Why Adverse Selection Need Not Be Adverse

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Background

What is adverse selection?

No commonly accepted standard definition of *adverse selection*.

Definition (Actuarial perspective)

Insurer faces **loss** due to risk not factored in at the time of sale due to **asymmetric information** between the insurer and the insured.

Definition (Economic perspective)

An individual's **demand for insurance** (the propensity to buy insurance and the quantity purchased) is **positively correlated** with the individual's **risk of loss** (higher risks buy more insurance).

Question:

Why is this a **bad outcome** and **for whom**?

Background

Arguments against adverse selection:

If insurers cannot charge **risk-differentiated** premiums, then:

- higher risks buy more insurance, lower risks buy less insurance,
- raising the **pooled** price of insurance,
- lowering the demand for insurance,

usually portrayed as a bad outcome, both for **insurers** and for **society**.

In practice:

Policymakers often see merit in restricting insurance risk classification

- EU ban on using gender in insurance underwriting.
- Moratoria on the use of genetic test results in underwriting.

Question:

How can we reconcile theory with practice?

Agenda

We ask:

- **Why** do people buy insurance?
- **What** drives demand for insurance?
- **How much** of population losses is compensated by insurance (with and without risk classification)?
- **Which** regime is most beneficial to society?

We find:

Social welfare is maximised by maximising **loss coverage.**

Definition (Loss coverage)

Expected population losses compensated by insurance.

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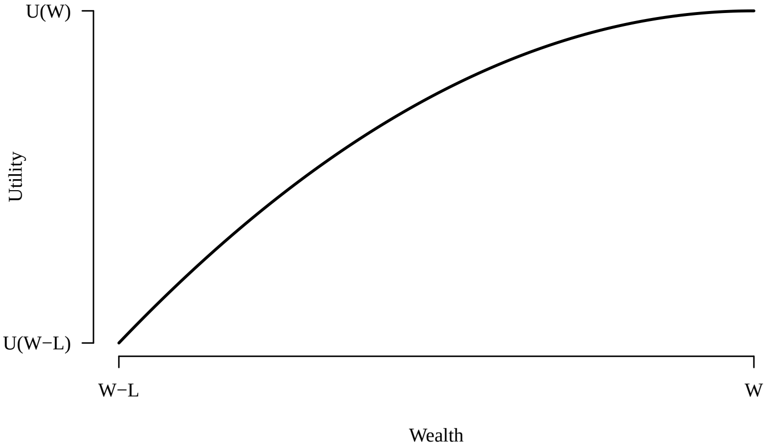
Why do people buy insurance?

Assumptions

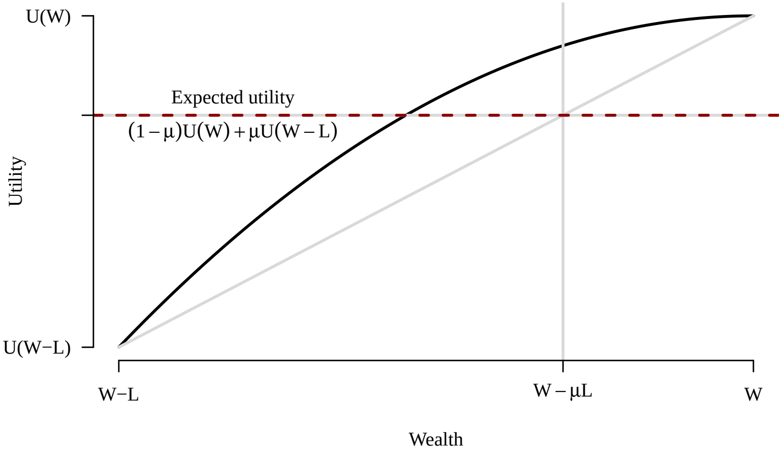
Consider an individual with

- 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.

