Imperfect Information in Health Care Markets

Exercise Session 5 - Insurance Demand & Selection

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Questions?

Exercise 9

Consider the same person as in the previous exercise. Let $p = 0.3$ and suppose the government guarantees a minimum income of 1500. Will the person still buy insurance? Discuss what features of the health care sector are similar to a minimum income guarantee in the model.

$\boxed{9}$ $\quad u(x) = \sqrt{x} \qquad C = 581{,}2$

Government guarantees a minimum income of 1500.

Will the person still buy insurance?

$$\mathbb{E}^{ins.}(u) = \frac{1}{4} \cdot \sqrt{2500 - 1500 + \underbrace{581{,}2}_{C} - \underbrace{0{,}3 \cdot 581{,}2}_{pC}} + \frac{3}{4} \cdot \sqrt{2500 - 0{,}3 \cdot 581{,}2}$$

$$\approx 45{,}55$$

$$\mathbb{E}^{no\,ins.}(u) = \frac{1}{4} \cdot \sqrt{\underbrace{1500}_{\text{minimum income guaranteed by the government}}} + \frac{3}{4} \cdot \sqrt{2500} \approx 47{,}18 > 45{,}55$$

$\Rightarrow$ With an income guarantee, the person will not buy an insurance as the government will pay part of the loss in case it occurs.

$\rightarrow$ government guarantees crowd out insurance

Similar feature in the health care sector:

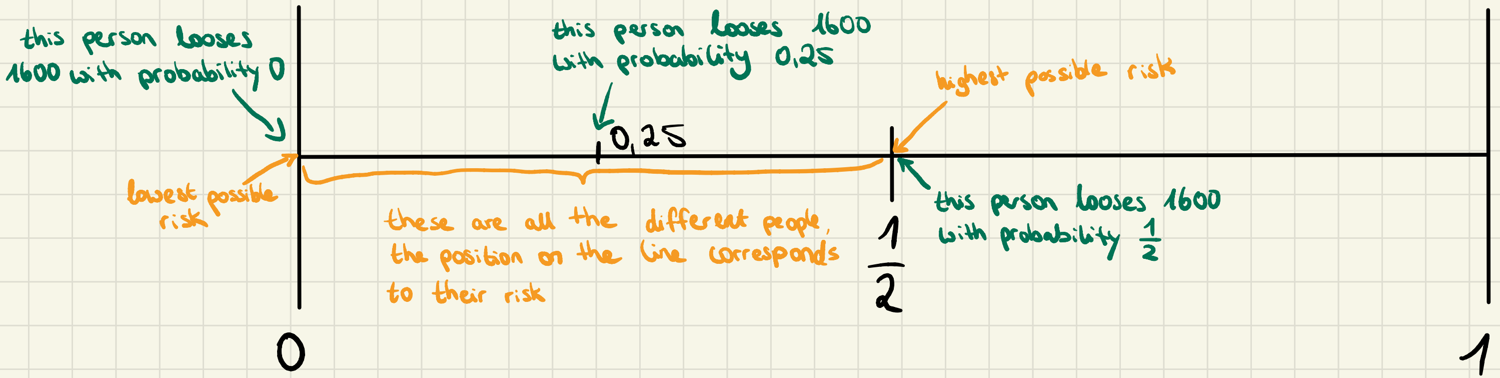
- Hospitals are obliged to treat you, even if you cannot (fully) pay for the treatment.

Exercise 10

a)- e): What is the equilibrium?
f): Why is it inefficient?
g) - j): What can be done to fix this?

We now have a continuum of people of length $1/2$. More precisely, we have a person i for each $i \in [0, 1/2]$. All people have the same utility function $u(x) = \sqrt{x}$ and the same income of 2500. However, they differ in terms of risk: Person i loses 1600 with probability i. We consider an insurance policy with full coverage, i.e. a policy that pays out 1600 in case of a loss. Every person knows his own risk but insurance companies cannot distinguish people (and will therefore have to offer the same premium to everybody).

a) Determine the willingness to pay for the insurance of person i.


this person looses
1600 with probability 0
this person looses 1600
with probability 0,25
highest possible risk
0,25
lowest possible
risk
these are all the different people,
the position on the line corresponds
to their risk
this person looses 1600
with probability 1/2
0
1/2
1

$\boxed{10\,a)}$ $u(x) = \sqrt{x}$

Determine the willingness to pay for the insurance of person i.

