

# Longevity, Health and Housing Risks Management in Retirement\*

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## **Abstract**

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

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

**JEL classification**— J14, G52, G53

# 1 Introduction

Longer-living North American retirees<sup>1</sup> have recently witnessed important changes in asset returns and composition. First, registered pensions have shifted away from defined benefit (DB) towards defined contributions (DC) and self-administered plans which do not provide a steady income stream in retirement.<sup>2</sup> Second, retirees' net worth has increased considerably,<sup>3</sup> with housing<sup>4</sup> and liquid assets (cash, bonds and equity) replacing pension and life insurance claims as the main drivers of wealth growth, and mortgages consolidating their role as key determinant of liabilities.<sup>5</sup>

The combined effects of longevity gains, the gradual shift toward riskier pension plans in terms of longevity risk and the increasingly important role of non-pension, and especially housing wealth, brings up the twin problems of: (i) financial asset and home equity decumulation and (ii) risk management strategies. Longer lifetimes raise the risk of outliving one's assets, and being exposed to illness associated with old age. Indeed, publicly-provided long-term care (LTC) is often means-tested, and it may be unsuitable for a person's needs and preferences.<sup>6</sup> Consequently, out-of-pocket LTC spending can be a major drain on disposable resources.<sup>7</sup> Moreover, long-term care may require moving to a nursing facility and thus jeopardize an agent's preference to remain in her own home

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<sup>1</sup>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; US life expectancy increased from 15.1 (female: 17.0, male 13.1) to 19.5 (female 20.8, male 18.2) over the same period (OECD, 2021, Fig. 10.3).

<sup>2</sup>The share of retirement-age active members in Canadian DB plans relative to total fell from 93.7% in 1980 to 66.6% in 2020 (Statistics Canada, 2023c). In the US, the DB membership share fell from 65.6% to 22.4% over the same period (Employee Benefits Security Administration, 2022, Tab. 4, p. 5).

<sup>3</sup>Canadian average net worth per household has increased from 522.7 to 989.5 KC\$ between 2012 and 2022 (Statistics Canada, 2023b). US net worth per household increased from 571 KUS\$ to 1,130 KUS\$ over the same time frame (Board of Governors of the Federal Reserve System, US, 2023).

<sup>4</sup>Canadian (resp. US) residential property prices indices increased by 229% (resp. 214%) between 2012:Q1 and 2022:Q1 (Bank for International Settlements, 2023a,b).

<sup>5</sup>Canadian pension and life insurance shares fell from 24.3% to 20.23% between 2012 and 2022, with mortgages representing 72.6% of total liabilities in 2022 (Statistics Canada, 2023b). US pension shares of net worth dropped from 24.25% to 17.9%, while mortgages share of total liabilities was 64.08% over the same time frame (Board of Governors of the Federal Reserve System, US, 2023).

<sup>6</sup>See Ameriks et al. (2011), Achou et al. (2022) for justification and modelling of 'Public Care Aversion' in long-term care decisions.

<sup>7</sup>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), Lockwood (2018), Ameriks et al. (2011, 2018, 2020b) for the US for additional evidence and discussion of the importance of LTC-related spending risks.

after retirement.<sup>8</sup> The decumulation of housing equity is further complicated by the volatility in house prices, the utilitarian services provided by housing, illiquidities involving home sales and relocations, as well as transaction and emotional costs associated with changes in home-owning statuses that are absent in the case of more liquid financial assets such as bonds.

Three financial instruments appear particularly relevant for addressing these problems. First, annuities (ANN) effectively protect against the risk of outliving accumulated assets by converting equity to cash flows that are guaranteed until death. Second, long-term care insurance (LTCI) offers fixed payments when deteriorating health conditions lead to consequential limitations in activities of daily living (ADL), such as 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. 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 constraint, and limit exposure to both debt repayment and downward house price risks.<sup>9</sup>

However, despite their potential effectiveness as part of post-retirement decumulation and risk insurance strategies, these three instruments have generated limited interest 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. Ultimately, judgments about the take-up of these instruments as well as the speed of asset decumulation depend on the benchmark used to define what might be optimal given financial constraints and preferences.

This paper aims to estimate such a benchmark for all three risk management instruments *jointly* while allowing departure from the fully rational expectations life-cycle model in terms of subjective expectations as well as rational inattention and inertia in decision making. We estimate a flexible household life cycle (LC) model to assess the contributions of the following factors to explain the

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<sup>8</sup>Elders' preference for 'aging in place' is discussed by Cocco and Lopes (2020).

<sup>9</sup>In particular, the RMR debt is rolled forward and interests are accumulated until the house is sold; the non-recourse provision guarantees that effective debt repayment is bounded above by the house value at time of sale, thereby limiting exposure to downside risk in housing prices. 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.

low take-up rates for ANN, LTCI and RMR: (i) preferences towards risk, housing, health and bequests, (ii) biases in information processing and favoring inaction as well as in expectations, and (iii) heterogeneity in the balance sheet and (objective and subjective) risk exposure of households. 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.

To this end, we first commissioned a pan-Canadian experimental survey of individuals age 60 to 70 covering a wide range of questions about their financial situation, pension coverage 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 the randomization of contract attributes provides relevant information towards the identification of the model’s parameters. We do so in a framework where we elicit probabilistic take-up (Manski, 1999) and embed the fully rational model in a behavioral discrete choice model that allows for rational inattention in the form of status-quo bias and trembling hand following the generalized logit formulation of Matejka and McKay (2015).<sup>10</sup>

Second, given our focus on identifying an individual-specific benchmark, we account for the considerable degree of heterogeneity. Objective house price distributions are obtained by respondent’s residence for each census metropolitan area (CMA) we covered, and are augmented by individual-specific subjective beliefs about these processes. Furthermore, a dynamic micro-simulation model uses respondents’ health and socio-economic status to compute *personalized* objective health transitions probabilities, to which we also append individual-specific subjective

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<sup>10</sup>The links between rational inattention due to costly information acquisition and/or processing and stochastic choices are also 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).

beliefs. 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 preference parameters governing these attitudes.

The estimated benchmark model goes a long way towards rationalizing low demand. Indeed, when abstracting from informational and behavioral biases, the optimal take-up rates falls to only one-third in the scenarios we presented. When information acquisition/processing and status-quo biases are re-activated, these take-up rates align with the survey levels of 17.5% (ANN), 17.9% (LTCI) and 8.0% (RMR). Hence, these results suggest that these products offered are far from being optimal for the majority of respondents.

Preferences play a major role when decision biases are accounted for. First, we estimate a low Arrow-Pratt index of relative risk aversion of 0.56. This is consistent with Handel and Kolstad (2015) who show that accounting for such biases significantly lowers estimated risk aversion. Moderate aversion largely explains the low appetite for market-provided insurance procured by annuities, LTCI and RMR. Moreover, the associated high elasticity of inter-temporal substitution (EIS) of 1.78 suggests dominance of substitution over income effects following the large increases in housing returns, which is consistent with a low demand for liquidating both financial (through ANN) and house equity (through RMR). Second, we identify strong discounts on the marginal utility of consumption in low and high disability states relative to being healthy. These discounts are consistent with a reduced demand for both annuities (state-independent payouts) and for LTCI (payments in disability states). Third, our results also indicate that housing procures significant distinct utilitarian services, but has a lower expenditures share compared to, and is substitutable with consumption. Hence, households use the house as an insurance against post-retirement risks. Fourth, our estimate suggest that altruistic bequests are considered as luxury good and therefore play a very limited role in explaining low take-up.

We also highlight additional contributors to annuities, LTCI and reverse mortgages decisions. First, household composition amplifies the contributions of health-dependent preferences. Since

health shocks are imperfectly correlated, respondents in couples demand LTCI to protect their spouse and themselves from the other’s medical expenses. Second, biased expectations also play a role, but towards *increasing* demand relative to objective expectations given that we find respondents to be overly optimistic with respect to longevity and too pessimistic regarding house prices. Third, the relatively high resource floor provided by the Canadian retirement income system discourages demand for annuities and long-term care insurance. Finally, 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 rate almost doubles (28.9% to 51.8%) due to the optimality of an annuity - reverse mortgage joint solution for many households.

This paper contributes to the quantitative life cycle literature on post-retirement asset and risk management, with special emphasis on the puzzles regarding slow asset decumulation,<sup>11</sup> annuities,<sup>12</sup> long-term care insurance,<sup>13</sup> and reverse mortgage.<sup>14</sup> Our main contributions are twofold: (i) we analyze these decisions *jointly* and therefore bridge the gap between otherwise separate strands of literature and (ii) we integrate the role of housing decisions, couples, as well as informational and behavioral biases in financial choices. Among the most related papers is Koijen et al. (2016) who study annuities, life, and LTC insurance by comparing the theoretical and empirical health and mortality deltas.<sup>15</sup> Whereas we also advocate the importance of joint interactions between annuities and LTCI choices, we abstract from the life insurance decisions they consider,<sup>16</sup> 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

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<sup>11</sup>See Abel (1985), Bernheim et al. (1985), Hurd (1989), Hubbard et al. (1995), Palumbo (1999), Ameriks et al. (2011), Ameriks et al. (2018, 2020b), De Nardi et al. (2010), Lockwood (2018) and Achou (2021).

<sup>12</sup>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.

<sup>13</sup>See Pauly (1990), Brown and Finkelstein (2007, 2008, 2011), Lockwood (2018), Ameriks et al. (2018), Braun et al. (2019), Boyer et al. (2020a), and Leroux et al. (2021), Achou (2021).

<sup>14</sup>See Nakajima (2012), Lucas (2016), Nakajima and Telyukova (2017), Blevins et al. (2020), Chen and Yang (2020), and Cocco and Lopes (2020).

<sup>15</sup>Measured by the differential net payoffs of the three instruments in unhealthy, as well as death states relative to good health state.

