German Long-Term Health Insurance: Theory Meets Evidence

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Automobile vs. Health

(a) Automobile

(b) Health

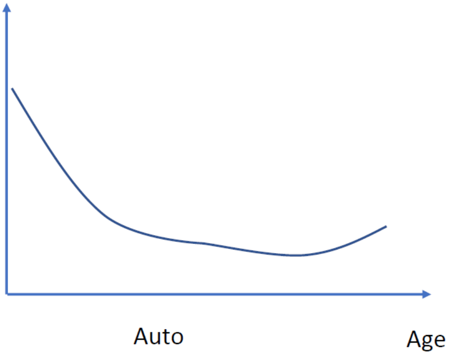
Automobile vs. Health Insurances: Similarities

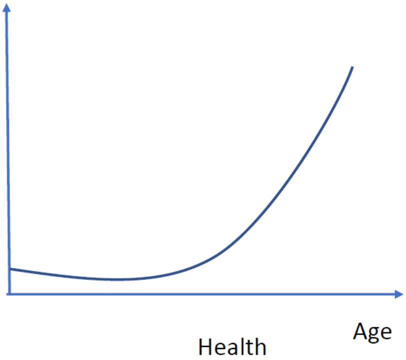
- **Cross-sectional heterogeneity in risk:** Large variations in risks across individuals;
- **Life-cycle heterogeneity in risk:** Predictable variations in risks over time;
- **Moral hazard:** Concern that insurance changes the "risk" realizations
- **Annual contracts:** Pricing of the contracts are annual; policyholders are subject to *reclassification risks*
- **Monitoring devices:** Health insurance: Health monitoring apps; automobile insurance: telematics; severe impacts from technological changes

Automobile vs. Health Insurances: Differences

- **Life cycle risk patterns differ:**
  - Health insurance: older folks have higher expected medical expenditures (though infant years have somewhat higher health expenditures as well);
  - Automobile insurance: From legal driving age onward, the risks decline and pick up at the very old age

Life Cycle Risk Profiles: Auto vs. Health





Automobile vs. Health Insurances: Differences

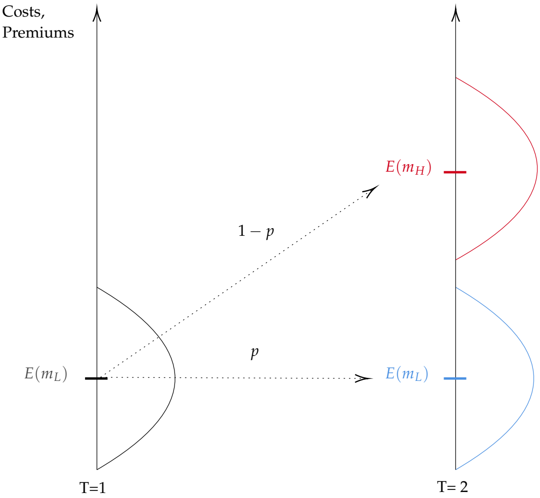
- **Outside options differ:** with automobiles, there is always an option of living without a car, and rely on public transportation, taxi, etc.; no such option with health.
- **Moral hazard differs:**
  - For health insurance, there are both ex ante (exercise, preventive care etc.), interim (expenditure conditional on being sick), and ex post (claims) moral hazard;
  - Both consumers and care providers have moral hazards;
  - For automobile insurance, ex ante moral hazard is the key.
- **Pricing regulations differ:** Health: community rating; Auto: Bonus-Malus
- Health insurance -¿ social insurance; auto insurance –¿ private insurance

