Lecture 3
Economics of Health Insurance

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Today

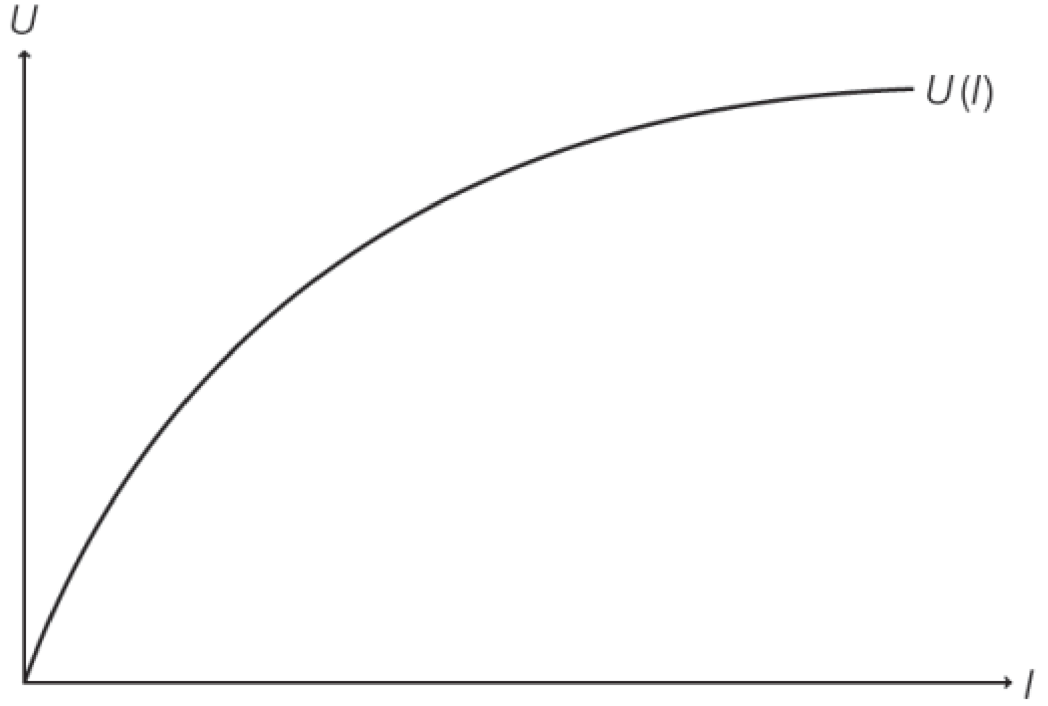
Theory of Health Insurance

- Demand for insurance (Ch.7) continued
- Adverse selection (Ch. 8)

HW1 due next Monday in class

Recall: Utility of a risk-averse consumer

- Utility increasing with income $U'(I) > 0$
- Marginal utility decreasing $U''(I) < 0$ (Concave utility function)



Risk Aversion drives demand for insurance: people refer certain outcomes

→ $U[E(x)] > E[U(x)]$

Where $E[U(X)] = p_1 U(x_1) + p_2 U(x_2) + \cdot \cdot \cdot + p_n U(x_n)$

Example: One will prefer a guaranteed $ 100 to uncertain scenarios with 50/50 chances of having either $ 50 or $ 150.

$U[E(100)] = 170 > E[U(x)] = (50+150)/2 = 150$

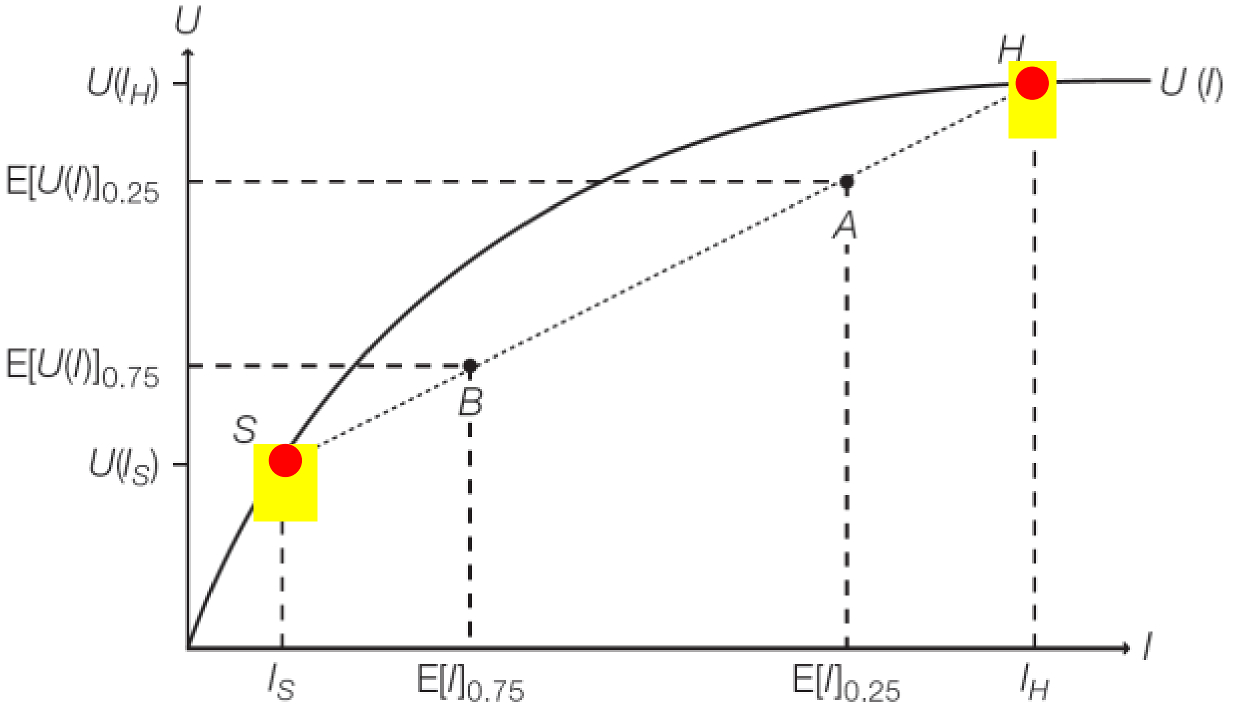
→In this case, even though the expected income of both cases are equal, this individual will prefer the certain payout over the less certain one (i.e. act in a risk-averse manner over the choices available).