<sup>16</sup>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.

constraints explicitly. Importantly, we fully endogenize housing choices, thereby allowing us to consider the important interactions of housing with annuities, RMR and LTCI which are abstracted from in their paper.<sup>17</sup> Finally, we differ in our explicit treatment of household composition risks (i.e. singles vs couples) for risk management which, to our knowledge, remains largely unexplored.<sup>18</sup>

Second, Inkmann et al. (2011) also emphasize bequest motives in a quantitative Life-cycle (LC) model of annuities. While they consider continuous (rather than one-shot) adjustments of the annuities position and rely on more flexible utility functions, they nonetheless abstract from housing, mortgages (and therefore RMR) choices and risks as well as from morbidity (and therefore LTCI) decisions and risk exposure. Health risks and bequest motives are emphasized in the annuities model of Ameriks et al. (2011) who stress aversion to publicly-provided long-term care as main motive for slow asset decumulation. However both LTCI (separately addressed in Ameriks et al., 2018), as well as housing and RMR choices are also abstracted from. Finally 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. 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,<sup>19</sup> 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.

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<sup>17</sup>See Achou (2021) for a joint treatment of LTCI and housing decisions, with special emphasis on illiquidities.

<sup>18</sup>A notable exception is De Nardi et al. (2021) who study post-retirement decumulation of savings in couples and Hubener et al. (2015) who study interactions with social security claiming decisions.

<sup>19</sup>The ageing-in-place utilitarian costs are partially captured by our exogenous financial moving costs.



## 2 Model

We model consumption, housing, and financial decisions made by households composed of retired singles and couples, that are subject to longevity, health and housing prices risks. Insurance against these shocks is provided by one-shot decisions on annuities, long-term care insurance and reverse mortgages, whereas housing statuses (owner vs renter) and consumption/savings decisions are made continuously. Agents are forward-looking expected utility maximizers with rational expectations, and derive utilitarian services from consumption, home owning and from leaving bequests.

### 2.1 Health statuses and expenses

**Agents, time, age and households** We consider agents whose identity, gender, and age at survey characteristics are expressed as indices  $i$  (head), and  $j$  (spouse). Time is denoted  $t = 0, 1, 2, \dots, T$ , 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 living agents be denoted by  $\mathcal{A} = \{G, \ell, L\}$ , indicating good health, low ( $\ell$ ) and high ( $L$ ) limitations in activities of daily living (ADL) respectively <sup>20</sup> and let  $\mathcal{D}$  denote death. The health status of agent  $i$ 's is  $s_{it} \in \mathcal{S} = \{\mathcal{A}, \mathcal{D}\}$ , with the corresponding indicators  $\mathbb{1}_{it}^s = \mathbb{1}(s_{it} = s \in \mathcal{S})$ . Individual health statuses  $s_{it}$  are governed by a Markovian process, with exogenous, age-dependent transition probability elements and matrices denoted:

$$q_{it}^n(s, s') = \Pr_t [s_{it+n} = s' \mid s_{it} = s]$$

$$\mathbf{q}_{it}^n = [q_{it}^n(s, s')] = \prod_{k=0}^{n-1} \mathbf{q}_{it+k}^1,$$

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<sup>20</sup>See also Ameriks et al. (2011, 2020b) for similar modelling of ADL statuses.

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 bi-directional transitions between better and worse states.

Similarly, denote by  $s_{ijt} = (s_{it}, s_{jt}) \in \mathcal{S}^2 = \{(G, G), (G, \ell), \dots, (D, D)\}$  the pair of spouses' contemporary health statuses with corresponding indicator function  $\mathbb{1}_{ijt}^s = \mathbb{1}(s_{ijt} = s \in \mathcal{S}^2)$ , and transition probabilities:

$$q_{ijt}^n(s, s') = \Pr_t [s_{ijt+n} = s' \mid s_{ijt} = s]$$

$$\mathbf{q}_{ijt}^n = [q_{ijt}^n(s, s')]$$

for states  $(s, s') \in \mathcal{S}^2 \times \mathcal{S}^2$  and horizon  $n \in (1, T - t)$ . For tractability, we assume that the widowed spouse's transition probabilities revert back to her distribution as single:

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

This assumption, combined with the no new couples hypothesis, implies that a single individual is indistinguishable from a widow(er), from a health status perspective. The rest of the analysis will therefore rely on the couples notation for health states and transition matrices whenever suitable.<sup>21</sup>

**Medical expenses** Household health expenses for agents are state-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  $\ell$  (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.

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<sup>21</sup>Health transitions are spouse-specific but the empirical implementation of the model allows for these health transition processes to be correlated 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 the price  $P_i^A$  and the benefit  $b^A$ .

**LTC insurance** Individual-specific insurance against LTC expenditures is offered to the household head  $i$  and is characterized by the benefits denoted as  $b^L$  paid out conditional upon state  $L$  only, and by the premium  $P_i^L b^L$  to be paid only in  $G, \ell$  states. The subsequent scenarios presented to respondents separately alter both price  $P_i^L$  and benefit  $b^L$ .

## 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, that are jointly distributed as:

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

$$P_t^R = \phi P_t^H, \quad \phi \in (0, 1). \quad (2b)$$

The housing price processes in (2) are similar to Pelletier and Tunc (2019) and 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.<sup>22</sup>

### 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

<sup>22</sup>Cocco and Lopes (2020) consider a more complex time-varying loading for  $\phi$  to capture user-costs components in rental charges.

purchasing another home.<sup>23</sup> 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  $D_t$ :

$$W_t^H = H_t [P_t^H - D_t(1 + r_d)], \quad (3)$$

where  $r_d$  is the mortgage rate of interest.

We follow Goria 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 the outstanding mortgage for continuing owners, i.e.  $(H_t, H_{t+1}) = (1, 1)$ , or a share  $\omega^D \in (0, 1)$  of house value for new mortgages, i.e.  $(H_t, H_{t+1}) = (0, 1)$ :

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

We will henceforth assume that the constraint (4) is binding. 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 his outstanding mortgages, so it 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:

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

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

$$MC_t^k = \tau_0^k + \tau_1^k P_t^H, \quad k = s, b \quad (5c)$$

where  $\tau_0^k, \tau_1^k$  in (5c) are fixed and proportional costs paid as moving expenses that may differ for sellers and buyers. Table A1 in Appendix A 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.

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<sup>23</sup>Cocco and Lopes (2020) also propose proxying housing market illiquidities by including moving costs. We differ from their approach, however, by allowing transitions back to home owning for renters, which they abstract from.

### 2.3.3 Reverse mortgage

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

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

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

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

The maximal reverse mortgage loan  $L_0$  in (6a) is a share  $\omega^R$  of the 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.<sup>24</sup> 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 interest given by the premium  $\pi_{ij}^R$  over the risk-free rate  $r$ . The premium is household-specific and accounts for the health status of all members since the latter determines the decision to sell. The effective amount due at termination  $b_{ijt}$  in (6c) is the lesser of the nominal amount and house value at sale. The scenarios presented to respondents below will vary both the maximal loan-to-value  $\omega^R$  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** Household income  $Y_t$  pools all labour or pension income of household members, and, conditional on being alive, is independent of health status:

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

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<sup>24</sup>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).

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

Additional net financial revenues are defined as:

$$Z_t = Z_t^{ben} - Z_t^{prem} \quad (7b)$$

and capture net proceeds from time-0 annuity, LTC insurance and RMR choices, and it differs across initial and subsequent periods. At time  $t = 0$ , Table A2 reveals that continuing home-owners  $(H_t, H_{t+1}) = (1, 1)$  receive the selected reverse mortgage loan net of any outstanding mortgage  $(L_0 - D_0)$  while the household purchases  $b^A$  annuities at price  $P_i^A$  and 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).

Means-tested government transfer programs complete the pre-transfer (gross) cash-on-hand  $\tilde{X}_t$  in (7c), which 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:

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

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

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

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:

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

### 2.4.2 Borrowing constraints

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

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

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:

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

Equation (8b) reveals that debt servicing requirements restrict both renters ( $H_t = 0$ ) and owners ( $H_t = 1$ ) to borrow at most  $\omega_y$  of income plus transfers. In addition, HELOCs allow eligible owners to borrow the lesser of  $\omega_1^h$  of house price, or of  $\omega_2^h$  of their house price minus outstanding mortgages. Observe that the borrowing constraint can equivalently be rewritten as an upper bound on household consumption:

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

As discussed below, the upper bound (8c) is used to determine the admissible range for optimal consumption.

## 2.5 Preferences and household's problem

### 2.5.1 Preferences

We rely on expected utility to model 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. 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:

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

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

$$S_t^H = [\phi + H_t \nu^H] P_0^H \quad (9c)$$

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

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 curvature index  $\gamma$  in (9a)  $\gamma$  is linked to the Arrow Pratt consumption RRA  $\tilde{\gamma} = (1 - \rho) + \gamma\rho$ .<sup>25</sup> Second, the elasticity of inter-temporal substitution (EIS) is  $1/\tilde{\gamma}$ , and  $\beta$  is the subjective discount factor. Third, we follow Nakajima and Telyukova (2017), Achou (2021) in relying on a Cobb-Douglas function with consumption share  $\rho$  to aggregate consumption and home-

<sup>25</sup>Rewrite utility (9a) and (9b) as:

$$U(c, S^H) = \frac{\left[ \left( \frac{\nu}{n} \right) c^\rho S^{H^{1-\rho}} \right]^{1-\gamma}}{1-\gamma} = \rho \left[ \left( \frac{\nu}{n} \right) S^{H^{1-\rho}} \right]^{1-\gamma} \frac{c^{\rho(1-\gamma)}}{\rho(1-\gamma)} \propto \frac{c^{1-\tilde{\gamma}}}{1-\tilde{\gamma}}$$

to solve for the consumption Arrow-Pratt RRA index:  $\tilde{\gamma} = (1 - \rho) + \gamma\rho$ .



owning utilitarian services  $S_t^H$  in (9b). Housing services are captured in (9c) by the rent paid  $P_t^r = (P_t^H)^\phi$  by renters ( $H_t = 0$ ), and the incremental services  $\nu^H$  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,  $P_0^H$ , such that housing services  $S_t^H$  movements will be caused by endogenous housing decisions  $H_t$  exclusively.<sup>26</sup>

The health-dependent taste shock for household member(s) in (9b) are  $\nu_{ijt} = \nu(s_{ijt})$  for  $s_{ijt} \in \mathcal{S}^2$  for which we expect that health shocks  $\nu_{ijt}$  are lower in a poorer health state and additive and independent across household members. Observe that the utility flows are averaged for couples by dividing by the equivalent scale for household size  $n_t$ .<sup>27</sup> Third,  $V_{ijt+1}$  in (9d) is the (warm-glow) utility of bequest in (7e) with  $b$  capturing the strength of the bequest motive, and  $\tilde{b} \equiv b^{1/(1-\gamma)}$  measuring the intended share of bequeathed cash-on-hand  $X_{t+1}$ . The parameter  $\kappa$  captures whether bequests are a luxury good ( $\kappa > 0$ ), or a necessity ( $\kappa < 0$ ) (De Nardi, 2004, Lockwood, 2012, 2018, De Nardi et al., 2010).