Reclassification Risks in Health Insurance

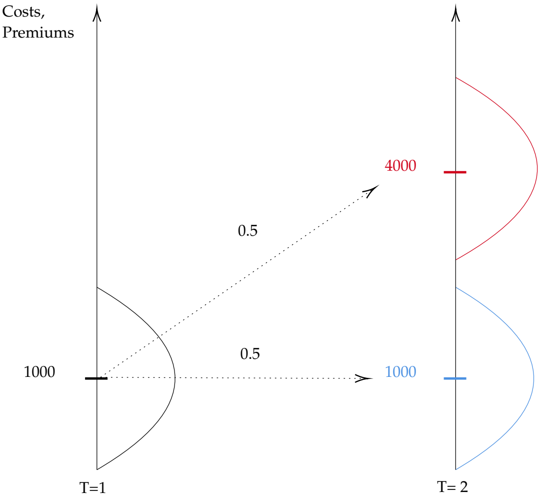
(a) 1982

(b) 2022

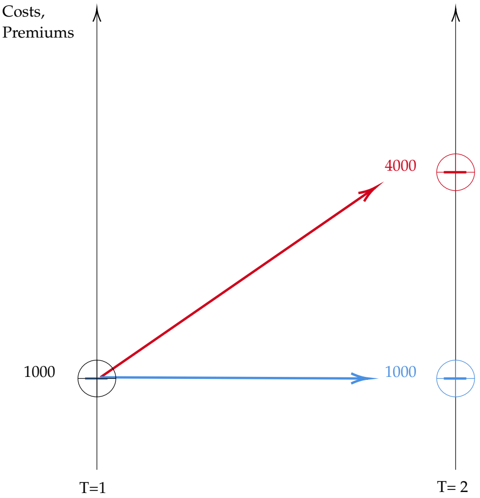
Basic Setup



Setup



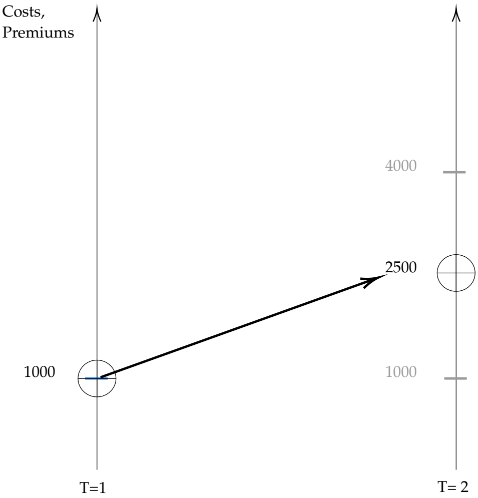
Reclassification Risk in Short Term Contracts



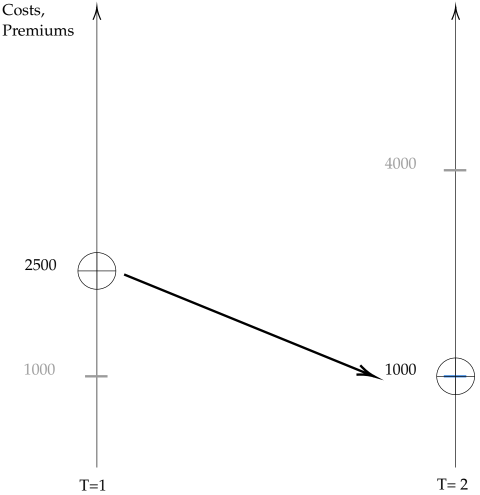
Introduction

- Health insurance contracts sold in the private market tend to be short term, typically annual.
- Short-term contracts expose policyholders to potentially large premium fluctuations, a.k.a. **reclassification risk** $\Rightarrow$ welfare losses (Diamond, 1992; Cochrane 1995).
- Options to regulate short-term health insurance: community-rated premiums and guaranteed issuance, e.g. in the ACA;
- Consequence: trade-off with *adverse selection*, requiring (controversial) remedies such as individual mandates or premium subsidies, or both.

Adverse Selection



Pauly et al. 1995



Zero Profit: $2500 - 1000 + 0.5 \times (1000 - 4000) = 0$

Introduction

- Long-term private health insurance: alternative to provide policyholders with reclassification risk insurance without adverse selection problems.
- LT contracts leverage individuals' private intertemporal incentives: individuals are willing to pay upfront to insure themselves against the reclassification risk, *via* **frontloaded premiums**.
- Carefully designed LT contract can reduce reclassification risk, while ensuring market participation and eliminating adverse selection (Pauly et al. 1995).

German LTHI

- Despite theoretical appeal, few real-world applications: Germany and Chile are the only two countries with active markets of LTHI contracts.
- German LTHI: largest and oldest individual private LTHI market in the world with 8.8M individuals (10% of pop.)
  - Certain groups (e.g., self-employed, Civil Servants and earners $>$€ $59K$): 44 private insurers.
  - Opting out of public option is a lifetime decision.
- Appealing features:
  - Stand-alone comprehensive insurance;
  - Pure financial contract (no differentiation in provider network across insurers or plans);
  - Simple pricing design.

