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How Can Adverse Selection Increase Social Welfare?

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Actuarial Teachers' and Researchers' Conference, June 2019

Background

Adverse selection:

Information asymmetry leading to **raised pooled price** of insurance and **lowering of demand** for insurance, usually portrayed as a bad outcome, both for insurers and for society.

↳ Economic vs actuarial adverse selection.

Adverse selection vs Moral hazard

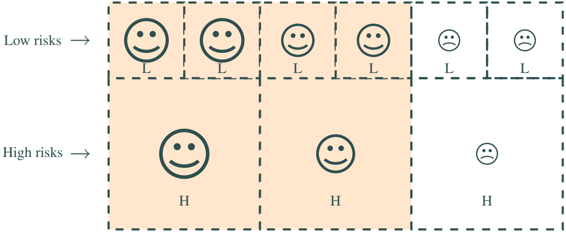
- **Moral hazard** occurs when asymmetric information leads to a change in the behaviour of the policyholder **after** purchasing insurance.
- **Adverse selection** occurs when there is an information asymmetry **prior** to insurance purchase.

↳ Our focus here is on adverse selection.

Question: Policymakers often see merit in restricting insurance risk classification. How can we reconcile theory with practice?

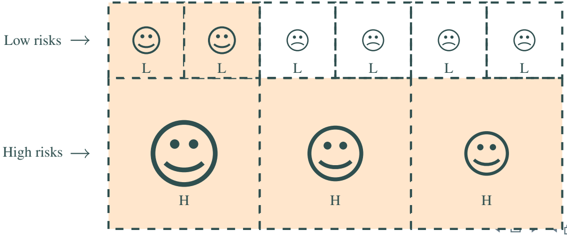
Motivation: Two risk-groups $\mu_L = 0.01$ and $\mu_H = 0.04$

Scenario 1: No adverse selection: Risk-differentiated premiums: $\pi_L = 0.01$ **and** $\pi_H = 0.04$



Utility increase:
66.2×10^{-4}

Scenario 2: Some adverse selection: Pooled premiums: $\pi_L = \pi_H = 0.028$



Utility increase:
71.2×10^{-4}

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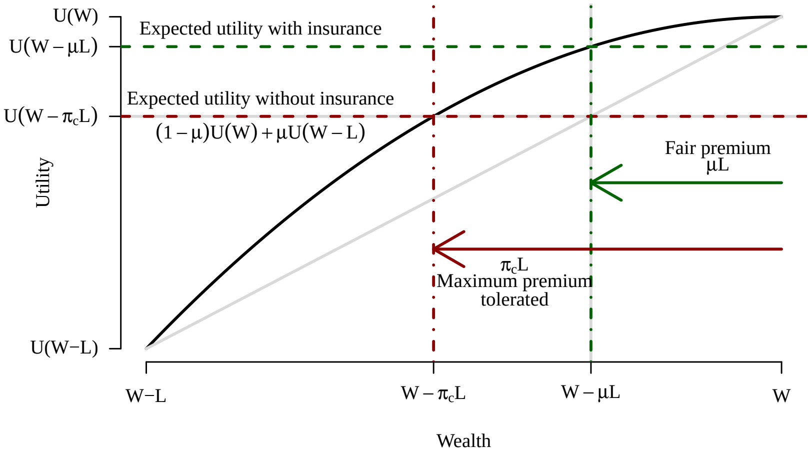
Why do people buy insurance?

Assumptions

Consider an individual with

- an initial wealth W,
- exposed to the risk of loss L,
- with probability μ,
- utility of wealth $U(w)$, with $U'(w) > 0$ and $U''(w) < 0$,
- an opportunity to insure at premium rate π.

Expected utility: With and without insurance



Modelling demand for insurance

Simplest model:

If everybody has exactly the same W, L, μ and $U(\cdot)$, then:

- All will buy insurance if $\pi < \pi_c$.
- None will buy insurance if $\pi > \pi_c$.

Reality: Not all will buy insurance even at fair premium. **Why?**

Heterogeneity:

- Even if individuals are **homogeneous** in terms of underlying risk,
- they can still be **heterogeneous** in terms of **risk aversion**.

