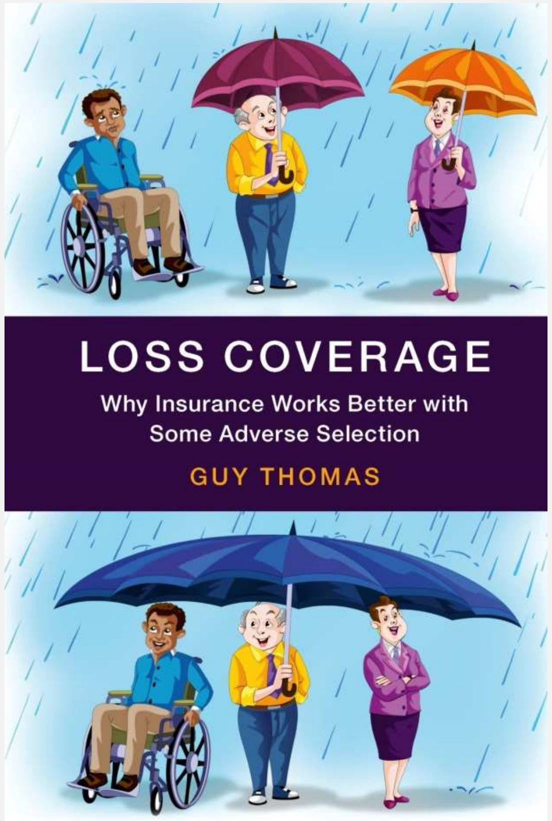
Loss Coverage

Why Insurance Works Better with Some Adverse Selection



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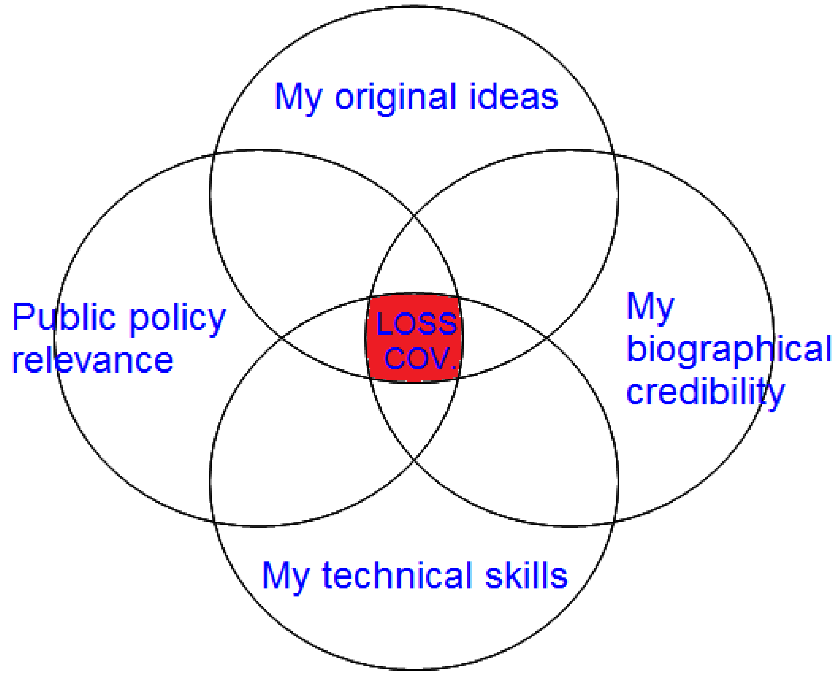
Purpose & context
A public policy perspective on risk classification

Think about issue from viewpoint of society
(*not* viewpoint of insurers)

Idealistic do-gooder



Poetry not plumbing (but we need plumbing)

Thanks: Pradip Tapadar, MingJie Hao

Plan of talk

Adverse selection: orthodox view v. my view (outline)

Toy examples

Loss coverage in context: usefulness, alternatives

Loss coverage: models & results

Reality checks

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Orthodox view

Restrictions on risk classification (*ie* anti-discrimination laws) are said to have the following effects:-

(1) (The few) high-risk people are more likely to buy

(2) (The many) low-risk people are less likely to buy

(3) so the break-even price of insurance rises

(4) and the total number of people who buy insurance falls

(5) return to (1) and repeat….

Adverse selection "spiral" ?.........

Public policy implication:

Limit adverse selection. More risk classification is always good.

My view

Models with plausible demand elasticities suggests that markets don’t spiral to nothing, they stabilise

A modest degree of adverse selection is a good thing….

…because it increases the expected population losses compensated by insurance (the “*loss coverage”*).

This happens *despite* higher average price and smaller number of people insured

Public policy implication:

Target an optimal degree of adverse selection. Some restrictions on risk classification (and hence some induced adverse selection) may help.

