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LONGEVITY, HEALTH AND HOUSING RISKS MANAGEMENT IN RETIREMENT

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ABSTRACT

Annuities, long-term care insurance and reverse mortgages remain puzzlingly unpopular to manage post-retirement longevity, health and housing price risks. We analyze the lack of interest using a flexible life-cycle model structurally estimated with a unique stated-preference survey experiment of Canadian households. High risk aversion, preference for early resolution of uncertainty, strong discounting of valuation in disability states, housing substitutability and bequest motives play key roles in explaining most of the limited demand. The remaining disinterest is accounted for by information frictions and inertia. We also document evidence of public crowding out, spousal co-insurance and of responsiveness to products bundling.

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1 Introduction

Motivation Retirees face significant changes in their economic environment.[1] While they can expect to live longer, registered pensions plans have shifted away from 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 accounting for most liabilities. The combined effects of longevity gains, riskier pension benefits, and increasing contribution of housing wealth, have important implications for two interrelated post-retirement decision problems: (i) risk management strategies and (ii) financial asset and home equity decumulation. Longer lifetimes raise the spectre of outliving one's assets and being exposed financially to illness associated with old age since means-tested, publicly-provided long-term care (LTC) do not insure against considerable residual out-of-pocket LTC spending risk.[2] Housing equity further complicates the decumulation problem if lumpy, illiquid and imperfectly substitutable with financial wealth.[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) pays state-dependent benefits 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

[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. See also Ko (2022), Coe et al. (2023) for adverse selection, and demand issues in the LTCI market related to access to informal care-giving by children.

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

limits exposure to both debt repayment and downward house price risks through non-recourse protection.[4] Notwithstanding their potential relevance, these three instruments have proven remarkably unpopular in Canada with RMR and LTCI take-up rates even lower than those of annuities (Boyer et al., 2020a,b, Choinière-Crèvecoeur and Michaud, 2023). Moreover, post-retirement asset decumulation remains unabatedly slow, which could be explained by precautionary motives, bequests intentions, and utilitarian services of housing (De Nardi et al., 2010, Lockwood, 2018).

Methodology This apparent sub-optimality of instruments and decumulation strategies 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: (i) generalized recursive preferences towards risk and inter-temporal substitution, 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 empirical strategy using observational data and exploit a different identification strategy using a unique Stated Preferences 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

[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.

towards the identification of the model's deep parameters. Our estimation framework elicits probabilistic take-up and nests the fully rational model in a behavioral discrete choice model that allows for 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 stochastic processes. Moreover, a dynamic micro-simulation model uses each respondents' health and socio-economic status to compute *personalized* objective health transitions probabilities, to which we also append individual-specific subjective beliefs. The objective and subjective housing and health distributions are combined to *individually* solve for and map welfare gains into probabilistic take-ups.

Main findings We find that the pure theoretical model explains well the observed lack of interest for these three products, but that both informational and inertia frictions are required to replicate observed take-up rates, price and benefits elasticities. Moreover, the theoretical model performs remarkably well in an out-of-sample validation whereby we reproduce life cycle asset decumulation expectations reported in the survey that were not used in the estimation.

Our preference parameters have complex, non-monotone effects on the demand for the three instruments. First, we structurally estimate a high risk aversion ($\gamma = 5.891$) which warrants a high demand for both (i) static insurance, and (ii) precautionary wealth reserves. Static insurance favors hedging longevity (ANN), and medical expenses (LTCI) risks, but precautionary wealth discourages depletion of financial and housing reserves through ANN and RMR.

Second, we confirm the relevance of recursive preferences with inverse elasticity of inter-temporal substitution $\varepsilon = 2.276 < 5.891 = \gamma$, consistent with (i) preference for early resolution of timing uncertainty (PERU), and (ii) concern over long-run risk (LRR). Third, we find evidence of time preference (i.e. valuation) shocks with strong discounts on the marginal utility of consumption and housing services in high-disability states ($\nu = 0.130 < 1.0$). The implications are that households will favor instruments insuring against both short- and long-run risks to both marginal utility and valuation. Long-run risks are particularly relevant for retirees to the extent that disability risk exposure increases in age, and correlates strongly with medical expenses and mortality, as well as the conditions under which housing capital is liquidated. Annuity effectively hedges longevity risks, but its (alive) state-independent benefits will be valued poorly in the long-run when exposure to disability increases. The valuation concern is even more relevant for LTCI which effectively hedges long-run medical OOP risks, but pays out benefits specifically in high-disability, low-valuation states. Conversely, RMR offers loans in current high-valuation (healthy) states and its long-run non-recourse protection will be appreciated when disability induces the liquidation of home capital offering low-valued services, exposing households to idiosyncratic home price risks associated with under-maintenance and market timing errors. Our findings are thus consistent with detrimental (resp. beneficial) effects of recursive preferences and of valuation shocks on the demand for ANN, LTCI (resp. RMR).

Fourth, we identify a relative substitutability between financial and housing capital which justifies maintaining high housing reserves for precautionary motives. Precautionary housing reserves hinder the demand for market insurance through ANN and LTCI, and make agents reluctant to liquidate housing wealth through RMR. Finally, we identify a non-negligible bequest motive ($b = 0.071$). When removed, financial and residential wealth previously earmarked for bequests can be reallocated for precautionary reserves and/or consumption purposes. The former hinders the demand for market insurance procured by ANN and LTCI, while the latter encourages liquidation through RMR.

Our other results confirm the importance of crowding out of private insurance by public safety nets which penalizes both ANN and LTCI, while encouraging the liquidation of precautionary financial and residential reserves through ANN and RMR. We also show the importance of household composition. The death of a spouse induces a transfer of wealth to the widow(er) which is annuitized by low EIS agents, and discourages demand for credit via RMR. Being single also removes the need to co-insure against own/spouse medical expenses, thereby lowering the demand for LTCI. Our final results concern non-indifference to product packaging. In particular, bundling RMR with ANN and/or LTCI tends to boost overall demand. In addition to providing more comprehensive hedging of LRR, cash inflows for RMR can be used to top-up insufficient pension claims and medical insurance, instead of for current consumption purposes.

Contributions 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] First, we analyze these decisions *jointly*, estimating a unique set of preferences that explain demand for these products, and therefore bridge the gap between otherwise separate strands of the literature and second, we integrate the role of housing decisions, valuation shocks, couples, informational and behavioral biases in financial choices related to decumulation. 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 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,

[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.

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, 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

[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.

[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.

credit, rather than via RMR draw-downs exclusively, and by considering couples health dynamics in housing decisions, rather than singles only.

