The Effect of Exit Rights on Cost-based Procurement Contracts

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Procurement and exit-rights

- Principal hires a firm to complete a project at the lowest possible cost
- Information about a project's cost arrives over time
- Suppliers often have exit rights
  - Limited liability protection
  - Bankruptcy laws
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- Information about a project's cost arrives over time
- Suppliers often have exit rights
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- How to design procurement contracts that assure the project completion?
What we do:

- Two-period model:
  1. Firm privately observes a signal about the expected intrinsic costs
  2. Firm learns actual intrinsic cost

- Firm has exit-rights at any point in time
Related literature


- **Dynamic mechanism design** Freixas et al. (1985), Myerson (1986), Courty and Li (2000), Pavan et al. (2014), Bergemann and Välimäki (2019), Gerardi and Maestri (2020)...

- **Mech design with ex-post participation constraints:** Ollier and Thomas (2013), Krämer and Strausz (2015, 2016), Bergemann et al. (2021), Moreira and Gottlieb (2021)...

- **Our main contributions:**
  - Effect of exit-rights on procurement contracts
  - Relation between competition and ex-post participation
Canonical procurement model

- Project’s cost: $C = \beta - e$
- Firm’s type: $\beta \in \{\beta_L, \beta_H\}$
- $C$ is verifiable but not effort nor $\beta$
- Firm’s utility:
  \[
  U(T, C, e) = T - C - \psi(e)
  \]
  $\psi : \mathbb{R}_+ \rightarrow \mathbb{R}_+$ strictly increasing, strictly convex, twice continuous differentiable
- Firm’s outside option normalized to 0
- Direct Mechanism: $(e_H, T_H), (e_L, T_L)$
Dynamic procurement model

- **Period 1:**
  - Firm privately observes signal $s \sim F \in \Delta((0, 1))$
    - $Pr(\beta = \beta_H) = s$
  - Principal offers a menu of contracts
  - Firm chooses a contract or the ex-ante outside option

- **Period 2:**
  - Firm learns $\beta$
  - Firm decides whether to exit (ex-post outside option value $\bar{u} \in \mathbb{R}$)
  - Firm chooses effort
  - Payments are realized
Principal’s problem

\[ P : \min_{\{T_i(\cdot), e_i(\cdot)\}_{i \in \{L,H\}}} \int_{s}^{\bar{s}} \left\{ (1 - s)T_L(s) + sT_H(s) \right\} dF(s) \]

subject to (IC-1),(IC-2),(IR-1),(IR-2)

- \( T \) and \( e \) might depend on \( s \) and \( \beta \).
Principal’s problem

\[ \mathcal{P} : \min_{\{e_i(\cdot), u_i(\cdot)\}_{i \in \{L, H\}}} \int_{s}^{\bar{s}} \{(1 - s)[u_L(s) + \beta_L - e_L(s) + \psi(e_L(s))] + s[u_H(s) + \beta_H - e_H(s) + \psi(e_H(s))}\} dF(s) \]

subject to (IC-1), (IC-2), (IR-1), (IR-2)

• \( u \) and \( e \) might depend on \( s \) and \( \beta \).
Main Result

Theorem

There exists $\bar{u}_3 < \bar{u}_2 < \bar{u}_1 < 0$ such that

- If $\bar{u} > \bar{u}_1$: no first-period screening, (IR-1) is slack, and (IR-2) binds
- If $\bar{u} \in (\bar{u}_2, \bar{u}_1]$: no first-period screening, (IR-1) binds, and (IR-2) binds
- If $\bar{u} \leq \bar{u}_3$: full first-period screening, (IR-1) binds, and (IR-2) is slack
  (under regularity conditions)

High $\bar{u}$ ($> \bar{u}_2$): cost-plus contracts — payments only depend on realized costs.

Low $\bar{u}$ ($< \bar{u}_3$): payments depend on self reported estimated costs.
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Main Intuition

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  - (IR-2) binds \(\Rightarrow u_H(s) = \bar{u}\)

- Low \(\bar{u}\):  
  - Slack (IR-2) = \(\Rightarrow u_H(s)\) works as an additional screening instrument.

- Absence of non-reponsiveness: screening is optimal.
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- **High \(\bar{u}\):**
  - (IR-2) binds \(\implies u_H(s) = \bar{u}\)
  - The lower \(s\) the more likely \(\beta = \beta_L \implies\) the costlier to increase \(u_L\)

- **Low \(\bar{u}\):** Absence of non-responsiveness: screening is optimal.

Non-responsiveness: conflict between monotonicity required for (IC-1) and desired by the principal.
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- **Low \(\bar{u}\):**
  - Slack (IR-2) \(\implies u_H(\cdot)\) works as an additional screening instrument.
  - Absence of non-responsiveness: screening is optimal.
Optimal ex-post profits in response to $\bar{u}$
Multiple Firms

1. Period 1:
   - Each of \( n \) firms privately observes signal \( s_i \in [s, \bar{s}] \subset (0, 1) \)
     - \( \Pr(\beta_i = \beta_H) = s_i \)
     - Signals and types are iid across firms
   - Principal selects one firm to execute the project

2. Period 2:
   - The selected firm:
     - Learns its \( \beta_i \)
     - Decides whether to exit (ex-post outside option value \( \bar{u} \leq 0 \))
     - Chooses effort
   - Payments are realized
Second-best allocation

Principal directly observes $s$ but not $\beta$. 
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- Selects the firm with the lowest signal.

