Risky Insurance: Life-cycle Insurance Portfolio Choice with Incomplete Markets

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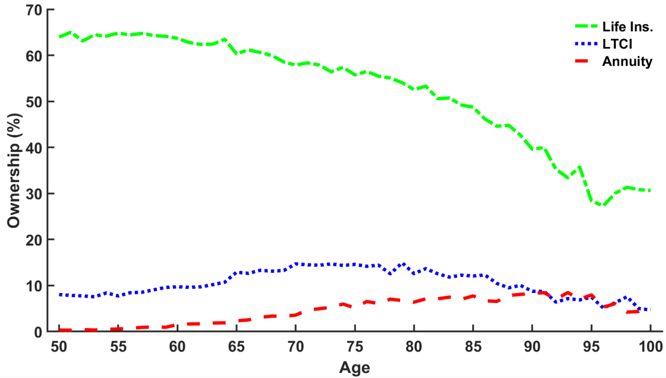
Note: Preliminary Results (active work in progress)

Background

- Despite significant financial risks and spending needs late in life, most people choose not to purchase insurance
  - Annuity and long-term care insurance (LTCI) are typically owned by less than 10 percent of older Americans



Background: Literature

Understanding consumer insurance demand has been the subject of a large body of research:

- **Annuities**: Yaari (1965); Brown (2001); Davidoff, Brown, Diamond (2005); Inkmann, Lopes, Michaelides (2011); Peijnenburg, Nijman, Werker (2016); etc.
- **Life Insurance**: Bernheim (1991); Chambers, Schlagenhauf, Young (2004); Inkmann, Michaelides (2012); Hong Rios-Rull (2012); etc.
- **LTCI**: Brown, Finkelstein (2008); Lockwood (2012); Ameriks, Briggs, Caplin, Shapiro, Tonetti (2018); Mommaerts (2016); etc.
- **Insurance Portfolio**: Hubener, Maurer, and Rogalla (2013); Koijen, Van Nieuwerburgh, Yogo (2016)

Many "puzzles." Generally find that consumer insurance holdings are suboptimal and suboptimal holdings impose large welfare costs

Background: Economic Forces

- Fact: Slow decrease in wealth at older ages (for those with wealth)
- Motive: Uncertain death timing
  - Don't want to run out of wealth if live longer than expected (consumption and bequests)
- Motive: Long-term-care Risks
  - Want to be able to fund high-quality care if needed
  - $\sim$ 1/3 of 65 year olds will enter nursing home; 1/6 will need help with ADLs for ≥ 3 years
  - Average cost at nursing home $\sim$ \$100K per year
- Environment (in U.S.):
  - Medicaid is means tested, limits private demand for insurance for lower wealth individuals
  - Most Americans already annuitized via Social Security (less replacement income for high-wealth individuals)
  - Insurance market with high loads, complicated contract structures, and quantity restrictions

Reasons to expect purchase of private insurance and reasons to expect no purchase. Function of preferences, states, and environment.

Existing Research Approaches

Typically, studies that use structural models take one of two approaches:

1. Introduce a one-time option to purchase a single state contingent asset (i.e., insurance) and compare demand to actual insurance holdings
2. Assume markets are complete and calculate life-cycle profiles of demand for state contingent assets

- Both typically model simple idealized insurance product (w/ load over actuarial ZP price)
- Such simple idealized products might not (be perceived to) be available in market
- Incomplete markets: Neither one-time purchase of single asset and nor complete markets are great representation of asset market available to consumers

Quote About Real-World Insurance

"There is really no mystery about [why people don't buy] long term health insurance. The reason it seems to defy reason is because your assumptions are flawed. .... My father had emphysema and the insurance company fought tooth and nail to prevent paying for years. ... And of course, only paying 50 to 80% of what they owed him. Not that they were stupid, but that they were greedy. If we believed they would pay what they should when they should, we'd buy. It's not what the odds are on that lottery ticket, it is what are the odds you'll get paid if you win." – Anonymous Reader

- Email I received in response to my previous research on long-term care risks
- Insurance in practice is often far from the simple state-contingent assets in many models

This Paper: Question and Research Design

Question: Are sub-optimal consumer choices or incomplete insurance markets the source of low demand and large welfare costs of late-in-life risks?

