Lecture 21

Markets, Mechanisms and Machines

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Economics of Information

- Approach in Economics: study choices of individuals in “product space” or “space of commodities”
- Could treat information as commodity
  - Determine is value for consumers and producers
  - Construct demand and supply
  - Study market for information
- Characteristic feature of information: symmetric availability of information has significant effect on market outcomes

Economics of Information

`Why' is what separates us from them, you from me. `Why' is the only real social power, without it you are powerless. And this is how you come to me, without `why,' without power.

Economics of Information

- Information has both properties of "standard" commodities and has unique features
- Commodity properties
  - Can measure stock of information (accumulated knowledge; e.g. Wikipedia) and flow of information (incremental changes in the knowledge; e.g. edits to Wikipedia article)
- Unique properties
  - Information can be shared, but cannot be simply moved between parties (need a concept of "forgetting")
  - Information can be altered or deliberately misrepresented

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Value of Information

- Information impacts quality of decisions under uncertainty
- Can measure its value by utility gains from better decisions
- Simple model: S states, $s = 1, 2, \ldots, S$ with
- Probability distribution of state realization $\boldsymbol{P}=\{p_s\}$
- Consumer can take actions $a \in A$
- Utility outcome is function of state and action: $u(a,s)$ (ex post utility)
- Ex ante utility $EU(a, \boldsymbol{P})=\Sigma_s\, p_s\, u(a,s)$

Value of Information

- Contrasts ex ante utility with ex post utility
- Ex post: choose $a_s = \text{argmax}_{a \in A} u(a,s)$
- Ex ante: choose $a^* = \text{argmax}_{a \in A} EU(a, \boldsymbol{P})$
- Given that $\Sigma_s \, p_s \max_{a \in A} u(a,s) \geq \max_{a \in A} \Sigma_s \, p_s \, u(a,s)$, ex post utility maximization always yields higher utility
- Difference is value of information service
  - Maximum willingness to pay to intermediary to eliminate uncertainty
- Similarly analyze value of improving information

Value of Information

- Can relate to financial risk hedging with options
  - Pay to postpone risky decisions until after realization of uncertainty
- Simple model: investment I in asset with return $R(s)$, monotone in s with density of distribution of s, $f(s)$ with support on [0,1]
- Assume that $R(0)<I<R(1)$, but $\int R(s)f(s)ds > I$
  - There is a risk to loose investment
  - However, for risk-neutral player it is optimal to invest

Value of Information

- Expected profit from investment is $\int[R(s)- I]f(s)ds >$
- An option, is a contract that allows to buy asset only when return above a given threshold
- What is the value V of such contract?
  - There is threshold state s^* for exercising option
  - If investor's utility from "money" is u then expected utility from unhedged investment is $\int u(R(s) - I)f(s)ds$
  - Expected utility from hedged investment is $\int_{s^*}^{1} u(R(s) - V)f(s)ds + u(I-V)F(s^*) = \int u(R(s)- I)f(s)ds$
  - A risk-neutral investor hedges with $R(s^*)=I$

Types of “Information Environments”

- Verifiable information: can be demonstrated to outsiders according to an accepted standard of evidence or proof.
  - Recall: we can use cryptography to verify information
  - Contractable
- Observable information: can be seen by all parties of transaction but may not be provable to external observers
  - Can only rely on incentives to enforce actions based on this information
- Private information: known only to one party in transaction
  - Explicitly kept secret and requires formation of beliefs
  - Recall: auctions

Asymmetry of information

- Ex ante asymmetry vs asymmetry arising during transaction
- Adverse selection: ex ante asymmetry
  - Individuals have private types that "principal" (insurer, employer) does not observe
- Moral hazard: asymmetry during transaction
  - Individuals have private actions (e.g. effort) that principal does not observe
- Typically consider contract between principal and agent
  - Principal designs contract to optimize her objective
  - Agent chooses actions that optimize her utility subject to constraints of contract

Control of information

- Unique property of information is difficulty to transfer it entirely from one individual to another (instead of sharing)
- Control over information sharing is linked with concept of privacy
  - Not sharing enough information prohibits optimal allocation and leads to welfare loss
  - Sharing “too much” information may allow price discrimination (or other worse forms of discrimination)
- Privacy protection trade-offs costs and benefits of information asymmetry

Control of information

- Spence (1973): “The lemon market”
  - To avoid market collapse individuals may engage in costly “signaling” to reveal their type
- Gottlieb and Smetters (2011): 9 out of 15 top MBA programs in the US do not disclose student grades to employers
- Simple model: Ability of MBA student $\theta \in [0,1]$ produces grade g with effort cost g/θ
- When student graduates θ is her productivity at work
- With public grades, offered wage will depend on g
- When grades are not public, employers have to pay the same wage to all MBA graduates

Control of information

- Utility of graduate

  $U(w, g, \theta) = w - g/\theta$
- Profit of the firm is $\theta - w$
- Assume that θ takes values on [0,1]
- This principal-agent setting of a sequential game:
  1. MBA graduate makes decision to exert effort by choosing g
  2. Firms make competitive offers w
  3. MBA graduate accepts or rejects it

Control of information

- Find grade-dependent wage $w(g)$
  - MBA student chooses effort (expressed in grade g) to maximize utility $U(w(g), g, \theta)$ with respect to
    - FOC: $w'(g)=1/\theta$, which implicitly defines $g(\theta)$
  - Firms make competitive offers $w(g)$
    - Since firms know $w(g)$, they know mapping $g(\theta)$
    - Thus firm can infer θ from observing grade g
  - Competitive offer is then $w=\theta$
  - This means that $w(g)= \theta = 1/w'(g)$
  - Solve differential equation to get

$$w(g) =(2g)^{1/2} \text{ (calibration } w(0) =0)$$

Control of information

Ensure separating equilibria

- Students with different abilities choose different effort
- In this equilibrium $g^*(\theta)=\theta^2/2$ (students with higher ability earn higher grades)
- Equilibrium payment $w^*(g)=\theta$ and utility $U^*(\theta)=\theta/2$

- In "grade privacy" regime firms offer uniform wage $w_U=\mathrm{E}[\theta]$
- Grade privacy is optimal if $U^*(\theta)< \mathrm{E}[\theta]$, i.e. $\mathrm{E}[\theta]>1/2$
  - MBA students have to be "selectively smart"