Imperfect information between patient and physician

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Outline

1. Supplier induced demand
2. Credence good model
3. Cost saving incentives and communication

Section 1

Supplier induced demand

Physician roles

- roles
  - supplier
  - adviser
- renumeration can lead to non-aligned incentives

Supplier induced demand

- some observations:
  - physician density increased in Germany from 16 to 41 from 1970 to 2014 (#physicians/10000 inhabitants)
  - no under-employment of physicians
  - areas with higher density of surgeons have more surgeries/capita but not lower surgical fees (Fuchs 1978)

Supplier induced demand (SID)

Physicians control quantity of treatment, that is, demand is not independent from supply but induced by the supplier beyond a perfectly informed patient's optimal choice. Physicians can induce because they control information (about necessity, state of the art etc.) that the patient does not have.

Supplier induced demand

- a couple of new physicians arrive in a town in which all citizens have comprehensive health insurance
  - what happens in a normal supply and demand framework?
  - what happens under supplier induced demand?
- factors making SID easier
  - comprehensive insurance
  - riskless treatment technology

Supplier induced demand: model

- price per unit of medical care: p (exogenous, regulated)
- a physicians, n inhabitants, density $\delta = a/n$
- "primary demand" for care per capita is M (no inducement)
- primary care per physician: $nM/a = M/\delta$
- each physician can induce additional demand $s \in [0, \infty)$ leading to demand $M/\delta + s$
- working time of a physician: $t = \min\{M/\delta + s, 1\}$
- disposable income of physician: $y(pt)$ with $y' > 0$, $y'' \leq 0$
- physician utility $u(y, t, s)$
  - increasing and concave in y
  - decreasing and concave in s and t
- physician maximizes over s
- for simplicity: $u(y, t, s) = \sqrt{y} - t - \gamma s$, $y(pt) = pt$

Supplier induced demand: analysis

$$u(y,t,s) = \sqrt{pt} - t - \gamma s = \sqrt{p \min\{M/\delta + s, 1\}} - \min\{M/\delta + s, 1\} - \gamma s$$

- if $M/\delta + s < 1$, then
$$\frac{du}{ds} = \frac{\sqrt{p}}{2\sqrt{M/\delta + s}} - 1 - \gamma$$
- if $M/\delta + s > 1$, then
$$\frac{du}{ds} = -\gamma$$
- solution candidates:
  - no inducement $s = 0$ if $M/\delta \geq 1$ or $\frac{\sqrt{p}}{2\sqrt{M/\delta}} - 1 - \gamma < 0$
  - interior inducement $s = p/(4(1+\gamma)^2) - M/\delta$
  - maximal inducement $s = 1 - M/\delta$ if $p/(4(1+\gamma)^2) \geq 1$

Supplier induced demand: results

- positive demand inducement requires a fee for service
- assume $p/(4(1+\gamma)^2) < 1$
- how does the solution evolve when increasing δ?
  - $\delta \leq M$:
  - $M < \delta \leq M/(\frac{p}{4(1+\gamma)^2})$:
  - $\delta > M/(\frac{p}{4(1+\gamma)^2})$:
- plot billed services per patient as a function of δ
- what if $p/(4(1+\gamma)^2) > 1$?
- driving force:
  - income effect
- how does demand inducement change when the fee for service p increases (slightly)?

Supplier induced demand: alternative explanations

- SID fits empirical observation that more physicians lead to more services
- alternative explanations
  1. permanent excess demand
  2. higher quality of treatment if more physicians around
  3. reverse causality
- empirical design should try to tease these explanations apart
  - how does our model provide different predictions than the 3 explanations above? how to design a convincing empirical study?

Some empirical evidence

- Fuchs (1978) uses cross-sectional variation and tries to rule out (3) by statistically accounting for the supply of surgeons (2-stage least square)
  - method criticized as it also indicates SID in child births
- Gruber and Owings (1996) show that decline in birth rates in the 1970s was accompanied by an increase in Caesarean sections

Second wave of SID studies I

- suppose a physiscian can offer 2 services
- physician has utility $u(y, s_1 + s_2)$ where Y is income, $s_i \in [0, \infty)$ is inducement for service i
- assume $u_y > 0$, $u_{yy} < 0$, $u_s < 0$, $u_{ss} < 0$
- $y = p_1 x_1(s_1) + p_2 x_2(s_2)$ where x_i is the level of service i and we assume $x_i' > 0$, $x_i'' < 0$, and p_i is the fee for service i
- solving the utility maximization problem:

$$p_1 x_1'(s_1) = -u_s / u_y$$

$$p_2 x_2'(s_2) = -u_s / u_y$$

- how does the optimal s_1 and s_2 change if p_1 increases?
    - income effect:
    - substitution effect:

Second wave of SID studies II

- how to empirically test for SID given the model above?

