

Lecture 9: The Theories of the Firm

Largely from Gibbons (2004) and Goyal's lecture notes

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Introduction: Coase's Bold Question

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- What are the factors that determine the boundaries of firms?
- Managers, governments: The 'make or buy' problem
- Regulators: When is vertical or horizontal integration socially efficient?

What is a “complete” theory of the firm?

- Must explain why “all types” of firms exist in “all” relevant situations
- Must explain the *scope* of a firm
 - Ideally, there must be some *disadvantage* of size that, for a large enough firm, outweighs any advantage! I will refer to this as “*crossing over*”

Some key issues: Classical

- Economies of scale and scope

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- Double marginalization

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- Market power (over consumers and other firms)

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Looking inside the firm...

- Incentives of management and transfer pricing

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- ‘Adaptive, sequential decision-making’

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- ‘Adaptive, sequential decision-making’
- Relational adaptation

1. R. Coase (1937), "The nature of the firm," *Economica*.
2. **O. Hart and S. Grossman** (1986), The costs and benefits of integration: A Theory of Vertical and Lateral Integration, *The Journal of Political Economy*.
3. **R. Gibbons** (2004), *Four Formalizable theories of the firm*. mimeo, MIT.
4. O. Hart (1995), *Firms, Contracts and Financial Structure*. Oxford University Press. Chapters 1-4.
5. Tirole, Jean, *The Theory of Industrial Organization*, Chapter 1.

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For exam: know competing theories of the firm, know Hart and Grossman (incomplete contracting) type model well.

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The relevant explanation for firms should depend on the definition chosen.

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- Grossman and Hart: ‘We define a firm to consist of those assets that it owns or over which it has control.’

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- Hart: 'Neoclassical theory is consistent with there being one huge firm in the world ... [or] with every plant and division of an existing firm becoming a separate and independent firm.'
- On the other hand, why do we need a "firm" to achieve this scale: different entities can cooperate and band together without coming under one owner.

Market Power and integration

Double marginalization – example with one upstream and one downstream firm; both monopolies

Upstream firm produces a single input at zero cost, which is converted one-to-one into final output by the downstream firm.

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Assume that the downstream faces a linear demand: $Q = 1 - P$.

Thus, upstream firm will set price: $p_u = 1/2$, downstream firm will demand $q = 1/4$, total profits of the firms are given by $3/16$.

But the firms do better by integrating: if a single firm sets the optimal input price of 0 and final quantity of $1/2$ then profit of $1/4$ can be attained.

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Also, this could alternately be solved with a discriminatory price (two-part tariff). So a “firm” may not be necessary.

Modeling double marginalization

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If the production requires buying an input from an upstream firm whose cost to produce this is c , the retailer (downstream firm) will set price to maximize:

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Where p^u is the upstream price of this input. Note that if the upstream firm has market power then $p^u(c) > c$ – it will charge a markup.

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Where ξ is the elasticity of demand for the input (this is called the 'Lerner markup rule' where α_j represents the market share in Cournot competition, $\alpha_j = 1$ for monopoly).

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Since the retailer also sets price and quantity so that MR=MC, but now his marginal cost is 'marked up' by $\frac{D(p^u)}{D'(p^u)}$ he will charge a higher price and sell a lower quantity than the integrated monopoly firm.

Since the integrated firm was both the upstream and downstream firm the integrated price p_I^* maximized the 'joint profit.' Hence, p_R^* must yield a lower 'joint profit'.

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$$\implies \pi_d^*(p_u) = \left(\frac{1 + p_u}{2} - p_u\right) \left(\frac{1 - p_u}{2}\right)$$

$$= \left(\frac{1 - p_u}{2}\right)^2$$

The downstream firm will thus buy $\frac{(1-p_u)}{2}$ units of the input.

The upstream firm thus solves:

$$\max_{p_u} (p_u - c)q^*(p_u) = (p_u - c)\frac{1 - p_u}{2}$$
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$$\pi_u^* + \pi_d^*(p_u) = \frac{(1 - c)^2}{8} + \left(\frac{1 - \frac{1+c}{2}}{2}\right)^2$$

$$= \frac{3}{16}(1 - c)^2$$

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So the integrated firm (and the consumer, as we could show a lower price) does better.

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This suggests that the firms would be better off by merging, **if** collusion between firms is impossible (for legal reasons or because of failures of coordination).

...But we have firms even in very competitive industries – this can't be the only explanation for a firm.

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- Is it easier (legally, technically) to implement incentive schemes and mechanisms within a firm? If so, why?
- If so, this could explain the existence of firms, but not their scope.

Do agency costs increase in firm size?

