Physician – Patient Relationship as a Game of SIT

By De Jaegher and Jegers

Motivations

- Concerned with SID(supplier induced demand) hypothesis from Health Economics literature and analyses it through twin methodological lenses –
  - cheap talk signaling games in game theory,
  - credence goods in economics of information
- Evaluates the SID theories through these frameworks.

- SID is the hypothesis that sellers make buyers buy a different(higher) quantity than would the buyer with same information due to information asymmetries and incentives from overselling.

- Though hypothesis is known since decades, only recently new frameworks to analyze the empirically observed phenomenon. Previously treated in the framework of “Advertising” or “Persuasion”

Problems with orthodox("neoclassical approach")

- In such advertising or persuasive models, sellers shift demand through change in buyer's preferences.
- This makes it difficult to empirically test – can never observe original demand(demand is determined by seller)
- Also implies welfare effects cannot be ascertained since assumed that preferences change.(manipulated or convinced?)
- The authors bypass this problem by assuming
  - Demand inducement not from change in preferences
  - Buyers can constrain demand.

Listed Contributions

- Highlight the importance of credence good literature and cheap talk games as method of analysis.

- To determine whether healthcare is always “credence”? (In cases where expensive treatment effective in curing several states, but efficient in some)

- Constructs a game where Nash Eqbm exists and the buyer is able to constrain demand induction from seller(without market failure)
- To show that non trivial equilibrium is unique, given multiple nash equilibria

Objectives

- In equilibrium, there should be a unique solution where patient constrains induced demand without market failure, where signals should contain enough information to be relevant to patient's action
- In cheap talk with conflict of interest there are few problems
  - If patient follows E signal then best response of physician is to always recommend E.
- The credence nature of the good makes the signal cheap

Calcott

- SID as cheap talk game with conflict of interest.
- Cheap talk is a signaling game where the sender with consumer relevant private information and receiver action which affect both payoffs. The sender sends a message to influence the action, with the message being costless.(doesn’t enter utility of sender)
- Calcott finds equilibria where the induced treatment is either always provided or never.(trivial equilibria)
- Assumes optimal for consumer for no treatment at ‘C’ state.
  - Results in patient’s inability to constrain demand.
- Calcott is able to apply ‘neologism proofness’(an equilibrium refinement concept for cheap talk games,discussed later) since for commonly observable diagnostic results, interests coincide.

Pitchik and Schotter

- There is Cheap treatment for less severe state ‘C’ and Expensive for severe state ‘E’, each efficient for own. E solves C though inefficiently.
- Unlike PS analyzes equilibria for varying preferences and payoffs
- Unlike PS No ‘Take it or leave it ‘ signals
- If rejects, Second opinion always sought.

Cheap talk

- Three issues in refining cheap talk games
  - Absence of out of equilibrium signals
  - Meaning of signals
  - Credibility

- Evolutionary perspective – Warneryd proposes an evolutionary stable equilibrium if patient and physician strategies remain best response against population strategies. According to such analysis, non communicative equilibria are not evolutionary stable, and believes that out of equilibrium signals exist, although unlike farell without a pre-defined meaning(meaning evolves)

- The mixed strategy equilibrium in the game is evolutionary unstable. In this equilibrium indifference condition between E and 0 on E signal. If a fraction starts saying the truth then model will evolve to full consumer naivety.

- Hence major focus on common interest games

Credence good literature

- What makes seller talk cheap – Credence assumption
- If buyer knows how a good will affect utility ex ante – Search Good
  - Provision of verifiable information through verifiable costless signals
- If buyer knows how good will affect utility ex post – Experience Good
  - Lying becomes costly or costly signaling
- If buyer doesn’t even know ex post – Credence Good

Other literature

- The credence good literature handles the problem of multiple equilibria through institutional assumptions which cancel conflict of interest or on information assumptions on patient.
- Emons – PS with price setting expert where coi mitigated by equalizing margin on cheap and expensive(risk of treatment failure borne by patient)
- Taylor – expert before knowing state offers treatment at fixed price, ie, effectively selling insurance against the presence of disease.
- Wolinsky –Some physicians specialize in C treatment solving coi such that accurate diagnosis by C expert who can’t offer C for E because of experience character of underprovision.(“gatekeeper model”)

Informational cases

- Dranove – Patient observes average prescription of E by physician, ie a priori information on induced demand
- De jeger jeger and Farley – observes how much individual physicians contribute on average to patient's utility. Also treatment 'episode' rather than treatment quantity is unit of demand.
- In papers where it is assumed additional information, overprovision thus has an experience characteristic and recommendation to buy extra treatment becomes a costly signal.

