Decisions in Organizations

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Outline

Part One: Exogenous Governance Structures
1. Introduction: Setting, Problems, Responses
2. A Basic Model
3. Beyond the Basic Model

Part Two: Endogenous Governance Structures

“Traditionally, organizations are described by organization charts. An organization chart specifies the authority or reportorial structure of the system ... The kinds of models presented in this book provide another ... view of an organization. We can describe the organization as a decision-making process.”
“Where different parts of the organization have responsibility for different pieces of information relevant to a decision, we would expect some bias in information transmitted due to perceptual differences among the subunits and some attempts to manipulate information as a device for manipulating the decision. **We cannot reasonably introduce the concept of communication bias without introducing its obvious corollary - ‘interpretive adjustment’.”**
“... members of the organization may have an incentive to try to manipulate the information they develop and provide in order to influence decisions to their benefits. Such manipulation can take many forms, ranging from conscious lies concerning facts ... to simply presenting the information in such a way that accentuates the points supporting the interested party’s preferred decision.”
1. Intro: Some Responses - Milgrom and Roberts (1988)

1. Reduce the channels of communication (limit scope for strategic distortion)
2. Reduce the decision-maker’s discretion (limit response to biased information)
3. Alter the organization away from productive efficiency (limit incentives to influence)

- Some such responses discussed in Section 4
- Another response: delegation (Section 5)
  - Between firms (eg, Meyer et al. (1992))
  - Within firms? (eg, Dessein (2002))
2. Basic Model: Outline

1. Mintzberg (1979) Decision Process
2. Timing of Basic Model
3. Selected Illustrations
   A. Cheap Talk: Crawford and Sobel (1982)
   C. Signaling: Austen-Smith and Banks (2000)
   E. Strategic Management of Public Information: Kamenica and Gentzkow (2011)

4. Summary
   - Imperfect information transmission
   - Costly influence activities
   - Distorted “decisions”
   - Real organizations?
What is a “decision-making process?”

Information → Advice → Choice → Execution

* Mintzberg (1979: 188) also includes an “authorization” step between choice and execution.
### 2.2 Basic Model: Timing

1. State of world $s \in S$ realized: $s \sim f(s)$
2. Ex ante signal $\theta$ realized: $\theta \sim g(\theta | s)$, privately observed by player 1
3. **Influence**: Player 1 chooses $a \in A$
4. Ex post signal $\sigma$ realized: $\sigma \sim h(\sigma | s, a)$, privately observed by player 2
5. **Decision**: Player 2 chooses $d \in D$
6. Payoffs: $U_i(s, a, d), i \in 1, 2$

- Nothing contractible ($\rightarrow$ not mechanism design)

**Information $\rightarrow$ Advice $\rightarrow$ Choice $\rightarrow$ Execution**

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Gibbons, Matouschek, Roberts (2012) Decisions in Organizations
2.3A Crawford and Sobel (1982): Model

1. State $s \sim U[0, 1]$
2. 1’s signal: $\theta = s$
3. **1’s influence:** $a \in [0, 1]$ (or $a \in 2^{[0,1]}$) at no cost
4. 2’s signal: $\sigma = a$
5. **2’s decision:** $d \in [0, 1]$
6. Payoffs:
   - $U_1(s, d) = -(d - (s + b))^2$
   - $U_2(s, d) = -(d - s)^2$

- **Cheap talk:** $U_i$ independent of $a$
- Possible context: biased expert (1) advising manager (2)
Theorem

If \( b \neq 0 \), then in every equilibrium \( \exists s_1, s_2 \in [0, 1] \) such that \( a(s_1) = a(s_2) \).

- \( a(s) = s \rightarrow d(a) = a \rightarrow a(s) = s + b \)
- Recall Cyert and March (1963): bias \( \rightarrow \) distorted communication \( \rightarrow \) “interpretive adjustment”
**Multiple equilibria:** interval communication possible if $|b|$ not too large
- $0 = s_0 < s_1 < ... < s_N = 1$ for $N \geq 1$

- Cut-off $s_i$: Sender indifferent between $d^*(m_{i-1})$ and $d^*(m_i)$
- Comparative statics: $N_{Max} \uparrow$ as $|b| \downarrow$

References:
- Gibbons, Matouschek, Roberts (2012) Decisions in Organizations
- Handbook of Org. Econ.