### 2.5.2 Household's problem

The household's problem is to maximize  $V_{ijt}$  in (9) given the timing of decisions and constraints summarized in Table A3. 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 the housing state  $H_t$ . 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 state space for the subsequent periods. In all periods, the optimization is subject to the mortgage (4), budget (7),

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<sup>26</sup>The 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 value of home amenities at those in the initial period.

<sup>27</sup>We follow Scholz et al. (2006) in setting  $n_t = 1.55$  for couples, and  $n_t = 1$  for singles. See also De Nardi et al. (2021), Nakajima and Telyukova (2017) for use of equivalent scale measures in couples corresponding to 1.51 and 1.34, respectively (utility-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.

and borrowing (8) constraints, whereas the reverse mortgage constraint (6a) must only be satisfied for the time-0 choice only.<sup>28</sup>

Unsurprisingly, analytical solutions to problem (9) subject to constraints in Table A3 are infeasible, so we resort to standard approaches to solve the model numerically over a discretized state space grid.<sup>29</sup> Conditional upon the optimal sequences for  $\{C_t, H_{t+1}\}_{t=0}^T$ , the  $t = 0$  discrete choices for annuities, LTCI and RMR 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.

## 3 Data

### 3.1 Survey details

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.<sup>30</sup>

The survey design has four different components: (i) background socio-demographic and financial information, (ii) risk perceptions, (iii) knowledge of financial products, and (iv) stated-preference experiments for annuities, long-term care insurance and reverse mortgages. The complete questionnaire is found in Appendix F. Respondents from the Asking Canadians panel were rewarded for their participation in the online survey using a loyalty point reward system. A total of 3,057 completed questionnaires were collected.

Of the completed surveys, we first imputed missing values for financial variables using unfolding bracket questions.<sup>31</sup> We also top-coded income responses to 500,000C\$ and financial wealth as well as mortgage debt at 1,000,000C\$. We then imposed filters to select the sample for analysis. First,

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<sup>28</sup>Recall that assuming that the mortgage constraint (4) is binding removes the need to consider  $D_{t+1}$  as a control variable.

<sup>29</sup>Details on the solution method are found in Appendix B.

<sup>30</sup>We focus on urban areas who have seen the largest increases in house prices and therefore have the highest potential for home equity extraction.

<sup>31</sup>These imputations were done using chained multivariate regression, conditional on bracketing. Details on the imputation procedure are available upon request

we dropped couples with an age difference of more than 10 years (to speed up the solution of the model) 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 the to households who were initially home owners ( $H_0 = 1$ ). The final dataset contains 1,581 respondents (households), with 1,164 households being couples. Descriptive (unweighted) statistics on the key variables in our analysis are provided in Table 1. 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 ( $E[t_{i,r}, t_{jr}] = 1.1$  year). Retirement income ( $Y_{i,0}^R, Y_{j,0}^R$ ) 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\$ ( $P_0^h$ ), 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\$. Overall, our survey data can be considered as reasonably representative of Canadian household data.<sup>32</sup>

### 3.2 Health status

The questionnaire specifically asked about limitations in activities of daily living. We define respondents as being in good health ( $G$ ) if they indicated 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 ( $\ell$ ) if they have some IADLs or at most one ADL. Finally, we classify respondents as having severe limitations ( $L$ ) if they have two or more ADLs. The distribution of health status reported in Table 2 reveals that the sample is generally healthy, with few respondents

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<sup>32</sup>National data for Canadian residents aged 65 and over reveals that average household revenue was 60,182C\$ in 2019 (Statistics Canada, 2023a), whereas mean mortgages were 21,359C\$, average residential and financial wealth were 334,671C\$ and 407,352C\$ respectively (Statistics Canada, 2023b). The lower residential wealth in the population reflects the inclusion of non-owners, and the pan-Canadian coverage, compared to our sample of urban home-owners exclusively.

already facing limitations (fewer 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. Figure 1 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 average survival probabilities to cohort life tables (projected) produced by Statistics Canada, at 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. female 73%) probability of surviving up to 85, compared to an objective likelihood of 56% (resp. female 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. On average, respondents put a 30% probability on the possibility of a drop in prices over the next 10 years. That probability is highest for residents of 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 in the cross-section.

By comparison, panel b shows the actual house price index for each of these CMA’s over the 10 years prior to the survey. Three CMA’s saw a near doubling of house prices over that period (Toronto, Vancouver and Hamilton) and other CMAs witnessed 15-40% increases in house prices over that same period. Respondents thus 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 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<sup>33</sup> concerns a preference for a bequest motive (parameter  $b$  in the model). The second<sup>34</sup> provides information on preference for housing (parameter  $\nu_h$  in the model). We also ask a standard subjective question on five levels of risk aversion, ranging from very low aversion<sup>35</sup> to high and extreme risk aversion.<sup>36</sup> We recode the risk aversion question to a binary equal to one if the respondent either indicated 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.

## 3.4 The stated-choice experiment

The core component of the survey is a stated-choice experiment in order to elicit demand for three risk management products of interest: 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). Next, we describe the design of choice situations for each product.

### 3.4.1 Annuities

The first screen for annuities in section 4 of Appendix F was shown to respondents with positive financial wealth (non-housing, and potentially annuitized). In accordance with the literature stressing the importance of framing, minimizing complexity and emphasizing salient features in annuities decisions (e.g. Benartzi et al., 2011, Brown et al., 2019, Luttmer et al., 2022), the intro screen reviews relevant information on the main features of annuities, i.e. the immediate one-shot premium to be paid and the monthly benefit starting next year and paid until death. In order to

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<sup>33</sup>“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.”

<sup>34</sup>“A house is an asset that should only be sold in case of financial hardship.”

<sup>35</sup>Willingness to take substantial risk to earn substantial returns.

<sup>36</sup>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).

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 of 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 four markups  $\tau_A$  on the actuarial fair premium (0.5, 0.75, 1.25 and 1.5). For each of the four scenarios, respondents are asked to report the probability of purchase within the next year.

### 3.4.2 Long-term care insurance

The intro screen for long-term care insurance in section 6 of the questionnaire in Appendix F was shown to respondents who do not yet have LTCI. We follow a very similar strategy for long-term care insurance to 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.<sup>37</sup> We again stressed that there was no default risk, nor lapsing in the payment of premiums.<sup>38</sup> Product attractiveness is emphasized by stating that premiums cannot increase over time and that benefits (either 2,000C\$ or 4,000C\$ per month) would be adjusted for inflation. We presented each scenario twice, with a randomization of the markup  $\tau_L$  on actuarial premium by age group (60-64, 65-70) and gender. The loads considered are (0.5, 0.75, 1.25 and 1.5). For each scenario, we collect the probability of purchase.

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<sup>37</sup>Eating, washing, dressing, moving inside the house and getting in and out of bed.

<sup>38</sup>In practice, products include a provision that we abstract from for contract termination when monthly payments are not made.

### 3.4.3 Reverse mortgages

The intro screen for reverse mortgages was shown to home-owners who do not yet have a RMR contract. We first reminded 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 also emphasized that home owners would not be 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 could not exceed the house value at that date. For each of the four scenarios, we first set the maximal loan-to-value (LTV) ratio that can be borrowed as a function of the age of the respondent,<sup>39</sup> and two borrowing levels were considered: 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 rates, thereby spanning the actual rate of 6% on RMRs. 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) about each of the products before presenting scenarios. Table 3 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 less prior knowledge of 10.9%, respondents report higher take-up intentions for LTCI with a 17.4% probability of buying and a 39.2% probability of never buying. Again both price (-0.794) and benefit (0.525) elasticities are of the correct sign. Finally, our agents display the least interest (buy

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<sup>39</sup>The maximal LTV are 30% for those age 60-64 and 40% for those 65-70.

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

A mapping from the theoretical model to the stated-preference experimental data is made operational in two steps. First, the discrete choice of buying the product or not 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 a person-specific set of initial conditions and individual distributions for the exogenous processes governing health and house 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 B for numerical solutions details). Second, the binary purchase intentions from the welfare gains and losses are converted into likelihoods to compare to 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 grouped into 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 4. First, 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,  $r = 0.01$ . We also use the 2016 Survey of Financial Security to calibrate the average interest on fixed rate mortgages<sup>40</sup> among those age 60 to 70, at  $r_d = 0.03$ . For homeowners taking home equity lines of credit (HELOC's), we set the rate at 1% over the rate on mortgages, i.e.  $r_h = 0.04$ , using rates from various Canadian financial institutions. Finally, owners borrowing beyond the limits set by HELOCs and RMs, as well as renters, are assumed to rely on their credit cards with borrowing rate  $r_r = 0.095$ .<sup>41</sup>

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 (2018, p. 15), we set the amortization factor at  $\xi^D = 0.9622$  to generate a mortgage half-life of 12.5 years calculated using  $r_d$ .<sup>42</sup> In addition, homeowners can reverse-mortgage up to  $\omega^R = 0.55$  of their house prices. 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 exceed 80% of the value of the house (the LTV test).<sup>43</sup> We implement both of these rules for  $(\omega_0^h, \omega_1^h)$ .<sup>44</sup> For credit card borrowing by renters and owners who 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.<sup>45</sup>

We set the parameter of rental prices with respect to house prices is  $\phi = 0.035$ . Sellers must pay fixed legal fees and moving expenses ( $\tau_0^s$ ) of 1,500C\$, plus commission (i.e. broker) fees ( $\tau_1^s$ ) of 5% of house prices, whereas home buyers pay moving expenses ( $\tau_0^b$ ) of 500C\$ plus municipal transfer taxes ( $\tau_1^b$ ) of 1% of house prices.

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<sup>40</sup>More than 76% of home owners who have a mortgage in Canada have a fixed rate mortgage (typically 5 years).