Willingness to pay (WTP):

Amount that, if paid, gives you the same utility as the lottery = (maximal) willingness to pay to avoid the lottery.

$$u(\underbrace{2500 - WTP}_{\text{certainty equivalent}}) = \mathbb{E}(u)$$

certainty equivalent $(CE = W - WTP)$

$$\sqrt{2500 - WTP} = i \cdot \sqrt{2500 - 1600} + (1-i) \cdot \sqrt{2500}$$

↳ prob. of loss

$$\sqrt{2500 - WTP} = i \sqrt{900} + (1-i) \cdot 50$$

$$\sqrt{2500 - WTP} = i \cdot 30 + 50 - i \cdot 50$$

$$\sqrt{2500 - WTP} = 50 - 20i \qquad |()^2$$

$$(a-b)^2$$

$$= a^2 - 2ab + b^2$$

$$2500 - WTP = (50 - 20i)^2$$

$$2500 - WTP = 50^2 - 2 \cdot 50 \cdot 20i + (20i)^2$$

$$2500 - WTP = 2500 - 2000i + 400i^2$$

$$2500 - 2500 + 2000i - 400i^2 = WTP$$

$$2000i - 400i^2 = WTP \qquad (= WTP(i))$$

Exercise 10b)

b) For every possible insurance premium, how many people will buy insurance? Use your results to draw the demand for insurance.

10b)

$WTP(i) = 2000i - 400i^2$

Who has the highest WTP?

$i = \frac{1}{2}$ has the highest WTP

↳ the WTP goes up when i goes up

$$\frac{\partial WTP(i)}{\partial i} = 2000 - 800i > 0 \quad \text{for } i \in [0, \tfrac{1}{2}]$$

$$WTP\left(\frac{1}{2}\right) = 2000 \cdot \frac{1}{2} - 400 \cdot \left(\frac{1}{2}\right)^2 = 900$$

⇒ Nobody will buy an insurance if $p > 900$

For every premium p, we know that someone with $WTP(i) = p$ will buy this insurance, as will everybody with $WTP > p$.

$\Rightarrow$ for every p, we look for the person i with $WTP(i) = p$

$$p = WTP(i)$$

$$p = 2000i - 400i^2$$

pq-Formula:

$$x^2 + px + q = 0$$

$$\Rightarrow x_{1,2} = -\frac{p}{2} \pm \sqrt{\left(\frac{p}{2}\right)^2 - q}$$

$$400i^2 - 2000i + p = 0 \quad | : 400$$

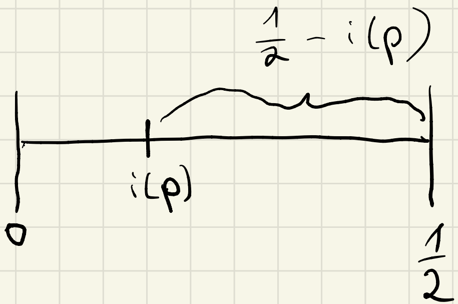
$$i^2 - \underbrace{5}_{p}i + \underbrace{\frac{p}{400}}_{q} = 0$$

$$i = -\frac{-5}{2} \pm \sqrt{\left(\frac{-5}{2}\right)^2 - \frac{p}{400}} = 2{,}5 \cancel{+}\!- \sqrt{6{,}25 - \frac{p}{400}} = \underbrace{2{,}5 - \sqrt{6{,}25 - \frac{p}{400}}}_{= i(p)}$$