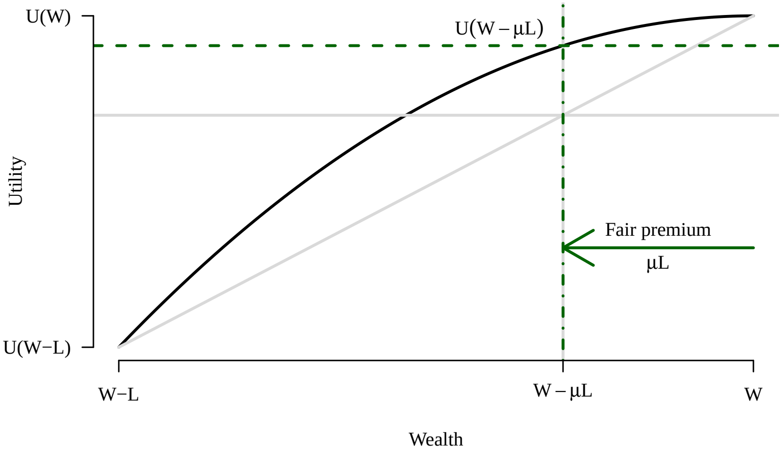
Utility of wealth



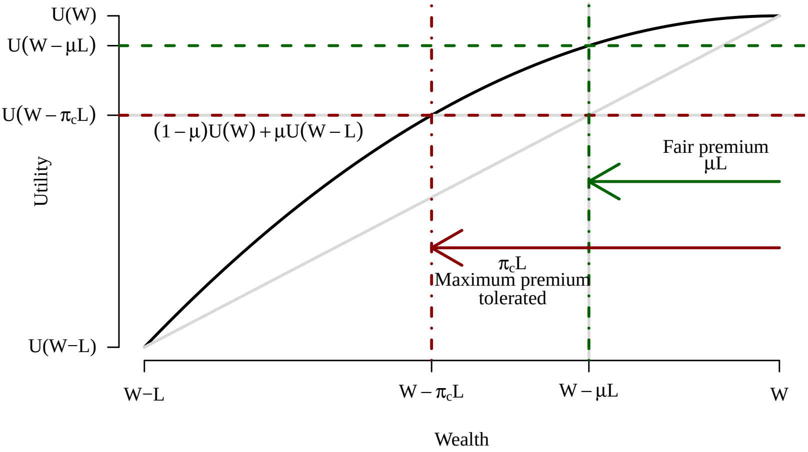
Expected utility: Without insurance



Expected utility: Insured at fair actuarial premium



Maximum premium tolerated: π_c



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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:

Heterogeneity can arise for many reasons.
Here we focus on perception of risk.

Perception of risk:

Suppose for a group of individuals (all else being equal):

- the underlying risk of loss is a constant μ^*, but
- perception of risk is a random variable $\mu \sim F$.

Demand is a survival function

Condition for buying insurance:

Given a premium π, an individual chosen randomly will buy insurance if perceived risk $\mu > \mu_c(\pi)$, where:

$$\underbrace{U(W - \pi L)}_{\text{With insurance}} = \underbrace{(1 - \mu_c(\pi))\, U(W) + \mu_c(\pi) U(W - L)}_{\text{Without insurance}}.$$

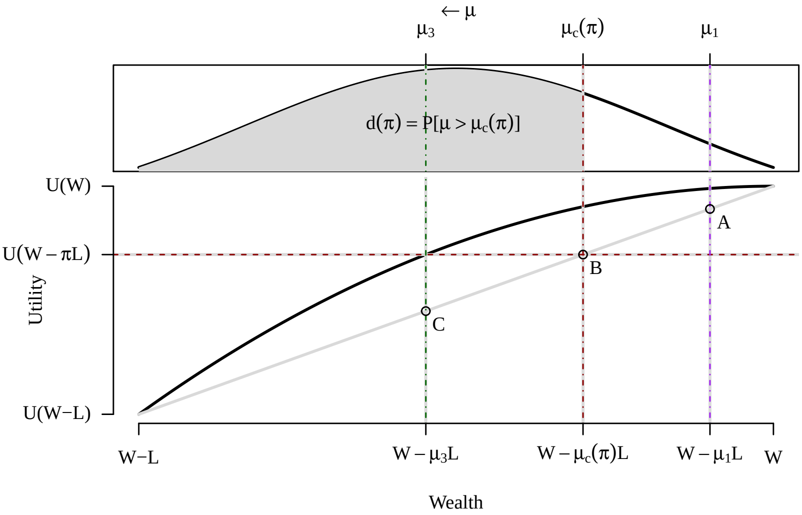
Demand as a survival function:

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

$$d(\pi) = \text{Prob}[\mu > \mu_c(\pi)],$$

i.e. those individuals who perceive their risks to be greater than the threshold risk $\mu_c(\pi)$ will purchase insurance.

Demand is a survival function



Illustrative example: $W = L = 1$

Power utility function:

$$U(w) = -\frac{(1-w)^{\gamma+1}}{\gamma+1}, \quad 0 \le w \le 1,\ \gamma \ge 0.$$

Threshold risk as a function of premium:

$$\mu_c(\pi) = \pi^{\gamma+1}.$$

Perception of risk:

$$\mu \sim Pareto(\mu_{min}, \alpha) \Rightarrow \mathrm{Prob}[\mu > x] = \left(\frac{\mu_{min}}{x}\right)^{\alpha}, \quad x > \mu_{min} > 0,\ \alpha > 0.$$