<sup>41</sup>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 provides a good approximation to Canadian credit card rates.

<sup>42</sup>More specifically,  $\xi^D = (1 + r_d) \times 0.5^{(1/12.5)} = 0.9622$ .

<sup>43</sup>See <https://www.chip.ca/reverse-mortgage-resources/reverse-mortgage/heloc-rates-comparison/>

<sup>44</sup>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 qualify, 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.

<sup>45</sup>We do not find evidence that this limit varies by age among the elderly (age 60+).

We calibrate medical expenditures  $M_{ijt}$  by including three types of expenditures. First, we consider out-of-pocket medical expenditures in states  $(G, \ell)$ . Second, we consider home care expenditures (state  $\ell$ ), 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. Table 5 reports estimates by CMA and health status.<sup>46</sup>

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 of 27,733C\$ for couples is provided. Several transfers are anchored on these floor values. 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 average tax rates by pension income for singles and couples.<sup>47</sup> 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. Finally, we follow Boyer et al. (2022) for Canadian data and standard practices in setting annual subjective discount rate to 3% corresponding to a discount factor  $\beta = 0.97$ .

#### 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<sup>48</sup> growth rates  $g$  and volatility

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<sup>46</sup>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  $\ell$  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  $\ell$ . 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 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.

<sup>47</sup>The [Simulateur de Revenu Disponible](#) is a Python-based disposable income simulator.

<sup>48</sup>We use census metropolitan areas level general consumer price index to deflate prices.

$\sigma$ . These are reported in Table 6. We test for and do not reject the null of no unit root for  $\epsilon_t$  in (2a) using an Augmented Dicky Fuller (ADF) test, for 10 out of the 11 CMAs (Ottawa being the exception).<sup>49</sup> 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 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 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  $\mu_i$  and  $\zeta_i$  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 will increase (or decrease) over the next 10 years. We show in Appendix C how these answers can be used to estimate  $\mu_i$  and  $\zeta_i$ . We report the distributions of estimated  $\mu$  and  $\zeta$  in Figure 3. Respondents are much more pessimistic about house price growth with an average  $\mu$  of 0.1 in panel a, but correctly perceive the volatility of house prices with an average  $\zeta$  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 ( $G, \ell, L, D$ ) 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. Appendix C shows 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 reported by respondents as the probability of

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<sup>49</sup>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).

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, in the first panel, a scatter plot of respondent’s objective probabilities of surviving to age 85. There is substantial heterogeneity in the sample, along with a positive correlation within couples. In the second panel, we report a scatter plot of the distribution of mortality belief parameters for respondents and spouses. A positive value of this mortality belief parameter denotes a respondent who is more pessimistic than the prediction from the objective health model. On average, respondents are optimistic about their survival prospects with average  $\xi = -1.42$ . However, there is substantial heterogeneity as can be seen in Figure 4. There is also substantial correlation in these beliefs, conditional on objective probabilities, which was to be expected given that the respondent also reports the probability for the spouse.

### 4.3 Structural estimation

#### 4.3.1 Respondents’ heterogeneity and responses

**Characteristics** Respondent  $i$  is associated with a set  $\mathbf{X}_i$  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  $\mathbf{X}_i$  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  $\Delta_\gamma$  for those who report being highly risk averse,  $\Delta_{\nu^h}$  for those who

express a strong preference for keeping their homes, and  $\Delta_b$  for those who express a stronger bequest motive.<sup>50</sup>

**Survey responses** Each respondent, indexed  $i = 1, \dots, N$ , was presented with scenarios indexed  $k = 1, \dots, K$  consisting of a three-dimensional tuple for the prices  $\mathbf{P}_{i,k} = (P_{i,k}^A, P_{i,k}^L, \pi_{i,k}^R)$  and for benefits  $\mathbf{B}_{i,k} = (b_{i,k}^A, b_{i,k}^L, L_{0,i,k})$  of annuities, LTC insurance and reverse mortgage products.<sup>51</sup> Let  $n(k)$  map to the product type  $\{A, L, R\}$  featured in scenario  $k$ . Each respondent  $i$  reports probabilities  $p_{i,k} \in [0, 1]$  of purchasing product  $k$ , relative to the benchmark case  $\mathbf{B}_{i,0} = (0, 0, 0)$  and  $\mathbf{P}_{i,0} = (0, 0, 0)$  of no participation in the three products.

### 4.3.2 Estimator and inference

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

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

We next consider the mapping of indirect utility gains, experience utility, to respondents' decision utility. For various reasons, respondents may not base their decisions entirely on the fully rational life-cycle model. Matejka and McKay (2015) show that, under mild assumptions, choice under rational inattention can be represented using a generalized logit model with a individual specific intercept and a scale parameter that dampens the effect of experience utility on decision utility. Consistent with these results, we assume that respondents make decisions based on a noisy measure of the indirect utility gain in (10) associated with a particular scenario, and they purchase product

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<sup>50</sup>Our preference shifter identification strategy differs from Ameriks et al. (2011, 2018, 2020b) who combine administrative asset holdings data with responses to the Strategic Survey Questions (SSQ's) in the estimation in order to identify the main preferences parameters.

<sup>51</sup>The number of presented scenarios  $K_i \leq 12$  is respondent-specific, as certain respondents will be presented with fewer choices if non-owners and/or if insufficient financial resources.

$k$  if:

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

where  $v_{i,k}$  follows a logistic distribution with product-specific scale parameter  $\sigma_{v,n}$  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- $i$  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. This approach is also similar in spirit to Ameriks et al. (2020a) who discuss attenuation biases in risky asset holdings and to Handel and Kolstad (2015) who also emphasize product-specific informational and inertia biases in the context of health insurance. Importantly, Handel and Kolstad (2015) show that omission of these biases leads to substantial effects in the estimation of preferences parameters, notably leading to high risk aversion (instead of high biases) to justify low take-up rates.

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

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

where  $\delta_{i,n} = \delta_{i,n}^*/\sigma_{v,n}$  and  $\lambda_{v,n} = 1/\sigma_{v,n}$ . A respondent who makes choices free of noise ( $\sigma_{v,n} \rightarrow 0$ ) 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  $\tilde{V}_{i,k}$ . This formulation is the same as that derived by Matejka and McKay (2015).

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

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

We rely on a within transformation, for each product type  $n(k)$ , to eliminate fixed effects  $\delta_{i,n}$ .<sup>52</sup> The resulting within differences are independent of  $\delta_{i,n}$  but are also linear in  $\lambda_{v,n}$  for a given value of  $\theta$  (and therefore of the  $\tilde{V}_{i,k}(\theta)$ ). Hence, the value of  $\lambda_{v,n}$  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  $\theta$ , speeding up the search for the best value of  $\theta$ . In Appendix D, we develop a concentrated non-linear least-square estimator to estimate  $\theta$  for which we rely on the derivative-free NEWUOA algorithm (Powell, 2006). In the estimation, we allow  $\lambda_v$  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  $(\lambda_{v,0}, \lambda_{v,1})$  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 D.

## 5 Estimation results

We discuss the estimation results starting first with the point estimates for the preference parameters, followed by the informational and status-quo biases estimates. We close this section by an appraisal of in- and out-of-sample model performance. The implications of our results for risk management strategies are postponed until Section 6.

### 5.1 Preference parameters

We report the estimated preference parameters in Table 7. We present equivalent estimates in Table 8 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 curvature parameter  $\gamma = 0.459$  in Table 7.a which corresponds to an Arrow-Pratt relative risk aversion index of  $\tilde{\gamma} = (1 - \rho) + \gamma\rho = 0.561$  (see footnote 25). We find no

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<sup>52</sup>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.

evidence of heterogeneity with those reporting being highly risk averse having a marginally higher curvature ( $\Delta_\gamma = 0.018$ ) that is not statistically different from zero. 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 8.a. However, the RRA are typically lower than the revealed preference estimates in Table 8.b, an issue to which we will return shortly. The implied elasticity of intertemporal substitution  $1/0.561 = 1.78$  is consistent with the asset pricing literature emphasizing long-term consumption risks (such as health and housing related) which advocates an EIS larger than one to generate plausible results.<sup>53</sup>

**State-dependent preferences** Relative to good health ( $\nu_{c,1} \equiv 1.0$ ), the state-dependent shifters in Table 7.b are indicative of strong declines in the marginal utility of consumption in low- ( $\nu_{c,2} = 0.235$ ) and high-ADL limitations states ( $\nu_{c,3} = 0.043$ ). These correlations are consistent with others who also find detrimental effects on the marginal utility of consumption following health deteriorations.<sup>54</sup>

**Housing** Table 7.c reveals a high consumption share  $\rho = 0.812$  and a calibrated unit elasticity of intratemporal substitution between consumption and housing that are similar to the calibrated value of 0.8 and unit elasticity used by Nakajima and Telyukova (2017), Achou (2021) and are realistic compared to other values in Table 8.b. Second, we also identify a positive utilitarian benefit of home ownership  $\nu_h = 0.312$ . This housing utility is slightly higher, although not statistically significantly so, for those expressing a preference for keeping their home as long as possible ( $\Delta_{\nu^h} = 0.037$ ).

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<sup>53</sup>See Bansal and Yaron (2004) for examples and Epstein et al. (2014) for discussion. For completeness, we did estimate a more flexible Epstein-Zin specification that allows to separate the EIS from relative risk aversion. However, we could not reject the restriction imposed by VNM expected utility that the inverse of the EIS 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.

<sup>54</sup>Finkelstein et al. (2013), Koijen et al. (2016), Peijnenburg et al. (2017), De Nardi et al. (2010), De Nardi et al. (2021), Achou (2021) all document delining marginal utility of consumption in deteriorated health statuses. Ameriks et al. (2020b) take a different approach of associating LTC expenses to *general* non-durables consumption and find an increasing marginal utility in high limitations states warranting more demand for LTC. De Nardi et al. (2016) take an intermediate path where they model utilitarian services of medical expenditures (associated with health improvements) separately from consumption utility. See also Finkelstein et al. (2009) for a review of methods to identify health-dependent preferences.



