# Relational Contracts and Their Interactions with Formal Arrangements

## —Lecture II—

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# II. The Holdup Problem in Relationships

## The Holdup Problem

- The (standard) holdup problem:
  = Underinvestment in relation-specific assets.
- How can the problem be mitigated?
  1. Institutions: ownership, financial structure
  2. Explicit contracts: "simple" contracts, option contracts
  3. Dynamic structure: repeated offers, graduate investment, long-term relationships

## Simple Setting

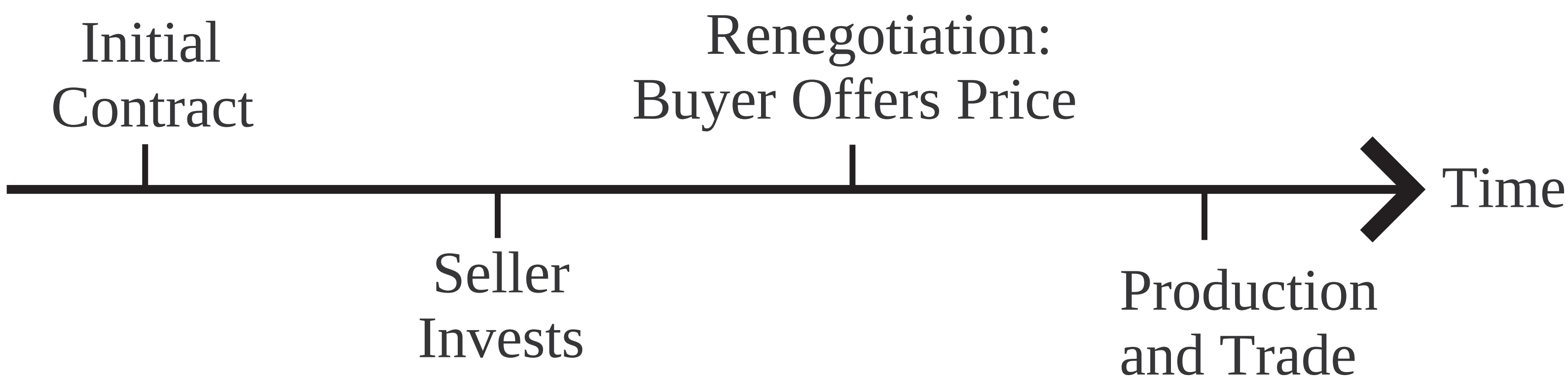
- Buyer and Seller
- Seller makes investment $a \in \{a_g, a_s\}$
  - Investment is observable but unverifiable.
  - Cost of investment: $d_s = d > 0 = d_g$.

- $v_i$: Buyer's valuation for the product under investment $a_i$
- Assume that the first-best investment is $a_s$:

$$\Delta_v \equiv v_s - v_g > d$$

- $m$: alternative-use value
- Assume $m \leq v_g$
- Note: $a_s$ is (more) relation-specific in the sense that $v_s > m$

# Timing


Initial
Contract
Renegotiation:
Buyer Offers Price
Time
Seller
Invests
Production
and Trade

## "Spot Outsourcing"

- Solve the stage game backwards
- Buyer's price offer: $p = m$, regardless of investment
- Seller's investment decision: choose $a = a_g$
  $\rightarrow$ the holdup problem

# A Little More General Setting

- The seller's investment $a \in [\underline{a}, \overline{a}]$
- $d(a)$: cost of investment, increasing in $a$
- $v(a)$: the buyer's value for the product, increasing in $a$
- $a^{fb}$: the first-best investment

$$a^{fb} = \arg\max_a v(a) - d(a) \quad \Leftrightarrow \quad v'(a^{fb}) - d'(a^{fb}) = 0$$

- $m$: alternative-use value
- Assume $m \leq v(\underline{a})$

# Timing

0. Initial contract
1. Seller: makes investment
2. Renegotiation: Assume that the renegotiation result follows the (generalized) Nash bargaining solution:
   - The buyer's share of the gain: $\alpha$
   - The seller's share of the gain: $1 - \alpha$
3. Production and payment (production cost is assumed to be zero for simplicity).

# The Holdup Problem

- Renegotiation price: $p(a) = \alpha m + (1 - \alpha)v(a)$
  - The buyer's payoff:
    $v(a) - p(a) = \alpha(v(a) - m)$
  - The seller's payoff:
    $p(a) - d(a) = v(a) - \alpha(v(a) - m) - d(a)$
- Seller's investment decision: $(1 - \alpha)v'(a) - d'(a) = 0$
  $\rightarrow a < a^{fb}$
  $\rightarrow$ the holdup problem

## Remark #1

This is a case of "purely cooperative" investment: the seller's investment only affects the buyer's payoff.