- some empirical evidence supporting SID along these lines, e.g. Yip (1998) shows that thoracic surgeons increased volume of both Medicare and non-Medicare patients when Medicare fees were cut significantly

(Danish) Physicians respond to incentives I

- Reform of physician pay in Copenhagen city (Denmark) in October 1987
  - before: capitation
  - after: mixed system of capitation and fee for service
- control: Copenhagen county had new enumeration already
- physicians were asked to record all activities in a given week at three points in time (February/March 87, February/March 88, November 88)
- 75 of 265 GPs participated in all three waves
- Results by Krasnik et al. (1990)

(Danish) Physicians respond to incentives II

TABLE I—*Number of contacts and activities in a week and number of enlisted patients in March 1987, March 1988, and November 1988 for 71 doctors in Copenhagen city*

	March 1987	March 1988	November 1988
Contacts	9 942	11 387	10 618
Diagnostic services*	536	768	896
Curative services*	99	201	203
Referrals to specialist	1 276	1 176	1 002
Referrals to hospital	251	226	176
Number of enlisted patients	122 223	125 412	125 536

*Services for which additional fee is paid.

TABLE II—*Estimated changes in number of contacts per 1000 enlisted patients in March and November 1988 compared with that in March 1987 in Copenhagen city (95% confidence interval) and change in Copenhagen county, by type of contact*

		Copenhagen city		Copenhagen county	
Type of contact	March 1987	March 1988	November 1988	March 1988	November 1988
Face to face consultations	100	112·7 (106·8 to 118·8)	104·4 (98·9 to 110·2)	105·5	104·9
Consultations by telephone	100	118·6 (108·5 to 129·7)	115·4 (105·5 to 126·3)	108·4	104·0
Renewal of prescriptions	100	82·5 (68·4 to 99·7)	65·2 (53·2 to 79·9)	91·5	92·6
Total	100	111·7 (106·4 to 117·4)	104·2 (99·1 to 109·6)	106·0	104·0

(Danish) Physicians respond to incentives III

TABLE III—*Estimated changes in number of activities per 1000 enlisted patients in March and November 1988 compared with that in March 1987 in Copenhagen city (95% confidence interval) and change in Copenhagen county, by type of activity*

Type of activity	March 1987	Copenhagen city: March 1988	Copenhagen city: November 1988	Copenhagen county: March 1988	Copenhagen county: November 1988
Diagnostic services	100	138·1 (118·7 to 160·5)	159·5 (137·8 to 184·7)	105·3	107·6
Curative services	100	194·6 (152·2 to 248·9)	194·8 (152·3 to 249·2)	106·0	115·0
Referrals to specialist	100	90·1 (80·7 to 100·6)	77·0 (68·6 to 86·4)	99·4	98·1
Referrals to hospital	100	87·4 (71·1 to 107·5)	68·4 (54·7 to 85·4)	97·1	102·1

Section 2

Credence good model

Credence good

- credence good: expert knows more about the quality a consumer needs than the consumer
- physician = expert, patient = consumer
- potential efficiency problems:
  - overcharging
  - overtreatment
  - undertreatment
  - excessive search
- how should physician renumeration be structured to avoid problems above?
- how does this depend on environment?

