}^G + \mathbb{1}_{it}^\ell) P_i^L b^L + H_t(1 - H_{t+1}) b_{ijt}$

Transfers

Back to Budget Constraint

Cash-on-Hand is given by

$$\tilde{X}_t = W_t + W_t^H + Y_t + Z_t^{ben} - M_{ijt}$$
$$TR_t = \max\left[X_{\min} + (1 - H_{t+1})P_t^r - \tilde{X}_t, 0\right]$$
$$X_t = \tilde{X}_t + TR_t - C_t^h - MC_t - Z_t^{prem}.$$

The household allocates disposable net cash-on-hand X_t between savings $W_{t+1}/(1 + r_t)$, and non-housing consumption C_t so as to satisfy the budget constraint:

$$\frac{W_{t+1}}{1 + r_t} + C_t \leq X_t$$

Borrowing Constraints

Back to Budget Constraint

- The effective interest rate r_t is higher for borrowers ($r_b \in (r_r, r_h) > r$), especially for borrowing renters ($r_r > r_h$): $r_t = \mathbb{1}_t^b r_b + (1 - \mathbb{1}_t^b) r$ and $r_b = (1 - H_t) r_r + H_t r_h$. [1]
- The maximum amount that can be borrowed X_t^W is determined by both an income (i.e. debt servicing) criterion for all agents, and by a house value (i.e. collateral) criterion in the case of Home Equity Lines of Credits (HELOC's) for owners:

$$-W_{t+1} \leq X_t^W \equiv (1 - H_t)\omega_y(Y_t + TR_t) + H_t \min\left[\omega_y(Y_t + TR_t), \omega_1^h P_t^H, \omega_2^h \max\left(P_t^H - D_t, 0\right)\right].$$

- The borrowing constraint can equivalently be rewritten as an upper bound on household consumption:

$$0 < C_t \leq C_t^{max} \equiv \frac{X_t^W}{1 + r_b} + X_t.$$

[1] $\mathbb{1}_t^b = \mathbb{1}(W_{t+1} \leq 0)$ denotes the borrowing indicator.

Experiment: Long-term care insurance

Back to Scenarios

LTCI Intro Screen: We are going to show you some simple insurance policies and ask you to rate those. You can assume that if you were to have two or more limitations in your activities of daily living (eating, washing, dressing, moving inside the house and getting in and out of bed), the insurance company offering you this product would pay the benefits no matter what the circumstances. Once you receive benefits, you do not pay any premiums. Assume that you will continue to pay premiums until you receive benefits or die.
Each product has two attributes:
a) a monthly premium you have to pay;
b) a monthly benefit if you have 2 or more limitations in your activities of daily living; and
The premium cannot increase once you have purchased the product. Finally, the benefits are adjusted for inflation (indexed).

The benefit is either 2,000C\$ or 4,000C\$ per month. We present each twice, with a randomization of the markup τ_L on market premium by age group and sex (60-64,65-70). The loads considered are (0.5, 0.75, 1.25 and 1.5).

Experiment: Reverse mortgages

Back to Scenarios

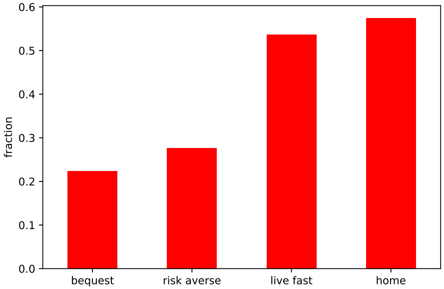
RM Intro Screen: When we use the expression "current home equity", we are referring to the current market value of your primary residence after subtracting outstanding mortgage balances. For the rest of this section, try to have your current home equity in mind. We are going to show you some simple reverse mortgage products and ask you to rate them.
Each reverse mortgage has two attributes:
a) The percentage of your current home equity that you borrow.
b) A fixed annual interest rate on the balance of the loan, generating interests that you do not need to pay before you move, sell or die.
Suppose you have the certainty that you will never be put under pressure to sell your residence and that the contract terms will be respected.

For scenarios, we first set the maximal loan-to-value (LTV) ratio that can be borrowed as a function of the age of the respondent: 30% for those age 60-64 and 40% for those 65-70 (market). We then consider two borrowing levels,: 50% and 100% of maximal LTV. We randomly pick (without replacement) from (2,4,6 and 8%) interest rate $(r_h + \pi)$. The actual rate currently charged for RM is close to 6%. We emphasize the NNEG.

Preference Heterogeneity

Back to Shifters

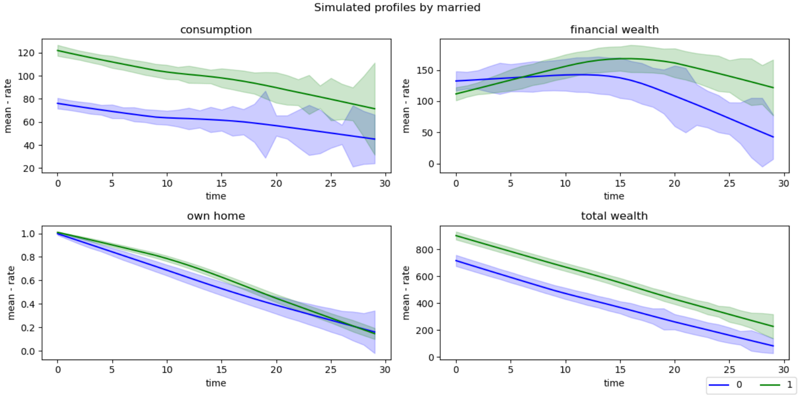
Figure: Preference Types



Spending Down Wealth: What does the Model Predict?