**Bequests** We report evidence of a bequest motive in Table 7.d, with a statistically significant  $b = 0.342$ . This value implies a share of wealth to be bequeathed  $\tilde{b} = b^{1/(1-\gamma)} = 0.138$  that is within the range of equivalent estimates in Table 8.b and corresponds to an intended bequest of 109K\$ at mean financial + residential wealth in Table 1. Again, heterogeneity is not apparent; those who do express a stronger bequest motive (20% of our sample) have a statistically insignificant increment  $\Delta_b = 0.102$ . Finally, the statistically significant curvature parameter  $\kappa = 119.5$  is also realistic and indicative of bequests being perceived as luxury goods,<sup>55</sup> consistent with other evidence in Table 8.b.

## 5.2 Informational and behavioural biases

Recall from (12) that the informational and behavioural biases are captured by the parameters  $\lambda_{v,n} = 1/\sigma_{v,n}$  that gauge the informational content of the utility gradients (10) in predicting take-up rates, and by the parameters  $\delta_{i,n} = \delta_{i,n}^*/\sigma_{v,n}$  which measure the agent  $i$ -specific status-quo or default biases, and where  $\sigma_{v,n}$  captures the noise added to the utility gradient for product  $n$ .

**Info content of utility gradients** With the exception of  $\lambda_{v,A(1)}$ , the parameters  $\lambda_v$  are all positive, finite and statistically significant in Table 7.d, confirming that respondents' choices correlate positively with the estimated utility gradients of purchasing particular products and cannot entirely be explained by random decisions ( $\lambda_{v,n} = 0$ ). Although the magnitude of the loading on welfare gain is product-specific, the levels appear realistic.<sup>56</sup> Interestingly, with the exception of annuities, better prior knowledge ( $\lambda_{v,n(1)}$ ) is associated with a higher weight attributed to welfare gains/losses, consistent with costly information acquisition/processing interpretations of the  $\lambda$  terms.

**Status-quo biases and product knowledge** The estimates of the parameters  $\delta_{i,n(k)}$  can be recovered for each respondent  $i$  to chart the effects of self-reported prior knowledge of the demand

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<sup>55</sup>In particular, bequest motives only become operational past a threshold consumption level of  $\kappa = 119.5\text{K}\$$  and exhibit lower and increasing relative risk aversion compared to the constant consumption RRA. See also De Nardi (2004), Lockwood (2018), Ameriks et al. (2020b) for a more detailed discussion of the implications of bequests as luxury good.

<sup>56</sup>In a different setting, Ameriks et al. (2020a, Tab. 6, p. 645) find that the loading a pure model-based individual signal for equity shares is about 0.05, with the remaining share placed on the average market portfolio.

for products  $n$  in scenario  $k$ .<sup>57</sup> Figure 5 plots the cumulative distribution of these estimates, while Table 9 reports how these  $\delta_{i,n(k)}$  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 7.d and the lower inaction rates for informed agents in Table 3.b. In short, 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.

### 5.3 Model performance

#### 5.3.1 In-sample validation

**Take-up rates** We use a comparative statics exercise to identify the respective contributions to the take-up rates of (i) the pure model-based predictions and (ii) the model augmented with informational and status-quo biases. Toward this purpose, the pure theoretical discrete choice model where the sign of welfare gradients entirely determines binary take-up probabilities is obtained by setting  $(\lambda_{v,n}, \delta_{i,n}) = (\infty, 0)$  and can be contrasted with the estimated model with biases  $(\lambda_{v,n}, \delta_{i,n})$  set at values in Table 7 in the context of the scenarios presented to respondents which varied the pricing of each product.

The results in Table 10 confirm that the pure model-based specification in column c performs well in explaining the low demand for annuities, LTCI and reverse mortgage. Compared to the observed take-up rates in the data (column a), the puzzles are much less salient with predicted

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<sup>57</sup>We can retrieve product specific individual fixed effects  $\delta_{i,n(k)}$  using within differences. Note first that:

$$\bar{g}_{i,n(k)} = -\delta_{i,n(k)} + \lambda_{v,n(k)} \bar{V}_{i,n(k)}(\theta)$$

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

$$\hat{\delta}_{i,n(k)} = -(\bar{g}_{i,n(k)} - \hat{\lambda}_{v,n(k)} \bar{V}_{i,n(k)}(\hat{\theta})).$$

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.

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  $\lambda_{v,n}$ , and (ii) systemic deviations related to preference for status-quo identified by  $\delta_{i,n}$ . Indeed, the estimated model allowing the latter in column b performs very well in reproducing the data in column a.

**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 10 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. However, in the absence of biases, both elasticities are much larger in magnitude compared to observed ones. Reintroducing informational and behavioural deviations dampens responses and produces lower elasticities that are better aligned with observed values.

**Parametric estimation biases and decision biases links** The overarching message from the in-sample validation exercise is that both (i) low estimated risk aversion ( $\tilde{\gamma} = 0.561$ ) and (ii) significant informational  $\lambda_{i,n}$  and status-quo biases  $\delta_{i,n}$  are required to explain both the observed take-up rates, and their responsiveness to variations in price and benefits. These results accord with the findings of Handel and Kolstad (2015) who argue that *not* accounting for behavioral biases (as typically the case in the Revealed Preference literature) leads to significantly *higher* risk aversion estimates.<sup>58</sup> Equivalently, our low estimates for risk aversion are consistent with the important dampening role of informational and status-quo biases in take-up rates and elasticities that are typically abstracted from in the literature.

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<sup>58</sup>Handel and Kolstad (2015, Tab. 4, p. 2484) report an average CARA parameter  $\mu_\gamma = 1.6\text{e-}03$  in base scenario (column 1),  $2.3\text{e-}04$  in base + inertia (column 2) and  $8.6\text{e-}05$  in full model with inertia, hassle costs and informational biases (column 3). Consequently, the ratios of CARA coefficients (also equal to the ratios of CRRA parameters) are 6.96 times higher when inertia is unaccounted for and 18.60 times higher when inertia and informational biases are omitted.

### 5.3.2 Out-of-sample validation

We complete our model validation by performing an out-of-sample exercise to assess the model’s ability to reproduce asset decumulation survey data not used in the estimation. More precisely, we close down the risk management instruments and gauge our framework’s capacity to replicate the self-assessed probabilities of having exhausted all financial wealth by the time that respondents reach age 85. For each of the 1,370 persons who provided a probability for this question (asked prior to being presented with scenarios), we use their initial health and socio-economic data to simulate the financial paths predicted by the model and compute the share with zero or negative wealth at age 85. Contrasting the sample statistics (panel a) and coefficients on socio-economic regressors (panel b) of the Data (first column) and Simulated (second column) in Table 11 provides unambiguous evidence of the model adequacy; both the distribution, and socio-economic gradients of wealth decumulation are very well replicated. Equivalently, the preference parameters consistent with explicit risk management choices are also consistent with households’ implicit asset decumulation strategies.

**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 rate, and 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 addition of informational and behavioural biases linked to inertia is required to align both take-up rates levels and elasticities to the data and warrants our finding of lower risk aversion, and (iv) the model performs very well in replicating both in-sample risk management data and out-of-sample asset decumulation data.

## 6 Implications for low risk management take-up rates

To better understand of the implications of our results for households’ demand for longevity, health, and housing risk management products, we rely on a comparative statics exercise whereby we (i) abstract from all informational as well as status-quo biases, and (ii) impose fair pricing at the

respondent level to gauge the demand for the three products in an idealized setting.<sup>59</sup> The take-up rates from the comparative statics exercise are reported in Table 12. Observe that because prices used in the experiment spanned below and above market prices and were therefore not necessarily fair at the individual level, the baseline optimal take-up of the three products differs from the ones reported in Table 10, column c. Indeed, the optimal take-up of fairly-priced annuities is 28.1% (vs 34.6%), that of LTCI is 16.6% (vs 33.1%) and that of reverse mortgages is 63.4% (vs 31.2%), suggesting that the price/benefits combinations in the experiment were more advantageous than fair for ANN and LTCI, and less advantageous than fair for RMR. An important finding is that optimal demand remains well below 100% at fair prices. We now investigate the reasons for this lack of interest.

## 6.1 Role of preferences

**Risk aversion and elasticity of inter-temporal substitution** Risk aversion affects risk management and asset decumulation strategies through three different channels. First, it determines the demand for market-provided insurance against longevity, medical expenditures and housing price risks (insurance channel). Second, it determines the degree of relative prudence (Kimball, 1990) and therefore the demand for precautionary financial and housing wealth reserves (precautionary wealth channel). Third, the elasticity of inter-temporal substitution, i.e. the inverse of the risk-aversion coefficient in VNM settings with iso-elastic preferences, governs the dynamic reallocation of consumption following changes in asset returns (EIS channel).

The low RRA ( $\gamma = 0.459 \implies \tilde{\gamma} = 0.561$ ) and high EIS ( $1/\tilde{\gamma} = 1.784$ ) we estimate in Table 7.a are both consistent with low take-up rates for the three risk management products.<sup>60</sup> First, the insurance channel motives are limited, and warrant a low demand for insurance against longevity (procured by ANN), medical expenditures (procured by LTCI) and downward house price

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<sup>59</sup>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). Respondent-level fair pricing is discussed in Appendix E.

<sup>60</sup>The low subjective discount rate we calibrate ( $-\log(\beta) = 0.03$ ) is also 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.

(procured by RMR) risks. Second, a low precautionary wealth motive should favor liquidation through annuities and reverse mortgages. However, these effects are offset by the high EIS channel which implies dominance of substitution over income effects. An increased marginal propensity to save is induced by the large returns to housing and goes against liquidation instruments for financial (via annuities) and residential wealth (via reverse mortgages). These three channels can be highlighted further by increasing the curvature parameter to  $\gamma = 3.0$  corresponding to a RRA  $\tilde{\gamma} = 2.624$  and a lower EIS  $1/\tilde{\gamma} = 0.381$ , both levels frequently advocated in the Revealed Preference literature (see Table 8.b). As expected, high risk aversion in row 1 of Table 12.a induces a sharp increase in the demand for LTC insurance (from 0.166 to 0.973). The demand for insurance against longevity procured by ANN also increases (from 0.281 to 0.459), however that movement is mitigated by more demand for precautionary wealth reserves which goes against annuitization of financial wealth. Similarly, high risk aversion goes against the liquidation of precautionary housing wealth capital through reverse mortgages and cause the demand for RMR to collapse (from 0.634 to 0.030). This potent precautionary wealth channel more than offsets the low EIS channel whereby the prevalence of income over substitution effects following the large gains in returns induce more demand for asset liquidation.

