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Presentation
How Can Adverse Selection Increase Social Welfare?

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Actuarial Teachers’ and Researchers’ Conference, June 2019
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 $\pi_H = 0.04$

- Low risks →
- High risks →

Utility increase: $66.2 \times 10^{-4}$

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

- Low risks →
- High risks →

Utility increase: $71.2 \times 10^{-4}$
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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 $\mu$,
- utility of wealth $U(w)$, with $U'(w) > 0$ and $U''(w) < 0$,
- an opportunity to insure at premium rate $\pi$. 
Expected utility: With and without insurance

Utility

$U(W)$
$U(W - \mu L)$
$U(W - \pi_c L)$
$U(W - L)$

Wealth

$W - L$
$W - \pi_c L$
$W - \mu L$
$W$

Expected utility with insurance

$U(W) + \mu U(W - L)$

Expected utility without insurance

$(1 - \mu)U(W) + \mu U(W - L)$

Fair premium

$\mu L$

Maximum premium tolerated

$\pi_c L$
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:

- 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 $\gamma$ is drawn from random variable $\Gamma$ with distribution function $F_\Gamma(\gamma)$. 
Standardisation

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

Condition for buying insurance:

Given a premium $\pi$, an individual will buy insurance if:

$$U_\gamma(W - \pi L) > (1 - \mu) U_\gamma(W) + \mu U_\gamma(W - L) = (1 - \mu).$$

With insurance

Without insurance

Demand as a function of premium:

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

$$d(\pi) = P[U_\Gamma(W - \pi L) > 1 - \mu].$$
Insurance demand and heterogeneity in risk aversion

Wealth

Utility

$(1 - \mu)U(W) + \mu U(W - L)$

$W - \pi L$

$W$

Utility

$U(W)$

$U(W - L)$

Wealth

Density

$d(\pi)$

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How can adverse selection increase social welfare

ATRC, June 2019
Insurance demand

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:

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

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

\[ F_\Gamma(\gamma) = P[\Gamma \leq \gamma] = \begin{cases} 0 & \text{if } \gamma < 0 \\ \tau \gamma^\lambda & \text{if } 0 \leq \gamma \leq (1/\tau)^{1/\lambda} \\ 1 & \text{if } \gamma > (1/\tau)^{1/\lambda}. \end{cases} \]
Risk classification

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: $\pi_1, \pi_2$;
- 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.
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 $\pi_0$, 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 $\pi = (\pi_1, \pi_2)$, is the expected utility for the whole population:

$$S(\pi) = E\left[ QU_\Gamma(W - \Pi L) + (1 - Q) \left[(1 - X) U_\Gamma(W) + X U_\Gamma(W - L)\right]\right].$$

It is possible to split $S(\pi)$ into two components:

$$S(\pi) = f(\pi) + K,$$

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

Full risk classification vs Pooling

- $S(\mu)$: Social welfare under full risk classification.
- $S(\pi_0)$: Social welfare under pooling.
Same iso-elastic demand elasticity $\lambda$

- $\lambda < 1 \iff S(\pi_0) > S(\mu) \implies$ Pooling is *better* than full risk classification.
- $\lambda > 1 \iff S(\pi_0) > S(\mu) \implies$ Pooling is *worse* than full risk classification.
- **Empirical evidence suggests** $\lambda < 1$ *in many insurance markets.*
Different iso-elastic demand elasticities \((\lambda_1, \lambda_2)\)

- \(S(\pi_0) > S(\mu)\) everywhere to the left of red boundary curve
- \(S(\pi_0) = S(\mu)\) guaranteed in shaded area for all population structures
- \(S(\pi_0) < S(\mu)\) everywhere to the right of red boundary curve
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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 $\pi$, loss coverage is defined as expected population losses compensated by insurance, i.e.:

$$LC(\pi) = E[QX].$$
Different iso-elastic demand elasticities \((\lambda_1, \lambda_2)\)

- \(\text{LC}(\pi_0) > \text{LC}(\mu)\) everywhere to the left of red boundary curve
- \(\text{LC}(\pi_0) < \text{LC}(\mu)\) everywhere to the right of red boundary curve
- \(\text{LC}(\pi_0) = \text{LC}(\mu)\) guaranteed in shaded area for all population structures
Social welfare and loss coverage

Social welfare

Loss coverage

\[ S(\pi_0) > S(\mu) \]
guaranteed in shaded area for all population structures

\[ LC(\pi_0) > LC(\mu) \]
guaranteed in shaded area for all population structures
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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/