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Yes, No, Perhaps? – Explaining the Demand for Risk Classification Insurance with Fuzzy Private Information

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Motivation

- Risk classification insurance is available in some markets
  - Accident forgiveness
  - German private health insurance (Anwartschaft)
- Standard assumptions on information distribution do not explain observed demand in these markets

- Does a more general modeling of private information provide theoretical explanation for observed demand?
- Which factors determine the existence of such equilibria?

Agenda

- Literature Overview
- The Basic Model
- The Model with Private Information
- Conclusions

Literature Overview

- Without risk classification: threat of adverse selection, Akerlof (1970)
  - Risk classification is necessary (Rothschild and Stiglitz, 1976, Wilson, 1977, Miyazaki, 1977, Cooper and Hayes, 1987, Bond and Crocker, 1991, Crocker and Snow, 2000)
- However, welfare implications are not clear.
  - Welfare effects are ambiguous (Hoy, 1982, Hoy, 2006, Harrington and Doerpinghaus, 1993, Crocker and Snow, 1984)

→ Insuring against classification risk seems to be a sensible thing for a risk averse individual.

- Previous work in the field of risk classification insurance (RCI)
  - Making RCI mandatory for genetic tests (Tabarrok, 1994, Doherty and Thistle, 1996)
  - Use part of the premium for classification risk vs. stand-alone RCI (Cochrone, 1995, Pauly et al. 1995, Kifmann, 2001, Kifmann, 2002)

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The Basic Model

- Two points in time t_1 and t_2
- Time-additively separable utility function, individuals are risk-averse at any time such that u‘ > 0 and u‘‘ < 0

At t_1

- Homogeneous group of insured
- Lifetime‘s wealth W assumed to be available
- Individuals consume C_1

At t_2

- The random loss results in costs of T
- Fairly priced insurance is available
- Two different risk types are revealed who differ in the probability of facing a loss, such that $0 < p_L < p_H < 1$

The Basic Model

- Results without RCI

Proposition 1: If no classification insurance is available, individuals will fully insure against the health risk at t_2. They will split consumption in such a way that they will consume most at t_2 if they are a low risk and least if they are a high risk at t_2. Consumption at t_1 lies between these levels.

→ Expected utility of $u(C_1) + z \cdot u(W - C_1 - P_L) + (1 - z) \cdot u(W - C_1 - P_H)$

- RCI available, but no private information

Proposition 2: Without private information risk classification insurance will increase individual and social welfare for risk averse individuals.

- RCI available with complete private information

Proposition 3: If private information is complete, risk classification insurance does not enhance welfare of either low or high risk types and will not be in demand.

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Time Structure / Sequence of Play

t_1

- Individual observes signal z regarding future risk type
  - Independent draws from distribution Z
- Classification insurance is offered at an actuarially fair price
  - Insurer uses knowledge about signal distribution and anticipates demand
- Individual decides about consumption and purchase of RCI
  - Decision is based on individual signal