Expected utility without insurance

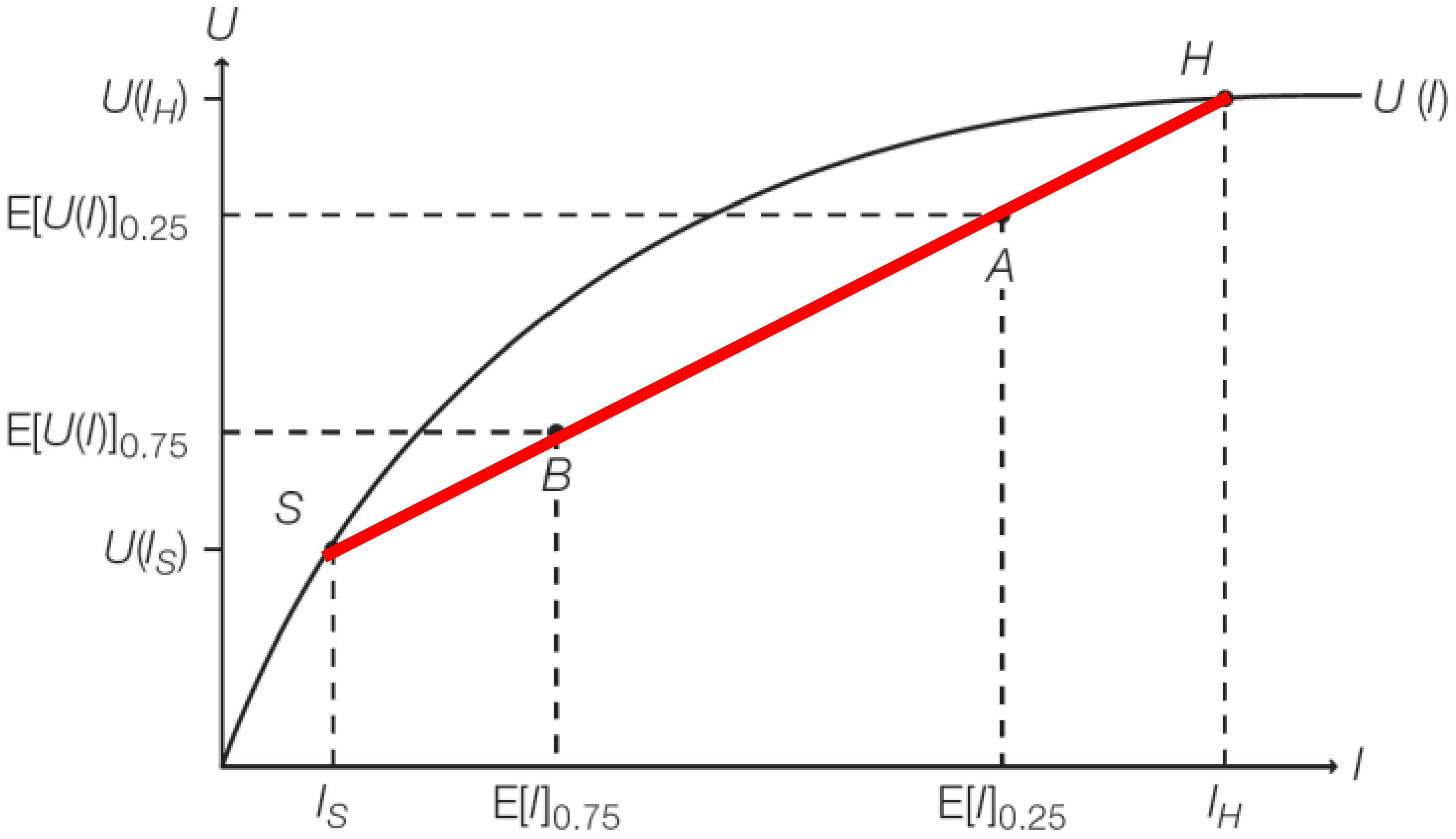
- Again, assume an individual faces uncertainty of being sick. He can be sick and earn $50 (prob. = p) or healthy and earn % 150 (prob. 1-p).