- In this paper we study demand for annuities, life insurance, and LTCI

Approach:

- New data:
  - Measured beliefs about nonpayment risk
- New model:
  - Life-cycle model of joint demand for insurance with exogenously incomplete markets
  - We model products as they are in the market and as they are perceived by consumers
  - Buy/Sell price wedges, nonpayment risk, quantity limits (age), aggregate risk

This Paper: Key Results

1. Perceived nonpayment risk is large in annuity, life insurance, and LTCI markets
2. Perceived nonpayment risk is predictive of actual insurance holdings
3. Nonpayment risk and buy/sell price wedges have large affect on insurance ownership
4. After accounting for nonpayment risk and other sources of incomplete markets, welfare costs associated with deviations from optimal insurance portfolios are much smaller

- **Incomplete markets and beliefs about nonpayment risks are important determinants of insurance holdings**
- **Measuring and modeling actual product features is important when studying consumer choices and welfare**

Literature

- **Demand for insurance products:** Koijen Van Nieuwerburgh Yogo (2016) and previously mentioned studies.
- **Choice in the presence of uninsurable risk and incomplete markets:** Storesletten Telmer Yaron (2007), Gomes Michaelides (2008), Guvenen (2009), Blundell Pistaferri Preston (2008), Heaton Lucas (2004), Fagereng Guiso Pistaferri (2016)
- **Trust, counterparty risk, and asset demand:** Guiso Sapienza Zingales (2008), Lopes Michaelides (2007), Pashchenko (2013), Jang Koo Park (2013), Fagereng Gottlieb Guiso (2016)
- **Subjective expectations and consumer financial behavior:** Manski (2004), Beshears Choi Laibson Madrian Zeldes (2014), Fuster Zafar (2018), Adelino Schoar Severino (2018)
- **Financial stability of insurance markets:** Merrill Nadauld Stulz Sherlund (2012), Becker Opp (2013), Becker Ivashina (2015), Ellul Jotikasthira Lundblad Wang (2015), Koijen Yogo (2015), Koijen Yogo (2016)

Koijen, Van Nieuwerburgh, Yogo (JF 2016): Insurance Portfolio Choice with Complete Markets

- Major advance in literature for studying portfolio choice instead of one asset at a time
- Represented optimal insurance in low-dimensional health and mortality deltas
- Welfare cost of suboptimal insurance holdings order of magnitude larger than underdiversification in stocks
- Differences in our approach and their approach
  - Utility functional form and parameter estimation
  - Incomplete markets
- Difference in findings
  - Prefs: Long-term-care risk is very important to consumers (Ameriks et. al. 2020, 2018)
  - Ownership: When products are not so good, people want to own less of them
  - Welfare: When products are not so good, welfare cost of not owning them is not so large

Overview

- Survey:
  - Survey Description
  - Survey Fielding Details
  - Overview of Results
  - Credibility
- Model
  - Model Description
  - Model Solution
  - Model Predicted Demand
  - Welfare Analysis

Survey Overview

- Insurance product ownership
- Nonpayment risk measures
  - Adapted from Luttmer-Samwick (2018)
  - Probability of full default on contract value
  - Distribution of annual payment
  - Repeat for different aggregate economic state
- Certainty equivalent measure
- Other supplementary measures

Survey Measurement

- Understanding America Study (UAS)
  - Internet panel run by team at USC Dornsife CESR
  - Representative of US population (sampling weights provided)
  - HRS modules (health/labor/income/wealth/etc.) recorded every two years
- Our module (UAS 118)
  - Fielded in May 2018
  - $\approx$ 45 questions
  - Average 16 minutes long
  - 1040 usable responses (82% response rate)

Survey Sample is Broadly Comparable to HRS

	HRS (1)	UAS (2)
Male	.47	.51
Age	59.2	61.4
Retired	.28	.36
Education		
High School	.46	.52
Some College	.29	.26
College & Above	.25	.18
Married	.69	.59
Race		
White	.75	.88
Black	.16	.09
Hispanic & other	.09	.04
Health		
Good	.72	.81
Bad	.24	.16
LTC	.04	.03
Income (K \$)	64	130
Wealth (K \$)	280	573
Insurance Ownership		
Annuity	.06	.11
Life Insurance	.61	.56
LTCI	.09	.11
N	10,234	1,040