**Health-dependent preferences** Recall from Table 7.b that, relative to being healthy ( $\nu_{c,1} \equiv 1.0$ ), detrimental health states significantly lower the marginal utility of consumption, and consequently the marginal value of payments received in low ( $\nu_{c,2} = 0.235$ ), and in high ( $\nu_{c,3} = 0.043$ ) ADL limitation statuses. These discounts significantly lower the attractiveness of both annuities (payouts in all alive states) and of LTCI (payouts in high-ADL states only). Indeed, removing state-dependent utility ( $\nu_{c,s} \equiv 1, \forall s$ ) in row 2 of Table 12.a induces large increases in the demand for both annuities and LTCI in particular. In contrast, the demand for liquidating house capital through RMR falls when the expected value of future disposable resources in non-healthy states increases.

**Preferences for housing** Third, recall from Table 7.c that the unit elasticity of substitution between housing and consumption and lower utility weight of housing ( $1 - \rho = 0.188$ ) implies that

home-owners can smoothly adjust housing position in function of personal needs and changing spreads between financial vs residential returns. This flexibility contributes to maintaining home ownership for precautionary wealth motives and induces a low demand for asset liquidation through ANN and for insurance by LTCI. Removing utilitarian services from housing ( $\rho = 1, \nu_h = 0$ ) in row 3 of Table 12.a is equivalent to imposing perfect substitution between financial and residential wealth.<sup>61</sup> This further lowers the demand for stable net income provided by annuities and LTCI in order to guarantee home ownership. Similarly, the demand for RMR, which allows house-rich and cash-poor households to tap into house equity without leaving their house, evaporates when housing utility services are shut down.

**Bequest motivations** It will be recalled from Table 7.d that we estimated a sizeable bequest motive (corresponding to bequeathed share of wealth  $\tilde{b} = 0.138$ ). High intended bequests increase the need to (i) accumulate and (ii) insure bequeathed wealth reserves against fluctuations in asset and house values. However, the large bequest curvature parameter  $\kappa = 119.5$  also indicates that bequests are a luxury good, that is, the motivation is operational only for the richer households, and also for those with lower aversion to bequests risk. Removing the bequest motives (by setting  $b = \kappa = 0$ ) in row 4 of Table 12.a therefore has a very moderate impact on take-up rates. It slightly decreases the demand for stable disposable income provided by annuities and insurance for long-term care risks, and moderately increases demand for RMR to liquidate house equity instead of setting it aside for heirs.

## 6.2 Other contributing factors

**Public insurance and LTC expenditures** Removing the state-provided resource floor entails both a risk and a wealth effect. First, households are exposed to greater downside risk in consumption. Second, they also are poorer having lost free claims (conditional on the tax structure) to guaranteed income in low revenue and/or high medical expenditure states. Row 5 of Table 12, panel b reveals that the additional risk in net revenues justifies a demand for net income insurance

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<sup>61</sup>See Kojien et al. (2016) for an application on annuities and LTCI with perfect substitutability between bonds and housing capital.

provided by annuities, as well as by LTCI, consistent with Pauly (1990) on the substitutability between private and public LTC insurance, whereas reverse mortgages are unaffected. Conversely, removing long-term care expenditure risk in row 6 of Table 12.b naturally eliminates the demand for LTCI. It also implies an increase in the net present value of disposable pension income that is converted to annuities, and it lowers the demand for RMR. 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 richer, and has fewer incentives to co-insure herself (resp. spouse) from the spouse’s (resp. own) medical expenditure risk. In row 7 of Table 12.b, the demand for LTCI in particular and for RMR thus falls sharply, whereas the windfall in transferred wealth is annuitized. This implies that there is a substantial motive for couples to insure the surviving spouse from the financial risk associated with long-term care expenditures. Indeed, the declining marginal utility of consumption in poor health implies low demand for own LTCI among singles. But for couples, the marginal utility of consumption for the surviving spouse is much higher in the future if the individual spends down financial wealth to pay for long-term care services. De Nardi et al. (2021) also find that spousal co-insurance and bequest motives are particularly relevant for slow asset decumulation

**Biased expectations** Recall from Figure 1 that respondents tend to be over-optimistic with respect to both their own and their spouse’s longevity. Removing these biases in row 8 of Table 12.c is thus tantamount to shortening people’s expected lifespans. Lower life expectancy significantly reduces the attractiveness of both annuities and LTCI, since the individual is more likely to die faster and before reaching a deteriorated health state. Conversely, a ‘live fast and die young’ strategy, of high short-term consumption in the face of shorter longevity, is warranted by the high elasticity of inter-temporal substitution ( $1/\tilde{\gamma} = 1.78$  in Table 7.a) and the demand for RMR increases.<sup>62</sup>

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<sup>62</sup>See Hugonnier et al. (2013, 2022) for theoretical links between mortality risks, the EIS and the marginal propensity to consume. Our results are in contrast to O’Dea and Sturrock (2023) who finds for the U.K. that pessimism explains



Since it is fairly-priced based on objective agent-specific risk, why does the demand for annuities collapse when we remove biases in survival expectations? Based on insights from Davidoff et al. (2005), one might expect a 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 people are 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 and use financial wealth as a buffer, instead of investing in annuities. If one eliminates house price returns and other explanations, 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, and when housing provides direct utilitarian services that are absent in other assets. Annuities are not unambiguously superior in this setting, even under fair pricing.

An additional subjective bias concerns house price appreciation, subject to overly pessimistic forecasts by our respondents (Figure 2). Removing these biases in row 9 of Table 12.c results in more robust expected house price increases, and therefore to an increase in net worth. Richer households convert this additional wealth into more annuities and also demand more of the relatively expensive LTCI coverage. Conversely, we predict a strong decline in the demand for RMR which is unsurprising, since its value is equivalent to that of a put option with positive value only when house price are expected to decrease (Davidoff, 2015).

### 6.3 Product bundling

The risk management scenarios presented in the survey, as well as in the model, were evaluated independently of each other: that is, 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 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.

given the way these products are typically presented to retirees. On 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 and using actuarially fair prices, and abstracting from informational and status-quo biases.<sup>63</sup> Table 13 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 annuity purchases would rise the most with a near doubling of total demand (28.6% to 51.8%), whereas the total demand for LTCI and RMR are only slightly affected. Panel b reveals that the key driver of 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 if offered an ANN-RMR basket which allows them to use the cash proceeds from reverse mortgages to top-up insufficient pension claims via additional annuity purchases, rather than for consumption purposes. This preference for bundling accords with the arguments of Ameriks et al. (2011), Koijen et al. (2016), Cocco and Lopes (2020) on the importance of complementarity and substitutability between risk management products.

## 7 Conclusion

Determining the optimal depletion rate for financial and residential assets during retirement and the best way of handling risk management requires complex decision making. Indeed, older persons face age-increasing disability, rising mortality risk and 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 precautionary wealth reserves. Annuities insure against the risk of outliving one's assets, long-term care insurance protects against high

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<sup>63</sup>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 actuarially-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.

medical expenses associated with disability, and reverse mortgage allow cash-poor and house-rich households to tap into residential equity, while remaining in house and hedge downward house price 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 product choices. This model was structurally estimated using a novel stated-preferences experiment involving a large sample of newly-retired Canadian respondents. Our empirical strategy allows us to systematically review the role of preferences, bequests, health shocks and housing, household composition, biased expectations and behavioural information and status-quo biases in rationalizing the puzzles.

In the absence of biases, our model goes a long way towards that objective. 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. Our main findings confirm that low risk aversion rationalizes a low demand for insurance against longevity, disability and housing risks provided by annuities and long-term care insurance. The high implied elasticity of inter-temporal substitution also justifies a low appetite for liquidation through annuities and RMR in the face of increasing returns to housing. Health shocks strongly discount consumption utility (and therefore the marginal value of LTC insurance payouts) in disability states. Removing couples from the equation leads to sharp declines in demand for co-insurance procured by annuities and LTCL. Housing is found to be relatively substitutable with consumption, and facilitates liquidation of housing wealth reserves in case of need, instead of using RMR to remain in one's house. Finally, bequests motives were found to be significant. However, since they are a luxury good, they have a limited incidence except for the richest. A final experiment highlights the potential for products bundling; when offered jointly with other products, the demand for annuities nearly doubles, relative to separate choices, suggesting the importance of complex substitution and complementarity issues.

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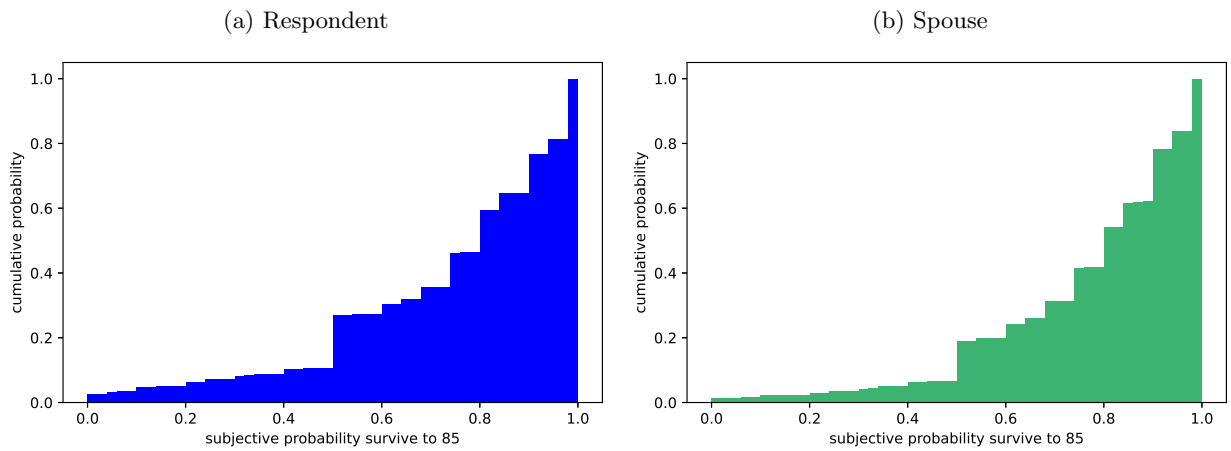
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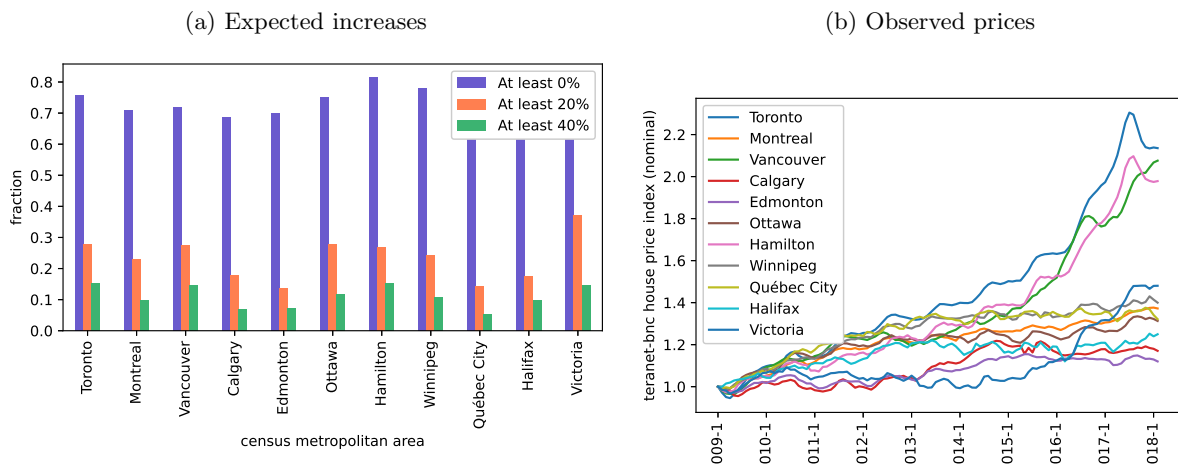
# Figures

