Imperfect Information in Health Care Markets

Exercise Session 11 - Moral Hazard

Exercise 26

$D = 200\$$, $M = 10.000\$$

Health insurance plans can often be described by a deductible D, a copayment rate c and a maximal out of pocket amount M: Up to D all expenditures are paid by the insured, for every \$ spent between D and M the insured pays c and the insurance bears all expenses above M.[1] Assume that consumers act as to maximize the utility function $cons - 0.5(2 - s - t)^2$ where *cons* is consumption, i.e. all money left to the consumer after paying for treatment $t \in [0, 2 - s]$, and $s \leq 1$ is a health state. Assume that the consumer has an initial wealth of 4 (net of the insurance premium) and therefore consumption is $4 - t$ if he has no insurance.

a) Suppose the consumer has no insurance (or equivalently $D > 4$). How much treatment will he buy in health state $s \in [0, 1]$?

[1] Hence, the total copayment if expenditures are x is x if $x \leq D$; is $D + c(x - D)$ if $D < x < M$ and is $D + c(M - D)$ for $x \geq M$.

Exc. 26

a) To find the optimal treatment decision t (depending on s), we look for the amount where the marginal benefits (MB) equal the marginal costs (MC)

$$MB \overset{!}{=} MC \qquad (cons = 4 - t)$$

$$\Leftrightarrow 2-s-t = 1$$

$$\hookrightarrow = \frac{\partial(-0{,}5(2-s-t)^2)}{dt} \qquad \frac{dt}{dt}$$

$$\Leftrightarrow t = 1-s \quad (\text{which is in } [0,1] \text{ for } s \in [0,1])$$

mathematical approach: Take first derivative of utility fct.:

$$\max_{t \in [0, 2-s]} \quad 4-t - 0{,}5(2-s-t)^2$$

$$\text{FOC:} \quad -1 - 0{,}5 \cdot 2(2-s-t) \cdot (-1) \overset{!}{=} 0$$

$$\Leftrightarrow -1 + (2-s-t) = 0$$

$$\Leftrightarrow 2-s-t = 1$$

$\leadsto$ consumer will buy treatment of the amount $t = 1-s$.

Exercise 26

b) Suppose the consumer has a coinsurance rate of $c \in [0, 1)$ while $D = 0$ and $M = \infty$. How much treatment will he buy in health state $s \in [0, 1]$?

c) Now let $D = 0.5$, $c = 1/2$ and $M = \infty$. How much treatment will the consumer buy in health state $s \in [0, 1]$?

d) Think now about expected expenditure at the time of insurance purchase (i.e. we do not know the health state yet). Under which conditions on the distribution of health states will an increase in the deductible reduce expected expenditures? What does this imply for the effectiveness of small deductibles in reducing expected expenditures?

Exc. 26

b) With a copayment rate of $c \in [0,1)$, we get:

$$MB \overset{!}{=} MC$$

$\Leftrightarrow 2-s-t = c$ → for 1 € of treatment, I only pay c € $(c<1)$

$\Leftrightarrow t = 2-c-s$ (this is >0, since $s \in [0,1]$)

c) There are now 2 relevant cases depending on t.

First case: $t \leq 0{,}5$ → deductible D

→ $MB \overset{!}{=} MC \Leftrightarrow 2-s-t=1 \Leftrightarrow t = 1-s$ (only consistent, if $s \geq 0{,}5$)

Second case: $t > 0{,}5$

→ $MB \overset{!}{=} MC \Leftrightarrow 2-s-t = c \overset{c=\frac{1}{2}}{\Leftrightarrow} t = 1{,}5-s$ (always consistent as $s \in [0,1]$)

So in total, for $s < 0{,}5$, it is clear that we take $t = 1{,}5-s$ as a treatment choice.