Finally, we contribute to the literature on time preference (valuation) shocks under EZW utility.[12] Whereas research remains agnostic on the causes of shocks to the discount rate on future utility flows, we specifically relate these to disability to capture lower quality and quantity of life effects when ADL are impaired. Because disability also covaries with the returns on the three instruments, the disability state dependence has importance consequences for insurance demand. Moreover, we also add to the literature on long-run risks,[13] by emphasizing the effects of non-indifference to the timing of the resolution of uncertainty on demand for long-run hedging.

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. 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 $s_{it} \in \mathcal{S} = \{\mathcal{A}, \mathcal{D}\}$ for single agent i, and is $s_{ijt} \in \mathcal{S}^2$ for couple ij, with corresponding indicators $\mathbb{1}_t^s$. We assume Markovian health processes with exogenous, age-dependent, person-specific transition probabilities.[14] Aside from death being an absorbing state, the elements of the transition matrices are unrestricted, thereby allowing bi-directional transitions between better and worse states.

[12] Albuquerque et al. (2016), Chen and Yang (2019), de Groot et al. (2022), Normandin and St-Amour (1998)

[13] Bansal and Yaron (2004), Epstein et al. (2014), Kaltenbrunner and Lochstoer (2010), Albuquerque et al. (2016), Chen and Yang (2019), de Groot et al. (2022)

[14] 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). For tractability, we also assume that the widowed spouse's transition probabilities revert back to her distribution as single who is thus indistinguishable from a widow(er) in terms of health, such that the ij notation accommodates all family arrangements.

The household 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.

Consistent with the timing in the survey experiment, all market insurance choices occur only at time 0. 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 $P_i^A b^A$ where P_i^A is the price per unit of coverage and will vary across respondents. Insurance against LTC expenditures is offered 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. Consistent with market practices, the LTCI coverage is assumed to lapse when households fail to pay the premium. In the survey experiment, 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 flows 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.[15] We follow Cocco and Lopes (2020) in assuming 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 value:

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

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

Households' current home-owning status is denoted $H_t \in \{0, 1\}$ (rent, own), with pairs (H_t, H_{t+1}) denoting renters (0,0), buyers (0,1), sellers (1,0) and (continuing) owners (1,1). The extensive margin housing choices does not allow for downsizing, yet permits

[15] We subsequently omit the i and ij subscripts to ease notation.

full in and out transitions to houses of similar (market) values. The net housing wealth is zero for non-owners and otherwise the house value net of principal and interest r_d on mortgages:

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

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 collateral share $\omega^D \in (0,1)$ of house value for new mortgages:

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

The household's net cash flows from housing X_t^H in function of status (H_t, H_{t+1}) is:

$$\begin{aligned} X_t^H =& (1 - H_{t+1}) H_t [P_t^H - (1 + r_d) D_t] - H_{t+1}(1 - H_t)(1 - \omega^D) P_t^H \\ & - H_{t+1} H_t (1 - \xi^D + r_d) D_t - (1 - H_{t+1}) P_t^R \end{aligned} \tag{4}$$

i.e. sellers receive house price P_t^H net of principal and interest on outstanding mortgages $(1 + r_d)D_t$; buyers pay $(1 - \omega^D)P_t^H$ of house value as collateral; owners pay amortization $(1 - \xi^D)$ plus interest r_d on outstanding mortgages D_t; renters pay rental price P_t^R.

Residential market imperfections are proxied by imposing different moving costs on sellers $(k = s)$ and buyers $(k = b)$:

$$\begin{aligned} MC_t &= H_t(1 - H_{t+1}) MC_t^s + (1 - H_t) H_{t+1} MC_t^b, \\ MC_t^k &= \tau_0^k + \tau_1^k P_t^H, \end{aligned} \tag{5}$$

where τ_0^k are the fixed and τ_1^k are the variable moving costs.

Reverse mortgage A reverse mortgage contract is offered to agents with positive home equity $W_t^H > 0$ and specifies the maximal loan at origination, as well as the nominal and effective amounts due at termination:

$$H_{t+1}L_0 \leq \mathbb{1}_{D_t<\omega^R P_t^H}\left(\omega^R P_t^H H_t\right), \quad t=0 \tag{6a}$$

$$L_t = L_0 \exp\left[\left(r+\tau^R\pi^R\right)t\right], \tag{6b}$$

$$b_t = \min[L_t, P_t^H]. \tag{6c}$$

The maximal reverse mortgage loan L_0 in (6a) 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.[16] The RMR is terminated when the house is sold at time $t \geq 1$, and the amount due by the borrower L_t in (6b) compounds the interest given by the risk-free rate r plus a risk premium $\pi^R = \pi(s_0)$ 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 (s_0 is initial health status). The effective amount due at termination b_t in (6c) 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 $\tau^R\pi^R$ charged for the RMR, where τ^R is a load factor equal to one at actuarially-fair pricing.

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 (e.g. pension income). Additional net financial flows Z_t aggregate net proceeds from annuity, LTC insurance and RMR choices,

[16]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 (6a).

and differ across initial ($t = 0$) and subsequent periods:

$$Z_t = \begin{cases} H_t H_{t+1}(L_0 - D_0) - \left[P^A b^A + P^L b^L\right], & t = 0, \\ \left[b^A + \mathbb{1}_t^L b^L\right] - \left[(\mathbb{1}_t^G + \mathbb{1}_t^\ell) P^L b^L + H_t(1 - H_{t+1}) b_t\right], & t \geq 1. \end{cases} \tag{7a}$$

Time-0 owners receive the reverse mortgage loan net of any outstanding mortgage ($L_0 - D_0$) while all households purchase $P^A b^A$ of ANN and $P^L b^L$ of LTCI. For the subsequent periods, annuities b^A are cashed-in, insured agents with high ADL limitations receive the insurance benefit b^L, and otherwise continue to pay the premium. Home sellers repay the effective reverse mortgage payment b_t given by (6c).

Means-tested government transfers TR_t aggregates financial W_t, and housing wealth W_t^H in (2), plus income Y_t to determine eligibility to aid covering a consumption floor $C_{\min}$, plus rental costs for renters and sellers and medical expenses for poor households:

$$TR_t = \max\left[C_{\min} + (1 - H_{t+1}) P_t^R + M_t - \left(W_t + W_t^H + Y_t\right), 0\right]. \tag{7b}$$

The household's net cash on hand X_t sums financial wealth, net housing proceeds, income and financial flows and (if any) transfers, net of medical and moving costs:

$$X_t = W_t + X_t^H + Y_t + Z_t + TR_t - (M_t + MC_t) \tag{7c}$$

Budget and borrowing constraints The household allocates cash-on-hand X_t in (7c) between financial wealth $W_{t+1}/(1 + r_t)$, and non-housing consumption C_t to satisfy the budget constraint:

$$\frac{W_{t+1}}{1 + r_t} + C_t \leq X_t. \tag{7d}$$

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

$$r_t = \mathbb{1}_t^b \left[H_t r_h + (1 - H_t) r_r \right] + (1 - \mathbb{1}_t^b) r \tag{8a}$$

Second, the maximum amount that can be borrowed is determined by both an income test (all agents), and by a home equity (home owners) test for HELOC:

$$-W_{t+1} \leq (1 - H_t)\omega_y Y_t + H_t \min \left[\omega_y Y_t, \omega_1^h P_t^H, \omega_2^h \max \left(P_t^H - D_t, 0 \right) \right]. \tag{8b}$$

The debt servicing requirements (8b) restrict renters to borrow at most ω_y of income. HELOC's allow eligible owners to borrow at most the lesser of three elements: (i) ω_y of income, (ii) ω_1^h of house price, or (iii) ω_2^h of the house value minus outstanding mortgages.