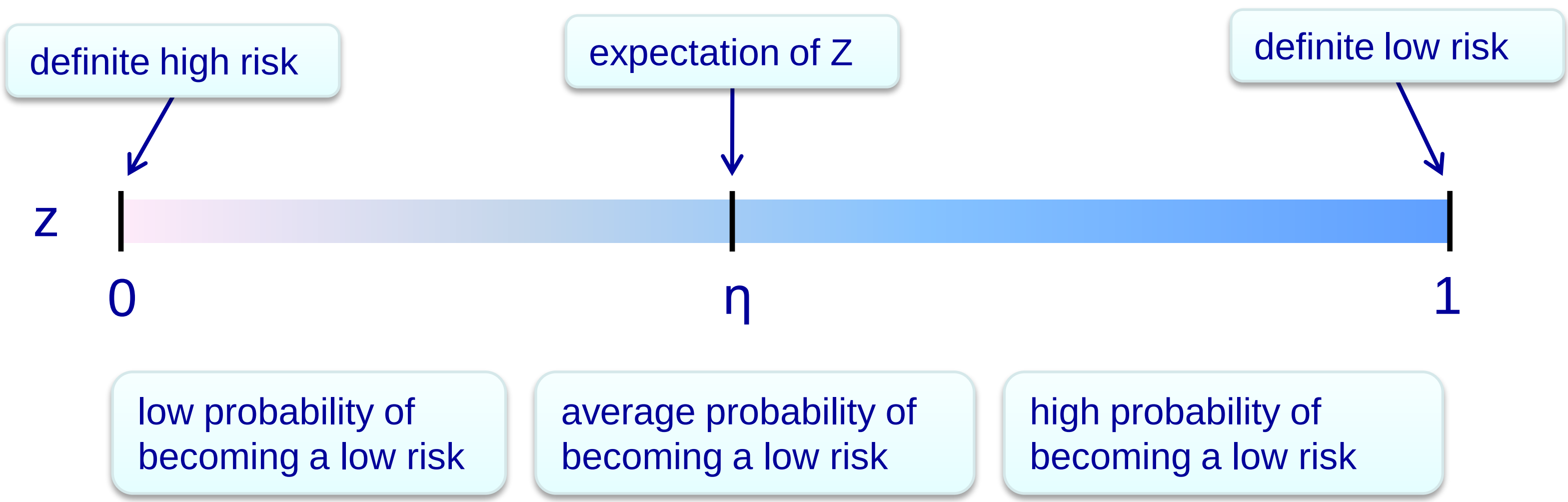
t_2

- Risk type is revealed, health risk is insured
- Loss realization

timeline

Modeling Heterogeneous Private Information

- Technically we assume Z to be a random variable with density function f where the signal z denotes the probability of becoming a low risk.
- The expectation of Z is denoted by η.



Comparison with Standard Adverse Selection Frameworks

Rothschild & Stiglitz (1976)

- Discrete risk types
- Insured perfectly know their type.
- Insurers have no knowledge about individual type, but know distribution of types

Nash equilibrium may exist, but not necessarily.

Our Approach

- Discrete risk types
- Continuous signal
- Insured have some, but imperfect knowledge about their future type.
- Insurer only knows signal distribution.

Nash equilibrium always exists, two possible forms.

Riley (1979)

- Continuous types
- Sellers/Insured perfectly know their type.
- Buyers/Insurers observe activity of seller.

- (Local) Nash equilibrium does not exist
- Reactive equilibrium

Cutoffs and Cutoff Conditions

- A definite low risk (z=1) will never buy RCI, as he does not face classification risk and would only subsidize others
- A definite high risk (z=0) will always purchase RCI, as he benefits from the subsidization of better risk types and avoids paying the higher insurance premium for the loss T.
- **Is there a critical threshold z*, such that individuals receiving a signal below z* purchase RCI and the ones with a signal above z* do not?**
- Such signals will be referred to as **cutoffs** or **cutoff signals**.

Cutoffs and Cutoff Conditions

- Assuming the existence of a cutoff z*, the fair insurance premium against classification risk is

expected probability of becoming a low risk for the purchasers of RCI

$$P(z^*) = (1 - E(Z|Z \leq z^*)) \cdot (P_H - P_L)$$

expected probability of becoming a high risk for the purchasers of RCI

- difference in premium between high and low risks
- has to be paid to insured that turn out to be high risks at t_2

Cutoff Signal

- To determine cutoff-signals we compare utility with and without RCI. Technically, a cutoff signal can be defined as a null of the following function:

$$g(z) := \underbrace{u(C_1) + z\, u(W - C_1 - P_L) + (1 - z)\, u(W - C_1 - P_H)}_{\text{utility without risk classification insurance}}$$

$$- \underbrace{2\, u((W - P(z) - P_L) / 2)}_{\text{utility with risk classification insurance}}$$

$g(0) = 0$

$g(1) > 0$

A Sufficient Condition for the Existence of a Cutoff

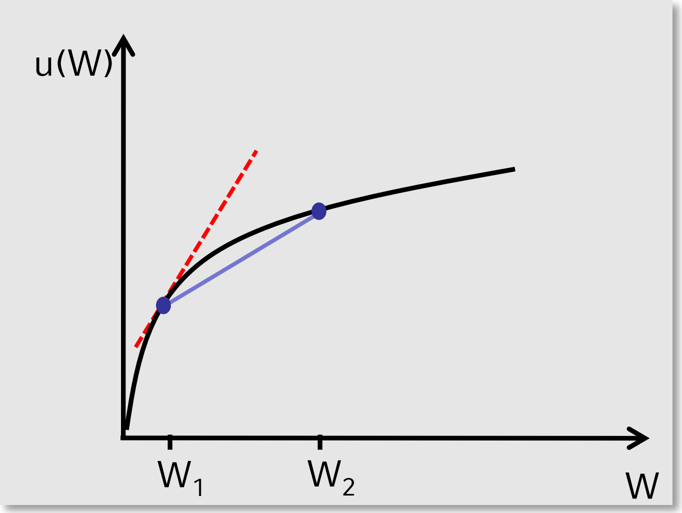
Proposition 5: Assuming $\lambda := \lim_{z^* \downarrow 0} \frac{E(Z \mid Z \leq z^*)}{z^*}$ to exist, a sufficient condition for an **interior** cutoff is that