Measuring Insurance Ownership

- For each insurance product, do you own it and if so how much does it promise to pay?
  - Measurement details differ for annuity, LI, and LTCI. Survey publicly available
  - We focus the survey on immediate annuities and whole life insurance
- For survey about nonpayment, we focus on largest policy owned for each type of insurance
- If respondent doesn't own a particular type of insurance, we ask them to imagine they owned the best product they think they could buy that promises to pay $X per payout
  - X randomized
- Summary: For each type of insurance each respondent has a product in mind that promises to pay a certain quantity per qualifying event

Measuring Nonpayment Risk - Full Default

Suppose that you own an annuity that promises to pay $5,000 each year for the rest of your life. Suppose further that you never trade this annuity for cash and hold the contract until the end of your life.

We are now interested in the percent chance that the annuity becomes worthless due to no fault of your own at any point before the end of your life. This means that the annuity permanently stops making payments. This might occur if the insurance company goes out of business, they claim you violated a clause in the contract, or they ruled the policy void for some other reason.

What is the percent chance this occurs?

100

Or type in:

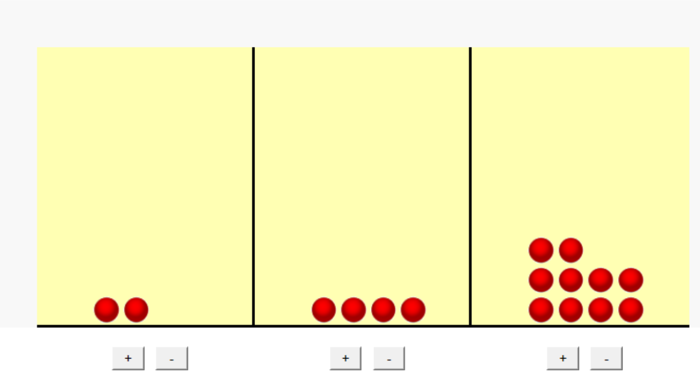
You think that there is a **0% chance** that the annuity becomes worthless at some point before the end of your life

Measuring Nonpayment Risk - Annual Payout Default (1/2)

Suppose that you own an annuity that promises to pay $24,000 each year for the rest of your life. We would now like to focus on what might happen just during the next calendar year.

You have been given 20 balls to put in the following bins. Each bin describes a scenario that involves the annuity payment that you are supposed to receive next year. The more likely you think a bin is, the more balls you should put in that bin.

What do you think will happen to the annuity payment next year?



I will receive no payment at all

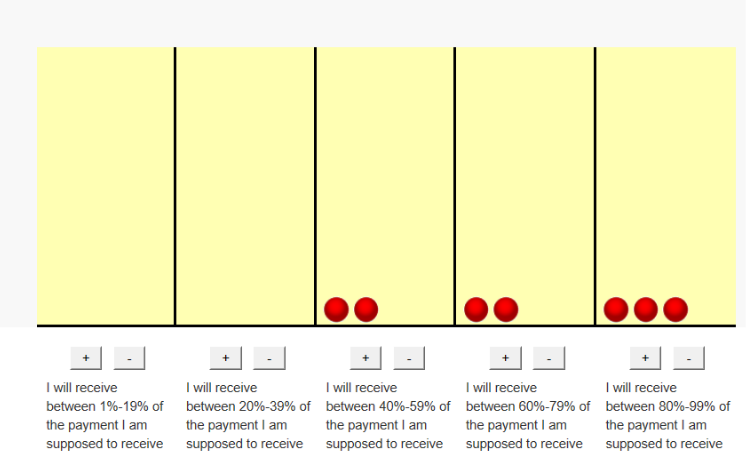
I will receive a payment less than I am supposed to receive

I will receive a payment at least as large as I am supposed to receive

Measuring Nonpayment Risk - Annual Payout Default (2/2)

You put 8 ball(s) in the bin marked "I will receive a payment less than I am supposed to receive." Please distribute those balls in the following bins. The more likely you think a bin is, the more balls you should put in that bin.