- Consider a case where the person is sick with certainty (p = 1):
    - E[U] = $U(I_S)$ equals the utility from certain income I_S (Point S)

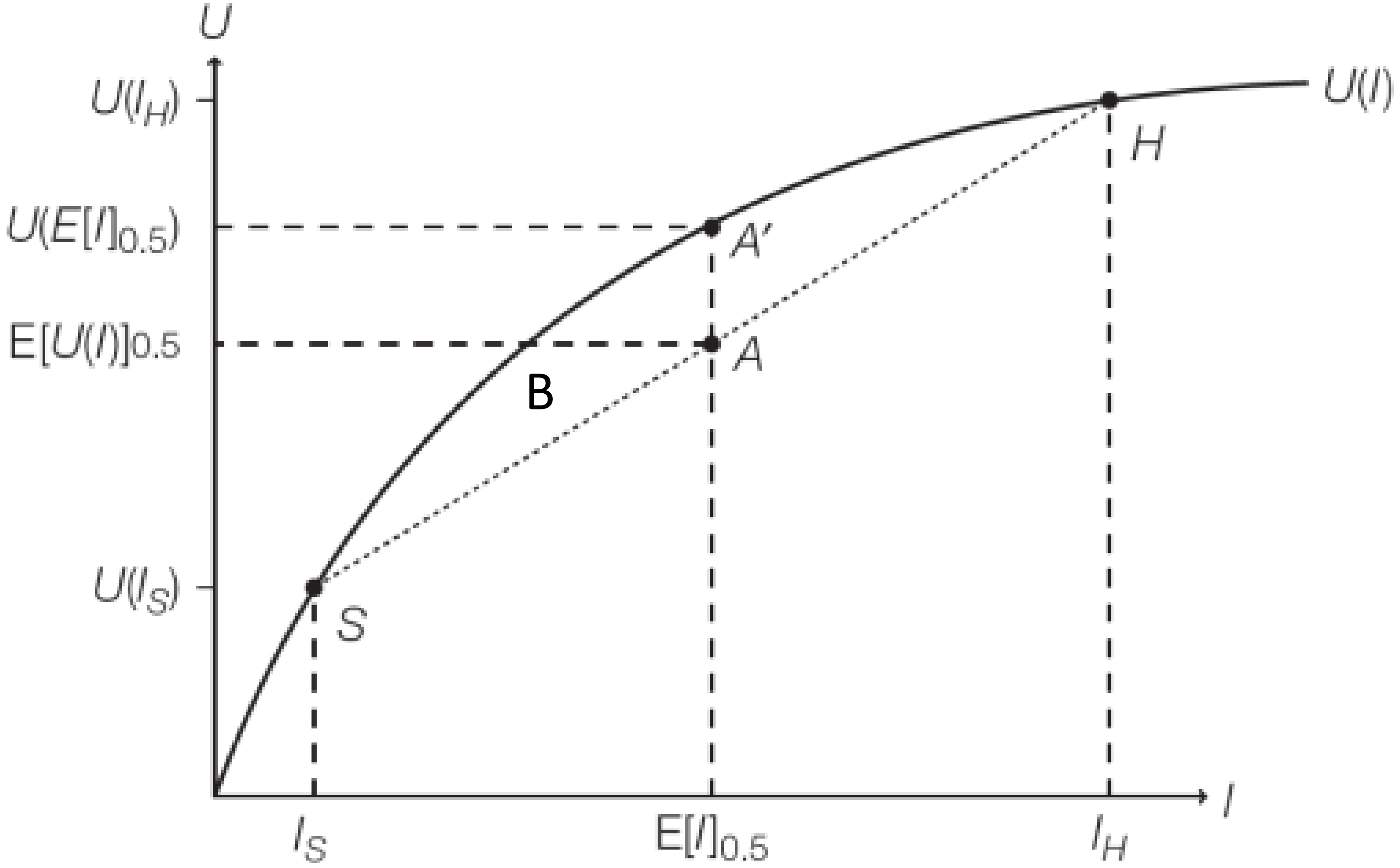
- Consider case where person has no chance of becoming sick (p = 0):
    - E[U] = $U(I_H)$ equals utility from certain income I_H (Point H)



- For p between 0 and 1, expected utility falls on a line segment between S and H



Important distinctions



Now, let’s add insurance…

A basic health insurance contract

- Customer pays an upfront fee
  - Payment r is known as the **insurance premium**
- If ill, customer receives q -- the **insurance payout**
- If healthy, customer receives nothing