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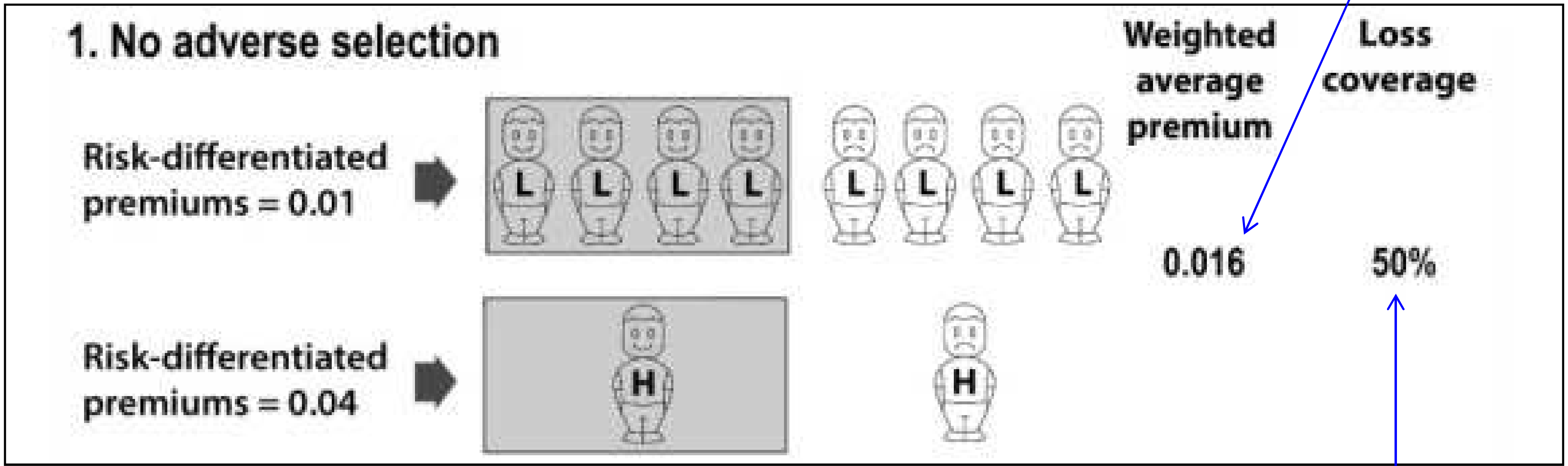
Toy Examples

$$\frac{(4\times 0.01+1\times 0.04)}{5}$$

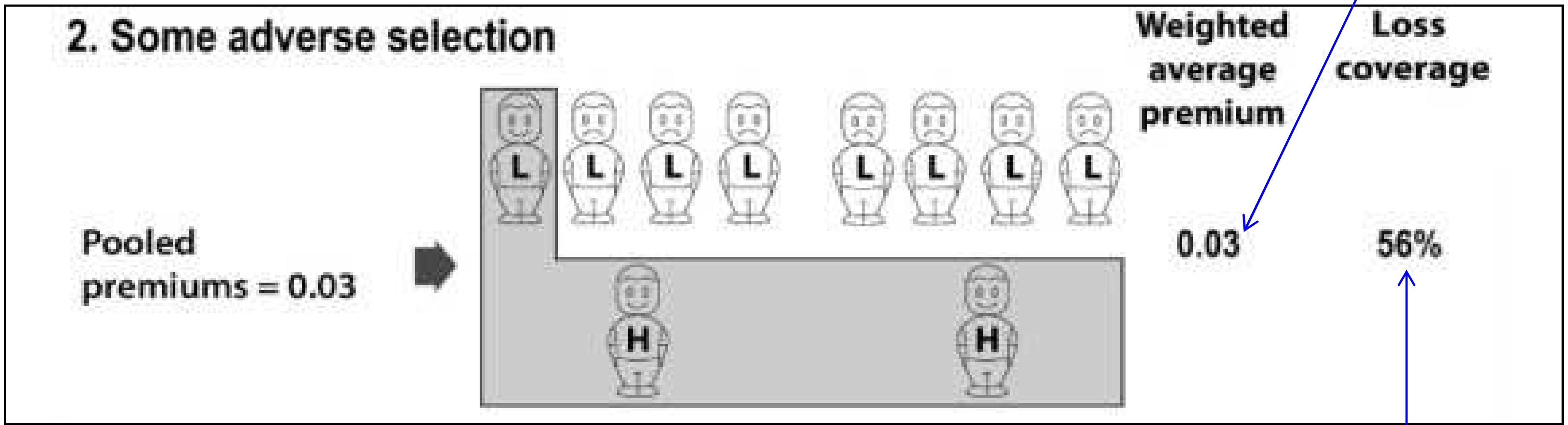


$$\frac{(4\times 0.01+1\times 0.04)}{(8\times 0.01+2\times 0.04)}$$

- High and low risks covered in same proportions as in population => No adverse selection.

Toy Examples (cont.)