For $s \geq 0{,}5$, we compare the utilities of spending $t = 1-s$ and $t = 1{,}5-s$:

$$\frac{1}{8} = 0{,}125$$

$u(1-s) = 4-(1-s)-0{,}5\cdot 1^2 = 2{,}5+s$ (for $s \geq 0{,}5$, $1-s$ is $\leq$ the deductible $0{,}5$)

$u(1{,}5-s) = 4 - \boxed{\left(0{,}5 + \frac{1{,}5-s-0{,}5}{2}\right)} - 0{,}5\,(2-s-(1{,}5-s))^2 = 2{,}875 + \frac{s}{2}$ (for $s \in [0{,}5;1]$, we have $1{,}5-s \geq 0{,}5$)

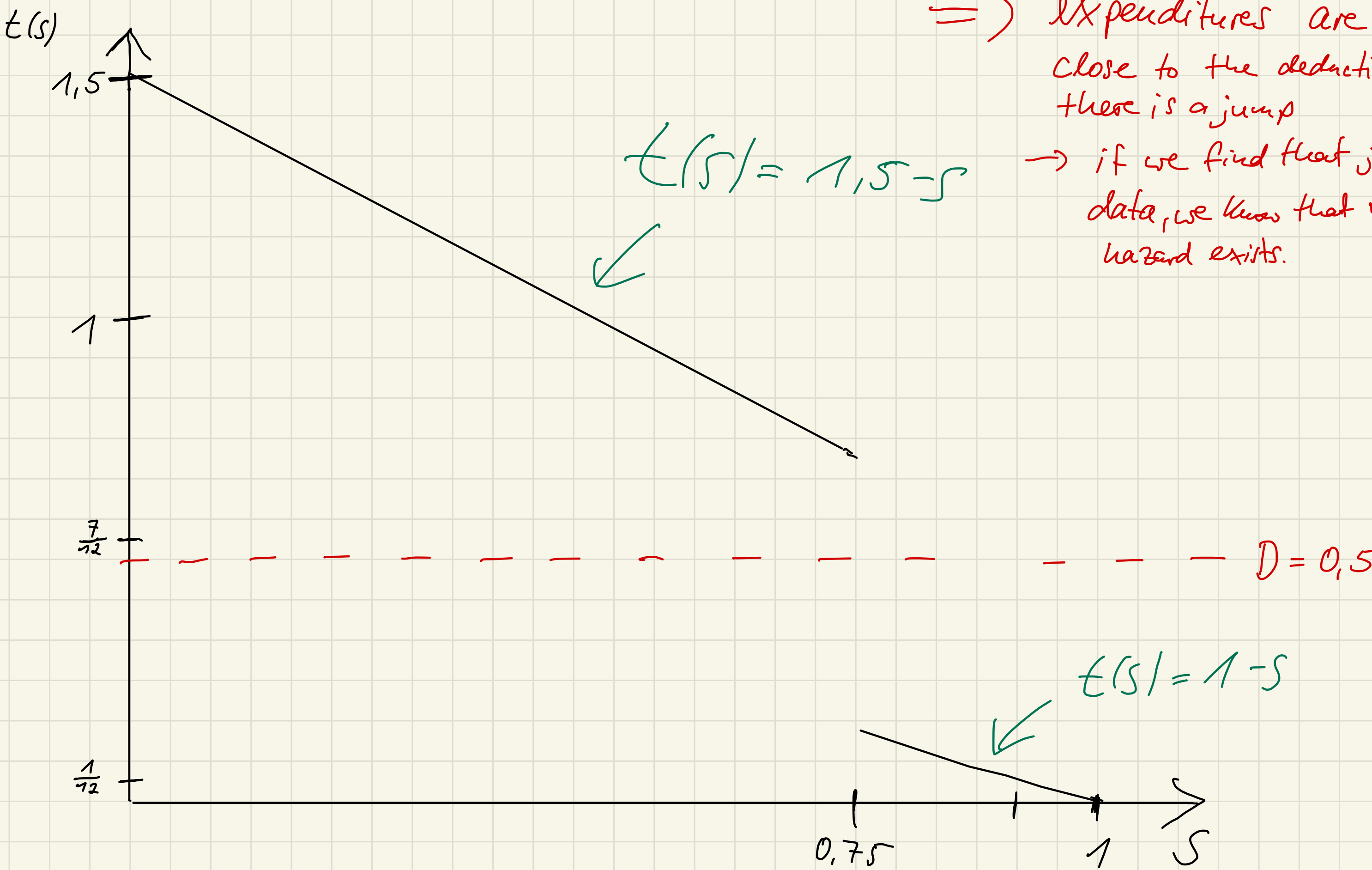
$= 4-\left(0{,}5+\frac{1}{2}-\frac{s}{2}\right) - 0{,}5\cdot(0{,}5)^2 = 3+\frac{s}{2}-\frac{1}{8}$