2.4 Preferences and household's problem

We rely on the Epstein and Zin (1991), Weil (1990) (EZW) recursive preferences to model the household's objective function. Given the current state set S_t and continuation utility $V_t = V(S_t)$, the household's problem is select controls I_t to solve:

$$V_t = \max_{\{I_t\}} \left\{ (1 - \beta) \nu_t^\varepsilon u_t^{1-\varepsilon} + \beta \left[\mathbb{E}_t V_{t+1}^{1-\gamma} \right]^{\frac{1-\varepsilon}{1-\gamma}} \right\}^{\frac{1}{1-\varepsilon}} \tag{9a}$$

$$\nu_t = (1 - \mathbb{1}_t^L) 1 + \mathbb{1}_t^L \nu, \quad \nu \in (0, 1) \tag{9b}$$

$$u_t = n_t^{-1} C_t^\rho S_t^{H\,1-\rho} \tag{9c}$$

$$S_t^H = [\phi + H_t \nu^H] P_0^H \tag{9d}$$

$$V_{t+1} = b^{\frac{\varepsilon}{1-\varepsilon}} X_{t+1}, \quad \text{for } s_{it+1} = \mathcal{D} \tag{9e}$$

where state and controls sets (S_t, I_t) are described below. The conditional expectations $\mathbb{E}_t$ are taken over the joint health statuses $s_{t+1} \in \mathcal{S}^2$, and housing prices $P_{t+1}^H \in \mathcal{R}_+$ processes. The optimization (9) is subject to constraints (3), (6a), (8) and (7), with time-varying sets of controls $I_t = \left\{ C_t, H_{t+1}, \mathbb{1}_{t=0}(b^A, b^L, L_0) \right\}$, and states $S_t =$

$\{D_t, W_t, s_t, H_t, P_t^H, \mathbb{1}_{t\geq 1}(b^A, b^L, L_0)\}$. Unsurprisingly, analytical solutions to this problem are intractable and we resort to numerical methods described in Online Appendix A to solve the model.

First, the parameter β in (9a) is a subjective discount factor, ε is the inverse EIS which is disentangled from risk aversion γ. Second, the health-dependent time preference shocks $\nu_t = \nu(s_t) \in (0, 1]$ in (9b) capture heavier discounting at rates $(1 - \beta)\nu_t^\varepsilon$ of future flows under severe disability $s_t = L$. As discussed in the literature, shocks to time preferences induce changes in the effective discount factor that alter the valuation of future costs and benefits (*valuation risk*).[17] Whereas the literature often remains agnostic as to which underlying factor(s) may alter ν_t, we relate these factors explicitly to disability level s_t. Heavier discounting of future flows under severe disability can be justified through the significant decline in both quality and quantity of life for disabled agents.[18] Third, we follow Nakajima and Telyukova (2017), Vestman (2019), by using a Cobb-Douglas with consumption share ρ to aggregate consumption and home-owning utilitarian services S_t^H, whereas the utility flows are averaged for couples by dividing by the equivalent scale for household size n_t in utility (9c).[19] Fourth, the housing services S_t^H in (9d) are benchmarked by the rent paid $P_t^R = \phi P_t^H$ by renters ($H_t = 0$), and the incremental benefit ν^H provided from home ownership ($H_t = 1$).[20] Finally, V_{t+1} in (9e) is the (warm-glow) utility of bequest with b capturing the strength of the bequest motive.[21]

[17] Albuquerque et al. (2016), Chen and Yang (2019), de Groot et al. (2022), Normandin and St-Amour (1998)

[18] See Blundell et al. (2024), Finkelstein et al. (2013), Koijen et al. (2016), Peijnenburg et al. (2017), De Nardi et al. (2010), De Nardi et al. (2021), Russo (2023) for quality of life arguments. Bahk et al. (2019, Tab. 1, p. 3) report a 2017 Korean life expectancy of 84.4 (no disability) dropping by 6.7 years (least severe disability) and by 34.6 years (most severe disability). See also Steensma et al. (2017), Lefebvre and Carrière (2022) for additional Canadian evidence.

[19] 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.

[20] 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.

[21] We follow Kraft et al. (2022) in scaling the bequest intensity with curvature ε to ensure that b corresponds to bequest motivation under EZW preferences.

2.5 Long-run risks and the demand for insurance

The literature on long-run risks (LRR) emphasizes the importance of stochastic factors that alter the expected growth rate and volatility of consumption in the long run. Such risks are accounted for by EZW preferences, but are abstracted from under VNM (e.g. Bansal and Yaron, 2004, Epstein et al., 2014). Concerns over LRR are particularly relevant for the risk management and asset decumulation of retirees. Indeed, disability risk is highly persistent, increasing in age, correlates positively with mortality, medical expenses. Disability also correlates with idiosyncratic housing prices risks arising from insufficient maintenance and market timing errors linked to forced home liquidation, while also lowering valuation of costs and benefits ν_t in (9b).

To better understand the relevance of LRR in our setting, consider a simplified version of the model shutting down both housing services ($\rho = 1$) and bequests ($b^{\varepsilon/(1-\varepsilon)} = 0$). It can then be shown[22] that the inter-temporal marginal rate of substitution (IMRS) simplifies to:

$$M_{t+1} = \beta \left(\frac{\nu_{t+1}}{\nu_t}\right)^{\varepsilon} \left(\frac{C_{t+1}}{C_t}\right)^{-\varepsilon} \left(\frac{V_{t+1}}{\mathrm{CE}_t(V_{t+1})}\right)^{\varepsilon-\gamma}, \tag{10}$$

where $\mathrm{CE}_t(V_{t+1}) = [\mathbb{E}_t V_{t+1}^{1-\gamma}]^{1/(1-\gamma)}$ is the certainty-equivalent of continuation value V_{t+1}. From first principles, an asset will provide valuable insurance if it pays high benefits in high IMRS states.[23] Imposing VNM preferences ($\gamma = \varepsilon$) on (10) reveals that this insurance property is then only attributable to short-run (realized) positive covariance with valuation growth ν_{t+1}/ν_t and/or negative covariance with consumption growth C_{t+1}/C_t.

