Longevity, Health and Housing Risks Management in Retirement*

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Abstract

Annuities, long-term care insurance and reverse mortgages remain unpopular products to manage longevity, health and housing price risks after retirement. We analyze the lack of interest using a life-cycle model structurally estimated with a unique stated-preference survey experiment of Canadian households. Low risk aversion, substitution between housing and consumption, and low marginal utility when in poor health explain most of the limited demand. Bequests motives are found to be a luxury good and play a restricted role. The remaining disinterest is explained by information frictions and inertia. We find evidence of strong spousal co-insurance motives motivating LTCI and of responsiveness to bundled products with a near doubling of demand for annuities when reverse mortgages can be used to annuitize home equity.

Keywords— retirement wealth, insurance, longevity, health risk, housing

JEL classification— J14, G52, G53

1 Introduction

Retirees face significant changes in their economic environment.[1] While they can expect to live longer, registered pensions have shifted away from delivering defined benefit (DB) towards more volatile pension income from defined contributions (DC) and self-administered plans. Moreover, households' net worth has increased considerably, with housing and financial assets replacing pension and life insurance claims as the main drivers of growth, and mortgages dominating in terms of liabilities. The combined effects of longevity gains, riskier pension benefits, and increasing contribution of housing wealth, have important implications for two interrelated decision problems: (i) risk management strategies and (ii) financial asset and home equity decumulation. Longer lifetimes raise the risk of outliving one's assets and being exposed to illness associated with old age. Means-tested publicly-provided long-term care (LTC) do not insure against considerable residual out-of-pocket LTC spending risk.[2] Housing equity complicates the decumulation problem even more as it constitutes a lumpy and illiquid type of wealth which is difficult to draw from or use as insurance.[3]

Three financial instruments are particularly relevant for addressing the insurance and decumulation problems. First, annuities (ANN) effectively protect against longevity risk by converting financial wealth into guaranteed cash flows until death. Second, long-term care insurance (LTCI) offers fixed payments when deteriorating health conditions severely limit activities of daily living (ADL), and protects against excessively rapid depletion of resources in the face of surging long-term care expenses. Third, reverse mortgages (RMR) allow house-rich and cash-poor households to tap into their home equity without having to move out of their residence. Indeed, unlike traditional home equity lines of credit (HELOC), an RMR has more flexible debt servicing constraints, and limits exposure to both debt repayment and downward house price risks through non-

[1]Table 1 provides stylized facts for Canada and the US.

[2]See Ameriks et al. (2011), Achou et al. (2022) for imperfect public and private care substitution and Boyer et al. (2020a) for Canada, as well as Palumbo (1999), Scholz et al. (2006), De Nardi et al. (2010), Lockwood (2018), Ameriks et al. (2011, 2020b) for US evidence and discussion of LTC-related risks.

[3]See Cocco and Lopes (2020) for preference for ageing in place after retirement.

recourse protection.[4] However, despite their potential relevance, these three instruments have proven remarkably unpopular in Canada with RMR and LTCI take-up rates even lower than take-up rates of annuities (Boyer et al., 2020a,b, Choinière-Crèvecoeur and Michaud, 2023). Moreover, post-retirement asset decumulation remains unabatedly slow, consistent with precautionary motives, bequests, and housing services (De Nardi et al., 2010, Lockwood, 2018).

This apparent sub-optimality of instruments and decumulation strategies crucially depends on the modeling choices underlying the theoretical prescriptions. This paper characterizes such a benchmark for the three risk management instruments *jointly* while allowing departure from the fully rational expectations paradigm. We solve and estimate a flexible household life cycle (LC) model to assess the contributions of the following factors to explain the lack of demand for ANN, LTCI and RMR: (i) preferences towards risk, housing, health and bequests, (ii) biases in information processing and favoring inaction as well as in expectations, and (iii) heterogeneity in both assets and (objective and subjective) risk exposure of households.

We depart from the standard Revealed Preferences (RP) approach and exploit a different identification strategy using a unique Stated Preferences (SP) survey experiment. We commissioned a pan-Canadian experimental survey of 1,500 individuals aged 60 to 70 covering their financial situation, pension and home-owning statuses, as well as health, household composition, subjective expectations and preferences. Respondents were asked to report the likelihoods of buying annuities, LTCI and RMR for a large set of characteristics (e.g. benefits, restrictions) and price combinations. The two related advantages are that (i) unlike non-experimental data, we effectively control for the unobserved (and potentially endogenous) investment opportunity set of agents and (ii) the randomization of contract attributes provides relevant information towards the identification of the model's parameters. Our estimation framework elicits probabilistic take-up and embeds the fully rational model in a behavioral discrete choice model that

[4] See Shao et al. (2015), Nakajima and Telyukova (2017), Shao et al. (2019), Cocco and Lopes (2020) for discussion of RMR design and demand.

allows for rational inattention in the form of inertia and information frictions following the generalized logit formulation of Matejka and McKay (2015).

Second, we account for the considerable degree of heterogeneity among survey participants in tailoring individual-specific benchmarks. Objective house price distributions are obtained by respondent's residence by census metropolitan area (CMA), and are augmented by individual-specific subjective beliefs about these processes. Furthermore, a dynamic micro-simulation model uses respondents' health and socio-economic status to compute *personalized* objective health transitions probabilities, to which we also append individual-specific subjective beliefs. Finally, we use survey responses regarding attitudes towards risk aversion inter-temporal substitution, housing and bequest motives to complement the identification of preference parameters governing these attitudes. The objective and subjective housing and health distributions, the reported product-specific prior knowledge on annuities, RMR and LTCI, as well as preferences responses are combined to *individually* solve for and map welfare gains into probabilistic take-ups.

The structural model goes a long way towards rationalizing low demand; when abstracting from informational and behavioral biases, the optimal take-up rates falls to only one-third in the scenarios we presented. This suggests that the products offered are far from being uniformly optimal for the majority of respondents. When the biases are re-activated, the take-up rates align with the survey levels of 17.5% (ANN), 17.9% (LTCI) and 8.0% (RMR). Preferences play a major role in generating low optimal take-ups. First, an Arrow-Pratt index of relative risk aversion of 0.56 contributes to low appetite for market-provided insurance procured by ANN, LTCI and RMR. Moreover, the associated high elasticity of inter-temporal substitution (EIS) of 1.78 suggests dominance of substitution over income effects following the large increases in housing returns, consistent with a low demand for liquidating both financial (through ANN) and house equity (through RMR). Second, we identify strong discounts on the marginal utility of consumption in low and high disability states relative to being healthy, consistent with a reduced demand for both state-independent payouts (ANN) and for payments in disability states (LTCI). Third, our results also indicate that housing procures significant distinct utilitarian services, but remains substitutable with consumption, thereby justifying home ownership as a service-providing insurance against post-retirement risks. Fourth, bequests are found to be a luxury good and therefore play a very limited role in explaining low take-up for most respondents.

Non-preference factors are also at play. First, since health shocks are imperfectly correlated, couples demand LTCI to protect each other from medical expenses. Second, biased expectations *increase* demand; over-optimism with respect to longevity justifies more ANN and LTCI, whereas over-pessimism with respect to house prices warrants more RMR. Third, the generous Canadian public pension and health system crowds-out demand for annuities and long-term care insurance. Finally, demand is responsive to packaging; allowing for decisions over product bundles, instead of independent choices, particularly benefits annuities whose take-up rate almost doubles (28.9% to 51.8%) consistent with an optimal ANN-RMR package for house-rich and pension-poor households.

We offer two contributions to the quantitative life cycle literature on slow asset decumulation,[5] annuities,[6] long-term care insurance,[7] and reverse mortgage,[8] (i) we analyze these decisions *jointly* and therefore bridge the gap between otherwise separate strands and (ii) we integrate the role of housing decisions, couples, as well as informational and behavioral biases in financial choices. Among the most related papers is Koijen et al. (2016) who study annuities, life, and LTC insurance by comparing the differential net payoffs of the three instruments across health states (deltas). Whereas we also stress the importance of joint interactions between annuities and LTCI choices, we abstract from the life insurance decisions they consider,[9] thereby channeling all monetary transfers to

[5]See Hurd (1989), Palumbo (1999), Ameriks et al. (2011), Ameriks et al. (2020b), De Nardi et al. (2010) and Lockwood (2018).

[6]See Inkmann et al. (2011), Lockwood (2012), Peijnenburg et al. (2016), Laitner et al. (2018), André et al. (2022) and O'Dea and Sturrock (2023). See Horneff et al. (2008) and Maurer et al. (2013) for models involving deferred variable annuities.

[7]See Pauly (1990), Brown and Finkelstein (2008), Lockwood (2018), Ameriks et al. (2018) and Boyer et al. (2020a).

[8]See Nakajima and Telyukova (2017), Blevins et al. (2020), and Cocco and Lopes (2020).

[9]Life insurance is typically decided at a younger age than in our sample (60–70). See Hong and Rios-Rull (2012, Fig. 1 and Tab. 1) for evidence and discussion.

survivors via bequests. Moreover, whereas they assume perfect substitutability between risk-less bonds and housing wealth, we account for explicit utilitarian housing services, different risky returns, and borrowing constraints, as well as moving-in and -out costs. Importantly, we fully endogenize housing choices, thereby allowing us to consider the important interactions of housing with annuities, RMR and LTCI which are abstracted from in their paper. Finally, we differ in our explicit treatment of household composition risks (i.e. singles vs couples) for risk management which, to our knowledge, remains largely unexplored.[10]

Inkmann et al. (2011) also emphasize bequest motives in a quantitative life-cycle model of annuities. While they consider continuous (rather than one-shot) annuitization and rely on more flexible utility functions, they nonetheless abstract from housing, mortgages (and therefore RMR) choices and risks as well as from morbidity (and therefore LTCI) decisions and risk exposure. Health risks and bequest motives are accounted for in the annuities model of Ameriks et al. (2011) who stress aversion to publicly-provided long-term care as main motive for slow asset decumulation. However both LTCI (separately addressed in Ameriks et al., 2018), as well as housing and RMR choices are abstracted from. Finally our paper is related to the RMR analysis of Nakajima and Telyukova (2017) and Cocco and Lopes (2020) who both consider LC models with uninsurable idiosyncratic risks as well as bequests and precautionary motives in explaining the low demand for RMR. Whereas Nakajima and Telyukova (2017) admit endogenous house size which we abstract from, we are more general in allowing full back and forth transitions between owner and renter statuses, as well as renter borrowing. Similar to us, Cocco and Lopes (2020) consider the role of bequests, uncertain LTC expenditures, and well as expected house price growth to explain low RMR take-up rates. However, they emphasize an age-increasing preference for ageing-in-place that hinders house selling, as well as endogenous maintenance choices as a mean to tap into the housing equity without having to sell,

[10] Notable exceptions include De Nardi et al. (2021) who study post-retirement decumulation of savings in couples and Hubener et al. (2015) who study interactions with social security claiming decisions.

neither of which we consider.[11] We also differ by explicitly considering conventional mortgage debt, allowing for more general access to credit via HELOC's, or consumer credit, rather than via RMR draw-downs exclusively, and by considering couples health dynamics in housing decisions, rather than singles only.