$$\frac{(1\times 0.01+2\times 0.04)}{3}$$

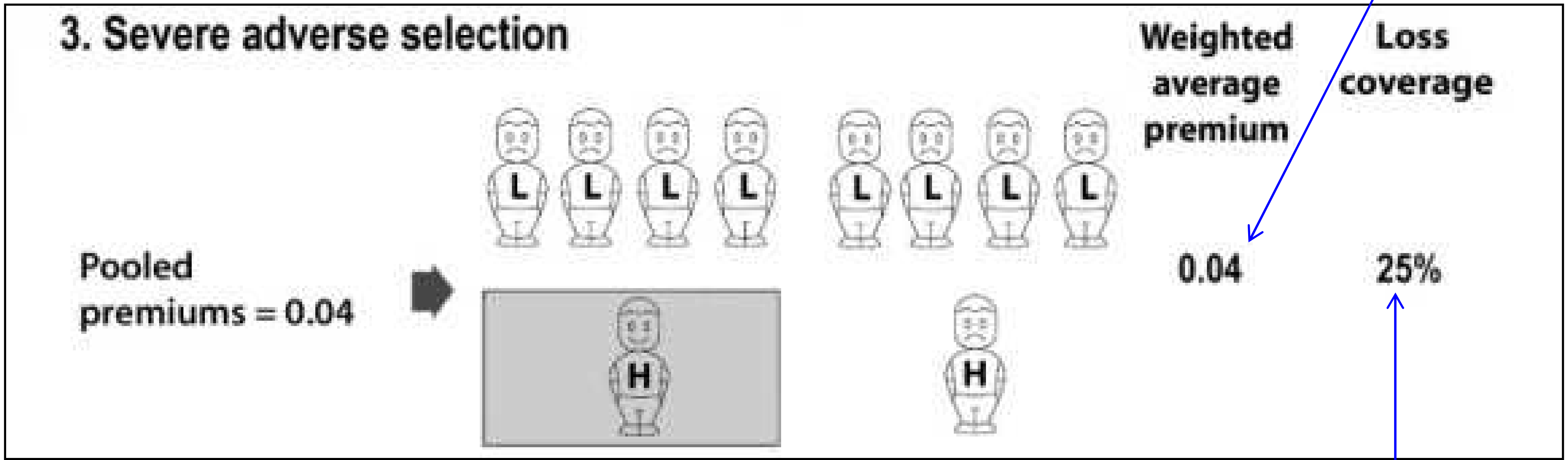


$$\frac{(1\times 0.01+2\times 0.04)}{(8\times 0.01+2\times 0.04)}$$

- *Higher* weighted average premium, *lower* numbers insured
- Moderate adverse selection
- But shift in coverage towards higher risks more than offsets lower numbers insured => *higher* loss coverage.

Toy Examples (cont.)

$$\frac{(1 \times 0.04)}{1}$$



$$\frac{(1 \times 0.04)}{(8 \times 0.01 + 2 \times 0.04)}$$

- Only one individual (higher risk) remains insured
- Shift in coverage towards higher risks *does not* offset lower numbers insured => *lower* loss coverage.

Toy examples: summary

Loss coverage is increased by the “right amount” of adverse selection (but reduced by “too much” adverse selection)

Outcome depends on response of each risk-group to change in price, *i.e.* demand elasticities

=> Our research agenda: look for conditions on demand elasticities which ensure higher loss coverage under pooling

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Loss coverage: why it's a useful metric

Compensation of losses is the social purpose of insurance

Loss coverage focuses on this purpose

Loss coverage puts same weight on compensation of everyone's losses *ex-post* (no 'favouritism' towards higher or lower risks)…

…so more weight on coverage of higher risks *ex ante…*

…but only in proportion to their higher risk.

For some purposes, policymaker might want to vary the weighting scheme (e.g. higher/lower weight on large losses which occur at low frequencies)

But loss coverage's "equal weight on equal expected losses" (i.e. amount x frequency) seems an obvious place to start.

Loss coverage: Better than alternative metrics

Alternative 1: (unweighted) coverage

Common in public policy discussions.

Unsatisfactory because ignores probabilities of loss.

If coverage is concentrated over low risks, coverage can be high, but only small fraction of population's losses is compensated. Bad!

Coverage = *unweighted* insurance demand.
Loss coverage = *risk-weighted* insurance demand.

Alternative 2: utilitarian welfare ("social welfare")

Sum of expected utilities.

Common in formal economic modelling.

Unsatisfactory because utilities always unobservable.

(But reconciled, under certain assumptions, in Hao et al. 2016a.)

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Loss coverage: models

Assume all losses and cover are unit amounts

Timeless zero-profit equilibrium

Two risk-groups, with…

- probabilities of loss: μ_1 and μ_2 [say 0.01 and 0.04]
- Population proportions: p_1 and p_2 [say 0.9 and 0.1]
- *"fair-premium demands"* : $d_1(\mu_1) = \tau_1$ and $d_2(\mu_2) = \tau_2$ [say 0.5 and 0.5]

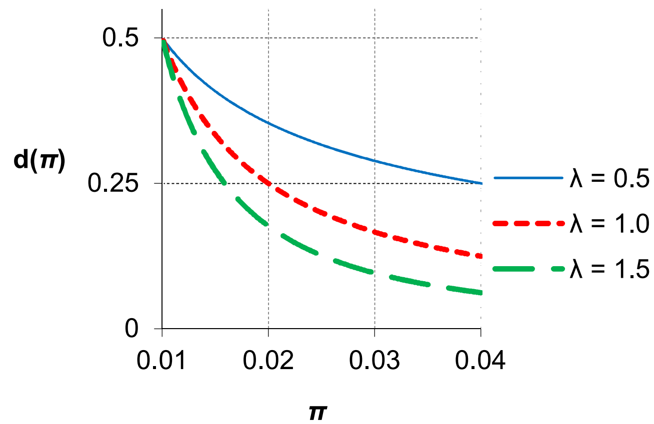
Iso-elastic demand:

$$d_i(\mu_i, \pi_i) = \tau_i \left(\frac{\mu_i}{\pi_i} \right)^{-\lambda_i}$$

where λ_i is a positive constant.