- Given the selected firm’s signal $s_i$, regulate it as a monopolist.
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How costly it is to implement the second-best allocation with competition?
How costly it is to implement the second-best?

**Proposition 1**

Suppose $\bar{u}$ is sufficiently low. As the number of firms increase, the principal’s expected cost of implementing the second-best allocation converges to the cost when she directly observes the first-period signals.
How costly it is to implement the second-best?

Proposition 1

Suppose \( \bar{u} \) is sufficiently low. As the number of firms increase, the principal's expected cost of implementing the second-best allocation converges to the cost when she directly observes the first-period signals.

Proposition 2

Suppose \( \bar{u} = 0 \). Then, the principal's expected cost of implementing the second-best allocation diverges to infinity when the number of firms increase.
Contrasting Propositions 1 and 2

- **High ex-post outside option:**
  - Reporting the lowest $s$
    - Firm is selected with probability 1
    - $u_L(s) > u_H(s) \geq 0$ implies rents bounded away from 0
    - Increasing number of firms $\Rightarrow$ information rents explodes

- **Low ex-post outside option:**
  - Under-reporting $s$
    - $\uparrow$ probability of being selected
    - $\downarrow u_H(s) \times \uparrow u_L(s)$
    - Firm gains if $\beta_L$ but loses if $\beta_H$
    - Rents needed to prevent under-reporting go to 0 as $n$ increases.
Contrasting Propositions 1 and 2

- High ex-post outside option:
  - Reporting the lowest \( s \):
    - Firm is selected with probability 1
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- Low ex-post outside option:
  - Under-reporting \( s \):
    - ↑ probability of being selected
    - ↓ \( u_H(s) \) × ↑ \( u_L(s) \)
    - Firm gains if \( \beta_L \) but loses if \( \beta_H \)
  - Rents needed to prevent under-reporting go to 0 as \( n \) increases.
Summary

- Dynamic procurement model: gradual information arrival and ex-post exit rights
- Optimal contracts as a function of ex-post reservation utility:
  - High: no first-period screening, (IR-1) is slack, and (IR-2) binds
  - Intermediary: no first-period screening, (IR-1) binds, and (IR-2) binds
  - Low: full first-period screening, (IR-1) binds, and (IR-2) is slack
- Competition achieves the second-best only for low ex-post reservation utilities
Thank you!
Revelation principle

- Direct mechanisms:
  - Recommended efforts: $e_\beta(s)$
  - Transfers: $T_\beta(s)$

- Satisfying incentive compatibility and participation in both periods
IC’s and IR’s

- Ex-post incentive compatibility:
  
  $$u_L(s) \geq T_H(s) - C_H(s) - \psi(e_H - \Delta \beta)$$
  
  $$u_H(s) \geq T_L(s) - C_L(s) - \psi(e_L + \Delta \beta)$$

  (IC-2s)
IC’s and IR’s

- Ex-post incentive compatibility:
  
  \[
  u_L(s) \geq T_H(s) - C_H(s) - \psi(e_H - \Delta \beta)
  \]
  
  \[
  u_H(s) \geq T_L(s) - C_L(s) - \psi(e_L + \Delta \beta)
  \]  
  
  (IC-2s)

- Ex-ante incentive compatibility:
  
  \[
  (1 - s)u_L(s) + su_H(s) \geq (1 - s)u_L(\hat{s}) + su_H(\hat{s}), \quad \forall \hat{s}, s
  \]  
  
  (IC-1s, \hat{s})
IC’s and IR’s

- **Ex-post incentive compatibility:**
  \[ u_L(s) \geq T_H(s) - C_H(s) - \psi(e_H - \Delta \beta) \]
  \[ u_H(s) \geq T_L(s) - C_L(s) - \psi(e_L + \Delta \beta) \]  
  \[ (IC-2_s) \]

- **Ex-ante incentive compatibility:**
  \[ (1 - s)u_L(s) + su_H(s) \geq (1 - s)u_L(\hat{s}) + su_H(\hat{s}), \quad \forall \hat{s}, s \]  
  \[ (IC-1_{s,\hat{s}}) \]

- **Ex-ante and ex-post participation:**
  \[ U(s) := (1 - s)u_L(s) + su_H(s) \geq 0, \quad \forall s \]  
  \[ u_H(s) \geq \bar{u}, \quad \forall s \]  
  \[ (IR-1) \]  
  \[ (IR-2) \]
Revelation principle with multiple firms

- Direct mechanisms:
  - Firm selection:
    \[ x : [s, \bar{s}]^n \to \Delta\left(\{1, \ldots, N\}\right) \]
  - Recommended effort for the selected firm:
    \[ e^i : [s, \bar{s}]^n \times \{\beta_L, \beta_H\} \to \mathbb{R}_+^n \]
  - Transfers:
    \[ T^i : \{\beta_L, \beta_H\} \times [s, \bar{s}]^n \to \mathbb{R}_+^n \]

- Satisfying incentive compatibility and participation in both periods