CIRANO
Knowledge into action

LONGEVITY, HEALTH AND HOUSING RISKS MANAGEMENT IN RETIREMENT

PIERRE-CARL **MICHAUD**
PASCAL **ST-AMOUR**

2023s-07
WORKING PAPER

CS

ISSN 2292-0838 (online version)

Longevity, Health and Housing Risks Management in Retirement*

Pierre-Carl Michaud† *and Pascal St-Amour*‡

Abstract/Résumé

Annuities, long-term care insurance and reverse mortgages remain unpopular to manage longevity, medical and housing price risks after retirement. We analyze low demand 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 reduced demand. Bequests motives are found to be a luxury good and play a limited role. The remaining disinterest is explained by information frictions and behavioural status-quo biases. We find evidence of strong spousal co-insurance motives motivating LTCI and of responsiveness to bundling with a near doubling of demand for annuities when reverse mortgages can be used to annuitize, instead of consuming home equity.

Les rentes, l'assurance soins de longue durée (ASLD) et les prêts hypothécaires inversés restent impopulaires pour gérer les risques de longévité, les risques médicaux et les risques liés au prix du logement après la retraite. Nous analysons la faible demande à l'aide d'un modèle de cycle de vie estimé de manière structurelle avec une expérience par enquête unique de préférences déclarées auprès de ménages canadiens. Une faible aversion pour le risque, la substitution entre le logement et la consommation et une faible utilité marginale en cas de mauvaise santé expliquent principalement la faible demande. Les motifs de legs s'avèrent être un bien de luxe et ne jouent qu'un rôle limité. Le désintérêt restant s'explique par des frictions informationnelles et des biais comportementaux (inertie). Nous trouvons des preuves de l'existence d'une forte motivation de coassurance entre conjoints, qui motive l'achat d'ASLD; et de réactivité à l'offre groupée, avec un quasi-doublement de la demande de rentes lorsque les prêts hypothécaires inversés peuvent être utilisés pour constituer des rentes, au lieu de consommer la valeur nette du logement.

Keywords/Mots-clés: retirement wealth, insurance, health risk, housing risk / patrimoine retraite, assurance, risque santé, risque logement

JEL Codes/Codes JEL: J14, G52, G53

Pour citer ce document / To quote this document

Michaud P-C. and St-Amour P. (2023). Longevity, Health and Housing Risks Management in Retirement (2023s-07, CIRANO). https://doi.org/10.54932/RNKF5751

---

* We are grateful to seminar participants at HEC Montreal, the 2022 CEAR-RSI Household Finance conference, CEPAR Pension Colloquium (Australia) and the University of Western Ontario (Canada). We thank François Laliberté-Auger, Yann Décarie, Ismael Choiniere-Crevecoeur for excellent research assistance. We acknowledge funding from the FRQSC (Quebec Society and Culture Research Council) and SSHRC (Social Science and Humanities Research Council).

† HEC Montreal, Retirement and Savings Institute, CIRANO and NBER

‡ HEC Lausanne, University of Lausanne, Retirement and Savings Institute, CIRANO and Swiss Finance Institute

1 Introduction

1.1 Motivation

Longer-living retirees have recently witnessed important changes in asset returns and composition.[1] First, registered pension plans have shifted away from defined benefits (DB) towards the riskier defined contributions (DC), and self-administered plans, at least in North America.[2] Second, net worth has increased considerably, with housing and liquid assets (cash, bonds and equity) replacing pension and life insurance claims as the main drivers of wealth growth, and mortgages replacing consumer credit as key determinant of liabilities.[3]

The combined effects of longevity gains, gradual shift towards more risky pension plans and increasing role of non-pension, and especially housing wealth, brings up two interrelated issues (i) financial and home asset decumulation and (ii) risk insurance strategies. Prolonged living raises the risk of outliving one's assets, as well as of being exposed to illnesses associated with old age. Indeed, the publicly-provided level of long-term care (LTC) is means-tested and may be unsuitable for a person's needs and preferences. Consequently, out-of-pocket LTC spending can be a major drain on disposable resources.[4] Moreover, long-term care cannot always be provided at a person's residence and may require moving to nursing facilities. Both factors concur to jeopardize an agent's preference to remain in her own home after retirement.[5] The decumulation of housing assets is further complicated by the volatility in house prices, the utilitarian services provided by housing, the illiquidities involving sale and relocation delays, as well as transaction and emotional

[1]Canadian life expectancy at age 65 has increased from 15.6 (female: 17.5, male: 13.7) in 1970 to 20.9 years (female: 22.5, male: 19.5) in 2019 (OECD, 2021, Fig. 10.3).

[2]The share of retirement-age active members in DB plans relative to total fell from 93.7% in 1980 to 66.6% in 2020 (Statistics Canada, 2022b, and authors' calculations).

[3]In Canada, average net worth per household has increased from 522.7 to 989.5 KC$ between 2012 and 2022, with pension and life insurance shares falling from 24.3% to 20.23%. Mortgages share of total liabilities increased from 64.2% to 72.6% (Statistics Canada, 2022a, and authors' calculations).

[4]For example, the government of Quebec LTC accommodation program required a means-tested monthly payment of 2,019C$ to cover food and lodging expenses for an individual room in a publicly-subsidized nursing home in 2022. The equivalent required payment under the government of Ontario LTC program was 2,701C$ for individual room accommodation, with maximal means-tested subsidy of 1,891C$. See also Boyer et al. (2020a) for Canada, as well as Palumbo (1999), Scholz et al. (2006), De Nardi et al. (2010), and Lockwood (2018) for the US for additional evidence and discussion of the importance of LTC-related spending risks.

[5]Elders' preference for 'aging in place' is discussed by Cocco and Lopes (2020).

costs associated with changes in home-owning statuses that are absent in the case of more liquid financial assets.

Three financial instruments appear particularly relevant in addressing the wealth decumulation and insurance problems. First, life annuities (ANN) effectively protect against the risk of outliving accumulated assets by converting equity to state-independent cash flows that are guaranteed until death. Second, long-term care insurance (LTCI) offers fixed payments when deteriorating health conditions involve consequential limitations in activities of daily living (ADL, e.g. moving around, cooking, home- and self-care). It thus helps in slowing down excessively rapid depletion of resources in the face of surging long-term care expenses, and usefully complements publicly-provided, means-tested base long-term care which may be unavailable/unsuitable for richer agents. Third, reverse mortgages (RMR) allow house-rich and cash-poor households to tap into their home equity to address LTC and other consumption needs without having to move out of their home. Indeed, unlike traditional home equity lines of credit (HELOC's), RMR's have more flexible debt servicing constraints, and limited exposure to both debt repayment and house price risks. Interests on reverse mortgage loans are accumulated, and the debt is rolled forward until the house is sold; the non-recourse provision guarantees that effective debt repayment is bounded above by house value at time of sale, thereby limiting exposure to downside risk in housing prices.[6]

Despite their potential effectiveness as part of post-retirement decumulation and risk insurance strategies, these three instruments have generated limited interests among households. Indeed, both RMR and LTCI instruments have proven remarkably unpopular with take-up rates even lower than the already low take-up for annuities. More fundamentally, post-retirement asset decumulation remains unabatedly slow suggesting that households prefer to maintain precautionary financial and residential wealth reserves to offset longevity and morbidity risk exposures, remain at own home as long as possible, and guarantee that eventual bequest objectives are met.

[6]Shan (2011), Nakajima (2012), Shao et al. (2015), Haurin et al. (2016), Nakajima and Telyukova (2017), Shao et al. (2019), and Cocco and Lopes (2020) provide thorough discussion of RMR design and demand.

1.2 Outline

This paper proposes a structural estimation of a flexible life cycle (LC) model to assess the contributions to the low take-up rates for ANN, LTCI and RMR of (i) preferences towards risk, housing, health and bequests, (ii) biases in information processing and favoring inaction and in expectations, and (iii) heterogeneity in socio-economic variables, risk exposure and preferences. We depart from the standard Revealed Preferences (RP) approach to the puzzles and exploit a different identification strategy using a unique Stated Preferences (SP) experimental survey on annuities, LTCI and RMR conducted in Canada.

First, we commissioned a pan-Canadian experimental survey of individuals aged 60 to 70 covering a wide range of characteristics on financial, pension and home-owning, as well as health, household composition, subjective expectations and preferences. Importantly, 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. Compared to the standard *ex-post* RP identification strategy based on realized decisions, the two related advantages of the SP approach are that we effectively control for the unobserved (and potentially endogenous) investment opportunity set of agents, and that it allows us to trace out the individual demand curves for these products. There is plenty of evidence that information frictions and awareness of these products is limited. [7]

Second, the reliance on probabilistic take-up, rather than binary (yes/no) stated preferences also presents two advantages. First, it allows for a much richer informational content compared to deterministic responses, notably in instances where the proposed scenario lacks relevant information (Manski, 1999). Moreover, the probabilistic take-up framework is readily adaptable to departures from the rational expectations paradigm in life cycle models. Indeed, we do allow for a flexible treatment of information in the decision process that implements biases identified by the Stochastic Choice and by the Behavioral Economics literature. The utility gain from a discrete participation scenario is thus converted into a probabilistic measure of buying the proposed instrument using a logistic distribution. A scale parameter first identifies the informational content of the model-based welfare gain for purchasing a product, and can be interpreted as a stochastic 'trembling hand', or

[7] See Boyer et al. (2020a) for an application in the context of LTCI demand.

'rational inattention' departure from the first-best solution. Second, an intercept parameter is also appended to capture 'status-quo biases' (e.g. informational, habit barriers, . . .) in implementing the optimal strategy.[8]

Third, we account for the considerable degree of heterogeneity in survey answers. Objective house price distributions are obtained by respondent's residence for each census metropolitan area (CMA) we covered. We also allow for subjective probability beliefs about these processes based on survey questions regarding the distribution of house price growth. Furthermore, we use a dynamic micro-simulation model to calculate personalized objective health transitions probabilities based on respondents' socio-economic statuses. We also append subjective beliefs to these objective measures gathered from individual responses. The objective and subjective housing and health distributions, as well as the reported product-specific prior knowledge on annuities, RMR and LTCI are combined to *individually* solve for and map welfare gains into probabilistic take-ups. Finally, we resort to survey responses regarding attitudes towards risk aversion inter-temporal substitution, housing and bequest motives to complement the identification of the preference parameters governing these attitudes.

1.3 Main findings

Our structural preference parameter estimates are largely in-line with values found in the relevant literature and are robust to preference heterogeneity. Model adequacy is further assessed and confirmed by (i) the predictive power of welfare comparisons across product scenarios and (ii) an out-of-sample comparison of respondents- and model-predicted likelihoods of asset depletion by age 85. Several key contributors to low demand for risk-management products can be highlighted.

[8]The links between rational inattention due to costly information acquisition and/or processing and stochastic choices are explored in Sims (2003); Agranov and Ortoleva (2017); Caplin et al. (2019) among others. Extensions are discussed in Dean et al. (2017) and by Steiner et al. (2017) who provide rationales for logit representations with status-quo bias in the context of rational inattention. An enlightening overview on stochastic choice models discussing other rationales such as fluctuating preferences, trembling hand and learning is provided in Strzalecki (2019).

1.3.1 Contributions of preferences

Low risk aversion and high EIS We estimate a low relative risk aversion value of 0.459 that is consistent with levels found in the SP and Experimental literature, but lower than typical RP estimates. Moderate aversion largely explains the low appetite for insurance procured by annuities (against longevity risk), by LTCI (against long-term care expenditures risk) and by RMR (against downwards house price risks). Moreover, the associated high elasticity of inter-temporal substitution (EIS) of 2.18 suggests dominance of substitution over income effects following the large increases in housing returns, that are consistent with a low demand for liquidating financial and house equity made accessible by annuities and RMR.

Strongly health-dependent utility We identify strong discounts on the marginal utility of consumption in low and high disability states relative to being healthy. These discounts are consistent with a reduced demand for both annuities (state-independent payouts) and for LTCI (payments in disability states).

Housing services are valuable, but substitutable Housing procures significant distinct utilitarian services, but has a lower expenditures share compared to, and is substitutable with consumption. In light of (i) strong responsiveness to (ii) much more favorable housing returns, and (iii) relatively painless substitution with consumption, respondents prefer to stay in house and use its residential value as precautionary wealth to buying costly annuities and LTCI against longevity and medical expenditures risks.

Bequests are important, but a luxury good Bequest motives have long been suspected as key obstacle to asset liquidation via ANN and RMR. Although we also identify both statistically and economically significant motivations, the actual contribution of bequests to the puzzles is modest. Our results suggest a strong luxury good characteristic consistent with bequests (i) being operational only for the richest households, and (ii) associated with an even lower aversion to bequests risk. Both elements concur to reduce the attractiveness of bequest insurance against longevity, medical expenses and housing risks.

1.3.2 Other contributing factors

Public insurance crowds out risk management Our results support the crowding-out hypothesis regarding public insurance. Removing the minimal consumption floor results in both (i) greater exposure to downward consumption risk and (ii) loss of free insurance claims that encourage more demand for annuities and LTCI in particular.

Spouses co-insure each other Health-dependent preferences are particularly potent in conjunction with household composition. Whereas respondents in couples demand LTCI to co-insure their spouse and themselves from the other's medical expenses, the demand evaporates in the case of singles with low marginal values of benefits in disability states and devoid of co-insurance objectives.

Longevity and housing prices expectations are biased Biased expectations also play a role, but towards *increasing* demand relative to objective expectations. Indeed, the observed excess optimism in longevity tends to counter-factually increase demand for annuities (payments over longer period) and LTCI (age-increasing disability risk more likely), whereas the observed excess pessimism with respect to housing prices counter-factually increases the demand for RMR (downward house prices more likely).

Informational, status-quo biases and product knowledge Overall, the pure theoretical model goes a long way in rationalizing low demand. Indeed, the utility gradients we compute have predictive power in explaining observed risk management instrument take-up rates. Moreover, when abstracting from informational and behavioral biases, the take-up rates fall to only one-third in the scenarios we presented. Information acquisition and inaction biases are nonetheless relevant for two reasons. First, they align mean take-up with the observed levels of 17.5% (ANN), 17.9% (LTCI) and 8.0% (RMR). Second, the biases are necessary to dampen the predicted benefits and price elasticities to levels observed in our data. Consistent with expectations, agents with prior product knowledge significantly increase their reliance on the model, and are associated with lower inaction biases.

Responsiveness to product bundling Our results indicate that demand is responsive to packaging. Allowing for decisions over product bundles, instead of independent choices particularly benefits annuities whose take-up rates almost double (28.9% to 51.8%). The ANN-RMR bundle is the main driver for this increase, suggesting that households demand more annuities when they can use the cash proceeds from reverse mortgages to top-up insufficient pension claims via additional annuity purchases, instead of 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 complementarities and substitutability between risk management products.

1.4 Related literature

This paper contributes to the quantitative life cycle literature on post-retirement asset and risk management, with special emphasis on the slow asset decumulation,[9] the annuities,[10] long-term care insurance,[11] and reverse mortgage puzzles.[12]

Among the most related papers is Koijen et al. (2016) who study joint annuities, life and LTC insurance decisions via the concordance of theoretical and empirical health and mortality deltas.[13] Whereas we also advocate the importance of joint interactions between annuities and LTCI choices, we abstract from the life insurance decisions they consider,[14] thereby channeling all monetary transfers to survivors via bequests.Moreover, our treatment of housing is very different; 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. Importantly, we fully endogenize housing choices, thereby allowing us to consider the important interactions of

[9]See Abel (1985), Bernheim et al. (1985), Hurd (1989), Hubbard et al. (1995), Palumbo (1999), Ameriks et al. (2011), Ameriks et al. (2016, 2020), De Nardi et al. (2010), Lockwood (2018) and Achou (2023).

[10]See Inkmann et al. (2011), Lockwood (2012), Hubener et al. (2014), Peijnenburg et al. (2016, 2017), 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.

[11]See Brown and Finkelstein (2007, 2008, 2011), Lockwood (2018), Ameriks et al. (2016, 2018), Braun et al. (2019), Boyer et al. (2020a), and Leroux et al. (2021).

[12]See Nakajima (2012), Lucas (2016), Nakajima and Telyukova (2017), Blevins et al. (2020), Chen and Yang (2020), and Cocco and Lopes (2020).

[13]Measured by the differential net payoffs of the three instruments in unhealthy, as well as death states relative to good health state.

[14]Life insurance is typically decided at a younger age than in our sample. See Chen et al. (2001, Fig. 2 and Tab. 3) and Hong and Rios-Rull (2012, Fig. 1 and Tab. 1) for evidence and discussion on the age profile of purchases and ownership.

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). To our knowledge, the effect of household formation on demand for these products is largely unexplored. De Nardi et al. (2021) study decumulation of savings in couples in retirement.

Second, Inkmann et al. (2011) also emphasize bequest motives in a quantitative LC model of annuities. However, whereas they consider continuous (rather than one-shot) adjustments of the annuities position and rely on more flexible utility functions,[15] they abstract from both housing, mortgages (and therefore RMR) choices and risks as well as from morbidity (and therefore LTCI) decisions and risk exposure. Third we are related to the RMR analysis of Nakajima and Telyukova (2017) and Cocco and Lopes (2020) who both consider LC-relevant uninsurable idiosyncratic risks as well as bequests and precautionary motives in explaining the low demand for RMR. However, the emphasis of Nakajima and Telyukova (2017) on the effects of the Great Recession, and of the 2013 reform on RMR demand differs from ours. Moreover, whereas Nakajima and Telyukova (2017) consider endogenous house size which we abstract from, we are more general in allowing for back and forth transitions between owner and renter statuses and for (constrained) access to borrowing from financial assets. Similar to us, Cocco and Lopes (2020) consider the role of bequests, uncertain LTC expenditures, and well as expected housing price increases to explain low RMR take-up rates. However, they emphasize age-increasing preference for ageing-in-place that hinder house selling,[16] as well as endogenous maintenance choices as a mean to tap into the housing capital without having to sell, neither of which we consider. We also differ from Cocco and Lopes (2020) 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

[15] For completeness, we also estimated a more general Epstein and Zin (1989, 1991); Weil (1990) (EZW) specification. However with no sizable gain in performance, we opted for the simpler VNM specification.

[16] The ageing-in-place utilitarian costs are partially captured by our exogenous financial moving costs.

2.1 Health statuses and expenses

Agents, time, age and households We consider agents whose identity, gender, and age at interview characteristics are encompassed in indices i (head), and $j = 1, 2, \ldots, N$ (spouse). Time is denoted $t = 0, 1, 2, \ldots T$, where time-0 is the date of interview. Households are composed of singles (denoted i), or of couples (denoted as ij), where we follow standard practices (e.g. Nakajima and Telyukova, 2017) in assuming that no new couples are formed for $t \geq 1$, i.e. neither singles nor widowers find new spouses. Independent of composition, we will henceforth refer to i as household head/respondent.

Health status and transitions Let possible health states for alive agents be denoted $\mathcal{A} = \{G, \ell, L\}$, resp. good health, low and high limitations in activities of daily living (ADL) and $\mathcal{D}$ denote death. Publicly observable health status of agent i's is $s_{it} \in \mathcal{S} = \{\mathcal{A}, \mathcal{D}\}$, with corresponding indicators $\mathbb{1}_{it}^{s} = \mathbb{1}(s_{it} = s \in \mathcal{S})$. The individual health statuses s_{it} are Markovian, with exogenous, age-dependent transition probability elements and matrices denoted:

$$
\begin{aligned}
q_{it}^{n}(s, s') &= \mathrm{Pr}_t \left[s_{it+n} = s' \mid s_{it} = s \right] \\
\mathbf{q}_{it}^{n} &= \left[q_{it}^{n}(s, s') \right] = \prod_{k=0}^{n-1} \mathbf{q}_{it+k}^{1},
\end{aligned}
$$

for states $(s, s') \in \mathcal{S}^2$ and horizon $n \in (1, T - t)$. Aside from death being an absorbing state, i.e. $q_{it}^{n}(\mathcal{D}, s') = 0, \forall s' \in \mathcal{A}$, the elements $q_{it}^{n}(s, s')$ of the transition matrices are unrestricted, thereby allowing transitions from better to worse states and back.