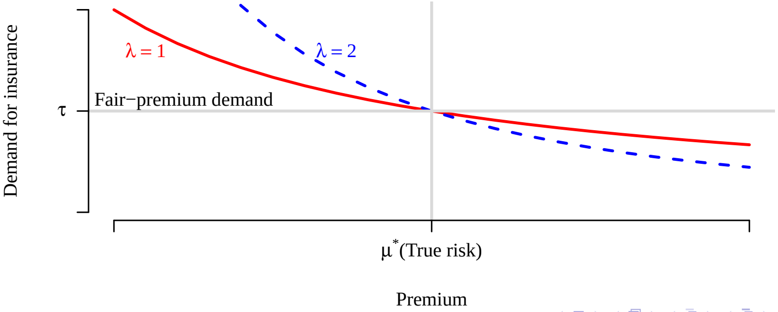
Demand for insurance:

$$d(\pi) = \mathrm{Prob}[\mu > \mu_c(\pi)] \propto \pi^{-\lambda}, \quad \text{for } \lambda = \alpha(\gamma+1) > 0.$$

Illustrative example: $W = L = 1$

Demand elasticity (Iso-elastic demand):

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



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Risk classification

Consider a population of individuals with the same:

- initial wealth $W = 1$;
- potential loss $L = 1$;
- form of iso-elastic demand function $d(\pi) \propto \pi^{-\lambda}$; and
- demand elasticity λ.

Suppose the population can be divided into 2 risk-groups, with:

- risk of losses: $\mu_1 < \mu_2$;
- population proportions: p_1 and p_2;
- fair premium demand: $d_1(\mu_1) = \tau_1$ and $d_2(\mu_2) = \tau_2$, i.e.

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

Risk-differentiated premium

Equilibrium:

If risk-differentiated premiums π_1 and π_2 are allowed,

- Total premium: $\sum_i p_i \, d_i(\pi_i) \, \pi_i$.
- Total claims: $\sum_i p_i \, d_i(\pi_i) \, \mu_i$.

Equilibrium is achieved when insurers break even, i.e. $\pi_i = \mu_i$.

Adverse Selection:

No losses for insurers. No (actuarial/economic) adverse selection.

Loss coverage (Population losses compensated by insurance):

Loss coverage = $\sum_i p_i \, d_i(\mu_i) \, \mu_i = \sum_i p_i \, \tau_i \, \mu_i$.

Pooled premium

Equilibrium:

If only a pooled premium π_0 is allowed,

- Total premium: $\sum_i p_i \, d_i(\pi_0) \, \pi_0$.
- Total claims: $\sum_i p_i \, d_i(\pi_0) \, \mu_i$.

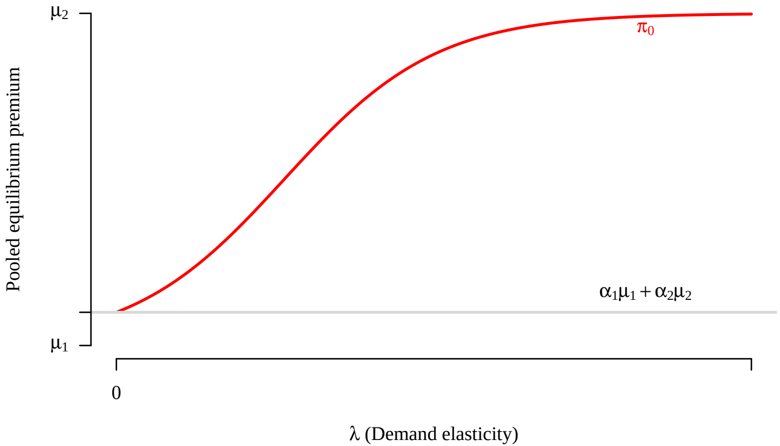
Equilibrium is achieved when insurers break even, i.e.

$$\text{Total premium} = \text{Total claims},$$

$$\Rightarrow \sum_i p_i \, d_i(\pi_0)\pi_0 = \sum_i p_i \, d_i(\pi_0) \, \mu_i,$$

$$\Rightarrow \pi_0 = \frac{\alpha_1 \mu_1^{\lambda+1} + \alpha_2 \mu_2^{\lambda+1}}{\alpha_1 \mu_1^{\lambda} + \alpha_2 \mu_2^{\lambda}}, \text{ where } \alpha_i = \frac{\tau_i p_i}{\tau_1 p_1 + \tau_2 p_2}.$$

Pooled premium: Adverse selection



Pooled premium: Adverse selection

Adverse selection: Summary

- The pooled equilibrium is greater than the average premium charged under full risk classification:

$$\pi_0 > \alpha_1\mu_1 + \alpha_2\mu_2 \Rightarrow \text{(Economic) adverse selection.}$$

- No losses for insurers! $\Rightarrow$ No (actuarial) adverse selection.

Adverse selection is not useful to measure social efficacy of insurance.