Basic setup

- consumers
  - continuum of consumers
  - each consumer has either *major* or *minor* problem
    - major problem can be fixed by expensive treatment $\bar{c}$
    - minor problem can be fixed by cheap treatment $\underline{c} < \bar{c}$ or expensive treatment
  - do not know problem and assign prob h to major
  - cost of visiting expert: d per expert
  - utility: $v > \bar{c} + d$ if fixed, 0 otherwise (minus price in both cases)
  - homogeneity: all consumers are the same
- $n \geq 2$ experts
  - know problem and recommend treatment
  - bear cost of treatment and receives price from consumer
  - maximize pofit: price minus cost
- prices:
  - $\bar{p}$ for $\bar{c}$ and $\underline{p}$ for $\underline{c}$ (for now fixed)

Possible assumptions/environments

- *commitment*
  - consumer is committed to follow the expert's recommendation
  - consumer cannot reject treatment and visit another expert
- *liability*
  - expert is liable in case of undertreatment and will therefore never administer $\underline{c}$ if the problem is major
- *verifiability*
  - consumer can verify which treatment is administered $\rightarrow$ overcharging cannot occur

Benchmark: no liability, no verifiability

Theorem (Market breakdown)

If commitment but neither liability not verifiability hold, the market outcome is inefficient.

- which treatment will experts administer and which price will they charge?
- what is the equilibrium if experts set prices before consumers decide which expert to visit?
- (possible?) remedy: separation of diagnosis and treatment

Verifiability and commitment

- what will experts do if $\bar{p} - \bar{c} > \underline{p} - \underline{c}$?
- what will experts do if $\bar{p} - \bar{c} < \underline{p} - \underline{c}$?
- what is the equilibrium if experts set prices before consumers decide which expert to visit?

Liability and commitment

- what will experts do if $\bar{p} > \underline{p}$?
- what will experts do if $\bar{p} < \underline{p}$?
- what is the equilibrium if experts set prices before consumers decide which expert to visit?

Liability only

- assume $n \geq 4$ and d not too high (as high d is like commitment)
- assume that experts set prices before consumers choose which expert to visit

Theorem (Specialization equilibrium)

At least two experts post prices $\underline{p} = \underline{c}$ and $\overline{p} > \overline{c} + d$ and at least two experts post prices $\underline{p} \leq \overline{p} = \overline{c}$. The former diagnose honestly while the latter always recommend the expensive treatment. Consumers visit the former experts first and go to the latter if a major problem is diagnosed.

- inefficiency: duplication of diagnosis cost d

Summary and comments

- right prices can solve some of the problems
  - same prices for all treatments avoid overcharging
  - same markups for all treatments avoid under-/overtreatment
- competitive equilibria are efficient if commitment + either liability or verifiability hold
- specialization can emerge (without commitment)
- does it matter whether consumers are insured, i.e. insurance pays price to expert, or not?

Section 3

Cost saving incentives and communication

Incentives for physicians

- moral hazard
- insurances incentivize physicians to save costs

Possible conflict of interest between patient and physician

- insured patient wants best treatment (no matter what costs)
- physician takes costs into account in prescription behavior
- patient has to communicate symptoms etc. to physician to allow accurate diagnosis
  - incentives to exaggerate

Communication model

- true health state unknown
- fully insured patient reports symptoms to physician
- physician hears report privately observes signal about health state
- physician prescribes treatment
- prior information (commonly known):
  - likelihood of different health states
  - probability distribution of symptoms given each health state
  - probability distribution of signals given each health state
- payoffs (commonly known):
  - u_P depending on health state and treatment
  - $u_D = u_P - \beta c(treatment)$
  - welfare: $u_P - c(treatment)$

Cost saving incentives can backfire: example

- information (see section 3 Schottmüller (2013))

prior	2/5	2/5	1/5
signal/state	A	B	C
(0,0)	0	0	1
(0,1)	0	4/5	0
(1,0)	1/5	1/5	0
(1,1)	4/5	0	0

- u_P and costs

treatment/state	A	B	C	costs
a	8	9.7	9.2	5
b	4	9	9.6	3
c	0	5	10	1

- say $\beta = 0$; what is the equilibrium? any problems for welfare?
- say $\beta = 1$; what is the equilibrium? any problems for welfare?

Variation of the example

- let $\beta = 1$ and the prior be $2/5 + x$, $2/5 + x$, $1/5 - 2x$ for $x \in (0, 1/10)$
  - what is the equilibrium?
  - how do equilibrium costs compare with the equilibrium costs when $\beta = 0$?

Communication model: results

following Schottmüller (2013):

- exaggeration leads to worse information for physician
- worse diagnosis can reduce welfare and in some cases increase costs
- if the physicians signal is sufficiently informative, $\beta = 1$ leads to higher welfare than $\beta = 0$
- if cost differences between treatments are sufficiently large, $\beta = 1$ leads to higher welfare than $\beta = 0$
- welfare maximal β is strictly between 0 and 1
- copayments can reduce the conflict of interest and increase welfare

Can you draw a link from the Hippocratic oath to the model?