Source of Randomness:

An individual's utility function: $U_\gamma(w)$, where parameter γ is drawn from random variable Γ with distribution function $F_\Gamma(\gamma)$.

Insurance demand

Standardisation

As certainty equivalent is invariant to positive affine transformations, we assume $U_\gamma(W) = 1$ and $U_\gamma(W - L) = 0$ for all γ.

Condition for buying insurance:

Given a premium π, an individual will buy insurance if:

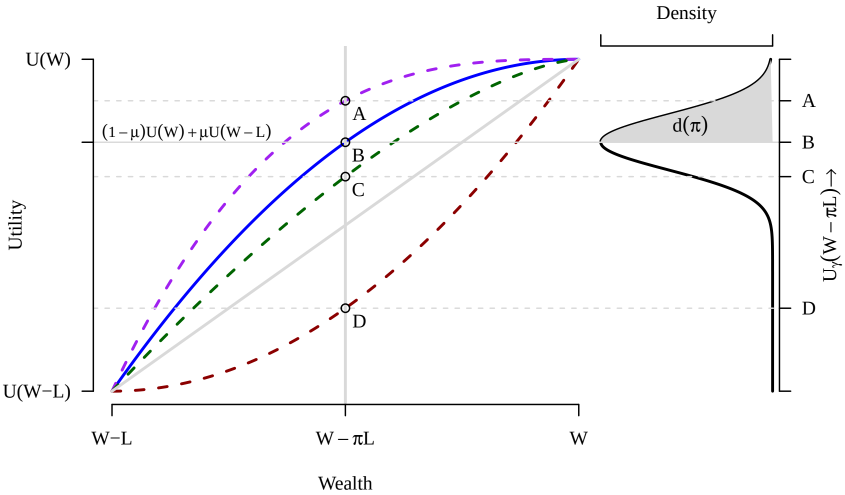
$$\underbrace{U_\gamma\left(W - \pi L\right)}_{\text{With insurance}} > \underbrace{\left(1 - \mu\right) U_\gamma(W) + \mu U_\gamma(W - L) = \left(1 - \mu\right)}_{\text{Without insurance}}.$$

Demand as a function of premium:

Given a premium π, insurance demand, $d(\pi)$, is:

$$d(\pi) = \mathrm{P}\left[U_\Gamma\left(W - \pi L\right) > 1 - \mu\right].$$

Insurance demand and heterogeneity in risk aversion



Iso-elastic demand

Constant demand elasticity

If demand for insurance can be modelled as[1]:

$$d(\pi) = \tau \left(\frac{\mu}{\pi}\right)^{\lambda},$$

then elasticity of demand is a constant:

$$\epsilon(\pi) = \left| \frac{\frac{\partial d(\pi)}{d(\pi)}}{\frac{\partial \pi}{\pi}} \right| = \lambda.$$

[1] Assumptions: $W = L = 1$, $U_\gamma(w) = w^\gamma$ and Γ has the following distribution function:

$$F_\Gamma(\gamma) = \mathrm{P}\left[\Gamma \le \gamma\right] = \begin{cases} 0 & \text{if } \gamma < 0 \\ \tau\,\gamma^\lambda & \text{if } 0 \le \gamma \le (1/\tau)^{1/\lambda} \\ 1 & \text{if } \gamma > (1/\tau)^{1/\lambda}. \end{cases}$$

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Risk classification

Risk-groups

Suppose a population can be divided into 2 risk-groups where:

- risk of losses: $\mu_1 < \mu_2$;
- population proportions: p_1, p_2;
- premiums offered: π_1, π_2;
- iso-elastic demand:

$$d_i(\pi) = \tau_i \left(\frac{\mu_i}{\pi}\right)^{\lambda_i}, \quad i = 1, 2;$$

- fair-premium demand: $\tau_i = d_i(\mu_i)$ for $i = 1, 2$.

Assume for simplicity $W = L = 1$.

Note: The framework can be generalised for $n > 2$ risk-groups.