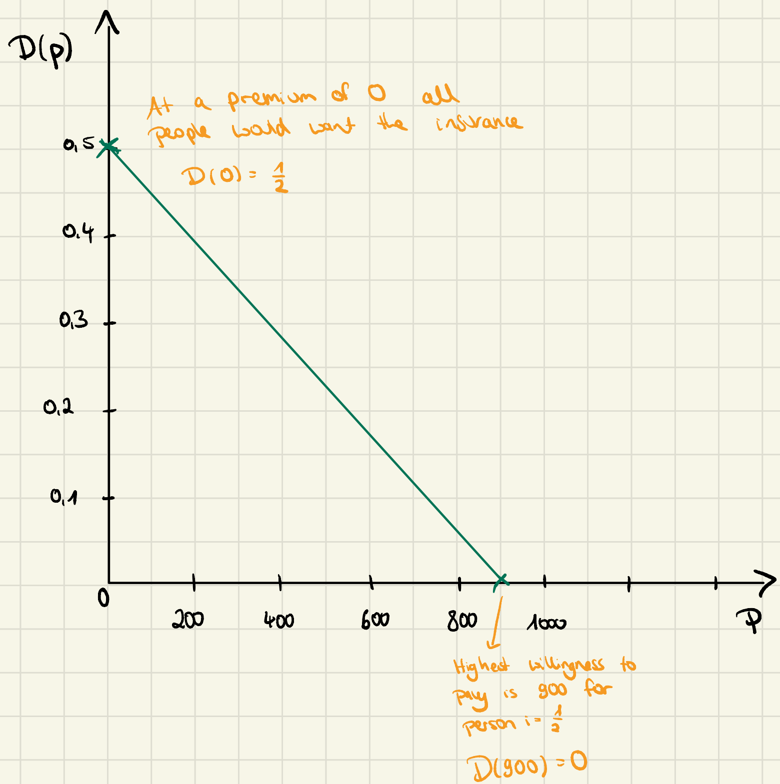
we want $i \in [0, \frac{1}{2}]$

Demand for insurance at premium p:

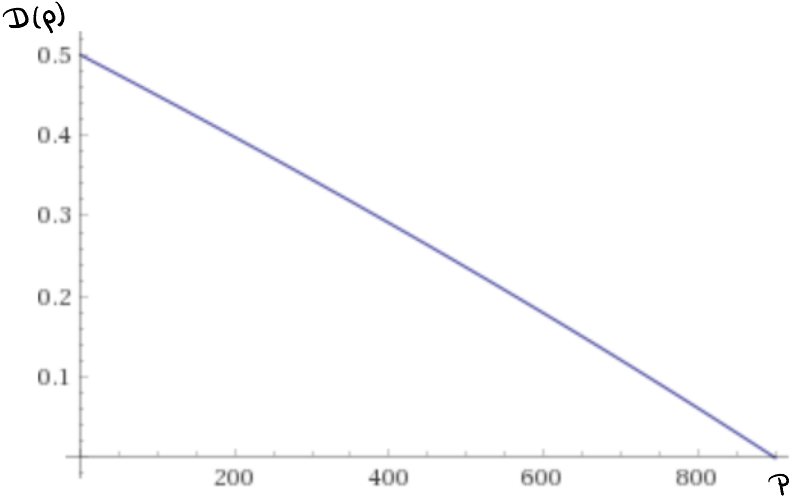
$$D(p) = \underbrace{\frac{1}{2}}_{\text{highest demand possible}} - i(p) = \frac{1}{2} - 2{,}5 + \sqrt{6{,}25 - \frac{p}{400}} = \sqrt{6{,}25 - \frac{p}{400}} - 2$$



Plot the demand function $D(p) = \sqrt{6{,}25 - \frac{p}{400}} - 2$



Plot of $D(p) = \sqrt{6.25 - \frac{p}{400}} - 2$



Exercise 10c)

c) Determine the marginal cost of person i.

$\boxed{10c)}$

Determine the marginal cost of person i.

The marginal cost of person i for the insurance is just

$i \cdot 1600$.

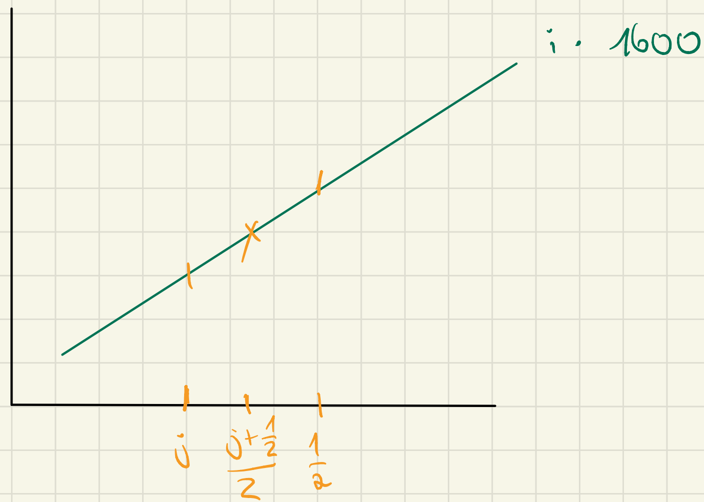
Exercise 10d)

d) Determine the average cost of insuring all people $i \geq j$, i.e. everyone in $[j, 1/2]$.

10d)

Denote average costs of insuring all people in $[j, \frac{1}{2}]$ by $AC(j)$.