2 Model

2.1 Households, health statuses and insurance

Time $t \in [0, T]$ is discrete, with 0 being the date of interview. Agents live in households as singles (i) or couples (ij), where i is respondent and j is spouse. We follow standard practices in assuming that no new couples are formed for $t \geq 1$, i.e. neither singles nor widowers find new spouses (e.g. Nakajima and Telyukova, 2017).

Similar to Ameriks et al. (2020b), the possible health states for alive agents are denoted by $\mathcal{A} = \{G, \ell, L\}$, respectively good health (G), low (ℓ) and high (L) limitations in activities of daily living (ADL). Letting $\mathcal{D}$ denote death, the health status is $s_{it} \in \mathcal{S} = \{\mathcal{A}, \mathcal{D}\}$, with corresponding indicators $\mathbb{1}^s_{it} = \mathbb{1}(s_{it} = s \in \mathcal{S})$ for single agent i, and is $s_{ijt} \in \mathcal{S}^2$ with indicator $\mathbb{1}^s_{ijt} = \mathbb{1}(s_{ijt} = s \in \mathcal{S}^2)$ for couple ij. We assume Markovian processes with exogenous, age-dependent health transition probabilities:

$$
\begin{aligned}
q^n_{it}(s, s') &= \Pr{}_t \left[s_{it+n} = s' \in \mathcal{S} \mid s_{it} = s \in \mathcal{S} \right] \\
q^n_{ijt}(s, s') &= \Pr{}_t \left[s_{ijt+n} = s' \in \mathcal{S}^2 \mid s_{ijt} = s \in \mathcal{S}^2 \right]
\end{aligned}
$$

over remaining horizon $n \in (1, T - t)$. Aside from death being an absorbing state, the elements $q^n_{it}(s, s')$ and $q^n_{ijt}(s, s')$ of the transition matrices are unrestricted, thereby allowing bi-directional transitions between better and worse states.[12] The household

[11] Preference for ageing in place is partially captured by moving-in/out costs in our model. The absence of maintenance costs induces biases towards more RMR as the only mean to tap into house equity without selling the house, making the RMR puzzle more salient.

[12] For tractability, we assume that the widowed spouse's transition probabilities revert back to her distribution as single. The latter is thus indistinguishable from a widow(er), from a health status perspective.

health expenses are health state-dependent and given as $M_{it} = M(s_{it} \in \mathcal{S})$ and $M_{ijt} = M(s_{ijt} \in \mathcal{S}^2)$, where health deteriorations inducing larger health spending.

Households insure against longevity risk using annuities offered at time 0 to the household head i paying one unit of numeraire upon survival ($s_{it} \in \mathcal{A}$) and zero upon death ($s_{it} = \mathcal{D}$) per dollar of benefits b^A. The total cost of an annuity is $P_i^A b^A$. Insurance against LTC expenditures is also offered at time 0 to the household head i and is characterized by the benefits denoted as b^L paid out conditional upon state $s_{it} = L$ only, and by the premium $P_i^L b^L$ to be paid only in $s_{it} \in \{G, \ell\}$ states. The subsequent scenarios presented to respondents separately alter both prices (P_i^A, P_i^L) and benefits (b^A, b^L).

2.2 Housing markets, states and decisions

Prices, states, and expenditures Let $p_t^H \equiv \log(P_t^H)$ denote the log of house price P_t^H and let P_t^R denote the rental price. We assume that housing prices follow a random walk with drift rate g, and are conditionally independently normally distributed (NID), while the rental prices P_t^R are proportional to house prices:[13]

$$p_t^H = g + p_{t-1}^H + \epsilon_t, \quad \epsilon_t \sim \text{NID}(0, \sigma^2), \tag{1a}$$

$$P_t^R = \phi P_t^H, \quad \phi \in (0, 1). \tag{1b}$$

Households' current home-owning status is denoted $H_t \in \{0, 1\}$ (rent, own), with pairs (H_t, H_{t+1}) denoting (continuing) owners (1,1), sellers (1,0), buyers (0,1) and renters (0,0). Net home equity W_t^H is given by:

$$W_t^H = H_t \left[P_t^H - D_t(1 + r_d) \right], \tag{2}$$

[13]See Cocco and Lopes (2020) for similar housing price hypotheses. For ease of notation, we omit the individual subscript i for house prices, keeping in mind that residential prices are CMA specific processes that vary across agents home location.

where r_d is the rate of interest on mortgages D_t. We follow Gorea and Midrigan (2018) by modeling mortgages as perpetuals with falling coupons, i.e. the next-period mortgage value D_{t+1} is $\xi^D \in (0,1)$ of the outstanding mortgage for continuing owners, or a share $\omega^D \in (0,1)$ of house value for new mortgages:

$$D_{t+1} = \left[\xi^D H_t D_t + (1 - H_t)\omega^D P_t^H\right] H_{t+1}. \tag{3}$$

Residential market imperfections are proxied by ruling out intra-period home repurchases, i.e. a seller must rent for at least one period before purchasing another home, as well as by moving costs. Housing expenses (C_t^H) and moving (MC_t) costs are given by:

$$C_t^H = (1 - H_{t+1}) P_t^R + H_{t+1} P_t^H - D_{t+1}, \tag{4a}$$

$$MC_t = H_t(1 - H_{t+1}) MC_t^s + (1 - H_t) H_{t+1} MC_t^b, \tag{4b}$$

$$MC_t^k = \tau_0^k + \tau_1^k P_t^H, \quad k = s, b \tag{4c}$$

where τ_0^k, τ_1^k in (4c) are fixed and proportional costs paid as moving expenses that may differ for sellers and buyers.

Reverse mortgage A reverse mortgage contract specifies the maximal loan at origination, as well as the nominal and effective amounts due at termination:

$$H_{t+1} L_0 \leq \mathbb{1}(D_t < \omega^R P_t^H) \left(\omega^R P_t^H H_t\right), \quad t = 0 \tag{5a}$$

$$L_{ijt} = L_0 \exp\left[\left(r + \tau^R \pi_{ij}\right) t\right], \tag{5b}$$

$$b_{ijt} = \min[L_{ijt}, P_t^H]. \tag{5c}$$

The maximal reverse mortgage loan L_0 in (5a) is a share ω^R of the house value at origination P_t^H that is lent to admissible home owners whose outstanding conventional mortgage D_t is lower than the RMR loan.[14] The RMR is terminated when the house is sold at time $t \geq 1$, and the amount due by the borrower L_{ijt} in (5b) compounds the interest given by the risk-free rate r plus a risk premium $\pi_{ij} = \pi(s_{ij0})$ which under fair pricing could be household-specific and account for the health status of all members since the latter determines the decision to sell. The effective amount due at termination b_{ijt} in (5c) is the lesser of the debt amount and the selling price (non-recourse protection). The scenarios presented to respondents below will vary both the maximal loan-to-value ω^R and the risk premium $\tau^R \pi_{ij}$ charged for the RMR.

2.3 Financial and borrowing constraints

Net revenue flows Household income Y_t pools all income sources of living household members and is independent of health status. Additional net financial flows Z_t aggregate net proceeds from annuity, LTC insurance and RMR choices, and differ across initial ($t = 0$) and subsequent periods:

$$\begin{aligned} Z_t &= Z_t^{ben} - Z_t^{prem}, \quad \text{where} \\ Z_t^{ben} &= \mathbb{1}_{t=0} H_t H_{t+1}(L_0 - D_0) + (1 - \mathbb{1}_{t=0}) \left[b^A + \mathbb{1}_{it}^L b^L \right], \\ Z_t^{prem} &= \mathbb{1}_{t=0} \left[P_i^A b^A + P_i^L b^L \right] + (1 - \mathbb{1}_{t=0}) \left[(\mathbb{1}_{it}^G + \mathbb{1}_{it}^\ell) P_i^L b^L + H_t(1 - H_{t+1}) b_{ijt} \right]. \end{aligned} \tag{6a}$$

Time-0 owners receive the reverse mortgage loan net of any outstanding mortgage ($L_0 - D_0$) while the household purchases $P_i^A b^A$ of ANN and $P_i^L b^L$ of LTCI. For the subsequent periods, annuities b^A are collected, insured agents with high ADL limitations ($\mathbb{1}_{it}^L = 1$) receive the insurance benefit b^L, and otherwise continue to pay the premium. Home sellers repay the effective reverse mortgage payment b_{ijt} given by (5c).

Means-tested government transfer programs complete the pre-transfer (gross) cash-on-hand $\tilde{X}_t$ in (6b), which includes financial wealth W_t, net housing wealth W_t^H in (2),

[14] As in the US, Canadian households are first required to repay any outstanding conventional mortgages with reverse mortgage loans to maintain top seniority of RMR issuer with respect to home-secured loans. Observe that since the RMR debt is not repaid before the house is sold, debt-servicing borrowing constraints linked to the agent's income are absent from (5a).

income Y_t, plus financial benefits Z_t^{ben} in (6a), minus health expenditures M_{ijt}. Cash-on-hand before transfers is compared to a threshold $X_{\min}$ in (6c) to determine eligibility to transfer income:

$$\tilde{X}_t = W_t + W_t^H + Y_t + Z_t^{ben} - M_{ijt}, \tag{6b}$$

$$TR_t = \max\left[X_{\min} + (1 - H_{t+1})P_t^R - \tilde{X}_t, 0\right], \tag{6c}$$

$$X_t = \tilde{X}_t + TR_t - C_t^h - MC_t - Z_t^{prem}. \tag{6d}$$

Eligible households with resources $\tilde{X}_t < X_{\min}$ are entitled to a transfer $TR_t \geq 0$ which subsidizes rental housing and bridges the gap to guarantee a minimal consumption floor equal to $X_{\min}$. The net post-transfer cash-on-hand X_t in (6d), aggregates the two, subtracts housing expenses C_t^H in (4a), moving costs MC_t in (4b), as well net financial flows from risk management products Z_t^{prem}.