Similarly, denote by $s_{ijt} = (s_{it}, s_{jt}) \in \mathcal{S}^2 = \{(G, G), (G, \ell), \ldots (D, D)\}$ the pair of spouses' contemporary health statuses with corresponding indicator function $\mathbb{1}_{ijt}^{s} = \mathbb{1}(s_{ijt} = s \in \mathcal{S}^2)$. For tractability, we assume that individual statuses are independent from household status, i.e. for agents in couple ij:

$$
q_{it}^{n}(s, s' \mid s_{jt}) = q_{it}^{n}(s, s').
$$

It follows that the transition elements and matrices for couples can be written as:

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

for states $(s, s') \in \mathcal{S}^2 \times \mathcal{S}^2$ and horizon $n \in (1, T-t)$. Since death is an absorbing state, observe that under our no new couples and independence assumptions, a single individual is indistinguishable from a widow(er) from a health status perspective. Without loss of generality, the rest of the analysis will therefore rely on the couples notation for health states and transition matrices whenever suitable.

Medical expenses Household health expenses for agents are status-dependent and given as:

$$M_{ijt} = M(s_{ijt}), \quad s_{ijt} \in \mathcal{S}^2 \tag{1}$$

where deteriorations in health induce larger spending, with ℓ (resp. L) statuses associated with home care (resp. nursing home care) LTC expenses. We assume that expenses are additive for couple (i, j), i.e. there are no (dis-)economies of scale for joint medical expenses across spouses.

2.2 Annuities and long-term care insurance

Annuity We consider agent-specific annuities offered to the household head i paying one unit of numeraire upon survival ($s \in \mathcal{A}$) and zero upon death ($s = \mathcal{D}$) per units of contract b^A, and associated with total cost $P_i^A b^A$. In subsequent sections, the scenarios presented to respondents will vary both price P_i^A and benefit b^A.

LTC insurance Agent-specific insurance against LTC expenditures is offered to the household head i and is characterized by the benefits denoted b^L that are paid out conditional upon state L only, and by the premium $P_i^L b^L$ to be paid only in alive, non-L states. The subsequent scenarios presented to respondents separately alter both price P_i^A and benefit b^A.

2.3 Housing markets, statuses and decisions

2.3.1 Prices

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

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

$$P_t^r = \phi P_t^H, \quad \phi \in (0, 1). \tag{2b}$$

The housing price processes in (2) are similar to Pelletier and Tunc (2019), Cocco and Lopes (2020) in assuming that residential prices follow a random walk with drift rate g, and are conditionally NID, and that the rental prices P_t^r are proportional to house prices.[17]

2.3.2 Owner status, mortgages, expenses and residential wealth

Period-t home-owning status of household is denoted $H_t \in \{0, 1\}$ (rent, own). We account for market frictions by incorporating moving costs – see equation (5b) discussed below – as well as by ruling out intra-period home repurchases, i.e., a seller must rent for at least one period before purchasing another home.[18] The household's net housing wealth W_t^H is zero for renters and is otherwise given by house value net of principal and interests on mortgages D_t:

$$W_t^H = H_t \left[P_t^H - D_t(1 + r_d) \right], \tag{3}$$

where r_d is the mortgage rate of interest.

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

[17] Cocco and Lopes (2020) consider a more complex time-varying loading for ϕ to capture user-costs components in rental charges.

[18] See also Cocco and Lopes (2020) for proxying housing market illiquidities by moving costs. We differ from their approach, however, by allowing transitions back to home owning for renters which they abstract from.

mortgages, i.e. $(H_t, H_{t+1}) = (0, 1)$:

$$D_{t+1} \leq \left[\xi^D H_t D_t + (1 - H_t)\omega^D P_t^H\right] H_{t+1}. \tag{4}$$

We will henceforth assume that the constraint (4) is binding, i.e. conditional upon housing statuses (H_t, H_{t+1}), new mortgages D_{t+1} are not a choice variable. Equivalently, the household cannot adjust repayment on outstanding mortgages, and must disburse $(1 - \omega^D)$ of new house purchases as collateral.

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

$$C_t^H = (1 - H_{t+1})\, P_t^r + H_{t+1} P_t^H - D_{t+1}, \tag{5a}$$

$$MC_t = H_t(1 - H_{t+1}) MC_t^s + (1 - H_t) H_{t+1} MC_t^b, \tag{5b}$$

$$MC_t^k = \tau_0^k + \tau_1^k P_t^H, \quad k = s, b \tag{5c}$$

where τ_0^k, τ_1^k in (5c) are fixed and proportional costs paid out as moving expenses that may differ for sellers and buyers.

Table 1 in Appendix B relies on housing wealth W_t^H in (3), new mortgages constraint D_{t+1} in (4), housing consumption C_t^H in (5a), and moving expenses in (5b) to summarize the relevant home-owning statuses, as well as net housing position. First, (continuing) renters have neither residential wealth, nor mortgages, nor moving expenses, and pay the rental price only. Second, (new) buyers have no residential wealth either, borrow new mortgages equal to share ω^D of house price, must pay the remaining as down-payment, while incurring moving-in costs. Third, sellers cash-in the housing price, entirely clear outstanding mortgages, and must pay the rental price P_t^r, plus moving-out cost. Finally, (continuing) owners' net housing wealth is identical to that of sellers, update their mortgage at $\xi^D < 1$ of past mortgages and have no moving expenses, such that their net expenses is amortization $(1 - \xi^D)$ plus the interest r_d on outstanding mortgages.

2.3.3 Reverse mortgage

The reverse mortgage (RMR) contract specifies the maximal loan at origination, as well as the nominal and effective amounts due at termination:

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

$$L_{ijt} = L_0 \exp\left[\left(r + \tau^R \pi_{ij}\right) t\right], \tag{6b}$$

$$b_{ijt} = \min[L_{ijt}, P_t^H]. \tag{6c}$$

The maximal reverse mortgage loan L_0 in (6a) is a share ω^R of house value at origination P_t^H. This loan is offered only to admissible (continuing) home owners $(H_t, H_{t+1}) = (1,1)$ whose outstanding conventional mortgages D_t are lower than the RMR loan.[19] The RMR is terminated when the house is sold at time $t \geq 1$, and the nominal amount due by the borrower L_{ijt} in (6b) compounds the interests given by the premia π_{ij}^R over the risk-free rate r. The premia is household-specific and accounts for the health status(es) of all member(s) since the latter determine(s) the decision to sell. The effective amount due at termination b_{ijt} in (6c) is the least of the nominal amount and house value at sale. 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.

2.4 Financial and borrowing constraints

2.4.1 Budget constraint

Net revenue flows The household income Y_t pools all labour, or pension income of household members and, conditional on being alive, is independent of statuses:

$$Y_t = \mathbb{1}_{ijt}^s Y_t^s, \quad s \in \mathcal{A}^2 \tag{7a}$$

where we assume that $Y_0^s > Y_{t\geq 1}^s$ i.e. post-retirement incomes of surviving spouses are lower.

[19] 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).

Additional net financial revenues

$$Z_t = Z_t^{ben} - Z_t^{prem} \tag{7b}$$

capture net proceeds from time-0 annuity, LTC insurance and RMR choices, and differ across initial and subsequent periods. At time $t = 0$, Table 2 reveals that continuing home-owners $(H_t, H_{t+1}) = (1, 1)$ receive the selected reverse mortgage loan net of outstanding mortgages $(L_0 - D_0)$ while the household purchases b^A annuities at price P_i^A, buys b^L units of LTC insurance at price P_i^L. For the subsequent periods $t \geq 1$, annuities b^A are paid out, insured agents with high ADL limitations $(\mathbb{1}_{it}^L = 1)$ receive the insurance benefit b^L, whereas insured agents in good $(\mathbb{1}_{it}^G = 1)$ or low $(\mathbb{1}_{it}^\ell = 1)$ ADL limitations statuses pay the premium. Home sellers $(H_t, H_{t+1}) = (1, 0)$ must pay back the effective reverse mortgage payment b_{ijt} given by (6c).

Next, means-tested government transfer programs compute the pre-transfer (gross) cash-on-hand $\tilde{X}_t$ in (7c). The latter includes financial wealth W_t, net housing wealth W_t^H in (3), income Y_t in (7a), plus financial benefits Z_t^{ben} in (7b), minus medical expenditures M_{ijt} given by (1). It is compared to threshold $X_{\min}$ in (7d) to determine eligibility:

$$\tilde{X}_t = W_t + W_t^H + Y_t + Z_t^{ben} - M_{ijt}, \tag{7c}$$

$$TR_t = \max\left[X_{\min} + (1 - H_{t+1})P_t^r - \tilde{X}_t, 0\right], \tag{7d}$$

$$X_t = \tilde{X}_t + TR_t - C_t^h - MC_t - Z_t^{prem}. \tag{7e}$$

Eligible poor agents with resources $\tilde{X}_t < X_{\min}$ are thus entitled a transfer $TR_t \geq 0$ which subsidizes rental housing and bridges the gap to guarantee a minimal consumption floor equal to $X_{\min}$ (e.g. Cocco and Lopes, 2020). The net post-transfer cash-on-hand X_t in (7e), combines the two, and subtracts housing expenses C_t^H in (5a), plus moving costs MC_t in (5b), as well as financial premia Z_t^{prem}.

Financial wealth dynamics The household allocates disposable net cash-on-hand X_t in (7e) between savings $W_{t+1}/(1 + r_t)$, and non-housing consumption C_t so as to satisfy the budget constraint:

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

2.4.2 Borrowing constraints

Financial market frictions are modelled by allowing spreads between borrowing and savings rates of interest, and by imposing debt-servicing and collateral constraints on the maximum borrowing. First, the effective interest rate r_t is higher for borrowers ($r_b \in (r_r, r_h) > r$), especially for borrowing renters ($r_r > r_h$):

$$\begin{aligned} r_t &= \mathbb{1}_t^b r_b + (1 - \mathbb{1}_t^b) r \\ r_b &= (1 - H_t) r_r + H_t r_h \end{aligned} \tag{8a}$$

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

Second, the maximum amount that can be borrowed X_t^W is determined by both an income (i.e. debt servicing) criterion for all agents, and by a house value (i.e. collateral) criterion in the case of Home Equity Lines of Credits (HELOC's) for owners:

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

Equation (8b) reveal that debt servicing requirements restricts both renters ($H_t = 0$) and owners ($H_t = 1$) to borrow at most ω_y of income plus transfers. In addition, HELOC's allow eligible owners to borrow the lesser of ω_1^h of house price, or of ω_2^h of house price minus outstanding mortgages. Observe that the borrowing constraint can equivalently be rewritten as an upper bound on household consumption:

$$0 < C_t \leq C_t^{max} \equiv \frac{X_t^W}{1 + r_b} + X_t. \tag{8c}$$

As discussed below, the upper bound (8c) will be relied upon to determine the admissible range for optimal consumption.

2.5 Preferences and household's problem

2.5.1 Preferences

As was mentioned earlier, the recourse to couples' ij notation implies no loss of generality since a single individual is indistinguishable from a widow(er) from a health status perspective. We rely on expected utility to model preferences. Given the spouses' current health statuses $s_{ijt} = (s_{it}, s_{jt}) \in \mathcal{S}^2$, the within-period $u_{ijt} = u(s_{ijt})$ and continuation utility $V_{ijt} = V(s_{ijt})$ satisfy:

$$V_{ijt} = \max \frac{u_{ijt}^{1-\gamma}}{1-\gamma} + \beta \mathrm{E}_t \sum_{s' \in \mathcal{S}^2} q_{ijt}^1(s, s') V_{ijt+1} \tag{9a}$$

$$u_{ijt} = \left(\frac{\nu_{ijt}}{n_t}\right) C_t^{\rho} S_t^{H\,1-\rho} \tag{9b}$$

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

$$V_{ijt+1} = \frac{b\,[X_{t+1} + \kappa]^{1-\gamma}}{1-\gamma}, \quad \text{for } s' = (\mathcal{D}', \mathcal{D}') \tag{9d}$$

where the expectation in (9a) is taken with respect to stochastic house prices, and where health-dependent taste shocks are:

$$\nu_{ijt} = \nu(s_{ijt}), \quad s_{ijt} \in \mathcal{S}^2.$$

First, the relative risk aversion (RRA) in (9a) is γ whereas the elasticity of inter-temporal substitution (EIS) is $1/\gamma$, and β is the subjective discount factor. Second, we rely on a Cobb-Douglas with consumption share ρ to aggregate consumption and home-owning utilitarian services S_t^H in (9b). The latter are captured in (9c) 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 ($H_t = 1$) of value P_t^H. For consistency with the house price dynamics, we fix housing prices at the initial time, $t = 0$, such that housing services S_t^H movements will be caused by endogenous housing decisions H_t exclusively.[20]

[20] Indeed, utilitarian services from residential amenities are correlated with house value which can increase from both endogenous investments in the house capital and from exogenous market price increases. Whereas home improvements would be consistent with improved house services, it is more difficult to make that argument for market movements in housing prices. Since house investment are abstracted from and the market house prices are modeled as an exogenous random walk in (2), we fix the level of home amenities at the initial period.

Moreover the health-dependent taste shock for household member(s) in (9b) are $\nu_{ijt} = \nu(s_{ijt})$ for $s_{ijt} \in \mathcal{S}^2$. Consistent with medical expenses M_{ijt} in (1), we assume that health shocks ν_{ijt} are lower in deteriorated health statuses,[21] are additive and independent across household members. Observe that the utility flows are averaged for couples by dividing by the equivalent scale for household size n_t.[22] Third, V_{ijt+1} in (9d) is the (warm-glow) utility of bequest in (7e) with b capturing the strength of the bequest motive, $b^{1/(1-\gamma)}$ measuring the intended share of bequeathed cash-on-hand X_{t+1}, and b_K capturing whether bequests are a luxury good ($b_K > 0$), or a necessity ($b_k < 0$) (Lockwood, 2012, 2018; De Nardi et al., 2010).

2.5.2 Household's problem

The household's problem is to maximize V_{ijt} given in (9), with the timing of decisions and constraints summarized in Table 3. For all periods, the continuous consumption C_t and binary housing H_{t+1} choices are conditioned by the mortgage D_t, wealth W_t, health s_{ijt} and house price P_t^H, as well as housing H_t states. In addition, the time-0 agent also selects annuities b^A, LTC insurance b^L and reverse mortgage loan L_0; these three variables complement the states for the subsequent periods. At all periods, the optimization is subject to the mortgage (4), budget (7), and borrowing (8) constraints, whereas the reverse mortgage constraint (6a) must be satisfied for the time-0 choice only.[23]

Unsurprisingly, analytical solutions to problem (9) subject to constraints in Table 3 are unattainable and we resort to standard approaches to solve the model numerically over a discretized state space grid.[24] Conditional upon optimal sequence for $\{C_t, H_{t+1}\}_{t=0}^{T}$, the $t = 0$ discrete choices for annuities, LTCI and RMR that are proposed in the various scenarios for b^A, b^L and L_0 can be obtained by contrasting the value functions $V_{ij,t}$ with and without the instruments.

[21] See De Nardi et al. (2010), Peijnenburg et al. (2017) for a similar assumption regarding health-dependent utility.

[22] We follow Scholz et al. (2006) in setting $n_t = 1.55$ for couples, and $n_t = 1$ for singles. See also Nakajima and Telyukova (2017) for use of equivalent scale measures in couples corresponding to 1.34 (utility-based) and 1.48 (income-based), and Hong and Rios-Rull (2012) who rely on 1.33 (utility-based). Hubener et al. (2014) set the equivalent scale equal to 1.3 for couples and find that it is a key parameter in capturing the change in consumption required to compensate the death of a spouse as a determinant of annuity demand.

[23] Recall that assuming that the mortgage constraint (4) is binding removes the need to consider D_{t+1} as a control variable.

[24] Details on the solution method are found in Appendix D.

3 Data

3.1 Survey details

3.1.1 Sampling

In April/May 2019, we fielded a survey with *Asking Canadians*, an online panel with more than 2 million members. We targeted individuals age 60 to 70 at the time of the survey from the 11 largest census metropolitan areas (CMA) in Canada: Victoria, Vancouver, Calgary, Edmonton, Winnipeg, Hamilton, Toronto, Ottawa - Gatineau, Montreal, Quebec and Halifax.[25]

3.1.2 Survey design

The survey design has four different components: (i) Background in 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. The complete questionnaire is found in Appendix G. Respondents from the Asking Canadians panel are rewarded for their participation in the online survey using a loyalty point reward system. A total of 3,057 completed questionnaires were collected.

3.1.3 Data cleaning and imputations

Of these 3,057 completed surveys, we first proceeded to impute missing values on financial variables using unfolding bracket questions for unanswered questions.[26] We also top-coded income responses to 500,000C$ and financial wealth as well as mortgage debt at 1,000,000C$. We then proceeded to impose filters for the sample analysis. First, we dropped couples with an age difference of more than 10 years and with outlier responses to questions on home equity, mortgage balance and payments, rent, retirement age (max 10 years before retiring) and income.

Given our focus on the role of home equity, we restricted to households who were initially home owners ($H_0 = 1$). The final dataset contains 1,581 respondents (households), with 1,164 households

[25] We focus on urban areas who have seen the largest increases in house prices and therefore have the highest potential for home equity extraction.

[26] These imputations were done using chained multivariate regression, conditional on bracketing. Details on the imputation procedure are available upon request

being couples. Descriptive (unweighted) statistics on the key variables required for our analysis is provided in Table 4 in Appendix B. The average current income of respondents ($Y_{i,0}$) is 71,810C$ while that of spouses ($Y_{j,0}$) is 51,621C$. On average, respondents are either retired or on the verge of retirement ($\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 average outstanding mortgage debt is 28,487C$ while the average house value is 710,711C$ (P^h_0), reflecting higher home values in those metropolitan areas represented in the sample. The average non-housing wealth (W_0) is 226,818C$ (median 190,000C$) and characterized by considerable heterogeneity, with 7% of households having less than 5,000C$.

3.2 Health status

The questionnaire specifically asks about limitations in activities of daily living. We define someone as being in good health (G) if they responded not having any limitations with instrumental activities of daily living (IADLs: preparing meals, doing shopping, doing housework, managing bills, going to the toilet or taking medication) or more basic activities of daily living (ADLs: eating, washing, dressing, moving inside the house and getting in and out of bed). We define someone as having mild limitations (ℓ) if they have some IADLs or at most one ADL. Finally, we define someone as having severe limitations (L) if they have two or more ADLs. The distribution of health status reported in Table 5, reveals that the sample is generally healthy, with few respondents already facing limitations (less than 5% among singles and 6.5% among couples have one spouse with limitations).