Loss coverage ratio

Loss coverage (Population losses compensated by insurance):

Loss coverage = $\sum_i p_i \ d_i(\pi_0) \ \mu_i$.

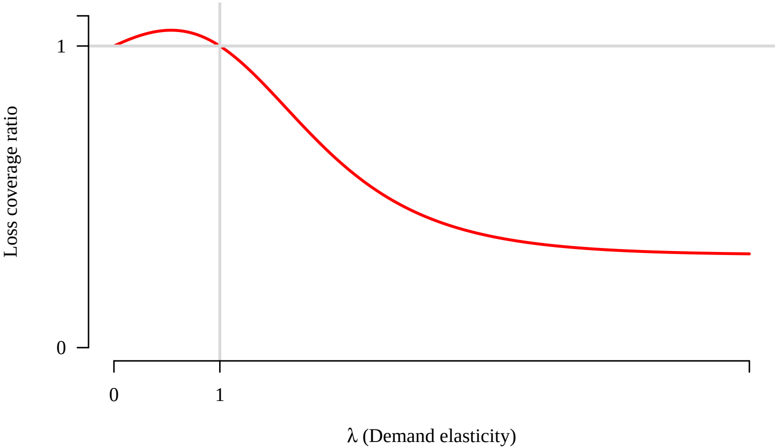
Loss coverage ratio:

$$C = \frac{\text{Loss coverage for pooled premium}}{\text{Loss coverage for risk-differentiated premium}},$$

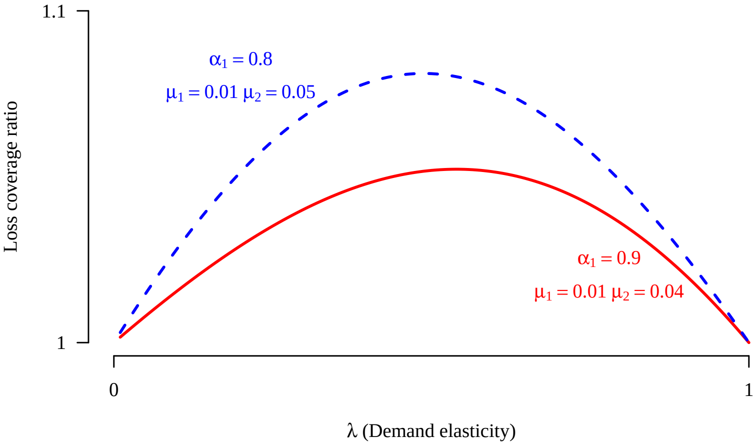
$$= \frac{\sum_i p_i \ d_i(\pi_0) \ \mu_i}{\sum_i p_i \ d_i(\mu_i) \ \mu_i},$$

$$= \frac{1}{\pi_0^\lambda} \frac{\alpha_1 \mu_1^{\lambda+1} + \alpha_2 \mu_2^{\lambda+1}}{\alpha_1 \mu_1 + \alpha_2 \mu_2}.$$

Loss coverage ratio



Loss coverage ratio



Loss coverage ratio: Summary

Summary

- $\lambda < 1 \Rightarrow$ Loss coverage is more when risk classification is banned.
- $\lambda = 1 \Rightarrow$ Loss coverage is the same in both risk classification regimes.
- $\lambda > 1 \Rightarrow$ Loss coverage is more when full risk classification is used.
- Empirical evidence suggests $\lambda < 1$, providing justification for restricting risk classification.
- The maximum value of loss coverage ratio depends on the relative risk and relative size of the risk groups.
- A pooled premium might be highly beneficial in the presence of a small group with very high risk exposure.

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Social welfare

Definition (Social welfare)

Social welfare, G, is the sum of all individuals' expected utilities:

$$G = \sum_i p_i \Big[\underbrace{d(\mu_i, \pi_i) U(W - L\pi_i)}_{\text{Insured population}} + \underbrace{(1 - d(\mu_i, \pi_i)) \left\{ \mu_i U(W - L) + (1 - \mu_i) U(W) \right\}}_{\text{Uninsured population}} \Big].$$

Linking social welfare to loss coverage

Setting $U(W - L) = 0$ and assuming $L\pi_i \approx 0$ gives:

$$\begin{aligned} G &= U(W) \sum_i p_i d(\mu_i, \pi_i) \mu_i + \text{Constant}, \\ &= \text{Positive multiplier} \times \textbf{Loss coverage} + \text{Constant}. \end{aligned}$$

Loss coverage provides a good proxy (which depends only on observable data) for social welfare (which depends on unobservable utilities).

Result: Maximising loss coverage maximises social welfare.

Contents

Conclusions

Adverse selection need not be adverse

Restricting risk classification

- will always increase adverse selection;
- increases loss coverage if $\lambda < 1$.

Summary

Loss coverage provides a better metric than adverse selection in measuring social welfare.

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