The λ_i controls shape of demand curve, and corresponds to:

price elasticity of demand = $-\dfrac{\partial \ln[d_i(\pi_i)]}{\partial \ln \pi_i}$



Equilibrium

For an individual selected at random from the population…
Define the random variables:

$$Q = I\left[individual\ is\ insured\right]$$

$$X = I\left[individual\ incurs\ a\ loss\right]$$

$$\Pi = premium\ offered\ to\ the\ individual$$

Expected premium: $$E\left[Q\Pi\right] = \sum_i p_i d_i\left(\pi_i\right)\pi_i$$

Expected claim: $$E\left[QX\right] = \sum_i p_i d_i\left(\pi_i\right)\mu_i$$

Equilibrium: $$E\left[Q\Pi\right] = E\left[QX\right]$$

Equilibrium (cont)

Quantities to characterise the equilibrium:

1. *Adverse selection, A* $= \dfrac{E[QL]}{E[Q]E[L]}$

so that A = 1 is neutral, A > 1 is adverse selection.

Note: equivalent to many econometrics papers which define as $\operatorname{cov}(Q,L)>0$.

2. *Adverse selection ratio* $= \dfrac{A}{A_0}$

where A_0 denotes some reference risk classification scheme (e.g. actuarially fair premiums).

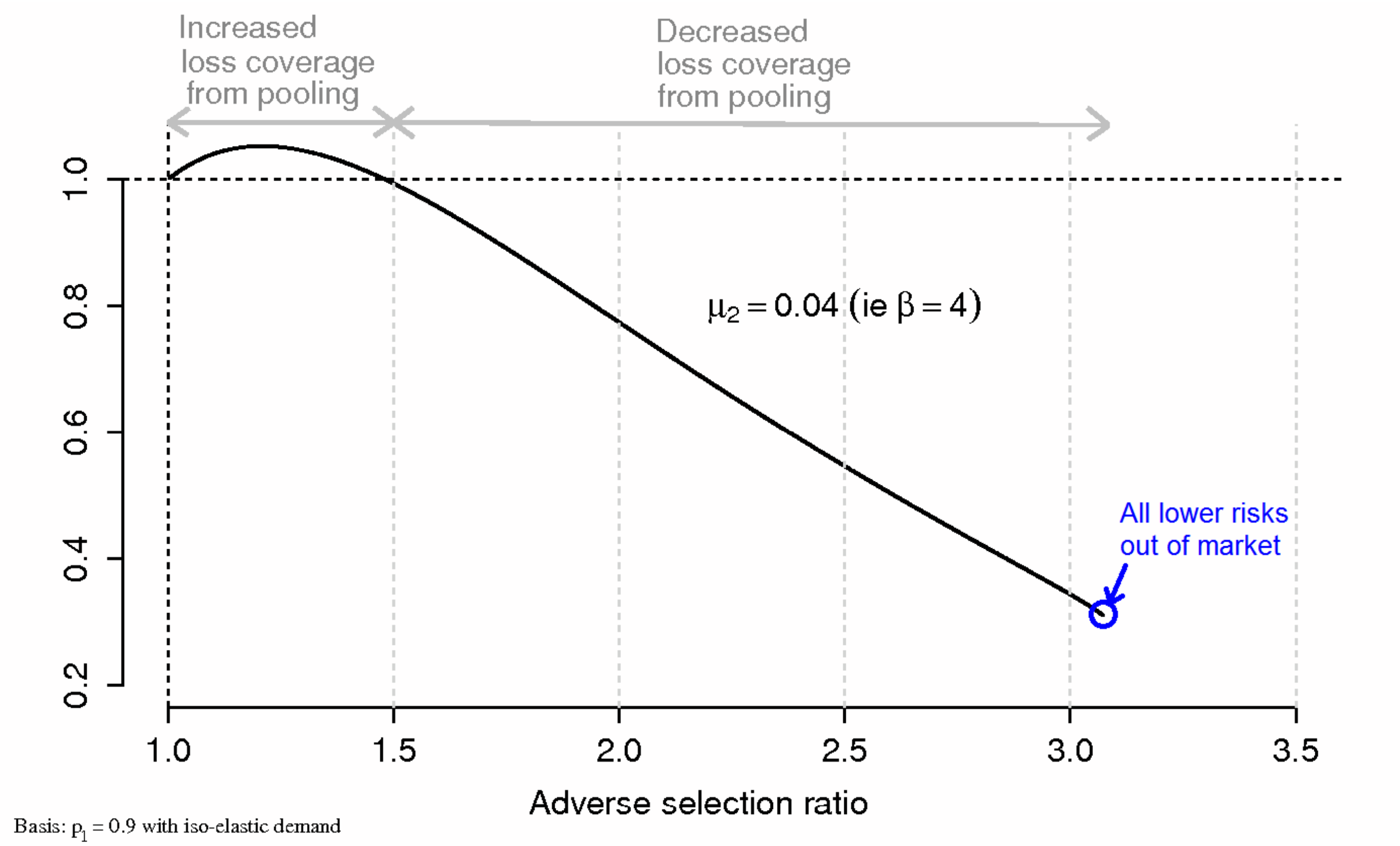
3. *Loss coverage, C* $= E[QL]$

Intuition: the product QL indexes the 'overlap' of cover and losses.