Market equilibrium

For a randomly chosen individual, define:

$$Q = I\,[\,\text{Individual is insured}\,]\,;$$
$$X = I\,[\,\text{Individual incurs a loss}\,]\,;$$
$$\Pi = \text{Premium offered to the individual.}$$

Expected premium, claim and market equilibrium

Expected premium: $E[Q\Pi] = p_1\, d_1(\pi_1)\, \pi_1 + p_2\, d_1(\pi_2)\, \pi_2.$

Expected claim: $E[QX] = p_1\, d_1(\pi_1)\, \mu_1 + p_2\, d_1(\pi_2)\, \mu_2.$

Market equilibrium: $E[Q\Pi] = E[QX].$

Full risk classification vs Pooling

Full risk classification

If risk classification is allowed:

- Equilibrium is achieved when $\pi_1 = \mu_1$ and $\pi_2 = \mu_2$.
- No losses for insurers.
- No (actuarial/economic) adverse selection.

Pooling

If risk classification is banned:

- Pooled (equilibrium) premium is π_0, where $\mu_1 \leq \pi_0 \leq \mu_2$.
- No losses for insurers! $\Rightarrow$ No (actuarial) adverse selection.
- Economic adverse selection!

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Social welfare

Definition (Social welfare)

Social welfare, S, under premium regime $\underline{\pi} = (\pi_1, \pi_2)$, is the expected utility for the whole population:

$$S(\underline{\pi}) = \mathrm{E}\Big[\underbrace{Q\,U_\Gamma(W - \Pi L)}_{\text{Insured population}} + \underbrace{(1-Q)\,[(1-X)\,U_\Gamma(W) + X\,U_\Gamma(W-L)]}_{\text{Uninsured population}}\Big].$$

↳ It is possible to split $S(\underline{\pi})$ into two components:

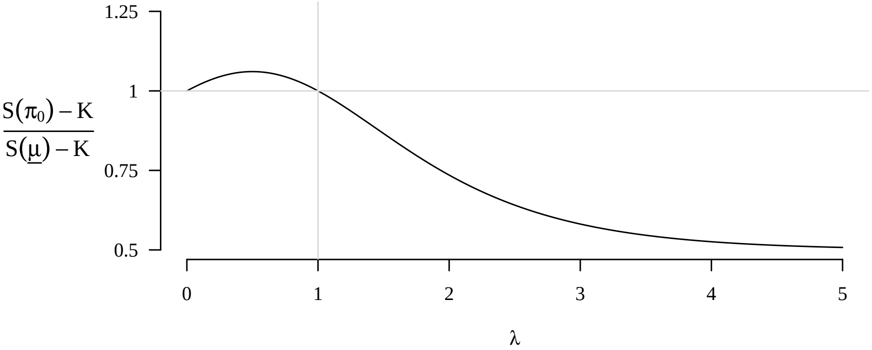
$$S(\underline{\pi}) = f(\underline{\pi}) + K,$$

where $f(\underline{\pi})$ depends on the premium regime under consideration, while K does not.

Full risk classification vs Pooling

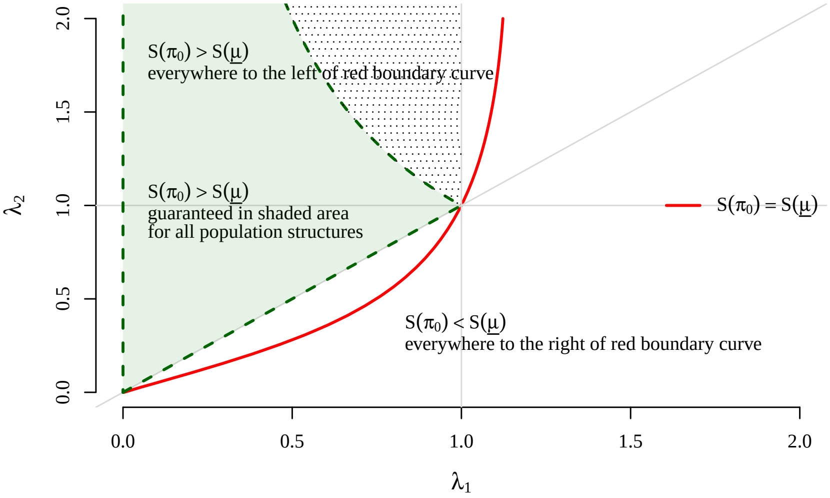
- $S(\underline{\mu})$: Social welfare under full risk classification.
- $S(\pi_0)$: Social welfare under pooling.