- The holdup problem occurs as well in the case of "purely selfish" investment: the seller's investment only affects his payoff

## Example: Purely Selfish Investment

- Example: the investment affects the seller's production cost ($c_s < c_g$) while it does not change the value of the product ($v$).
- $v - c_g$: the seller's payoff when trade with others (assume nonnegative)
- Assume that the first-best investment is $a_s$:

$$v - c_s - d > v - c_g \quad \Leftrightarrow \quad \Delta_c \equiv c_g - c_s > d$$

- The buyer's offer: $p = v - c_g$, regardless of investment $\rightarrow$ The seller chooses $a_g$ (the holdup problem)

## Remark #2

"Simple" specific performance contracts do not help.

- Price contract: $p$ for the deliver of the product
- Suppose that either

  (i) the courts enforce the specific performance; or

  (ii) while the breach of the contract is possible, the courts enforce the expectation damage (ED) rule.

  → The buyer must (or is willing to) pay $p$ regardless of the value of the product.

- The seller then chooses $a_g$ to save cost $d$.

Sophisticated communication mechanisms do not help, either.

If instead the investment is "purely selfish," specific performance contracts can resolve the holdup problem.

- Given $p$, the seller's payoff is as follows:
  - $a = a_s \Rightarrow p - c_s - d$
  - $a = a_g \Rightarrow p - c_g$
- Since $\Delta_c > d$, the seller prefers $a_s$.

## Remark #3

Option contracts can resolve the holdup problem if renegotiation can be prohibited.

- Initial contract: an option for the buyer to purchase the product at the prespecified price $p$.
- Setting $p = m + d$ does the job.
  - $a = a_s \Rightarrow$ the option exercised $\Rightarrow$ the seller obtains $p - d = m$
  - $a = a_g \Rightarrow$ the option not exercised $\Rightarrow$ the seller obtains $m$.

- Renegotiation makes the option contract useless.
  - When $a = a_s$, the buyer does not exercise the option.
  - Then renegotiate later: Offer $p = m$.
  - The seller thus chooses $a_g$.

# “Relational Outsourcing”

- Repeated transaction: an infinitely repeated game with perfect monitoring and common discount factor $\delta$
- Consider the implementation of $a = a_s$.
- Different from the models in the previous lecture, we first do not allow any court enforced fixed payment ($w$ in the previous lecture).
  $\leftarrow$ Because the fixed payment has some important role other than redistribution.

- Assume that the buyer offers the initial contract (take-it-or-leave-it offer)
- Focus on stationary contracts: the seller promises to choose $a = a_s$ and the buyer promises to offer $p_i$ if investment is $a_i$. Once deviated in payment, they revert to the spot outsourcing.

# Does Buyer Honor Agreement?

- Suppose that the seller chooses $a = a_s$
- And suppose that the buyer does not pay $p_s$
- Buyer then makes a renegotiation offer: $p = m$
- Seller accepts it
- Buyer's reneging temptation: $p_s - m$
- Her future loss:

$$\frac{\delta}{1-\delta}[(v_s - p_s) - (v_g - m)] = \frac{\delta}{1-\delta}[\Delta_v - (p_s - m)]$$

- Buyer honors the agreement if and only if

$$p_s - m \leq \frac{\delta}{1-\delta}[\Delta_v - (p_s - m)] \qquad \text{(DE-B)}$$

# Does Seller Honor Agreement?

- The seller's (IC): $p_s - d \geq p_g$
- The seller's reneging temptation: $-p_g + m$
- His future loss:

$$\frac{\delta}{1-\delta}[(p_s - d) - m]$$

- Seller honors the agreement if and only if

$$-(p_g - m) \leq \frac{\delta}{1-\delta}(p_s - m - d) \qquad \text{(DE-S)}$$

## Buyer's Optimal Contract

The buyer chooses $(p_s, p_g)$ to minimize $p_s$ subject to

$$p_s - d \geq p_g \qquad \text{(IC)}$$

$$-(p_g - m) \leq \frac{\delta}{1-\delta}(p_s - m - d) \qquad \text{(DE-S)}$$

$$p_s - m \leq \frac{\delta}{1-\delta}[\Delta_v - (p_s - m)] \qquad \text{(DE-B)}$$

- Result: *The holdup problem can be mitigated if and only if*

$$d \leq \frac{\delta}{1-\delta}(\Delta_v - d) \qquad (1)$$

## Extension: Variable Alternative-Use Value

- Suppose that investment affects alternative-use value as well.
- Assume $m_s < m_g$ ($\leq v_g < v_s$)
  - Specific-investment reduces the value of the product to other buyers.
  - Or, the seller incurs costs to adjust his asset to sell to others.
- Define $\Delta_m = m_g - m_s > 0$

- Spot outsourcing: the buyer offers
  - $p = m_g$ if $a = a_g$
  - $p = m_s = m_g - \Delta_m$ if $a = a_s$
- The holdup problem becomes more serious!

