LECTURE 5: Physician-~~Patient~~ Patient Interaction

① DRANOVE 1988 : MD-induced demand

- patient and providers get separate signals about severity
  ↓
  information asymmetry!
- MDs are profit-motivated

- EXAMPLE: ① you check your temperature (s_p) } ③ taken together, doc recommends treatment $t \in \{\underline{t}, \bar{t}\}$ ($\bar{t} > \underline{t}$)
  ② Doc orders chest x-ray (s_d)
  ↳ patient can't do this

① also involves choosing to go to MD at all.

④ Based on recommendation t, consumer updates signal s_p and accepts or rejects treatment
↳ patients know MDs have a profit motive (FFS) and respond accordingly.

- Intuition-Building: see Liu + Ma (2013) for relaxing this

Q: If MDs are purely profit-driven ($\alpha = 0$), what kind of recommendation would they make?
↳ But then, how would patients respond to s_d?
↳ Is this a Nash equilibrium? Is it a good one?

Q: What can doctors do to get s_D taken seriously? Commit rule

$$r(s_D) = \begin{cases} \bar{t} & s_D \geq \bar{s}_D \\ \underline{t} & s_D < \bar{s}_D \end{cases}$$

⇒ $\boxed{\text{Choose a treatment cutoff}}$
⇒ (normalize to $\underline{t} = 0$ from here on.)

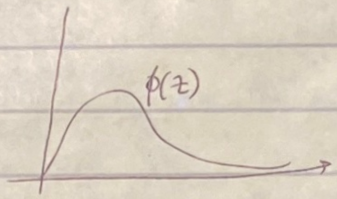
↳ So what is physician's optimal $r(s_D)$? Can't be too strict or too lax.

- Full Model (ish)

FINDING THE EQBM.
→ MD has to know when patient will choose to accept treatment to max own u^p
→ MD chooses $r(\cdot)$ given

Dranove model continued:

- Underlying severity $z \in \mathbb{R}$ with density $\phi(z)$



z — severity →

- severity is linked to signals $f(s_D|z)$, $g(s_p|z)$ ⟹ gives posteriors $j(z|s_i^?)$

- PATIENT UTILITY: $U^P = M + \mu(E - P(t))$

↑ health ↖ utility-wealth link → Price of treatment, $P(t)$

$$M(z,t) = \begin{cases} -\pi(z) & t = 0 \\ 0 & t \in \{\underline{t}, \bar{t}\} \end{cases}$$

Hence $U^P(\text{no treatment}) = -\pi(z) + \mu(E)$ ⟹ if z is unobserved, this is approximated as

$U^P(\text{treatment}) = \mu(E - P(t))$

⇓

$$EU^P(\text{no treatment}) = -\int_{-\infty}^{\infty} \pi(z) \underbrace{j(z|s_p)}_{\text{weighted by how likely signal is}} dz + \mu(E)$$

↑ given health outcome

Patients choose to seek treatment ⟺ $\underbrace{\mu(E - P(t)) \geq -\int_{-\infty}^{\infty} \pi(z) j(z|s^P) dz + \mu(E)}$

defines a cutoff $\bar{s}^P(s^P)$ to seek treatment

- Physician utility: $U^d(Y, W)$ $U_Y > 0$, $U_W < 0$ [note: $\alpha = 0$]

Monopolist; ↗ income; ↳ work disutility

Who gets treatment? ρ % of patients:

$$\rho = \int_{-\infty}^{\infty} \int_{\bar{s}_D}^{\infty} \int_{\bar{s}_p}^{\infty} g(s_p|z) f(s_D|z) \phi(z) \, ds_p \, ds_D \, dz$$

↑ who goes to doctor?

↳ who gets treatment recommended? (and accepts)

$\boxed{\text{Note } \rho(P, \bar{s}_D)}$ ⟹ these are MD choice variables (are they? what's missing?)

Dranove continued:

- MD chooses p and $\bar{S}_D$ to maximize utility.
- ~~FOCs are~~

$p\!p$: normalize to 1

$$U \text{ is } \quad U^D = U\Big[\underbrace{Q_P(p, \bar{S}^D)\times P}_{\text{revenue}},\ \underbrace{Q_P(p, \bar{S}^P)}_{\text{workload}}\Big]$$

FOCs are: $\cancel{\frac{\partial U^D}{\partial p} = \frac{\partial U}{\partial Y} Q_P(p,\bar{S}^D) \frac{\partial p}{\partial p} + \frac{\partial U}{\partial W}\frac{\partial p}{\partial p} = 0}$