Budget and borrowing constraints The household allocates cash-on-hand X_t in (6d) between financial wealth $W_{t+1}/(1 + r_t)$, and non-housing consumption C_t to satisfy the budget constraint:

$$\frac{W_{t+1}}{1 + r_t} + C_t \leq X_t. \tag{6e}$$

Financial market frictions are modeled in two ways. First, the effective interest rate r_t is empirically lower for savers than for borrowers ($\mathbb{1}_t^b = 1$), especially for borrowing renters ($r < r_h < r_r$):

$$r_t = \mathbb{1}_t^b \left[H_t r_h + (1 - H_t) r_r\right] + (1 - \mathbb{1}_t^b) r \tag{7a}$$

Second, the maximum amount that can be borrowed $-W_{t+1} \leq X_t^W$ is determined by both an income test (all agents), and by a home equity (home owners) test for HELOC:

$$\begin{aligned} X_t^W \equiv\, & (1 - H_t)\omega_y(Y_t + TR_t) \\ & + H_t \min\left[\omega_y(Y_t + TR_t), \omega_1^h P_t^H, \omega_2^h \max\left(P_t^H - D_t, 0\right)\right]. \end{aligned} \tag{7b}$$

The debt servicing requirements (7b) restrict both renters and owners to borrow at most ω_y of income plus transfers. HELOC's allow eligible owners to borrow the lesser of ω_1^h of house price, or of ω_2^h of the house value minus outstanding mortgages.

2.4 Preferences and household's problem

Given the household's current health status $s_{ijt} =\in \mathcal{S}^2$, the within-period felicity $u_{ijt} = u(s_{ijt})$ and continuation utility $V_{ijt} = V(s_{ijt})$, the problem is given by:

$$V_{ijt} = \max \frac{u_{ijt}^{1-\gamma}}{1-\gamma} + \beta \mathrm{E}_t \sum_{s' \in \mathcal{S}^2} q_{ijt}^1(s, s') V_{ijt+1} \tag{8a}$$

$$u_{ijt} = \left(n_t^{-1} \nu_{ijt}\right) C_t^\rho S_t^{H\,1-\rho} \tag{8b}$$

$$S_t^H = [\phi + H_t \nu^H] P_0^H \tag{8c}$$

$$V_{ijt+1} = \frac{b\left[X_{t+1} + \kappa\right]^{1-\gamma}}{1-\gamma}, \quad \text{for } s' = (\mathcal{D}', \mathcal{D}'), \tag{8d}$$

where β is a subjective discount factor. The curvature index γ in (8a) is linked to the consumption RRA $\tilde{\gamma} = (1-\rho) + \gamma\rho$, and the elasticity of inter-temporal substitution (EIS) is $1/\tilde{\gamma}$ Similar to Nakajima and Telyukova (2017), we use a Cobb-Douglas with consumption share ρ to aggregate consumption and home-owning utilitarian services S_t^H in utility (8b). Housing services in (8c) are benchmarked by the rent paid $P_t^R = \phi P_t^H$ by renters ($H_t = 0$), and the incremental services ν^H provided from owning a house ($H_t = 1$). We fix housing prices at the initial time, P_0^H, such that changes in housing services S_t^H are caused by endogenous housing decisions H_t only, rather than by exogenous fluctuations in housing prices. The health-dependent taste shocks $\nu_{ijt} = \nu(s_{ijt})$ alter utility in different health states, and the utility flows are averaged for couples by dividing by the equivalent scale for household size n_t.[15] Finally, V_{ijt+1} in (8d) is the (warm-glow) utility of bequest in (6d) with b capturing the strength of the bequest motive, and $\tilde{b} \equiv b^{1/(1-\gamma)}$ measuring the intended share of bequeathed cash-on-hand X_{t+1}, and parameter κ capturing whether bequests are a luxury good ($\kappa > 0$), or a necessity ($\kappa < 0$).[16] The optimization (8) is subject to constraints (3), (5a), (7) and (6), with time-varying controls $\{C_t, H_{t+1}, \mathbb{1}_{t=0}(b^A, b^L, L_0)\}$, and states $\{D_t, W_t, s_{ijt}, H_t, P_t^H, (1 - \mathbb{1}_{t=0})(b^A, b^L, L_0)\}$ sets. Unsurprisingly, analytical solutions to this problem are intractable and we resort to numerical methods described in Online Appendix A to solve the model.

3 Data

3.1 Survey design

In April/May 2019, we fielded an online survey with *Asking Canadians* targeting individuals age 60 to 70 from the 11 largest census metropolitan areas (CMA) in Canada, i.e. the cities with most important increases in house prices and therefore with the highest potential for home equity extraction.[17] The survey, detailed in Online Appendix F, covers (i) background socio-demographic and financial information, (ii) risk perceptions, (iii) knowledge of financial products, and (iv) stated-preference experiments for annuities, long-term care insurance and reverse mortgages. We imputed missing values for financial variables using unfolding bracket questions, imposed top-coding and filters for sample selection. Out of the 3,057 completed surveys, we filter out renters and those with

[15] We follow Scholz et al. (2006) in setting $n_t = 1.55$ for couples, and $n_t = 1$ for singles. See also De Nardi et al. (2021), Nakajima and Telyukova (2017) for similar equivalent scale values.

[16] See De Nardi et al. (2010) for discussion.

[17] *Asking Canadians* is a web-based panel with more than 2 million members, where respondents are rewarded for their participation using a loyalty point system. The CMA's we considered and housing prices are listed in Table 5.

critically missing or implausible responses. The final dataset contains 1,581 households, 1,164 of which are couples.[18]

Descriptive (unweighted) statistics in Table 2 reveal that the average current income of respondents ($Y_{i,0}$) is 71,810C$ while that of spouses ($Y_{j,0}$) is 51,621C$.[19] Respondents are either retired or close to retirement ($\mathrm{E}[t_{i,r}, t_{jr}] = 1.1$ year); retirement income ($Y^R_{i,0}, Y^R_{j,0}$) is either current income (for those retired) or projected retirement income for those who are still working, and is lower on average than current income. The outstanding mortgage debt (D_t) is 28,487C$, while the average house value (P^h_0) is 710,711C$. Average non-housing wealth (W_0) is 226,818C$ (median 190,000C$) and characterized by considerable heterogeneity, with 7% of households having less than 5,000C$.[20]

3.2 Health status, beliefs and preference heterogeneity

Health status Given our focus on long-term care risk and that Canada has a universal health insurance system for medical services, health status in the model is defined on the basis of limitations with instrumental (IADL) or basic (ADL) activities of daily living.[21] Respondents are classified as being in good health (G, no limitations), mild limitations (ℓ, some IADL, at most one ADL) and as having severe limitations (L two or more ADL). The distribution of health status reveals that the sample is generally healthy, with less than 5% among singles, and 6.5% among couples reporting current limitations.

[18]Missing-values imputations were done using chained multivariate regression, conditional on bracketing. Income responses were top-coded at 500,000C$ and financial wealth as well as mortgage debt at 1,000,000C$. Renters, and respondents with outlier responses to questions on home equity, mortgage balance and payments, rent, retirement age (max 10 years before retiring) and income, or couples with more than 10 years age difference were dropped.

[19]Amounts are reported in Canadian dollars C$ in the paper (2019 exchange: 1.0C$ = 0.75US$).

[20]National data for Canadian residents aged 65 and over reveals that average household revenue was 60,182C$ in 2019 (Statistics Canada, 2023a), whereas mean mortgages were 21,359C$, average residential and financial wealth were 334,671C$ and 407,352C$ respectively (Statistics Canada, 2023b). The lower residential wealth in the population reflects the inclusion of non-owners, and the pan-Canadian coverage in national statistics, compared to our sample of urban home-owners exclusively with higher residential values.

[21]IADL: preparing meals, doing shopping, doing housework, managing bills, going to the toilet or taking medication. ADL: eating, washing, dressing, moving inside the house and getting in and out of bed.

Longevity expectations Respondents reported their subjective probability of surviving up to age 85. Figure 1 shows the CDF for the respondent (panel a) and spouse (panel b). Comparing with objective life tables reveals some degree of survival over-optimism; male (resp. female) respondents report a subjective 72% (resp. female 73%) probability of surviving up to 85, compared to an objective likelihood of 51.4% (resp. female 63.7%).[22]

House price expectations Figure 2.a plots the households' subjective expected house price growth in the next 10 years. Respondents assign a 30% probability of a drop in prices, with most pessimistic outlooks for residents of Calgary and Edmonton, as well as a 10% probability on price increases of more than 40% in other CMAs. Panel b shows the actual house price index over the 10 years prior to the survey, indicating a near doubling of house prices over that period (Toronto, Vancouver and Hamilton) and 15-40% increases in house prices in other CMAs. Respondents are thus over-pessimistic with respect to house price increases over the next 10 years.

Preferences heterogeneity Preference heterogeneity is assessed via a series of statements to be rated from *Strongly Disagree* to *Strongly Agree*, and recoded as binary variables equal to one for Agree and Strongly Agree. Two statements separately gauge a preference for a bequest motive (b), as well as preference for housing (ν^H),[23] whereas risk aversion levels are ranked from very low to high and extreme risk aversion.[24] Relatively few of the respondents report a strong bequest motive (20%) and substantial risk aversion (28%), whereas 55% report a strong preference for staying at home. These are used for as preference shifters, as explained later.

[22]Objective probabilities at age 65 in 2019 obtained from Life Tables (Statistics Canada, 2023d). Retirees' over-optimism regarding survival at 85 is a common finding in the literature (e.g. Hurd and McGarry, 2002) while younger respondents tend to be pessimistic (O'Dea and Sturrock, 2023).

[23]Respectively "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." for b and "A house is an asset that should only be sold in case of financial hardship." for ν^H

[24]Low willingness to take substantial risk to earn substantial returns. High: willingness to accept below average returns in exchange for below average risk. Extreme: willingness to accept low returns in exchange of zero risk.

3.3 The stated-choice experiment

The core component of the survey in Online Appendix F is a stated-choice experiment designed to elicit demand for three risk management products of interest, where each respondent was presented with 4 separate choice situations per product. In order to reduce the complexity, the scenarios were presented one product at a time, i.e. joint (bundled) products scenarios were omitted from the survey.

Annuities Consistent with the literature, the intro screen shown to respondents with positive financial wealth reviews relevant information on the main features of annuities, i.e. the immediate one-shot premium to be paid and the monthly benefit starting next year and paid until death.[25] To neutralize other explanations for low take-up, we emphasize that there is neither default risk (payments will be made no matter the circumstances), nor inflation risk by considering indexed benefits. In the spirit of Boyer et al. (2020b), respondents are presented with scenarios corresponding to two different level of annuitization of financial wealth repeated twice (20% and 50% of $W_{i,0}$), for which the price is drawn randomly twice (without replacement) using four markups $\tau_A \in [0.5, 1.75]$ on the actuarialy fair premium P^A.[26] For each of the four scenarios, respondents are asked to report the probability of purchase within the next year.

Reverse mortgages The intro screen was shown to home-owners who do not yet have a RMR contract describing the percentage of net home equity which can be borrowed, and the fixed interest on the loan amount. We make explicit reference to net home equity (house value minus outstanding mortgages) as basis for maximal borrowing, mention that cumulated interests need to be paid out only when the RMR buyer moves out (sells or dies) and stress the non-recourse guarantee on RMR loans whereby the amount due at house sale or agent's death could not exceed the house value at that date. We also

[25]See Benartzi et al. (2011), Brown et al. (2019), Luttmer et al. (2022) on the importance of framing, minimizing complexity and emphasizing salient features in annuities decisions.