1. State \( s \sim N(0, \frac{1}{h_s}) \)

2. 1’s signal: \( \theta = 0 \)

3. **Influence:** 1 chooses \( a \in \mathbb{R} \) at cost \( c(a) \)

4. 2’s signal: \( \sigma = s + a + \varepsilon, \varepsilon \sim N(0, \frac{1}{h_\varepsilon}) \)

5. **Decision:** 2 chooses \( d \in \mathbb{R} \)

6. **Payoffs:**
   - \( U_1(s, a, d) = -(d - (s + b))^2 - c(a), \)
     \[ c'(\infty) = c'(-\infty) = \infty, \ c'(0) = 0, \ c'' > 0 \]
   - \( U_2(s, a, d) = -(d - s)^2 \)

**Signal jamming:** 1 does not have private info, but costly action \( a \) interferes with 2’s signal

**Possible context:** worker (1) lobbying a boss (2) to implement policy
a costly and unproductive, so $a^{FB} = 0$ in first-best

If $a = 0$ in equilibrium:

- 2 would believe
  \[
  E[s \mid \sigma] = \frac{h_\varepsilon}{h_s + h_\varepsilon} \sigma
  \]

- 2 would choose $d = E[s \mid \sigma]$
- 1’s deviation:
  \[
  a' \neq 0 \rightarrow d = \frac{h_\varepsilon}{h_s + h_\varepsilon} (s + a' + \varepsilon)
  \]

- $c'(0) = 0 \rightarrow$ small $a'$ is profitable deviation
2 adjusts belief based on conjecture $\hat{a}$ about 1’s action:

$$d^*(\sigma, \hat{a}) = E[s \mid \sigma, \hat{a}] = \frac{h_\varepsilon (\sigma - \hat{a})}{h_s + h_\varepsilon}$$

1 chooses $a^*(\hat{a})$ to

$$\max_a \quad - \int_{s, \varepsilon} [d^*(\sigma, \hat{a}) - (s + b)]^2 dF(s, \varepsilon) - c(a)$$

$$\longrightarrow \quad c'(a) = \frac{2h_\varepsilon b}{h_s + h_\varepsilon}, \text{ for all } \hat{a}$$

In equilibrium, $\hat{a} = a^*$ (“interpretive adjustment”) 

$\rightarrow d$ not affected by manipulation

BUT, manipulation is costly $\rightarrow$ inefficiency
2.3C (Inspired by) Austen-Smith and Banks (2000): Model

1. State \( s \in [0, 1] \), \( s \sim f(s) \)
2. 1’s signal: \( \theta = s \)
3. **Influence:** 1 chooses \( a \geq 0 \) at cost \( c(a) \)
4. 2’s signal: \( \sigma = a \)
5. **Decision:** 2 chooses \( d \geq 0 \)
6. **Payoffs:**
   - \( U_1(s, a, d) = -[d - (s + b)]^2 - c(a) \),
   - \( U_2(s, a, d) = -(d - s)^2 \)

**Signaling:** “money burning” \( a \) informs 2 about parameter \( s \).

Possible context: “decision” by team member with private information (1) signals project value to another (2)
a(s) = 0 is not equilibrium (as in H 82/99 → G05)

There can be perfect revelation of the state.

- IC constraint for sender type s:
  
  \[ -b^2 - c(a^*(s)) \geq -[s' - (s + b)]^2 - c(a^*(s')) \]

  \[ \iff c(a^*(s')) - c(a^*(s)) \geq b^2 - [s' - (s + b)]^2 \]

- If \( c(a) = a \), then \( a^*(s) = 2bs \) satisfies the IC.

Inefficiency: “money-burning” (increases with state)

1. State $s \in S \subseteq \mathbb{R}$, $s \sim f(s)$
2. 1’s signal: $\theta = s$
3. Influence: 1 chooses $a \in \{\emptyset, s\}$
4. 2’s signal: $\sigma = a$
5. Decision: 2 chooses $d \in D \subseteq \mathbb{R}$
6. Payoffs:
   - $U_1(s,d) \uparrow$ in $d$, independent of $a$ and $s$.
   - $d^*(s)$ uniquely maximizes $U_2(s,d)$, $d^*(s) \uparrow$ strictly in $s$

- **Verifiable Info**: can be null or any subset of $S$ that includes $s$
- **Possible Context**: Expert (1) decides whether to let $s$ be revealed to boss (2)
Unraveling $\to$ Full Revelation: $a(s)$ is different for each $s \in S$.