4. *Loss coverage ratio* $= \dfrac{C}{C_0}$

where C_0 denotes some reference risk classification scheme (e.g. actuarially fair premiums).

Loss coverage ratio as a function of adverse selection ratio

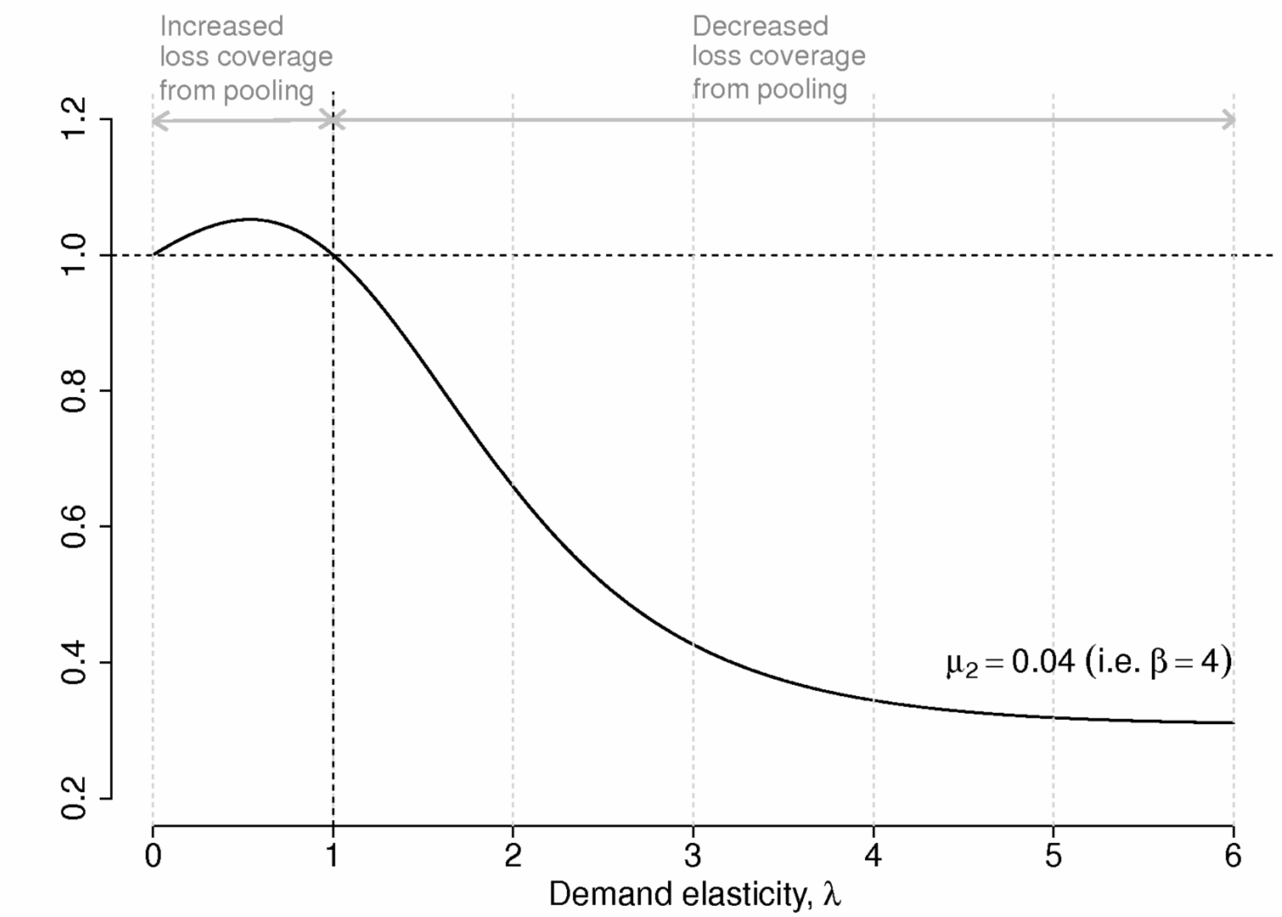


Loss coverage is highest with an intermediate level of adverse selection…

….so we may want some restrictions on risk classification to induce that adverse selection.