This paper

- Present the main principles and functioning of GLTHI, formulate its theoretical foundations
- Leverage unique claims panel data and survey data to estimate key empirical inputs to assess the welfare.
- Compare welfare consequences of GLTHI to several benchmarks, including short term contracts and the optimal dynamic contract.

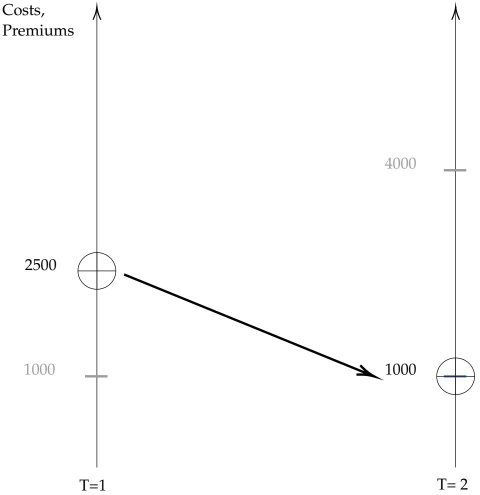
Private “GLTHI” Plans

- Medical underwriting at inception:
  - Risk-rated premiums.
  - Pre-existing condition clauses allowed (rare 1.6 %).
  - No guaranteed issue – coverage can be denied.
- In subsequent periods: **Principle of constant, guaranteed premium:**
  - Guaranteed renewability.
  - Premium increases community-rated at plan level.
- **One-sided commitment** (by insurer).

Modeling Premiums for the GLTHI (I)

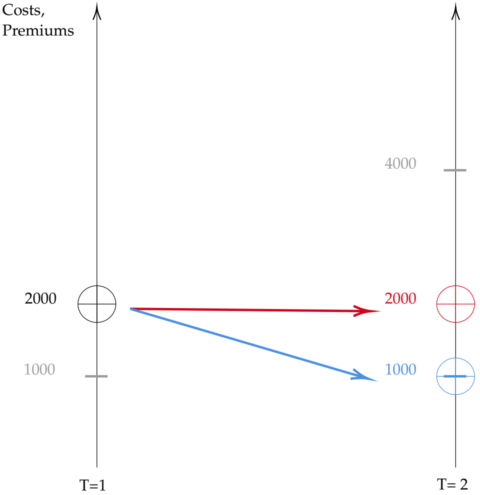
- At inception in t for risk type ξ_t: Offer is $P_t(\xi_t)$
  - $P_t(\xi_t)$ is the guaranteed premium for $t, ..., T$, regardless of future risk.
- $P_t(\xi_t)$ breaks even in expectation, given **endogenous lapsation**.
- Lapse in $\tau > t$ if (and only if) $P_\tau(\xi_\tau) < P_t(\xi_t)$ (symmetric learning).
  - Paid premiums *can only decrease* (when consumers lapse)

Pauly et. al (1995)



Zero Profit: $2500 - 1000 + 0.5 \times (1000 - 4000) = 0$

GLTHI



Zero Profit: $2000 - 1000 + 0.5 \times (2000 - 4000) = 0$

Modeling Premiums for the GLTHI (II)

- Lifetime premium offered in $t < T$ solves the zero-profit condition:

$$P_t(\xi_t) = \frac{E(m_t|\xi_t) + \sum_{\tau>t}^{T} \delta^{\tau-t} \sum_z E(m_\tau|z) \times p_\tau(z|\xi_t, \mathbf{P_{t+1}}, P_t(\xi_t))}{1 + \sum_{\tau>t}^{T} \delta^{\tau-t} \sum_z p_\tau(z|\xi_t, \mathbf{P_{t+1}}, P_t(\xi_t))}$$

- $E(m_\tau|z)$ expected claims given type z.
- $p_\tau(z|\xi_t, \mathbf{P_{t+1}}, P_t(\xi_t))$: probability that
  1. $\xi_\tau = z$ conditional on health state being ξ_t in period t;
  2. individual did not lapse (or die) between periods t and τ, given set of future premium guarantees $\mathbf{P}_{t+1}$.