Direct Signals

- ’Direct signals’ – Verifiable information on true state. An E action by patient to E signal then implies a weak best response for physician to send E and optimal for patient to take E. A non-E signal implies the patient ‘knows’ that C state and buys C.(Other Nash equilibrium where patient ignores any signal also exist, implying failure of communication)
- However standard refinements easily eliminate equilibria without communication in such a case. (backward induction)
- Not perfect
- Hence unique communication equilibrium given rational patient, SID hypothesis doesn’t apply when the “able” to send verifiable signals
- Search good

Costly signals

- Suppose warranty for E treatment.(or reputation)
- E signal implies E action by patient, and C state implies C signal sent(or no signal)[since E is a costly signal)
- Again standard refinements eliminate non communicative equilibria.
- The refinements which work are forward induction, intuitive criterion and divinity
- Here ex-post verifiability and liability. That is U(E/C) =/= U(E/E)

Cheap signals

- E signal is not verifiable. If E action => Physician's best response to always send E.
- If non-E action at E signal, communication breaks down.
- In the common interest version, informative equilibria can exist, but standard refinements don't work.
- Babbling equilibrium

Cheap talk

- In non communicative equilibria in costly signaling, in equilibrium no signal from physician, such that action based on signal would be out of equilibrium path. Even if physician sends such OES , the action would not correspond with such signals, making such NE unstable
- In cheap talk the doctor can randomize over all possible signals costlessly, such that no OES left to destabilize resulting equilibrium in what is known as a babbling equilibrium
- Unlike verifiable signals, and costly signals, cheap talk signals don’t necessarily reveal anything, and have credibility issues.

Cheap talk Proposed resolutions of three issues

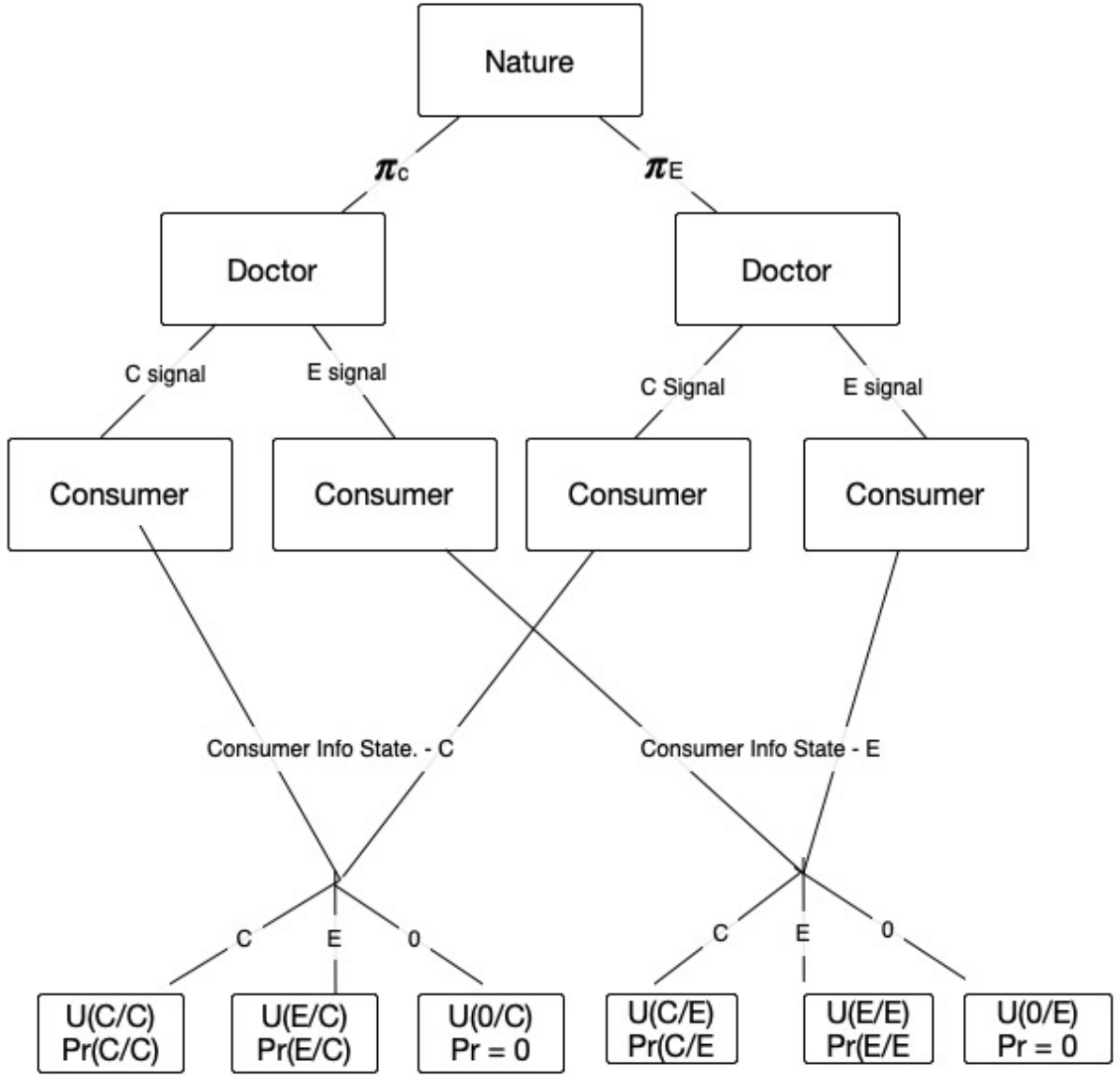
- Farrell's notion of "neologism proof" equilibria which state where neologisms are out of equilibrium signals which always exist with a pre-existing conventional meaning.
- For credibility – Axiom that the receiver believes any signal which sender would like the receiver to believe iff it's true
- Neologism proofness less restrictive than forward induction.
- Forward induction states the truth of a signal ascertained (complete)