If you do receive a payment that is less than you are supposed to receive, how much do you think you would get?



Measuring Nonpayment Risk - Aggregate Risk Scenario

Suppose that you own an annuity that promises to pay $10,000 each year for the rest of your life.

Suppose that the stock market **decreases by 20%** next year.

We are now interested in the percent chance that during this next year the annuity becomes worthless due to no fault of your own. This means that the annuity permanently stops making payments. This might occur if the insurance company goes out of business, they claim you violated a clause in the contract, or they ruled the policy void for some other reason.

What is the percent chance this occurs?

0 **100**

Or type in: 25

You think that there is a **25% chance** that the annuity becomes worthless next year.

Measuring Certainty Equivalence

The way you put balls into various bins shows that you expect to receive about 83% of your annuity payment next year. It also shows that you could receive more or less than 83% of the promised payment.

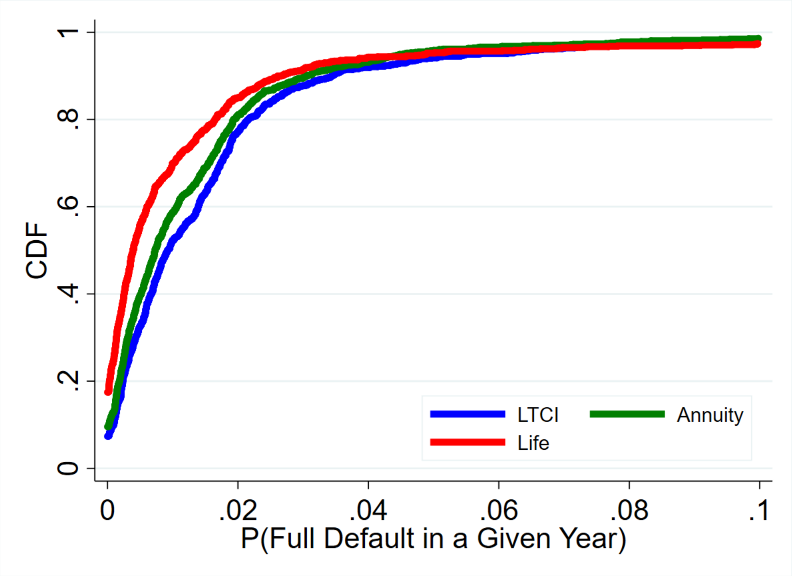
Let's call this distribution of possible payments, as described by you using the bins and balls, your "uncertain payments." So, your uncertain payments are whatever payments you think you might receive next year.

We are now interested in how you value having a contract with no uncertainty. Imagine a contract that is guaranteed to pay 62% of your annuity payment with no risk of the insurance company not paying out as promised. This is like having all 20 balls on this certain percentage. This contract is unbreakable and cannot be changed by anybody. This contract has no risk, but is guaranteed to pay less than the full promised amount of your original contract.

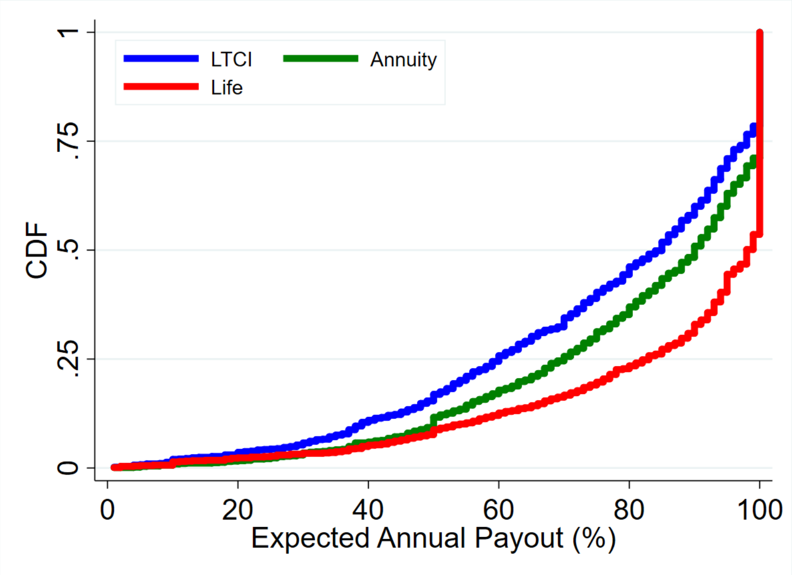
Would you rather have:

