Incentivizing Physicians' Diagnostic Effort and Testing with Moral Hazard and Adverse Selection

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1. Introduction

- Health care sector amounts for 9.6% of GDP (OECD, 2022).
- Physicians are key actors.
- Different medical decisions can lead to different healthcare outcomes.
- **Diagnostic errors:** incorrect, delayed or miscommunicated diagnoses, account for 16% of preventable patient harm (WHO).
- $\rightarrow$ **Need to set the right incentives for the optimal use of diagnostic tests.**

- A non exhaustive list of examples:
    - Target specific molecular markers to determine the optimal cancer treatment.
    - Molecular profiling of microbes: identify whether bacterium, fungi, or virus.
    - Different families of antibiotics for different types of bacteria. Antibiotic resistance.
    - Pharmacogenomics for tailored drug prescriptions and dosages.

- In this paper
    - We investigate the characteristics of physician payment schemes that lead to the optimal use of diagnostic tests, in a setting where physicians are imperfectly altruistic and can exert costly effort.

    - Compared to the existing literature, we are first to study a physician agency problem with both **a MH problem** (hidden action and hidden information) & an **AS problem** (on the degree of altruism).

2. The set-up

Patients and treatments

- Two types of patients ($i \in \{A, B\}$) in equal proportions.
- Neither the patient nor the physician knows the patient's type.
- Two treatments $j \in \{D, P\}$ which give (net) utility U_i^j
- A is better treated with P than with D, but B is better treated with D.
- D is "default" means that all patients should be treated with D if no individual information on type.

Technologies. (i) Diagnostic Effort

- Effort $\varepsilon \in [1/2, 1]$ which generates a signal about the agent's type

Table 1: Frequencies in the population

Type $\rightarrow$ Signal $\downarrow$	A	B	Total
A	$\frac{\varepsilon}{2}$	$\frac{1-\varepsilon}{2}$ false pos.	$1/2$
B	$\frac{1-\varepsilon}{2}$ false neg.	$\frac{\varepsilon}{2}$	$1/2$
	$1/2$	$1/2$	

- Physician's cost of effort is increasing and convex, $\psi(\varepsilon)$
- Signal on the patient's type is the doctor's private information.

Technologies. (ii) Diagnostic Test:

- Reveals perfectly whether of type B or A (no errors), but cost of z to the patient
- The **fraction of patients tested**, and the **test cost** z are observable (and contractible) by the health authority,
- but the physician privately observes the **test result**.

Timing:

- The health authority proposes a payment scheme to physicians who accept / refuse.
- She chooses first $\varepsilon \in (1/2, 1)$.
- She receives a signal and updates belief.
- She chooses whether to test based on signal received.
- She chooses treatment $\{P, D\}$.

Pay-offs

- **Patients** are passive, but their welfare ($\tilde{U}_i^j = U_i^j$ minus test cost z) is important to physicians and to social planner.
- **The physician** is imperfectly altruistic:

$$V = \alpha \tilde{U}_i^j + T - \psi(\varepsilon),$$

with

  - $\alpha \in]0, 1[$ her degree of altruism,
  - T a monetary transfer received from the planner/health authority.

3. The social optimum

- The planner maximizes the sum of (patients and physicians) utilities, excluding the altruistic component of the physician's utility.
- Looks for optimal levels of effort and the optimal decision to test.

- **3 possible cases**:
  - **Case All: Test All patients (effort ε_{All})**
  - **Case 1: Test patients with A-signal only (effort ε_1)**
  - **Case 0: Test no patients (effort ε_0)**

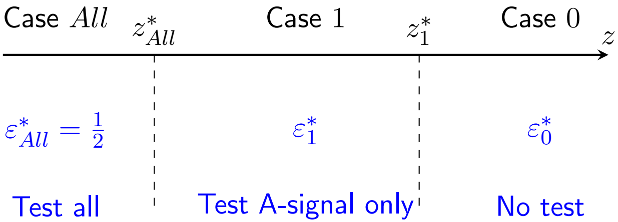
Proposition

Effort and test are strategic substitutes: $\varepsilon^*_{All} = 1/2 < \varepsilon^*_1 < \varepsilon^*_0$.

