Timing Decisions in Organizations: Communication and Authority in a Dynamic Environment

Steven Grenadier   **Andrey Malenko**   **Nadya Malenko**

Stanford University   MIT   Boston College

Financial Intermediation Research Society

May 25, 2015

Decision-making inside firms

- Uninformed decision-maker $+$ informed but biased agent $+$ incomplete contracts
- Important questions:
  - Does agent communicate information efficiently?
  - Allocation of authority

- Existing literature: decisions that must be done today (e.g., project scale)
  - Crawford and Sobel (1982), Aghion and Tirole (1997), Dessein (2002), Harris and Raviv (2005, 2008), Chakraborty and Yilmaz (2011), and others.

This paper: Real options

- Most decisions are not purely static:
  - many decisions are about **timing**: bringing a new product, shutting down a plant, drilling an oil well.
  - most decisions can be delayed.

This paper: Real options

- Most decisions are not purely static:
  - many decisions are about **timing**: bringing a new product, shutting down a plant, drilling an oil well.
  - most decisions can be delayed.

This paper:

- A theory of how organizations make timing decisions.
  - Centralized decision-making: principal retains authority and communicates with agent via cheap talk.
  - Decentralized decision-making: principal delegates authority to the agent.
  - Which decisions should be delegated?

Results

- *Main insight*: Timing decisions have different economics from static decisions.
- Asymmetry between "delay bias" and "early exercise bias" cases.
  - E.g., shutting down the plant vs. product launch;
  - Reason: Irreversibility of time.

Results

- *Main insight*: Timing decisions have different economics from static decisions.
- Asymmetry between "delay bias" and "early exercise bias" cases.
  - E.g., shutting down the plant vs. product launch;
  - Reason: Irreversibility of time.
- *Delay bias:*
  1. Often full communication of information, but too late;
  2. Delegation never helps.
- *Early exercise bias:*
  1. Noisy communication, but correct or delayed timing;
  2. Delegation helps if the bias is low or if delegation can be timed.

Model overview

- Principal (P), agent (A), and a call option (e.g., drill oil)
- Upon exercise at t, P obtains $\theta X(t) - I$, where

$$dX(t) = \mu X(t)dt + \sigma X(t)dB(t).$$

  - $X(t)$ is public.
  - θ is A's private information, uniform on $[\underline{\theta}, 1]$; mostly, $\underline{\theta} = 0$.
  - θ is learned by A at $t = 0$.
  - discount rate $r > \mu$.

Model overview

- Principal (P), agent (A), and a call option (e.g., drill oil)
- Upon exercise at t, P obtains $\theta X(t) - I$, where

$$dX(t) = \mu X(t)dt + \sigma X(t)dB(t).$$

  - $X(t)$ is public.
  - θ is A's private information, uniform on $[\underline{\theta}, 1]$; mostly, $\underline{\theta} = 0$.
  - θ is learned by A at $t = 0$.
  - discount rate $r > \mu$.

- Payoffs upon exercise:

$$\begin{aligned} \text{P:} \quad & \theta X(t) - I, \\ \text{A:} \quad & \theta X(t) - (I - b). \end{aligned}$$

  - $b > 0$ ($b < 0$) is bias towards early (late) exercise.
  - b is common knowledge.

Model setup: Timing

- Now: Nothing is contractible. P relies on informal communication with A ("cheap talk").
- Later: Allocation of authority is contractible.

Model setup: Timing

- Now: Nothing is contractible. P relies on informal communication with A ("cheap talk").
- Later: Allocation of authority is contractible.

Heuristic timing of events over $[t, t + dt]$:

1. Nature determines $X_t = X_{t-dt} + dX_{t-dt}$.
2. A decides on message $m_t \in M$ to send to P.
3. P decides whether to exercise or not.
   - If P exercises, the game ends, and players receive payoffs.
   - Otherwise, the game continues and $X_{t+dt} = X_t + dX_t$ is realized.