- Either $a(s) = s$ or $a(s) = \emptyset$
- Suppose, eg, $s < s'$ both satisfy $a(s) = a(s') = \emptyset$
- Then $d^*(\emptyset) < d^*(s')$
- Then $s'$ has incentive to deviate to $a = s'$

2 can infer true state $s$ from $a(s)$
$\to$ picks $d$ to maximize $U_2$

Seidmann and Winter (1997):

- if $U_1 = -(d - [s + b])^2$ and $U_2 = -(d - s)^2$ then full revelation in equilibrium
2.3E (Inspired by) Brocas and Carrillo (2007): Model

1. State $s \sim U[\underline{s}, \bar{s}], \underline{s} < 0 < \bar{s}$
2. 1’s signal: $\theta = \emptyset$
3. Influence: 1 chooses $a \in \{0, 1\}$
4. 2’s signal: $\sigma = sa$
5. Decision: 2 chooses $d \in \{0, 1\}$
6. Payoffs:
   - $U_1(s, d) = d$
   - $U_2(s, d) = ds$

- Player 1 has no private info
- 1 influences 2’s belief by affecting public info 2 observes
- Possible Context:
  - agenda control: $E(s) > 0 \rightarrow a = 0, E(s) < 0 \rightarrow a = 1$
Kamenica and Gentzkow (2011): generalizes BC 07

Example:

1. **Influence:** 1 chooses \( a \in [s, \bar{s}] \)
2. 2's **signal:** \( \sigma = H \) if \( s \geq a \) or \( \sigma = L \) if \( s < a \).

Possible Context:
- pharmaceutical company: designing clinical trial

\[ E(s) < 0 \rightarrow a^* = -\bar{s} \]
Summary of Basic Model

- Decomposition of Distortions
  - Imperfect information transmission (cheap talk)
  - Costly influence activities (signal jamming)
  - Distorted "decisions" (signaling)

- Real organizations?
Loss Decomposition for the Quadratic Case

Payoffs

- \( U_1(s, a, d) = -(d - (s + b))^2 - c(a) \),
- \( U_2(s, a, d) = -(d - s)^2 \)

Under **full info** about \( s \), action \( a = 0 \) and decision \( d = s + \frac{b}{2} \) maximize the parties’ total payoff

- the total payoff is \(-\frac{1}{2}b^2\).

But \( d \) is **non-contractible**, so in all five models, player 2’s equilibrium decision is \( d^*(\sigma) = E_{s|\sigma}(s|\sigma) \).

- the equilibrium expected total payoff is

\[
E[U_1 + U_2] = E_s[-(d - (s + b))^2 - c(a(s)) - (d - s)^2] \\
= E_\sigma \{ E_{s|\sigma}[-(d - (s + b))^2 - (d - s)^2]|\sigma \} - E_s[c(a(s))] \\
= -b^2 - 2E_\sigma[Var(s|\sigma)] - E_s[c(a(s))]
\]

Gibbons, Matouschek, Roberts (2012)
Loss Decomposition for the Quadratic Case

- Total expected equilibrium loss from strategic communication and decision making in all five models:

\[ -\frac{1}{2}b^2 - \left\{ -b^2 - 2E_{\sigma}[Var(s|\sigma)] - E_s[c(a(s))] \right\} \]

\[ = \frac{1}{2}b^2 + 2E_{\sigma}[Var(s|\sigma)] + E_s[c(a(s))] \]

- First term: **loss from non-contractible** \( d \), so 2’s equilibrium decision is \( d^*(\sigma) = E_{s|\sigma}(s|\sigma) \) rather than \( E_{s|\sigma}(s|\sigma) + \frac{1}{2}b \)

- Second term: **loss from imperfect adaptation** to the state (not about average decision, but about how the decision varies with state)