$$\frac{u(W_2) - u(W_1)}{W_2 - W_1} < \lambda \cdot u'(W_1)$$

where $W_1 := \frac{W + P_H}{2} - P_H$ and $W_2 := \frac{W + P_H}{2} - P_L$.

Remark: This condition is fulfilled more easily

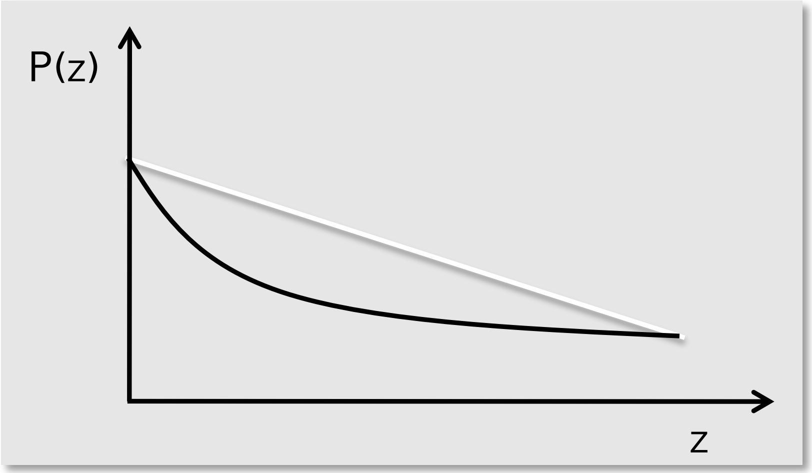
- the greater the absolute curvature of the utility function,
- the greater the difference in premiums,
- the greater the absolute slope of the premium function.

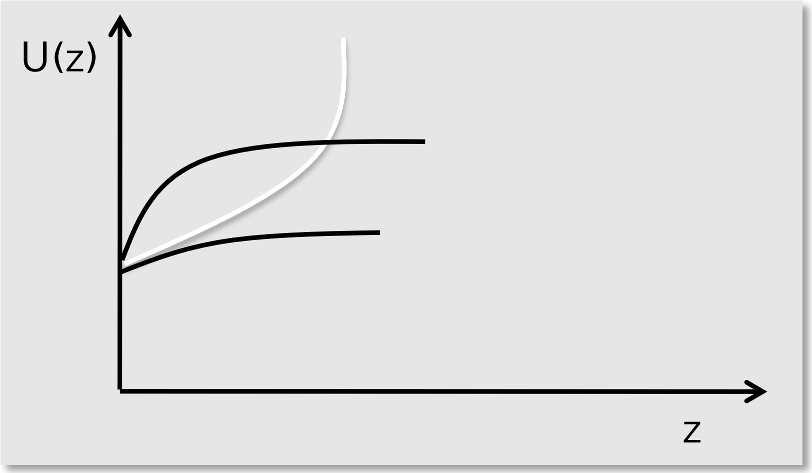


Refining the Cutoff Condition

Proposition 6: Assuming P''(z) to exist and to be non-negative implies that

1. condition (6) of Proposition 5 will not only be sufficient but also necessary for the existence of an interior cutoff.
2. if condition (6) is fulfilled there is a unique interior cutoff.





$P(z^*) = (1 - E(Z|Z \leq z^*)) \cdot (P_H - P_L)$

Welfare Analysis

Proposition 7: A higher cutoff dominates a lower cutoff in the Pareto-sense.

Proposition 8: The highest cutoff is a unique Nash-equilibrium.

Conclusion

- Fuzzy private information can explain the observed demand patterns for risk classification insurance
- We derived a sufficient condition for the existence of an interior cutoff and discussed conditions when this will also be a necessary condition
  - The condition is fulfilled more easily with a higher degree of risk aversion, higher volatility of outcomes without RCI and a greater absolute slope of the premium function
- A higher cutoff is always Pareto-superior which implies the existence of a unique equilibrium which is either
  - that nobody purchases RCI
  - or a fraction of the population purchases RCI

Thanks for your attention!

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