From this, we can see that for high s (e.g. $s \approx 1$), we prefer $t = 1-s$ and for low s, we prefer $t = 1{,}5-s$.

The threshold is given by $2{,}5+s = 2{,}875+\frac{s}{2}$

$\Leftrightarrow \frac{s}{2} = 0{,}375 \Leftrightarrow s = 0{,}75$

Exc. 26 c)



$\Rightarrow$ Expenditures are never close to the deductible, but there is a jump

$\rightarrow$ if we find that jump in the data, we know that moral hazard exists.

26. d) Consider an increase in the deductible from D_1 (1€) to D_2 (5€). Then, expenditures are only affected if health states in which we want to spend between D_1 and D_2 (under D_1) have positive probability / share in the population.
Otherwise, there is no difference between D_1 and D_2.

$\Rightarrow$ small deductibles have practically no effect on expenditures as they can prevent only small expenditures and have no effect on big spenders that cause the majority of health care expenditures.

Exercise 27

Suppose a study like the RAND health insurance experiment could be redone for $ 200 million. On what should the new study focus, i.e. how should it be different from the old one? Do you think it would be worth the money?

Exc. 27

What such a new study could focus on:

- potential for consumers to shop for value in health care
- inpatient care that may or may not be prevented by generous drug benefits
- mental health treatment approaches
- health savings accounts
- other forms of cost sharing (e.g. in Germany the "Quartalspauschale")
- maybe focus more on deductibles rather than copayment

⇒ could well be worth the money since potential savings are very high

Exercise 28

A consumer has wealth $W = 64$ and faces a potential loss of $L = 15$. The consumer has to decide whether to "be careful" or not. If he is careful, the loss realizes with probability $1/4$. If he is not careful, the loss realizes with probability $1/2$. Being careful costs (the money equivalent of) 1 unit of income. (The consumer is a risk averse expected utility maximizer and you can assume $u(x) = \sqrt{x}$.)

a) Consider the situation where the consumer is not insured. Will he be careful?

b) Consider the situation where the consumer is fully insured at premium $p > 0$. Will he be careful?

Exc. 28

a) Consumer is careful: $E(u) = \frac{3}{4} u(\overbrace{W-1}^{\text{cost of being careful}}) + \frac{1}{4} u(W-L-1)$

$= \frac{3}{4} \cdot \sqrt{63} + \frac{1}{4} \cdot \sqrt{48} \approx 7{,}68$

consumer is not careful: $E(u) = \frac{1}{2} \cdot u(W) + \frac{1}{2} \cdot u(W-L)$

$= \frac{1}{2} \cdot \sqrt{64} + \frac{1}{2} \cdot \sqrt{49} = 7{,}5$

$\Rightarrow$ the consumer will be careful if he has no insurance

b) with full coverage insurance:

$E(u)_{careful} = u(W-p-1)$

$E(u)_{careless} = u(W-p) > E(u)_{careful}$

he will not be careful due to moral hazard

Note: Being careful is socially desirable as the expected benefit is $\frac{15}{4}$ and costs are only 1.