3.3 Subjective beliefs and preference heterogeneity

3.3.1 Longevity expectations

We asked respondents for their subjective probability (in %, rescaled between 0 and 1) that they will still be alive by the time they reach 85 years old. Figure 1 in Appendix A shows the cumulative distribution of these probabilities for both respondent (panel a) and spouse (panel b), with some evidence of bunching at 0.5 and at 1. We can compare mean survival probabilities to cohort life tables (projected) produced by Statistics Canada, for the average age of 65 in our sample. This exercise reveals some degree of over-optimism regarding survival. Indeed male (resp. female) respondents report a subjective 72% (resp. 73%) probability of surviving up to 85, compared to an objective likelihood of 56% (resp. 67%). This over-optimism at a target age of 85 is a common finding in the literature (e.g. Hurd and McGarry, 2002) while in some countries respondents tend to be pessimistic at earlier ages (O'Dea and Sturrock, 2023).

3.3.2 House price expectations

Figure 2.a plots respondents' subjective expectations regarding own house price increases in the next 10 years. Respondents put on average a 30% probability on the possibility of a drop in prices over the next 10 years. That probability is highest in Calgary and Edmonton. In several CMA's respondents put roughly a 10% probability on price increases of more than 40%. Hence, respondents hold uncertain beliefs about house price increases, again with substantial heterogeneity across agents.

In comparison, panel b shows the actual house price index for each of these CMA's over the last 10 years prior to the survey. Three CMA's saw a near doubling of house prices over that period (Toronto, Vancouver and Hamilton). Other CMA's witnessed between 15% and 40% increase in house prices over that 10 year horizon. Respondents thus appear to display over-pessimism, being quite reluctant to expect the same kind of house price increases over the next 10 years.

3.3.3 Preferences heterogeneity

To capture heterogeneity in preferences, we present respondents with a series of statements which they need to rate from *Strongly Disagree* to *Strongly Agree*. Responses are recoded as a binary variable if the respondent reports agreement or strong agreement with the statement.

A first statement[27] concerns a preference for a bequest motive (parameter b in the model). The second[28] provides information on preference for housing (parameter ν_h in the model). We also ask a standard subjective question on five levels of risk aversion, ranging from very low aversion[29] to

[27] "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."
[28] "A house is an asset that should only be sold in case of financial hardship."
[29] Willingness to take substantial risk to earn substantial returns.

high and extreme risk aversion.[30] We recode the risk aversion question to a binary equal to one if the respondent either high or extreme aversion. Overall, relatively few of the respondents report a strong bequest motive (20%) and substantial risk aversion (28%). Conversely 55% report a strong preference for staying at home (55%).

3.4 The stated-choice experiment

We designed a stated-choice experiment in order to elicit demand for three risk management products we consider: annuities, long-term care insurance and reverse mortgages. Each respondent was presented with 4 choice situations for each product (a total of 12 choices for home owners and 8 for renters). We describe the design of choice situations for each product. The complete questionnaire is included in Appendix G.

3.4.1 Annuities

The intro screen for annuities in section 4 of Appendix G is proposed to respondents with positive financial wealth (non-housing, and potentially annuitized). This screen reminds that annuities' main features are the immediate one-shot premium to be paid and the monthly benefit starting next year and paid until death. In order to create ideal conditions, we emphasize that there is neither default risk (payments will be made no matter the circumstances), nor inflation risk by considering indexed benefits.

The modelling approach is similar to that followed by Boyer et al. (2020b) whereby respondents are presented with scenarios corresponding to two different level of annuitization of financial wealth repeated twice (20% and 50% of $W_{i,0}$). 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. For each annuitization level, the premium shown for each scenario is drawn randomly twice (without replacement) using the following markups τ_A on the actuarial premium (0.5, 0.75, 1.25 and 1.5), resulting in four scenarios. For each of the four scenarios, respondents are asked to report the probability of purchase within the next year.

[30] Respectively willingness to accept below average returns in exchange for below average risk (high), and to accept low returns in exchange of zero risk (extreme).

3.4.2 Long-term care insurance

The intro screen for long-term care insurance in section 6 of the questionnaire in Appendix G is proposed to respondents who do not yet have LTCI. We follow a very similar strategy for long-term care insurance which has also been used by Boyer et al. (2020a). This intro screen first informs respondents about the two attributes of the product, i.e. the monthly benefits for agents with two or more limitations in activities of daily living (ADL) and the monthly premium to be paid by individuals without limitations.

We describe the admissible limitations set in ADLs to qualify for benefits, which are the same ones we consider for the ADL questions in the survey.[31] We again stress that there is neither default risk, nor lapsing in the payment of premiums.[32] Product attractiveness is emphasized by stating that premiums cannot increase over time and that benefits (either 2,000C$ or 4,000C$ per month) are adjusted for inflation. We present each twice, with a randomization of the markup τ_L on actuarial premium by age group and sex (60-64,65-70). The loads considered are (0.5, 0.75, 1.25 and 1.5). For each scenario, we collect the probability of purchase.

3.4.3 Reverse mortgages

The intro screen for reverse mortgages in section 5 of the questionnaire in Appendix G is proposed to respondents who do not yet have a RMR contract. This screen reminds respondents of the two characteristics of RMR: a percentage of net home equity which can be borrowed, and a fixed interest on the loan amount.

We emphasize that home owners are not forced to sell their home by RMR providers and that there is no contract risk in order to make the product attractive. We make explicit reference to net home equity (house value minus outstanding mortgages) as basis for maximal borrowing. We also mention that cumulated interests need to be paid only when the RMR buyer moves out, sells or dies, and emphasize the non-negative equity guarantee on RMR loans whereby the amount due at house sale or agent's death cannot exceed the house value at that date. For each of the four

[31] Eating, washing, dressing, moving inside the house and getting in and out of bed.

[32] In practice, products include a provision that we abstract from for contract termination when monthly payments are not made.

scenarios, we first set the maximal loan-to-value (LTV) ratio that can be borrowed as a function of the age of the respondent,[33] and consider two borrowing levels: 50% and 100% of maximal LTV. We repeat each twice and randomize the interest rate charged on the loan. We randomly pick (without replacement) from (2, 4, 6 and 8%) interest rate, thereby spanning the actual rate of 6% on RMR. For each respondent, we collect the four probabilities of purchase for these RMR products.

3.4.4 Product knowledge and choice probabilities

We also asked respondents whether they knew (i.e. a lot, a little, not at all) each of the products before presenting scenarios. Table 6 reports statistics by products and across all associated scenarios. Agents report a 10.8% probability of buying annuities at least once, whereas 55.8% report zeros across all scenarios, with 26.9% reporting a lot of prior knowledge of the product. The (within) price and benefit elasticities are both of the correct sign at -0.584 and 0.487. Second, despite lower prior knowledge of 10.9%, respondents report higher take-up intentions for LTCI with 17.4% probability of buying and 39.2 of never buying. Again both price (-0.794) and benefit (0.525) elasticities are of the correct sign. Finally, our agents display the least interest (buy 7.3%, never buy 63.8%) for reverse mortgage, despite similar prior knowledge (28.7%) compared to annuities, and again have anticipated responses to price and benefits incentives.

4 Empirical framework

4.1 Linking the model to the experimental data

The mapping from the theoretical model to the stated-preference experimental data is performed in two steps. First, the discrete choice of buying or not the product in the proposed price-benefit configuration is inferred through the welfare gain or loss relative to the benchmark of no purchase. Each ANN, RMR and LTCI scenario modifies the investment opportunity set by changing the budget constraint. Moreover, each respondent has an agent-specific specific set of initial conditions and individual distributions for the forcing processes governing health and house

[33] The maximal LTV are 30% for those age 60-64 and 40% for those 65-70.

prices. Consequently, the theoretical model presented in Section 2 must be numerically solved 20,553 times, i.e. for (i) the benchmark plus each of the 12 scenarios, and (ii) *individually* for each of the $N = 1{,}581$ respondents (see Appendix D for numerical solutions details). Second, the binary purchase intentions from the welfare gains and losses are converted into likelihoods to be comparable to the reported take-up probabilities. For this task, we rely on a reporting model (described in Section 4.3.2) that accounts for trembling-hand noise and default-bias. This two-step procedure allows for the joint estimation of structural preference parameters and those of the reporting model.

4.2 Calibration of auxiliary parameters and stochastic processes

The model's rich parametric set can be segmented between the calibrated parameters of auxiliary interest and the estimated parameters of primary interest.

4.2.1 Auxiliary parameters

We summarize our calibration choices for the auxiliary parameters in Table 7 of Appendix B.

a. Financial Rates The financial rates are set to 2019 levels, a relatively low interest rate environment, and are all expressed in real terms using a 2% inflation rate. We assume a fixed real rate of return on savings and for discounting purposes of $r = 0.01$. Second, we use the 2016 Survey of Financial Security to calibrate the average interest on fixed rate mortgages[34] among those aged between 60 and 70 at $r_d = 0.03$. For home-owners borrowing out of home equity line of credits (HELOC's), we set the rate at 1% over the rate on mortgages, i.e. $r_h = 0.04$, using rates at various Canadian financial institutions. Finally, both owners borrowing beyond the limits set by HELOCs and RMs, as well as renters are assumed to rely on their credit card with borrowing rate $r_r = 0.095$.[35]

b. Borrowing constraints We use financial information from mortgage providers to set the maximal LTV for mortgages at $\omega^D = 0.65$ of home price. In the spirit of Gorea and Midrigan

[34] More than 76% of home owners who have a mortgage in Canada have a fixed rate mortgage (typically 5 years).

[35] In the absence of Canadian data on credit card rates, we use U.S. data from the 2016 Survey of Consumer Finance to find an average real rate (APR) among credit card borrowers of 9.49%. Given the similarities between the two countries, we remain confident that this should provide a good approximation to Canadian credit card rates.

(2018, p. 15), we set the amortization factor at $\xi^D = 0.9622$ to generate a mortgage half-life of 12.5 years, when calculated using r_d.[36] In addition, a homeowner can reverse-mortgage up to $\omega^R = 0.55$ of house price. HELOC's eligibility is typically tested against both the loan-to-value as well as on the value of the house. In particular, the HELOC cannot be more than 65% of the value of the house (the Value test), while the HELOC plus the mortgage balance cannot be more than 80% of the value of the house (the LTV test).[37] We implement both of these rules for (ω_0^h, ω_1^h).[38] For credit card borrowing used by renters and by owners having exhausted home leverage limits, we set maximal borrowing to $\omega^r = 32.9\%$ of household income using the average limit found for respondents from the Canadian Survey of Financial Security of 2016.[39]

c. Housing First, the elasticity of rental prices with respect to house prices is set at $\phi = 0.035$. Second, sellers must pay fixed legal fees and moving expenses (τ_0^s) of 1,500C$, plus commission (i.e. broker) fees (τ_1^s) of 5% of house prices, whereas home buyers pay moving expenses (τ_0^b) of 500C$ plus municipal transfer taxes (τ_1^b) of 1% of house prices.

d. Income and expenditure flows We calibrate medical expenditures M_{ijt} by including three types of expenditures. First, we consider out-of-pocket medical expenditures in states (G, ℓ). Second, we consider home care expenditures (state ℓ) and finally nursing home expenditures (state L). Using multiple sources of data, we compute province specific out-of-pocket cost estimates for each component and sum these up. In the Appendix B, Table 8, we report estimates by CMA and health status.[40]

[36] More specifically, $\xi^D = (1 + r_d) \times 0.5^{(1/12.5)} = 0.9622$.

[37] See https://www.chip.ca/reverse-mortgage-resources/reverse-mortgage/heloc-rates-comparison/

[38] An additional requirements for benefiting from a low premium over the borrowing rate on mortgages is that the credit score of the individual be excellent. If the score is low, respondents may not quality, or qualify with a risk premium of up to 6% over the rate on fixed mortgages. For simplicity, we assume all respondents have excellent credit scores.

[39] We do not find evidence that this limit varies by age among the elderly (age 60+).

[40] We use the 2009 Survey of Household Spending (SHS), the latest public release file available, to calibrate out-of-pocket medical expenditures. The SHS contains an indicator variable for disability status of both the reference person and the spouse. which we map to the less severe health state ℓ in the model. We compute average out-of-pocket expenditures by region and the number of persons disabled in the couple (only one if single). We adjust for prices using the CMA specific CPI. Home care expenditures are incurred in health state ℓ. The 2002 General Social Survey collected data on number of (paid) hours of care provided. We consider paid time to do laundry, house cleaning, house maintenance, errands, meal preparation and personal care. We impute costs for these tasks using an hourly wage of 20C$. Average expenditures are computed by province and then mapped to CMAs. For health expenditures

The resource floor for retirees in Canada ($X_{\min}$) corresponds to the sum of old age pension (OAS) benefits and the Guaranteed income supplement (GIS). When a retiree has no other income sources, a minimum income floor of 18,212C$ for singles and 27,733C$ is provided. Several transfers are anchored on these same floor. For example, nursing home out-of-pocket expenditures are reduced one for one for retirees with net income less than the combined OAS and GIS rates.

Income flows from the survey were reported before income taxes. Hence, we need to impute taxes and compute after-tax income to reflect actual resources available to retirees. We use a tax simulator to separately compute pension income average tax rates for singles and couples.[41] For Quebec, we use Quebec tax parameters and for other provinces, we use tax parameters from Ontario. These tax rates are applied to first period income and retirement income to produce after-tax income figures.

e. Preferences Finally, we follow standard practices in setting annual subjective discount rate to 3% corresponding to a discount factor $\beta = 0.97$.[42]

4.2.2 Objective and subjective stochastic processes

House prices We use data from Teranet on historical house price indices by census metropolitan area (CMA) for the period 1991 to 2017 to compute annual real[43] growth rates g and volatility σ. These are reported in the Appendix, Table 9. We test for and do not reject the null of no unit root for ϵ_t in (2a) using an Augmented Dicky Fuller (ADF) test, for 10 out of the 11 CMAs (Ottawa being the exception). [44] Overall, we find heterogeneity in average growth rates over the recent period (2010-2017), with Toronto and Vancouver house prices increasing at a rate of 6.4% and 6.2% per year respectively compared to much more modest growth in Montreal (1.4%) and Calgary or Edmonton (respectively 0.7% and -0.01%).

in state L, we calibrate using the average costs using the cost of a single room in a nursing home by province. In 2016, the price of a single room was 3,240C$ per month in British Columbia and 1,837C$ in Quebec. We use these provincial estimates and inflate to 2019 dollars using CMA specific price indices.

[41] The Simulateur de Revenu Disponible is a Python based disposable income simulator.

[42] Boyer et al. (2022) estimate an average value of $\beta = 0.969$ using multiple price lists on a sample of Canadians.

[43] We use census metropolitan areas level general consumer price index to deflate prices.

[44] For certain CMAs, we find some evidence of serial correlation in growth rates. See also Case and Shiller (1989) for evidence of serial correlations in U.S. housing prices. However, the evidence is broadly consistent with the random walk assumption for p_t^H in (2).

In addition to the objective house price process by CMA, we build into the model the possibility that respondent's subjective beliefs about house price growth which may differ from historical trends as seen in Figure 2 in Appendix A. In particular, 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 over-optimism or pessimism parameters that are respondent specific. We use a set of questions from the experiment on the subjective probability that house prices with increase (or decrease) over the next 10 years. We show in Appendix E how these answers can be used to estimate μ_i and ζ_i. We report the distributions of estimated μ and ζ in Figure 3. Respondents are much more pessimistic about house price growth with an average μ of 0.1 in panel a, but correctly perceive the volatility of house prices with an average ζ of 0.96 in panel b.

Health risk process To solve the model, we need respondent- (and spouse-) specific rates of transitions across health states (G, ℓ, L, D) by age and gender. The survey instrument is specifically designed to ask about current health status in terms of common health conditions (mental health problems, hypertension, diabetes, heart disease, stroke, cancer and lung disease). In addition, we asked about smoking status and have 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 forecast the likely path of health of each respondents as a function of the inputs collected in the survey. In Appendix E, we show how we use these simulated health profiles to estimate a respondent-specific dynamic multinomial logit model for the markov transition probabilities $q_{it}(s, s')$. Next, we also account for subjective survival expectations revealed by respondents. They report 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. We then estimate a correction to mortality probabilities from any state to death, a mortality belief parameter, to match this subjective probability. We do this for both respondent and spouses.

Figure 4 shows on the first panel a scatter plot of the objective probabilities of surviving to age 85. There is substantial heterogeneity in the sample. There is also a positive correlation within the couple. On the second panel, we report a scatter plot of the distribution of mortality belief parameters for respondents and spouse. 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 $\xi = -1.42$. However, there is substantial heterogeneity as can be seen in Figure 4. There is also substantial correlation in these beliefs, conditional on objective probabilities. This is perhaps to be expected given the respondent reports also the probability for the spouse.

4.3 Structural estimation

4.3.1 Respondents' heterogeneity and responses

Characteristics Respondent i is associated with a set $\boldsymbol{X}_i$ of observable individual characteristics at the time of the decision. This set includes age, pre- and post-retirement incomes Y_t and health status for both respondent and spouse (if any) s_{ijt}. In addition, it 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. Finally, the set $\boldsymbol{X}_i$ incorporates the parameters of the health process for both respondent and spouse q_{ijt}^n, where those parameters are estimated separately from a simulation model based on health characteristics in the survey, as described in Section 4.2.2.

Preference shifters We allow preferences to vary across respondents using preference shifters. We introduce the parameter Δ_γ for those who report being more risk averse, Δ_{ν^h} for those who express a strong preference for keeping their home and finally Δ_b for those who express a stronger bequest motive.

Survey responses Each respondent, indexed $i = 1, \ldots, N$, is 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 $\boldsymbol{B}_{i,k} = (b_{i,k}^A, b_{i,k}^L, L_{0,i,k})$ in annuities, LTC insurance and reverse mortgage products.[45] Let $n(k)$ map to the product type $\{A, L, R\}$ featured in scenario k. Each agent i reports probabilities

[45] The number of presented scenarios $K_i \leq 12$ is agent-specific, as certain respondents will be presented with fewer choices if non-owners and/or if insufficient financial resources.

$p_{i,k} \in [0,1]$ of purchasing product k, relative to the benchmark case $\boldsymbol{B}_{i,0} = (0,0,0)$ and $\boldsymbol{P}_{i,0} = (0,0,0)$ of no participation in the three products.

4.3.2 Estimator and inference

Denote by θ the estimated structural parameters $\theta = (\gamma, \Delta_\gamma, \rho, b, \Delta_b, \kappa, \nu_{c,2}, \nu_{c,3}, \nu_h, \Delta_\nu)$. Conditional upon θ, define the indirect utility in scenario k as $V_{i,k}(\theta) \equiv V(\boldsymbol{X}_i, \boldsymbol{P}_{i,k}, \boldsymbol{B}_{i,k}, \theta)$. For a given value of θ, we can solve for V as given in (9). The indirect utility gain to respondent i of purchasing product k can be written as:

$$\tilde{V}_{i,k}(\theta) = V_{i,k}(\theta) - V_{i,0}(\theta) \tag{10}$$

We next consider the mapping of indirect utility gains to decision utility of respondents. We assume that respondents make decisions based on a noisy measure of the indirect utility gain in (10) associated with a particular scenario. We assume they purchase product k if:

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

where $\upsilon_{i,k}$ 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. The parameter $\delta^*_{i,n}$ is a respondent- and product-type $n = A, L, R$ specific fixed effect that captures inertia or status-quo bias. Given welfare gain $\tilde{V}_{i,k}$ in (10), the larger is $\delta^*_{i,n}$, the less likely is respondent i to purchase a product of type n in a given scenario.