Figure 1: Subjective survival probabilities



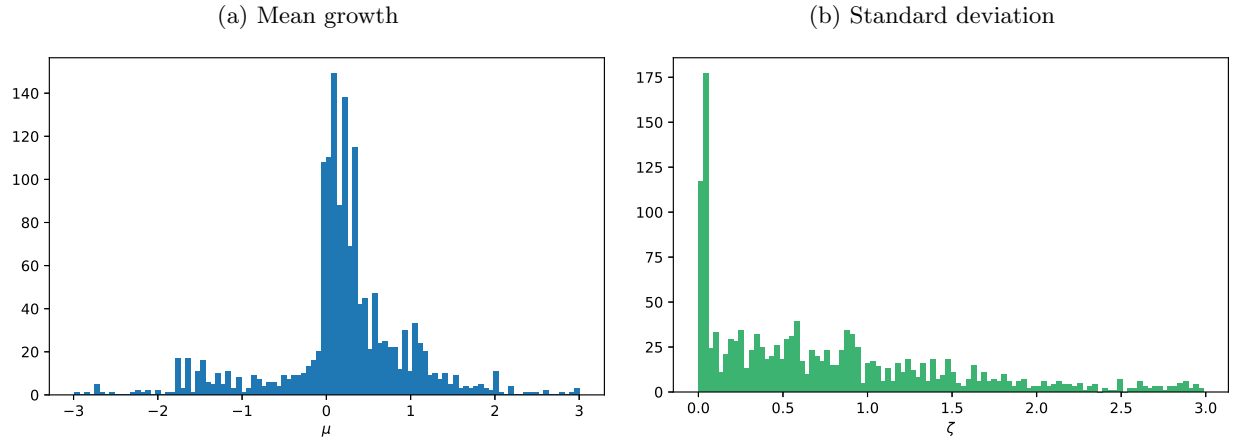
Notes: Cumulative distribution of subjective probability beliefs of surviving up to age 85.

Figure 2: Subjective expectations and observed home prices



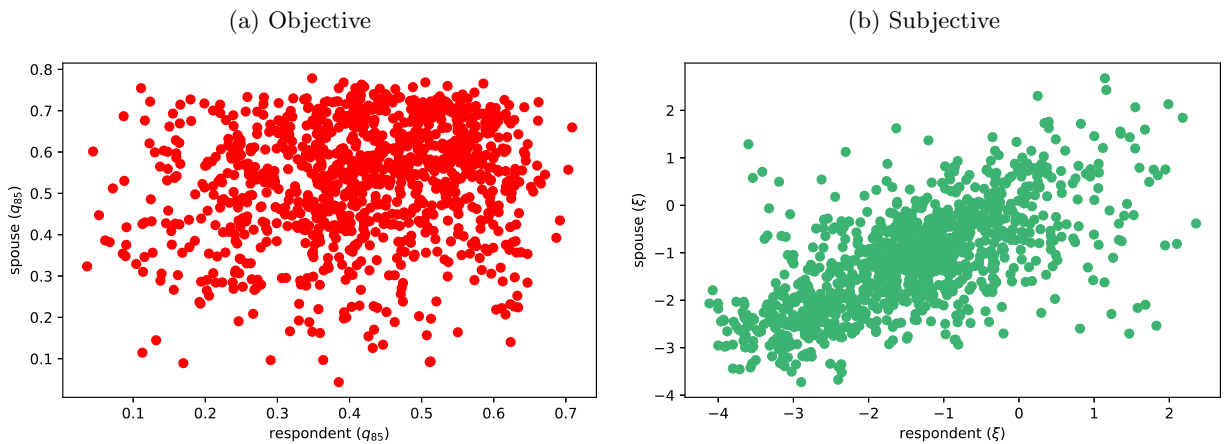
Notes: (a) Reported expected house price increases (in %) over the next 10 years, by CMA. (b) Observed home prices, source National Bank - TeraNet House Price Index by CMA (2009=1).

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



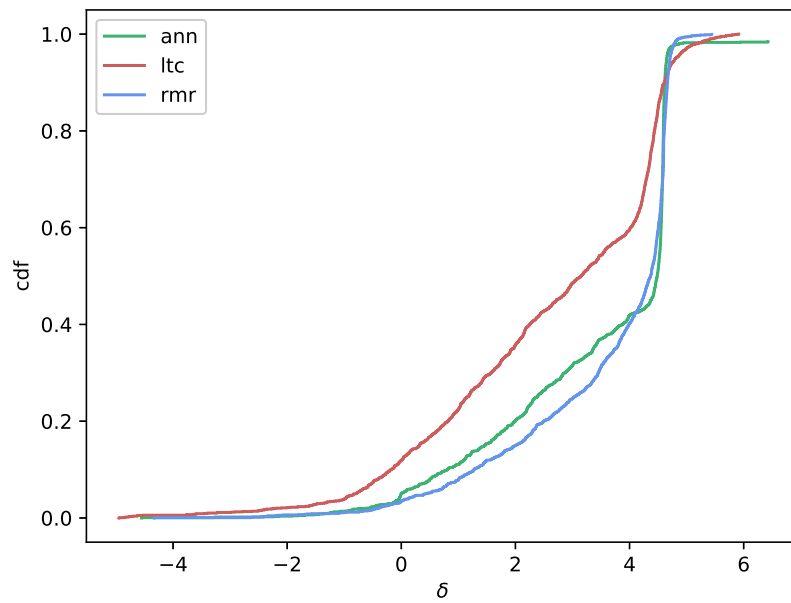
Notes: Panel a shows beliefs about price growth ( $\mu = 1$  is historical estimate) while panel b shows beliefs regarding the standard deviation of house price shocks ( $\zeta = 1$  is historical census metropolitan area (CMA) estimate). Outliers below -3 and above 3 are removed from figure.

Figure 4: Objective and subjective survival belief distributions



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  $\delta$  for each product



Notes: We report the empirical cumulative distribution of default bias estimates for each product (individual fixed effects  $\delta$ ), ann for annuities, ltc for long-term care insurance and rmr for reverse mortgages.

## Tables

Table 1: 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 homeowners age 60 to 70 at time of interview.

Table 2: Distribution of health status in the sample

Head $i$	Single	Spouse $j$		
		$G$	$\ell$	$L$
$G$	0.95	0.935	0.030	0.007
$\ell$	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,  $\ell$  some IADL limitations and most one ADL and  $L$  two or more ADL.

Table 3: 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 4: 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:			
$\omega^D$	(4)	Mortgage LTV	0.65
$\xi^D$	(4)	Mortgage amortization	0.9622
$\omega^R$	(6a)	Reverse mortgage LTV	0.55
$(\omega_1^h, \omega_2^h)$	(8b)	Owners credit limit	(0.65,0.80)
$\omega^r$	(8b)	Renters credit limit	0.3297
(c) Housing:			
$\phi$	(2b)	Rental price parameter	0.035
$(\tau_0^s, \tau_1^s)$	(5c)	Seller's moving costs	(1.50,0.05)
$(\tau_0^b, \tau_1^b)$	(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:			
$\beta$	(9a)	Subjective discount factor	0.97

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

Table 5: Annual medical expenses by health statuses and CMA.

	Health status		
	$G$	$\ell$	$L$
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
Qubec 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\$. Health status  $G$  refers to good health,  $\ell$  refers to some iADL limitations and  $L$  at least 2 ADL limitations.