- ○ Guaranteed payment equal to 62% of the annuity payment you are supposed to receive
- ◉ Uncertain payments around an expectation of 83% of the annuity payment you are supposed to receive

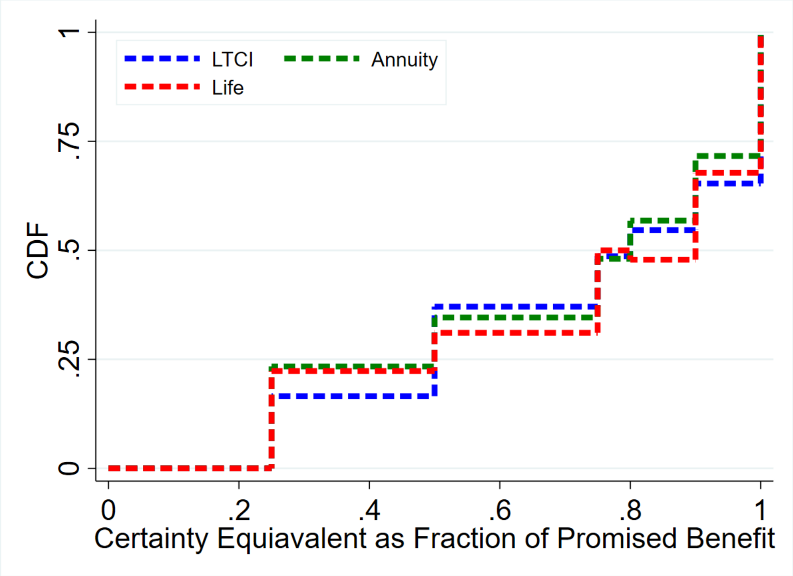
Distribution of Full Default Probability



Distribution of Expected Value of Annual Payments



Distribution of Certainty Equivalent Measures

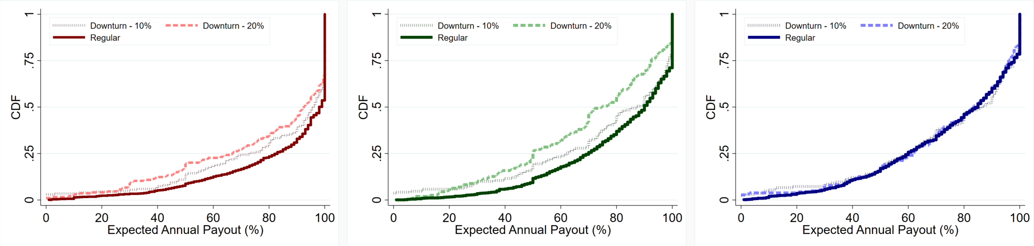


Average Expected Payouts, Certainty Equivalents, and Implied Risk Premia

	Population Mean Expected Value (1)	Population Mean Certainty Equivalent (2)	Risk Premia (3)
Life	87.16	81.43	5.72
Annuity	81.51	73.79	7.72
LTCI	76.17	72.90	3.27

Annuity and Life Expected Payouts Vary with Aggregate Risk, but LTCI Payouts Do Not