- Third term: **loss from costly influence activities**

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“An emphasis on the political character of organizational decision-making is implicitly a focus on the strategic nature of organizational information...In a conflict system, information is an instrument of consciously strategic actors. Information may be false; it is always serving a purpose....Thus information is itself a game. Except insofar as the structure of the game dictates honesty as a necessary tactic, all information is self-serving. Consequently, meaning is imputed to messages on the basis of theories of intention that are themselves subject to strategic manipulation. The result is a complicated concatenation of maneuver in which information has considerably less value than it might be expected to have if strategic considerations were not so pervasive.”
3. Beyond the Basic Model

A. Multi-Dimensional Cheap Talk

B. Enrichment: More Players
   ▶ Caillaud and Tirole (2007)

C. Enrichment: More Dates

D. Reinterpretation: Choice → Execution

E. Enrichment: Information → Advice → Choice
   ▶ Aghion and Tirole (1997), Che and Kartik (2009)

F. Enrichment: Partly Contractible
   ▶ Krishna and Morgan (2008)

G. Contests for Control

1. State $s = (s_1, s_2) \in S = \{A, B, C\}^2$, $s \sim p(s_1, s_2)$
   - Probability of $s_2$ given $s_1$: $p(s_2 | s_1)$
   - $p(i, i) = 0$ for each $i \in \{A, B, C\}$
   - $\text{Prob}\{s_2 = i\} > 0$ for each $i \in \{A, B, C\}$
   - $p_i = \max_{s_2} \{p(s_2 | s_1 = i)\} \in [\frac{1}{2}, 1]$

2. 1’s signal: $\theta = s$

3. 1’s influence: $a \in 2^S$ at no cost (cheap talk)

4. 2’s signal: $\sigma = a$

5. 2’s decision: $d \in \{A, B, C\}$

6. Payoffs:
   1. $d = s_i \rightarrow U_i = b_i$, $U_{-i} = 0$
   2. $d \notin \{s_1, s_2\} \rightarrow U_1 = U_2 = -K$
Suppose $p_i = 1$, all $i \in \{A, B, C\}$
- $s_1$ and $s_2$ perfectly correlated (but still different)

Rubber-stamping impossible:
- Suppose $a = s_1$ in equilibrium
- $2$ perfectly infers $s_2$ from $a$, chooses $d(s_1) = s_2$
- $1$’s profitable deviation: choose $a$ so that $d(a) = s_1$
- Because $\text{Prob}\{s_2 = i\} > 0$, such an $a$ must exist

Like Crawford-Sobel (82), $2$ cannot infer preferred $d$ from truth-telling $1$
Suppose $p_i = \frac{1}{2}$, all $i \in \{A, B, C\}$

- Given $s_1$, $s_2$ equally likely to be either element of $S \setminus s_1$

Rubber-stamping may be possible:

- Suppose $a = s_1$ in equilibrium
- If 2 picks $d(a) = a \rightarrow U_2 = 0$
- If 2 picks $d(a) \neq a \rightarrow U_2 = \frac{1}{2}b_2 + \frac{1}{2}(-K)$
- $b_2 < K \rightarrow d(a) = a$, so $a = s_1$ leads to rubber-stamping

Like Aghion-Tirole (97), 2 prefers to rubber stamp 1’s proposal
Multiple player 1s or player 2s, with possibly sequential moves

- **Persuading a group:**
  Caillaud and Tirole (2007)

Capture longer horizon in reduced-form payoffs:

- **Career concerns**
3D. Reinterpretation: Choice $\rightarrow$ Execution

- Mintzberg (1979) revisited:
  
  Information $\rightarrow$ Advice $\rightarrow$ **Choice** $\rightarrow$ Execution

- Basic Model, Reinterpreted:
  - $a =$ choice, $d =$ execution of that choice
  - Player 1 is boss, 2 is worker deciding how to carry out orders

- Utility function:
  - Cheap Talk: $U_i(s, d)$
  - Signal Jamming: $U_i(s, d) - c(a)$
  - Money Burning: $U_i(s, d) - c(a)$
  - Choice $\rightarrow$ Execution: $U_i(s, a, d)$

- Examples
  - Landier et al. (2009)
  - Marino et al. (2010)
(Inspired by) Blanes i Vidal and Möller (2007): Model

1. State $s \in \{A, B\}$

2. 1’s signal: $\theta = \{\theta_{pvt}, \theta_{pub}\} \in \{A, B\} \times \{A, B\}$
   - $1 > \text{Prob}\{\theta_{pvt} = s \mid s\} = p_{pvt} > p_{pub} = \text{Prob}\{\theta_{pub} = s \mid s\} > \frac{1}{2}, \forall s$
   - $\theta_{pvt}, \theta_{pub}$ conditionally independent, given $s$