[26]The actuarial premium, by age and sex, is then computed using yields on annuities for Canadian singles provided by CANNEX, a private data provider on life insurance and annuity products.

emphasize that home owners would not be forced to sell their home by RMR providers, and that there is no contract risk (e.g. risk that the lender defaults or changes rules). For each of the four scenarios, we first set the age-dependent maximal LTV ratio that can be borrowed (30% for 60-64, 40% for 65-70) and consider 50% and 100% of that maximal loan-to-value (LTV). We repeat each twice and randomize (without replacement) the interest rate charged on the loan (from 2, 4, 6 and 8%), thereby spanning the actual rate of 6% on RMRs observed on the Canadian market. For each respondent, we collect the four probabilities of purchase for these RMR products.

Long-term care insurance The intro screen was shown to respondents who do not yet have LTCI. As in Boyer et al. (2020a), respondents are informed about the monthly benefits for agents with two or more limitations in activities of daily living (defined in earlier segment) and the monthly premium to be paid otherwise. We stressed ideal conditions whereby there was no default risk, nor lapsing in the payment of premiums, that premiums cannot increase over time and that benefits (either 2,000C$ or 4,000C$ per month) would be adjusted for inflation.[27] Each scenario are presented twice, with a randomization of the markup $\tau_L \in [0.5, 1.75]$ on actuarial premium P^L calculated by age group (60-64, 65-70) and gender and purchase probabilities are recorded.

Take-up probabilities, product knowledge and elasticities Table 3 reports statistics on product takeup, prior knowledge, as well as elasticities.[28] Responses indicate low take-ups for ANN and RMR (10.8% and 7.3%) and sizable zero take-ups across all scenarios for the two (55.8% and 83.8%), despite moderate knowledge (26.9% and 28.7%). Conversely, despite less prior knowledge of 10.9%, respondents report higher take-up intentions for LTCI with a 17.4% probability of buying and a 39.2% probability of never buying. Both price and benefits elasticities are of the correct sign for all three products.

[27]The respondents are asked to abstract from a real-life provision for contract termination when monthly payments are not made.

[28]Prior to being presented with the scenarios, respondents were asked whether they knew (i.e. a lot, a little, not at all) about each of the products.

4 Empirical framework

4.1 Calibration of auxiliary parameters and stochastic processes

Auxiliary parameters The choice for the calibrated auxiliary parameters is detailed in Online Appendix B and reported in Table 4. The interest rate in panel a is set at 1%, with higher mortgage, HELOC and credit card rates obtained from market data. The borrowing constraints in panel b are also market-based, with amortization calculated for a typical 25-year mortgage. Rental rates are set at 3.5% of home value in panel c, with moving costs set from typical fixed and variable real estate and moving companies. Finally, the consumption floor in panel d is set at 18.5KC$, and obtained from first-pillar public pension programs, whereas the discount factor is set to $\beta = 0.97$.

House prices We use data from Teranet on historical house price indices by census metropolitan area, as well as CMA-level deflators to compute the annual real growth rates g and volatility σ over the period 1997 to 2017 reported in Table 5.a. We test for and do not reject the null of a unit root for ϵ_t in (1a) using an Augmented Dicky Fuller (ADF) test, for all CMAs except Ottawa.[29] 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 more modest growth in Montreal (1.4%) and Calgary or Edmonton (respectively 0.7% and -0.01%). Disparities between subjective and objective house prices distributions are also accounted for. We model the perceived expected return as well as standard deviation as $g_i = \mu_i g_c$ and $\sigma_{T,i} = \zeta_i \sigma_c$ where μ_i and ζ_i are respondent-specific over-optimism or pessimism parameters.[30] The corresponding estimated distributions are plotted in panels c, d of Figure 2, confirming that respondents are much more pessimistic about house price growth with an average μ

[29]For certain CMAs, we find some evidence of serial correlation in growth rates. The evidence is broadly consistent with the random walk assumption for p_t^H in (1).

[30]Survey responses on the subjective probability that house prices with increase (or decrease) over the next 10 years are used to estimate μ_i and ζ_i. See Online Appendix C for details.

of 0.10 in panel a, but correctly perceive the volatility of house prices with an average ζ of 0.96 in panel b.

Health risk process and expenditures Respondent- (and spouse-) specific rates of transitions $q^n_{ijt}(s, s')$ across health states $s, s' \in \{G, \ell, L, D\}^2$ are required to solve the model. The survey asks about current health status in terms of common health conditions (mental health problems, hypertension, diabetes, heart disease, stroke, cancer and lung disease), as well as about smoking status and gives information on age, gender as well as education as a marker of socio-economic status. Following Boyer et al. (2020a), we use a dynamic health microsimulation model to measure the objective transitions of each respondents as a function of these inputs.[31] Next, we also account for subjective survival expectations reported by respondents as the probability of surviving to age 85. We use the objective parameters from the preceding step to compute the predicted objective probability of surviving to age 85. For both respondent and spouses, we then estimate a subjective correction to objective mortality probabilities from any state to death.

Figure 1.c shows a scatter plot of respondent's objective probabilities of surviving to age 85. There is substantial heterogeneity in the sample, along with a positive correlation within couples. In panel d, we report a scatter plot of the distribution of mortality belief parameters for respondents and spouses. A positive value of this mortality belief parameter denotes a respondent who is more pessimistic than the prediction from the objective health model. On average, respondents are optimistic about their survival prospects with average mortality correction $\xi = -1.42$, however with considerable heterogeneity, as well as correlation in these beliefs, which was to be expected given that the respondent also reports the survival probability for the spouse. Finally, the health costs estimates are computed by CMA and health status. Table 5.b displays sharp increases in deteriorated states and considerable regional variation.

[31]See Online Appendix C for details on how we use these simulated health profiles to estimate a respondent-specific dynamic multinomial logit model for the Markov transition probabilities $q_{it}(s, s')$.

4.2 Structural estimation

Respondents' characteristics and preferences shifters The set $\boldsymbol{X}_i$ of individual-i's observable characteristics at the time of the survey experiment include age, pre- and post-retirement incomes Y_t and health status for both respondent and spouse (if any) s_{ijt}. It also includes household level variables such as home ownership status H_t, marital status, CMA (metropolitan area), financial wealth W_t, the value of the house P_t^H, and mortgage D_t as well as the health transition probabilities for both respondent and spouse q_{ijt}^n that were estimated separately from the micro-simulation described earlier. Preferences are also allowed to vary across respondents, with the shifter parameter Δ_γ being used for those who report being highly risk averse, Δ_{ν^h} for those who express a strong preference for keeping their homes, and Δ_b for those who express a stronger bequest motive.

Reporting model Each respondent $i = 1, \ldots, N$ was presented with scenarios indexed $k = 1, \ldots, K$ consisting of a three-dimensional tuple for the prices $\boldsymbol{P}_{i,k} = (P_{i,k}^A, P_{i,k}^L, \pi_{i,k}^R)$ and for benefits $\boldsymbol{B}_{i,k} = (b_{i,k}^A, b_{i,k}^L, L_{0,i,k})$ of annuities, LTC insurance and reverse mortgage products, for which (s)he reported purchasing probabilities $p_{i,k} \in [0,1]$.[32] Let $\boldsymbol{\theta} = (\gamma, \Delta_\gamma, \rho, b, \Delta_b, \kappa, \nu_{c,2}, \nu_{c,3}, \nu_h, \Delta_\nu)$ denote the estimated structural parameters, conditional upon which the indirect utility solving (8) in scenario k is defined as $V_{i,k}(\boldsymbol{\theta}) \equiv V(\boldsymbol{X}_i, \boldsymbol{P}_{i,k}, \boldsymbol{B}_{i,k}, \boldsymbol{\theta})$. The indirect utility gain to respondent i of purchasing product k can be written as:

$$\tilde{V}_{i,k}(\boldsymbol{\theta}) = V_{i,k}(\boldsymbol{\theta}) - V_{i,0}(\boldsymbol{\theta}), \tag{9}$$

where $V_{i,0}$ is the no-participation benchmark case corresponding to $\boldsymbol{B}_{i,0} = (0,0,0)$ and $\boldsymbol{P}_{i,0} = (0,0,0)$.

We next consider the mapping of indirect utility gains $\tilde{V}_{i,k}(\boldsymbol{\theta})$ to respondents' decisions allowing for departures from the fully rational life-cycle model. Matejka and McKay

[32]The number of presented scenarios $K_i \leq 12$ is respondent-specific, as certain respondents will be presented with fewer choices if insufficient financial resources.

(2015) show that, under mild assumptions, choice under rational inattention can be represented using a generalized logit model with a individual specific intercept and a scale parameter that dampens the effect of experience utility on decision utility.[33] We follow this insight by assuming that respondents make decisions based on a noisy measure of the indirect utility gain in (9) associated with a particular scenario. They purchase product k if:

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

where $n(k)$ maps scenario k to the product type $\{A, L, R\}$. The error term $\upsilon_{i,k}$ follows a logistic distribution with product-specific scale parameter $\sigma_{\upsilon,n}$ measuring the importance of noise in self-reports relative to the signal coming from the utility differences. This idiosyncratic noise can be motivated by the presence of unspecified features of the environment in the scenarios presented. It also allows to capture inattention to the information provided by the welfare change $\tilde{V}_{i,k}$. The parameter $\delta^*_{i,n}$ is a respondent-i and product-type $n = A, L, R$ specific fixed effect that captures inertia. Given welfare gain $\tilde{V}_{i,k}$ in (9), the larger is $\delta^*_{i,n}$, the less likely is respondent i to purchase a product of type n in a given scenario.[34]

Following Matejka and McKay (2015), the self-reported probability $p_{i,k} \in [0, 1]$ for respondent i of purchasing the financial product in scenario k can be contrasted with its theoretical counterpart, defined as

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

where $\delta_{i,n} = \delta^*_{i,n}/\sigma_{\upsilon,n}$ and $\lambda_{\upsilon,n} = 1/\sigma_{\upsilon,n}$. A respondent who makes choices free of noise ($\sigma_{\upsilon,n} \to 0$) and inertia ($\delta_{i,n} = 0$) will purchase the product in scenario k with degenerate

[33]The links between rational inattention due to costly information acquisition and/or processing and stochastic choices are also explored in Sims (2003), Caplin et al. (2019) among others. Extensions are discussed in Steiner et al. (2017) who provide rationales for logit representations with status-quo bias in the context of rational inattention.

[34]This approach is also similar in spirit to Ameriks et al. (2020a) who discuss attenuation biases in risky asset holdings and to Handel and Kolstad (2015) who also emphasize product-specific informational and inertia in the context of health insurance.

probability $\mathbb{1}_{\tilde{V}_{i,k}>0} \in \{0,1\}$ determined by the sign of the indirect utility gain $\tilde{V}_{i,k}$ only. As discussed in Online Appendix D, the estimation relies on a within transformation per product on the log-odds ratio to eliminate $\delta_{i,n(k)}$; the OLS estimator of $\lambda_{v,n(k)}$ from the ratio on the welfare gain is then concentrated-out, to obtain a non-linear least squares (NLLS) estimator of the deep parameters $\boldsymbol{\theta}$.

