NO CURE NO PAY — CONTRACTS WITH LIMITED LIABILITY

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- Payment schemes should be constructed to increase output
- But most focus seems to be on motivating the “health organization”
- Usually contracts are linear — per item — fees or fixed wages
- I show that the optimal contract is a non-linear, contingent claim contract

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- Well known from real estate and US lawyers
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THE PLAN

- Introduce the model
- show that a fixed wage is optimal when effort is observed, and in-optimal if not
- Show that the optimal contract is non-linear when effort is unobserved
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ENVIRONMENT I

- The physician is employed by a health organization (hospital/municipal)
- The physicians work is measured by observable output y
- y is random, with density $g(y|e)$ where e is the physicians effort
- It is assume that $g(\cdot)$ has a monotone likelihood ratio property

$$\frac{\partial}{\partial y}\left(\frac{g_e(y|e)}{g(y|e)}\right) > 0$$

  I.e. y and e are "complements"
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- The physicians payment is given by $r = R(y, e)$
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The main problem is to find a contract $r = R(y, e)$, with the property that expected utility of the physician

$$U(R, e) = \int u(R(y, e), y) g(y|e) \, \mathrm{d}y - C(e) \tag{1}$$

cannot be increased by a change in $R(y, e)$, without decreasing the expected net income of the hospital

$$V(R, e) = \int \left[y - R(y, e) \right] g(y|e) \, \mathrm{d}y$$

subject to the *incentive constraint* that effort in eq. (1) insures maximal utility

- A key feature of the model is limited liability
- Implies that the physician cannot be forced to pay for bad outcome and the hospital cannot be forced to pay more than the value of output
- Formally $0 \leq R(y, e) \leq y$
- Limited liability reduces the set of contracts
- E.g. it rules out a Mirrlees forcing contract

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$$\max_{R,e} \int_0^\infty \left[u(R(y,e)) + \delta y\right] g(y|e)\, \mathrm{d}y - C(e) \tag{2a}$$

$$\text{s.t.} \int_0^\infty v(y - R(y,e))g(y|e)\, \mathrm{d}y \geq y_L^0 \tag{2b}$$

$$E[u(R(y,e),y)|e] \leq E[u(R,e^*)|e] \tag{2c}$$

$$0 \leq R(y,e) \leq y \tag{2d}$$

where eqs. (2a) and (2b) are the physicians and hospitals utility. eq. (2c) is the physicians *incentive constraint* and eq. (2d) is the limited liability constraint

FIRST-BEST AND THE IN-OPTIMALITY OF FIXED WAGE I

- When effort is observable the problem becomes

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- Using point-wise optimization the optimal contract is implicitly given by

$$\frac{v'(y - R(y,e))}{u'(R(y,e))} = \frac{1}{\lambda}$$

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$$\frac{v'(y - R(y,e))}{u'(R(y,e))} = \frac{1}{\lambda} + \frac{\mu}{\lambda}\frac{g_e(y|e)}{g(y|e)} > R_\lambda(y)$$

- The optimal contract is now increasing in y by the monotone likelihood ratio
- Due to limited liability, even if the physician is risk neutral, the first-best is not achievable

FIRST-BEST AND THE IN-OPTIMALITY OF FIXED WAGE II

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Proposition

If $R(y, e)$ solves the maximization problem, then there is some threshold value y^*, such that

$$R^*(y) = \begin{cases} 0 & \text{for } y < y^* \\ y & \text{for } y \geq y^* \end{cases}$$

Further, **(i)** the hospital is payed according to their participation constraint. **(ii)** if the *incentive constraint* binds, then the solution is not the *first-best*. **(iii)** if the *incentive constraint* does not bind the first best is achieved.