① $$\frac{\partial U}{\partial \bar{S}^D} = \frac{\partial U}{\partial Y}\cdot P\frac{\partial p}{\partial \bar{S}^D} + \frac{\partial U}{\partial W}\cdot\frac{\partial p}{\partial \bar{S}^D} = 0$$

$$\Rightarrow (PU_Y + U_W)\underbrace{p_{\bar{S}^D}}_{} = 0$$

↳ solved only if $p_{\bar{S}^D} = 0$, so $\boxed{\bar{S}^D \text{ is chosen to maximize } p}$

② $$\frac{\partial U}{\partial P} = \frac{\partial U}{\partial Y}\left(\frac{\partial p}{\partial P}\cdot P + p\right) + \frac{\partial U}{\partial W}\frac{\partial p}{\partial P} = 0$$

$$\Rightarrow U_Y(p\epsilon + p) + U_W\left(\epsilon\cdot\frac{p}{P}\right) = 0, \quad \text{where } \epsilon = \underbrace{\frac{\partial p}{\partial P}\frac{P}{p}}_{\text{elasticity of demand}}$$

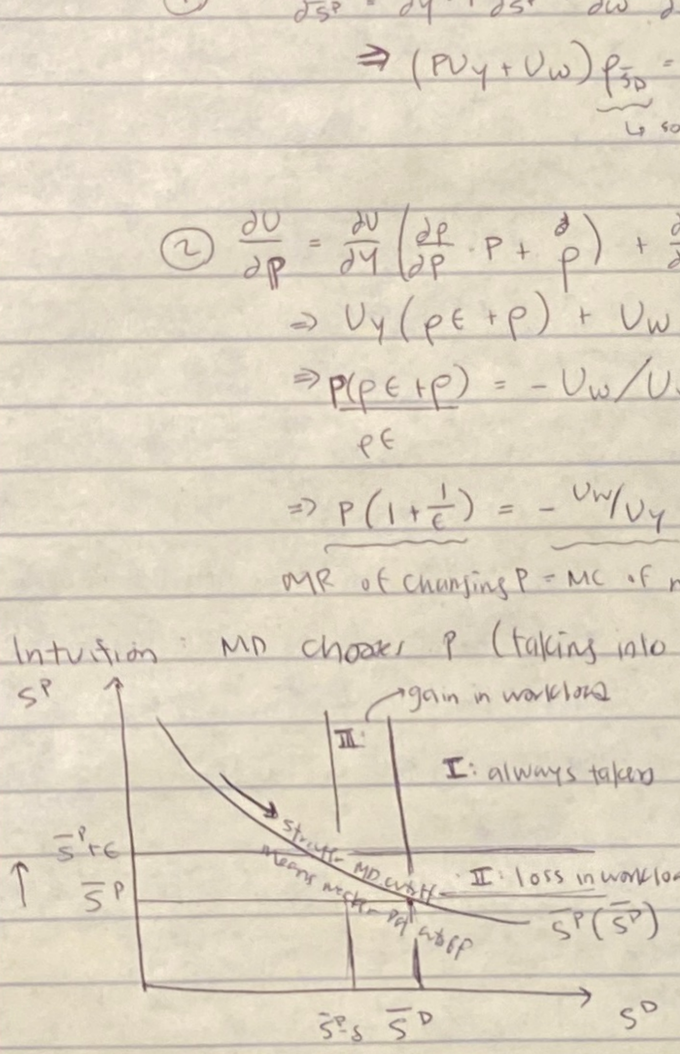
$$\Rightarrow \frac{P(p\epsilon + p)}{p\epsilon} = -U_W/U_Y$$

$$\Rightarrow \underbrace{P\left(1+\frac{1}{\epsilon}\right)}_{} = \underbrace{-U_W/U_Y}_{}$$

MR of changing P = MC of new treatment

Intuition: MD chooses P (taking into account cost) then $\bar{S}^D$ to maximize $p \mid P$.

$\Rightarrow$ Changing $\bar{S}^D$ changes $\bar{S}^P$.



Notes:

- What does "steepness" of $\bar{S}^P(\bar{S}^P)$ indicate? Persistence to inducement

② Suppose $\bar{S}^D \to \bar{S}^D - \delta$ (an "inducement" of demand by δ)

① Is $(\bar{S}^P, \bar{S}^D)$ an eqbm? Yes!

- MD chooses $P \Rightarrow$ fixed $\bar{S}^P$
- Then MD chooses $\bar{S}^D$ taking into account $\bar{S}^P(P)$.
- No incentive for patient to deviate $\Rightarrow t$ accepted if $S^D \geq \bar{S}^D$.