Life Annuity LTCI



Nonpayment Risk Measures Predict Insurance Ownership

	Own Annuity (1)	Own Life (2)	Own LTCI (3)	Own Annuity (4)	Own LIfe (5)	Own LTCI (6)
Annuity Payment Exp. Value	-0.0018			-0.0005		
	(0.212)			(0.373)		
Annuity Full Def. Prob	-0.0021***			-0.0020***		
	(0.000)			(0.000)		
Annuity Payment SD	-0.0043**			-0.0029***		
	(0.002)			(0.000)		
Life Payment Exp. Value		0.0046***			0.0045**	
		(0.001)			(0.003)	
Life Full Default Prob		-0.0015			-0.0013	
		(0.129)			(0.142)	
Life Payment SD		-0.0006			-0.0002	
		(0.686)			(0.896)	
LTCI Payment Exp. Value			0.0007			0.0006
			(0.111)			(0.181)
LTCI Full Default Prob			-0.0023***			-0.0022***
			(0.000)			(0.000)
LTCI Payment SD			-0.0009			-0.0010
			(0.195)			(0.136)
Trust				0.0188	-0.0063	0.0162
				(0.091)	(0.758)	(0.241)
Cognitive Score				-0.0007	-0.0033	0.0004
				(0.747)	(0.271)	(0.852)
Financial Literacy Score				-0.0112	-0.0662*	-0.0083
				(0.459)	(0.019)	(0.609)
Numeracy Score				-0.0079	0.0207	-0.0240
				(0.560)	(0.319)	(0.101)
Experienced Fraud				0.0298	0.0545	-0.0031
				(0.549)	(0.375)	(0.941)
Risk Aversion				-0.0072	-0.0160	-0.0015
				(0.252)	(0.072)	(0.776)
Propensity to Plan				0.0137	-0.0013	0.0016
				(0.243)	(0.947)	(0.888)
Early Stock Returns				0.1474	-0.5123	-0.7936
				(0.757)	(0.441)	(0.122)
N	1055	1046	1040	1055	1046	1040
R^2	0.170	0.132	0.129	0.268	0.218	0.179
Demographic Controls	Yes	Yes	Yes	Yes	Yes	Yes

p-values in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Extrapolation of Regression Suggests Nonpayment Risk Limits Market Size

Counterfactual Predictions of Probit Regressions Under Various Specifications of Risk Perception

			Maginal Effects, 1 Std. Dev. Increase		
	P(Own)	P(Own—No Risk)	Exp. Value	Full Default	Std. Dev.
	(1)	(2)	(3)	(4)	(5)
Annuity	.12	.24	-.010	-.017	-.030
Life	.57	.66	.111	-.042	-.010
LTCI	.10	.23	.039	-.046	-.003

Model Overview

Life-cycle, heterogeneous agent model where agents choose how much to:

- Consume (C_t)
- Save in one-period bonds (B_{t+1})
- Invest in insurance products (W_t^k)

subject to

- Liquid wealth (B_t)
- Insurance holdings (D_t^k)
- Income (Y_t)
- Age (t)
- Health status (s_t)
- Sex (f)
- Aggregate economic state (G_t)
- Government consumption floor (Tr_t)

Demographics

- Age:
  - $t = 45, ..., 100$
- Sex:
  - $f = 1$ if female
  - $f = 0$ if male
- Health:
  - $s = \{0, 1\}$ if {good,bad}
  - $s = 2$ if LTC
  - $s = 3$ if dead
  - Transition matrix $\Gamma_{t,f}$.
- Health cost shocks:
  - Transitory random variable $HC_{t,s,f}$
  - Significantly larger in LTC state

Preferences

- Households have health-state dependent non-homothetic preferences defined over a consumption good C_t and bequests b

$$V_t = \nu_s(C_t) + \beta \mathbb{E}\left[\nu_s(C_{t+1})\right]$$

$$\nu_s(C_t) = \frac{\theta_s}{1-\sigma}(C_t + \kappa_s)^{1-1/\sigma}$$

- Specification from Ameriks et. al. (JPE 2020)
- Key fucntional-form innovation is nonhomotheticity ($\kappa_2 \neq 0$) in long-term-care health state

Aggregate State, Bonds, and Income

- **Aggregate State**: $G \in \{0, 1\}$ evolves according to Markov matrix

$$G' \sim \Lambda_{|G}$$
$$\Lambda_{|G} = \begin{bmatrix} .5 & .5 \\ .8 & .2 \end{bmatrix}$$

- **Bonds**: Agents save in bonds (B_t) with interest rate (r_G) that varies with G

$$\begin{cases} r_0 & = .06 \quad \textit{if} \quad G = 0 \quad \text{(expansion)} \\ r_1 & = .02 \quad \textit{if} \quad G = 1 \quad \text{(recession)} \end{cases}$$