- The rest of the presentation will be a proof of the proposition
- I assume that both parties are risk neutral and the utility is additive and separable
- $u(\cdot) = R(y, e) + \delta y$ and $v(\cdot) = y - R(y, e)$
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THE OPTIMAL CONTRACT II

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- The problem is then[1]

$$\max_{R,e} \int_0^\infty \left[R(y,e) + \delta y\right] g(y|e)\,\mathrm{d}y - C(e) \tag{3a}$$

$$\text{s.t.} \int_0^\infty (y - R(y,e))g(y|e)\,\mathrm{d}y \geq y_L^0 \tag{3b}$$

$$\frac{\partial}{\partial e} E[u(R(y,e),y)|e] \geq 0 \tag{3c}$$

$$0 \leq R(y,e) \leq y \tag{3d}$$

[1]Note eq. (3c) is now replaced by it's *relaxed* first order condition (see Rogerson 1985, for more details)

I can write this in Lagrangian form

$$\begin{aligned}\mathcal{L} =& [R(y,e)+\delta y]g(y|e) - C(e) + \\ & \mu[(R(y,e)+\delta y)g_e(y|e) - C_e(e)] + \\ & \lambda[(y-R(y,e))g(y|e) - y_L^0] + \\ & \theta(y)R(y,e) + \theta(y)\left(y - R(y,e)\right)\end{aligned} \tag{4}$$

The first order conditions are

$$\frac{\partial}{\partial R}\mathcal{L} = g(y|e)\left[1-\lambda+\mu\frac{g_e(y|e)}{g(y|e)}\right]+\theta(y)-\eta(y)=0 \tag{5a}$$

$$\begin{aligned}\frac{\partial}{\partial e}\mathcal{L} = {} & [R(y,e)+\delta y]g_e(y|e)-C_e(e)+ \\ & \mu\left[(R(y,e)+\delta y)g_{ee}(y|e)-C_{ee(e)}\right] \\ & +\lambda\left[(y-R(y,e))g_e(y|e)-y_l^0\right]=0\end{aligned} \tag{5b}$$

- Because of non-negativity and complementary slackness conditions for $\theta(y)$ and $\eta(y)$, eq. (5a) yields

$$\phi(y,e) = g(y|e)\left[1-\lambda+\mu\frac{g_e(y|e)}{g(y|e)}\right] > 0 \;\Rightarrow\; R(y,e) = y$$

$$\phi(y,e) = 0 \;\Rightarrow\; R(y,e) \in [0,y]$$

$$\phi(y,e) < 0 \;\Rightarrow\; R(y,e) = 0$$

- Because $\frac{g_e(y|e)}{g(y|e)}$ is increasing in y, $\phi(y,e)$ crosses zero once and from below. I.e. $R(y,e)$ is 0 for some $y < y^*$ and y for $y > y^*$

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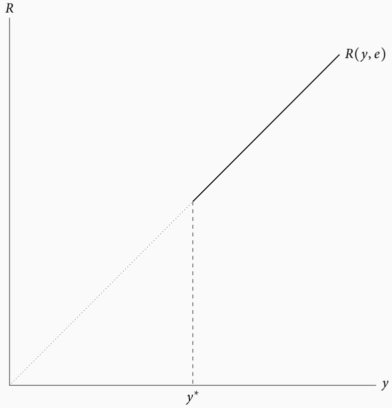

intuition: By moving payment from low outcome states to high outcome states, forces the physician to commit to higher effort levels

- To proof (i) that $y = y_L^0$ note that

$$\frac{\partial}{\partial e}\mathcal{L} = \overbrace{[R(y,e)+\delta y]g_e(y|e) - C_e(e)}^{=0} +$$
$$\mu \overbrace{\left[(R(y,e)+\delta y)g_{ee}(y|e) - C_{ee(e)}\right]}^{<0}$$
$$+\lambda\left[(y-R(y,e))g_e(y|e) - y_l^0\right] = 0 \qquad (7)$$

- So $\lambda\left[(y-R(y,e))g_e(y|e) - y_l^0\right] > 0$ which implies that $\lambda > 0$ and the constraint binds

- to proof (ii), that the optimum is below the *first-best*, note from (i) it follows trivially that $y \in [0, y]$
- Thereby I can write the contract as

$$R(y,e) = \frac{1}{\lambda} + \frac{\mu}{\lambda}\frac{g_e(y_L^0|e)}{g(y_L^0|e)} > R_\lambda(y)$$

- From this, it is easy to see that if the *incentive constraint* does not hold ($\mu = 0$), then the first best is achieved.

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FUTURE WORK

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- Look at change in effort when the physicians "caring" changes
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