Loss coverage ratio as function of demand elasticity

Iso-elastic case

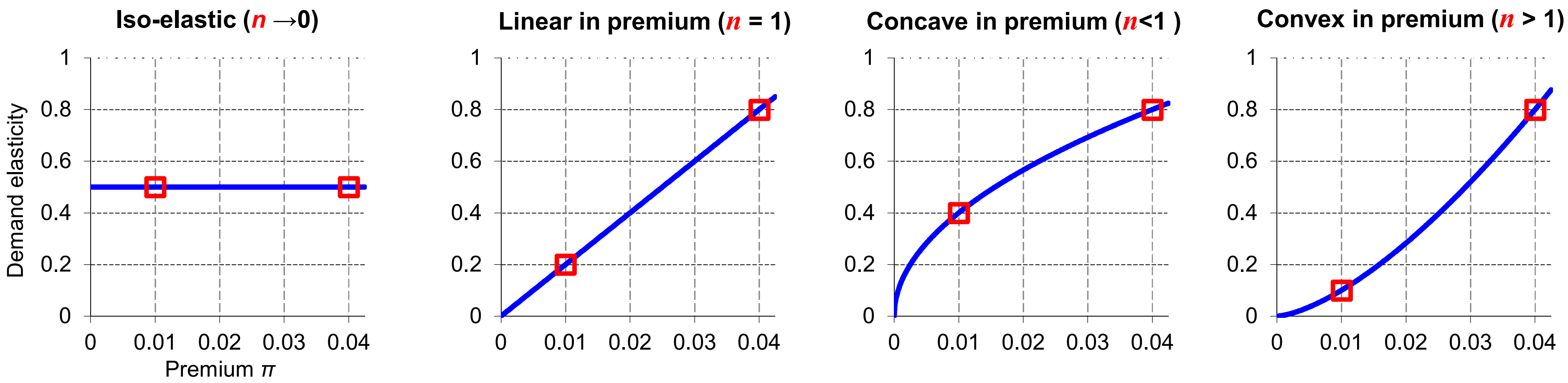


Result (iso-elastic demand):

$$\lambda \gtreqqless 1 \Rightarrow \mathrm{LCR}(\lambda) \lesseqqgtr 1$$

Loss coverage ratio as function of demand elasticity
Range of cases

Suppose elasticity is same function of π for both risk-groups…4 possible patterns…



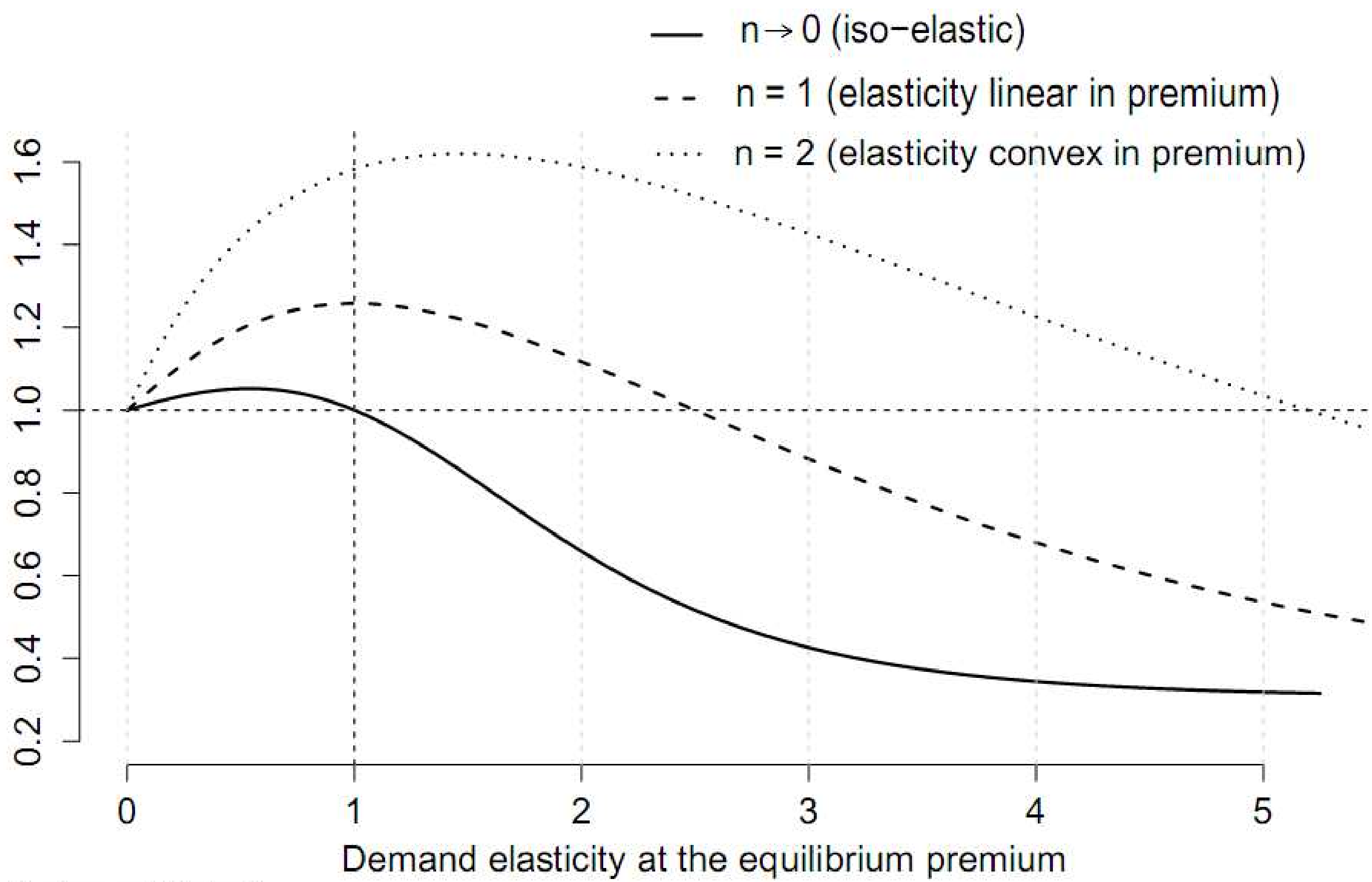
A negative exponential formula can represent all the patterns above:

$$d(\mu_i, \pi_i) = \tau_i \exp\left\{\left[1 - \left(\frac{\pi_i}{\mu_i}\right)^n\right]\frac{\lambda_i}{n}\right\}$$

Parameter n is the "elasticity of elasticity" (or "second-order elasticity").

