Technology adoption in health care

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Introduction

Motivation

- General consensus: tech develop primer driver HC expenses $\rightarrow$ **adoption**;
- New techs spread with different rhythms in HC sector $\rightarrow$ **diffusion**

Literature

- Empirical literature:
  Vast documentation of impact of innovation on HC expenditure
- Theoretical literature: very scarce

Aim of the paper

Provide a theoretical model to study the role of reimbursement systems on the rate of technology adoption by providers in HC.

Our model: General overview

Elements of the model

- model of uncertain demand
- technological shift driven by the increased benefit for patients, financial variables, and the reimbursement system to providers.

Objective: assess the impact of the payment system to providers on the rate of technology adoption.

Payment schemes:

- Cost reimbursement according to the cost of treating patients,
- DRG payment system where the new technology may or may not be reimbursed differently from the old technology.

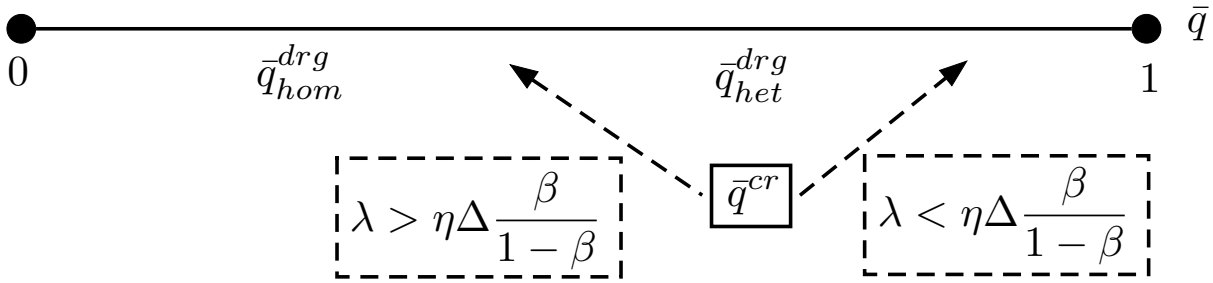
DRG: patient class. system relating types of patients (given by common demographic and therapeutical attributes) to costs incurred by hospital.

Our model: Conclusions

Role of patients' benefits

- CR&DRGhom: large enough patient benefits are necessary for adoption to occur
- DRGhet: with discriminatory reimbursement, adoption may occur even in the absence of patients' benefits

CR vs. DRG [Illustration]



λ: het DRG reimb; Δ: Pat Bfts; η: altruism; β: cost sharing

Notation and assumptions

- Semi-altruistic hospital $W(V(R), B) = V(R) + \eta B$
  - valuation of net revenues: $V(\cdot), V'(\cdot) > 0, V''(\cdot) < 0$
  - valuation of patients' benefits (B)
- Population of individuals: q^*
- Uncertain number of patients to treat q; $F(q), f(q) \in [0, q^*]$
- Hospital 2 tech: new, old
  - new tech
    - capacity $\bar{q}$ patients
    - cost per unit of capacity p
    - marginal cost per patient treated θ
  - old tech
    - treats remaining $q - \bar{q}$ (when positive)
    - marginal cost per patient treated c
  - $p + \theta > c$ [new tech not cost saver; driver of cost inflation]

Notation and assumptions (2)

- Hospital reimbursement R: prospective, retrospective, mixed
- 2 payment systems
  - total cost reimb; partial cost reimb; fixed fee/capitation
  - DRG
- patients' benefits
  - new tech: b; old tech: $\hat{b}$; $\Delta \equiv b - \hat{b}$
  - $b > \hat{b};\ b > p + \theta;\ \hat{b} > c$
- new tech approval [HTA]: $\Delta > p + \theta - c > 0$
- Hospital's W: financial results + patients' benefits
  - Financial: profits from patients treated with new & old tech
  - Benefits: benefits to patients treated with new & old tech
- Hospital's problem: choice of $\bar{q}$ to $\max W$

Tech Adoption under cost reimbursement

Cost reimbursement system

$$R = \alpha + \beta TC, \qquad \alpha > 0, \beta \in [0, 1]$$

Total cost

$$TC = \begin{cases} p\bar{q} + \theta q & \text{if } q \leq \bar{q} \\ p\bar{q} + \theta\bar{q} + c(q - \bar{q}) & \text{if } q > \bar{q} \end{cases}$$

Proposition

- Full adoption is never optimal for the provider.
- Patients' benefits above a threshold ensure positive adoption for every level of reimbursement.

Intuition

Assumption $p + \theta > c$ and common reimbursement for both technologies yield that patients' benefits are Nc for adoption.