Same iso-elastic demand elasticity λ



- $\lambda < 1 \Leftrightarrow S(\pi_0) > S(\underline{\mu}) \Rightarrow$ Pooling is *better* than full risk classification.
- $\lambda > 1 \Leftrightarrow S(\pi_0) > S(\underline{\mu}) \Rightarrow$ Pooling is *worse* than full risk classification.
- **Empirical evidence suggests $\lambda < 1$ in many insurance markets.**

Different iso-elastic demand elasticities (λ_1, λ_2)



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Loss coverage

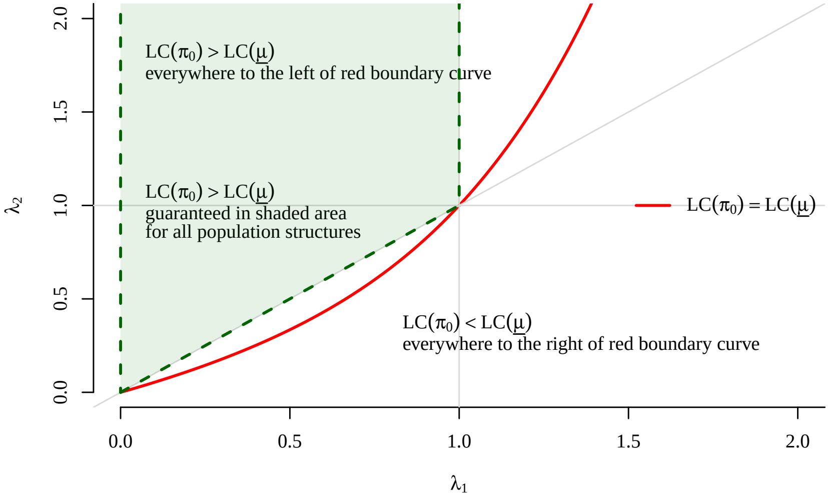
Individual utilities are inherently unobservable, so quantification of social welfare can be problematic. An alternative approach is to quantify the (observable) loss coverage.

Definition (Loss coverage)

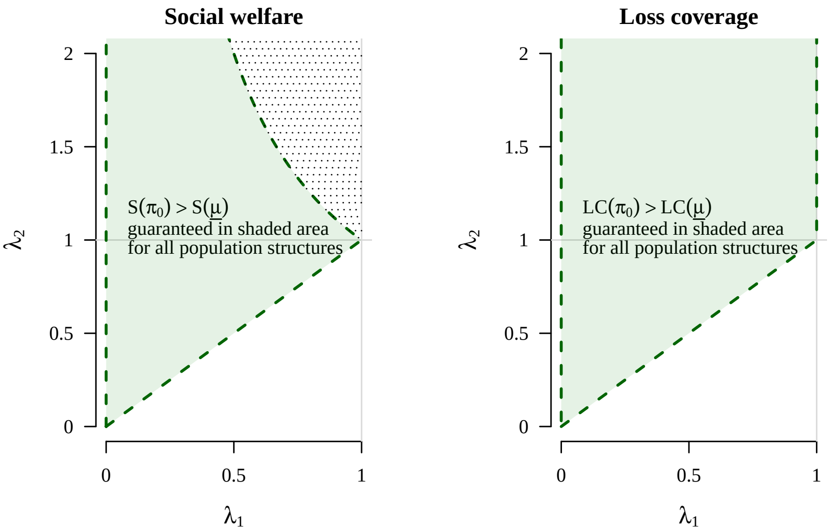
For a premium regime $\underline{\pi}$, loss coverage is defined as expected population losses compensated by insurance, i.e.:

$$LC(\underline{\pi}) = E[QX].$$

Different iso-elastic demand elasticities (λ_1, λ_2)



Social welfare and loss coverage



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Conclusions

Adverse selection need not always be adverse.

Under realistic assumptions of insurance demand elasticities, restricting risk classification can increase social welfare.

Reference: Loss coverage blog

https://blogs.kent.ac.uk/loss-coverage/