- **Income**: Y_t includes labor income, social security, and DB pensions.
    - Income is assumed to be deterministic and based on one of five income quintiles

Insurance Products: Introduction

- Three insurance products (indexed by k):
  - Life Annuities (ANN)
  - Life Insurance Policies (LI)
  - Long-Term Care Insurance ($LTCI$).
- Specifying $\bar{D}^k$ is a dividend vector for asset k, where row s is defined as the payout in state s:

$$
\begin{aligned}
\bar{D}^{Ann} &= [1, 1, 1, 0] \\
\bar{D}^{LI} &= [0, 0, 0, 1] \\
\bar{D}^{LTC} &= [0, 0, 1, 0].
\end{aligned}
$$

Insurance Products: Pricing and Dividends

- Insurance products are priced by a risk neutral insurance company as expected value of payments of one insurance unit:

$$p^k_{t_0,s_0,f,G_0} = \sum_{t=t_0+1}^{T} v'_{G_0} \Lambda^{t-t_0} \left[\frac{1}{(1+r_0)^{t-t_0}}, \frac{1}{(1+r_1)^{t-t_0}} \right]' \times v'_{s_0} \Gamma^{t-t_0}_{t,f} \left[\bar{D}^k \right]$$

  - v_{G_0}: 2 x 1 vector with one in row G_0, zero otherwise
  - v_{s_0}: 4 x 1 vector with one in row s_0, zero otherwise

- LI, ANN: insurance units paid for lump-sum; LTCI paid for with annual premium equaling some fraction Υ^{LTCI}_t of lifetime income
- Let D^k_t denote the number of units of product k the agent holds. Then the value of an agent's contract can be expressed as:

$$\begin{aligned} A^k_t(D^k_t) &= p^k_{t_0,s_0,f,G_0} D^k_t \\ D^{LIFE,ANN}_t &\in [0, \infty] \\ D^{LTCI}_t &\in \{0, H^{LTC}\} \end{aligned}$$

Insurance Products: Transactions

- W_t^k denotes net transactions in insurance product k.
- $\lambda_+^k(\lambda_-^k)$ denotes % transaction cost to buying (selling) product k.
- For LIFE and ANN, lump-sum cost is:

$$W_t^k p_{t,s,f,G}^k \left(1 - \lambda_-^k \mathbb{I}_{W_t^k<0} + \lambda_+^k \mathbb{I}_{W_t^k>0}\right)$$

- For LTCI, annual premium is constant fraction of income Υ_t:

$$\Upsilon_t^{LTCI} = \frac{W_t^{LTCI} p_{t,s,f,G}^{LTCI} \left(1 + \lambda_+^{LTCI} \mathbb{I}_{W_t^{LTCI}>0}\right)}{PDV(Y_t)}$$

  where $PDV(Y_t)$ is risk-neutral price of future claims of income, given Y_t.
- No new purchases after age $t^{max,k}$: $W_t^k \leq 0 \; if \;\; t > t^{max,k}$
- Can only purchase LTCI products at 5-year intervals and if $s \in \{0, 1\}$

Intertemporal Budget Constraints

- Insurance product k exhibits annual payout ($q^{k,D}$) and full default ($q^{k,FD}$) probabilities

$$D^k_{t+1} = \begin{cases} D^k_t + W^k_t & \textit{with prob} \quad 1 - q^{k,FD} \\ 0 & \textit{with prob} \quad q^{k,FD} \end{cases}$$

$$\hat{D}^k_{t+1} = \begin{cases} \bar{D}^k & \textit{with prob} \quad 1 - q^{k,D} \\ 0 & \textit{with prob} \quad q^{k,D} \end{cases}$$

- Bonds:

$$\begin{aligned} B_{t+1} =& (1+r)\left(B_t - C_t - \sum_{k \in ANN, LIFE} \left[W^k_t p^k_{t,s,f,G} \left(1 - \lambda^k_- \mathbb{I}_{W^k_t < 0} + \lambda^k_+ \mathbb{I}_{W^k_t > 0}\right)\right]\right) \\ &+ Y_{t+1}(1 - \Upsilon^{LTCI}_t) - HC_{t+1,s,f} + v'_{s_{t+1}} \sum_k D^k_{t+1} \hat{D}^k_{t+1} + Tr_{t+1} \end{aligned}$$