Credence assumptions

- Ex post utility evaluation –
  - If U(E/E)>U(E/C) – Experience
  - If U(E/E) = U(E/C) – Credence
  - That is E is effective in curing C but inefficient and/or costly.[U(C/C)>U(E/C)]

- Since U(C/C) > U(E/E) (assumed in framework) then underprovision gets ruled out that is impeded demand which would require U(C/E) = U(C/C) which is inconsistent.

The Game


Nature
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Pr(E/C)
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Pr = 0
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Pr(E/E
U(0/E)
Pr = 0

Base Assumptions(buyer = patient, seller = doctor)

- Patient has already decided to consult doctor

- Abstraction from common information both observe(such as diagnosis)

- Doctor can observe private information costlessly
  - Bypasses diagnostic effort as hidden action
  - Justifies it by disregarding “blind treatment”

- Patient observes Treatment
  - Bypasses treatment effort as hidden action
  - Justifies it by physical presence of patient during treatment
- For private information to be relevant – no dominant strategy for all information states
- Assumes that in order to induce demand
  - Physician prefers to provide E no matter the state
  - Lying is costless – Signals don’t enter physician’s utility
- For Patient to constrain demand –
  - Possesses some information- Incidence of disease, physician’s incentives.

Formalizing Assumptions

- $u\left(\frac{C}{C}\right) > u\left(\frac{0}{C}\right)$
- $u\left(\frac{C}{C}\right) > u\left(\frac{\mathrm{E}}{\mathrm{C}}\right)$
- $u\left(\frac{E}{E}\right) > u\left(\frac{0}{E}\right)$
- $u\left(\frac{E}{E}\right) > u(\frac{C}{E})$
- $\Pi\left(\frac{E}{i}\right) > \Pi\left(\frac{\mathrm{C}}{\mathrm{i}}\right) > \Pi(\frac{0}{i})$

