Beyond the Coasian Irrelevance: Hold-up and Incomplete Contracts

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I. Introduction

• *Hold-up problem:* An investment is specific to a relationship and difficult to contract, so that its return is ex post not fully appropriable by the investor.

- Specific investment (e.g., firm specific skills, customization..) $\Rightarrow$ Thin market.

- Noncontractability $\Rightarrow$ Its return subject to negotiation.

• Noncontractability becomes a source of transaction costs and leads to inefficiencies, particularly underinvestment.

• The inefficiencies have explained many organizational and contractual remedies, particularly asset ownership allocation.

II. Basic Model

- A buyer and a seller, denoted B and S, can trade quantity $q \in [0, \overline{q}] =: Q$, where $\overline{q} > 0$.

- Prior to trade, S invests $I \in \{0, 1\}$, with $I = 1$ meaning "invest" and $I = 0$ meaning "not invest."

  - Investment is sunk (irreversible).
  - The investment I costs the seller $k \cdot I$, where $k > 0$.

- Payoffs: Given investment I, trade q and transfer t from B to S.

  Buyer: $v_I(q) - t$
  Seller: $t - c_I(q)$.
  Assume: v_I and c_I are strictly increasing and continuous, with $v_I(0) = c_I(0) = 0$.

- Efficiency:

  $\phi_I = \max_{q \in Q}[v_I(q) - c_I(q)]$: the efficient social surplus given I.

  q_I^* be an associated maximizer.

  Maximized net social surplus: $W(I) := \phi_I - kI$.

Assume

$$\phi_1 - k > \phi_0, \tag{1}$$

so it is socially desirable for S to invest.

- Assumption INC:

i) Investment relevant information $(I, v_I(q), c_I(q))$ observable but nonverifiable.
ii) Trade decision q only ex post contractible.

- Terms of trade negotiated à la Nash:

  They choose q_I^* and split ϕ_I equally. T

  S gets $U_S(I) := \frac{1}{2}\phi_I - kI$.

Assuming

$$\frac{1}{2}\phi_1 - k < \frac{1}{2}\phi_0, \tag{2}$$

S will not invest.

- The hold-up problem generates underinvestment.

- This result holds quite generally (e.g., two sided investment; continuous investment level, etc.)

II. Organizational remedies

- Vertical integration (Klein, Crawford and Alchian (1978) and Williamson (1979))

  - Why does the holdup problem disappear or at least diminish through integration?

  - Unclear, need a more general theory about how the hold-up problem varies with asset ownership.

- **Theory of Asset Ownership** (Grossman and Hart (1986) and Hart and Moore (1990))

- Specific right: contractually specifiable
- Residual right: contractually unspecifiable; then who has it?

- According to GHM, asset ownership gives the owner the right to determine the use of the asset that is contractually not specifiable.

- The parties will still negotiate the terms of trade (presumably to achieve an efficient outcome), but this *residual right* — and thus ownership — matters, since it determines the status quo payoffs of the parties in the negotiation.

Model

- Two assets to be owned by either B or S or one each.

  B-*integration* if B owns both;
  S-*integration* if S owns both.
  N-*integration* if B and S separately own one each.

- Status quo payoffs: Fix i-integration and fix S's investment decision $I \in \{0, 1\}$.

  $\psi_i^i(I)$: agent i's status quo payoff
  $\psi_j^i(I)$: agent $j \neq i$'s status quo payoff.

Assumption GHM: (i) $\psi_i^i(I) + \psi_j^i(I) \leq \phi_I$, $I \in \{0, 1\}$; (ii) $\psi_S^i(1) - \psi_S^i(0) < \phi_1 - \phi_0$; (iii) $\psi_i^i(1) > \psi_i^i(0)$ and $\psi_j^i(1) = \psi_j^i(0)$, for $j \neq i$.