- Fixed-point problem, solved by backwards induction, with

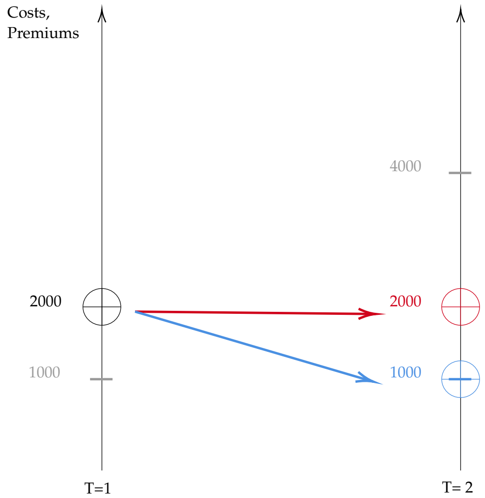
$$P_T(\xi_T) = E(m_T|\xi_T)$$

Optimal Contracts

- Optimal balance between reclass. risk and consumption smoothing (Harris and Holmstrom, 1982, Krueger and Uhlig, 2006, Ghili et al., 2020)
- Maximize lifetime expected utility s.t.
    - Break-even; one-sided commitment; symmetric learning; **no-borrowing constraints.**
- At inception in t: Offers a constant consumption guarantee $\bar{c}_t(\xi_t)$ for $t, ..., T$.
- Consumption "bumped up" at $\tau > t$ if $\bar{c}_t(\xi_t) < \bar{c}_\tau(\xi_\tau)$.
    - Consumption *can only increase*.
- Equivalent to GLTHI if income is constant over time.
- Requires knowledge of lifecycle income path.

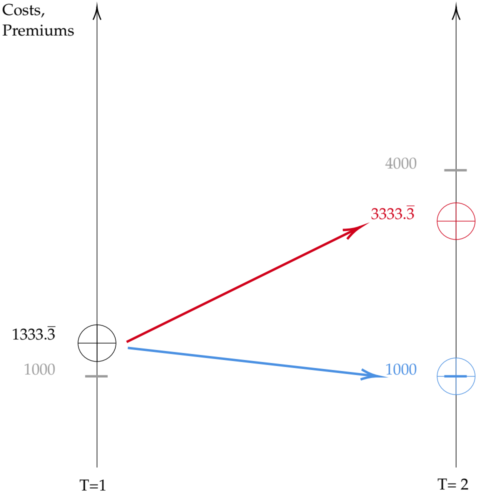
GHHW

GLTHI



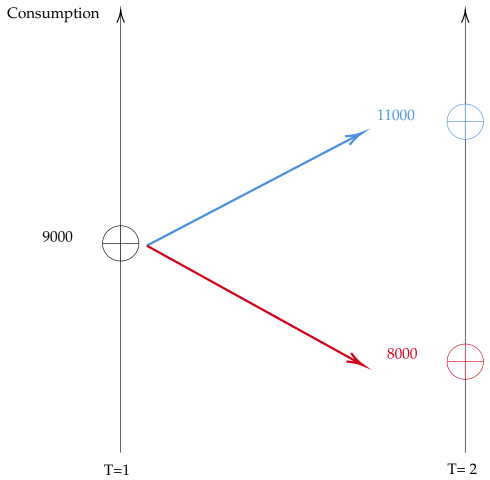
Zero Profit: $2000 - 1000 + 0.5 \times (2000 - 4000) = 0$