Welfare analysis

w.r.t α and β

Higher R ($\uparrow \alpha, \beta$) lead to higher $\bar{q}$ because $\uparrow$ patients' benefits (Δ) are assumed to offset $\uparrow$ mg cost ($p + \theta - c$) [HTA]

w.r.t $dR = 0$

- Trade-off between α and β with risk aversion
  $dR = 0$, and totally differentiating f.o.c. yield ambiguous result. Depend on properties of $V(\cdot)$. BUT $\neq$ hospitals, $\neq$ properties of $V(\cdot)$. Issue behind difficulties to interpret empirical work on tech adoption.
- Trade-off between α and β with risk neutrality
  $dR = 0$, and totally differentiating f.o.c. $\uparrow \beta$ induces $\uparrow \bar{q}$ but $\downarrow \alpha$. No impact on welfare: $\uparrow$ patient's benefits, $\downarrow$ hosp. surplus.

w.r.t $dS = 0$ (risk neutrality)

- $\uparrow R\ (\uparrow \alpha, \beta) \Rightarrow \uparrow \bar{q} \Rightarrow \uparrow W$ from Pat Bfts

Tech Adoption under DRG payment

Types of DRG reimbursement

- Homogenous DRG reimbursement:
  Hospital receives same reimbursement under both technologies, i.e. technology used does not change DRG

$$R = Kq$$

- Heterogenous DRG reimbursement:
  New technology leads to coding sickness in a different DRG, and receives different reimbursement.

$$R = \begin{cases} K_1 q & \text{if new tech} \\ K_2 q & \text{if old tech} \end{cases}$$

with $K_1 > K_2$, and $\lambda \equiv K_1 - K_2$.

Tech Adoption under DRG payment (2)

Homogenous DRG payment.

- Full adoption is never optimal for the provider.
- Patients' benefits above a threshold necessary for adoption.
- $\bar{q}$ indep of K. Decision driven by cost minimization.
- $\frac{\partial^2 W}{\partial \bar{q} \partial K} > 0 \rightarrow V$ concave; otherwise no impact.

Heterogenous DRG payment.

- Full adoption is never optimal for the provider.
- Assumption $(K_1 - K_2) - (p + \theta - c) > 0$ sufficient (not necessary) for adoption even under absence of patients' benefits.
- Large enough patients' benefits necessary for adoption (but not sufficient).

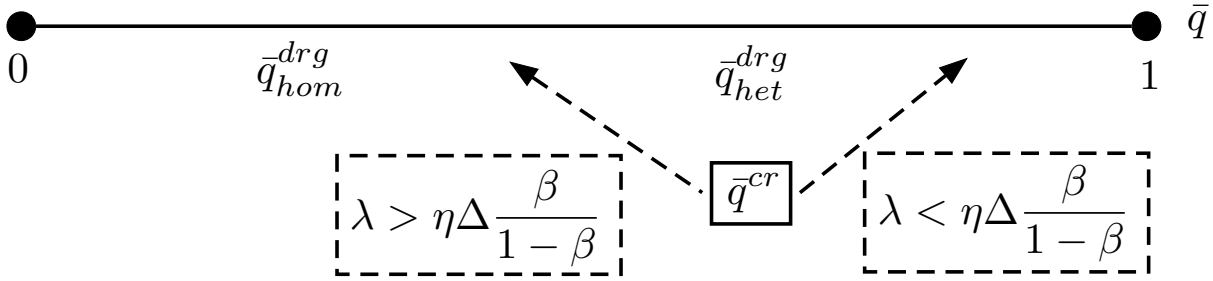
Comparing payment regimes

Assume $V'(\cdot) = 1$, unif. distr., $q^* = 1$, $\lambda \equiv K_1 - K_2$, and $\Delta \equiv b - \hat{b}$.

$$\bar{q}^{drg}_{hom} < \bar{q}^{dgr}_{het}$$

$$\bar{q}^{drg}_{hom} < \bar{q}^{cr}$$

$$\bar{q}^{cr} \lessgtr \bar{q}^{drg}_{het}$$



Vindication of CR against prospective reimbursement.

Welfare analysis

- Question: Over- or Under-adoption w.r.t. 1st best?
- Assume $V'(\cdot) = 1$, uniform distribution, $q^* = 1$.
- Define $SW =$ benefits-costs
- Cost reimb: $\bar{q}^{cr} > \bar{q}^{swcr}$ (over-adoption) [provider does not bear full cost of adoption].
- DRG^{hom} : $\begin{cases} \bar{q}^{hom} > \bar{q}^{swhom}, & \text{if } \eta > 1 \text{[PatBfts larger under new tech]} \\ \bar{q}^{hom} = \bar{q}^{swhom}, & \text{if } \eta = 1. \end{cases}$
- DRG^{het} : $\bar{q}^{het} > \bar{q}^{swhet}$ (over-adoption) [new tech higher reimb].

Caveats

- static model (adoption) vs dynamic model (diffusion),
- no influence from other sectors; no hospital competition,
- hospital no capacity constraints,
- no difficulties for patients and providers to assess health benefits,
- homogeneous patients (health benefits, severity, sickness),
- individuals fully insured.