Unlike VNM, EZW preferences ($\gamma \neq \varepsilon$), also price expected long-run movements to valuation ν_{t+k} and consumption C_{t+k} for $k > 1$ that are encoded in the deviations between the continuation utility's realization V_{t+1}, and its (non-stochastic) certainty-

[22] For example, by adapting Hansen et al. (2008, p. 273) or Chen and Yang (2019, p. 230).

[23] For example, as captured by the insurance premia, i.e. the difference between the risk-free and expected rates of return $R_{f,t+1} - \mathbb{E}_t(R_{i,t+1})$.

equivalent $\mathrm{CE}_t(V_{t+1})$.[24] Under preference for early resolution of uncertainty (PERU) induced by $\gamma > \varepsilon$, long-run insurance services are provided through negative covariance with $V_{t+1}/\mathrm{CE}_t(V_{t+1})$, i.e. the asset pays high benefits in future detrimental states when next-period continuation utility is below its current certainty-equivalent value. Equivalently, EZW/PERU preferences imply that both the short-run (realized) and long-run (expected) valuation (resp. consumption) risks are priced negatively (resp. positively), i.e an asset provides insurance services if it pays high future benefits in bad states of the world occurring in both the short-run ($k = 1$) and the long-run ($k > 1$) that are associated with high valuation ν_{t+k} and/or low consumption C_{t+k}.

3 Data

3.1 Survey design

In April/May 2019, we fielded an online survey with *Asking Canadians* targeting individuals aged 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.[25] 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 and imposed top-coding.[26] We also relied on

[24]See Kaltenbrunner and Lochstoer (2010), Albuquerque et al. (2016), Chen and Yang (2019), de Groot et al. (2022) for discussions.

[25]*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.

[26]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 80 with 1,000,000C$.

filters for sample selection,[27] resulting in a complete usable dataset with 1,581 households (74% in couples).

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$.[28] Respondents are either retired or close to retirement ($\mathbb{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$) and characterized by considerable heterogeneity, with 7% of households having less than 5,000C$.[29]

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.[30] 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.

[27] Starting with an initial sample of 3,057 respondents, we dropped 550 renters (non eligible for RMR), and 446 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. Finally, we removed 480 respondents with non-imputable missing critical information.

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

[29] 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.

[30] 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 only 51.4% (resp. female 63.7%).[31]

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.

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. All applicable taxes were accounted for in presenting both net costs and benefits.

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

[31]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).

next year and paid until death.[32] 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 actuarial premium P^A.[33] 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 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.

[32] See Benartzi et al. (2011), Brown et al. (2021), Luttmer et al. (2022) on the importance of framing, minimizing complexity and emphasizing salient features in annuities decisions.

[33] 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.

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, see footnote 30) and the monthly premium to be paid otherwise. We stressed ideal conditions whereby there was no default risk, that premiums cannot increase over time and that benefits (either 2,000C$ or 4,000C$ per month) would be adjusted for inflation. 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.[34] 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 and suggest limited responsiveness on the part of the respondents.

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 (real) 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,

[34] 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.

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. With the exception of Ottawa, an Augmented Dickey Fuller (ADF) test does not reject the null of a unit root for ϵ_t in (1a) for all CMA's.[35] 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 relative to the estimated drift g_c and volatility σ_c.[36] 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 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

[35] 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^H_t in (1).

[36] 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.

use a dynamic health microsimulation model to measure the objective transitions of each respondents as a function of these inputs.[37] Next, we also account for subjective survival expectations. 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.

4.2 Structural estimation

Respondents' characteristics 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.

[37]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 $q_{it}(s, s')$.

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 $\boldsymbol{P}_{i,k} = (P^A_{i,k}, P^L_{i,k}, \pi^R_{i,k})$ and for benefits $\boldsymbol{B}_{i,k} = (b^A_{i,k}, b^L_{i,k}, L_{0,i,k})$ of annuities, LTC insurance and reverse mortgage products, for which (s)he reported purchasing probabilities $p_{i,k} \in [0, 1]$.[38] Let $\boldsymbol{\theta} = (\gamma, \varepsilon, \rho, b, \nu, \nu^H)$ denote the estimated structural parameters, conditional upon which the indirect utility solving (9) 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:

$$\tilde{V}_{i,k}(\boldsymbol{\theta}) = V_{i,k}(\boldsymbol{\theta}) - V_{i,0}(\boldsymbol{\theta}), \tag{11}$$

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 (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.[39] We follow this insight by assuming that respondents make decisions based on a noisy measure of the indirect utility gain in (11) 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.

[38] 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.

[39] 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.

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 (11), the larger is $\delta^*_{i,n}$, the less likely is respondent i to purchase a product of type n in a given scenario.[40]

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

$$p_{i,k}(\boldsymbol{\theta}) = \frac{\exp(-\delta_{i,n(k)} + \lambda_{\upsilon,n(k)} \tilde{V}_{i,k}(\boldsymbol{\theta}))}{1 + \exp(-\delta_{i,n(k)} + \lambda_{\upsilon,n(k)} \tilde{V}_{i,k}(\boldsymbol{\theta}))}. \tag{12}$$

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 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-respondent transformation per product on the log-odds ratio to eliminate $\delta_{i,n(k)}$; the OLS estimator of $\lambda_{\upsilon,n(k)}$ from the log-odds ratio on the welfare gain is then concentrated-out, to obtain a non-linear least squares (NLLS) estimator of the deep parameters $\boldsymbol{\theta}$. Importantly, the within transformation implies that the deep parameters are not identified through the *levels* of financial instruments, but through their *changes* with respect to changes in their prices and benefits attributes; the predicted levels can ex-post be recovered and compared to observed ones in an out-of-sample validation.

[40] 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.

5 Estimation results

5.1 Preferences, information frictions and inertia

Preference parameters Table 6(a) reports our RRA estimated parameter (std. error) $\gamma = 5.891$ (0.007) indicative of high risk aversion, and inverse EIS parameter $\varepsilon = 2.276$ (0.002), corresponding to a low elasticity of inter-temporal substitution $1/\varepsilon = 0.43935 < 1.0$. Both parameters are precisely estimated and consistent with estimates found in the empirical EZW literature.[41] We clearly reject the null of VNM preferences $H_0 : \gamma = \varepsilon$ and confirm the hypothesis of $\varepsilon < \gamma$ consistent with preference for early resolution of uncertainty (PERU).