- Either way, customer loses the upfront fee r
- Customer's final income is:
  - Sick: $I_S + q - r$
  - Healthy: $I_H + 0 - r$

Income <u>with</u> insurance

- Let I_H' and I_S' be income <u>with insurance</u>
  - Sick: $I_S' = I_S + q – r$
  - Healthy: $I_H' = I_H + 0 – r$

- Remember that risk-averse consumers want to avoid uncertainty
- For them, optimally

$$I_H' = I_S'$$

Full Insurance

- Full insurance means no income uncertainty

$$I_S' = I_H'$$

- Final income is **state-independent**
    - Regardless of healthy or sick, final income is the same

- Risk-averse individuals prefer **full** insurance to **partial** insurance (given the same price)

Full insurance

- State independence implies

$$I_H' = I_S'$$

- So

$$I_H + 0 - r = I_S + q - r$$

$$I_H = I_S + q$$

$$q = I_H - I_S$$

- The payout from a full insurance contract is difference between incomes in good/bad states without insurance.

Full vs. partial insurance

- Partial insurance does not achieve *state-independence*

■ **Full insurance**

$$I'_S = I'_H$$
$$I_S - r + q = I_H - r$$
$$I_S + q = I_H$$
$$q = I_H - I_S$$

■ **Partial insurance**

$$I'_S < I'_H$$
$$I_S - r + q < I_H - r$$
$$I_S + q < I_H$$
$$q < I_H - I_S$$

- Size of the payout q determines the fullness of the contract
    - Closer q is to $I_H - I_S$, the fuller the contract

Actuarially fair insurance

- Actuarially fair means that insurance is a **fair** bet
  - i.e. the premium equals the expected payout (expected value of loss)

    $r = p\ q$

- Insurer makes zero profit/loss from actuarially fair insurance *in expectation*

Insurer: profits

- Now consider the same insurance contract from the point of view of the insurer
  - Premium r
  - Payout q
  - Probability of sickness p
  - E[Π] = Expected profits

$$E[\Pi(p,q,r)] = (1-p)r + p(r-q)$$

$$= r - pq$$

Insurers: Fair and unfair insurance

- In a perfectly competitive insurance market, profits will equal zero

$$\mathrm{E}[\Pi(p,q,r)] = 0 \qquad \Longrightarrow \qquad r = pq$$

  - Same definition as actuarially fair!

- An insurance contract which yields positive profits is called **unfair insurance:**

$$\mathrm{E}[\Pi(p,q,r)] > 0 \qquad \Longrightarrow \qquad r > pq$$

- An insurer would never offer a contract with negative profits

Consumers: Actuarially fair + full insurance

Healthy State

$$\begin{aligned} I'_H &= I_H - r \\ &= I_H - pq \\ &= I_H - p(I_H - I_S) \\ &= pI_S + (1-p)I_H \\ I'_H &= \mathrm{E}[I]_p \end{aligned}$$