Table 6: 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
Qubec 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 7: Non-linear least squares estimates

Parameter	Point estimate	Std. Err.
(a) Risk preference (9a)		
$\gamma$	0.459	0.026
$\Delta_\gamma$	0.018	1.987
(b) State-dependence (9b)		
$\nu_{c,1}$	1.000	—
$\nu_{c,2}$	0.235	0.075
$\nu_{c,3}$	0.043	0.079
(c) Housing (9b)		
$\rho$	0.812	0.024
$\nu_h$	0.312	0.021
$\Delta_{\nu^h}$	0.037	0.551
(d) Bequests (9d)		
$b$	0.343	0.074
$\Delta_b$	0.102	0.254
$\kappa$	119.5	0.156
(d) Info content utility gradients (12)		
$\lambda_{v,A(0)}$	0.013	0.004
$\lambda_{v,A(1)}$	0.013	0.010
$\lambda_{v,L(0)}$	0.141	0.023
$\lambda_{v,L(1)}$	0.148	0.021
$\lambda_{v,R(0)}$	0.021	0.005
$\lambda_{v,R(1)}$	0.033	0.004
within SSE	7904.1	

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

Table 8: Comparison with other preference parameter estimates/calibration

	Base		Housing		Bequests	
	Disc	RRA	$C$ share	EIaS	Share	Curv
This paper	$\beta$ 0.970	$\tilde{\gamma}$ 0.561	$\rho$ 0.812	1.000	$b^{1/(1-\gamma)}$ 0.138	$\kappa$ 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: The Arrow-Pratt RRA index is  $\tilde{\gamma} = (1 - \rho) + \gamma\rho = 0.561$  (see footnote 25). 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 9: Estimates of default biases by prior knowledge of the product

	Prior knowledge		$t$ -value
	No	Yes	
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 10: Take-up rates, price and benefits elasticities

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

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

Table 11: 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 age 85. At that point, we check whether financial wealth is less than 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 is the reference category) 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 12: Counter-factual optimal take-up at fair prices

Counter-factual	ANN	LTCl	RMR
Baseline fair prices	0.281	0.166	0.634
(a) Preferences			
1. High risk aversion	0.459	0.973	0.030
2. No health-dep. margin. utility	0.414	0.364	0.521
3. No preference for housing	0.228	0.120	0.291
4. No bequest motive	0.261	0.141	0.658
(b) Health and household composition			
5. Low resource floor	0.385	0.223	0.631
6. No medical expenditures	0.312	0.000	0.629
7. Singles	0.297	0.016	0.619
(c) Biased expectations			
8. No subj. survival expectations	0.025	0.005	0.668
9. No subj. house price expectations	0.335	0.352	0.081

Notes: Optimal take-up under different counter-factual scenarios, abstracting from informational and status-quo biases by setting  $(\lambda_{v,n(k)}, \delta_{i,n(k)}) = (\infty, 0)$  and calculated at agent-specific fair prices detailed in Appendix E. Respondents can partially insure (4 equally spaced coverage choices on the (0,1) interval). For annuities, this is the fraction of financial wealth annuitized. For LTCl, it is the fraction of nursing home expenditures insured against. For RMR, it is the fraction of home equity that can be taken as a RMR (maximum being 55% of home equity). Panel (a): 1. High risk aversion replaces estimated  $\gamma = 0.459$  with  $\gamma = 3.0$ . 2. Sets the marginal utility of consumption constant across health states  $\nu_{c,s} \equiv 1.0, \forall s$ . 3. Turn off the utility benefit of being a home owner  $\rho = 1, \nu_h = 0$ . 4. Removes bequest motives  $b = 0$ . Panel (b): 5. Shuts down the resource floor (set to  $X_{min} = 1.0$  to avoid zero or negative consumption). 6. Removes medical expenditures  $m_s = 0, \forall s$ . 7. Assumes all respondents are singles and transfers income from spouse to the respondent. Panel (c): 8. Removes biases in subjective survival expectations. 9. Removes biases in house price expectations.

Table 13: 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		
$\emptyset$	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.



## A Additional tables

Table A1: 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
$W_t^H - C_t^H$	$-P_t^R$	$-\tau_0^b - (1 - \omega^D + \tau_1^b)P_t^H$	$-\tau_0^s + (1 - \tau_1^s)P_t^H$	$-D_t(1 - \xi^D + r_d)$
$-MC_t$			$-D_t(1 + r_d) - P_t^R$	

Table A2: Net financial revenues

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

Table A3: 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 A4: 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
$\epsilon_t$	$E$	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).

## B Model Solution

Consistent with the timing of decisions in Table A3, we start at the last possible period of life and solve the model backwards (at which mortality rate approaches one). This is achieved by maximizing continuation utility (9) over consumption  $C_t$  and housing  $H_{t+1}$ , conditional on the 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  $H_t$ . At 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 us to compute the (indirect) utility gain from purchasing a particular product in a given scenario.

The relevant state-space discretization is summarized in Table A4. 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 scaled with the square root). Third, 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 process in (2) home price shocks  $\epsilon_t$  are taken from -2 to +2 standard deviations  $\sigma$  from mean  $g$  using the CMA-specific statistics in Table 6 and relying on distributional properties for the log-normal processes. Finally, consistent with the model, current home-owning status  $H_t$  is 0 for renters and 1 for owners.

Several elements contribute to make computation time a key issue in our setting. A large subset of deep parameters is not calibrated, but rather 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  $G, \ell$  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 five 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 to 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 three 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 each 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 three years is correct, we think that this approach strikes a good compromise between speed and accuracy.<sup>64</sup>

To solve for optimal consumption we use a grid search between values of 0 and  $C_{\max}$  in (8c). Although we tried 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  $(D_{t+1}, W_{t+1})$ .

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<sup>64</sup>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.

## C Expectations Modeling

### C.1 House Prices

Consider respondent  $i$  in CMA  $c$ . The annual (log) change in house prices  $\Delta p_t^H$  in CMA  $c$  is distributed with mean  $g_c$  and standard deviation  $\sigma_c$ . 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  $\sigma_{T,i} = \zeta_i \sigma_{T,c}$ . 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 Q23 of the survey, respondents report  $J$  analogs of these probabilities at thresholds  $(p_1, \dots, p_J)$ . 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  $(\mu_i, \zeta_i)$  for each respondents Formally, we use the estimator:

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

### C.2 Health Process

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

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

where  $i$  denotes the respondent,  $s$  the current state and  $s'$   $n$ -period ahead states. We obtain, for each respondent, estimates of the parameters  $\alpha_i, \delta_i$  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  $q_{it}^1$  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,  $\xi$  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  $\xi$  that matches the subjective beliefs for both the respondent and the spouse (if any). For respondents who do not report a valid probability (do not know or refuse to answer), we assume they have  $\xi = 0$ . A total of 8.6% of respondents and 9% of spouses are missing mortality expectations.

## D Estimator and Inference

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

Consider the non-linear least-square estimator:

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

The first-order conditions with respect to  $\theta$  and  $\lambda_v$  for this problem are given by:

$$\begin{aligned} \sum_i \sum_j \sum_{k:j(k)=j} \frac{\partial(\tilde{V}_{i,k}(\theta) - \bar{V}_{i,j}(\theta))}{\partial \theta} ((g_{i,k} - \bar{g}_{i,j}) - \lambda_{v,j}(\tilde{V}_{i,k}(\theta) - \bar{V}_{i,j}(\theta))) &= \mathbf{0}_J \\ \sum_i \sum_{k:j(k)=j} ((g_{i,k} - \bar{g}_{i,j}) - \lambda_{v,j}(\tilde{V}_{i,k}(\theta) - \bar{V}_{i,j}(\theta))) &= 0, \quad j = A, L, R. \end{aligned}$$

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  $\lambda_{v,j}(\theta)$  :

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

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

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

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

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

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  $\lambda_{v,j}$ ,  $j = A, L, R$ . 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:

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

## E Actuarially fair pricing

Our empirical strategies propose variations from fixed pricing for annuities, long-term care insurance and reverse mortgages, proxied by market prices set by Canadian providers of these products. In the comparative statics exercises of Table 12 we compute and compare experimental with actuarially fair prices described next.

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

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

where  $r$  is a constant interest rate and  $\tau^A$  is an 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 paid conditional on being in states  $(G, \ell)$ :

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

where  $\tau^L$  is the LTC insurance markup factor that equals 1 under fair pricing.

**Reverse mortgages** We follow Shao et al. (2019), Shao et al. (2015) and Nakajima (2012) in letting  $T^h \in [1, T]$  denote the stochastic (and endogenous) RMR termination date, i.e. when the house is sold and the amount in RMR is due. The reverse mortgage contract relies on the home-owning continuation probabilities  $q_{ij}^h$ , as well as corresponding survival (i.e. non-termination) up



to time  $t$  denoted  $S_{ijt}^h$  that both depends both 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  $L_{ijt}$  to the lender, as well as, any loss to RMR issuer  $l_{ijt}$ :

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

$$l_{ijt} = \max[L_{ijt} - P_t^H, 0],$$

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

$$\underbrace{E_0 \sum_{t=0}^T \exp(-rt) S_{ijt}^h (1 - q_{ijt}^h) l_{ijt}}_{\text{NNEG}} = \underbrace{\pi_{ij} \sum_{t=0}^T \exp(-rt) S_{ijt}^h L_{ijt}}_{\text{MIP}}.$$

Here  $E_0$  is with respect to housing prices, conditional on time-0 information. The RMR markup  $\tau^R$  applied on the premium  $\pi_{ij}$  is equal to one under fair pricing.

## F 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](mailto: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](mailto: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]
<b>GOVERNMENT TRANSFERS</b>	
▪ 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), <b>excluding</b> 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]
<b>GOVERNMENT TRANSFERS</b>	
<ul style="list-style-type: none"> <li>▪ OAS (Old Age Security), GIS (Guaranteed Income Supplement), Spouse’s Allowance</li> </ul>	[INSERT AMOUNT – RANGE \$0 TO \$50,000]
<ul style="list-style-type: none"> <li>▪ CPP (Canada Pension Plan) or QPP (Quebec Pension Plan)</li> </ul>	[INSERT AMOUNT – RANGE \$0 TO \$50,000]
<ul style="list-style-type: none"> <li>▪ Other transfers (e.g. workers’ compensation, Employment Insurance, or social assistance/welfare)</li> </ul>	[INSERT AMOUNT – RANGE \$0 TO \$50,000]
Workplace pension(s), <b>excluding</b> 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 (TFSA) 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:

$$\text{Age\_benefit} = (\text{QB}+1)$$

$$\text{Premium} = [0.2, 0.5] * \text{FinWealth}$$

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)

$$\text{Price} = [0.5, 0.75, 1.25, 1.5]$$

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):

$$\text{Benefit} = \text{Premium} \times (\text{Yield}/100) \times \text{Price}/12$$

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:

<i>When you buy the annuity</i>	<i>Starting at age [Age benefit]</i>
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==2,777777

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:

$$\text{Benefit\_ltc} = [2000,4000]$$

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):

$$\text{prem} = \text{EPremium} * \text{Load}$$

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...

<i>While healthy...</i>	<i>Once you have at least 2 limitations in your activities of daily living...</i>
You pay \$[prem] per month	You receive \$[Benefit_ltc] per month

\*\*\*\*\*

**“EPremium”**

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

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