Preference for late exercise (b < 0): Stationary case

- If $b > -I$, there exists the following equilibrium:
  - Type θ sends $m = 1$ if and only if $X(t) \geq X_A^*(\theta)$.
  - P exercises the option at the first time he gets $m = 1$.

Preference for late exercise ($b < 0$): Stationary case

- If $b > -I$, there exists the following equilibrium:
    - Type θ sends $m = 1$ if and only if $X(t) \geq X_A^*(\theta)$.
    - P exercises the option at the first time he gets $m = 1$.

- Intuition:
    - A gets her most preferred timing of exercise.
    - P gets $m = 1 \Rightarrow$ knows it is too late $\Rightarrow$ exercises immediately.
    - P gets $m = 0 \Rightarrow$ trades off waiting for information vs. delay
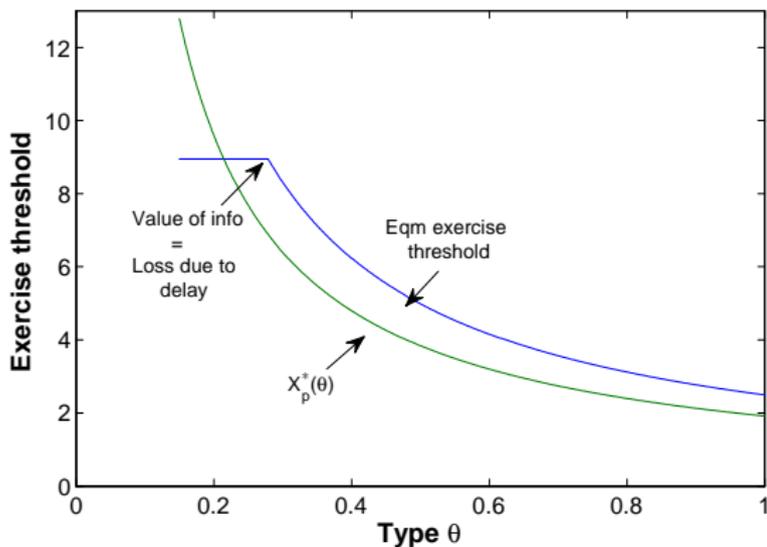 $\Rightarrow$ waits if $b > -I$.

Preference for late exercise: Illustration
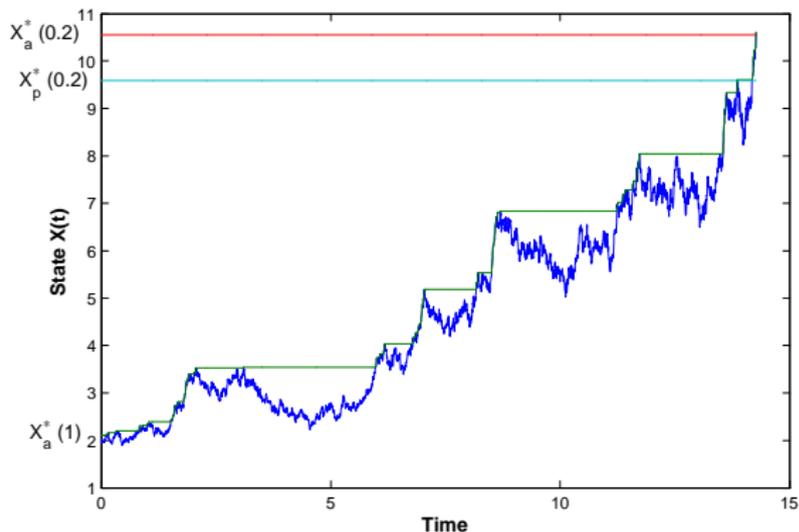
- Full communication, but with delay.
- P has formal authority, but A has unlimited real authority.