5 Estimation results

5.1 Preference parameters

Risk aversion and EIS We estimate a curvature parameter $\gamma = 0.459$ ($s.e. = 0.026$) in Table 6.a which corresponds to a consumption RRA index of $\tilde{\gamma} = (1-\rho) + \gamma\rho = 0.561$. We find no evidence of heterogeneity with those reporting being highly risk averse having a marginally higher curvature ($\Delta_\gamma = 0.018$) that is statistically insignificant. Our estimate, using a very unique experiment on risk management products, is consistent with estimates of relative risk aversion in risk preference experiments. For example, the seminal study by Holt and Laury (2002) finds that a large fraction of respondents in their experiment are in the 0.3 to 0.5 range in terms of relative risk aversion. Andersen et al. (2008) use a field experiment to elicite risk aversion and time preference and report a relative risk aversion coefficient of 0.741. Boyer et al. (2020b) replicate the Holt and Laury (2002) incentivized experiment for Canada and find an average relative risk aversion estimate of 0.42. Closer to our setting, Hurd (1989) focuses on asset decumulation and estimates the RRA between 0.73 and 1.12 using consumption data and identification that relies on variation in mortality rates. Salm (2010) uses subjective mortality risk and consumption data to estimate the RRA at 0.55, very close to our estimate of 0.561. Overall, our estimate is not very different from studies estimating risk aversion from consumption data. A meta-analysis by Elminejad et al. (2022) reports estimates of RRA that are centered on 1 in Economics using the consumption Euler methodology, while estimates from the Finance literature are often above 2. Indeed, our RRA estimate is lower than those obtained from using wealth data for identification. For example, De Nardi et al. (2010) estimate the RRA to be 3.81. In a specification with a similar discount factor to ours, Lockwood (2018) estimates an RRA of 2. We investigate the implications of these estimates in a counterfactual exercise below. The implied elasticity of intertemporal substitution $1/0.561 = 1.78$ is consistent with the asset pricing literature emphasizing long-term consumption risks (such as health and housing related) which advocates an EIS larger than one.[35]

State-dependent preferences Relative to being in good health ($\nu_{c,G} \equiv 1.0$), the state-dependent parameters in Table 6.b are indicative of strong declines in the marginal utility of consumption in low- ($\nu_{c,\ell} = 0.235$) and high-ADL limitations states ($\nu_{c,L} = 0.043$). These parameters are consistent with other findings on detrimental effects of poor health on the marginal utility of consumption.[36]

Housing Table 6.c reveals a high consumption share $\rho = 0.812$ and a calibrated unit elasticity of intratemporal substitution between consumption and housing that are similar to the calibrated values in Nakajima and Telyukova (2017), Achou (2021) and are realistic compared to other values (e.g. Cocco and Lopes, 2020, Pelletier and Tunc, 2019). We also identify a positive utilitarian benefit of home ownership $\nu_h = 0.312$. This housing utility is slightly higher, although not statistically significant, for respondents expressing a preference for keeping their home as long as possible ($\Delta_{\nu^h} = 0.037$).

Bequests We find evidence of a bequest motive in Table 6.d, with a statistically significant $b = 0.342$. This value implies a share of wealth to be bequeathed $\tilde{b} = b^{1/(1-\gamma)} = 0.138$ that is within the range of equivalent estimates (e.g. Cocco and Lopes, 2020, Inkmann et al., 2011, De Nardi et al., 2010, Koijen et al., 2016) and corresponds to

[35]See Bansal and Yaron (2004) for examples and Epstein et al. (2014) for discussion. For completeness, we also estimated a more flexible Epstein-Zin specification that disentangles the inverse EIS from the RRA. However, we could not reject the VNM restriction, and found limited improvement in fit.

[36]Finkelstein et al. (2013), Koijen et al. (2016), Peijnenburg et al. (2017), De Nardi et al. (2010), De Nardi et al. (2021) all document declining marginal utility of consumption in deteriorated health statuses.

an intended bequest of 109K\$ at mean financial + residential wealth in Table 2. Again, heterogeneity is not apparent; those who do express a stronger bequest motive (20% of our sample) have a statistically insignificant increment $\Delta_b = 0.102$. The curvature parameter $\kappa = 119.5$ is significant, realistic and indicative of bequests being luxury goods.[37]

5.2 Informational frictions and inertia

Info content of utility gradients With the exception of $\lambda_{v,A(1)}$, the parameters λ_v in Table 6.d are all positive, finite and statistically significant, confirming that respondents' choices correlate positively with the estimated utility gradients of purchasing particular products and cannot entirely be explained by random decisions ($\lambda_{v,n} = 0$). Interestingly, with the exception of annuities, better prior knowledge ($\lambda_{v,n(1)}$) is associated with a higher weight attributed to indirect utility gains/losses, consistent with costly information acquisition/processing interpretations of the λ terms.

Inertia and product knowledge Figure 3 plots the CDF of the agents-specific $\delta_{i,n(k)}$. The estimates reveal that inertia is (i) higher and less dispersed for both ANN and RMR, and (ii) significantly lower among respondents with prior product knowledge.[38] Conversely, the biases are lower, more dispersed, and less affected by product knowledge for LTCI. In short, respondents with prior knowledge (i) rely more heavily on model-based analysis, (ii) display lower inertia and (iii) are less likely to report no take-up in selecting risk management products.

[37] In particular, bequest motives only become operational past a threshold consumption level of $\kappa =$ 119.5K\$ and exhibit lower and increasing relative risk aversion compared to the CRRA. See also De Nardi (2004), Lockwood (2018), Ameriks et al. (2020b) for discussion.

[38] The t-values of differences in the inertia bias $\delta_{i,n(k)}$ classified by prior knowledge are -4.12 (ANN), and -2.10 (RMR) and not significant for LTCI. Other results show that inertia are (i) imperfectly correlated across products (Corr $\approx$ 0.40), (ii) lower for respondents with university degrees (ANN, LTCI), (iii) higher for the elderly (LTCI, RMR), and (iv) orthogonal to marital or children statuses.

5.3 In-sample model performance

Take-up rates We use a comparative statics exercise to identify the respective contributions to the take-up rates of (i) the pure model-based predictions and (ii) the model augmented with informational and status-quo biases. Toward this purpose, the pure theoretical discrete choice model where the sign of welfare gradients entirely determines binary take-up probabilities is obtained by setting $(\lambda_{v,n}, \delta_{i,n}) = (\infty, 0)$ and can be contrasted with the estimated model with biases $(\lambda_{v,n}, \delta_{i,n}) \in \mathbb{R}^2_{++}$ set at estimated values in Table 6.d and Figure 3. The results in Table 7 confirm that the pure model-based specification (column c) performs well in explaining the low demand for annuities, LTCI and reverse mortgage in the data (column a). Indeed, the puzzles are much less salient with predicted take-up rates of about one-third. The remaining discrepancies between observed and theoretical take-up rates can be rationalized by activating the imperfect informational content of utility gradients $(\lambda_{v,n})$, and the systemic deviations related to preference for status-quo $(\delta_{i,n})$.

Price-benefit elasticities The behavioural biases can also be expected to alter price and benefit responsiveness of demand. To assess these effects, Table 7 reports the price (panel b) and benefit (panel c) elasticities using observed choice probabilities (a. Data), as well as those predicted by the model with (b. Estimated) and without behavioural and informational biases (c. Model-based). We find that both Estimated and pure Model-based estimates correctly reproduce the observed and anticipated negative price and positive benefits elasticities. However, in the absence of biases, both responsiveness are much larger in magnitude compared to observed ones. Reintroducing biases dampens responses and yields elasticities that are better aligned with observed values.

5.4 Out-of-sample model performance

We complete our model validation by performing an out-of-sample exercise to assess the model's ability to reproduce asset decumulation survey data not used in the estimation.

More precisely, we revert to the no-participation benchmark case $V_{i,0}(\boldsymbol{\theta})$ and gauge our framework's capacity to replicate the self-assessed probabilities of having exhausted all financial wealth by the time that respondents reach age 85. For each of the 1,370 persons who provided a probability for this question (asked prior to being presented with scenarios), we use their initial health and socio-economic data to simulate the financial paths predicted by the model and compute the share with zero or negative wealth at age 85. Contrasting the sample statistics (panel a) and coefficients on socio-economic regressors (panel b) of the Data (first column) and Simulated (second column) in Table 8 shows that both the distribution, and socio-economic gradients of wealth decumulation are very well replicated, confirming that the predicted risk management choices are also consistent with households' implicit asset decumulation strategies.

6 Implications for risk management

To better understand the implications of the model estimates, we rely on a comparative statics exercise whereby we (i) abstract from all informational as well as status-quo biases, and (ii) impose fair pricing at the respondent level (discussed in Online Appendix E) to gauge the households' demand for longevity, health, and housing risk management products in an idealized setting. The take-up rates from the comparative statics exercise are reported in Table 9. Observe that because prices used in the experiment spanned below and above market prices and were therefore not necessarily fair at the individual level, the baseline optimal take-up of the three products differs from the ones reported in Table 7, column c. Indeed, the optimal take-up of fairly-priced annuities is 28.1% (vs 34.6%), that of LTCI is 16.6% (vs 33.1%) and that of reverse mortgages is 63.4% (vs 31.2%), suggesting that the price/benefits combinations in the experiment were more advantageous than fair for ANN and LTCI, and less advantageous than fair for RMR. Importantly, the optimal take-up rates remain well below 100% at individually-fair prices.

6.1 Role of preferences

Risk aversion and EIS Risk aversion affects risk management and asset decumulation strategies via three different channels. First, it determines the demand for market-provided insurance against longevity, health expenditures and house price risk (insurance channel). Second, it determines the degree of relative prudence and therefore the demand for precautionary financial and housing wealth reserves (precautionary wealth channel, e.g. Hubbard et al. (1995)). Third, the elasticity of inter-temporal substitution, i.e. the inverse of the risk-aversion coefficient in VNM settings with iso-elastic preferences, governs the dynamic reallocation of consumption following changes in asset returns (EIS channel).