- Nash Bargaining outcome:

S's payoff will be

$$U_S^i(I) = \psi_S^i(I) + \frac{1}{2}(\phi_I - \psi_B^i(I) - \psi_S^i(I)) - kI = \frac{1}{2}\phi_I + \frac{1}{2}(\psi_S^i(I) - \psi_B^i(I)) - kI.$$

Hence, S's gain from investing under i-integration is

$$U_S^i(1) - U_S^i(0) = \frac{1}{2}(\phi_1 - \phi_0) + \frac{1}{2}\Delta^i - k, \tag{3}$$

where

$$\Delta^i := \psi_S^i(1) - \psi_S^i(0) - [\psi_B^i(1) - \psi_B^i(0)].$$

Given Assumption GHM-(ii) and -(iii), $\phi_1 - \phi_0 \geq \Delta^S > 0 = \Delta^N > \Delta^B$. Hence,

$$W(1)-W(0) \geq U_S^S(1)-U_S^S(0) > U_S^N(1)-U_S^N(0) > U_S^B(1)-U_S^B(0).$$

- S-integration (i.e., investor ownership) is optimal. (If $U_S^S(1) - U_S^S(0) > 0 > U_S^N(1) - U_S^N(0)$, then the investment is sustainable if and only if the seller has the asset ownership.)

- GHM tenet: asset ownership reduces the owner's exposure to hold up.

  - Sensitive to bargaining solution (Chiu, 1998; De Meza and Lockwood, 1998).

III. Contractual solutions

- Assumption INC-ii) difficult to justify; e.g., inability to measure q ex ante objectively not enough; if the parties know the payoff consequences of their behavior (Maskin and Tirole, 1999).

- If the parties *can* contract on q prior to the investment decision, the hold-up problem may be solved.

- Consider a contract stipulating trade $\widehat{q}$ for the total price of $\widehat{t}$ (Edlin-Reichelstein).

- Status quo payoff:

  - Seller: $\widehat{t} - c_I(\widehat{q}) - kI$ given $I \in \{0, 1\}$.
  - Buyer: $v_I(\widehat{q}) - \widehat{t}$.

- Renegotiate iff $\widehat{q} \neq q_I^*$.

- Nash bargaining outcome: S's ex ante payoff will be

$$\widehat{U}_S(I; \widehat{q}) := \widehat{t} - c_I(\widehat{q}) + \frac{1}{2}[\phi_I - (v_I(\widehat{q}) - c_I(\widehat{q}))] - kI.$$

- S's net gain from investing:

$$\begin{aligned} & \widehat{U}_S(1;\hat{q}) - \widehat{U}_S(0;\hat{q}) \\ = \; & \tfrac{1}{2}(\phi_1 - \phi_0) - \tfrac{1}{2}[v_1(\hat{q}) - v_0(\hat{q})] + \tfrac{1}{2}[c_0(\hat{q}) - c_1(\hat{q})] - k. \end{aligned} \tag{4}$$

- Result depends on the nature of investment:

  - *Selfish*: $v_1(\cdot) = v_0(\cdot)$, $c_1(\cdot) < c_0(\cdot)$, benefits investor.
  - *Cooperative*: $v_1(\cdot) > v_0(\cdot)$, $c_1(\cdot) = c_0(\cdot)$, benefits investor's partner.

- If the investment is selfish,

$$c_0(q_1^*) - c_1(q_1^*) = v_1(q_1^*) - c_1(q_1^*) - [v_0(q_1^*) - c_0(q_1^*)] > \phi_1 - \phi_0.$$

Likewise, $c_0(q_0^*) - c_1(q_0^*) < \phi_1 - \phi_0$.
$\Rightarrow$ There exists $\widehat{q}^*$ between q_0^* and q_1^* such that $c_0(\widehat{q}^*) - c_1(\widehat{q}^*) = \phi_1 - \phi_0$.

With $\widehat{q} = \widehat{q}^*$, $\widehat{U}_S(1; \widehat{q}^*) - \widehat{U}_S(0; \widehat{q}^*) = W(1) - W(0)$, so S will indeed invest whenever it is efficient to do so.

- Intuition: Investment improves S's status quo payoff.

- Implication: Organization remedies (e.g., asset ownership) irrelevant.

- Remarks: What if Q is not convex? Both invest?

IV. Contractual failure

(1) Cooperative investments (Che-Hausch):

- Investment is *cooperative* (i.e., $v_1(\cdot) > v_0(\cdot)$ and $c_1(\cdot) = c_0(\cdot)$).
  - Examples: quality-enhancing R & D investment by a supplier and customization efforts by partners.