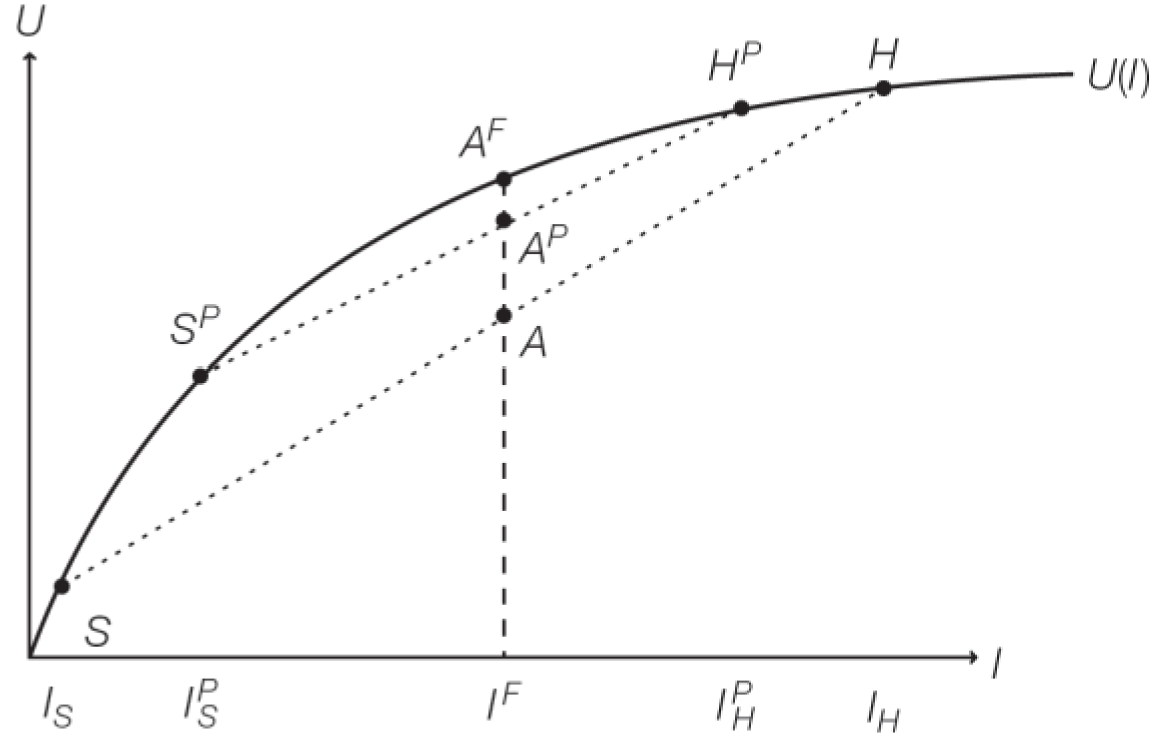
Sick State

$$\begin{aligned} I'_S &= I_S - r + q \\ &= I_S - pq + q \\ &= I_S - p(I_H - I_S) + (I_H - I_S) \\ &= pI_S + (1-p)I_H \\ I'_S &= \mathrm{E}[I]_p \end{aligned}$$

Notice consumers with actuarially fair, full insurance achieve their expected income with certainty!

Comparing insurance contracts

A^F -- Actuarially fair & full
A^P -- Actuarially fair & partial
A – No insurance



$U(A^F) > U(A^P) > U(A)$

What we learnt so far..

- As we have seen, insurance can make this risk-averse individual better off (higher utility) by reducing uncertainty.

- Relative to the state of no insurance, with insurance she loses income in the healthy state ($I_H > I'_H$) and gains income in the sick state ($I_S < I'_S$).
  - In other words, the risk-averse individual willingly sacrifices some good times in the healthy state to ease the bad times in the sick state.

Quiz

- Graphically, what will a full insurance imply? Influence on utility?

- Graphically, what will a actuarially fair insurance imply? Influence on utility?

The ideal insurance contract

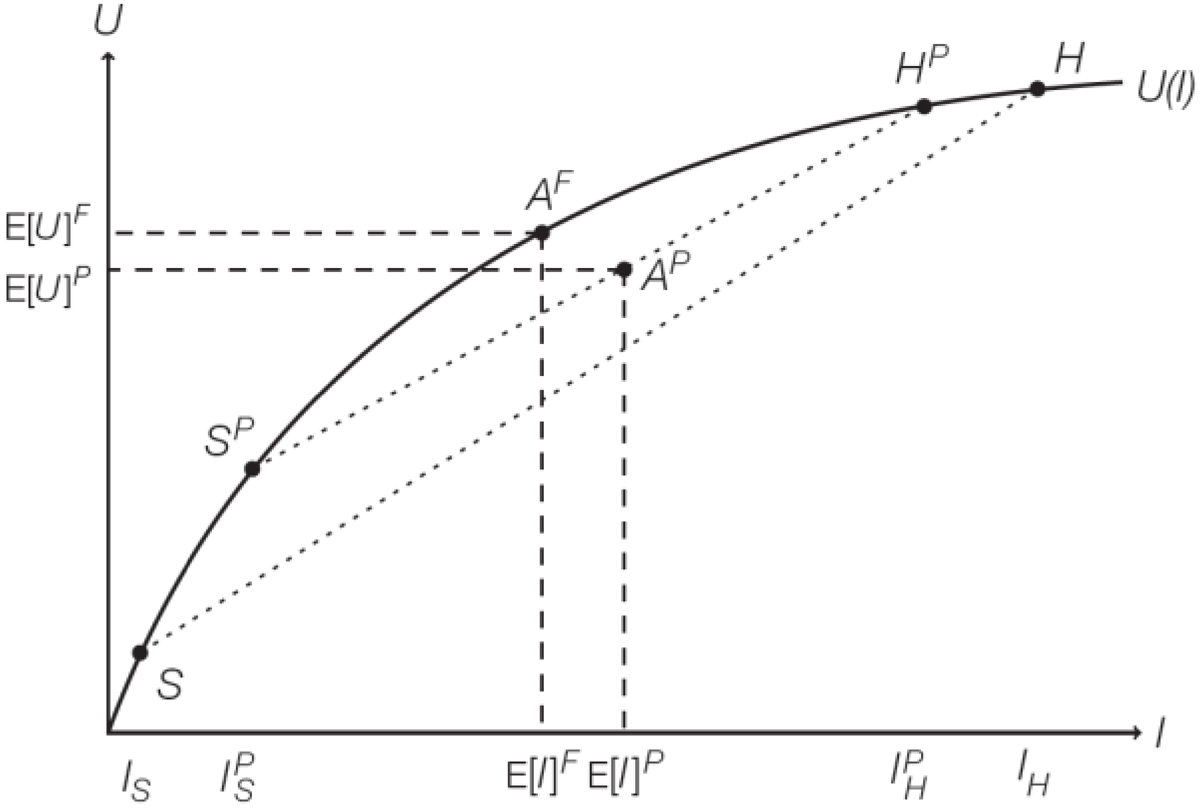
- For anyone risk-averse, actuarially fair & full insurance contract offers the most utility
  - Hence, it is called the **ideal insurance contract**