3. **Influence:** 1 chooses $a \in \{A, B\}$

4. 2’s signal: $\sigma = (a, \theta_{pub})$

5. **Decision:** 2 chooses $d \in [0, 1]$ at cost $c(d)$

6. **Payoffs:**
   - Project outcome: $a \neq s \rightarrow y = 0; a = s \rightarrow y = y_H$ with probability $d$
   - $U_1(s, a, d) = (1 - \alpha)y$
   - $U_2(s, a, d) = \alpha y - c(d)$, with $c'' > 0$
   - Possible context: Boss picks project $a$, agent exerts effort $d$
$p_{pvt} > p_{pub} \rightarrow$ first-best project choice is $a = \theta_{pvt} \in \{A, B\}$

First-best effort solves $\max_d E[y(d) \mid \theta_{pub}, \theta_{pvt}] - c(d)$

- $d$ depends on both $\theta_{pub}, \theta_{pvt}$
- Eg, when $\theta_{pub} \neq \theta_{pvt}$,

\[ c'(d^{FB}) = p_{pvt}(1-p_{pub})y_H \]
Consider equilibrium with \( a = \theta_{pvt} \):

- If \( \theta_{pvt} = \theta_{pub} \), then 1 picks \( a = \theta_{pvt} \)
- If \( \theta_{pvt} \neq \theta_{pub} \), then will 1 deviate from \( a = \theta_{pvt} \)?
  - 1 picks \( a = \theta_{pvt} \) \( \rightarrow \) \( d_{pvt} \) solves
    \[
    c'(d_{pvt}) = \alpha p_{pvt}(1 - p_{pub})y_H
    \]
  - 1 picks \( a = \theta_{pub} \) \( \rightarrow \) 2 thinks \( \theta_{pub} = \theta_{pvt} \), so \( d_{pub} \) solves
    \[
    c'(d_{pub}) = \alpha [1 - (1 - p_{pvt})(1 - p_{pub})]y_H
    \]

\( d_{pvt} < d_{FB} \rightarrow \text{too little effort} \)

\( c \) convex \( \rightarrow \) \( d_{pub} > d_{pvt} \)

- When \( \theta_{pub} \neq \theta_{pvt} \), 1 trades off effort, \( d_{pub} - d_{pvt} \), vs. probability that \( s = a \), \( p_{pvt} - p_{pub} \)
- If \( p_{pvt} - p_{pub} \) small, 1 will choose \( a = \theta_{pub} \) when \( \theta_{pub} \neq \theta_{pvt} \)
What happens if players can exert effort to change signals?

- Influence activities and decisions affect *ex ante* info gathering

Examples:

- Aghion and Tirole (1997)
- Dewatripont and Tirole (1999)
3F. Contracts: Krishna and Morgan (2008) Model

Commitment to Transfers:
1. 2 offers a contract $t(a)$, 1 accepts or rejects
2. Limited liability: $t(a) \geq 0$
3. $d$ not contractible $\rightarrow$ Revelation Principle does not hold

Basic Model:
1. State $s \sim U[0,1]$
2. 1’s signal: $\theta = s$
3. 1’s influence: $a \in [0,1]$ at no cost
4. 2’s signal: $\sigma = a$
5. 2’s decision: $d \in [0,1]$
6. Payoffs:
   - $U_1(s, a, d) = -(d - (s + b))^2 + t(a)$
   - $U_2(s, a, d) = -(d - s)^2 - t(a)$
   - $b > 0$
Full revelation: \( a(s) = s \rightarrow d(a) = a \)

- \( U_1(s, s) + t(s) \geq U_1(s, s') + t(s') \), \( \forall s, s' \)
- \( -b^2 + t(s) \geq 0 + t(s + b) \)
- \( t(s) = (1 - s)b \) will achieve separation
- 2’s expected payoff = 0 – \( E[t(s)] = -\frac{b}{2} \)

Full revelation: always feasible, **never** optimal

- Inducing revelation for high \( s \rightarrow \) large payments for revealing low \( s \)
- Pool high \( s \rightarrow \) reduce payments for revealing low \( s \)