With these elements in mind, the self-reported probability $p_{i,k} \in [0,1]$ for agent i of purchasing the financial product in scenario k can be contrasted with its theoretical counterpart, defined as

$$p_{i,k}(\theta) = \frac{\exp(-\delta_{i,n(k)} + \lambda_{\upsilon,n(k)}\tilde{V}_{i,k}(\theta))}{1 + \exp(-\delta_{i,n(k)} + \lambda_{\upsilon,n(k)}\tilde{V}_{i,k}(\theta))}. \tag{11}$$

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 status-quo bias ($\delta_{i,n} = 0$), given mortality and house price beliefs, will purchase the product in scenario k with degenerate probability $I(\tilde{V}_{i,k} > 0) \in \{0, 1\}$ determined by the sign of welfare gain $\tilde{V}_{i,k}$.

Given that we observe reported probabilities, we can use the following transformation to obtain a log odds-ratio which is linear in $\delta_{i,n}$,

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

We can use a within transformation, for each product type $n(k)$, to eliminate fixed effects $\delta_{i,n}$.[46] The resulting within differences are independent of $\delta_{i,n}$ but are also are linear in $\lambda_{\upsilon,n}$ for a given value of θ (and therefore of the $\tilde{V}_{i,k}(\theta)$). Hence, the value of $\lambda_{\upsilon,n}$ can be obtained by OLS of $g_{i,k}$ on $\tilde{V}_{i,k}(\theta)$ once a within transformation has been applied. Since a closed-form solution for their value is known, they can be concentrated-out of the objective function to estimate θ, speeding up the search for the best value of θ. In Appendix F, we propose a concentrated non-linear least-square estimator to estimate θ. We use the derivative-free NEWUOA algorithm (Powell, 2006) in order to find the solution to (**??**). In the estimation, we allow λ_υ to vary by product type (A, L, R) and also by whether or not respondents know the product based on their responses (if they respond that they know the product *a lot*). Hence, we estimate for each product type $(\lambda_{\upsilon,0}, \lambda_{\upsilon,1})$ where the index 1 denotes the product is known and zero if not. We compute cluster-robust standard errors from the full NLS estimator using numerical gradients. Details on the computation of standard errors are found in Appendix F.

[46] We fix probabilities to 0.01 when reported to be zero and to 0.99 when reported to be 1 so that the log-odds transformation gives a finite result.

5 Estimation results

5.1 Preference parameters

We report the estimated preference parameters in Table 10. We present equivalent estimates in Table 11 to facilitate comparison with results from other papers, starting first with the Experimental and Heterogeneous preferences literature that is more relevant to our setting (panel a), followed by the Revealed Preference literature (panel b).

Risk aversion We estimate a level of relative risk aversion $\gamma = 0.459$ in Table 10.a. We find no evidence of heterogeneity with those reporting being highly risk averse having a marginally higher RRA ($\Delta_\gamma = 0.018$) that is not statistically significant. Both this estimated RRA and the calibrated subjective discount $\beta = 0.97$ are similar to other values found in the experimental and heterogeneous preferences literature in Table 11.a., where the RRA are typically lower than the revealed preference estimates in Table 11.b. The implied elasticity of inter-temporal substitution $1/\gamma = 2.18$ is consistent with the asset pricing literature emphasizing long-term consumption risks (such as health and housing related) which advocates EIS larger than one to generate plausible results.[47]

Housing and state-dependence First, we estimate a high consumption share $\rho = 0.812$, and impose a unit elasticity of intra-temporal substitution between consumption and housing that are both realistic compared to other values in Table 11.b. Second, we also identify a positive utilitarian benefit of home ownership $\nu_h = 0.312$. This housing utility is slightly higher, however not significantly so for those expressing a preference for keeping their home as long as possible ($\Delta_{\nu^h} = 0.037$). Third, relative to good health ($\nu_{c,1} \equiv 1.0$), the state-dependent shifters are indicative of strong declines in the marginal utility of consumption in low- ($\nu_{c,2} = 0.235$) and high-ADL limitations states ($\nu_{c,3} = 0.043$), consistent with expectations on health-dependent consumption

[47] See Bansal and Yaron (2004), Yang (2016) for examples and Epstein et al. (2014) for discussion. We did estimate a more flexible Epstein-Zin specification that allows to separate the IES from relative risk aversion. However, we could not reject the restriction imposed by vNM expected utility that the inverse of the IES was equal to relative risk aversion. Furthermore, there was no improvement in the fit of the model over the vNM specification. We therefore decided to keep the simpler expected utility specification.

utility (e.g. Finkelstein et al., 2013). Given that LTCI covers financial losses in states with poor health, this will likely lower the value of LTCI insurance.

Bequests We find evidence of a bequest motive in Table 10.c, 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 in Table 11.b and corresponds to an intended bequest of 109K$ at mean financial + residential wealth in Table 4. Again, heterogeneity is not apparent; those who do express a stronger bequest motive (20% in our sample), have a statistically insignificant increment $\Delta_b = 0.102$. Finally, the statistically significant curvature parameter $\kappa = 119.5$ is also realistic and indicative of bequests being perceived as luxury goods,[48] consistent with other evidence in Table 11.b.

5.2 Model performance

Info content of utility gradients We can gauge our model performance through the informational content of the utility gradients in predicting take-up rates. With the exception of $\lambda_{\upsilon,A(1)}$, the parameters λ_υ are all positive and statistically significant in Table 10.d, confirming that respondent's choices correlate positively with the estimated utility gradients of purchasing particular products and cannot entirely be explained by random decisions ($\lambda_{\upsilon,j} = 0$). Interestingly, with the exception of annuities, we do find that those with better prior knowledge ($\lambda_{\upsilon,j(1)}$) systematically have a higher weight attributed to welfare gains/losses, consistent with a costly information acquisition and/or processing explanation for LTCI and RMR.

Out-of-sample validation We perform an out-of-sample exercise to assess the model's ability to reproduce asset decumulation survey data not used in the estimation. Abstracting from proposed risk management instruments, we gauge our framework's capacity to replicate the self-assessed probabilities of having exhausted all financial wealth by the time respondents reach age 85. For each of the 1,370 persons who provided a probability for this question (prior to being presented

[48] In particular, bequest motives only become operational past a threshold consumption level of $\kappa = 119.5$K$ and exhibit lower and increasing relative risk aversion compared to the constant consumption RRA (e.g. Lockwood, 2018, p. 2520).

with scenarios), we use their initial health and socio-economic data to simulate the financial paths predicted by the model and compute the share of zero or negative wealth at age 85. The sample statistics (panel a) and coefficients on socio-economic regressors (panel b) of the Data (first column) and Simulated (second column) are reported in Table 12. The results provides unambiguous evidence of the model adequacy; both the distribution, and socio-economic gradients of wealth decumulation are very well replicated.This implies that the preference parameters consistent with risk management choices are also consistent with other expected behavior of households regarding the decumulation of assets.

Overall assessment The estimation results allow us to conclude that our modelling and empirical strategies are appropriate for the stated preferences data we use. Indeed, (i) the risk aversion, discount, as well as housing and bequests parameters are consistent with comparable values in the literature, (ii) the absence of heterogeneity justifies our identification assumption of homogeneous preferences with shifters, (iii) the information in the utility gradient is relevant to predict annuities, LTCI and RMR take-up rates, in particular for respondents with prior knowledge of the products, and (iv) the model's performs very well in replicating asset decumulation data not used in the estimation.

6 Implications for low risk management take-up rates

We now discuss the implications of our results for the households' demand for longevity, health and housing risks management products, focusing first on the role of estimated preference parameters. We then consider a comparative statics exercise to gauge the effects of bequests, health and household composition risks, as well as biased expectations rationales. In order to derive purely theoretical effects, the comparative statics exercise is performed by abstracting from behavioural and informational biases and by imposing actuarially-fair prices for annuities, long-term care insurance and reverse mortgages.[49] These biases, as well as of prior product knowledge are

[49]Shutting down status-quo (resp. information) bias is achieved by imposing $\delta_{i,n} = 0$, (resp. $\lambda_{\nu,n} = \infty$) to obtain degenerate theoretical purchase probabilities $p_{ik} \in \{0, 1\}$ in (11). Fair pricing is discussed in Appendix C.

subsequently re-introduced and analyzed. We close this section with a product packaging discussion, looking at interest in bundled vs separate products.

6.1 Role of preferences

6.1.1 Point estimates

Risk aversion and elasticity of inter-temporal substitution First, moderate risk aversion ($\gamma = 0.459$) is consistent with low demand for longevity insurance procured by annuities, as well as with a low demand for long-term care insurance (against disability expenditures risk), and for reverse mortgages (against downward house price risk). The high implied elasticity of inter-temporal substitution ($1/\gamma = 2.18$) implies dominance of substitution over income effects. Consequently, the large returns in house prices induce a larger propensity to save, and therefore low reliance on liquidation instruments for financial (via annuities) and residential wealth (via reverse mortgages).[50]

6.1.2 Comparative statics

We abstract from all informational and status-quo biases, impose fair pricing and rely on a comparative statics exercise to better understand the role of health-dependent preferences, housing and bequests in panel a of Table 13. Fair pricing is imposed at the respondent level. Because prices used in the experiment are not necessarily fair at the individual level, and informational and status-quo biases are turn off, the baseline optimal take-up of the three products is different from what is observed in the experiment. The optimal take-up of annuities is 28.1%, that of LTCI is 16.6% and finally reverse mortgages are optimal for 63.4% of respondents. An important finding is that optimal demand is well below 100% even under fair pricing. We now investigate the reasons for this lack of optimality.

Health-dependent preferences Table 10.c indicated that, relative to being healthy ($\nu_{c,1} \equiv 1.0$), detrimental health states significantly lower the marginal utility of consumption, and conse-

[50] The low subjective discount rate we identify ($-\log(\beta) = 0.03$) is consistent with a slow asset depletion rate and therefore a low demand for annuities as the need for pension revenues can be accommodated via more generous interest revenues on financial (and housing) wealth. A low impatience is also consistent with a low demand for liquidation of housing wealth into current consumption made possible via RMR products.

quentially the marginal value of payments received in low ($\nu_{c,2} = 0.235$), and in high ($\nu_{c,3} = 0.043$) ADL limitations statuses. Removing state-dependent utility ($\nu_{c,s} \equiv 1, \forall s$) in row 1 of Table 13.a thus induces large increases in the demand for state-independent annuities, and for state-dependent LTCI payments in particular. In contrast, the demand for RMR – conditional on being in an already good state for home-owners – falls when the expected value of disposable resources in bad states increases. Hence, health-dependent preferences play an important role in keeping demand for LTCI and annuities down.

Preferences for housing 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 home ownership for precautionary wealth motives and induces a low demand for state-independent net revenues through ANN and insurance by LTCI. Removing utilitarian services from housing ($\rho = 1, \nu_h = 0$) in row 2 of Table 13.a is equivalent to imposing perfect substitution between financial and residential wealth. It lowers even further the demand for stable net income procured by annuities and LTCI in order to guarantee home ownership. Similarly, the demand for RMR which allows house-rich and cash-poor households to tap into house equity without leaving their house evaporates when housing utility services are abstracted from.

Bequest motivations Third, it will be recalled from Table 10.c that we estimated a sizeable bequest motive (corresponding to bequeathed share of wealth $\tilde{b} = 0.138$). High intended bequests increases 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. motivations are operational only for the richer households, and are associated with lower aversion to bequests risk. Removing bequests motives (by setting $b = \kappa = 0$) in row 3 of Table 13.a has thus 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 consumption. Second, they also are poorer by losing free claims to guaranteed income in low revenues and/or high medical expenditures states. Row 4 of Table 13, panel b reveals that the additional risk in net revenues justifies a demand for net income insurance that is provided by annuities, as well as by LTCI, whereas reverse mortgages are unaffected. The result for LTCI is consistent with the analysis of Pauly (1990). Conversely, removing long-term care expenditures risk in row 5 of Table 13.b naturally eliminates the demand for LTCI. It also implies an increase in the net present value of disposable pension income that is converted into annuities, and lowers the demand for RMR. For annuities, this is consistent with the view that annuities may be less desirable for liquidity constrained households faced with financial risk.

Household composition Eliminating couples and transferring spousal resources to the respondents implies that the single household head is both richer, and has less incentives to co-insure herself (resp. spouse) from the spouse (resp. own) medical expenditures risk. In row 6 of Table 13.b, the demand for LTCI in particular and for RMR thus falls sharply whereas the windfall in transferred wealth is annuitized. This result implies that there is a substantial motive or couples for insure the surviving spouse from the financial risk associated with LTCI. Indeed, the declining marginal utility of consumption in poor health implies little demand for LTCI among singles. But for individuals in couples, the marginal utility of consumption for the surviving spouse is much higher in the future if the individual spends down financial wealth to play for long-term care services. De Nardi et al. (2021) also find that bequest motives are particularly important in couples for the surviving spouse.

Biased expectations It will also be recalled from Figure 1 that respondents tended to be over-optimistic with respect to both own and spouse longevity. Removing these biases in row 7 of Table 13.c is thus tantamount to shortening expected lifespan. This significantly reduces the attractiveness of annuities and of LTCI, since the agent is more likely to die before reaching a deteriorated health state. 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 ($1/\gamma = 2.18$ in Table 10.a) and the demand for RMR increases.[51]

Since pricing is fair, based on objective risk, why is the demand for annuities collapsing when removing biases in survival expectations? Based on insights from Davidoff et al. (2005), one would expect much higher optimal take-up. However, this reasoning abstracts from alternative investments households can make. In our model, housing is an asset that yields a high (risky) return that appears to dominate annuities for these respondents (even when biased downward in terms of expectations). Recall that the degree of risk aversion is estimated to be low. Hence, households prefer to keep the house longer, use financial wealth as a buffer instead of investing in annuities. If one eliminates house price returns and other explanations (1-7), optimal demand for annuities jumps to more than 80%. Hence, the interaction between expectations and housing as an investment vehicle keep annuity demand low. Davidoff et al. (2005) show the superiority of annuities irrespective of preferences based on the budget constraint in a world where only bonds are available as an alternative to annuities. Housing as a risky investment alters this result when the expected return on that asset increases relative to the implicit yield from annuities. Annuities are not unambiguously superior in this setting, even under fair pricing.

An additional subjective bias concerns house price appreciation which were subject to overly pessimistic forecasts by our respondents (Figure 2). Removing these biases in row 8 of Table 13.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

[51] Our results are in contrast to O'Dea and Sturrock (2023) who finds for the U.K. that pessimism explains in part the low demand for life annuities. The fact that biases are different across countries is interesting and deserves more scrutiny in the future.

which is unsurprising since their value is equivalent to that of a put option with positive value only when house price are expected to decrease (Davidoff, 2015).

6.3 The role of behavioural biases

Status-quo biases and product knowledge We can retrieve estimates of the parameters $\delta_{i,j}$ for each respondent to chart the effects of self-reported prior knowledge of the products demand.[52] Recall from (12) that these parameters measure status-quo or default biases in purchase behaviour, i.e. the deviations from an exclusively utility-gradient motive for reported take-up rates. Figure 5 plots the cumulative distribution of these estimates, while Table 14 reports how these $\delta_{i,j}$ vary by product knowledge.

The estimates reveal that biases are higher and less dispersed for both annuities and reverse mortgages, and that they are also significantly lower among respondents with prior product knowledge. Conversely, the biases are lower, more dispersed, and less affected by product knowledge for long-term care insurance. These findings accord with both the previous evidence on the informational content of utility gradients $\lambda_{v,j}$ in Table 10.d and the lower inaction rates for informed agents in Table 6.b. Respondents with prior knowledge (i) rely more heavily on model-based analysis, (ii) display lower status-quo biases and (iii) are less likely to report no take-up in selecting risk management products.

Biases and take-up rates The role of informational and status-quo biases on take-up rates can further be identified through a comparative statics exercise whereby the bias estimates are set to $(\lambda_{v,j}, \delta_{i,j}) = (\infty, 0)$ in order to obtain the predicted choice solely based on predicted utility

[52] We can retrieve product specific individual fixed effects $\delta_{i,j}$ using within differences. Note first that:

$$\overline{g}_{i,j} = -\delta_{i,j} + \lambda_{v,j} \overline{V}_{i,j}(\theta)$$

where we assume that $\overline{v}_{i,j} \approx 0$ given that $E(\overline{v}_{i,j}) = 0$. Hence, an unbiased estimate of $\delta_{i,j}$ is given by

$$\hat{\delta}_{i,j} = -(\overline{g}_{i,j} - \hat{\lambda}_{v,j} \overline{V}_{i,j}(\hat{\theta})).$$

These estimates are noisy given that the number of scenarios per product is limited (4). Nonetheless, they provide valuable (unbiased) information on unobserved characteristics of respondents which make them systematically not likely to purchase a product.

gradients $\tilde{V}_{i,k}$ in (10). We do this in the context of the scenarios presented to respondents which varied the pricing of each product.

The results in Table 15 confirm that pure model-based specification in column c partially explains the low demand for annuities, LTCI and reverse-mortgage. As we show later the lower optimal take-up of RMR compared to fair pricing is explained by substantial price sentivity for RMRs and the use of generally unfair prices for RMR in the scenarios presented. Optimal demand falls from 63.4% in Table 13 to 31.2% in Table 15. Compared to the observed take-up rates in the data (column a), 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 adding (i) imperfect informational content (possibly linked with trembling-hand deviations and/or imperfect/incomplete product scenarios) of utility gradients identified by $\lambda_{v,j}$, and (ii) systemic deviations related to preference for status-quo identified by δ_{ij}. Indeed, the estimated model allowing the latter in column b performs very well in reproducing the data in column a.

Biases and price-benefit elasticities In addition to mean take-up rates, behavioural biases can be expected to alter price and benefit responsiveness of demand. To assess these effects, Table 15 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 (a) and pure Model-based (b) estimates correctly reproduce the observed and anticipated negative price and positive benefits elasticities. In the absence of biases, both elasticities are much larger in magnitude compared to observed ones. Reintroducing informational and behavioural deviations produces lower elasticities that are better aligned with observed values. Equivalently, the inclusion of biases significantly dampens and better replicates the responsiveness of demand to price and benefits incentives.

We conclude that the pure model-based approach yields annuities, LTCI and RMR take-up rates that are more nuanced in magnitude relative to the puzzles identified by the quantitative literature. Moreover, the sign of both price and benefits elasticities are correctly identified. However, the predicted take-up rates and demand gradients remain higher than observed and require the addition of deviations from the theoretical approach to encompass costly information acquisition and processing and/or behavioural biases.

6.4 Product bundling

Both the risk management scenarios presented in the survey, as well as in the model were evaluated independently of each other, i.e. 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 the way these products are typically presented to retirees. One the other hand, retirees could theoretically choose any risk management combination, raising the issue of optimal bundling.

To analyze the attractiveness of such products, we set up a large grid of potential bundles of annuities, LTCI and reverse mortgages, varying the product characteristics, using actuarially fair prices, and abstracting from informational and status-quo biases.[53] Table 16 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 (total demand) reveal that annuities are the main benefiters from bundling 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 for this result is the tripling in the ANN-RMR bundle (10.1% to 32.8%). Equivalently, households are responsive to packaging and demand more of annuities via 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 complementarities and substitutability between risk management products.

[53] 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. This yields 125 different bundles. We compute expected utility of each respondent for each bundle. To evaluate the value of bundles, we compare 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.

7 Conclusion

Determining the optimal speed of depletion for financial and residential assets after retirement and risk management is a complex issue. Indeed, agents are exposed to age-increasing disability, mortality as well as to housing uncertainty that is especially potent in the case of couples. Fortunately, three risk management products are helpful in solving this problem, and can fruitfully complement or replace costly maintenance of 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, whereas reverse mortgage allow cash-poor and house-rich households to tap into residential equity, while remaining in house and hedge downward house prices risk.