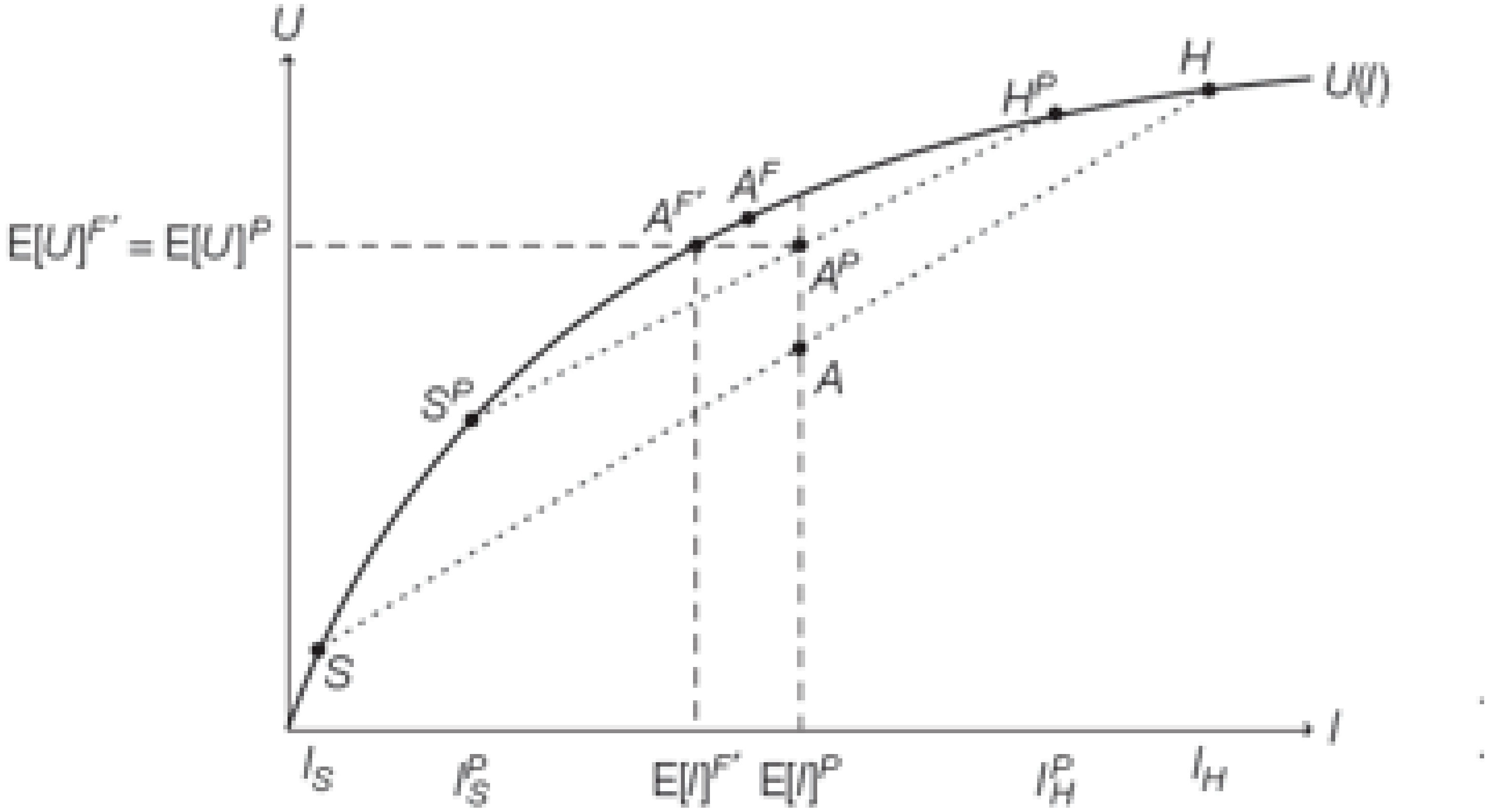
- Ideal and non-ideal insurance contracts:

	Fair	Unfair
Full	$r = pq$ $q = I_H - I_S$	$r > pq$ $q = I_H - I_S$
Partial	$r = pq$ $q < I_H - I_S$	$r > pq$ $q < I_H - I_S$

Comparing non-ideal contracts

- A^F – Full but actuarially unfair contract
- A^P – Partial but actuarially fair contract




U
H
U(I)
H^P
A^F
$A^{F'}$
$E[U]^{F'} = E[U]^P$
A^P
A
S^P
S
I
I_S
I_S^P
$E[I]^{F'}$
$E[I]^P$
I_H^P
I_H

Conclusion

- Demand for insurance driven by risk aversion
  - Desire to reduce uncertainty
  - Diminishing marginal utility from income
  - $U(I)$ is concave, so $U''(I) < 0$
  - $U(E[I]) > E[U(I)]$

- Risk aversion can explain not only demand for insurance but can also help explain
  - Large family sizes
  - Portfolio diversification
  - Farmers scattering their crops and land holdings

Adverse Selection: Akerlof’s Market

Intro

- A man walks into the office of a life insurance company.
- He wants to buy a $1 million life insurance policy for a term of one day. Your company will have to pay $1 million to his family if and only if he dies tomorrow.
- You know nothing else about this man.
- How much do you charge?