- No borrowing ($B_{t+1} \geq 0$) and no negative insurance holdings ($D^k_{t+1} \geq 0$)

Summary of Incomplete Market Features

- Nonpayment risk: $q^{k,FD} q^{k,D}$
- Maximum purchase age
- Price wedges: $\lambda_{+}^{k}, \lambda_{-}^{k}$
- Uninsurable medical expense: HC
- Uninsurable aggregate risk: r

Preliminary Calibration

Table 1: Baseline Calibration - Insurance products

	Annuities	Life	LTCI
Full Default ($q^{k,FD}$)	.018	.012	.023
Annual Payout Default ($q^{k,D}$)	.195	.128	.238
Price Wedge, buying (λ_+^k)	.2	.25	.32
Price Wedge, selling (λ_-^k)	.15	.25	-
Max Purchase age ($t^{max,k}$)	70	70	70

- Feed in measured values, as opposed to calibration to match insurance ownership
- $q^{k,FD}$, $q^{k,D}$: Original survey in this paper (average values)
- $\lambda_+^{ANN}, \lambda_+^{LTCI}$: Brown and Finkelstein (JEP 2011)
- λ_+^{LI}: Hong and Rios-Rull (AER 2012)
- $\lambda_-^{ANN}, \lambda_-^{LI}$: Industry Reports

Preliminary Calibration

Table 2: Baseline Calibration - Preferences

Time Preference - $\beta = .92$	**Risk Aversion** - $\sigma = 5.27$
Bequest motive - $\theta_3 = 1.09$	**Bequest motive** - $\kappa_3 = 7.83$
LTC motive - $\theta_2 = 0.67$	**LTC motive** - $\kappa_2 = -37.44$

- Ameriks et. al. (JPE 2020)
- Strategic Survey Questions + Wealth data (no insurance data)
- β still work in progress

Insurance Ownership: Model and Data

Preliminary Model Predictions

	No Insurance	Baseline	No Nonpayment Risk	No Price Wedges	No Price Wedges or Nonpayment Risk
A. *Insurance Ownership*					
Annuity	0	16%	51%	43%	53%
Life	0	39%	40%	52%	48%
LTCI	0	25%	36%	31%	40%
B. *Welfare Gains*					
Consumption Equivalent	0	0.8%	3.7%	2.9%	7.0%

- Real-world asset features have strong effect on ownership
    - especially for annuities and LTCI
- Welfare costs of "under-insurance" much smaller than complete market analysis suggests

Empirical Nonpayment Beliefs, but Payments Always Made

	No Insurance	Baseline	No Nonpayment Risk	No Price Wedges	No Price Wedges or Nonpayment Risk
B. *Welfare Gains*					
Consumption Equivalent	0	1.9%	3.7%	5.6%	7.0%

- Hold fixed empirical payment beliefs, change payouts in simulation
- Welfare Gains: Rational Expectations vs. Payments Always Made
  - Baseline: 1.9% vs. 0.8% — payouts are better than defaults
  - No Price Wedges/Agg Risk: 5.6% vs. 2.9%
- Incorrect beliefs would have large welfare costs: 3.7% vs. 1.9%
  - Even when all payments are made, only 1.9% welfare gain in baseline compared to 3.7% if beliefs correctly reflected zero non-payment risk

Conclusion

- Incomplete markets and perceived risks are important determinants of insurance holdings, and measuring and modeling actual product features is important when studying consumer choices and welfare
- Perceived nonpayment risk is large in annuity, life insurance, and LTCI markets
- Perceived nonpayment risk is highly predictive of actual insurance holdings
- After accounting for nonpayment risk and other sources of incomplete markets, welfare costs associated with deviations from optimal insurance portfolios are much smaller
- Valuable to study supply and demand of insurance products together, but deeper understanding of one side of the market valuable in and of itself