② Chandra + Staiger 2007: What kind of treatments are chosen in a market?

What's the key assumption?

$$\text{Survival}_i = \beta_i^s Z + \alpha_i^s P_i + \epsilon_i^s \quad i \in \{1,2\}$$ [measured in life]

patient characteristics; intensive option; treatment option; % of population receiving i; idiosyncratic shock (why?)

- What sign should α_i^s have?

$$\text{Cost}_i = \beta_i^c Z + \alpha_i^c P_i + \epsilon_i^c \quad i \in \{1,2\}$$ [measured in $]

- What sign should α_i^c have?

Now patient utility is given by $U_i = S_i - \cancel{\lambda} C_i = \beta_i Z + \alpha_i P_i + \epsilon_i$

↳ convert $ to life (QALY?) ≈ 100,000 / yr. (maybe 0?)

Suppose MD's are fully altruistic ($\alpha = 1$) [why did we change this assumption?]

- Which treatment is chosen?
- Choose intensive treatment $\Leftrightarrow U_2 \geq U_1(Z)$

$$
\begin{aligned}
Pr(i=2|Z) &= Pr(U_2(Z) \geq U_1(Z)) \\
&= Pr(\alpha_2 P_2 + \beta_2 Z + \epsilon_2 \geq \alpha_1 P_1 + \beta_1 Z + \epsilon_1) \\
&= Pr(\alpha_2 P_2 - \alpha_1 P_1 + (\beta_2 - \beta_1) Z + (\epsilon_2 - \epsilon_1) \geq 0) \\
&= Pr(\alpha_2 P_2 - \alpha_1 (1 - P_2) + \tilde{\beta} Z + \tilde{\epsilon} \geq 0) \\
&= Pr(\tilde{\alpha} P_2 - \alpha_1 + \tilde{\beta} Z + \tilde{\epsilon} \geq 0)
\end{aligned}
$$

why in probabilities? Because of ϵ!

↳ leftover costs from specializing in option 1

Then define $P_2 = \int Pr(\tilde{\alpha} P_2 - \alpha_1 + \tilde{\beta} Z + \tilde{\epsilon} \geq 0)\, dF(Z)$

↳ full distribution of patient characteristics

more appropriate ⇒ more treatment

OR

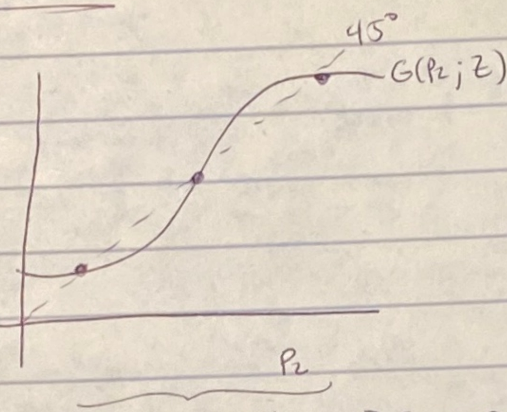
more specialization ⇒ more treatment

What's the equilibrium? $P_2 = G(P_2)$ [iterate until convergence; called a fixed point]

P_2 is endogenous! Equilibrium object.

② Chandra + Staiger Continued:

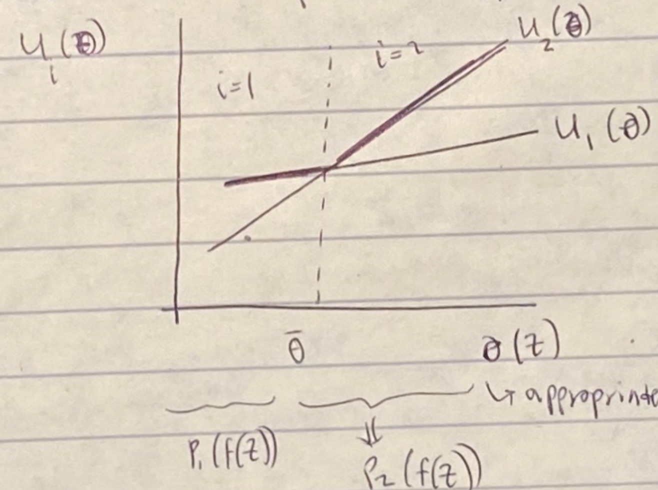
What is a fixed point?



Multiple equilibria ⇒ Geographic variation!

- What happens as you change $G(P_2)$? Can you implement P_2^* in a market?
- How does $f(Z)$ affect this?