The low RRA ($\gamma = 0.459 \implies \tilde{\gamma} = 0.561$) and high EIS ($1/\tilde{\gamma} = 1.784$) we estimate are both consistent with low take-up rates for the three risk management products. First, the insurance channel motives are limited, and warrant a low demand for protection against risks associated with longevity (procured by ANN), health expenditures (procured by LTCI), as well as debt repayment and downside house price (procured by RMR). Second, a low precautionary wealth motive should favor asset liquidation. However, these effects are offset by the high EIS channel which implies dominance of substitution over income effects. An increased marginal propensity to save is induced by the large returns to housing and goes against liquidation instruments for financial (via annuities) and residential wealth (via reverse mortgages). These three channels can be highlighted further by increasing the curvature parameter to $\gamma = 3.0$ corresponding to a RRA $\tilde{\gamma} = 2.624$ and a lower EIS $1/\tilde{\gamma} = 0.381$, both levels found in studies such as De Nardi et al. (2010) and Lockwood (2018). As expected, high risk aversion in row 1 of Table 9.a induces a sharp increase in the demand for LTC insurance (from 0.166 to 0.973). The demand for insurance against longevity procured by ANN also increases (from 0.281 to 0.459), however that movement is mitigated by more demand for precautionary wealth reserves which goes against annuitization of financial wealth. Similarly, high risk aversion goes against the liquidation of precautionary housing wealth capital through reverse mortgages and cause the demand for RMR to collapse (from 0.634 to 0.030). This potent precautionary wealth channel more than offsets the low EIS channel whereby the prevalence of income over substitution effects induce more demand for asset liquidation following the large gains in returns to housing.

Health-dependent preferences Recall from Table 6.b that, relative to being healthy ($\nu_{c,G} \equiv 1.0$), detrimental health states significantly lower the marginal utility of consumption, and consequentially the marginal value of payments received in low ($\nu_{c,\ell} = 0.235$), and in high ($\nu_{c,L} = 0.043$) ADL limitation statuses. These discounts significantly lower the attractiveness of both annuities (same payouts in all alive states) and of LTCI (payouts in high-ADL states only). Indeed, removing state-dependent utility ($\nu_{c,s} \equiv 1, \forall s$) in row 2 of Table 9.a induces large increases in the demand for both annuities and LTCI in particular. In contrast, the demand for liquidating house capital through RMR falls when the expected value of future disposable resources in unhealthy (ℓ, L) states increases.

Preferences for housing Third, recall from Table 6.c that the unit elasticity of substitution between housing and consumption and lower utility weight of housing ($1 - \rho = 0.188$) implies that home-owners can smoothly adjust housing position in function of personal needs and changing spreads between financial vs residential returns. This flexibility contributes to maintaining home ownership for precautionary wealth motives and induces a low demand for asset liquidation through ANN and for insurance by LTCI, while guaranteeing demand for remaining in home through RMR. Removing utilitarian services from housing ($\rho = 1, \nu_h = 0$) in row 3 of Table 9.a is equivalent to imposing perfect substitution between financial and residential wealth.[39] This further reduces the demand for stable net income provided by annuities and LTCI in order to guarantee home ownership. Similarly, the demand for RMR, which allows house-rich and cash-poor

[39]See Koijen et al. (2016) for an application on annuities and LTCI with perfect substitutability between bonds and housing capital.

households to tap into house equity without leaving their house, evaporates when housing utility services are shut down.

Bequest motivations It will be recalled from Table 6.d that we estimated a sizeable bequest motive (corresponding to bequeathed share of wealth $\tilde{b} = 0.138$). High intended bequests increase the need to (i) accumulate and (ii) insure bequeathed wealth reserves against fluctuations in asset and house values. However, the large bequest curvature parameter $\kappa = 119.5$ also indicates that bequests are a luxury good, i.e. the motivation is operational only for the richer households, and the bequests risk aversion motive is weak. Removing the bequest motives (by setting $b = \kappa = 0$) in row 4 of Table 9.a therefore has a very moderate impact on take-up rates. It slightly decreases the demand for stable disposable income provided by annuities and insurance for long-term care risks, and moderately increases demand for RMR to liquidate house equity instead of setting it aside for heirs.

6.2 Other contributing factors

Public insurance and LTC expenditures Removing the state-provided resource floor entails both a risk and a wealth effect. First, households are exposed to greater downside risk in disposable resources. Second, they are also poorer by having lost free claims (conditional on a given tax structure) to guaranteed income in low revenue and/or high medical expenditure states. Row 5 of Table 9, panel b reveals that the additional risk in net revenues justifies a demand for net income insurance provided by annuities, as well as by LTCI,[40] whereas reverse mortgages are unaffected. Conversely, removing long-term care expenditure risk in row 6 of Table 9.b naturally eliminates the demand for LTCI. It also implies an increase in the net present value of disposable pension income that is converted to annuities, and it lowers the demand for RMR.

[40]See also Pauly (1990), Hubbard et al. (1995) on the crowding out of private by public insurance.

Household composition Removing couples and transferring spousal resources to the respondents implies that the single household head is richer, and has fewer incentives to co-insure herself (resp. spouse) from the spouse's (resp. own) medical expenditure risk. In row 7 of Table 9.b, the demand for LTCI in particular and for RMR thus falls sharply, whereas the windfall in transferred wealth is annuitized. Equivalently, there is a substantial motive for couples to insure the surviving spouse from the financial risk associated with long-term care expenditures. Indeed, the declining marginal utility of consumption in poor health implies low demand for own LTCI among singles. Conversely, imperfect correlation between disability shocks across spouses implies much higher marginal utility of wealth for the healthy person when the other is affected by disability and therefore higher LTCI.[41]

Biased expectations Recall from Figure 1 that respondents tend to be over-optimistic with respect to both their own and their spouse's longevity. Removing these biases in row 8 of Table 9.c is thus tantamount to shortening people's expected lifespans. Lower life expectancy significantly reduces the attractiveness of both annuities and LTCI, since the individual is more likely to die faster and before reaching a deteriorated health state.[42] Conversely, a 'live fast and die young' strategy, of high short-term consumption in the face of shorter longevity, is warranted by the high elasticity of inter-temporal substitution ($1/\tilde{\gamma} = 1.78$ in Table 6.a) and the demand for RMR increases.[43]

Since it is fairly-priced at the objective, agent-specific risk level, annuities demand should be large when subjective biases are absent. However, this reasoning abstracts from alternative investments households can make. In our model, housing wealth yields a high (risky) return that dominates annuities even with pessimistic housing price expectations. High EIS households thus prefer to keep the service-providing house longer

[41]De Nardi et al. (2021) also find that spousal co-insurance and bequest motives are particularly relevant for slow asset decumulation.

[42]See also O'Dea and Sturrock (2023) who find that survival pessimism partially explains the low demand for life annuities in the UK.

[43]See Hugonnier et al. (2013) for theoretical links between mortality risks, the EIS and the marginal propensity to consume.

and keep disposable financial wealth instead of annuitizing it. Indeed, eliminating house price returns increases demand for annuities by more than 80%. Hence, the interaction between expectations and housing as an investment vehicle contributes to low demand for annuitization. Davidoff et al. (2005) show the superiority of annuities irrespective of preferences based only on the budget constraint in a world where only bonds are available as an alternative. Housing dominates fairly-priced annuities when (i) risk aversion is low, (ii) its expected return is higher than the implicit yield from annuities, and (iii) it provides direct utilitarian services that are absent in other assets.

Recall from Figure 2.a,c that respondents were overly pessimistic regarding house price appreciation. Removing these biases in row 9 of Table 9.c results in more robust expected house price increases, and therefore to an increase in net worth. Richer households convert this additional wealth into more annuities and also demand more of the relatively expensive LTCI coverage. Conversely, we predict a strong decline in the demand for RMR which is unsurprising, since it is equivalent to that a put option on the house with positive value only when residential price are expected to decrease (Davidoff, 2015).

6.3 Preference for product bundling

The risk management scenarios presented in both the survey and in the model were evaluated independently of each other; respondents separately considered the purchase of a single risk management product at a time. On the one hand, this assumption can be considered as realistic given marketing practices. On the other hand, retirees could theoretically choose any risk management combination, raising the issue of optimal bundling.

To analyze the attractiveness of such combinations, we set up a large grid of potential bundles of annuities, LTCI, and reverse mortgages, varying the product characteristics at actuarially-fair prices,[44] and abstracting from informational and status-quo biases.

[44]For annuities, we consider the fraction of financial wealth that would be annuitized. For long-term care insurance we consider the fraction of medical costs in the case of severe disability which would be insured. Finally, we consider the fraction of eligible home equity (55% of home equity) that could be used

Table 10 reports the take-up rates along the extensive margin (i.e. whether the bundle is purchased or not) by allowing joint versus independent product selection. The results in panel a confirm that annuity purchases would rise the most with a near doubling of total demand (28.6% to 51.8%), whereas the total demand for LTCI and RMR are marginally affected. Panel b reveals that the key driver of this result is the near tripling in the ANN-RMR bundle (10.1% to 32.8%), suggesting that households are responsive to packaging and demand more of annuities when offered an ANN–RMR basket which allows them to use the cash proceeds from reverse mortgages to top-up insufficient pension claims via additional annuity purchases, rather than for consumption purposes. This preference for bundling accords with the arguments of Ameriks et al. (2011), Koijen et al. (2016), Cocco and Lopes (2020) on the importance of complementarity and substitutability between risk management products.

7 Conclusion

Determining the optimal risk management and depletion rate for financial and residential assets during retirement requires complex decision making. Indeed, retirees face age-increasing disability, and mortality risks and housing uncertainty. Fortunately, three risk management products are helpful in solving this problem and can fruitfully complement or replace costly precautionary wealth reserves. Annuities insure against the risk of outliving one's assets, long-term care insurance protects against high medical expenses associated with disability, and reverse mortgage allow cash-poor and house-rich households to tap into residential equity, while remaining in house and hedge downside house price risk. The demand for these products however remains surprisingly weak relative to theoretical predictions at fair prices.

to extract a reverse mortgage. We allow for 5 equally spaced levels on the unit interval, i.e. 125 different bundles, computing expected utility of each respondent for each bundle, and comparing optimal choice at acturially-fair prices with two choice sets: with (joint) and without (independent) interactions among the three financial products. Note that a same person may *separately* choose two or more products, resulting in positive distribution mass off the main diagonal of the take-up matrix under the Independent scenario.

This paper has revisited these puzzles through a flexible theoretical model of consumption and housing choices, augmented with bequests motives and risk management product choices. This model was structurally estimated using a novel stated-preferences experiment involving a large sample of newly-retired Canadian respondents. Our empirical strategy allows us to systematically review the role of preferences, bequests, health shocks and housing, household composition, biased expectations and information frictions and inertia in rationalizing the puzzles.