Loss coverage ratio as function of demand elasticity

Range of simple cases



Basis: $\alpha_1 = 0.9$; $\beta = 4$.

…So iso-elastic demand is actually the 'least favourable' case.

Loss coverage ratio as function of demand elasticity

Fully general case

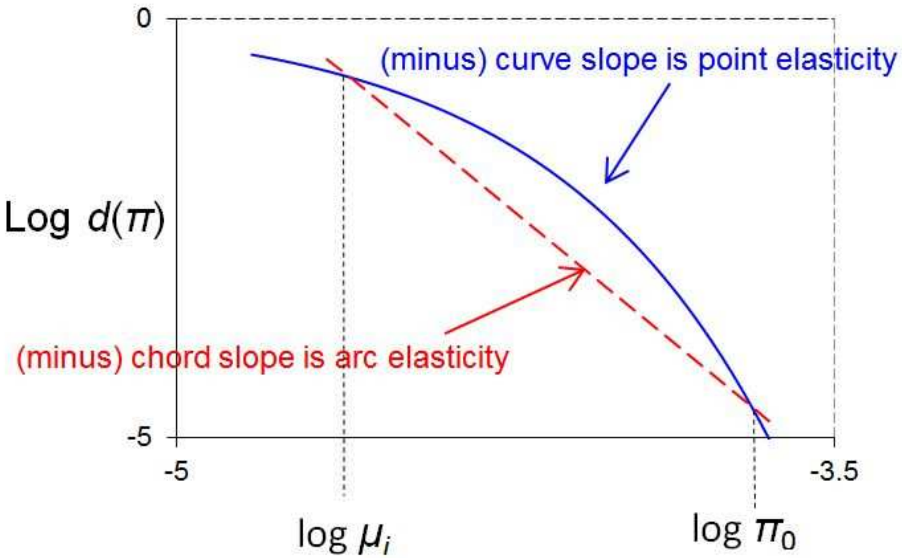
For *any* downward-sloping demand function (possibly different for different risk-groups), and *any* number of risk-groups...

Intuition for stating a general result:
We need to say something about how each risk-group's demand changes when the premium moves from the fair premium μ_i to the pooled premium π_0.

This can be characterised by *arc elasticity of demand*

– loosely, (minus) the percentage change in demand over the arc of the demand curve from μ_i to π_0.

Graphical intuition



Arithmetical intuition

$$\text{arc elasticity} = \frac{\int_{\pi_0}^{\mu_i} \varepsilon_i(s)\, d\log s}{\int_{\pi_0}^{\mu_i} d\log s}$$

"Weighted average of elasticity, with weights of log(premium)"

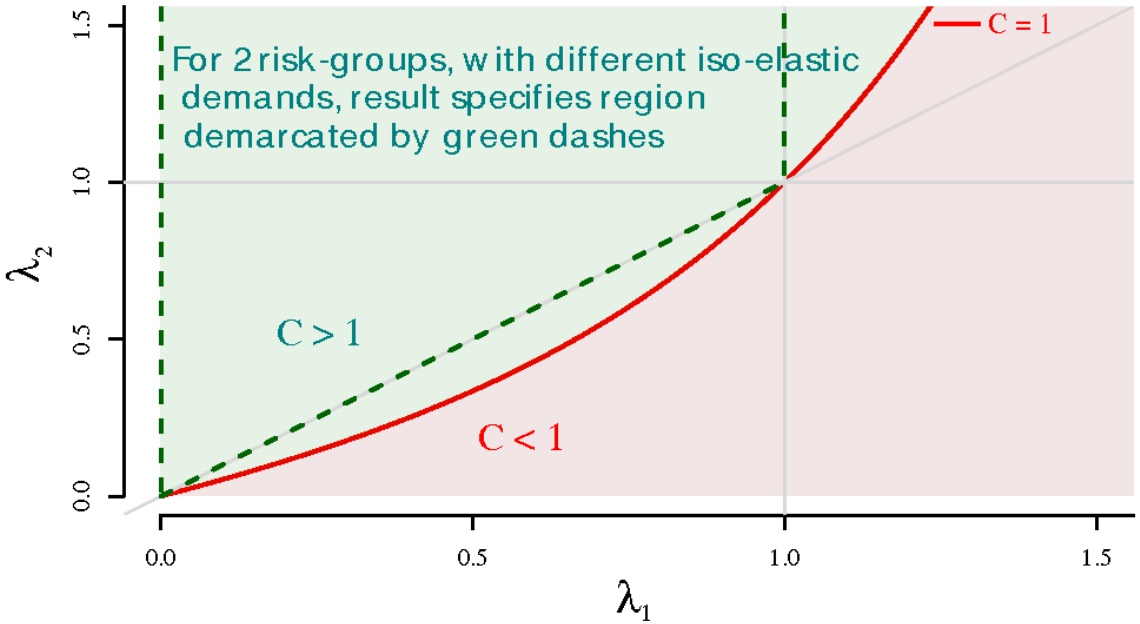
Loss coverage ratio as function of demand elasticity

Fully general case

Result (general demand):

Under pooled equilibrium…

- if arc elasticities of *lower* risk-groups (those paying less than their fair premiums) are *less than 1*, and
- arc elasticities of the *higher* risk-groups (those paying more than their fair premium) *exceed those of all lower risk-groups*
- then loss coverage is *higher* under pooling than under actuarially fair premiums.