Optimal Contract, w/ $y_1 = 10,000$, $y_2 = 12,000$

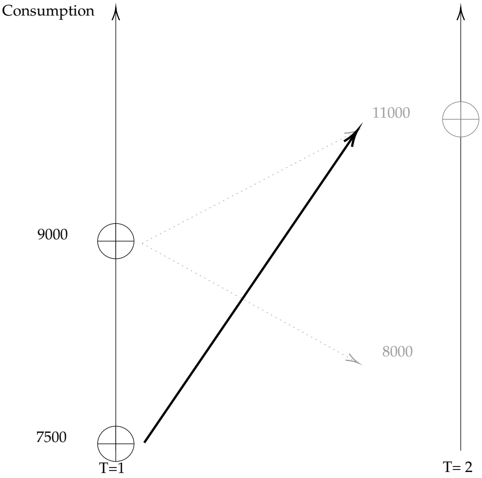


Zero Profit: $1333.\bar{3} - 1000 + 0.5 \times (3333.\bar{3} - 4000) = 0$

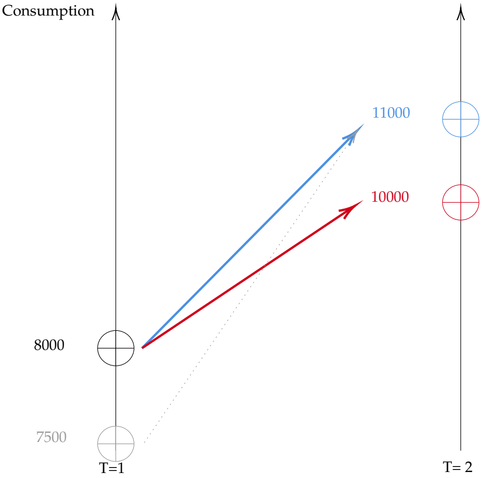
Short Term, w/ $y_1 = 10,000$, $y_2 = 12,000$



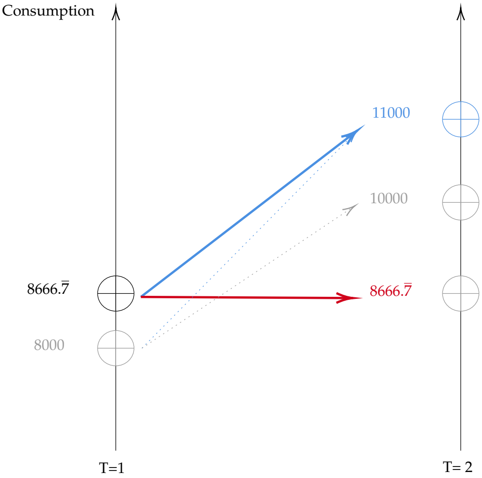
Pauly et al. (1995), w/ $y_1 = 10,000$, $y_2 = 12,000$



German Contracts, w/ $y_1 = 10,000$, $y_2 = 12,000$



Optimal Contract, w/ $y_1 = 10,000, y_2 = 12,000$



Estimation/Calibrations

Three key objects:

1. **Estimation: Dynamics in Risk and Expenditure**
   - Insurer claims data.
2. **Estimation: Life cycle income profiles**
   - Representative German household panel data (SOEP; 84-16):
3. **Calibration and Robustness Checks: Stable preferences**
   - CARA utility and discount factor (exponential discounting).

Claims Data

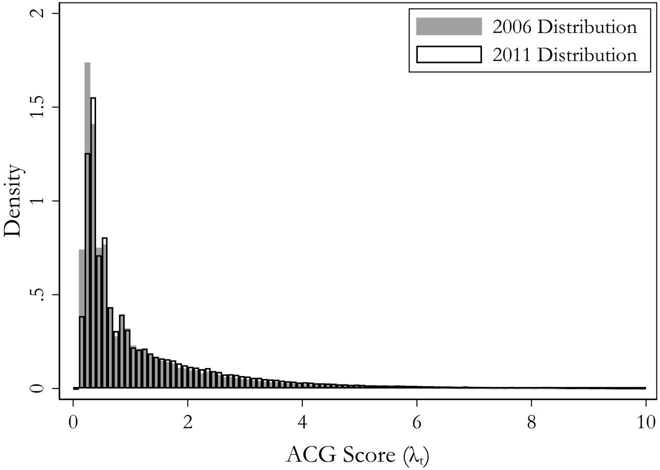
- Claims data from one of Germany's largest insurance companies
- 400,000 individuals covering 2005–2011:
  - **Personal characteristics** – age, sex, zip code, professional group.
  - **Plan parameters** – risk assessment, deductible, premium.
  - **Claims** – date, diagnosis, service type, amount.
  - **Mortality** – deaths are observed (and part of our model).
- Our insurer doubled the number of clients between the 1980s and 1990s and has thus a relatively young enrollee population, compared to all GLTHI enrollees. Still, there are individuals who
  - Have been clients for up to 86 years.
  - Have had the same plan for 40 years.

Modeling Health Risks

Three steps:

1. Generate health risk score for each person-year, based on claims, age, sex and pre-existing conditions; $\lambda_t^* \in [0, \infty)$: Adjusted Clinical Group (ACG) Software
2. Discretize health risk; $\left[\lambda_{t-n}^*, .., \lambda_t^*\right] \rightarrow \lambda_t \in \{1, ..., k\}$ **with a novel method**. Main purposes
   1. Model health dynamics in a parsimonious way.
   2. Capture degree of granularity in risk-rating used by actuaries.
3. Estimate $E(m_t | \underbrace{\lambda_t, Age_t}_{\equiv \xi_t})$ and $\Pr(\lambda_{t+1} | \underbrace{\lambda_t, Age_t}_{\equiv \xi_t})$ (not shown).