In the absence of biases, our model goes a long way towards that objective; predicted universal coverage falls to only one-third for all three products. However, these rates still remain too high and too responsive to products' characteristics and prices. The inclusion of behavioural and informational acquisition and processing biases is necessary to replicate observed take-up rates and elasticities. Our main findings confirm that low risk aversion rationalizes a low demand for insurance against longevity, disability and housing risks provided by annuities and long-term care insurance. The high implied elasticity of inter-temporal substitution also justifies a low appetite for liquidation through annuities and RMR in the face of increasing returns to housing. Health shocks strongly discount consumption utility, and therefore the marginal value of LTC insurance and ANN payouts in disability states. Removing couples from the equation leads to sharp declines in demand for co-insurance procured by annuities and LTCI. Housing is found to be relatively substitutable with consumption, and facilitates liquidation of housing wealth reserves in case of need, instead of using RMR to remain in one's house. Finally, bequests motives were found to be significant, but a luxury good, therefore having a limited incidence except for the richest. A final experiment highlights the potential for products bundling; when offered jointly with other products, the demand for annuities nearly doubles, relative to separate choices, suggesting the importance of complex substitution and complementarity issues.

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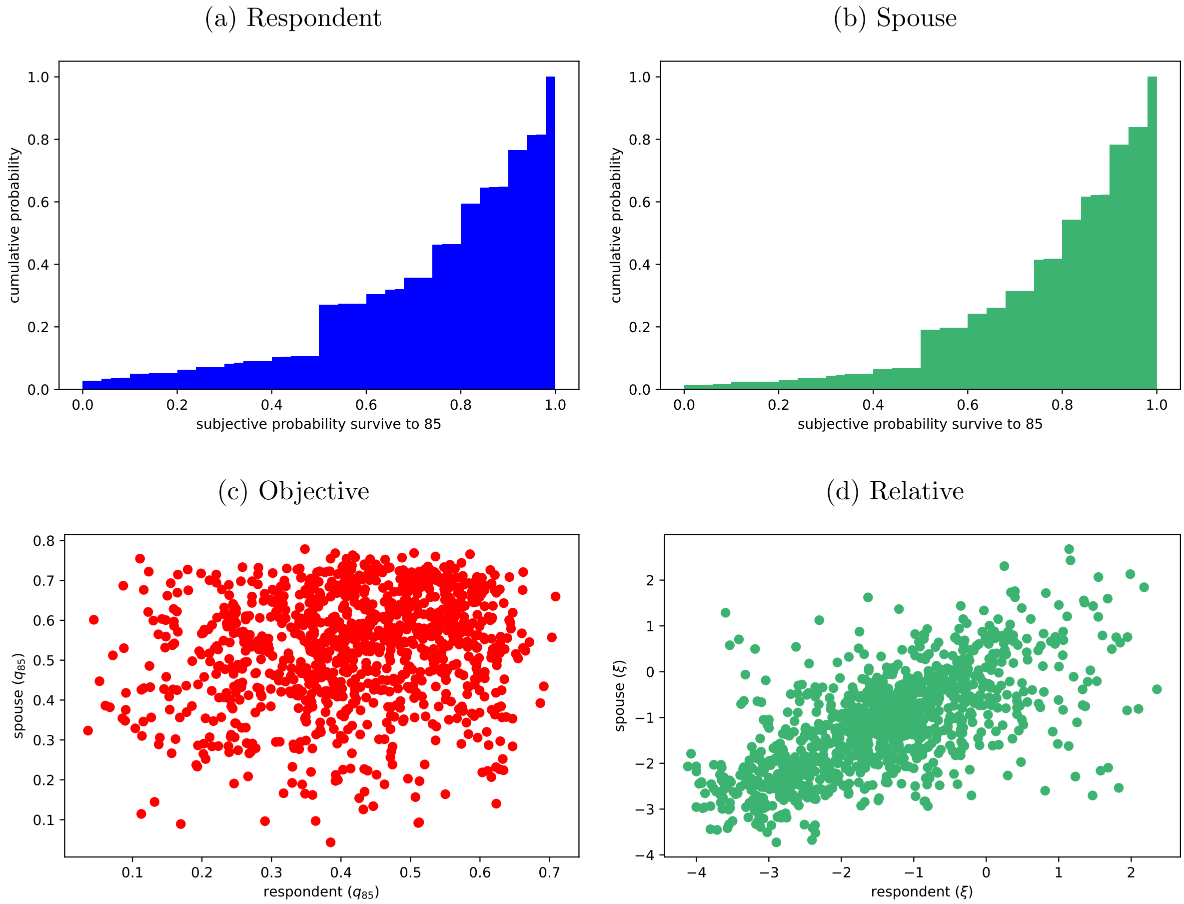
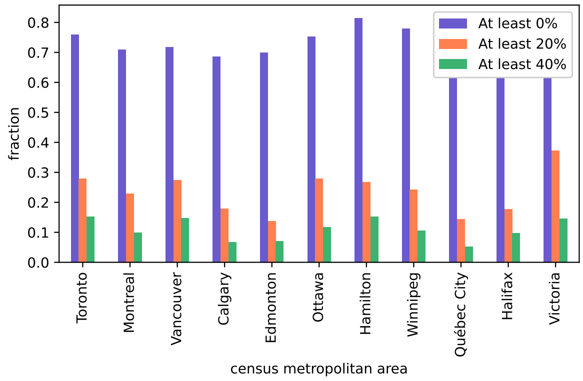
Figure 1: Survival to age 85 probabilities



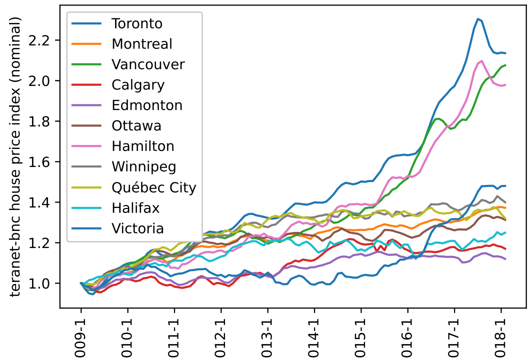
Notes: Reported own (a) and spouse (b) survival probabilities. (c) Joint distribution of objective probabilities accounting for health conditions and other individual characteristics. (d) Joint distribution of relative subjective beliefs (w.r.t. objective risk); a positive (resp. negative) number indicates pessimist (resp. optimistic) beliefs.

Figure 2: Subjective and objective home prices distribution

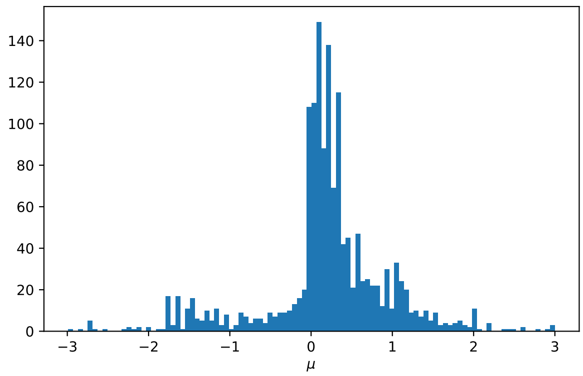
(a) Expected increases



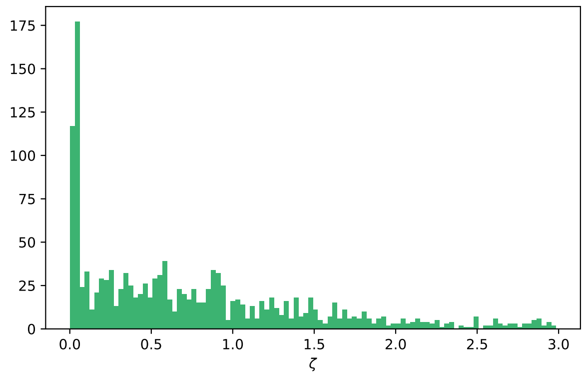
(b) Observed prices



(c) Mean growth beliefs



(d) Standard deviation beliefs



Notes: (a) Reported expected house price increases (in %) over the next 10 years, by CMA. (b) Observed home prices, source National Bank - TeraNet House Price Index by CMA (2009=1). (c) Beliefs about price growth ($\mu = 1$ is historical estimate). (d) Beliefs on standard deviation of house price shocks ($\zeta = 1$ is historical census metropolitan area (CMA) estimate). Outliers below -3 and above 3 removed.

Figure 3: CDF of default biases δ by product

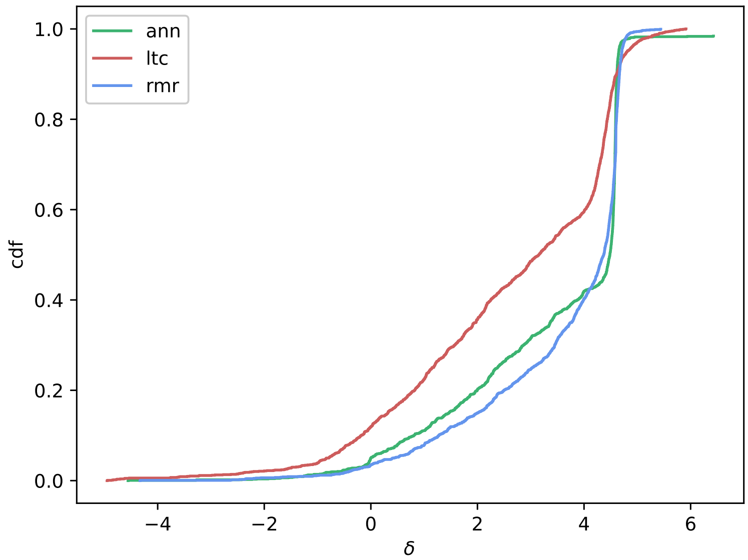


Table 1: Changing environment for North American retirees

	Period	Canada Past	Canada Recent	USA Past	USA Recent
1. Longevity at 65 (years)	1970 – 2019	15.6	20.9	15.1	19.5
2. DB enrollment share (%)	1980 – 2020	93.7	66.6	65.6	22.4
3. Net worth (KC$ and KUS$)	2012 – 2022	522.7	989.5	571	1,130
4. Resid. prop. prices growth (%)	2012 – 2022	229		214	
5. Pension + life insur. share NW (%)	2012 – 2022	24.3	20.23	24.25	17.9
6. Mortgage share liabilities (%)	2012 – 2022	72.6		64.08	

Notes: Sources are: 1. OECD (2021, Fig. 10.3) 2. Statistics Canada (2023e) and Employee Benefits Security Administration (2022, Tab. 4, p. 5) 3. Statistics Canada (2023b), and Board of Governors of the Federal Reserve System, US (2023) 4. Bank for International Settlements (2023a,b) 5. and 6. Statistics Canada (2023b), and Board of Governors of the Federal Reserve System, US (2023)

Table 2: Descriptive statistics

	N	mean	std	min	25 pct	50 pct	75 pct	max
age (t_i)	1581	65.10	3.09	60.0	63.0	65.0	68.0	70.0
male i	1581	0.60	0.49	0.0	0.0	1.0	1.0	1.0
age spouse (t_j)	1164	64.63	4.47	51.0	62.0	65.0	68.0	78.0
couple	1581	0.74	0.44	0.0	0.0	1.0	1.0	1.0
$Y_{i,0}$	1581	71 810	61 991	5 000	35 000	58 562	89 000	500 000
$Y_{j,0}$	1164	51 622	50 087	0.0	16 660	41 424	70 000	500 000
$t_{i,R}$	1581	1.10	2.25	0.0	0.0	0.0	0.0	10.00
$t_{j,R}$	1164	1.06	2.17	0.0	0.0	0.0	1.0	10.00
$Y_{i,0}^R$	1581	59 413	50 124	5 000	29 568	50 000	73 700	500 000
$Y_{j,0}^R$	1164	43 128	43 062	0.0	15 000	34 096	60 000	500 000
D_0	1581	28 487	81 507	0.0	0.0	0.0	0.0	800 000
P_0^h	1581	710 711	444 550	60 000	400 000	600 000	900 000	2 101 758
W_0	1581	226 818	178 454	0.0	80 000	190 000	343 949	1 000 000
$W_0 < 5e3$	1581	0.07	0.25	0.0	0.0	0.00	0.0	1.0

Table 3: Take-up probabilities, knowledge and elasticities

	ANN	LTCI	RMR
(a) Takeup rates			
1. probability buys	0.108	0.174	0.073
2. probability zero (all scenarios)	0.558	0.392	0.638
(b) Prior knowledge			
3. knows product	0.269	0.109	0.287
(c) Price and benefit (within) elasticities			
4. price	-0.584	-0.794	-1.285
5. benefit	0.497	0.525	0.143

Notes: 1. average probability of buying the product over all scenarios. 2. fraction of respondents who report zero probability of purchase over all scenarios for a given product. 3. fraction of respondents who respond that they know *a lot* about a particular product. 4. and 5. price and benefit elasticity estimate from a fixed effect regression of the probability of purchasing the product on the price and benefit in the scenario.