We know that for every i in $[j, \frac{1}{2}]$, the marginal costs are $i \cdot 1600$.



$$AC(j) = \frac{1}{2}\left(j \cdot 1600 + \frac{1}{2} \cdot 1600\right) = 800j + 400$$

↳ This just takes the average between both borders of the interval $[j, \frac{1}{2}]$ → the average cost between the lowest and the highest person

Alternatively, you can also compute the integral:

$$\frac{1}{\frac{1}{2}-j}\int_{j}^{1/2} i \cdot 1600\, di = 800j + 400$$

Exercise 10e)

e) If many risk neutral insurance companies with no administrative costs are active on this market, what is the market equilibrium?

$\boxed{10e)}$

Many risk neutral insurance companies with no administrative costs.

↳ perfect competition

What is the market equilibrium?

When there is perfect competition, the premium p will equal the average costs the insurance has from insuring everyone who wants to buy insurance at this premium.

$$AC(i^*) = p = WTP(i^*)$$

i^* is the lowest person who wants to buy insurance at premium p

↳ this holds because the lowest person that buys the insurance is exactly indifferent between buying the insurance and not buying

↳ his WTP is exactly p

$$AC(i^*) = WTP(i^*)$$

$$\Leftrightarrow \quad 400 + 800 i^* = 2000 i^* - 400 {i^*}^2$$

$$\Leftrightarrow \quad 400 {i^*}^2 - 1200 i^* + 400 = 0 \qquad | : 400$$

$$\Leftrightarrow \quad {i^*}^2 - 3 i^* + 1 = 0$$

$$\Leftrightarrow \quad i^* = 1{,}5 \; \cancel{+} \; - \sqrt{\left(-\frac{3}{2}\right)^2 - 1} \approx 0{,}38$$

↳ we look for solution in $[0, \frac{1}{2}]$

$$p = AC(0{,}38) = 400 + 800 \cdot 0{,}38 = 704$$

$\Rightarrow$ In equilibrium the premium will be 704 and the full insurance contract will be bought by everyone $[0{,}38, \frac{1}{2}]$ and everybody else remains uninsured.

Exercise 10f)

f) Is the market equilibrium efficient? If not, determine the size of the inefficiency. What would be welfare in "first best", i.e. in a situation in which everyone with a willingness to pay above marginal cost gets insurance? Determine the relative inefficiency due to adverse selection.

$\boxed{10\,f)}$

Is the market equilibrium efficient?

Compute the total welfare in the equilibrium from e):

$$\int_{0{,}38}^{\frac{1}{2}} \underbrace{WTP(i) - p}_{\text{welfare of person } i} + \underbrace{p - MC(i)}_{\text{welfare of insurance from person } i} \, di$$

$$= \int_{0{,}38}^{0{,}5} WTP(i) - MC(i) \, di$$

$$= \int_{0{,}38}^{0{,}5} 2000i - 400i^2 - 1600i \, di = \int_{0{,}38}^{0{,}5} 400i - 400i^2 \, di$$

$$= 400 \cdot \int_{0,38}^{0,5} i - i^2 \, di = 400 \left[\frac{1}{2} i^2 - \frac{1}{3} i^3 \right]_{0,38}^{0,5}$$

$$= 400 \cdot \left[\frac{1}{2} \cdot 0,5^2 - \frac{1}{3} \cdot 0,5^3 - \left(\frac{1}{2} \cdot 0,38^2 - \frac{1}{3} \cdot 0,38^3 \right) \right]$$

$$\approx 11,584$$

Efficiency: Everyone with WTP > MC is insured

$$WTP(i) - MC(i) = \underbrace{2000i - 400i^2}_{WTP} - \underbrace{1600i}_{MC}$$

$$= 400i - 400i^2 = 400(i - i^2) \geq 0 \text{ for all } i \text{ in } [0, \tfrac{1}{2}]$$

$\Rightarrow$ Would be efficient to insure <u>everyone</u>

Total welfare from insuring everybody:

$$\int_0^{\frac{1}{2}} WTP(i) - MC(i) \, di$$

$$= \int_0^{\frac{1}{2}} 400i - 400i^2 \, di = 400 \int_0^{\frac{1}{2}} i - i^2 \, di$$

$$= 400 \left[\frac{1}{2} i^2 - \frac{1}{3} i^3 \right]_0^{\frac{1}{2}} \approx 33{,}33$$

Relative inefficiency:

$$\frac{33{,}33 - 11{,}584}{33{,}33} \approx 0{,}653$$

$\Rightarrow$ There is quite an efficiency loss due to adverse selection.