**Theorem**

*With commitment to transfers, the optimal contract satisfies:*

1. **Positive payments and full separation** on \([0, a_0]\), \( 0 < a_0 \leq \frac{1}{4} \)
2. **No payments and pooling** on \([a_0, 1]\)
3G. Che and Kartik (2009): Model

1 Information Gathering:

   ▶ State $s \in \mathbb{R}$ is realized. **Open disagreement** about distribution:
      ▶ Player 1 believes $s \sim N(\mu, \sigma_s^2)$, $\mu > 0$
      ▶ Player 2 believes $s \sim N(0, \sigma_s^2)$

   ▶ Player 1 chooses $e \in [0, 1]$ at cost $c(e)$.

2 Baseline Model:

   1 1’s signal: $\theta \in \{0, \tilde{\theta}\}$, $\tilde{\theta} \sim N(s, \sigma_\theta^2)$, $\text{Prob}\{\theta = \tilde{\theta}\} = e$

   2 **Influence:** 1 chooses $a \in \{0, \theta\}$

   3 2’s signal: $\sigma = a$

   4 **Decision:** 2 picks $d \in \mathbb{R}$

   5 Payoffs: $U_1(s, e, d) = -(d - s)^2 - c(e)$, $U_2(s, d) = -(d - s)^2$

Possible context: advisor (1) has same preferences over outcome as boss (2), but different beliefs about optimum.
CK 2009: Disclosure

- **Inefficiencies:**
  - 1 doesn’t internalize 2’s preferences, exerts too little effort
  - 1 doesn’t always disclose signal

- **Interim bias** = difference in preferred actions given signal:
  \[ B = (1 - \rho)\mu \]

  where \( \rho = \frac{\sigma_s^2}{\sigma_s^2 + \sigma_\theta^2} \)

- **Fix** effort \( e \) → disclosure rule
  - Suppose 2 takes action \( d_{ND} \) if \( \sigma = \emptyset \)
  - 1 does **not** disclose when
    \[ \frac{d_{ND} - 2B}{\rho} \leq \theta \leq \frac{d_{ND}}{\rho} \]

- 2 picks \( d_{ND} \) to max utility, given 1’s non-disclosure rule
  - Exists unique fixed point = equilibrium
  - 1 does **not** disclose when \( \theta \in [\theta(B, e), \bar{\theta}(B, e)] \)
  - \( \theta, \bar{\theta}, d^*_{ND} \) decreasing in \( B, e \)
CK 2009: Effort and Benefits of Bias

- $e$ fixed $\rightarrow$ 2 wants $\mu = 0$
- But $\mu \uparrow \rightarrow e^* \uparrow$
  1. $d^*_{ND}$ decreasing in $\mu$, so 1’s penalty for not disclosing larger
  2. 1 expects signal $\theta$ to confirm prior, persuade 2
- “Persuasion” effect (2) result of differing priors

Theorem

There exists $\mu \neq 0$ such that 2 prefers an adviser with mean belief $\mu$ over an advisor with mean belief 0
4. Conclusion

- Real Organizations?
- Future Research?
Much information gathered that is not relevant to decision

Much information collected after the decision has already been made

Much information gathered in response to requests, but not considered when making decision

Regardless of the information initially available, more information is requested

Information ignored, but decision-makers also complain that organization does not have enough information
“It is possible, on considering these phenomena, to conclude that organizations are systematically stupid....[Alternatively,] it is possible to try and discover why reasonably successful and reasonably adaptive organizations might exhibit the kinds of information behaviors that have been reported. Perhaps the stories of information perversity tell us less about the weaknesses of organizations and more about the limitations of our ideas about information.”
“We need more satisfactory theories of organizational goals, organizational expectations, organizational choice, and organizational control. In our view, these are the four majors subtheories of a behavioral theory of the firm.”

“A theory of organizational...

- **Goals** would consider how goals arise in an organization, how they change over time, and how the organization attends to them.”

- **Expectations** would treat how and when an organization searches for information or new alternatives and how information is processed through the organization.”

- **Choice** would characterize the process by which the alternatives available to the organization are ordered and a selection made.”