Table 4: Calibrated auxiliary parameters

Parameter	Equation(s)	Interpretation	Value/Range
		(a) Financial rates:	
r	(5b), (7a)	Interest/discount rate	0.01
r_d	(2)	Borrowing rate (mortgage)	0.03
r_h	(7a)	Borrowing rate (owners)	0.04
r_r	(7a)	Borrowing rate (renters)	0.095
		(b) Borrowing constraints:	
ω^D	(3)	Mortgage LTV	0.65
ξ^D	(3)	Mortgage amortization	0.9622
ω^R	(5a)	Reverse mortgage LTV	0.55
(ω_1^h, ω_2^h)	(7b)	Owners credit limit	(0.65,0.80)
ω^r	(7b)	Renters credit limit	0.3297
		(c) Housing:	
ϕ	(1b)	Rental price parameter	0.035
(τ_0^s, τ_1^s)	(4c)	Seller's moving costs	(1.50,0.05)
(τ_0^b, τ_1^b)	(4c)	Buyer's moving costs	(0.50,0.01)
		(d) Consumption floor and discounting:	
$X_{\min}$	(6c)	Minimum cash-on-hand	18.2
β	(8a)	Subjective discount factor	0.97

Notes: Nominal values $(b^A, P^A, b^L, P^L, \tau_0^s, \tau_0^b, Y_t, X_{\min}, M_t)$ set in 1,000C$ units.

Table 5: House prices and health expenses, by CMA and status

CMA	(a) House prices mean gr.	std	ADF	(b) Health expenses G	ℓ	L
Toronto	0.044	0.037	0.999	2,235	3,466	32,162
Montreal	0.025	0.033	0.815	2,560	4,107	22,780
Vancouver	0.044	0.056	0.993	2,816	5,256	41,063
Calgary	0.030	0.081	0.493	2,538	5,282	24,862
Ottawa	0.026	0.025	0.000	2,165	3,374	32,031
Edmonton	0.036	0.086	0.355	2,536	5,240	24,937
Quebec City	0.026	0.039	0.815	2,532	4,062	22,589
Hamilton	0.043	0.034	0.996	2,200	3,420	32,097
Winnipeg	0.028	0.042	0.772	2,583	4,986	31,208
Halifax	0.019	0.025	0.920	2,334	5,182	41,390
Victoria	0.036	0.058	0.946	2,734	5,086	40,647

Notes: a. House prices from Teranet: Period 1991-2018, with p-value from the augmented Dickey-Fuller test (ADF-p). b. Health expenses: Sources, 2009-SHS and 2002-GSS (Statistics Canada, 2023f,c). Medical + home care + nursing home, per person, adjusted in 2019 C$. Health status G refers to good health, ℓ refers to some iADL limitations and L at least 2 ADL limitations.

Table 6: Non-linear least squares estimates

Parameter	Point estimate	Std. Err.
(a) Risk preference (8a)		
γ	0.459	0.026
Δ_γ	0.018	1.987
(b) State-dependence (8b)		
$\nu_{c,G}$	1.000	—
$\nu_{c,\ell}$	0.235	0.075
$\nu_{c,L}$	0.043	0.079
(c) Housing (8b)		
ρ	0.812	0.024
ν_h	0.312	0.021
Δ_{ν^h}	0.037	0.551
(d) Bequests (8d)		
b	0.343	0.074
Δ_b	0.102	0.254
κ	119.5	0.156
(d) Info content utility gradients (D)		
$\lambda_{v,A(0)}$	0.013	0.004
$\lambda_{v,A(1)}$	0.013	0.010
$\lambda_{v,L(0)}$	0.141	0.023
$\lambda_{v,L(1)}$	0.148	0.021
$\lambda_{v,R(0)}$	0.021	0.005
$\lambda_{v,R(1)}$	0.033	0.004
within SSE	7904.1	

Notes: Estimates obtained numerically using the concentrated non-linear least square estimator. Upon convergence, point estimates are used to retrieve the concentrated parameters $\lambda v, j(k)$ for prior knowledge $k = 0, 1$ of the product $j = A, L, R$. Clustered standard errors at the level of the respondent are computed using the numerical gradient of the NLS errors. The within (concentrated NLS) sum of squared errors is also reported.

Table 7: Take-up rates, price and benefits elasticities

	a. Data	b. Estimated	c. Model-based
		(a) Take-up rates	
ANN	0.115	0.089	0.346
LTCI	0.179	0.157	0.331
RMR	0.080	0.061	0.312
		(b) Price elasticities	
ANN	-0.151	-0.539	-3.165
LTCI	-0.228	-0.759	-2.714
RMR	-0.094	-1.140	-2.618
		(c) Benefits elasticities	
ANN	0.147	0.459	2.876
LTCI	0.203	0.503	2.742
RMR	0.080	0.126	2.707

Notes: Column a, Data: Mean take-up rates and price and benefits elasticities estimated from sample. Column b, Estimated: Predicted using the estimates default-bias $\hat{\delta}_{i,n(k)}$ and noise $\hat{\lambda}_{v,n(k)}$. Column c, Model-based: Predicted by only the life-cycle model utility gradients obtained by setting $(\lambda_{v,n(k)}, \delta_{i,n(k)}) = (\infty, 0)$. Elasticities in panels b, c calculated at the mean from a product-based regression of choice probabilities on price and benefits, with fixed effects.

Table 8: Probabilities of exhausting financial wealth by age 85

	Data	Simulated
(a) Statistics		
Mean	0.427	0.384
SD	0.376	0.276
p25	0.020	0.160
p50	0.400	0.292
p75	0.800	0.603
p90	1.0	0.825
(b) OLS regression coefficients		
Wealth quart. (ref 1st)		
2nd	0.0723**	−0.009
3rd	−0.093***	−0.012
4th	−0.141***	−0.045*
Home equity quart. (ref 1st)		
2nd	−0.067*	−0.046*
3rd	−0.142***	−0.106***
4th	−0.168***	−0.111***
Current income quart. (ref 1st)		
2nd	0.053	−0.061*
3rd	0.058	−0.033
4th	0.095*	−0.017
Ret. income quart. (ref 1st)		
2nd	−0.062	−0.124***
3rd	−0.146***	−0.193***
4th	−0.229***	−0.166***
Constant	0.663***	0.566***
N	1370	

Notes: Probability of zero financial wealth at age 85. Data: probability the respondent will have spent down all financial wealth by the time (s)he reaches age 85. Model: we simulate (1,000 replications) for each respondent the path of financial wealth forward until age 85 and calculate number with non-positive wealth. Rely on subjective mortality and house price risk. Panel a: distribution moments of reported (data) and simulated (model) probabilities. Panel b: regression estimates of these probabilities on quartile dummies (the first is the reference category) for financial wealth, home equity, current income and retirement income. Includes controls for gender and marital status in the regression. * denotes $p < 0.05$, ** $p < 0.01$ and *** $p < 0.001$.

Table 9: Counter-factual optimal take-up at fair prices

Counter-factual	ANN	LTCI	RMR
Baseline fair prices	0.281	0.166	0.634
(a) Preferences			
1. High risk aversion ($\gamma = 3.0$)	0.459	0.973	0.030
2. No health-dep. margin. utility ($\nu_{c,s} = 1.0, \forall s$)	0.414	0.364	0.521
3. No preference for housing ($\rho = 1.0, \nu_h = 0$)	0.228	0.120	0.291
4. No bequest motive ($b, \kappa = 0$)	0.261	0.141	0.658
(b) Health and household composition			
5. Low resource floor ($X_{\min} = 0$)	0.385	0.223	0.631
6. No medical expenditures ($m_s = 0$)	0.312	0.000	0.629
7. Singles ($ij \to i$)	0.297	0.016	0.619
(c) Biased expectations			
8. No subj. survival expect. ($\mu, \xi = 1.0$)	0.025	0.005	0.668
9. No subj. house price expect. ($\zeta = 0$)	0.335	0.352	0.081

Notes: Optimal take-up under different counter-factual scenarios, abstracting from informational and status-quo biases by setting $(\lambda_{v,n(k)}, \delta_{i,n(k)}) = (\infty, 0)$ and calculated at agent-specific fair prices detailed in Online Appendix E. Respondents can partially insure (4 equally spaced coverage choices on the (0,1) interval). ANN: fraction of financial wealth annuitized. LTCI: fraction of nursing home expenditures insured against. RMR: fraction of home equity that can be taken as a RMR (maximum being 55% of home equity).

Table 10: Demand for bundling

Bundle	Joint	Independent
(a) Total demand		
ANN	0.518	0.286
LTCI	0.174	0.166
RMR	0.649	0.635
(b) Distribution		
∅	0.242	0.248
RMR	0.218	0.440
LTCI	0.017	0.016
LTCI–RMR	0.004	0.014
ANN	0.037	0.049
ANN–RMR	0.328	0.101
ANN–LTCI	0.054	0.056
ANN–LTCI–RMR	0.099	0.080

Notes: Extensive margins (yes/no) take-up rates evaluated at actuarially-fair prices, and abstracting from informational and status-quo biases. Joint: Respondents choose among all possible bundles involving ANN, LTCI and RMR. Independent: Each product chosen independently from other. Panel (a) reports the total demand for each product, i.e. sum over all bundles involving the product. Panel (b) reports the distribution across the bundles.