Intuition: the larger the fraction of patients tested, the smaller the incentive to exert effort.

3. The social optimum

Optimal test decision depends on the cost of the test.



4. The physician's problem

The physician chooses both her level of effort, and the testing decision to maximize her utility subject to the participation constraints:

$$T_k(\varepsilon_k^{eq}) \quad \geq \quad \psi(\varepsilon_k^{eq}) \; \forall k \in \{All, 0, 1\}$$

$\rightarrow$ Altruism part is excluded from the doctor's PC: the health authority cannot take advantage of the physician altruism to reduce remuneration.

4. The physician's choices

When (lump sum) transfers are set to just meet the participation constraints in each case:

Proposition

Physicians exert insufficient effort ($\varepsilon_k^{eq} < \varepsilon_k^*, \forall k \in \{0, 1\}$), and for any given level of effort, test too little ($z_k^{eq} < z_k^*, \forall k \in \{All, 1\}$).

Intuition:

- Effort costly and doctors reap only fraction α of benefits to patients.
- Testing decision: physicians do not account for higher (socially costly) effort when test fewer people, because compensated by transfer to ensure participation.

5. First-best decentralization (with observable altruism)

We need two instruments to align incentives with respect to:

- **The effort decision**
  $\rightarrow$ **Pay-for-performance** part of the physician's remuneration scheme.

- **The test decision:** ensure that z_{All}^{eq} and z_1^{eq} are set to their optimal levels (once the effort levels have been optimally chosen)
  $\rightarrow$ **Case-dependent lump sum**, or **capitation** part of the physician's remuneration scheme.

5. First-best decentralization (with observable altruism)

Effort is not contractible but the number of correctly treated patients $n_{i,k}$ is observable:

- Need to observe fraction of patients who come back to visit the physician for same issue (as for hospitals)
- Can decentralize first-best allocation
- P4P enables to induce the optimal levels of efforts.
- Capitation part is different across cases, used to ensure participation and correct test decisions.
- Rents enjoyed by physician in Cases 1 and *All* increase with her degree of altruism.

6. Asymmetric information on doctor's altruism

- Two types of physicians, type-H physicians with a high degree of altruism, α_H, and type-L physicians with a low degree of altruism, α_L.
- Proportion ν of low-altruism doctors.
- The physician's altruism degree is her private information.
- The contract can only be conditioned on the number of correctly treated patients $n_{i,k}$.
- Concentrate on two-part tariffs (P4P and capitation)

6.1 Within cases

Proposition

The Second-Best contracts in Cases 0 and 1 are pooling.

Case of *non-responsiveness* (Guesnerie and Laffont, 1984) :

- New mechanism: planner wants to induce especially low altruism type to provide more effort ... but effort is especially costly for this type!
- Can't do better than a pooling contract (same for all)

Contract of the following form:

$$T_{i,k} = \bar{T}_k + \beta_k n_{i,k} \, \forall k.$$

- The P4P component, β_k must maximise SW assuming that the physicians choose the optimal Case k.
- β_k is based on average altruism $\bar{\alpha} = \nu\alpha_L + (1-\nu)\alpha_H$,
- $\beta_0 > \beta_1 > \beta_{All} = 0.$.
- This second-best optimal contract generates the following ranking of efforts

$$\varepsilon_{L,k}^{SB} < \varepsilon_k^* < \varepsilon_{H,k}^{SB} \; \forall k = \{0, 1\}.$$

6.2 Across cases: Optimal capitation payments

- **Recall**: Capitation set to (i) satisfy participation constraints, and (ii) induce the optimal testing decisions.
- If transfers are *only* set to satisfy participation constraints at the second-best effort levels, then **under-testing** by physicians.