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Empirical evidence on demand elasticities

From above, elasticity < 1 seems promising.
Empirically….

Market and country	Estimated Demand Elasticities	Authors
Yearly renewable term life insurance, USA	-0.4 to -0.5	Pauly et al (2003)
Term life insurance, USA	-0.66	Viswanathan et al (2007)
Whole life insurance, USA	-0.71 to -0.92	Babbel (1985)
Health insurance, USA	0 to -0.2	Chernew et al (1997), Blumberg et al (2001), Buchmueller and Ohri (2006)
Health insurance, Australia	-0.35 to -0.50	Butler (1999)
Farm crop insurance, USA	-0.32 to -0.73	Goodwin (1993)

….at least suggestive that relevant elasticities often less than 1.

Insurers' perspective

Maximise loss coverage = maximise premium income

So if profit loadings $\propto$ premiums, not obvious my agenda is bad for insurers!

But in real world where profits are not zero, many actions of insurers appear directed at *minimising* loss coverage

- *e.g.* policy design, small print, claims control

…So in this sense, insurers are *not* trying to maximise loss coverage.

Some things I’ve left out

- Perhaps insurance is not a probabilistic good, but a reassurance good (Chapter 3).
- Perhaps prices are only partially risk-differentiated
  - e.g. banning some variables but not others (Chapter 6).
- Perhaps restrictions on risk classification are justified by concerns other than maximising loss coverage
  e.g. unfairness, pre-existing disadvantage, controllability etc etc (Chapter 7).
- Perhaps adverse selection just isn’t very prevalent (Chapter 8)
- Perhaps adverse selection stories are mainly rhetorical (Chapter 9)
- Perhaps restrictions on risk classification will lead to insurers “screening” high and low risks e.g. by different deductibles
  - rich economics literature, but little evidence (Chapter 10)
- Perhaps adverse selection manifests via choice of larger sum insured
  - But see ‘fallacy of one-shot gambler’ (Chapter 11).

…..still, loss coverage may be a useful idea for an insurance-focused public policymaker

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Summary & next steps

Some adverse selection can be good

Stop telling policymakers (and students) it’s always bad!

Do some plumbing!

Public policy polemics on other topics! (see epilogue)

EPILOGUE
Public policy polemics: other topics

Uncrowded area, so initial returns on research effort potentially high

Why uncrowded? Habit, comfort, compliance → (hopes of) funding.

Some possible topics:

- Zero-sum and negative-sum risk management
  - shifting risk from institutions to individuals, or strong to weak, or more informed to less informed
  - imposing unwanted investment and risk choices on individuals
- Price optimisation in general insurance (Thomas 2012)
- Accident compensation (no-fault schemes; discount rates)
- Big data and privacy preservation (statistical disclosure control)
- Long-term fate of capitalism : $r > g$ (Piketty); high concentrations of wealth assuming equal skills & equal patience (Fernholz)

EPILOGUE
Public policy perspectives: methods

- Pure abstraction not enough
  - for new insights, start with polemics (even if poorly justified)
  - Motivated cognition helps

- Need theories to beat theories
  - evidence should be enough, but in practice it isn't

- Positive as well as normative theories
  - Explaining what is, as well as what should be

- Academic accountants, lawyers have distinct critical traditions…we don't!
  - e.g. *Critical Perspectives on Accounting; Accounting, Organizations and Society; Accounting, Auditing and Accountability,…*
  - *e.g. Critical Analysis of Law; Law and Critique; Journal of Law and Society,…*

- Some may say "not institutional management = not actuarial science!" I say "actuarial science = Yugoslavia!".

APPENDIX
Probabilistic goods versus reassurance goods

Probabilistic good:
- Insurance pays out in certain future states of world
- risk-weighting of coverage appropriately reflects the heterogeneity in the good provided to different individuals.

Reassurance good:
- insurance provides *ataraxia* (freedom from worry) in the present state
- Less clear that risk-weighting appropriately reflects individual heterogeneity. (OK if 4x the risk = 4x the worry...but subjective.)

Like most (all?) quantitative analysts, I view insurance as a probabilistic good.

If insurance viewed as a reassurance good, then arguable that quantum is not necessarily linear in probability of loss.

APPENDIX

Loss coverage in different markets

Market	Perceived social value of compensation of losses	Relevance of insured's personal circumstances	Observed public policy
Motor liability, employer liability	Very high	Nil	Compulsory insurance (100% loss coverage)
Life insurance	High	High (# dependants?)	Voluntary insurance, but regulate risk classification to maximise loss coverage
Pet insurance	Low?	High	Laissez-faire
FCA penalties	Negative	Nil	Insurance banned (0%)