Relative to being in good health or mild disability, $\nu(s_t = G, \ell) \equiv 1.0$, we find evidence of strong time preference shocks with heavy discounting under severe disability $\nu(L) = \nu = 0.130$ (0.0003). This finding is consistent with a reduction in both life quality and quantity for severely disabled persons (cf. footnote 18). Our results also reveal a consumption share $\rho = 0.962$ (0.001) that is somewhat higher than values found in the literature,[42] as well as a positive, but imprecisely estimated utilitarian benefit of home ownership $\nu_h = 0.318$ (0.385). Equivalently, the bulk of utilitarian services remain attributable to consumption, with housing capital being relatively substitutable with financial wealth. Finally, we find evidence of a bequest motive with a statistically significant $b = 0.071$ (0.0004) that is within the range of equivalent estimates.[43]

Information frictions and inertia Recall from (12) that behavioral biases are captured by informational content $\lambda_{v,n} = 1/\sigma_{v,n}$ and inertia $\delta_{i,n} = \delta^*_{i,n}/\sigma_{v,n}$, where $\sigma_{v,n}$ gauges the noise added to the utility gradient. Table 6(b) reports the λ estimates for

[41] The Swedish cross-sectional estimates of Calvet et al. (2021) have median RRA of 5.30 and median EIS of 0.42. Inkmann et al. (2011) calibrate the RRA at 5.0 and the EIS at 0.50, whereas Gomes and Michaelides (2005) calibrate the RRA at 5.0, with EIS between 0.2 and 0.8.

[42] Cocco and Lopes (2020, Tab. 6) use a CES with consumption share parameter $\theta^{1/\varepsilon} = 0.75$, while Nakajima and Telyukova (2017, Tab. 1) also rely on a Cobb-Douglas with consumption share $\eta = 0.792$.

[43] Gomes and Michaelides (2005, eq (2)) use EZW preferences with bequest motive $b^\rho = 2.5^5 = 97.66$ for their benchmark specification, which is close to our corresponding measure under the normalization advocated by Kraft et al. (2022) $b^{\varepsilon/(1-\varepsilon)} = 109.03973$.

ANN: 0.026 (0.002), for LTCI: 0.223 (0.012) and for RMR: 0.043 (0.003). The parameters are all positive, finite and statistically significant, confirming that respondents' choices load positively on the estimated utility gradients of purchasing particular products and cannot be attributed to purely random decisions ($\lambda_{v,n} = 0$). Table 6(c) reports the statistics for the agents-specific $\delta_{i,n(k)}$. The estimates reveal that inertia is higher and less dispersed for both ANN and RMR, and lower and more dispersed for LTCI. Other unreported results confirm that inertia correlates with respondent gender, age, product knowledge, education, and income, confirming our interpretation as product-specific status-quo biases.[44]

5.2 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 model-only predictions and (ii) the model augmented with informational and status-quo biases. Toward this purpose, we set $(\lambda_{v,n}, \delta_{i,n}) = (\infty, 0)$ to obtain the pure theoretical discrete choice model where the sign of welfare gradients entirely determines binary take-up decisions, and contrast this with the estimated model with biases $(\lambda_{v,n}, \delta_{i,n}) \in \mathbb{R}^2$ set at estimated values in Table 6(b,c). Table 7(a) confirms that the pure model-based specification in column (3) performs reasonably well in explaining the low demand for ANN, LTCI and RMR in the data column (1). Indeed, the puzzles are much less salient with predicted take-up rates of 0.424 (ANN), 0.093 (LTCI) and 0.586 (RMR). 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 deviations related to preference for status-quo ($\delta_{i,n}$) in column (2).

[44]When regressed on observables, we find that inertia is (i) higher for female (ANN, RMR) and for older respondents (LTCI, RMR), (ii) lower for agents with prior knowledge (ANN), with college degrees (ANN, LTCI), or with higher total income (ANN, LTCI), and (iii) orthogonal to family composition. Correlation coefficients are around 0.40 for the three products.

Price-benefit elasticities The behavioural biases can also be expected to alter price and benefit responsiveness of demand. Table 7(b,c) confirms that the pure model-based estimates correctly reproduce the observed and anticipated negative price and positive benefits elasticities. However, both theoretical responsiveness are excessive relative to observed ones in the absence of biases. Reintroducing the latter maintains expected signs, yet dampens responses and yields elasticities that are better aligned with observed values. Overall, we conclude that the model provides a good benchmark to explain in-sample decisions, but that inertia frictions must be accounted in order to replicate observed take-up levels and elasticities.

5.3 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 product scenarios), we use their individual health, socio-economic and CMA-level house-price levels and distributions 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) in columns (1, Data) and (2, Simulated) of Table 8 reveals that both the distribution, and socio-economic gradients of wealth decumulation are remarkably well replicated, confirming that the predicted risk management choices are *also* consistent with the households' implicit asset decumulation strategies.

6 Implication for risk management strategies

To summarize, our structural estimation provides good in- and out-of-sample performance and indicates (i) high RRA, (ii) preference for early resolution of uncertainty, (iii) strong time discounting in disability states, (iv) relative substitutability between housing and financial capital and (v) importance of bequest motives. The implications of these findings for risk management and decumulation strategies are that agents will (i) have strong demand for both static insurance, as well as precautionary wealth reserves,[45] (ii) be concerned with long-run risks and demand more of instruments that permit early resolution of long-run uncertainty, (iii) discount more heavily both benefits received and costs incurred in future disability states, (iv) be willing to convert housing into financial wealth for precautionary reserves and/or consumption purposes, and (v) set aside and insure financial and residential wealth reserves earmarked for bequest purposes.

In order to better understand the role of the model parameter estimates and assumptions in matching the demand for risk management, 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' theoretical demand for the three risk management products in an idealized setting. The take-up rates from the comparative statics exercise are reported in Table 9.[46]

[45]See Weil (1993), Wang et al. (2016), Douenne (2020) for the theoretical and empirical links between risk aversion and precautionary reserves in the context of recursive preferences.

[46]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(c). Indeed, the optimal take-up of fairly-priced annuities is 0.564 (vs 0.424), that of LTCI is 0.019 (vs 0.093) and that of reverse mortgages is 0.790 (vs 0.586), suggesting that the price/benefits combinations in the experiment were more advantageous than fair for LTCI, and less advantageous than fair for ANN, RMR. Importantly, the optimal take-up rates remain well below 100% at individually-fair prices.

6.1 Role of preferences

EZW vs VNM preferences Recall from Table 6(a) that our estimated parameters rejected VNM ($\gamma = \varepsilon$) and confirmed PERU ($\gamma = 5.891 > \varepsilon = 2.276$). This non-indifference to timing is consistent with preference for instruments that hedge LRR (cf. Section 2.5) whose effects are identified in row 1 of in Table 9. The long-run risks of outliving accumulated assets, and of long-term care out-of-pocket expenditures are respectively hedged by ANN and LTCI, yet neither offers specific protection against downside housing prices, and valuation risks. In particular, both provide benefits paid-out in low-valuation disability states which will debase long-run insurance value. The consequence is weak for state-independent ANN but potent for disability state-dependent LTCI whose demand falls sharply under EZW. Conversely, RMR allows access to current highly-valued loans (conditional on being healthy) and offers downside housing price risks protection linked to insufficient maintenance and housing market timing errors through its non-recourse feature. Because such risks are exacerbated by disability, and since the latter is also associated with low valuation ν_{t+k} of housing capital S^H_{t+k} in (9d), RMR also provides indirect insurance against the long-run risk of low housing valuation consistent with higher demand under EZW.