- Effect of contracts: Consider trade contract with any $\hat{q}$,

$$\hat{U}_S(1;\hat{q}) - \hat{U}_S(0;\hat{q}) = \frac{1}{2}(\phi_1 - \phi_0) - \frac{1}{2}[v_1(\hat{q}) - v_0(\hat{q})] - k \leq \frac{1}{2}(\phi_1 - \phi_0) - k < 0.$$

The contract creates no more incentives for S than the null contract.

With a cooperative investment, any commitment to trade exacerbates, rather than alleviates, the investor's vulnerability to hold up.

- This conclusion holds for all feasible contracts: By the revelation principle, no loss in considering contract that enforces a trade contract (q_{ij}, t_{ij}), based on B and S's reports $i \in \{0, 1\}$ and $j \in \{0, 1\}$ respectively about S's investment.

Suppose S has picked I, and B and S report i and j, respectively. If q_{ij} differs from q_I^*, renegotiation arises. Hence, S's payoff will be

$$u_S(i, j; I) := t_{ij} - c_I(q_{ij}) + \tfrac{1}{2}[\phi_I - (v_I(q_{ij}) - c_I(q_{ij}))] - kI,$$

and likewise the buyer's payoff will be

$$u_B(i, j; I) := v_I(q_{ij}) - t_{ij} + \tfrac{1}{2}[\phi_I - (v_I(q_{ij}) - c_I(q_{ij}))].$$

Notice the constant sum feature: $u_S(i,j;I)+u_B(i,j;I)=\phi_I-kI$.
In equilibrium, both parties must report truthfully, so

$$u_S(I,I;I)\geq u_S(I,j;I) \text{ and } u_B(I,I;I)\geq u_B(i,I;I).$$

Now consider the seller's gain from investing under this contract:

$$\begin{aligned}
u_S(1,1;1)-u_S(0,0;0) &= (\phi_1-k-u_B(1,1;1))-u_S(0,0;0)\\
&\leq (\phi_1-k-u_B(0,1;1))-u_S(0,1;0)\\
&\leq \tfrac{1}{2}(\phi_1-\phi_0)-\tfrac{1}{2}(v_1(q_{01})-v_0(q_{01}))-k<0.
\end{aligned}$$

- Contracts worthless!

(2) Unpredictable investment benefit (Hart-Moore-Segal)

- The investment is selfish, but it is difficult to predict the "type" of trade that will benefit from the investment.

- There are n potential goods the parties may wish to trade but that only one of them becomes a "specialtype and *only* the special type will benefit from an investment.
  - Each of the n goods has an equal chance of becoming that special type ex post.

- Adapted in our model: The surplus from trading the special type is ϕ_I given investment $I \in \{0, 1\}$, and the surplus from trading a "generic" type is ϕ_0, regardless of the investment decision. Assume $q_I^* = 1$, for $I = 0, 1$.

- Effect of a contract to trade any good: S's ex ante payoff from choosing $I \in \{0,1\}$:

$$\tilde{U}_S(I) := \frac{1}{n}(\hat{t} - c_I(1)) + \frac{n-1}{n}(\hat{t} - c_0(1)) + \frac{1}{2}\left[\phi_I - \frac{1}{n}\phi_I - \frac{n-1}{n}\phi_0\right] - kI.$$

- S's gain from investing:

$$\begin{aligned}\tilde{U}_S(1) - \tilde{U}_S(0) &= \tfrac{1}{n}(c_0(1) - c_1(1)) + \tfrac{1}{2}[\phi_1 - \phi_0 - \tfrac{1}{n}(\phi_1 - \phi_0)] - k \\ &= \tfrac{1}{2}(1 + \tfrac{1}{n})(\phi_1 - \phi_0) - k.\end{aligned}$$

- As the environment becomes "complexïn the sense that $n \to \infty$, contract becomes worthless.

- Implications: 1. The true challenge of the hold-up problem lies with the nature of specific investments — either the "cooperative" nature or the "unpredictability of investment benefit."