Existence of Equilibrium

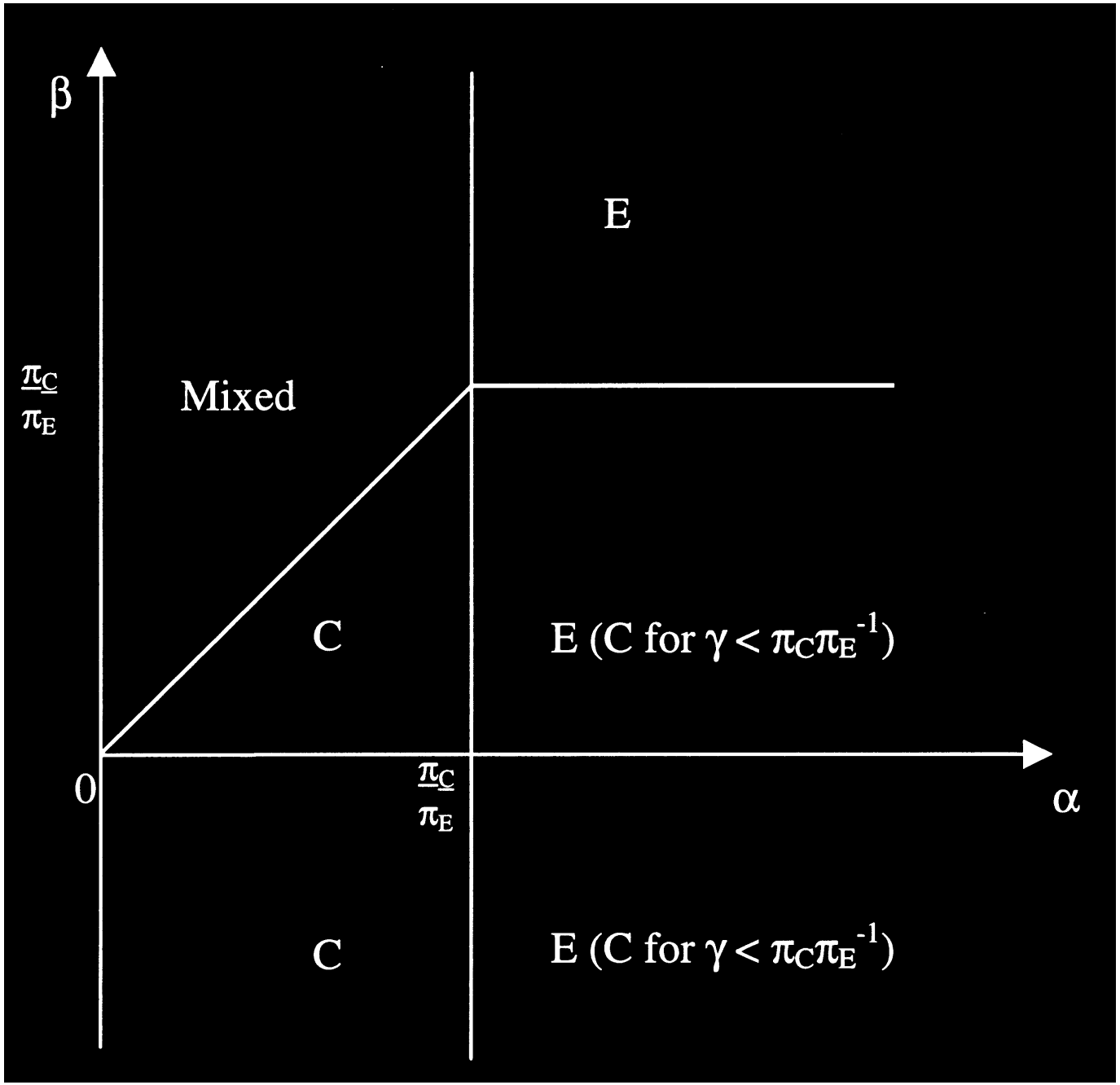
- For the communicative equilibrium, necessarily mixed strategy.
- Given E signal – Patient should not always buy E as then sender would only send E. Similarly the physician should not always send E signal exclusively for E state(patient will always buy and hence incentive to send only E)
- Given E signal , 2 randomization strategies
  - 1. E and 0 action
  - 2. E and C action
- Given C signal
  - If randomization between E and C then C signal and E signal are informationally equivalent
  - An action of not C will induce doctor to always best respond with E
- Therefore randomization between E and 0 in communicative equilibrium
- In C state inefficient to buy 0 from above reasoning.

Payoffs

- Unique mixed equilibrium exists for certain payoff levels
- Since the model abstracts that 0 action doesn't imply treatment from another, it implies for certain information states, 0 action preferred to either C or E. That is when U(0/C) > U(E/C) and U(0/E) > U(C/E)
- In the equilibrium, there must be possibility indifference between buying E and 0. That is if patient prefers a priori expensive treatment to no treatment, then will always buy E.
- There must be patient strategies for the communication equilibrium where patient strategies make doctor weakly prefer to be honest.
  - This happens when relative profit from treatment of corresponding state is as high as relative profit otherwise.
  - Formally $\Pi(C/C)* \Pi(E/E) >= \Pi(C/E)* \Pi(E/C)$. It will be assumed this payoff restriction holds.

Solutions

- From above conditions, a unique mixed equilibrium exists where Physician
  - Always sends E signal for E state
  - Randomizes between E and C signal for C state
- Such that patient is indifferent between E and 0 when E signal
- There also exist “trivial equilibria” where the patient always buys E, or always C or always 0 also exist.
- These trivial equilibria are pareto inferior to the mixed case
- The only case where we require refinement criterion is in the existence of a communicative(informative) and non communicative equilibrium in the mixed equilibrium
  - This is because multiple equilibria in trivial cases(always C or always E doesn’t change action in the corresponding payoff levels)


β
E
$\frac{\pi_C}{\pi_E}$
Mixed
C
E (C for $\gamma < \pi_C\pi_E^{-1}$)
0
$\frac{\pi_C}{\pi_E}$
α
C
E (C for $\gamma < \pi_C\pi_E^{-1}$)