Empirical evidence of trust and physician pay I

Kerr et al. (1997) report on "How satisfied are GPs with their relationship with patients?"

- 71% were very or somewhat satisfied with relationships with capitated patients (compared with 88% for overall practice)
- 64% were very or somewhat satisfied with the quality of care they provided to capitated patients (compared with 88% for overall practice),
- 51% were very or somewhat satisfied with their ability to treat capitated patients according to their own best judgment (compared with 79% for overall practice)
- 50% were very or somewhat satisfied with their ability to obtain specialty referrals (compared with 59% for overall practice)

Empirical evidence of trust and physician pay II

Kao et al. (1998) report on trust of patient in physician

Variable	Regression Coefficient (95% CI): Model Without Measure of Physician Behavior	*P* Value	Model With Measure of Physician Behavior	*P* Value
Salary patient†	−0.313 (−0.426 to −0.201)	<.001	−0.186 (−0.272 to −0.100)	<.001
Capitated patient†	−0.163 (−0.241 to −0.084)	<.001	−0.094 (−0.157 to −0.031)	.004
Fee-for-service (FFS) managed care patient†	−0.078 (−0.138 to −0.019)	.01	−0.044 (−0.094 to 0.006)	.08
Thought that physician was paid on a salaried basis‡	−0.068 (−0.191 to −0.055)	.28	−0.075 (−0.165 to 0.014)	.10
Thought that physician was paid on a capitated basis‡	−0.028 (−0.154 to 0.098)	.66	−0.068 (−0.162 to 0.026)	.16
Patient did not know how physician is paid‡	0.115 (0.028 to 0.202)	.009	0.036 (−0.029 to 0.102)	.28
Correctly identified that physician was paid on a salaried basis	0.269 (0.094 to 0.444)	.003	0.172 (0.029 to 0.316)	.02
Correctly identified that physician was paid on a capitated basis	0.024 (−0.125 to 0.172)	.75	0.049 (−0.059 to 0.157)	.38
Correctly identified that physician was paid on an FFS basis	−0.024 (−0.127 to 0.078)	.64	−0.017 (−0.097 to 0.064)	.68
Trust in health plan	0.164 (0.133 to 0.195)	<.001	0.112 (0.087 to 0.137)	<.001
Trust in health maintenance organizations in general	0.051 (0.023 to 0.079)	<.001	0.017 (−0.005 to 0.039)	.13
Believe in the benevolence of people	0.032 (−0.008 to 0.072)	.12	0.039 (0.007 to 0.070)	.02
Female patient	0.048 (−0.010 to 0.106)	.11	0.055 (0.012 to 0.099)	.01
White patient	0.064 (−0.002 to 0.130)	.06	0.096 (0.042 to 0.150)	.001
Self-reported health status	0.069 (0.041 to 0.096)	<.001	0.033 (0.011 to 0.056)	.004
Male physician	0.008 (−0.057 to 0.072)	.82	0.019 (−0.032 to 0.070)	.46
International medical graduate	−0.072 (−0.143 to −0.0001)	.05	−0.048 (−0.100 to 0.004)	.07
Solo practitioner§	−0.059 (−0.125 to 0.008)	.09	−0.040 (−0.088 to 0.007)	.10
2-Physician practice§	0.063 (0.001 to 0.126)	.05	0.044 (−0.010 to 0.099)	.11
Had enough choice of physician	0.293 (0.215 to 0.370)	<.001	0.147 (0.086 to 0.207)	<.001
Length of patient-physician relationship	0.015 (0.011 to 0.019)	<.001	0.008 (0.005 to 0.011)	<.001
Picker score	. . .	. . .	0.794 (0.723 to 0.860)	<.001
	$R^2 = 0.28$	. . .	$R^2 = 0.52$	. . .

*CI indicates confidence interval; ellipses, data not available.
†Reference group was composed of FFS indemnity patients.
‡Reference group was composed of patients who thought their physicians were paid on an FFS basis.
§Reference group was composed of physician practices of 3 or more physicians (multivariate regression analyses were based on n = 2063 due to missing data in the patient trust score and patients' identification of how their physicians were paid).

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