The demand for these products has however been surprisingly weak relative to theoretical predictions at fair prices. This paper has revisited these puzzles through a flexible theoretical model of consumption and housing choices, augmented with bequests motives and risk management products 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 behavioural information and status-quo biases in rationalizing the puzzles.

Our main findings confirm that low risk aversion rationalizes low demand for insurance against longevity, disability and housing risks provided by ANN, LTCI and RMR. The high implied elasticity of inter-temporal substitution also justifies a low appetite for flat consumption profiles made possible by annuities, and penalizes dis-savings allowed by RMR in the face of increasing returns to housing. Health shocks strongly discounts consumption utility (and therefore the marginal value of LTC insurance 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 house. Finally, bequests motives were found to be significant, but a luxury good, therefore with limited incidence except for the richest.

Importantly, when evaluated at fair prices and without any biases, our model goes a long way in rationalizing the risk management puzzles. Indeed, we find that predicted universal coverage falls to only one-third for all three products. However, these rates still remain too high and require the inclusion of behavioural and informational acquisition and processing biases to replicate observed take-up rates and elasticities. 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.

References

Abel, Andrew B. (1985) 'Precautionary saving and accidental bequests.' *American Economic Review* 75(4), 777 – 791

Achou, Bertrand (2023) 'Housing in medicaid: Should it really change?' *American Economic Journal: Economic Policy* 15(1), 1–36

Agranov, Marina, and Pietro Ortoleva (2017) 'Stochastic choice and preferences for randomization.' *Journal of Political Economy* 125(1), 40–68

Ameriks, John, Andrew Caplin, Steven Laufer, and Stijn Van Nieuwerburgh (2011) 'The joy of giving or assisted living? using strategic surveys to separate public care aversion from bequest motives.' *Journal of Finance* 66(2), 519 – 561

Ameriks, John, Joseph Briggs, Andrew Caplin, Matthew D. Shapiro, and Christopher Tonetti (2016) 'Late-in-life risks and the under-insurance puzzle.' Working Paper 22726, National Bureau of Economic Research, October

_ (2018) 'The long-term-care insurance puzzle: Modeling and measurement.' Unpublished manuscript, Stanford University, June

Ameriks, John, Joseph Briggs, Andrew Caplin, Matthew D. Shapiro, and Christopher Tonetti (2020) 'Long-term-care utility and late-in-life saving.' *Journal of Political Economy* 128(6), 2375 – 2451

Andersen, Steffen, Glenn W. Harrison, Morten I. Lau, and E. Elisabet Rutstrom (2008) 'Lost in state space: Are preferences stable?' *International Economic Review* 49(3), 1091 – 1112

_ (2018) 'Multiattribute utility theory, intertemporal utility, and correlation aversion.' *International Economic Review* 59(2), 537 – 555

André, Eric, Antoine Bommier, and François Le Grand (2022) 'The impact of risk aversion and ambiguity aversion on annuity and saving choices.' *Journal of Risk and Uncertainty* 65(1), 33–56

Bansal, Ravi, and Amir Yaron (2004) 'Risks for the long run: A potential resolution of asset pricing puzzles.' *The Journal of Finance* 59(4), 1481–1509

Bernheim, B. Douglas, Andrei Shleifer, and Lawrence H. Summers (1985) 'The strategic bequest motive.' *Journal of Political Economy* 93(6), 1045 – 1076

Blevins, Jason R., Wei Shi, Donald R. Haurin, and Stephanie Moulton (2020) 'A dynamic discrete choice model of reverse mortgage borrower behavior.' *International Economic Review* 61(4), 1437 – 1477

Boyer, M. Martin, Philippe d'Astous, and Pierre-Carl Michaud (2022) 'Tax-Preferred Savings Vehicles: Can Financial Education Improve Asset Location Decisions?' *The Review of Economics and Statistics* pp. 1–45

Boyer, M. Martin, Philippe De Donder, Claude Fluet, Marie-Louise Leroux, and Pierre-Carl Michaud (2020a) 'Long-term care insurance: Information frictions and selection.' *American Economic Journal: Economic Policy* 12(3), 134 – 169

Boyer, M. Martin, Sébastien Box-Couillard, and Pierre-Carl Michaud (2020b) 'Demand for annuities: Price sensitivity, risk perceptions, and knowledge.' *Journal of Economic Behavior and Organization* 180, 883–902

Braun, R. Anton, Karen A. Kopecky, and Tatyana Koreshkova (2019) 'Old, frail, and uninsured: Accounting for features of the U.S. long-term care insurance market.' *Econometrica* 87(3), 981 – 1019

Brown, Jeffrey R., and Amy Finkelstein (2007) 'Why is the market for long-term care insurance so small?' *Journal of Public Economics* 91(10), 1967–1991

_ (2008) 'The interaction of public and private insurance: Medicaid and the long-term care insurance market.' *American Economic Review* 98(3), 1083 – 1102

_ (2011) 'Insuring long-term care in the United States.' *Journal of Economic Perspectives* 25(4), 119 – 142

Caplin, Andrew, Mark Dean, and John Leahy (2019) 'Rational inattention, optimal consideration sets, and stochastic choice.' *Review of Economic Studies* 86(3), 1061 – 1094

Case, Karl E., and Robert J. Shiller (1989) 'The efficiency of the market for single-family homes.' *American Economic Review* 79(1), 125 – 137

Chen, Kuo-Shing, and J. Jimmy Yang (2020) 'Housing price dynamics, mortgage credit and reverse mortgage demand: Theory and empirical evidence.' *Real Estate Economics* 48(2), 599 – 632

Chen, Renbao, Kie Ann Wong, and Hong Chew Lee (2001) 'Age, period, and cohort effects on life insurance purchases in the U.S.' *Journal of Risk and Insurance* 68(2), 303 – 327

Cocco, Joao F., and Paula Lopes (2020) 'Aging in place, housing maintenance, and reverse mortgages.' *Review of Economic Studies* 87(4), 1799 – 1836

Cui, Min (2018) 'Evaluating consumption CAPM under heterogeneous preferences.' Manuscript, Department of Economics, Indiana University, May

Davidoff, Thomas (2015) 'Can 'high costs' justify weak demand for the home equity conversion mortgage?.' *Review of Financial Studies* 28(8), 2364 – 2398

Davidoff, Thomas, Jeffrey R. Brown, and Peter A. Diamond (2005) 'Annuities and Individual Welfare'

De Nardi, Mariacristina, Eric French, and John Bailey Jones (2010) 'Why do the elderly save? The role of medical expenses.' *Journal of Political Economy* 118(1), 39–75

De Nardi, Mariacristina, Eric French, John Bailey Jones, and Rory McGee (2021) 'Why do couples and singles save during retirement?' Working Paper 28828, National Bureau of Economic Research, May

Dean, Mark, Ozgur Kibris, and Yusufcan Masatlioglu (2017) 'Limited attention and status quo bias.' *Journal of Economic Theory* 169, 93 – 127

Epstein, Larry G., and Stanley E. Zin (1989) 'Substitution, risk aversion and the temporal behavior of consumption and asset returns: A theoretical framework.' *Econometrica* 57(4), 937–969

__ (1991) 'Substitution, risk aversion and the temporal behavior of consumption and asset returns: An empirical analysis.' *Journal of Political Economy* 99(2), 263–268

Epstein, Larry G., Emmanuel Farhi, and Tomasz Strzalecki (2014) 'How much would you pay to resolve long-run risk?.' *American Economic Review* 104(9), 2680 – 2697

Finkelstein, Amy, Erzo F.P. Luttmer, and Matthew J. Notowidigdo (2013) 'What good is wealth without health? The effect of health on the marginal utility of consumption.' *Journal of the European Economic Association* 11(s1), 221–258

Gorea, Denis, and Virgiliu Midrigan (2018) 'Liquidity constraints in the U.S. housing market.' NBER Working Paper w23345, National Bureau of Economic Research, June

Haurin, Donald, Chao Ma, Stephanie Moulton, Maximilian Schmeiser, Jason Seligman, and Wei Shi (2016) 'Spatial variation in reverse mortgages usage: House price dynamics and consumer selection.' *Journal of Real Estate Finance and Economics* 53(3), 392 – 417

Hong, Jay H., and Jose-Victor Rios-Rull (2012) 'Life insurance and household consumption.' *American Economic Review* 102(7), 3701 – 3730

Horneff, Wolfram J., Raimond H. Maurer, and Michael Z. Stamos (2008) 'Life-cycle asset allocation with annuity markets.' *Journal of Economic Dynamics and Control* 32(11), 3590–3612

Hubbard, R. Glenn, Jonathan Skinner, and Stephen P. Zeldes (1995) 'Precautionary saving and social insurance.' *Journal of Political Economy* 103(2), 360 – 399

Hubener, Andreas, Raimond Maurer, and Ralph Rogalla (2014) 'Optimal portfolio choice with annuities and life insurance for retired couples.' *Review of Finance* 18(1), 147 – 188

Hurd, Michael D. (1989) 'Mortality risk and bequests.' *Econometrica* 57(4), 779–813

Hurd, Michael D., and Kathleen McGarry (2002) 'The predictive validity of subjective probabilities of survival*.' *The Economic Journal* 112(482), 966–985

Inkmann, Joachim, Paula Lopes, and Alexander Michaelides (2011) 'How deep is the annuity market participation puzzle?' *Review of Financial Studies* 24(1), 279 – 319

Koijen, Ralph S. J., Stijn Van Nieuwerburgh, and Motohiro Yogo (2016) 'Health and mortality delta: Assessing the welfare cost of household insurance choice.' *Journal of Finance* 71(2), 957 – 1010

Laitner, John, Dan Silverman, and Dmitriy Stolyarov (2018) 'The role of annuitized wealth in post-retirement behavior.' *American Economic Journal: Macroeconomics* 10(3), 71 – 117

Leroux, Marie-Louise, Pierre Pestieau, and Gregory Ponthiere (2021) 'Fair long-term care insurance.' *Social Choice & Welfare* 57(3), 503 – 533

Lockwood, Lee M. (2012) 'Bequest motives and the annuity puzzle.' *Review of Economic Dynamics* 15(2), 226 – 243

_ (2018) 'Incidental bequests and the choice to self-insure late-life risks.' *American Economic Review* 108(9), 2513 – 2550

Lucas, Deborah (2016) 'Hacking reverse mortgages.' Working Paper, MIT Golub Center for Finance and Policy, September

Manski, Charles F. (1999) 'Analysis of choice expectations in incomplete scenarios.' *Journal of Risk and Uncertainty* 19(1-3), 49 – 66

Maurer, Raimond, Olivia S. Mitchell, Ralph Rogalla, and Vasily Kartashov (2013) 'Lifecycle portfolio choice with systematic longevity risk and variable investment?linked deferred annuities.' *Journal of Risk and Insurance* 80(3), 649–676

Nakajima, Makoto (2012) 'Everything you always wanted to know about reverse mortgages but were afraid to ask.' *Federal Reserve Bank of Philadelphia Business Review* pp. 19–31

Nakajima, Makoto, and Irina A. Telyukova (2017) 'Reverse Mortgage Loans: A Quantitative Analysis.' *The Journal of Finance* 72(2), 911–950

O'Dea, Cormac, and David Sturrock (2023) 'Survival Pessimism and the Demand for Annuities.' *The Review of Economics and Statistics* 105(2), 442–457

OECD (2021) 'Health at a glance.' https://doi.org/10.1787/ae3016b9-en

Palumbo, Michael G. (1999) 'Uncertain medical expenses and precautionary saving near the end of the life cycle.' *Review of Economic Studies* 66(2), 395–421

Pauly, Mark V. (1990) 'The rational nonpurchase of long-term-care insurance.' *Journal of Political Economy* 98(1), 153–168

Peijnenburg, Kim, Theo Nijman, and Bas J. M. Werker (2017) 'Health cost risk: A potential solution to the annuity puzzle.' *Economic Journal* 127(603), 1598 – 1625

Peijnenburg, Kim, Theo Nijman, and Bas J.M. Werker (2016) 'The annuity puzzle remains a puzzle.' *Journal of Economic Dynamics and Control* 70, 18 – 35

Pelletier, Denis, and Cengiz Tunc (2019) 'Endogenous life-cycle housing investment and portfolio allocation.' *Journal of Money, Credit, and Banking* 51(4), 991 – 1019

Powell, M. J. D. (2006) 'The NEWUOA Software for Unconstrained Optimization Without Derivatives.' In 'Large-Scale Nonlinear Optimization' (Springer, Boston, MA) pp. 255–297

Scholz, John Karl, Ananth Seshadri, and Surachai Khitatrakun (2006) 'Are Americans saving optimally for retirement?' *Journal of Political Economy* 114(4), pp. 607–643

Shan, Hui (2011) 'Reversing the trend: The recent expansion of the reverse mortgage market.' *Real Estate Economics* 39(4), 743 – 768

Shao, Adam W., Hua Chen, and Michael Sherris (2019) 'To borrow or insure? long term care costs and the impact of housing.' *Insurance: Mathematics and Economics* 85, 15–34

Shao, Adam W., Katja Hanewald, and Michael Sherris (2015) 'Reverse mortgage pricing and risk analysis allowing for idiosyncratic house price risk and longevity risk.' *Insurance: Mathematics and Economics* 63, 76–90

Sims, Christopher A. (2003) 'Implications of rational inattention.' *Journal of Monetary Economics* 50(3), 665 – 690

Statistics Canada (2022a) ‘Distributions of household economic accounts, wealth, by characteristic, Canada, quarterly.’ https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610066001. Table 36-10-0660-01

_ (2022b) ‘Registered pension plans (RPP’s) active members and market value of assets by normal retirement age.’ https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1110012001. Table 11-10-0120-01

Steiner, Jakub, Colin Stewart, and Filip Matejka (2017) ‘Rational inattention dynamics: Inertia and delay in decision-making.’ *Econometrica* 85(2), 521 – 553

Strzalecki, Tomasz (2019) ‘Lectures on stochastic choice.’ Hotelling Lectures, Harvard University, March

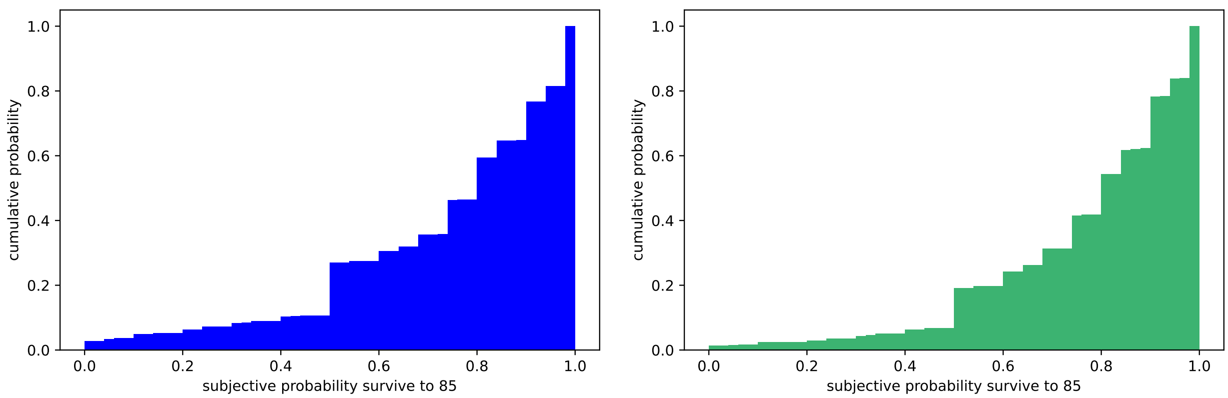
Weil, Philippe (1990) ‘Non-expected utility in macroeconomics.’ *Quarterly Journal of Economics* 105(1), 29–42

Yang, Wei (2016) ‘Intertemporal substitution and equity premium.’ *Review of Finance* 20(1), 403 – 445

A Figures

Figure 1: Subjective survival probabilities

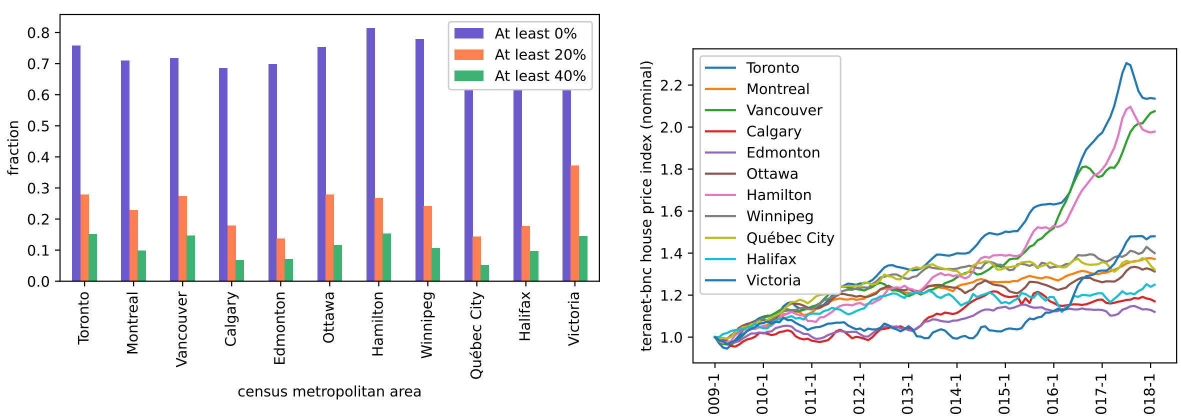
(a) Respondent (b) Spouse



Notes: Cumulative distribution of subjective probability beliefs of surviving up to age 85.

Figure 2: Subjective expectations and observed home prices

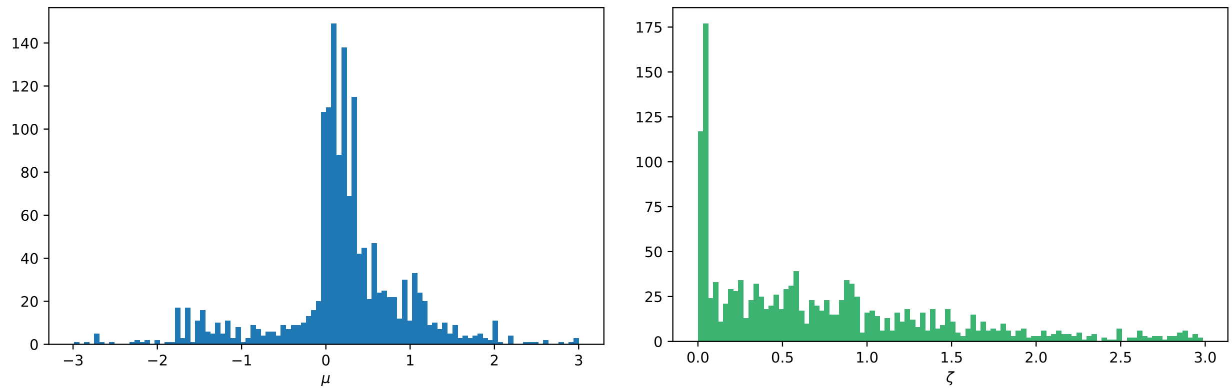
(a) Expected increases (b) Observed prices



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) .