# Relational Outsourcing Revisited

- Focus on stationary contracts: the seller promises to choose $a = a_s$ and the buyer promises to offer $p_i$ if investment is $a_i$. Once deviated in payment, they revert to the spot outsourcing.

$$p_s - d \geq p_g \tag{IC}$$

$$-(p_g - m_g) \leq \frac{\delta}{1-\delta}(p_s - m_g - d) \tag{DE-S1}$$

$$p_s - m_s \leq \frac{\delta}{1-\delta}[\Delta_v - (p_s - m_g)] \tag{DE-B1}$$

- Result: *The holdup problem can be mitigated if and only if*

$$d + \Delta_m \leq \frac{\delta}{1-\delta}(\Delta_v - d) \qquad (2)$$

## Explicit Contract

- Suppose the buyer offers price contract $p$, enforced by the courts, at the beginning of each period.
- As we have already seen, under spot outsourcing, such a contract does not help since the seller will choose $a_g$ to save $d$.

## Explicit Contract in Relational Outsourcing

- Consider stationary contracts: the buyer and the seller agree a price contract $p$, and the seller promises to choose $a = a_s$. Once deviated, they revert to the spot outsourcing.

- Seller's reneging temptation: $d$
- Seller's future loss:

$$\frac{\delta}{1-\delta}(p - d - m_g)$$

- The seller honors the promise if and only if

$$d \leq \frac{\delta}{1-\delta}(p - m_g - d) \qquad \text{(DE-S2)}$$

- Note that $p - d > m_g$ must hold
- The buyer wants to minimize $p$ subject to (DE-S2)
- Result: *The holdup problem can be mitigated if and only if*

$$d \leq \frac{\delta}{1-\delta}(\Delta_v - d) \qquad (3)$$

# Comparison

$$d + \Delta_m \leq \frac{\delta}{1-\delta}(\Delta_v - d) \tag{2}$$

$$d \leq \frac{\delta}{1-\delta}(\Delta_v - d) \tag{3}$$

1. Introducing formal price contract in relationships facilitates the implementation of $a = a_s$.

2. When both conditions are satisfied, the buyer prefers not to write a price contract.
   - $p_s = m_g + d$
   - $p = m_g + d/\delta > p_s$
3. $\Delta_m \downarrow$ ($m_s \uparrow$) may benefit the buyer.

# More Sophisticated Contracts

## 1. Option Contracts

- Initial contract: an option for the buyer to purchase the product at the prespecified price $p$.
- If the buyer can commit herself not to renegotiate, the option contract with $p = m_s + d$ can induce the relation-specific investment.
- However, renegotiation makes the option contract useless.
  $\rightarrow$ Buyer does not exercise the option and offers $p = m_s$ in renegotiation.

- Can relationship help? It may make the commitment not to renegotiate credible.
- The buyer's reneging temptation is $p - m_s$, which is the same as the temptation under the no contract case.
  → The result does not change from the no contract case.

## 2. Relational Contract

- Suppose that promising a bonus contingent on $a$, along with a fixed price $p$, is feasible.
- $(p, b_g, b_s)$: relational contract
  - $p$: credible fixed price.
  - $b_i$: discretionary bonus contingent on investment $a_i$

- (IC) and (DE):

$$b_s - b_g \geq d \tag{IC}$$

$$b_s - b_g \leq \frac{\delta}{1-\delta}(\Delta_v - d) \tag{DE}$$

- Substituting $b_s - b_g = d$ yields the condition for a relational contract implementing $a_s$ to exist

$$d \leq \frac{\delta}{1-\delta}(\Delta_v - d) \tag{3}$$

- Since the buyer has all the bargaining power at the beginning of each period, $(p, b_g, b_s) = (m_g, 0, d)$
  - No rent to the seller: $p + b_s - d = m_g$
  - The seller does not benefit from reneging.
  - The buyer cannot hold up the seller by offering $m_s$.