Proposition

Under the Assumption that $\nu = 1/2$, we have:

$$z^{eq}_{All}(\alpha_L, T^*_{All}, T^*_{L,1}) < z^{eq}_{All}(\alpha_H, T^*_{All}, T^*_{H,1}) < z^{SB}_{All}(\alpha_H) = z^{SB}_{All}(\alpha_L).$$

Intuition: Mix of rents (for low altruism types) and/or of lack of consideration for change in effort levels when changing test decisions if perfectly compensated.

$z^{eq}_{All}(\alpha_L)$ $\quad z \quad$ $z^{eq}_{All}(\alpha_H)$ $\quad z^{SB}_{All}(\alpha_L) = z^{SB}_{All}(\alpha_H)$ $\quad z$

Type L	All	A-signal	A-signal	A-signal
Type H	All	All	A-signal	A-signal
	Optimal and equilib. choices coincide	Suboptimal testing choice for α_L but, optimal choice for α_H	Suboptimal choices for both	[Next Case]

6.3 Across cases: Optimal capitation payments

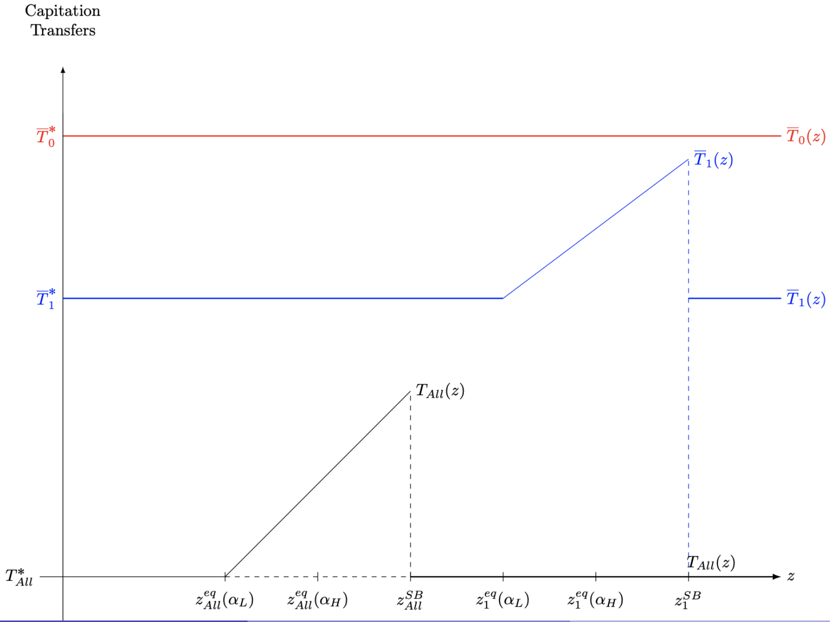
How to set capitation transfers in order to incentivize the right testing decisions?

- Because the contract is pooling, it is impossible to equalize $z^{eq}(\alpha_i)$ with $z^{SB}(\alpha_i)$ for each physician.
- But it is sufficient that the regulator observes the value of z and can condition the capitation transfer on this value.

$\Rightarrow$ **Increase the value of the uniform capitation transfer for all physicians,** in each case so as to incentivize them to test more.

The capitation transfer will now depend on z.

Summing-up SB capitation transfers



Conclusion

Study the optimal diagnostic effort and testing decisions of imperfectly altruistic physicians when 2 treatments are available.

- *When physicians payments are fixed to just meet their PCs*: effort is lower than optimal and they tend to under-use tests.
- *Decentralization of FB*: The payment scheme includes a capitation part (for participation constraint + optimal testing decision) + P4P part (to incentivize effort)
  $\rightarrow$ depend on physician altruism.
- *Decentralization of SB* requires pooling contract with capitation + P4P.

  Capitation based on the (observable) level of the test cost z.