Figure 3: Distribution of house price growth and volatility belief estimates

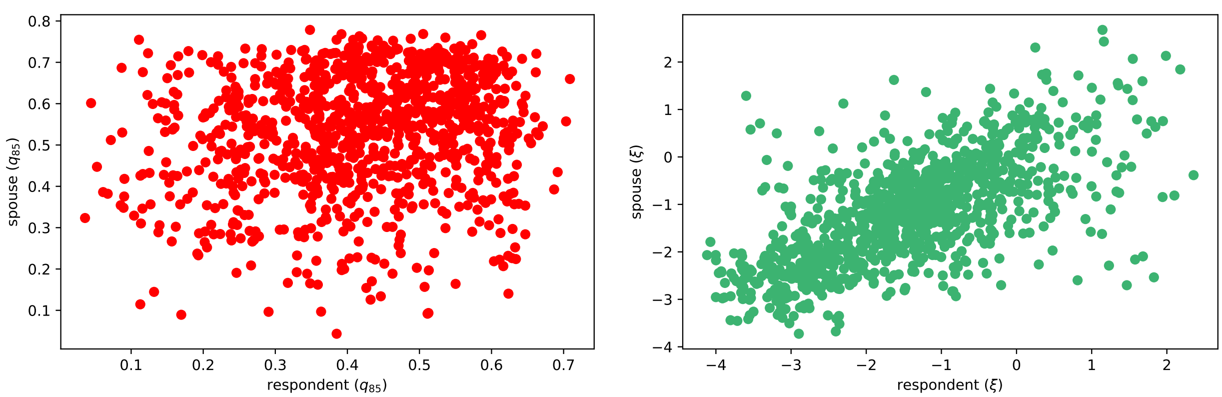
(a) Mean growth (b) Standard deviation



Notes: Panel a shows beliefs about price growth ($\mu = 1$ is historical estimate) while panel b shows beliefs regarding the standard deviation of house price shocks ($\zeta = 1$ is historical CMA estimate). Outliers below -3 and above 3 are removed from figure.

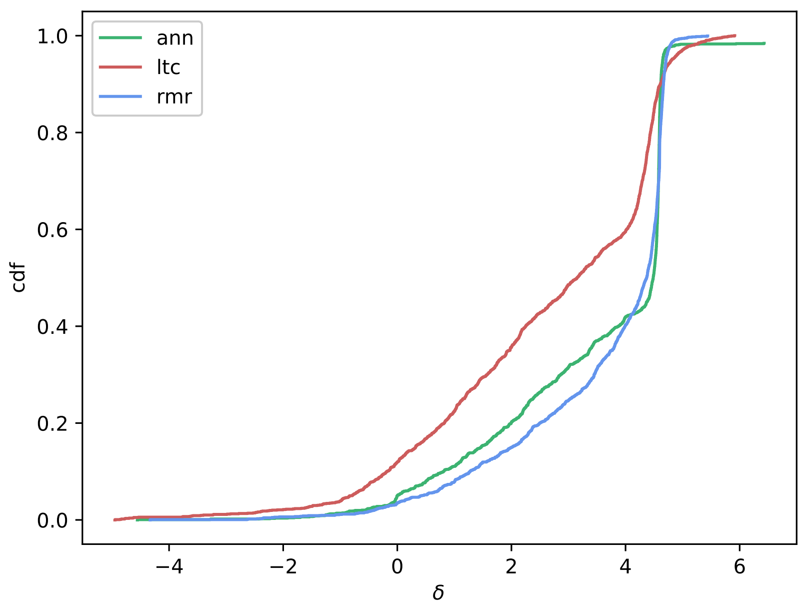
Figure 4: Objective and subjective survival beliefs distributions

(a) Objective (b) Subjective



Notes: Panel a shows the joint distribution of objective survival probabilities that account for health conditions and other individual characteristics. Panel b plots the joint distribution of subjective mortality beliefs (relative to objective risk). A positive number indicates pessimist beliefs about mortality while a negative number indicators optimistic beliefs.

Figure 5: Cumulative distribution function of δ for each product



Notes: We report the empirical cumulative distribution of default bias estimates for each product.

B Tables

Table 1: Home-related statuses, wealth, mortgages, housing and moving expenses

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

Table 2: Net financial revenues

Item	$t=0$	$t \geq 1$
Z_t^{ben}	$H_t H_{t+1}(L_0 - D_0)$	$b^A + \mathbb{1}_{it}^L b^L$
Z_t^{prem}	$P_i^A b^A + P_i^L b^L$	$(\mathbb{1}_{it}^G + \mathbb{1}_{it}^\ell)P_i^L b^L + H_t(1-H_{t+1})b_{ijt}$

Table 3: Timing of decisions

Variables and constraints	$t=0$	$t \geq 1$
Control variables:	C_t, H_{t+1} b^A, b^L, L_0	C_t, H_{t+1}
State variables:	$D_t, W_t, s_{ijt}, P_t^H, H_t$	$D_t, W_t, s_{ijt}, P_t^H, H_t$ b^A, b^L, L_0
Borrowing constraints:	(4), (6a), (8)	(4), (8)
Budget constraint:	(7)	(7)

Table 4: 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
H_0	1581	1.00	0.00	1.0	1.0	1.0	1.0	1.0
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

Notes: Sample restricted to home-owners aged between 60 and 70 at time of interview.

Table 5: Distribution of health status in the starting sample

	Single	Spouse j		
Head i		G	ℓ	L
G	0.95	0.935	0.030	0.007
ℓ	0.043	0.018	0.005	-
L	0.007	0.004	0.001	0.000

Notes: Head i is respondent and j denotes the spouse. Health status G denotes good health, ℓ some IADL limitations at and most one ADL and L two or more ADL.

Table 6: Choice probabilities by scenario

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

Notes: The first row reports the average probability of buying the product over all scenarios. The second row reports the fraction of respondents who report zero probability of purchase over all scenarios for a given product. The third row reports the fraction of respondents who respond that they know *a lot* about a particular product.The fourth and fifth rows report the 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 7: Calibrated auxiliary parameters

Parameter	Equation(s)	Interpretation	Value/Range
(a) Financial rates:			
r	(6b), (8a)	Interest/discount rate	0.01
r_d	(3)	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	(4)	Mortgage LTV	0.65
ξ^D	(4)	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	(2b)	Rental price elasticity	0.035
(τ_0^s, τ_1^s)	(5c)	Seller's moving costs	(1.50,0.05)
(τ_0^b, τ_1^b)	(5c)	Buyer's moving costs	(0.50,0.01)
(d) Income and Expenditure Flows:			
M_t	(1)	Medical expenses	varies by CMA
$X_{\min}$	(7d)	Minimum cash-on-hand	18.2
(e) Preferences:			
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 8: Medical expenses by health statuses and CMA.

	Health status G	ℓ	L
Toronto	2 235	3 466	32 162
Montreal	2 560	4 107	22 780
Vancouver	2 816	5 256	41 063
Calgary	2 538	5 282	24 862
Ottawa	2 165	3 374	32 031
Edmonton	2 536	5 240	24 937
Québec City	2 532	4 062	22 589
Hamilton	2 200	3 420	32 097
Winnipeg	2 583	4 986	31 208
Halifax	2 334	5 182	41 390
Victoria	2 734	5 086	40 647

Notes: Total medical, home care and nursing home care expenditures, by person and respondent health status. Sources: 2009 Survey of Household Spending and 2002 General Social Survey. Adjusted in 2019 C$.

Table 9: Estimated real house price growth, volatility and persistence

	mean	std	ADF (p-value)
Toronto	0.044	0.037	0.999
Montreal	0.025	0.033	0.815
Vancouver	0.044	0.056	0.993
Calgary	0.030	0.081	0.493
Edmonton	0.036	0.086	0.355
Ottawa	0.026	0.025	0.000
Hamilton	0.043	0.034	0.996
Winnipeg	0.028	0.042	0.772
Québec City	0.026	0.039	0.815
Halifax	0.019	0.025	0.920
Victoria	0.036	0.058	0.946

Notes: For each census metropolitan area (CMA), we report the average real growth (mean) over the period 1991-2018, the volatility (standard deviation, std) and finally the p-value from the augmented Dickey-Fuller test (ADF-p).

Table 10: Non-linear least squares estimates

Parameter	Point estimate	Std. Err.
(a) Base preference (9a)		
γ	0.459	0.026
Δ_γ	0.018	1.987
(b) Housing and state-dependence (9b)		
ρ	0.812	0.024
$\nu_{c,2}$	0.235	0.075
$\nu_{c,3}$	0.043	0.079
ν_h	0.312	0.021
Δ_{ν^h}	0.037	0.551
(c) Bequests (9d)		
b	0.343	0.074
Δ_b	0.102	0.254
κ	119.5	0.156
(d) Info content utility gradients (12)		
$\lambda_{\upsilon,A(0)}$	0.013	0.004
$\lambda_{\upsilon,A(1)}$	0.013	0.010
$\lambda_{\upsilon,L(0)}$	0.141	0.023
$\lambda_{\upsilon,L(1)}$	0.148	0.021
$\lambda_{\upsilon,R(0)}$	0.021	0.005
$\lambda_{\upsilon,R(1)}$	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 $\lambda\upsilon, j(k)$ 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 11: Comparison with other preference parameter estimates/calibration

	Base		Housing		Bequests	
	Disc	RRA	C share	EIaS	Share	Curv
This paper	β	γ	ρ		$b^{1/(1-\gamma)}$	κ
	0.970	0.459	0.812	1.000	0.138	119.5
	(a) Experimental and heterogeneous pref. lit.					
Andersen et al. (2008)		0.620				
Andersen et al. (2018)	0.898	0.450				
Boyer et al. (2022)	0.968	0.410				
Cui (2018)	0.990	0.220				
	(b) Revealed preference lit.					
Cocco and Lopes (2020)	0.970	3.030	0.752	1.250	0.294	6.0
Inkmann et al. (2011)	0.990	5.000			0.639	
Lockwood (2018)	0.840	4.500			0.017	410.4
De Nardi et al. (2010)	0.970	3.660			0.053	215.0
Nakajima and Telyukova (2017)	0.906	2.006	0.762	1.000	0.050	7.6
Koijen et al. (2016)	0.960	2.170			0.047	
Ameriks et al. (2011)	0.970	3.000			0.003	346.5
Pelletier and Tunc (2019)	0.950	3.780	0.500	1.493	1.000	

Notes: Panel (a): Andersen et al. (2008, p. 1101). Andersen et al. (2018, p. 544). Boyer et al. (2022, Tab. 1, panel d). Cui (2018, Tab. 4). Panel (b): When necessary, parameters have been re-normalized to ensure comparability with modelled preferences (9). Cocco and Lopes (2020, Tab. 6) Consumption share is $\theta^{1/\epsilon}$; Bequeathed share of wealth is $b^{1/(1-1/\sigma)}$. Inkmann et al. (2011, Tab. 5, Shareholders), Bequest share is $b^{(1/(1-\gamma))}$. Lockwood (2018, Tab. 3, Col. (1)), Bequeathed share of wealth is $(\phi/(1-\phi))^{\sigma/(1-\sigma)}$; Bequest curvature is $\phi/(1-\phi) * c_b$. De Nardi et al. (2010, Tab. 3, Col. (4)) Bequeathed share of wealth is $\theta^{(1/(1-\nu))}$. Nakajima and Telyukova (2017, Tab. 1, panel b); House load is $1-\eta$; Bequeathed share of wealth is $\gamma^{(1/(1-\sigma))}$. Koijen et al. (2016, Tab. IV, p. 894); Bequeathed share is $\omega_1^{\gamma/(1-\gamma)}$. Ameriks et al. (2011, Tab. IV, p. 543); Bequeathed share is $\bar{\omega}^{\gamma/(1-\gamma)}$. Pelletier and Tunc (2019, Tab. 1 and p. 1006).

Table 12: Reported and simulated 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: The probability of having no financial wealth at age 85 in the data and in the model: For the data, we use the question asking what is the probability the respondent will have spent down all financial wealth by the time he or she reaches age 85. A total of 1370 respondents reported an answer to this question. For the model, we simulate for each respondent the path of financial wealth forward until they reach age 85. At that point, we check whether financial wealth is less or equal to zero. We perform 1000 such simulations per respondent and record the fraction of those simulations where the event occurs. Importantly, perceived mortality and house price risk are used for these calculations. The first panel of the Table (a) reports the moments of the distribution of reported (data) and simulated (model) probabilities. The second panel (b) report regression estimates of these probabilities on quartile dummies (the first always ommitted) for financial wealth, home equity, current income and retirement income. We also include controls for gender and marital status in the regression. * denotes $p < 0.05$, ** $p < 0.01$ and *** $p < 0.001$.

Table 13: Counter-factual optimal take-up of risk management products

Counter-factual	ANN	LTCI	RMR
Baseline	0.281	0.166	0.634
(a) Preferences			
1. No health-dep. margin. utility	0.414	0.364	0.521
2. No preference for housing	0.228	0.120	0.291
3. No bequest motive	0.261	0.141	0.658
(b) Health and household composition			
4. Low resource floor	0.385	0.223	0.631
5. No medical expenditures	0.312	0.000	0.629
6. Singles	0.297	0.016	0.619
(c) Biased expectations			
7. No subj. survival expectations	0.025	0.005	0.668
8. No subj. house price expectations	0.335	0.352	0.081

Notes: Optimal take-up under different counter-factual scenarios: Expected utility at fair prices computed under different counter-factuals and used to compute take-up for a given product. Respondents can partially insure (4 equally space coverage choices on the (0,1) interval). For annuities, this is the fraction of financial wealth annuitized. For LTCI, it is the fraction of nursing home expenditures insured against. For RMR, it is the faction of home equity that can be taken as a RMR (maximum being 55% of home equity). Panel (a): 1. Sets the marginal utility of consumption constant across health states. 2. Turn off the utility benefit of being a home owner. 3. Removes bequest motives. Panel (b): 4. Shuts down the resource floor (set to $X_{min} = 1.0$ to avoid zero or negative consumption). 5. Removes medical expenditures. 6. Assumes all respondents are singles and transfers income from spouse to the respondent. Panel (c): 7. Removes biases in subjective survival expectations. 8. Removes biaises in house price expectations.

Table 14: Estimates of default biases by prior knowledge of the product

	Prior knowledge		
	No	Yes	t-value
ANN	3.514	3.133	-4.124
LTCI	2.623	2.779	0.961
RMR	3.654	3.484	-2.100

Notes: For each product we compute the mean of the $\delta_{i,j}$ estimates capturing default bias. We stratify by whether or not the respondent knows the product. We also report a student t-test of the difference in means between between the two groups.

Table 15: 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: Panel (a): Mean take-up probability for each product-type; (a) data; (b) predicted using the estimates default-bias $\hat{\delta}_{i,j}$ and noise $\hat{\lambda}_{v,j}$; (c) predicted by only the life-cycle model utility gradients obtained by setting $\delta_{i,j} = 0$ and $\lambda_{v,j} = \infty$. Calculated as averages over all scenarios for each product type. Panels (b) and (c): Price and Benefit elasticities for each product-type; (a) data; (b) predicted using the estimates default-bias $\hat{\delta}_{i,j}$ and noise $\hat{\lambda}_{v,j}$; (c) predicted by only the life-cycle model utility gradients obtained by setting $\delta_{i,j} = 0$ and $\lambda_{v,j} = \infty$. Calculated from a product-based regression of choice probabilities on price and benefits, with fixed effects. Elasticities are computed at the mean.

Table 16: 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.

C Actuarially-fair pricing

Our empirical strategies proposes variations from fixed pricing for annuities, long-term care insurance, as well as reverse mortgage, where the latter are proxied by market prices set by Canadian providers of these products. In the comparative statics exercises of Table 13 we compute and compare experimental with actuarially-fair prices where the latter are next described.

Annuities Under our independence assumption, the annuity price is conditional on buyer i's initial health status s_{i0} and satisfies:

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

where r is a constant interest rate, τ^A is annuity markup factor that equals 1 under fair pricing.

Long-term-care insurance Again under our independence assumption, the price of the benefit is conditional on the insuree i's initial health status s_{i0} and is to be paid conditional on being in states (G, ℓ) only:

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

where τ^L is LTC insurance markup factor that equals 1 under fair pricing.

Reverse mortgages We follow Shao et al. (2019), Shao et al. (2015), Nakajima (2012) in letting $T^h \in [1, T]$ denote the stochastic (and endogenous) RMR termination date, i.e. house sold and amount in RMR is due. The reverse mortgage contract relies on the home-owning continuation probabilities q_{ijt}^h, as well as corresponding survival (i.e. non-termination) up to time t denoted S_{ijt}^h that both depend on the health statuses of household ij's member(s):

$$q_{ijt}^h = \Pr[H_{t+1} = 1 \mid H_t = 1, s_{ijt}],$$
$$S_{ijt}^h = \prod_{k=0}^{t-1} q_{ijk}^h$$

Given the RMR nominal amount due by borrower L_{ijt}, as well as loss to RMR issuer l_{ijt}:

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

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

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

where E_0 is with respect to housing prices, conditional on time-0 information. The RMR markup τ^R applied on the premium π_{ij} is equal to one under fair pricing.

D Model Solution

Consistent with the timing of decisions in Table 3, we start at the last biological period of life and solve the model backwards. This is achieved by maximizing continuation utility (9) over consumption C_t and housing H_{t+1}, conditional upon state variables of contemporaneous mortgage D_t, household health status s_{ijt}, house prices P_t^H, as well as wealth W_t and housing status H_t. For initial time $t = 0$, we compute the indirect utility V_{ijt} over all 12 scenarios per respondent in addition to a baseline scenario without any product. This allows to compute the (indirect) utility gain from purchasing a particular product in a given scenario.

The relevant state-space discretization is summarized in Table 17. First, mortgages D_t are set at between zero and $\omega^D = 0.65$ of house prices, where a convex scale captures bunching in the lower end for our population of older individuals (we use a square root transformation). Second, our survey summary statistics and tests on solving the model for reasonable parameter values suggest that financial wealth W_t is best represented between 0 and 3.0MC$, where the scaling is convex to capture unequal wealth distributions (again square root). Third, the health shocks s_{ijt} are taken to be one of the 16 possible combinations in $\mathcal{S}^2 = \{G, \ell, L, D\}^2$. Fourth, consistent with housing price processes in (2) home price shocks ϵ_t are taken from -2 to +2 standard deviations σ from mean g using the CMA-specific statistics in Table 9 and relying on distributional properties for log-normal processes. Finally, consistent with the model, current home-owning status H_t is 0 for renters and 1 for owners.

Table 17: Discretized state space

Variable	Set	Interpretation	Range	Dimension	Scale
		a. Primary: for $t \geq 0$			
D_t	D	Mortgage	$[0, 0.65]$	5	convex
W_t	W	Financial wealth	$[0, 3000]$	10	convex
s_{ijt}	S	Health status	$[1, 16]$	16	linear
ϵ_t	E	House price shocks	$[-2, +2]$	5	linear
H_t	H	Owner status	$[0, 1]$	2	binary
Total				8K	

Notes: Mortgage measured in percentage of current house prices. Wealth in 1,000C$ units. Health shocks for couples $s_{ij} = (s_i, s_j) \in \mathcal{S}^2 = \{G, \ell, L, D\}^2$. House price shocks measured in standard errors deviations from mean. Owner status: renter (0) and owner (1).

Several elements contribute to make computation time a key issue in our setting. A large subset of deep parameters are not calibrated, but estimated, implying that the solution algorithm must be repeated a large number of times. This problem is compounded by the fact that the model must be solved/estimated for each of the 1581 respondents 13 times (12 scenarios plus one baseline). Hence, we make a number of careful restrictions to speed up computation of the solution. For instance, the model restricts all mortgages to be cleared by sellers, thereby ruling out renters ($H_t = 0$) with positive mortgage ($D_t > 0$). Moreover, preferences are such that at least one household member must be in G, ℓ health status to own a house, ruling out home-owning in all other health states.