Valuation risk Table 6(a) revealed that, relative to the other health states, high disability states significantly lower the expected future marginal utility of wealth ($\nu(s_t = L) = \nu = 0.130 < 1.0$), and therefore the expected future marginal benefit (resp. cost) of income received (paid out). This discount results in two opposing forces for annuities. On the one hand, the marginal value of state-independent income is lower, impairing the demand for ANN. On the other hand, so is the expected marginal utility value of precautionary wealth accumulated by highly risk averse households, thereby increasing the demand for annuitization. When valuation risk is abstracted from in row 2, the net effect on annuities is neutralized. In comparison, the disability-contingent benefits under LTCI have low marginal utility value; abstracting from the latter results in a sizeable increase in the demand for medical insurance.[47] Third, highly risk averse households are less reluctant to liquidate precautionary housing wealth when marginal utility is low in future disability states. Conversely, removing valuation risk increases the future opportunity costs of liquidating housing wealth and explains the drop in RMR demand.

Preferences for housing Recall also that the unit elasticity of substitution between housing and consumption, low utility weight of housing ($1 - \rho = 0.038$) and the statistically non-significant home ownership utility ($\nu_h = 0.318$) implies that homeowners consider financial and residential wealth as near substitutes and 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 RMR, as well as for insurance by LTCI. Removing utilitarian services from housing altogether ($\rho = 1, \nu_h = 0$) in row 3 is equivalent to imposing perfect substitution between financial and residential wealth.[48] It further reduces the demand for the three instruments, although the effect is weak for ANN and LTCI, and somewhat stronger for RMR reflecting preference for ageing in place made possible by the latter.

Bequest motivations Our high estimated bequest motives ($b = 0.071$) are associated with high bequeathable wealth reserves. When $b = 0$ in row 4, wealth previously earmarked for bequests may be converted into (i) precautionary wealth reserves, and/or (ii) consumption. More self-insurance through precautionary reserves reduces demand for market insurance against longevity and medical expenses, explaining the fall in both ANN and LTCI, whereas removing the need to accumulate financial and residential bequest reserves warrants more consumption through RMR.[49]

[47]See also De Donder and Leroux (2021) for a similar negative effect of state-dependent preferences on LTCI demand in a static setting.

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

[49]See also Nakajima and Telyukova (2017) for similar negative effects of bequests on RMR.

6.2 Health and household composition

Public insurance and LTC expenditures Eliminating the state-provided resource floor in row 5 entails greater exposure to disposable resources risk. This increase in background risk explains the larger demand for net income stabilization through ANN and LTCI and a lower demand for the liquidation of precautionary wealth through RMR. Conversely, when medical expenditures are abstracted from in row 6, the capitalized value of net income increases and richer households demand more annuities and less RMR, whereas the demand for insurance against medical expenses procured by LTCI evaporates.

Household composition We analyze the effects of household composition by assuming the death of one spouse and inheritance of household resources by the widow(er). The transfer of spousal resources implies that the richer surviving household 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 windfall in transferred wealth is annuitized, and lowers the demand for RMR, whereas the lower demand for co-insurance reduces the demand for LTCI.

6.3 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 ANN and LTCI, since the individual is more likely to die younger and before reaching a deteriorated health state, whereas RMR increases slightly.[50]

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

Recall also from Figure 2.a,c that respondents were overly pessimistic regarding home price appreciation. Removing these biases in row 9 implies more robust expected house price returns that justify keeping large residential balances and lowers the demand for both annuities and reverse mortgages. The demand for RMR is further reduced since they are equivalent to a put option on the house with positive value when residential price are expected to decrease (Davidoff, 2015).

6.4 Preference for product bundling

The risk management scenarios presented in both the survey and in the model were evaluated independently of each other as 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 simultaneously choose any risk management combination, raising the issue of optimal product bundling.

To analyze the attractiveness of such combinations, we set up a large grid of potential bundles of ANN, LTCI, and RMR, varying the product characteristics at actuarially-fair prices,[51] and again abstracting from informational and status-quo biases. 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 (0.562 $\rightarrow$ 0.699) and long-term care insurance (0.018 $\rightarrow$ 0.096) would rise the most, whereas the total demand for reverse mortgage is hardly affected. Panel b reveals that the key drivers are the increases in demand for LTCI-RMR (0.001 $\rightarrow$ 0.032), ANN-

[51]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 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.

RMR (0.415 $\rightarrow$ 0.491), as well as ANN-LTCI-RMR (0.014 $\rightarrow$ 0.062) bundles, whereas RMR only falls (0.359 $\rightarrow$ 0.202).

Non-indifference to packaging suggests at least two interpretations. First, households demand more of ANN and LTCI when offered in a basket including RMR which allows them to use the reverse mortgaged loans to top-up insufficient pension claims and medical insurance, rather than use the latter for consumption purposes. Second, the long-run risks induced by age-increasing exposure to disability risk and its consequences for longevity, consumption and valuation, as well as housing returns are imperfectly hedged by the three individual instruments. Bundling ANN, LTCI and RMR may thus allow a more complete LRR insurance, consistent with the importance of complementarity and substitutability between risk management products advocated by Ameriks et al. (2011), Koijen et al. (2016), Cocco and Lopes (2020).

7 Conclusion

This paper has emphasized the importance of (i) preferences towards risks, inter-temporal substitution and disability-dependent discounting, (ii) heterogeneity in both objective and subjective beliefs regarding housing and health risks, as well as (iii) household composition, (iv) public insurance and (v) product bundling in explaining the low demand for ANN, LTCI and RMR. Our flexible model goes a long way in rationalizing the disinterest for the three instruments, yet behavioural frictions (informational and inertia) must be appended to better align take-up rates and responsiveness to price and benefits combinations.

We have omitted a number of elements which are potentially also relevant. First, we focused on the sub-sample of home-owners exclusively. This restriction is consistent with the prevalence of home ownership among Canadian retirees,[52] and was required to analyze RMR whose relevance depends on ownership.Still, the information from current renters

[52]Between 2011-2021, the ownership rate was 62.6% among primary household maintainers aged 55-74 and 68.9% after age 75 (source Statistics Canada).

