Demand and supply of health insurance.
Folland *et al* Chapter 8

Chris Auld
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What is insurance?

- From an individual's perspective, insurance transfers wealth from good states of the world to bad states of the world.
- e.g. state of the world is one of: "house burns down," "house doesn't burn down." Buying fire insurance makes you better off in the bad state and worse off in the good state.
- e.g. state of the world is: "Require \$X worth of dental surgery." Buying Blue Cross transfers wealth from good states of the world (\$X is small) to bad states of the world (\$X is large).

Private versus social insurance

- Private insurance is provided on markets. Social insurance refers to government programs.
- Social insurance may be heavily subsidized, e.g., health insurance premiums in Canada are either zero or nowhere near outlays.
- Social insurance acts as both an insurance scheme to reduce risk and often as a redistribution scheme.

Some terminology.

- You pay a **premium** for your insurance which pays **coverage** when some event occurs.
- When the bad event occurs, the fraction you pay is the **coinsurance rate**, and the amount the insurer pays is the **copayment.**
- You may have to pay up to $\$X$ out of pocket, and thereafter insurance kicks in. Your **deductible** is $\$X$.

Decision under uncertainty.

- How do people value uncertain outcomes, like a lottery ticket or an insurance plan?
- Need to extend theory of the consumer to allow for uncertainty.

Expected value.

- The **expected value** of an uncertain outcome is the sum of the possible outcomes weighted by their probabilities.
- e.g. flip a fair coin. If it comes of heads, get two dollar, tails, get nothing. The expected value of this uncertain outcome is

$$
\begin{aligned}
E(\text{wealth}) =& \Pr(\text{heads})(\text{outcome if heads}) \\
& + \Pr(\text{tails})(\text{outcome if tails}) \\
=& (0.5)(2) + (0.5)(0) = 1.00
\end{aligned}
$$

- People are generally not willing to pay the expected value of an uncertain event.
- e.g. Consider this game: flip a fair coin over and over until tails comes up. If the coin comes up heads n times in a row, payoff is 2^n.
- How much would you pay to play?

St. Petersburg Paradox

$$
\begin{aligned}
E(\text{wealth}) &= [(1/2)2^0 + (1/2)^2 2^1 + (1/2)^3 2^2 + ... \\
&= 1/2 + 1/2 + 1/2 + 1/2 + ... \\
&\to \infty
\end{aligned}
$$

But people actually willing to pay a few bucks.

Risk aversion.

- People are generally not willing to pay the expected value of an uncertain event. They are willing to pay extra to avoid risk.
- Basic idea: utility of uncertain outcome $<$ utility of expected value of outcome.
- e.g., you are probably not willing to pay \$5 to play a game in which you have equal chance of getting \$10 or nothing.

Simple example

- Flip a coin. Get \$4 if heads, nothing if tails.
- utility function: $u(w) = \sqrt{w}$.

simple example cont.

- average payout: $EV = (0.5)0 + (0.5)4 = 2$.
- utility under risk: $EU = 0.5\sqrt{p} + 0.5\sqrt{4} = 1$
- utility from certainly getting average payout: $U(EV) = U(2) = \sqrt{2}$.
- certainty equivalent of risky outcome: $U(W^{CE}) = EU = U(1) \rightarrow W^{CE} = 1$.

- Risk aversion implies that an insurance industry may work.
- Consider a population in which each person owns a house worth \$90,000. Each house burns down with (exogenously set) probability 1%. A burned house is worth \$10,000.
- Each person's utility function is $U(w) = w^{1/2}$.
- Houses are people's only assets.

- In the absence of insurance, the utility each person gets is

$$
\begin{aligned}
EU &= 0.01[U(10,000)] + 0.99[U(90,000)] \\
&= 0.01[100] + 0.99[300] = 298.
\end{aligned}
$$

- The expected value of the house is 0.01(100)+0.99(90,000) = 89,200.
- If the consumer faced no risk and owned the expected value of the asset, her utility would be $\sqrt{89,200} =$ 298.66. Risk lowers utility by 0.66 units.
- The certainty equivalent of owning a house which might burn down is 298^2=88,804.
- The consumer is better off if fully insured for any premium less than 90,000-88,804=1,196.

- An insurance firm which offers to fully insure a homeowner pays zero when a house doesn't burn down and \$80,000 when a house does burn down.
- The expected payout from such a contract is then $0.01[80{,}000] = \$800$.
- But the consumer is willing to pay up to \$1,196.
- Any price between \$800 and \$1,196 potentially makes both the firm and the consumer better off.
- The firm sells a very large number of contracts and does not bear (much) risk itself.

More on choice under uncertainty.

- If the utility function $u(w)$ is linear, the uncertain outcome is worth the outcome's expected value to the agent.
- If the utility function is strictly concave, the agent is risk averse, she is willing to pay less than the expected value.
- If the utility function is strictly convex, the agent is risk loving, she is willing to pay more than the expected value.

Demand for insurance

- Consider a slightly richer model in which the consumer with wealth W can buy \$$q$ worth of insurance (insurance which pays off q in the bad state).
- The loss in the bad state is L.
- The premium per dollar of coverage is a. E.g., if a policy which pays \$1,000 in the bad state has a premium of \$100, then $a = 100/1000 = 0.10$.
- The consumer's expenditure to get q coverage is aq.

