Insurance – Supply and Demand

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Definitions

- What is insurance?
  If one of us will have a $2500 injury this year, with equal probability, then if we each gave $100 (20 of us), we could insure us all from the majority of the cost.
- premium = pay some amount ($100) for insurance
- coverage = amount insured for ($2000)
- copayment = the dollar amount payment you make when each event happens ($50)
- deductible = you must pay this amount first before insurance applies ($150)
- coinsurance = you are required to pay a fraction of the cost if the event happens ($\frac{\$300}{\$2300} = 13\%$)

More definitions

- expected value $= \sum prob(event) * return(event)$
  EV(1 lotto ticket)
  $= .00000001 * \$1m + .000001 * \$100k = \$.11$
- actuarially fair insurance policy = when cost (premium) exactly equals expected benefits (if EV=\$1 and ticket costs \$1)
- utility = economists' term for happiness
- marginal utility of wealth = additional happiness for a given increase in wealth

Demand for Insurance

Why do people buy insurance?

To protect against risk, which people don't like.

The utility of wealth is increasing but concave.

Demand for Insurance

Why is the utility of wealth concave?

- Happier if richer, but not twice as happy if twice as rich
- How happy would \$10 make you if you earned \$100? \$10,000? \$100,000?
- Steep at low levels, flat at high levels

Implication of this concavity:
Having money with certainty makes you happier than having it with some uncertainty – people don't like risk

To show that people don't like risk...

Example: W=\$20, if sick (5% chance), then W=\$10, $U = ln(W)$

Expected value:

$$\begin{aligned} E(W) &= (1 - P(sick)) * W(well) + P(sick) * W(sick) \\ &= .95 * \$20 + .05 * \$10 \\ &= 19.50 \end{aligned}$$

Expected utility without risk:

$$\begin{aligned} U(E(W)) &= U(19.50) \\ &= ln(19.50) \\ &= 2.97 \end{aligned}$$

$\rightarrow$ pt on the U(wealth) curve

Graph

Example continued

In reality, you don't get \$19.50, you get \$10 with a 5% probability and \$20 with a 95% probability.
Expected utility with risk:

$$\begin{aligned} E(U) &= (1 - P(sick)) * U(W(well)) + P(sick) * U(W(sick)) \\ &= .95 * ln(\$20) + .05 * ln(\$10) \\ &= 2.965 \end{aligned}$$

$\longrightarrow$ pt below curve

Graph

Example continued

- 2.97 is the **certainty equivalent** (value if received with certainty) of 2.965 expected with risk
- People will insure even if premium is higher than actuarially fair because will pay **risk premium** to avoid risk
- In this example, $ln(\$19.39) = 2.965$ so risk premium is 11 cents

$$\begin{aligned} U(W) = ln(W) &= 2.965 \\ e^{ln(W)} &= e^{2.965} \\ W &= 19.39 \end{aligned}$$

Graph

How much insurance do people buy?

Such that MB=MC

$$E(U) = P * U(Q(1 - pr)) + (1 - P) * U(X - Qpr)$$

- P = probability of being sick
- pr = premium rate (fraction of insurance coverage)
- Q = insurance coverage amount (how much get if sick)
- X = extra wealth if not sick (assume 0 if sick)

How much insurance do people buy?

$$E(U) = P * U(Q(1 - pr)) + (1 - P) * U(X - Qpr)$$

- MB is difference in $E(U)$ of extra insurance if sick:
  - $Q = 0, P = 1$: $E(U) = 0$
  - $Q = 100, P = 1$: $E(U) = U(100(1 - pr)) = U(100 - 100pr)$
  - MB of add'l \$100 of insurance is utility of (\$100 - premium)
- MC is difference in $E(U)$ of extra insurance if not sick:
  - $Q = 0, P = 0$: $E(U) = U(X)$
  - $Q = 100, P = 0$: $E(U) = U(X - 100pr)$
  - MC of add'l \$100 of insurance is utility of lost premium

How much insurance do people buy?

Because of diminishing MU, as Q goes up:

- MB falls
  extra $Q(1 - pr)$ gives less utility because richer when sick
- MC rises
  extra Qpr takes away more utility because poorer when well

If premium rises, what happens to insurance coverage?

- MB shifts down if pr rises b/c getting $Q(1 - pr)$
- MC shifts up if pr rises b/c paying Qpr
- Q falls

Supply of Insurance

Profit = total revenue - total cost

- Revenue = premiums
- Costs = payout to those who get sick, processing costs
- $\pi = Qpr - PQ - admin$
- e.g. $Q = 500, pr = .10, P = .05, admin = 5$:
  $\pi = \$500 * .10 - .05 * \$500 - 5 = 50 - 25 - 5 = \$20$

What is premium if competitive market?

Competition means that profit goes to 0

$$\begin{aligned}
\pi = Qpr - PQ - admin &= 0 \\
Q(pr - P) - admin &= 0 \\
Q(pr - P) &= admin \\
pr - P &= \frac{admin}{Q} \\
pr &= \frac{admin}{Q} + P \\
pr &= \frac{5}{500} + .05 \\
pr &= 0.06
\end{aligned}$$

Is this actuarially fair?

Actuarially fair?

NO.

- Actuarially fair means expected benefit equals premium

$$E(U) = PU(Q(1 - pr)) + (1 - P)U(X - Qpr)$$

- Expected benefit $= PQ$
- Premium $= prQ$
- Actuarially fair if $pr = P$
- But in competition:

$$pr = \frac{admin}{Q} + P$$

- So, only actuarially fair if $admin \longrightarrow 0$