Back to Estimates

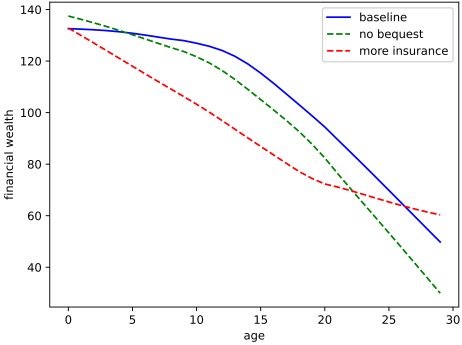
Figure: Simulated profiles by marital status



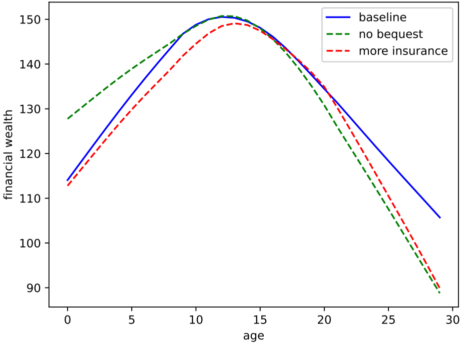
Spending Down Wealth: Why?

Back to Estimates

Figure: What drives wealth decumulation in the model?



(a) Singles



(b) Couples

Fair Pricing of Insurance against Health Risks

Back to Fair Pricing

- Annuities allow to sell part of financial wealth against an annual income flow until death. The premium (fair $\tau^A = 1$) is given by

$$P_i^A = P^A(s_{i0}) = \tau^A \sum_{n=1}^{T} \exp(-rn) \left[1 - q_{i0}^n(s_{i0}, \mathcal{D})\right]$$

- LTCI reduce LTC costs against an annual premium. The premium (fair $\tau^L = 1$) is given by

$$P_i^L = P^L(s_{i0}) = \frac{\tau^L \sum_{n=1}^{T} \exp(-rn) q_{i0}^n(s_{i0}, L)}{\sum_{n=1}^{T} \exp(-rn) \left[q_{i0}^n(s_{i0}, G) + q_{i0}^n(s_{i0}, \ell)\right]}$$

Extracting Home Equity: Fair Reverse mortgages pricing

- The reverse mortgage (RMR) allows owners to borrow up to a share ω^R of house value. The debt at origination L_0 is rolled over until the house is sold following which the cumulated interests and principal must be repaid up to an upper bound determined by house value at termination.
- The RMR contract satisfies the borrowing constraint:

$$H_{t+1}L_0 \leq \omega^R P_t^H H_t, \quad t = 0$$

- The reverse mortgage contract relies on the home-owning continuation probabilities q^h_{ijt}, as well as corresponding survival (i.e. non-termination) up to time t denoted S^h_{ijt} that both depend on the health statuses of household ij's member(s):

$$q^h_{ijt} = \Pr[H_{t+1} = 1 \mid H_t = 1, s_{ijt}], \quad S^h_{ijt} = \prod_{k=0}^{t-1} q^h_{ijk}$$

Fair Pricing of RMR

- To understand the pricing of such a loan, consider the case where a reverse-mortgaged house is sold at time $t = T^h > 0$ (r_h is HELOC rate). The nominal amount due L_{ijt}; loss to lender l_{ijt}; and effective payment by borrower b_{ijt} are:

$$L_{ijt} = L_0 \exp\left[\left(r_h + \tau^R \pi_{ij}\right) t\right],$$
$$l_{ijt} = \max\left[L_{ijt} - P_t^H, 0\right],$$
$$b_{ijt} = \min[L_{ijt}, P_t^H].$$

- The household status-dependent insurance premium $\pi_{ij} = \pi(s_{ij0})$ is implicitly defined from equality between non-negative equity guarantee (NNEG) and mortgage insurance premia (MIP):

$$\underbrace{\mathrm{E}_0 \sum_{t=0}^{T} \exp(-r_h t) S_{ijt}^h (1 - q_{ijt}^h) l_{ijt}}_{\text{NNEG}} = \underbrace{\pi_{ij} \sum_{t=0}^{T} \exp(-r_h t) S_{ijt}^h L_{ijt}}_{\text{MIP}}$$

Drivers of Low Fair Premium on RMR

What explains the very low fair premiums on Reverse mortgages?

Table: Determinants of Reverse Mortgage fair prices

	count	mean	std	min	25%	50%	75%	max
Baseline	1581	0.000	0.001	0.000	0.000	0.000	0.000	0.012
+ No HP Growth	1581	0.001	0.001	0.000	0.000	0.000	0.001	0.015
+ Higher LTV limit	1581	0.011	0.000	0.002	0.004	0.008	0.012	0.049

Notes: The table reports statistics on reverse mortgage premiums (above HELOC rates) under three scenarios: line 1) Baseline scenario, 2) + No house price (HP) growth, 3) + LTV borrowing limit set to 100% of home equity (compared to 55% in baseline scenario).

Back to Fair Pricing

Scenarios vs. Fair Premiums

Table: Comparison

	ANN		LTCI		RMR	
Prices	Survey + Model	Actuar. fair	Survey + Model	Actuar. fair	Survey + Model	Actuar. fair
a. Prices						
mean	11.260	16.946	0.077	0.101	0.054	0.050
min	5.197	6.041	0.061	0.084	0.020	0.050
max	19.242	23.441	0.093	0.159	0.080	0.062
b. Take-up rates						
mean	0.294	0.055	0.380	0.169	0.395	0.521

Back to Demand Curves

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