We have explored various methods to reduce the number of recursion steps (ages). First, we attempted to make each period in the model represent jumps of 5 years. Although this speeds up computations, it also leads to non-neutral time aggregation issues when considering the valuation of income flows such as annuities. We found solutions were be very different when varying time increments. Instead, our preferred strategy is to actively solve for new decision rules as a function of state variables at certain ages while maintaining these decision rules fixed at ages in between. For example, we solve for decision rules by backward induction at the last periods but skip years where the decision rules do not change much. After much experimentation, we found that a frequency of 3 years for updating rules yields very similar values for indirect utility at the time of interview. Behavioural parallels with our approach would argue that it is costly for respondents to update their decision rules at every age. In the spirit of rational inattention models, agents may optimally fail to recompute decision rules when the value of doing so is less than the cognitive burden of doing so. While we have no evidence that a gap of 3 years is correct, we think that this approach strikes a good compromise between speed and accuracy.[54]

To solve for optimal consumption we use a grid search between values of 0 and $C_{\max}$ in (8c). Although we attempted to use faster algorithms such as golden section search, we found that the presence of kinks and non-convexities yielded solutions that were not reliable. We use 10 points for this grid. We have also experimented with a larger number of points with limited impact on the computation of indirect utilities. We interpolate the value function for next period using bi-linear interpolation over a (square root) grid in (D_{t+1}, W_{t+1}).

E Expectations Modeling

E.1 House Prices

Consider respondent i in CMA c. The annual (log) change in house prices Δp_t^H in CMA c is distributed with mean g_c and standard deviation σ_c. Given the random walk process assumed, the cumulative change in house prices (percent terms) after T years, $\Delta^T p_t^H = p_{t+T}^H - p_t^H$ is approximately normally distributed with mean $g_{T,c} = Tg_c$ and standard deviation $\sigma_{T,c} = \sqrt{T}\sigma_c$. We can use this insight to map the objective house price process to beliefs of respondents regarding house prices in 10 years.

Denote the perceived parameters of the random walk process for respondent i: $g_i^T = \mu_i g_{T,c}$ and $\sigma_{T,i} = \zeta_i \sigma_{T,c}$.

[54] Hong and Rios-Rull (2012) rely on 5-year time interval, whereas Nakajima and Telyukova (2017) use a 2-year interval in numerical optimization settings that are similarly demanding in terms of computational intensity.

Then the probability that the cumulative return is lower than some threshold p is given by

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

where $\Phi(\cdot)$ is the standard normal CDF. In question Q23 of the survey, respondents report J analogs of these probabilities at thresholds $(p_1, ...p_J)$. Denote these probabilities $l_{i,j}$ and the corresponding thresholds p_j. For each threshold, we set the following restriction, $l_{i,j} - \pi_c(p_j, \mu_i, \zeta_i) = 0$. Denote by $L_i(\mu_i, \zeta_i)$ the set of J such restrictions. We use a minimum distance estimator to estimate (μ_i, ζ_i) for each respondents Formally, we use the estimator

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

E.2 Health Process

We feed each respondent's characteristics 5,000 times in this simulator and collect the state in terms of (G, ℓ, L, D) for each of these draws at each age. We then estimate for each respondent a dynamic multinomial logit process of the form,

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

where i denotes the respondent, s the current state and s' n-period ahead states. We obtain for each respondents estimates of the parameters α_i, δ_i using the 5,000 simulated life trajectories. The microsimulation model produces two-year respondent-specific Markov transition matrices for each age. We rescale these two-year Markov transition rates to obtain one-year transitions q^1_{it} using the eigen values and vectors of the two-year matrices. We denote these probabilities the objective health probabilities of respondent i.

For those with valid responses to mortality probabilities, we introduce new intercepts $\tilde{\delta}_i(s, \mathcal{D}) = \delta_i(s, \mathcal{D}) + \xi$ for $s \in (G, \ell, L)$. Hence, ξ measures the degree to which subjective beliefs about mortality are above (pessimistic) or below (optimistic) what the objective risk would predict. We solve numerically for the value of ξ that matches the subjective beliefs. We do this for both the respondent and the spouse. For respondents who do not report a valid probability (do not know and refuse to answer), we assume they have $\xi = 0$. A total of 8.6% of respondents and 9% of spouses are missing mortality expectations.

F Estimator and Inference

Because we want to exploit within differences and get rid of $\delta_{i,j}$, define $\overline{g}_{i,j} = \frac{1}{4}\sum_{k:j(k)=j} g_{i,k}$ and similarly for $\overline{V}_{i,j}(\theta) = \frac{1}{4}\sum_{k:j(k)=j} \tilde{V}_{i,k}(\theta)$ the individual-product specific means.

Consider the non-linear least-square estimator

$$(\hat{\theta}, \hat{\lambda}_\upsilon) = \arg\min_{\theta,\lambda_\upsilon} \sum_i \sum_j \sum_{k:j(k)=j} ((g_{i,k} - \overline{g}_{i,j}) - \lambda_{\upsilon,j}(\tilde{V}_{i,k}(\theta) - \overline{V}_{i,j}(\theta)))^2.$$

The first-order conditions with respect to θ and λ_υ for this problem are given by:

$$\sum_i \sum_j \sum_{k:j(k)=j} \frac{\partial(\tilde{V}_{i,k}(\theta) - \overline{V}_{i,j}(\theta))}{\partial\theta'}((g_{i,k} - \overline{g}_{i,j}) - \lambda_{\upsilon,j}(\tilde{V}_{i,k}(\theta) - \overline{V}_{i,j}(\theta)) = \mathbf{0}_J$$
$$\sum_i \sum_{k:j(k)=j} ((g_{i,k} - \overline{g}_{i,j}) - \lambda_{\upsilon,j}(\tilde{V}_{i,k}(\theta) - \overline{V}_{i,j}(\theta)) = 0, \quad j = A, L, R.$$

where $\mathbf{0}_J$ is a J by 1 vector of zeros.

The first-order conditions (FOC) can conveniently be solved by concentration methods. First, using the FOC, we get the partial solution for $\lambda_{\upsilon,j}(\theta)$

$$\lambda_{\upsilon,j}(\theta) = \frac{\sum_{i=1}^N \sum_{k:j(k)=j}(\tilde{V}_{i,k}(\theta) - \overline{V}_{i,j}(\theta))(g_{i,k} - \overline{g}_{i,j})}{\sum_{i=1}^N \sum_{k:j(k)=j}(\tilde{V}_{i,k}(\theta) - \overline{V}_{i,j}(\theta))^2},$$

which is an ordinary least square estimate on within differences (within estimator) for a given product type j. For a given value of θ, $\lambda_{\upsilon,j}(\theta)$ can thus be obtained as the OLS coefficient of a regression of $(g_{i,k} - \overline{g}_{i,j})$ on $\tilde{V}_{i,k}(\theta) - \overline{V}_{i,j}(\theta)$. This has the advantage of avoiding evaluation of

$\tilde{V}_{i,k}(\theta)$ for trial values of $\lambda_{v,j}$ in a non-trivial numerical problem to find $\hat{\theta}$. Second, using this partial solution in the FOC, the following (concentrated) NLS estimator is used to solve for $\hat{\theta}$ numerically:

$$\hat{\theta} = \arg\min_{\theta} \sum_i \sum_j \sum_{k:j(k)=j} ((g_{i,k} - \overline{g}_{i,j}) - \lambda_{v,j(k)}(\theta)(\tilde{V}_{i,k}(\theta) - \overline{V}_{i,j}(\theta))^2.$$

To compute standard errors, denote the NLS residual $\hat{e}_{ik}$ as

$$\hat{e}_{ik} = (g_{i,k} - \overline{g}_{i,j(k)}) - \hat{\lambda}_{v,j(k)}(\tilde{V}_{i,k}(\hat{\theta}) - \overline{V}_{i,j(k)}(\hat{\theta})).$$

These residuals are likely correlated for a given respondent and also potentially heteroscedastic. We compute standard errors clustered at the respondent i's level. Denote $Q = J+3$ to be the total number of estimated parameters, including the signal to noise scalars $\lambda_{v,j}, \quad j = A, L, R$. Denote by $\hat{e}_i$ the $1 \times K$ vector of errors for a given respondent i, and by $\nabla\hat{e}_i$ the $Q \times K$ matrix of derivatives of the residuals with respect to estimated parameters. The clustered-robust covariance matrix of the estimates based on asymptotic properties of the NLS estimator is

$$\Omega(\hat{\theta}_e, \hat{\lambda}_v) = \left(\sum_{i=1}^{N} \nabla\hat{e}_i \nabla\hat{e}_i'\right)^{-1} \left(\sum_{i=1}^{N} \nabla\hat{e}_i (\hat{e}_i'\hat{e}_i) \nabla\hat{e}_i'\right) \left(\sum_{i=1}^{N} \nabla\hat{e}_i \nabla\hat{e}_i'\right)^{-1}.$$

G Questionnaire (Online Appendix)

INSTRUCTIONS INCLUDED WITH AN ANONYMOUS QUESTIONNAIRE

FINANCIAL PRODUCTS FOR RETIREMENT

The following pages contain an anonymous questionnaire, which we invite you to complete. This questionnaire was developed as part of a research project at HEC Montréal.

Since your first impressions best reflect your true opinions, we would ask that you please answer the questions included in this questionnaire without any hesitation. We ask, however, that you take the time needed to consider certain questions on knowledge, which might involve concepts with which you are less familiar. There is no time limit for completing the questionnaire, although we have estimated that it should take approximately 20 minutes.

The information collected will be anonymous and will remain strictly confidential. It will be used solely for the advancement of knowledge and the dissemination of the overall results in academic or professional forums. It is possible that the collected data will be shared with other researchers, solely for non-commercial research purposes, but for projects other than the one for which the data was originally collected. Note as well that the anonymized dataset resulting from the survey may, at a later date, be made publicly available for academic research purposes.

The online data collection provider agrees to refrain from disclosing any personal information (or any other information concerning participants in this study) to any other users or to any third party, unless the respondent expressly agrees to such disclosure or unless such disclosure is required by law.

You are free to refuse to participate in this project and you may decide to stop answering the questions at any time. By completing this questionnaire, you will be considered as having given your consent to participate in our research project and to the potential use of data collected from this questionnaire in future research. Since the questionnaire is anonymous, you will no longer be able to withdraw from the research project once you have completed the questionnaire because it will be impossible to determine which of the answers are yours.

If you have any questions about this research, please contact the principal investigator, Pierre-Carl Michaud, at the telephone number or email address indicated below.

HEC Montréal's Research Ethics Board has determined that the data collection related to this study meets the ethics standards for research involving humans. If you have any questions related to ethics, please contact the REB secretariat at (514) 340-6051 or by email at cer@hec.ca.

Thank you for your valuable cooperation!

Pierre-Carl Michaud
Professor
Department of Applied Economics
HEC Montréal
514-340-6466
pierre-carl.michaud@hec.ca

Section 1: Background

QA Are you…?
1 Male
2 Female

QB How old are you?
Please Enter [TERMINATE IF NOT 60-70 INCLUSIVELY]
[PN: MUST ENTER THE 2 CHARACTERS]

*****

Q0 Can you please enter the first 3 characters of your postal code? Please type in below
[PN: MUST ENTER FIRST 3 CHARACTERS] *FSAs validated with FSA file
[TERMINATE IF FSA IS NOT PART OF THE 11 TARGETED CMAs]

Q1 What is the highest degree, certificate or diploma you have obtained?
1 Less than high school diploma or its equivalent
2 High school diploma or a high school equivalency certificate
3 Trade certificate or diploma
4 College, CEGEP or other non-university certificate or diploma (other than trades certificates or diplomas)
5 University certificate or diploma below the bachelor's level
6 Bachelor's degree (e.g. B.A., B.Sc., LL.B.)
7 University certificate, diploma, degree above the bachelor's level

Q2 What is your marital status?
1 married
2 living common-law
3 widowed
4 separated
5 divorced
6 single, never married

IF Q2==1,2

Q2a How old is your partner (spouse)?
Numeric (>12)

Q2b What is the highest degree, certificate or diploma your spouse has obtained?
1 Less than high school diploma or its equivalent
2 High school diploma or a high school equivalency certificate
3 Trade certificate or diploma
4 College, CEGEP or other non-university certificate or diploma (other than trades certificates or diplomas)
5 University certificate or diploma below the bachelor's level
6 Bachelor's degree (e.g. B.A., B.Sc., LL.B.)
7 University certificate, diploma, degree above the bachelor's level

END IF

Q3 Do you have children?
1 Yes
2 No

IF Q3==2 SKIP TO Q4

ELSE IF Q3==1
[SHOW ON SAME PAGE]
Q3a How many children do you have?
Numeric (>=0)
END IF

Q4 For 2018, what is your best estimate of your income from various sources, before taxes and personal deductions?

[“TOTAL” ROW AT BOTTOM AUTO-SUMS AMOUNTS IN RIGHT COLUMN]

Wages and salaries, including self-employment income net of business expenses	**[INSERT AMOUNT – RANGE $0 TO $99,999,999]**
GOVERNMENT TRANSFERS	
▪ OAS (Old Age Security), GIS (Guaranteed Income Supplement), Spouse’s or Survivor’s Allowance	**[INSERT AMOUNT – RANGE $0 TO $50,000]**
▪ CPP (Canada Pension Plan) or QPP (Quebec Pension Plan)	**[INSERT AMOUNT – RANGE $0 TO $50,000]**
▪ Other transfers (e.g. workers’ compensation benefits, Employment Insurance, or social assistance/welfare benefits)	**[INSERT AMOUNT – RANGE $0 TO $50,000]**
Workplace pension(s), **excluding** OAS/GIS/Allowance and CPP/QPP	**[INSERT AMOUNT – RANGE $0 TO $99,999,999]**
Income from annuities	**[INSERT AMOUNT – RANGE $0 TO $99,999,999]**
Total income from these sources in 2018	**[AUTOSUMS]**

IF MORE THAN 3 CELLS IN Q4 LEFT EMPTY (OTHERWISE SKIP TO Q4f):
[SHOW ON SAME SCREEN AS Q4, IF POSSIBLE; IF NOT, ALLOW RESPONDENT TO GO BACK TO Q4]
Q4a For 2018, what is your best estimate of your total income from the sources listed above, before taxes and personal deductions?
Numeric (>0)
9999999 Don’t know or prefer not to say

IF Q4a==9999999

Q4b Is it more than $60,000? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don't know

IF Q4b==1

Q4c Is it less than $120,000? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don't know

IF Q4c == 1

Q4d Is it more than $90,000? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don't know

END IF

ELSE IF Q4b==2

Q4e Is it more than $30,000? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don't know

END IF

END IF

END IF

IF Q2==1,2

[SHOW ON SAME SCREEN AS Q4, IF POSSIBLE; IF NOT, ALLOW RESPONDENT TO GO BACK TO Q4]

Q4f For 2018, what is your best estimate of the income received by your spouse from the sources listed above, before taxes and personal deductions?

Numeric (>0)

9999999 Don't know or prefer not to say

IF Q4f==9999999

Q4g Is it more than $60,000? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don't know

IF Q4g==1

Q4h Is it less than $120,000? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don't know

IF Q4h == 1

Q4i Is it more than $90,000? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don't know

END IF

ELSE IF Q4g==2

Q4j Is it more than $30,000? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don't know

END IF

END IF

END IF

Q5 Do you consider yourself retired?

1 Yes
2 No

IF Q5==2

Q5a At what age do you plan to be fully retired?
Numeric (Current Age [RESPONSE TO QB] – 100)

Q5b What is your best estimate of the income you will receive from the various sources we listed, before taxes and personal deductions, once you are fully retired?
[“TOTAL” ROW AT BOTTOM AUTO-SUMS AMOUNTS IN RIGHT COLUMN]

Wages and salaries, including self-employment income net of business expenses	**[INSERT AMOUNT – RANGE $0 TO $99,999,999]**
GOVERNMENT TRANSFERS	
▪ OAS (Old Age Security), GIS (Guaranteed Income Supplement), Spouse’s Allowance	**[INSERT AMOUNT – RANGE $0 TO $50,000]**
▪ CPP (Canada Pension Plan) or QPP (Quebec Pension Plan)	**[INSERT AMOUNT – RANGE $0 TO $50,000]**
▪ Other transfers (e.g. workers’ compensation, Employment Insurance, or social assistance/welfare)	**[INSERT AMOUNT – RANGE $0 TO $50,000]**
Workplace pension(s), **excluding** OAS/GIS/Allowance and CPP/QPP	**[INSERT AMOUNT – RANGE $0 TO $99,999,999]**
Income from annuities	**[INSERT AMOUNT – RANGE $0 TO $99,999,999]**
Total income from these sources in full retirement	**[AUTOSUMS]**

IF MORE THAN 3 CELLS IN Q5b LEFT EMPTY (OTHERWISE SKIP TO Q6):

[SHOW ON SAME SCREEN AS Q5b, IF POSSIBLE; IF NOT, ALLOW RESPONDENT TO GO BACK TO Q5b]
Q5c What is your best estimate of the total income from the sources listed above you plan to receive once fully retired, before taxes and personal deductions?
Numeric (>0)
9999999 Don’t know or prefer not to say

IF Q5c==9999999

Q5d Is it more than $60,000? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don’t know

IF Q5d==1

Q5e Is it less than $120,000? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don’t know

IF Q5e == 1
Q5f Is it more than $90,000? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don't know
END IF

ELSE IF Q5d==2
Q5g Is it more than $30,000? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don't know
END IF
END IF
END IF

IF Q2==1,2
Q6 Does your spouse consider himself or herself retired?
1 Yes
2 No

IF Q6==2
Q6a At what age does he or she plan to be fully retired?
Numeric (Current Spouse Age [RESPONSE TO Q2a] – 100)

[SHOW ON SAME SCREEN AS Q5b, IF POSSIBLE; IF NOT, ALLOW RESPONDENT TO GO BACK TO Q5b]
Q6b What is your best estimate of the total income from the sources listed above that your spouse plans to receive once fully retired, before taxes and personal deductions?
Numeric (>0)
9999999 Don't know or prefer not to say

IF Q6b==9999999
Q6c Is it more than $60,000? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don't know

IF Q6c==1
Q6d Is it less than $120,000? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don't know

IF Q6d == 1
Q6e Is it more than $90,000? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don't know
END IF

ELSE IF Q6c==2
Q6f Is it more than $30,000? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don't know
END IF
END IF
END IF
END IF

Q6g For 2018, what is your best estimate of your household's average total monthly spending?
Numeric $(1-850,000)
9999999 Don't know or prefer not to say

IF Q6g== 9999999
    Q6h Is it more than $9,000? 1 Yes 2 No 7777777 Don't know 8888888 Prefer not to say

    IF Q6h== 1
        Q6i Is it less than $13,000? 1 Yes 2 No 7777777 Don't know 8888888 Prefer not to say

        IF Q6i==1
            Q6j Is it more than $11,000? 1 Yes 2 No 7777777 Don't know 8888888 Prefer not to say

        ELSE IF Q6i==2
            Q6k Is it more than $15,000? 1 Yes 2 No 7777777 Don't know 8888888 Prefer not to say

            IF Q6k==1
                Q6l Is it less than $17,000? 1 Yes 2 No 7777777 Don't know 8888888 Prefer not to say
            END IF
        END IF

    ELSE IF Q6h== 2
        Q6m Is it more than $5,000? 1 Yes 2 No 7777777 Don't know 8888888 Prefer not to say

        IF Q6m==1
            Q6n Is it less than $7,000? 1 Yes 2 No 7777777 Don't know 8888888 Prefer not to say

        ELSE IF Q6m==2
            Q6o Is it less than $3,000? 1 Yes 2 No 7777777 Don't know 8888888 Prefer not to say

            IF Q6o==1
                Q6p Is it more than $1,000? 1 Yes 2 No 7777777 Don't know 8888888 Prefer not to say
            END IF
        END IF
    END IF
END IF

Q7 Do you own your primary residence?
1 Yes
2 No

IF Q7==1

Q8 What is your best estimate of the current market value of your primary residence (if you were to sell it)?
Numeric $(1-9,999,998)
9999999 Don't know or prefer not to say

IF Q8==9999999
    Q8a Is it more than $300,000? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don't know

    IF Q8a==1
        Q8b Is it less than $600,000? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don't know

        IF Q8b == 1
            Q8c Is it more than $450,000? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don't know

        ELSE IF Q8b ==2
            Q8d Is it less than $750,000? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don't know

            IF Q8d == 2
                Q8e Is it more than $900,000? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don't know
            END IF
        END IF

    ELSE IF Q8a==2
        Q8f Is it more than $150,000? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don't know
    END IF
END IF

Q9 Do you still have a mortgage on this residence?
1 Yes
2 No

IF Q9==1
    Q9a How many years do you have left before completing your mortgage repayment?
    Numeric (0-40)
    9999999 Don't know or prefer not to say

    Q9b What are the total regular monthly mortgage or loan payments for this dwelling? Please enter the amount per month, **excluding municipal taxes**.
    Numeric $(1-10,000)

    Q10 How much do you still owe on your mortgage?
    Numeric $(1-5,000,000)
    9999999 Don't know or prefer not to say

IF Q10 == 9999999

Q10a As a fraction of the current market value of your house, is it more than 50%? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don’t know

IF Q10a == 1

Q10b As a fraction of the current market value of your house, is it less than 75 %? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don’t know

IF Q10b == 1

Q10c As a fraction of the current market value of your house, is it more than 60%? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don’t know

ELSE IF Q10b == 2

Q10d As a fraction of the current market value of your house, is it more than 85%? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don’t know

END IF

ELSE IF Q10a == 2

Q10e As a fraction of the current market value of your house, is it less than 25 % 1 Yes 2 No 8888888 Prefer not to say 7777777 Don’t know

IF Q10e == 1

Q10f As a fraction of the current market value of your house, is it more than 10%? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don’t know

IF Q10f == 2

Q10g As a fraction of the current market value of your house, is it less than 5%? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don’t know

END IF

ELSE IF Q10e == 2

Q10h As a fraction of the current market value of your house, is it more than 35%? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don’t know

END IF

END IF

END IF

END IF

ELSE IF Q7==2

Q10i What is the current monthly rent for your dwelling? Please enter the amount per month. Numeric $(1-10,000)

END IF

*****

Defined-contribution pension plans are plans sponsored by employers, where you choose how much to contribute and the balance of your account fluctuates with the financial markets. Upon retiring, you are allowed to withdraw as much as you want from the account.