Distribution of ACG Health Risk Scores λ_t^*



Modeling Health Risks

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1. Generate health risk score for each person-year, based on claims, age, sex and pre-existing conditions; $\lambda_t^* \in [0, \infty)$: Adjusted Clinical Group (ACG) Software
2. Discretize health risk; $\left[\lambda_{t-n+1}^*, .., \lambda_t^*\right] \to \lambda_t \in \{1, ..., k\}$ **with a novel method**. Main purposes
   1. Model health dynamics in a parsimonious way.
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Modeling Health Risk

We propose a new method for discretizing health risk

$$[\lambda^*_{t-n}, .., \lambda^*_t] \to \lambda_t \in \{1, ..., k\}$$

Two steps, with following *guiding principles*

1. **Decide efficient partition** given k (and n). Finger (2006):
    1. *Homogeneity*: individuals in same risk category have similar risk;
    2. *Separation*: categories are sufficiently different in terms of expected claim to warrant distinct categories.

2. **Decide k (and n).**
    - *Parsimony*

Modeling Health Risk: Steps 1 and 2, more details

1. **Efficient cutoffs** (”given k”): For the case $n = 1$, solve (Finger, 2006),

$$\min_{c_1,\ldots,c_{k-1}} \sum_{g=1}^{k} \int_{\lambda^*=c_{g-1}}^{c_g} \int_{m=0}^{\infty} f\left(m,\lambda^*\right)\left(m - \mathbb{E}\left[m \mid c_{g-1} < \lambda^* < c_g\right]\right)^2 \mathrm{d}m\mathrm{d}\lambda^*$$

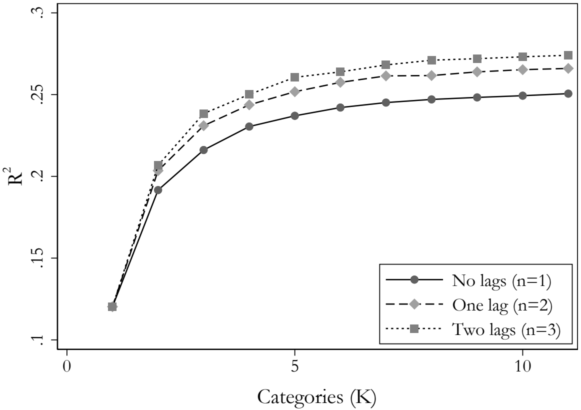
   where $f\left(m,\lambda^*\right)$ is the joint distribution of m and λ^*

   - optimal cutoffs **minimize the residual variations in health cost** not summarized in categories
   - We show it boils down to k-means clustering of λ^*

2. **Number of Partitions (k) and lags (n)**: No improvement in explanatory power of partition for $P_t(\xi_t)$ (at inception)

   - We find R^2 stabilizes at $k = 7$.

Choosing the Number of Categories and Lags (Step 2)