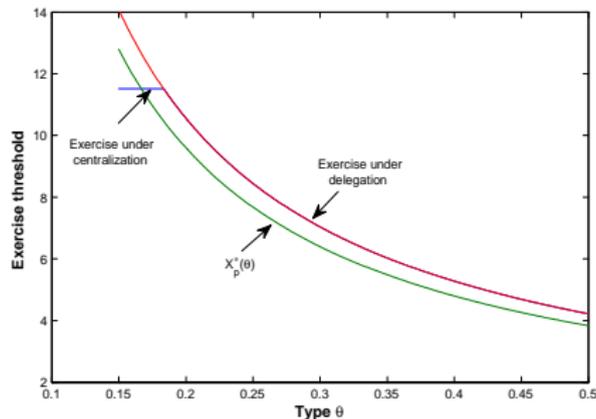# Preference for late exercise: Non-stationary case

- If $\underline{\theta} > 0$, exercise at $X_A^*(\theta)$ up to a lower cut-off $\hat{\theta}^*$:

- Intuition: Informational advantage of agent decreases over time.

Delegation vs. Centralization: Bias towards late exercise

- Centralization is always weakly superior to delegation. It is strictly superior if $\underline{\theta} > 0$.

  - No mechanism can improve on centralization if $b < 0$.

- Intuition: Centralization implements conditional delegation.

Preference for early exercise (b > 0)

Equilibrium with truthful revelation does not exist:

- If A recommends exercise at $X_A^*(\theta)$, P infers θ and waits till $X_P^*(\theta) > X_A^*(\theta)$.
- Being strategic, A will mimic a higher type $\Rightarrow$ Truthful communication breaks down.

Preference for early exercise (b > 0)

All equilibria have a partition structure:
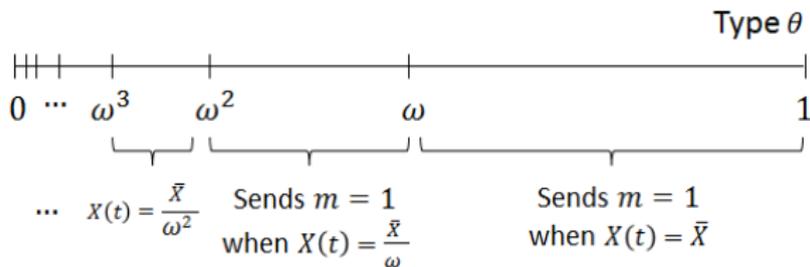
- Continuum of equilibria: $\omega \in [\underline{\omega}, \omega^*]$.
- Equilibrium with $\omega = \omega^*$ is "best": most informative, unbiased exercise.
- Partial communication, but decisions are unbiased.

Delegation vs. Centralization: Bias towards early exercise

Result: There exist cutoffs $b_1 > 0$ and $b_2 > b_1$ such that:

- For any $0 < b < b_1$, delegation is better.
- For any $b > b_2$, centralization is better.

Result: There exist cutoffs $b_1 > 0$ and $b_2 > b_1$ such that:

- For any $0 < b < b_1$, delegation is better.
- For any $b > b_2$, centralization is better.

Delegation of timing decisions: Implications

- Decisions like plant closures (late exercise bias) should never be delegated.
- Decisions like product launches should be delegated if the agent's bias is small enough.

Timing of delegation

Suppose the principal can choose the *timing of delegation.*

- Irrelevant if $b < 0$. Matters if $b > 0$.

Result: If $b > 0$, delegation at the right time implements the optimal contract. Delegation occurs later if bias is higher.

- Not delegating early pools very high types.
- Delegation efficiently uses information of low types.

Conclusion

Question: How do firms make timing decisions?

- How does information flow from lower to upper levels?
- What decisions should be delegated?

Results:

- *Delay bias*: Communication is often efficient, but timing is delayed. Delegation is always inferior.
- *Early exercise bias*: Communication is inefficient, and timing is unbiased or delayed. Delegation is optimal if bias is low or if delegation can be timed.
- Direction of the bias is crucial for allocation of authority for timing decisions.