Demand cont.

- Utility in the good state is then $U(W - aq)$.
- Utility in the bad state is $U(W - L - aq + q)$.
- Expected utility is the utility in the good state times the probability the good state occurs plus utility in the bad state times the probability the bad state occurs.

The supply of insurance

- We have seen that consumers are willing to pay to avoid risk.
- Firms can sell many contracts so that, by a law of large numbers, they face little or no risk.
- Consider a large population of people who face a probability p of incurring q damages.
- Assume it costs the firm t to process the sale of an insurance policy ("loading costs").
- A policy costs \$$aq$, where a is the premium.

The expected profit per claim is

$$
\begin{aligned}
E(\text{profit}) &= P(\text{loss})(\text{profit if loss}) + P(\text{no loss})(\text{profit if no loss}) \\
&= p(aq - q - t) + (1 - p)(aq - t) \\
&= aq - pq - t.
\end{aligned}
$$

In a zero profit equilibrium, expected profits are zero, so

$$
\begin{aligned}
aq &= pq - t \\
a &= p + \frac{t}{q}.
\end{aligned}
$$

Actually fair insurance

- Actuarially fair prices for insurance mean that the the expected value of the insurance is zero, that is, its price is the expected loss.
- e.g., there is a 1% chance your house will be destroyed in an earthquake. The house is valued at 100,000. The actuarially fair fair price to fully insure your house is $1,000.
- Letting t go to zero above, we see that $a = p$ defines actuarially fair insurance in this simple environment.

Actuarially fair insurance cont.

- A consumer who buys q coverage has expected wealth:

$$EW = p[W - L - aq + q] + (1 - p)[W - aq] \quad (1)$$

- Increasing q by one unit then changes expected wealth by

$$\Delta EW = p(-a + 1) + (1 - p)(-a) = p - a \quad (2)$$

If insurance is not fair ($a > p$), expected wealth decreases with q. If insurance is fair, expected wealth does not vary with q.

Numerical example.

- Suppose $q = 100,000$, $p = 0.10$.
- The expected payout is pq=10,000.
- The fair premium is therefore 10,000. Writing the premium as per dollar of coverage: $aq = 10000$, or $a = 0.10$.

Example cont.

- The consumer's expected wealth is

$$\begin{aligned} E(wealth) &= p[W - L - aq + q] + (1-p)[W - aq] \\ &= W - pL - aq + pq \\ &= W - pL - (a-p)q \end{aligned}$$

  So if $a = p$ (insurance is fair), expected wealth is $W - pL$ regardless of how much insurance is purchased.
- If $a > p$ (insurance is unfair), every dollar of coverage reduces expected wealth by $(a - p)$.
- e.g. if $t = 1,000$ and markets are competitive, $a = 0.01 + 1000/100000 = 0.02$. Then $(a - p) = 0.02 - 0.01 = 0.01$, and an extra dollar of coverage reduces expected wealth by one cent.

Fair insurance cont.

- How much insurance would a risk–averse person who faces fair insurance rates buy?
- We know that with fair insurance, expected wealth does not change with q, and also that risk decreases with q until the consumer is fully insured ($q = L$).
- Therefore, a risk–averse person facing fair insurance will fully insure and have the same wealth in all states of the world.
- A risk–averse facing unfair insurance will less than fully insure and have less wealth in the bad state of the world.

Insurance so far

- Risk-averse people are willing to pay to reduce uncertainty.
- Insurers can spread risk over many people.
- Fair insurance—insurance with zero expected value—implies risk-averse people will fully insure.
- When the cost of providing insurance ("loading cost") is positive ($t > 0$), insurance will not be fair and people will not fully insure.

Moral hazard

- Generally, **moral hazard** refers to a change in behavior induced by the presence of insurance.
- e.g., buy a crappy bike lock if you have good bike theft insurance.
- In the context of health care, insurance often changes the price paid out of pocket for care.
- When the price the consumer faces decreases, she may choose to consume more care. This is called moral hazard.
- e.g. Blue Cross pays 50% of a dental procedure. A given person with Blue Cross will be more likely to choose the procedure than if he does not have Blue Cross.

Moral hazard and demand for care

- How much extra care people consume when insured depends on the elasticity of demand.
- (graphs)
- Insurance implies extra resource costs: the insurer must charge a premium that covers the risk and the extra care that an insured person will demand.
- A market might not even form for insurance if moral hazard is a severe enough problem.

- We might then predict:
  1. We should be more likely to see insurance markets against risks with little possibility of moral hazard (e.g., you can buy life insurance but not employment insurance).
  2. More complete insurance against risks with little possibility of moral hazard.

Moral hazard may lead to overuse of health care

- Suppose we imagine we live in a world in which the demand curve is the same as the social marginal benefits world.
- In this world, the competitive equilibrium is efficient.
- A coinsurance rate of less than 1.0 induces consumers to purchase more care than they would if they faced the full price.
- Under these assumptions, too much care is consumed and market prices are too high.
- (graph).

Moral hazard cont.

- Insurance then involves a tradeoff: decreasing the amount consumers pay out of pocket:
  1. increases welfare because it reduces uncertainty
  2. decreases welfare because people do not face the correct incentives to economize on care
- Theory suggests an optimal fraction of the price to be paid out of pocket.
- In Canada, for "necessary" care the actual fraction is zero!