(550 individuals in the original sample) may also be useful to understand ANN and LTCI and fruitfully integrated. Second, we omitted life insurance as an alternative to costly bequeathable wealth against the risk of living too short. Third, we have abstracted from non-housing risky decisions such as stocks, thereby potentially under-estimating background risk exposure and diversification strategies. Finally, we have voluntarily focused on respondents at or near retirement, conditioning on contemporary financial and residential assets to explain take-up rates. Backward induction arguments require that projected post-retirement risk exposure and decumulation strategies be accounted for in pre-retirement labor supply, consumption, and housing decisions, and therefore could be integrated in disposable net worth at retirement. These four features might play an important role in understanding ANN, LTCI and RMR disinterest, but their integration is beyond the scope of the current project and is left on the research agenda.

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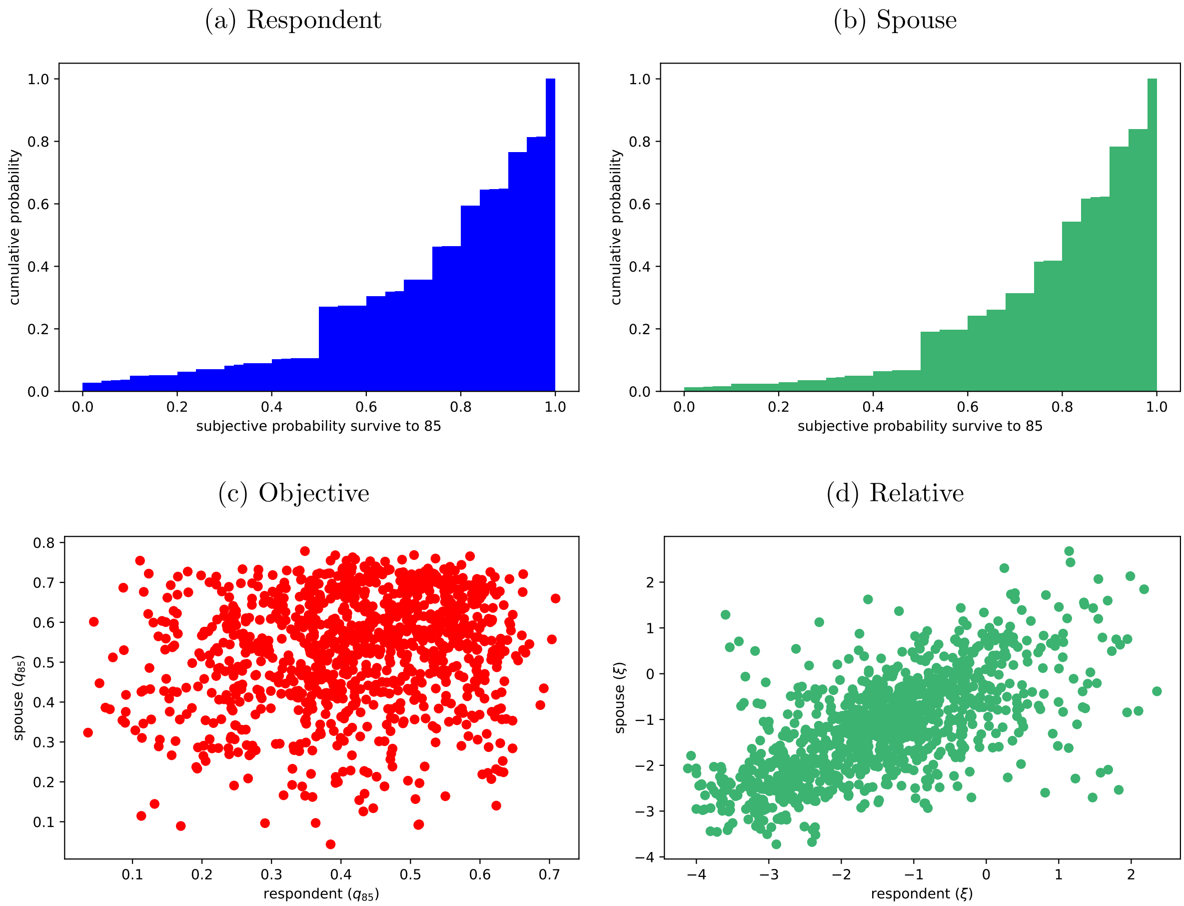
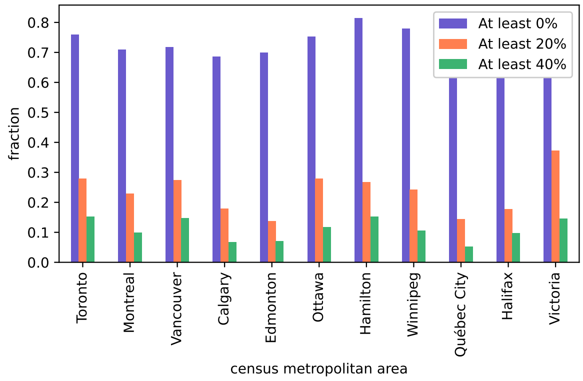
Figure 1: Survival to age 85 probabilities



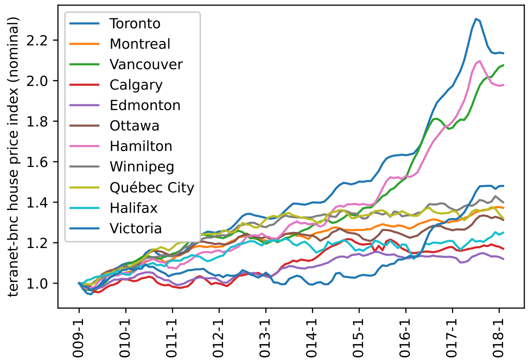
Notes: Reported own (a) and spouse (b) survival probabilities. (c) Joint distribution of objective probabilities accounting for health conditions and other individual characteristics. (d) Joint distribution of relative subjective beliefs (w.r.t. objective risk); a positive (resp. negative) number indicates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

Figure 2: Subjective and objective home prices distribution

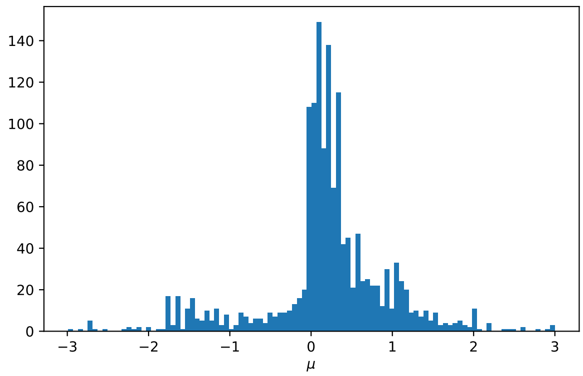
(a) Expected increases



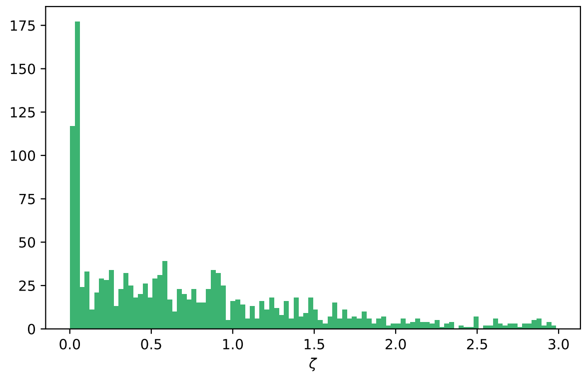
(b) Observed prices



(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.