probability of losing 15 reduces by $\frac{1}{4}$

Exercise 29

A consumer with Bernoulli utility $u(x) = -x^2 + 10x$ has wealth $W = 4$ and faces a potential (money equivalent) loss $L = 2$ which realizes with probability $\alpha = 1/2$. If the loss realizes the consumer can (partially) make up for the loss by treatment $M \in [0, 2]$. The insurance will cover qM of these treatment expenditures for some coverage rate $q \in [0, 1]$. Treatment M will mitigate the loss to $L - 2M + M^2/2$.

a) If the consumer is ill, what treatment intensity $M^*(q)$ will he choose?

b) (numerical) Assume that the insurance premium is fair, i.e. $p = \alpha q M^*(q)$. Write down the consumers expected utility. Which q maximizes expected consumer utility? How and why does this result differ from models without moral hazard?

Exc. 29

a) First, note that $u'(x) = -2x + 10 > 0$ for $x < 5$

$\rightarrow u(x)$ is a positive monotone transformation of x in this case (as income will be between 0 and 4)

$\hookrightarrow \tilde{u}(x) = x$

$\Rightarrow$ If the consumer is ill, he solves the following problem: (as we can also just use the utility function $u(x) = x$)

$$\max_{\mu \in [0,2]} \quad W - p - \underbrace{L + 2\mu - \frac{\mu^2}{2}}_{\text{(mitigated) loss part}} - \underbrace{(1-q)\mu}$$

($q \cdot \mu$ is paid by insurance)

FOC (first-order-condition) :

$$2 - \mu - (1-q) \overset{!}{=} 0$$

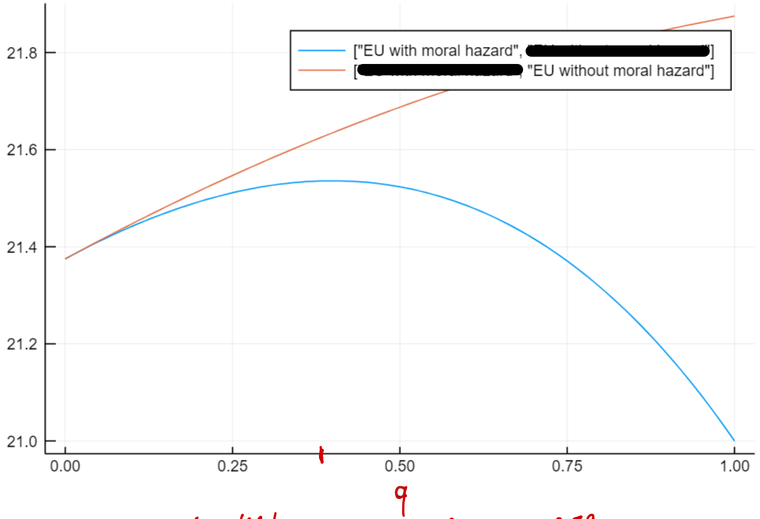
$$\Leftrightarrow \mu^*(q) = 1 + q$$

b) Consumer's expected utility:

$$U = \underset{\text{loss case}}{\alpha} \cdot u\Big(W - \underbrace{L + 2\mu^*(q) - \frac{\mu^*(q)^2}{2}}_{\text{Loss}} - \underbrace{\alpha \cdot q \cdot \mu^*(q)}_{\text{premium}} - \underbrace{(1-q)\,\mu^*(q)}_{\text{own costs of treatment}}\Big)$$

$$+ \underset{\text{no loss case}}{(1-\alpha)}\, u\big(W - \underbrace{\alpha q\, \mu^*(q)}_{\text{premium}}\big)$$

Optimal coverage level with Moral Hazard



→ Consumer's utility is maximized for $q \approx 0{,}39$

29. b) (continued)

This result is interesting since without moral hazard, a risk-averse consumer would always prefer more coverage over less coverage (at a fair premium).

The problem here is that with higher coverage, the consumer adjusts his behavior (overconsumption) and pays a higher premium (which he dislikes).

This is why the optimal coverage level for the consumer with the presence of moral hazard is smaller than 1 (partial coverage only).