Asymmetric Information

- **Definition:** a situation in which agents in a potential economic transaction do not have the same information about the quality of the good being transacted

- *A major theme of this course, and the source of many problems in health insurance markets*

First: symmetric information

- Imagine a well-functioning used car market
- Sellers advertise cars, and buyers can accurately assess the condition of each car for sale
- Some buyers will be willing to pay more for cars in good condition; others are happy to get a deal
- Symmetric information: buyers and sellers have symmetric info about car quality.
- **Outcome**: *each car sells for a different price, depending on its quality*

First: symmetric information

- **Pareto-improving transaction**: a transaction that leaves all parties at least no worse off
- One goal of a market is to make sure all Pareto-improving transactions take place
- In the market we have described, there is nothing to stop all Pareto-improving transactions from taking place
- All the cars end up with the people who value them the most

Next: asymmetric information

- New assumption: sellers can determine car quality, *but buyers cannot*
- All cars look identically good to the buyers
- This market will look different from the previous one in several ways:
  - *any cars that sell, sell for the same price*
  - *The best cars will not be offered on the market*
  - *It is possible that the cars will not end up with the people who value them most (buyers)*

Why is there only one price?

- Imagine that two cars are offered for different prices in this market: $\boldsymbol{P}$ and $\boldsymbol{P'} > P$

- No buyer will want to buy the expensive car, because both cars will seem the same

- All sellers will have to lower their prices to match the lowest price on the market

Why are some cars not offered?

- We know the market has one price *P*
- Consider the seller who owns the nicest car on the market – it is probably worth way more than *P*
  - That seller has no reason to remain in the market
  - Why doesn't he advertise the high quality of his vehicle and charge a higher price?
    - Remember, buyers can't "see" quality
- **Outcome**: only the lower-quality cars stay on the market. This is our first example of ***adverse selection.***

Recall:

- Definition of Adverse Selection:

the oversupply of low-quality goods, products, or contracts that results when there is asymmetric information.

What happens to our market?

- Recap
  - Cars only sell at one price
  - As a result, the best cars leave the market
- What do buyers do?
  - They know the average car remaining on the market is of low quality.
  - Unless buyers value cars very highly, they will not want to buy these cars.
- The market unravels, and potential Pareto-improving transactions do not occur. This is a market failure.

A formal treatment

- Introduce a formal model of the market we discussed in the previous slides with:
  - Explicit utility functions
  - A specific distribution of car quality

to make the argument more concrete.

- But the logic of the argument is the same as what we just saw.

Seller and buyer utility functions

- Sellers and buyers derive utility from the cars they own and other goods
- Buyers value cars 50% more than sellers (that' s why they are buyers in the first place)
- X_j = quality of the *j*th car owned
- M = utility from other goods

$$U_S = \sum_{j=1}^{n} X_j + M$$

$$U_B = \sum_{j=1}^{n} \frac{3}{2} X_j + M$$

Distribution of car quality

- Car quality X is uniformly distributed between 0 and 100

→ Cars are equally likely to have any quality level between 0 and 100

  - You are equally likely to have a car of quality level 50 as you are to have a car of quality 96, 17, π, 54.2828 or any real number between 0 and 100

- We use the term X_i to denote the quality of car i

Information assumptions

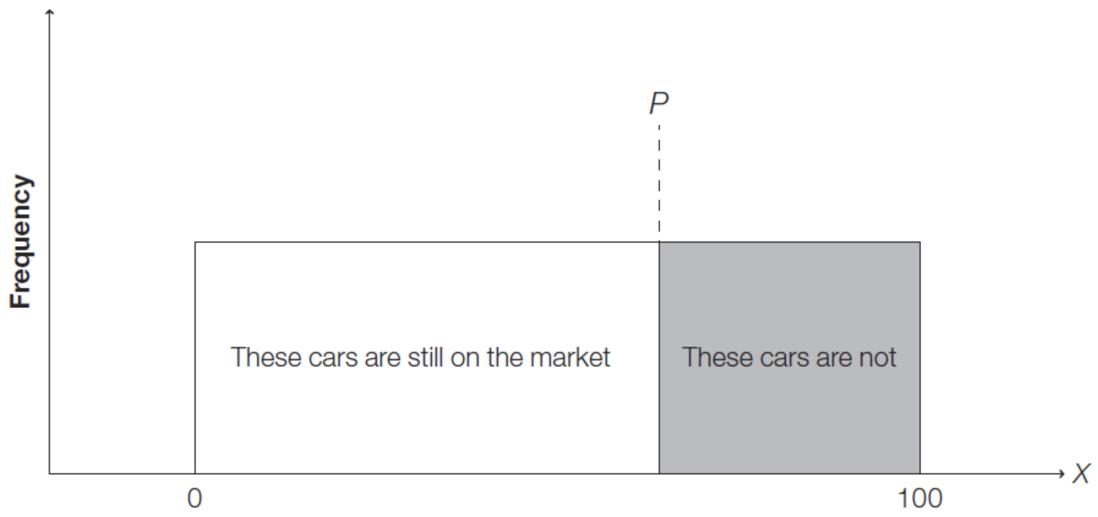
- Buyers do not know the true quality of a particular car.