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 (1)	LTCI (2)	RMR (3)
(a) Takeup rates			
1. probability buys	0.107	0.174	0.072
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	−0.849	−0.891	−0.584
5. benefit	0.268	0.109	0.287

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 (log) probability of purchasing the product on the (log) price and (log) benefit in the scenario.

Table 4: Calibrated auxiliary parameters

Parameter	Equation(s)	Interpretation	Value/Range
(a) Financial rates:			
r	(6b), (8a)	Interest/discount rate	0.01
r_d	(4)	Borrowing rate (mortgage)	0.03
r_h	(8a)	Borrowing rate (owners)	0.04
r_r	(8a)	Borrowing rate (renters)	0.095
(b) Borrowing constraints:			
ω^D	(3)	Mortgage LTV	0.65
ξ^D	(3)	Mortgage amortization	0.9622
ω^R	(6a)	Reverse mortgage LTV	0.55
(ω_1^h, ω_2^h)	(8b)	Owners credit limit	(0.65,0.80)
ω^r	(8b)	Renters credit limit	0.3297
(c) Housing:			
ϕ	(1b)	Rental price parameter	0.035
(τ_0^s, τ_1^s)	(5)	Seller's moving costs	(1.50,0.05)
(τ_0^b, τ_1^b)	(5)	Buyer's moving costs	(0.50,0.01)
(d) Consumption floor and discounting:			
$C_{\min}$	(7b)	Consumption floor	18.2
β	(9a)	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	Interpretation	Equation	Estimate	Std. Err.
		(a) Preferences		
γ	RRA	(9a)	5.891	0.007
ε	Inverse EIS	(9a)	2.276	0.002
ν	Time preference shock	(9b)	0.130	0.0003
ρ	Consumption share	(9c)	0.962	0.001
ν_h	Own home utility	(9d)	0.318	0.385
b	Bequest intensity	(9e)	0.071	0.0004
		(b) Info content utility gradients		
$\lambda_{v,A}$	ANN loading	(12)	0.026	0.002
$\lambda_{v,L}$	LTCI loading	(12)	0.223	0.012
$\lambda_{v,R}$	RMR loading	(12)	0.043	0.003
within SSE		7891.2		

(c) Inertia biases

	ANN	LTCI	RMR
mean	3.432	2.400	3.837
s.d.	1.629	1.986	1.389
p25	2.349	0.950	3.429
p50	4.478	2.876	4.573
p75	4.600	4.168	4.649

Notes: (a) Estimates obtained numerically using the concentrated non-linear least square estimator. (b) Upon convergence, point estimates are used to retrieve the concentrated parameters $\lambda_{v,j}$ for 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

	Data (1)	Estimated (2)	Model-based (3)
(a) Take-up rates			
ANN	0.115	0.089	0.424
LTCI	0.179	0.157	0.093
RMR	0.080	0.061	0.586
(b) Price elasticities			
ANN	−0.849	−0.214	−1.625
LTCI	−0.891	−0.411	−2.047
RMR	−0.585	−0.124	−0.576
(c) Benefits elasticities			
ANN	0.769	0.205	1.545
LTCI	0.529	0.093	1.472
RMR	0.036	0.083	0.251

Notes: Column (1), Data: Mean take-up rates and price and benefits elasticities estimated from sample. Column (2), Estimated: Predicted using the estimates default-bias $\hat{\delta}_{i,n(k)}$ and noise $\hat{\lambda}_{\upsilon,n(k)}$. Column (3), Model-based: Predicted by only the life-cycle model utility gradients obtained by setting $(\lambda_{\upsilon,n(k)}, \delta_{i,n(k)}) = (\infty, 0)$. Elasticities in panels b, c calculated at the mean from a product-based regression of choice probabilities on price and benefits, with fixed effects. For annuities and long-term care insurance, we use a log-log specification.

Table 8: Probabilities of exhausting financial wealth by age 85

	Data (1)	Model (2)
(a) Statistics		
mean	0.427	0.423
s.d.	0.376	0.334
p25	0.020	0.076
p50	0.400	0.418
p75	0.800	0.742
(b) OLS regression coefficients		
Wealth quart. (ref 1st)		
2nd	0.0723**	−0.045
3rd	−0.093***	−0.116***
4th	−0.141***	−0.149***
Home equity quart. (ref 1st)		
2nd	−0.067*	−0.001
3rd	−0.142***	−0.051*
4th	−0.168***	−0.061*
Ret. income quart. (ref 1st)		
2nd	−0.062	−0.089**
3rd	−0.146***	−0.059
4th	−0.229***	0.064
Constant	0.663***	0.445***
N	1370	

Notes: Probability of zero financial wealth at age 85. Column (1), Data: probability the respondent will have spent down all financial wealth by the time (s)he reaches age 85. Column (2), 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 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

	ANN (1)	LTCI (2)	RMR (3)
At fair prices (baseline)	0.564	0.019	0.790
(a) Preferences			
1. VNM ($\varepsilon = \gamma = 5.891$)	0.565	0.356	0.452
2. No valuation risk ($\nu = 1.0$)	0.559	0.717	0.645
3. No preference for housing ($\rho = 1.0, \nu_h = 0$)	0.559	0.014	0.759
4. No bequest motive ($b = 0$)	0.514	0.003	0.910
(b) Health and household composition			
5. Low resource floor ($X_{\min} = 0$)	0.642	0.092	0.479
6. No medical expenditures ($m_s = 0$)	0.583	0.000	0.781
7. Singles ($ij \to i$)	0.657	0.016	0.600
(c) Biased expectations			
8. No over-optim. survival expect. ($\mu, \xi = 1.0$)	0.502	0.001	0.799
9. No over-pessim. house price expect. ($\zeta = 0$)	0.493	0.032	0.743

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 (1)	Independent (2)
(a) Total demand		
ANN	0.699	0.562
LTCI	0.096	0.018
RMR	0.786	0.790
(b) Distribution		
∅	0.065	0.073
RMR	0.202	0.359
LTCI	0.001	0.001
LTCI–RMR	0.032	0.001
ANN	0.148	0.132
ANN–RMR	0.491	0.415
ANN–LTCI	0.000	0.002
ANN–LTCI–RMR	0.062	0.014

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.