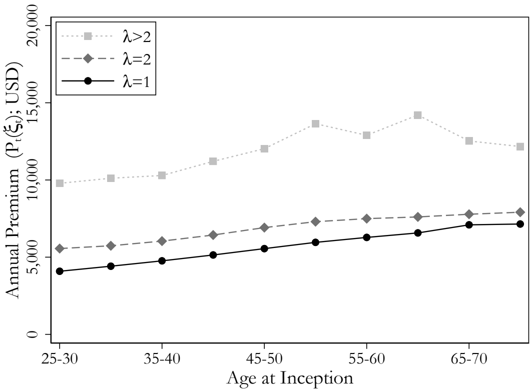


Transition of Health Risks: $\lambda_{t+1}|\lambda_t$

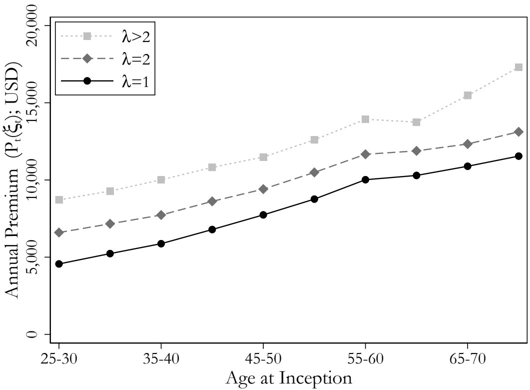
25–29 years old

Age	λ_t	λ_{t+1}							
		1	2	3	4	5	6	7	8 (†)
25-29	1	0.8907	0.1024	0.0047	0.0011	0.0004	0.0003	0.0001	0.0004
	2	0.3197	0.4257	0.2020	0.0432	0.0077	0.0011	0.0003	0.0003
	3	0.1242	0.2829	0.4104	0.1404	0.0378	0.0043	0.0000	0.0000
	4	0.0892	0.1688	0.2484	0.3917	0.0860	0.0159	0.0000	0.0000
	5	0.0938	0.1250	0.0625	0.3750	0.2917	0.0521	0.0000	0.0000
	6	0.0909	0.0000	0.0455	0.2273	0.3182	0.3182	0.0000	0.0000
	7	0.0000	0.0000	0.0002	0.0045	0.0240	0.1447	0.7619	0.0647

Calibrated versus Actual Premiums $P_t(\xi_t)$



(a) Calibrated



(b) Observed

Contract Terms at Inception at age 25

λ_{25}	1	2	3	4	5	6	7
%	89.11	10.25	0.47	0.11	0.04	0.03	0.00
Expected claims	1,473	3,559	6,019	9.302	14,600	24,554	54,930
	(a) GLTHI						
Premium	3,973	5,517	7,563	10,363	15,291	24,561	54,930
Frontloading	2,499	1,957	1,545	1,062	691	7	0

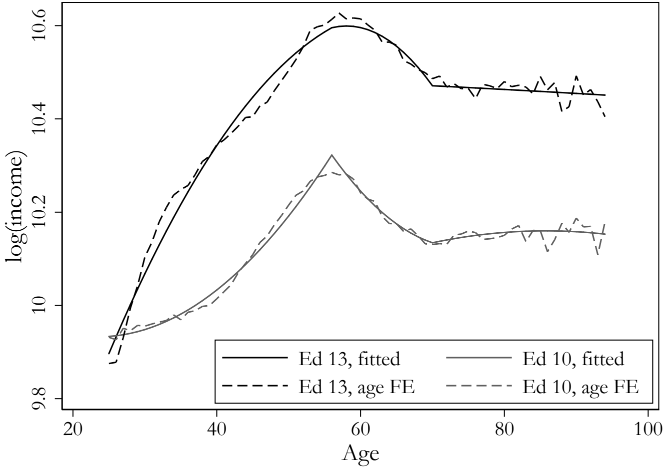
Modeling Income process

- Data: 84-06 German SOEP
- We consider all sources of income beyond wages: equivalized post-tax post-transfer annual income.
- We estimate the following individual fixed effects model for 2 education groups:

$$log(y_{it}) = \theta_i + f(age_{it}) + \epsilon_{it} \tag{1}$$

  - where: y_{it} stands for our income measure in 2016 U.S. dollars in year t for individual i.
  - θ_i are individual fixed effects.
  - The flexible function $f(age_{it})$ represents a piece-wise polynomial of age.

Income Profiles



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Frontloading	2,499	1,957	1,545	1,062	691	7	0
	(b) Optimal *Ed 13*						
Premium	1,895	4,578	6,988	10,103	15,187	24,554	54,930
Frontloading	421	1,019	970	801	586	0	0

