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Why Adverse Selection Need Not Be Adverse

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2 Why do people buy insurance?

3 What drives demand for insurance?

4 How much of population losses is compensated by insurance?

5 Which regime is most beneficial to society?

6 Conclusions
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**?
Introduction
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?
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 $\mu$,
- utility of wealth $U(w)$, with $U'(w) > 0$ and $U''(w) < 0$,
- an opportunity to insure at premium rate $\pi$. 
Utility of wealth

Utility

$U(W)$

$U(W-L)$

Wealth

$W-L$

$W$
Expected utility: Without insurance

\[ U(W) - \mu U(W - L) \]

Expected utility

\[ (1 - \mu)U(W) + \mu U(W - L) \]

Utility

U(W-L)

W-L

W - \mu L

W

Wealth

U(W)

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Why do people buy insurance?

Expected utility: With insurance

Expected utility: Insured at fair actuarial premium

\[ U(W) \]

\[ U(W - \mu L) \]

\[ U(W - L) \]

\[ W - L \]

\[ W - \mu L \]

\[ W \]

Utility

Wealth

Fair premium

\[ \mu L \]
Why do people buy insurance?

Maximum premium tolerated: \( \pi_c \)

Maximum premium tolerated: \( \pi_c \)

Utility

\[ U(W) \]
\[ U(W - \mu L) \]
\[ U(W - \pi_c L) \]
\[ U(W - \mu L) \]

\[ (1 - \mu)U(W) + \mu U(W - L) \]

Fair premium

\( \mu L \)

Maximum premium tolerated

\( \pi_c L \)

Wealth

\[ W - L \]
\[ W - \pi_c L \]
\[ W - \mu L \]
\[ W \]
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Modelling demand for insurance

Simplest model:
If everybody has exactly the same $W$, $L$, $\mu$ 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 $\mu^*$, but
- perception of risk is a random variable $\mu \sim F$. 
What drives demand for insurance?

Demand is a survival function

Condition for buying insurance:

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

$$U(W - \pi L) = (1 - \mu_c(\pi))U(W) + \mu_c(\pi)U(W - L).$$

With insurance Without insurance

Demand as a survival function:

Given a premium $\pi$, 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

\[
d(\pi) = P[\mu > \mu_c(\pi)]
\]

Utility

- \( U(W) \)
- \( U(W - \pi L) \)
- \( U(W - L) \)

Wealth

- \( W - L \)
- \( W - \mu_3 L \)
- \( W - \mu_c(\pi) L \)
- \( W - \mu_1 L \)
- \( W \)
Illustrative example: $W = L = 1$

Power utility function:

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

Threshold risk as a function of premium:

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

Perception of risk:

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

Demand for insurance:

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

Demand elasticity (Iso-elastic demand):

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

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 $\pi_1$ and $\pi_2$ 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 $= \sum_i p_i d_i(\mu_i) \mu_i = \sum_i p_i \tau_i \mu_i$. 
How much of population losses is compensated by insurance?

Pooled premium

Equilibrium:

If only a pooled premium $\pi_0$ 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.

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

$$\Rightarrow \pi_0 = \frac{\alpha_1 \mu_1^{\lambda+1} + \alpha_2 \mu_2^{\lambda+1}}{\alpha_1 \mu_1^\lambda + \alpha_2 \mu_2^\lambda}, \text{ where } \alpha_i = \frac{\tau_i \rho_i}{\tau_1 \rho_1 + \tau_2 \rho_2}.$$
Pooled premium: Adverse selection

$$\pi_0 = \alpha_1 \mu_1 + \alpha_2 \mu_2$$

$$\lambda$$ (Demand elasticity)
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):

\[
\text{Loss coverage} = \sum_i p_i \ d_i(\pi_0) \ \mu_i.
\]

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

\[
\lambda \quad \text{(Demand elasticity)}
\]

How much of population losses is compensated by insurance?
How much of population losses is compensated by insurance?

Loss coverage ratio

\[ \lambda \] (Demand elasticity)

\[ \alpha_1 = 0.8 \]
\[ \mu_1 = 0.01 \quad \mu_2 = 0.05 \]

\[ \alpha_1 = 0.9 \]
\[ \mu_1 = 0.01 \quad \mu_2 = 0.04 \]
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.
Which regime is most beneficial to society?

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Social welfare

**Definition (Social welfare)**

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

$$G = \sum_i p_i \left[ d(\mu_i, \pi_i) U(W - L\pi_i) + (1 - d(\mu_i, \pi_i)) \{\mu_i U(W - L) + (1 - \mu_i) U(W)\} \right].$$

**Linking social welfare to loss coverage**

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

$$G = U(W) \sum_i p_i d(\mu_i, \pi_i) \mu_i + \text{Constant},$$

$$= \text{Positive multiplier} \times \text{Loss coverage} + \text{Constant}.$$

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.**
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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.
References