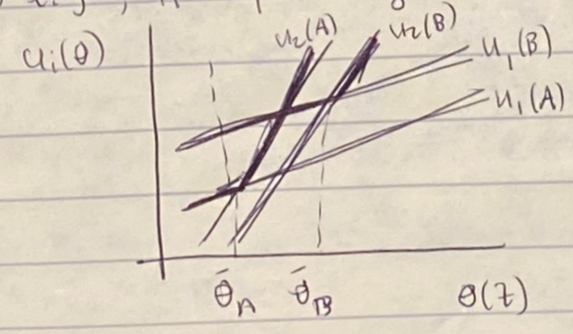
Who gets treated in eq'm? Recall pats receive $i=2$ iff $EU_2(Z) \geq EU_1(Z)$.



- Why are slopes different?

→ $\bar{\theta}$ depends on Z in a region, as does P_1, P_2

→ e.g., if you change the "intensity" of an area?



area A: high returns to specialization in $i=2$

area B: specializes in $i=1$

Who is better off in each area?

★ As $\theta \uparrow$, more utility from being in lower $\bar{\theta}$.

LECTURE 5: Physician-Patient Interactions

- MDs are 100% profit-motivated ($\alpha = 0$)

- Goal: define STRATEGIES for - patients
  - MDs

↓

commitment rule

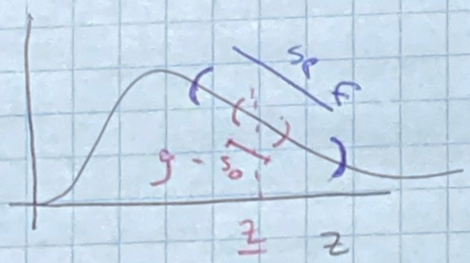
$$\text{MD}: r(s_D) = \begin{cases} t & \text{if } s_D \geq \bar{s}_D \\ 0 & \text{if } s_D < \bar{s}_D \end{cases}$$

↑ MD signal

EQBM strategy:

1. MD knows patient's strategy
2. chooses $r(s_D)$ to max π s.t. pat strategy

MODEL DETAILS: $z \in \mathbb{R}$ with density $\phi(z)$



- one physician (monopolist)
- each gets signals $\{s_D, s_P\}$

$\Rightarrow$ posterior beliefs about z: $\begin{matrix} f(s_D|z) \\ g(s_P|z) \end{matrix} \Rightarrow j(z|s)$

PATIENT UTILITY: $u^P = M + \mu(E - P(t))$

health, conversion, wealth, price of treatment

if no treatment is chosen: $u^P = -\pi(z) + \mu(E)$

health loss; ↳ no spending

z unobserved ⇓

$$EU^P = \int_{-\infty}^{\infty} \pi(z) \cdot j(z|s_P)\, d\phi(z) + \mu(E)$$

if treatment: $\mu(E - p(t))$

PATIENT RULE:

Seek treatment if $\underbrace{\mu(E-P(t)) \geq \int_{-\infty}^{\infty} -\pi(z) j(z|s_p)\, d\phi(z) + \mu(E)}$

defines cutoff $\bar{s}_p$ where condition is an equality

PHYSICIAN UTILITY

$U^D = u^D(Y, w)$

income — disutility from work

$u_Y > 0 \quad u_w < 0$

$$\rho = \int_{-\infty}^{\infty} \int_{\bar{s}^D}^{\infty} \int_{\bar{s}^P}^{\infty} g(s_p|z) f(s_D|z) \phi(z)\, ds_p\, ds_D\, dz$$

$\rho(\underbrace{P(t), \bar{s}^D})$

MD choice variables

$$u^D = u^D[Q \cdot \underbrace{\rho(P(t), \bar{s}^D) \times P}_{\text{revenue}},\ Q \cdot \rho(P(t), \bar{s}^D)]$$

normalize $Q = 1$

FOC's:

① $\frac{\partial U}{\partial \bar{s}^D} = \frac{\partial U}{\partial Y} \cdot P \cdot \frac{\partial \rho}{\partial \bar{s}^D} + \frac{\partial U}{\partial W} \cdot \frac{\partial \rho}{\partial \bar{s}^D} = 0$

$= \frac{\partial \rho}{\partial \bar{s}^D}(\underline{U_Y \cdot P} + \underline{U_w}) = 0$