- Buyers know the *utility function of the sellers* and know the *distribution* of cars available for sale.

- They also understand that sellers will withdraw highest-quality cars if the price does not justify selling.

Which cars will sellers offer?

- A seller will put a car on the market if selling it will increase his utility.
- If a seller sells his car of quality X for P dollars, he loses X units of utility but gains P dollars
- Hence, he will only put car j on the market if $P > X_j$



When will buyers buy?

- Figuring out when buyers buy is trickier due to uncertainty (don’t know the quality of cars).

- Like sellers, buyers are trying to maximize utility. But think about a buyer who is considering buying a car of uncertain quality. How does she know what will happen to her utility?

- Buyers have to think in terms of *expected utility*.

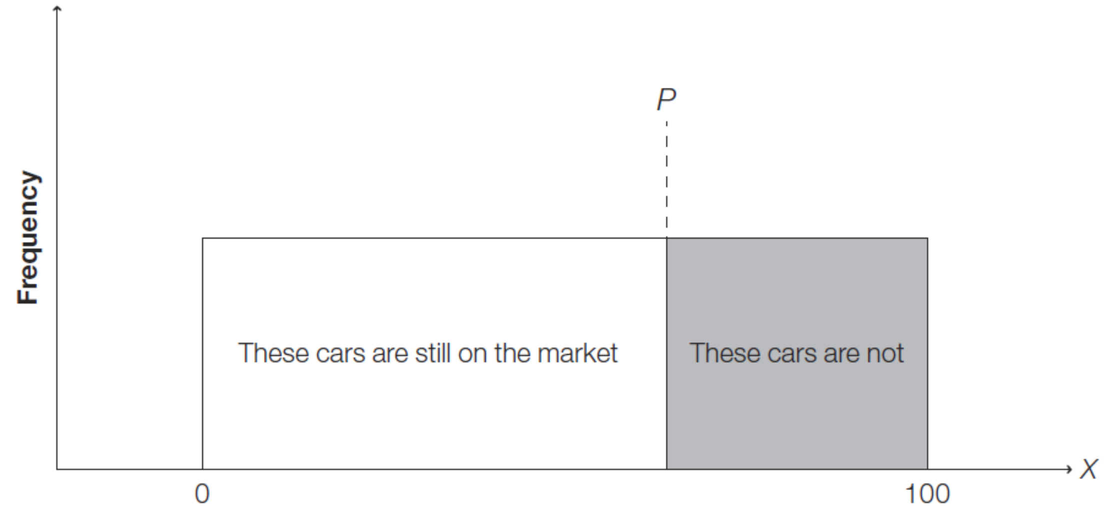
When will buyers buy?

- Suppose a buyer buys a car in this market.
- She pays P dollars and thus loses P units of utility.
- She gains a car with expected value $E[X|P]$, so she gains 3/2 $E[X|P]$ units of utility.
  - Remember, $E[X|P]$ means "expectation of X conditional on P." We need to think about P because it affects sellers' decisions, and hence affects the distribution of quality X.
- Hence, buyers will buy if:

$$\frac{3}{2} E[X_i|P] \geq P$$

When will buyers buy?

- We need to find $E[X|P]$ to decide if buyers will buy
- Remember the distribution of cars now:



- The formula for expectation for a uniform distribution is simply the average of the endpoints. So $E[X|P] = \frac{1}{2} P$

When will buyers buy?

- So $E[X|P] = \frac{1}{2} P$
- We plug that into our condition for buying:

$$3/2\ E[X|P] > P$$

$$3/2 * \frac{1}{2} P > P$$

$$\frac{3}{4} P > P$$

- This is impossible; hence buyers will not buy for any *P*!
- No cars sell, no Pareto-improving trades take place, the cars stay with sellers (who do not want them as much as the buyers do). The market unravels (Pareto-inefficient).

Summary for this car market

- A single price P is somehow established in the market
- Sellers remove all cars of quality greater than P
- Of the cars that remain, the average quality ($E[X|P]$) is only ½ P
- Buyers do not like cars enough to buy a car of quality ½ P for a price of P
- No cars sell, even though buyers like cars better than sellers and all the cars “should” end up with buyers.