Contract Terms at Inception at age 25

λ_{25}	1	2	3	4	5	6	7
%	89.11	10.25	0.47	0.11	0.04	0.03	0.00
Expected claims	1,473	3,559	6,019	9.302	14,600	24,554	54,930
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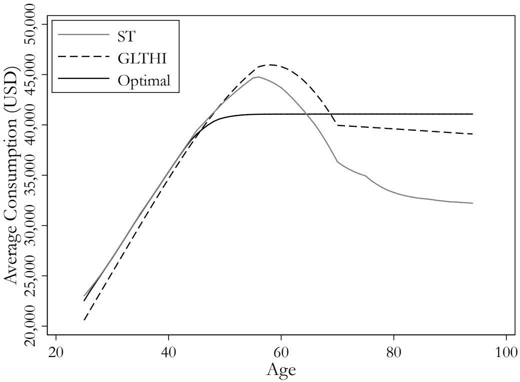
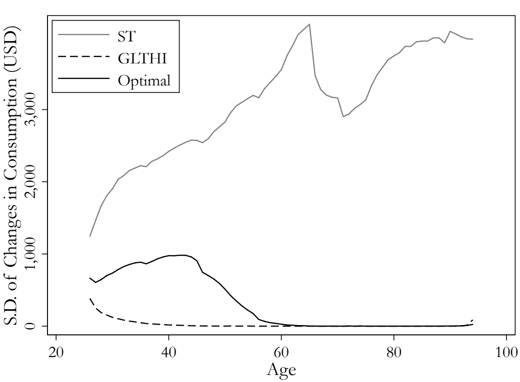
Frontloading	2,499	1,957	1,545	1,062	691	7	0
	(b) Optimal *Ed 13*						
Premium	1,895	4,578	6,988	10,103	15,187	24,554	54,930
Frontloading	421	1,019	970	801	586	0	0
	(c) Optimal *Ed 10*						
Premium	2,571	5,366	7,489	10,307	15,273	24,554	54,930
Frontloading	1,097	1,807	1,471	1,006	673	0	0

Simulated Consumption Paths, Ed 13



(a) Average Consumption



(b) SD of consumption changes

Welfare criterion

- We simulate welfare using a CARA utility function.

$$u(c) = -\frac{1}{\gamma}e^{-\gamma c}$$

  with $\gamma = 0.0004$

- Will examine the robustness of the results to γ and functional form (CRRA, Epstein-Zin).
- Discount Factor: $\delta = 0.966$ (same for insurance company and individual).
- Lifetime utility (considering mortality S_t), summarized with certainty equivalent annual consumption:

$$u(CE) = \frac{\mathbb{E}\left(\sum_{t=t_0}^{T} S_t \delta^{t-t_0} u\left(c_t\right)\right)}{\mathbb{E}\left(\sum_{t=t_0}^{T} S_t \delta^{t-t_0}\right)}$$

Details

Main Result: Welfare Under Various Contracts (CE)

	$C_{FirstBest}$	C_{ST}	C_{GLTHI}	$C_{Optimal}$	$\frac{C_{GLTHI}-C_{ST}}{C_{FirstBest}-C_{ST}}$	$\frac{C_{Optimal}-C_{GLTHI}}{C_{Optimal}}$
Panel A: $\Delta_0 = \frac{1}{100}[89.11, 10.25, 0.47, 0.11, 0.04, 0.03, 0]$						
Ed 10	22,980	-10,119	21,168	21,945	0.945	0.035
Ed 13	34,159	-2,223	25,088	26,093	0.751	0.039

Main Result: Welfare Under Various Contracts (CE)

	$C_{FirstBest}$	C_{ST}	C_{GLTHI}	$C_{Optimal}$	$\frac{C_{GLTHI}-C_{ST}}{C_{FirstBest}-C_{ST}}$	$\frac{C_{Optimal}-C_{GLTHI}}{C_{Optimal}}$
Panel A: $\Delta_0 = \frac{1}{100}[89.11, 10.25, 0.47, 0.11, 0.04, 0.03, 0]$						
Ed 10	22,980	-10,119	21,168	21,945	0.945	0.035
Ed 13	34,159	-2,223	25,088	26,093	0.751	0.039
Panel B: $\Delta_0 = \frac{1}{100}[100, 0, 0, 0, 0, 0, 0]$						
Ed 10	23,082	-10,153	21,484	22,587	0.952	0.049
Ed 13	34,857	-1,954	26,125	28,115	0.763	0.071
Panel C: $\Delta_0 = \frac{1}{100}[0, 0, 0, 0, 0, 0, 100]$						
Ed 10	13,261	-26,690	-26,673	-26,673	0.000	0.000
Ed 13	24,631	-24,214	-24,212	-24,212	0.000	0.000

Summary of Main Findings

- German LTHI, simple design of long-term insurance, comes close to optimal contract in terms of welfare
- GLTHI performs surprisingly well: **between 0 to 7% welfare loss** compared to the optimal contract
  - GLTHI entails **excessive frontloading** (welfare loss equivalent to US $6,900$ per year)
  - ...but largely compensated with higher insurance against reclassification risk
- Can long-term automobile insurance work?
  - Need to subsidize individuals when they are young, but charge a higher than actuarially fair premium when older
  - To prevent lapsation by older policyholders, need to introduce a non-renewal fee.

Thank you!