- **Control** would specify the differences between executive choice in an organization and the decisions actually implemented.”
2.3C (Inspired by) Hermalin (1998): Model

1. State $s \in [0, 1]$, $s \sim f(s)$
2. 1's signal: $\theta = s$
3. **Influence:** 1 chooses $a \geq 0$ at cost $c(a)$
4. 2's signal: $\sigma = a$
5. **Decision:** 2 chooses $d \geq 0$ at cost $c(d)$
6. Payoffs:
   - $U_1(s, a, d) = \frac{1}{2} s(a + d) - c(a)$
   - $U_2(s, a, d) = \frac{1}{2} s(a + d) - c(d)$

- **Signaling:** “money burning” $a$ informs 2 about parameter $s$.
- Possible context: “decision” by team member with private information
  - (1) signals project value to another
  - (2)
First-best: given $s$, solve

$$\max_{a,d} s(a + d) - c(a) - c(d)$$

For simplicity, $c(a) = \frac{1}{2}a^2$:

$$a^{FB} = d^{FB} = s$$

2 doesn’t know $s \rightarrow$ to achieve FB, $d(a) = a \rightarrow$ in equilibrium, 1 would solve

$$\max_a s(a + a) - c(a)$$

$$a^* = 2s > s$$
Consider separating equilibrium: $d^{\text{sig}}(a)$ solves

$$\max_d \frac{1}{2} a^{-1}(a)(a + d) - c(d)$$

- Example: $a = ks \to a^{-1}(a) = \frac{a}{k}$
- 1 solves

$$\max_a \frac{1}{2} s(a + d^{\text{sig}}(a)) - c(a)$$

$$\to a^{\text{sig}}(s) : \quad \frac{1}{2} s(1 + \frac{dd^{\text{sig}}(a)}{da}) = c'(a)$$

- $k = \frac{1+\sqrt{5}}{4} \to a^{\text{sig}}(s) \in (a^{\text{sym}}(s), a^{FB}(s))$
- $a^{\text{sym}}(s) = 1$’s action if $s$ commonly known
If \( c(a) = \frac{1}{2} \gamma a^2 \), decrease \( \gamma \) to make \( a \) more effective signal (MR 88, response 3)

If

\[
U_1 = \alpha s(a + d) - c(a)
\]
\[
U_2 = (1 - \alpha) s(a + d) - c(d)
\]

then \( \alpha \downarrow \rightarrow d \uparrow \rightarrow \) action \( a \) is more valuable to 1 (MR 88, response 3)

1 observes \( \theta = s + \varepsilon \rightarrow \sigma_{\varepsilon}^2 \downarrow \)
Aghion and Tirole (1997): Model

Info Acquisition Stage:

1. $s = \{s_1, s_2\} \in S \times S$ realized
2. **Effort**: player $i$ chooses $e_i \in [0, 1], i \in \{1, 2\}$

Basic Model:

1. 1's signal: $\theta \in \{\emptyset, s_1\}, \text{Prob}\{\theta = s_1\} = e_1$
2. **Influence**: 1 picks $a \in S$
3. 2's signal: $\sigma = \{a, \sigma_2\}, \sigma_2 \in \{\emptyset, s_2\}, \text{Prob}\{\sigma_2 = s_2\} = e_2$
4. **Decision**: 2 picks $d \in \{S, \emptyset\}$

Payoffs: $U_i(s, e_i, d) = \begin{cases} B_i - c(e_i) & \text{if } d = s_i \\ \alpha_i B_i - c(e_i) & \text{if } d = s_{-i} \\ 0 & \text{if } d = \emptyset \\ -\infty & \text{otherwise} \end{cases}$

- $\alpha_1 B_1 + B_2 > B_1 + \alpha_2 B_2$

Possible context: worker (1) and boss (2) explore possible projects, boss decides which to pursue
2 picks \( d = s_2 \) if known, otherwise picks \( d = a \)

Payoffs:

\[
U_1 = e_2 \alpha_1 B_1 + (1 - e_2)e_1 B_1 - k(e_1)
\]

\[
U_2 = e_2 B_2 + (1 - e_2)e_1 \alpha_2 B_2 - k(e_2)
\]

Effort choices:

\[
k'(e_1^*) = (1 - e_2)B_1
\]

\[
k'(e_2^*) = B_2 - e_1 \alpha_2 B_2
\]

With probability \( (1 - e_2)e_1 \), 2 chooses 1’s preferred project