2. Ownership structures become "relevant" given these types of investments.

3. Crucial for the parties to be unable to commit not to renegotiate their contract.

V. Dynamics

- The basic holdup model assumes that there is a single opportunity to invest, followed by the distribution of the surplus.

- If the interaction is repeated, inefficiencies can be greatly reduced or eliminated (Klein and Leffler (1981)).

- Even in an one shot interaction, allowing simply for dynamic investment patterns can make a dramatic difference (Che-Sákovics).

Che-Sakovics Model (2004)

- B and S play infinite horizon investment-bargaining game (with a common discount factor $\delta \in (0,1)$. At $t = 1$, S chooses $I \in \{0,1\}$, B and S are selected at random to propose trade terms. If it is accepted, game ends; if rejected, they move on to $t = 2$ where S can invest if she hasn't before, followed by the bargaining....

Proposition 1 *It is a (Markov perfect) equilibrium for S to invest and trade in the first period q_1^* for δ sufficiently close to 1 iff $\frac{1}{2}\phi_1 - k \geq 0$.*

Proof. Consider a *strategy:* "S invests whenever she hasn't before."

If S invests, the ensuing subgame has a unique SPE: B and S receives $\frac{1}{2}\phi_1$ and $\frac{1}{2}\phi_1 - k$, respectively.
Suppose S does not invest, she can at most earn

$$\max\{\delta(\tfrac{1}{2}\phi_1 - k), \phi_0 - \delta\tfrac{1}{2}\phi_1\},$$

which is less than $\frac{1}{2}\phi_1 - k$ for $\delta \approx 1$ iff $\frac{1}{2}\phi_1 - k \geq 0$. ▮

• Intuition: Investment dynamics affects incentives. They split the surplus on the equilibrium path much in the standard hold-up problem; but if S doesn't invest (off the equilibrium path), S earns even less due to the unfavorable expectation (i.e., B demands more).

• Summary: Dynamics in the trading relationship and/or investment technology either lessens the risk of hold up or the degree of inefficiencies caused by it.

- Implications: 1. This questions the relevance of the hold-up problem as a rationale for organization and/or contractual remedies.

2. The presence of dynamics alters the nature of the incentive problems and calls for different types of contractual/organizational prescriptions against holdup (e.g. Baker-Gibbons-Murphy, Che-Sákovics, Halonen).

Illustration

- Consider the asset ownership problem in the Che-Sakovics model.

- Noncooperative version of Nash bargaining: Given ownership $m \in \{B, S, N\}$ (signed in period 0), in each period, rejection of an offer triggers bargaining breakdown with probability, $1 - \delta$ (and no discounting), which is followed by $i = B, S$ collecting $\psi_i^m(I)$.

- Suppose $\psi_i^m(1) = \psi_i^m(0) = \bar{\psi}_i^m$. Then, the ownership structure doesn't matter in GHM. But it does with investment dynamics.

- For $m \in \{S, B, N\}$, the condition for S to invest for $\delta \approx 1$:

$$\tfrac{1}{2}[\phi_1 - \bar{\psi}_B^m] + \tfrac{1}{2}\bar{\psi}_S^m - k \geq \bar{\psi}_S^m.$$

$$\Leftrightarrow \tfrac{1}{2}\phi_1 - k \geq \tfrac{1}{2}[\bar{\psi}_B^m + \bar{\psi}_S^m].$$

- *The status quo minimization principle:* If $m, m' \in \{S, B, N\}$ with $\bar{\psi}_B^m + \bar{\psi}_S^m > \bar{\psi}_B^{m'} + \bar{\psi}_S^{m'}$, then

"Invest" sustainable under $m \Rightarrow$ "Invest" sustainable under m'.

- If assets are complementary in the sense that

$$\bar{\psi}_B^N + \bar{\psi}_S^N < \min\{\bar{\psi}_B^S + \bar{\psi}_S^S, \bar{\psi}_B^B + \bar{\psi}_S^B\},$$

then separate ownership dominates common ownership, in contrast with the GHM prescription.

- Could explain arrangements that makes parties interdependent (i.e., exacerbates their exposure to the hold-up problem).

  - Exclusive contracts
  - Hostage exchange