Q11 What is your best estimate of how much your household has accumulated in defined-contribution employer pension plans (and which has not been taken out to date)?
Numeric (>=0)
9999999 Don’t know or prefer not to say

IF Q11==9999999
    Q11a Is it more than $50,000? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don’t know

    IF Q11a==1
        Q11b Is it less than $200,000? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don’t know

    ELSE IF Q11a==2
        Q11c Is it more than $10,000? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don’t know
    END IF
END IF

Q12 What is your best estimate of how much your household has accumulated in individual Registered Retirement Savings Plans (RRSPs)? (Exclude savings in accounts linked to an employer.)
Numeric (>=0)
9999999 Don’t know or prefer not to say

IF Q12==9999999
    Q12a Is it more than $50,000? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don’t know

    IF Q12a==1
        Q12b Is it less than $200,000? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don’t know

    ELSE IF Q12a==2
        Q12c Is it more than $10,000? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don’t know
    END IF
END IF

Q13 What is your best estimate of how much your household has accumulated in individual Tax-Free Savings Accounts (TFSAs) and individual non-registered savings accounts? (Exclude savings in accounts linked to an employer.)
Numeric (>=0)
9999999 Don’t know or prefer not to say

IF Q13==9999999

Q13a Is it more than $50,000? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don't know

IF Q13a==1
Q13b Is it less than $200,000? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don't know

ELSE IF Q13a==2
Q13c Is it more than $10,000? 1 Yes 2 No 8888888 Prefer not to say 7777777 Don't know
END IF
END IF

Q14 Looking at the following list of health conditions, has a doctor ever said you suffered from:
[Check any of:]
1 Heart disease
2 Stroke
3 Lung disease
4 Diabetes
5 Hypertension
6 Depression or other mental health problems
7 Cancer
8 None of the above [NO OTHER RESPONSE ALLOWED WITH THIS SELECTION]

IF Q2=1,2
Q14a Looking at the following list of health conditions, has a doctor ever said your spouse suffered from:
[Check any of:]
1 Heart disease
2 Stroke
3 Lung disease
4 Diabetes
5 Hypertension
6 Depression or other mental health problems
7 Cancer
8 None of the above [NO OTHER RESPONSE ALLOWED WITH THIS SELECTION]
END IF

Q15 Have you ever smoked cigarettes daily?
1 Yes
2 No

IF Q2=1,2
Q15a Has your spouse ever smoked cigarettes daily?
1 Yes
2 No
END IF

Q16 Do you regularly have problems with the following activities (for which you need help):
Check all that apply in this list

1. Preparing meals
2. Getting to appointments and running errands such as shopping for groceries
3. Doing everyday housework
4. Making bank transactions or paying bills
5. Washing
6. Dressing
7. Going to the toilet
8. Getting in and out of bed
9. Eating
10. Taking medication
11. Moving inside the house

IF Q2=1,2

Q16a Does your spouse regularly have problems with the following activities (for which he or she needs help):

Check all that apply in this list

1. Preparing meals
2. Getting to appointments and running errands such as shopping for groceries
3. Doing everyday housework
4. Making bank transactions or paying bills
5. Washing
6. Dressing
7. Going to the toilet
8. Getting in and out of bed
9. Eating
10. Taking medication
11. Moving inside the house

END IF

Section 2: Risk Perception

Q17 On a scale of 0 to 100, where 0 is absolutely no chance and 100 is absolutely certain, what do you believe is the percent chance you will live to age 85 or more?
Numeric (0-100)
7777777 Don't know

IF Q2==1,2 & Q2a < 85
    Q17a On a scale of 0 to 100, where 0 is absolutely no chance and 100 is absolutely certain, what do you believe is the percent chance your partner (spouse) will live to age 85 or more?
    Numeric (0-100)
    7777777 Don't know
END IF

Q18 On a scale of 0 to 100, where 0 is absolutely no chance and 100 is absolutely certain, what do you believe is the percent chance you will live more than 1 year during your lifetime with two or more limitations in activities of daily living? Activities of daily living include eating, washing, dressing, moving inside the house and getting in and out of bed.
Numeric (0-100)
7777777 Don't know

IF Q18>0
    Q18a … 2 or more years?
    Numeric (0 – [ANSWER TO Q18])
    7777777 Don't know

    IF Q18a>0
        Q18b … 4 or more years?
        Numeric (0 – [ANSWER TO Q18a])
        7777777 Don't know
    END IF
END IF

Q19 Some may wish to go to a long-term care home when they have difficulties with activities of daily living. On a scale of 0 to 100, what do you believe is the percent chance that you will one day move to a long-term care home?
Numeric (0-100)
7777777 Don't know

Q20 On a scale of 0 to 100, where 0 is absolutely no chance and 100 is absolutely certain, what do you believe is the percent chance you will leave a bequest to your heirs of more than $100,000?
Numeric (0-100)
7777777 Don't know

Q21 On a scale of 0 to 100, where 0 is absolutely no chance and 100 is absolutely certain, what is the percent chance you will have withdrawn all your financial assets (RRSP, TFSA, other savings) by the age of 85?
Numeric (0-100)
7777777 Don't know

IF Q7==1

Q22 Here are three possibilities concerning your future expected residence. On a scale of 0 to 100, where 0 is absolutely no chance and 100 is absolutely certain, what is the percent chance that each of these possibilities comes true? Given that only one of these possibilities can occur, the sum of the three probabilities must equal 100.

Q22a I'm going to stay in my current home until I die.
Numeric (0-100)

Q22b I will eventually move from my current home to live in another house or apartment.
Numeric (0 TO (100 – ANSWER TO Q22a))

Q22c I will eventually move from my current home to live in a long-term care home if my own condition and/or my spouse's condition requires it.
Numeric (0 TO (100 – ANSWER TO Q22a – ANSWER TO Q22b))

[NOTE: SUM OF ANSWERS TO Q22a, Q22b AND Q22c MUST EQUAL 100.]
[NOTE: MAKE SURE THE QUESTION IS PROPERLY NUMBERED ON THE SCREEN.]
[NOTE: WOULD IT BE POSSIBLE TO INCLUDE A COUNTER TO LET THE RESPONDENT KNOW HOW MANY % LEFT TO FILL IN?]

Q23 Over the **next 10 years**, on a scale of 0 to 100, where 0 is absolutely no chance and 100 is absolutely certain, what is the percent chance that the value of your house:
Q23a decreases, Numeric (0-100)
Q23b increases by more than 10%, Numeric (0-100) (CHECK SMALLER THAN 100-Q23a)
Q23c increases by more than 20%, Numeric (0-100) (CHECK SMALLER THAN Q23b)
Q23d increases by more than 40%, Numeric (0-100) (CHECK SMALLER THAN Q23c)
Q23e increases by more than 50%, Numeric (0-100) (CHECK SMALLER THAN Q23d)

END IF

Q24 Do you agree with the following statements? (Answers: 5 Strongly Agree; 4 Agree; 3 Disagree; 2 Strongly Disagree; 1 Don't know)

Q24a 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
Q24b Children should inherit their parents' family home
Q24c A house is an asset that should only be sold in case of financial hardship
Q24d Being in debt is never a good thing
Q24e I prefer to live well but for fewer years than to live long and have to sacrifice my quality of life

[NOTE: MAKE SURE THE QUESTION IS PROPERLY NUMBERED ON THE SCREEN.]
[NOTE: MIGHT THE SCALE FOR EACH STATEMENT BE INVERTED (I.E. "INCREASING" FROM LEFT TO RIGHT)? WE LEAVE THIS WITH YOUR EXPERTISE.]

Q25 Which of the following statements comes closest to describing the amount of financial risk that you are willing to take when you wish to save or make investments?
1 I am willing to take substantial financial risks expecting to earn substantial returns
2 I am willing to take above average financial risks expecting to earn above-average returns
3 I am willing to take average financial risks expecting to earn average returns
4 I am willing to take below average financial risks expecting to earn below-average returns
5 I am not willing to take any risk, knowing I will earn a small but certain return

Section 3: Knowledge of Financial Products

We would now like to ask you a few questions about 3 financial products used by some households in retirement.

An **annuity** is a financial product that guarantees you a regular payment every month or year until death (the “benefit”), in exchange for an initial one-time payment (the “premium”).

Q26 Which of the following best describes your current knowledge about this type of product?
1 A lot
2 A little
3 None at all

Q27 Have you purchased an annuity in the private market, for which you are currently receiving or will eventually receive benefits (please exclude all government provided benefits such as those coming from your provincial pension plan, the Canada Pension Plan or Old Age Security)?
1 Yes, I have purchased an annuity
2 Yes, I have purchased more than one annuity
3 No
7777777 Don't know

IF Q27==3,7777777 GOTO Q28

ELSE IF Q27==1,2
    Q27a What was the total premium you paid for all your annuities, after any income taxes owed?
    Numeric $(>=0)
    7777777 Don’t know
    Q27b What is the total amount of the benefit(s) you are currently receiving, or will receive when payouts begin (monthly)?
    Numeric $(>=0)
    7777777 Don’t know
END IF

We will refer to a **reverse mortgage** as a financial product that lets you turn part of your current home equity into cash. Unlike many mortgage-based financial products, you’re not obligated to make any payments until you move, you sell your home, or you die. You have the certainty that once your residence will be sold, the amount required to repay the loan (including accumulated interest) will not exceed the selling price of the residence.

Q28 Which of the following best describes your current knowledge about this type of product?
1 A lot
2 A little
3 None at all

Q29 Have you received a loan as a reverse mortgage? (Do not include lines of credit.)
1 Yes, I have received a loan as a reverse mortgage
2 No
7777777 Don't know

IF Q29==2,7777777 GOTO Q30

ELSE IF Q29==1

Q29a How much did you take as a loan?
Numeric $(>=0)
7777777 Don’t know
Q29b What is the interest rate on that loan?
Numeric (0-60)%
7777777 Don’t know

END IF

We define **long-term care insurance** as a type of insurance that helps to pay for **extended** stays in a long-term care home or assisted living facility, or for personal or medical care in your home. This insurance is typically separate from your health insurance and distinct from the benefits offered by an employer, and it requires paying separate premiums. It is not provided by Medicare or the public healthcare system.

Q30 Which of the following best describes your current knowledge about this type of insurance?
1 A lot
2 A little
3 None at all

Q31 Do you have a long-term care insurance policy?
1 Yes
2 No
7777777 Don't Know

IF Q31==2,7777777 GOTO Q32

ELSE IF Q31==1

Q31a What is the monthly premium on that policy?
Numeric $(>=0)
7777777 Don’t know
Q31b What is the amount of the benefit the insurance would pay out (monthly)?
Numeric$ (>=0)
7777777 Don’t know

END IF

[RANDOMIZE ORDER OF SECTIONS 4, 5 AND 6]

Section 4: Preferences for Annuities [SCENARIOS]

IF FINWEALTH>0 [SEE DEFINITION BELOW]

We are going to show you some simple annuity products and ask you to rate them. You can assume that the institution offering the annuity will pay the monthly benefit no matter the circumstances. Once you pay the premium, you receive monthly benefits and have nothing else to pay.

Each product has two attributes:
a) a premium you have to pay;
b) a monthly benefit starting next year and lasting until death.

The benefit is adjusted for inflation (indexed).

Q32-Q35
[SCENARIOS]

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

END IF

*****
Scenarios randomization scheme

Parameters:

Age_benefit = (QB+1)

Premium = [0.2,0.5]*FinWealth
where FinWealth = Q11+Q12+Q13 (if bracketed, use mid-point in interval; if "Don't know" (7777777) or "Prefer not to say" (8888888), use FinWealth = 40,000)

Price = [0.5, 0.75, 1.25, 1.5]

For each combination of age and gender we provide Yield in table below. Use Age_benefit, as defined above, and gender (QA) to select correct Yield from table.

The benefit for the contract is given by (please round to nearest $10):

Benefit = Premium x (Yield/100) x Price/12

Randomize order of Price above (for 4 scenarios), sampling without replacement:
Scenario 1, Premium = 0.2*FinWealth
Scenario 2, Premium = 0.5*FinWealth

Scenario 3, Premium = 0.2*FinWealth
Scenario 4, Premium = 0.5*FinWealth
Present each scenario sequentially and not at once (4 screens in total), following this example:

When you buy the annuity	*Starting at age [Age_benefit]*
You pay $[Premium]	You receive $[Benefit] per month until death, indexed annually for inflation

CANNEX YIELDS (YEARLY BENEFIT AS % of PREMIUM), BY AGE AND GENDER

"Yield"

Age_benefit	Males	Females
60	5.623	5.197
61	5.749	5.331
62	5.895	5.482
63	6.061	5.618
64	6.236	5.761
65	6.399	5.914
66	6.557	6.054
67	6.748	6.223
68	6.958	6.407
69	7.181	6.604
70	7.441	6.770
71	7.515	6.882

Section 5: Preferences for Reverse Mortgages [SCENARIOS]

IF Q7==1 & Q29==2,7777777

When we use the expression "**current home equity**", we are referring to the current market value of your primary residence after subtracting outstanding mortgage balances. For the rest of this section, try to have your current home equity in mind.

We are going to show you some simple reverse mortgage products and ask you to rate them.

Each reverse mortgage has two attributes:
a) The percentage of your current home equity that you borrow.
b) A fixed annual interest rate on the balance of the loan, generating interests that you do not need to pay before you move, sell or die.

Suppose you have the certainty that you will never be put under pressure to sell your residence and that the contract terms will be respected.

Q36-Q39
[SCENARIOS]

What are the chances, 0% meaning no chance and 100% for sure, that you would buy this reverse mortgage if a trusted financial institution offered it to you within the next year?
Numeric (0-100)

END IF

*****
Scenarios randomization scheme

Parameters:

Interest_rates = [2.0%, 4.0%, 6.0%, 8.0%]
Share = [0.5, 1.0]

With these products we provide Borrow which is the proportion that is borrowed by age:
60-64: 30%
65-70: 40%

The contract of the reverse mortgage is given by (please round to nearest percentage point):

REVERSE = BORROW * SHARE * Q8 * (1-Q10/Q8)

For Q8, Q10, if bracketed, take mid points. If "Don't know" (7777777) or "Prefer not to say" (8888888), use Q8=400,000 and Q10=0.

Randomize order of interest rates above (sampling without replacement).
Scenario 1: Share = 0.5
Scenario 2: Share = 1.0
Scenario 3: Share = 0.5
Scenario 4: Share = 1.0

Present scenarios following this example, each on a separate screen:

You borrow [REVERSE].
You will be charged a fixed annual interest rate of [Interest_rates] on the balance of the loan for as long as you hold the loan. *Reminder: You're not obligated to make any payments until you move, you sell your home, or you die; and you have the certainty that once your residence will be sold, the amount required to repay the loan (including accumulated interest) will not exceed the selling price of the residence.*

Section 6: Preferences for Long-term Care Insurance [SCENARIOS]

IF Q31==2,7777777

We are going to show you some simple insurance policies and ask you to rate those. You can assume that if you were to have two or more limitations in your activities of daily living (eating, washing, dressing, moving inside the house and getting in and out of bed), the insurance company offering you this product would pay the benefits no matter what the circumstances. Once you receive benefits, you do not pay any premiums. Assume that you will continue to pay premiums until you receive benefits or die.

Each product has two attributes:
a) a monthly premium you have to pay;
b) a monthly benefit if you have 2 or more limitations in your activities of daily living;

and

The premium cannot increase once you have purchased the product. Finally, the benefits are adjusted for inflation (indexed).

Q40-Q43
[SCENARIOS]

What are the chances, 0% meaning no chance and 100% for sure, that you would purchase the policy if it were offered to you by a trusted financial institution?
Numeric (0-100)

END IF

*****
Scenarios randomization scheme

Parameters:

Benefit_ltc = [2000,4000]

With these benefits we provide EPremium (2x 2 = 4 data points; see table attached) which is the fair premium by age and sex.

The premium for the contract is given by (please round to nearest dollar):

prem = EPremium * Load
where Load = [0.5,0.75,1.25,1.5]

Randomize order of Load independently (4 possibilities) for 4 scenarios (sampling without replacement):
Scenario 1: Benefit_ltc = 2000
Scenario 2: Benefit_ltc = 4000
Scenario 3: Benefit_ltc = 2000
Scenario 4: Benefit_ltc = 4000

Present each scenario on a separate screen, following…

While healthy…	*Once you have at least 2 limitations in your activities of daily living…*
You pay $[prem] per month	You receive $[Benefit_ltc] per month

*****

“**EPremium**”

	Benefit_ltc = 2000	
	Male	**Female**
Age (QB)	**(QA==1)**	**(QA==2)**
60-64	122.66	141.78
65-70	162.74	185.41

	Benefit_ltc = 4000	
	Male	**Female**
Age (QB)	**(QA==1)**	**(QA==2)**
60-64	245.33	283.57
65-70	325.48	370.82