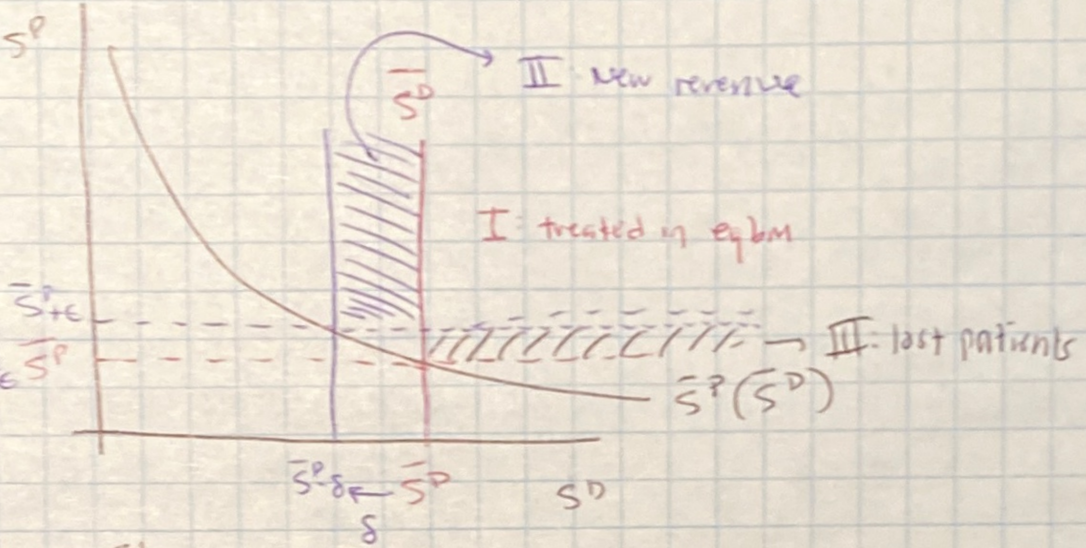
MB = MC $\Rightarrow \frac{\partial \rho}{\partial \bar{s}^D} = 0$

$\Rightarrow$ $\boxed{\bar{s}^D \text{ is chosen to maximize } \rho}$

② $\frac{\partial U}{\partial P} = U_Y\left(\frac{\partial \rho}{\partial P} \cdot P + \rho\right) + U_W \cdot \frac{\partial \rho}{\partial P} = 0$

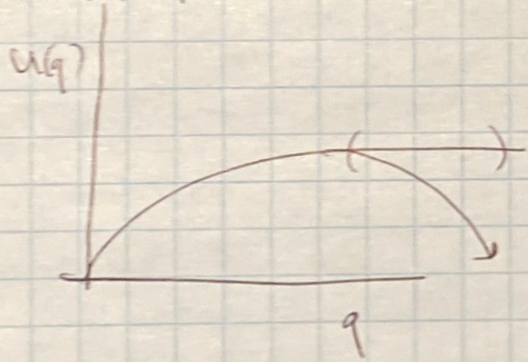
Define $\epsilon = \frac{\partial \rho}{\partial P} \cdot \frac{P}{\rho}$

$\Rightarrow P\left(1 + \frac{1}{\epsilon}\right) = -\frac{U_W}{U_Y}$ $\boxed{\text{GIVEN } \rho, \text{ MAXIMIZE } P}$



CHANDRA + STAIGER (2007)

Flat of the curve



MODEL DETAILS [back to $\alpha = 1$]

Survival$_i$ $\rightarrow$ $S_i = \beta_i^S \underline{Z} + \alpha_i^S P_i + \epsilon_i^S \quad i \in \{1, 2\}$

different #'s

same variables

% of treatments that are i in a region

$\text{Cost}_i = \beta_i^C \underline{Z} + \alpha_i^C P_i + \epsilon_i^C \quad i \in \{1, 2\}$

$u_i = S_i - \underline{\lambda} C_i = \boxed{\beta_i Z + \alpha_i P_i + \epsilon_i}$

↳ convert \$ to life

where $\beta_i = \beta_i^S - \lambda \beta_i^C$ for example

Choose $i=2$ if $U_2 \geq U_1$

$$\Leftrightarrow \Pr(i=2|z) = \Pr(U_2(z) \geq U_1(z))$$

$$= \Pr(\beta_2 z + \alpha_2 P_2 + \epsilon_2 \geq \beta_1 z + \alpha_1 P_1 + \epsilon_1)$$

$P_1 = 1 - P_2$

$$= \Pr(\tilde{\alpha} P_2 - \alpha_1 + \tilde{\beta} z + \tilde{\epsilon} \geq 0)$$

where $\tilde{\alpha}$ are $\alpha_2 - \alpha_1$

P_2 is endogenous

To find eqbm.

$$P_2 = \int \Pr(\tilde{\alpha} P_2 - \alpha_1 + \tilde{\beta} z + \tilde{\epsilon} \geq 0) \, dF(z)$$

need to be equal

$$x = f(x)$$

$\Rightarrow$ can be solved by iteration.