Rem, from CEO lecture: Pay increases in firm size, but power of incentives decrease. Are increased agency problem is a cost of company size? Greater percentage ownership will discourage wasteful perquisites and vanity projects . . . But greater total value of shares owned will make the risk-aversion problem worse

Also, who “monitors the monitors”? Possible collusion.... (double markups in a sense?) See, eg, Strausz, 1997, “Delegation of monitoring in a Principal-Agent Relationship”

See also Lucas, 1978 "On the Size Distribution of Business Firms"

Transactions Costs, Incomplete Contracts, hold-up: a case study

Investment, hold-up, and incomplete contracting – the General Motors-Fisher Body Example

In 1919 General Motors decided to switch from open body cars to (present day) closed body cars. It approached Fisher Body a leading body producer to supply these new bodies. The production of these bodies required substantial investments on the part of Fisher Body. However, once these investments were in place it feared that General Motors may insist on only buying bodies at marginal costs, leading to large losses.

To provide proper incentives to Fisher Body, General Motors entered into a contract in which explicit provision was made for fixed costs and investment costs, by providing for a mark-up above variable costs. Faced with this contract, however, Fisher Body had an incentive to inflate its costs via overstaffing. General Motors had no option but to pay prices corresponding to the inflated costs, given the contracts. At the end, these costs proved to be too high and GM bought out Fisher Body. It is worth noting that the price of this buy-out was high since Fisher Body had a strong bargaining position based on high expected profits given the contract in place.

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Knowing that such unforeseen contingencies are 'likely', GM will be reluctant to sign any contract with an outside firm to manufacture its bodies. This can be modeled as in Grossman and Hart (1986).

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- Original version of these theories are ‘incomplete’ – provide no explanation for firm’s scope – but Gibbons extends this.

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Asset allocation affects incentives ... as in Property Rights Model

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- Note, pay can be conditioned on the performance measure but not on output itself, perhaps output is observed only with great delay, is unverifiable, or is unobservable. Consider the education of a child..

A Simple Incentive-System Model of the Firm

Technology

Note: The matrix algebra is optional – you can solve this easily with simple algebra/calculus, which I also give.

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Payoffs (other than asset)

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$$w = S + bP$$

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Note: Even though there is a potentially unobserved action, the Principal can capture the entire generated surplus because he has all the bargaining power and there is no risk-aversion nor credit constraints. Thus, he always wants to maximize $y + v$.

Notes on matrix derivatives:

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Note: this notation is nonstandard. Economists usually use a subscript to refer to a vector derivative, but the subscript was already in use here.

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Answer: it depends on the parameters.

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- $\mathbf{g} = \mathbf{f} + \mathbf{h}$... ' P is perfectly aligned with y and v .'

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Setting $b = 1$:

$$\mathbf{a}_E^*(b) = \mathbf{bg} = \begin{bmatrix} 1 \\ 1 \end{bmatrix} = \mathbf{f} + \mathbf{h} = \mathbf{a}^{FB}$$
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So, the optimum can be attained in this case if P owns the asset.

Extreme example 1 continued

Suboptimal ownership

On the other hand, if the agent owns the asset (as a 'contractor'):

Would choose b to maximize:

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Taking the first-order conditions (using vectors; do it without matrix algebra as an exercise):

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- ...But principal needs to do this, to balance out incentives (to not 'overinvest' in asset), since the agent already gets 'private' reward from asset.
- So agent over-exerts in a_2 , the 'asset builder', and under-exerts in a_1 , the 'output builder'

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$$\implies \mathbf{a}_c^*(b_c^*) = \begin{bmatrix} 1 \\ 1 \end{bmatrix} = \mathbf{a}^{FB}$$

Conclusion: “asset ownership is useful when it gives the Principal improved control over the Agent’s incentives.”

Crossing over? Are more “distant” (more layers of authority) assets and employees less likely to be observable in their “preservation” activities?

Exercise: What if principal owns the machine (in above example)?

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Simon (1951; employment context); model follows Gibbons (2004)

Two parties: Boss (B), Employee (E)

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Or

(b) Allocate authority to decide on d after s is observed

Payoffs:

$U_B(s, d)$ and $U_E(s, d)$ $+/-$ transfers. Note these utility functions may not be the same, but both may depend on s !

(a) Ex-ante negotiation (assume efficient negotiation)

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(c) Authority to employee \implies

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Why 'Pareto-dominates'? More total surplus is generated.

If we are in the ownership structure that is Pareto-dominated, one side could make the other side an offer to switch to the other regime and compensate them for their different utility, and still have enough surplus left over to do better. So one does better without making the other worse off.

Analogy to integration and make/buy issues:

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- a) Ex-ante negotiation: Like a very strict locked-in contract between firms, or between a principal and agent within a firm.

- b) Authority to boss: Like integration; manager will act in own interest, 'hold-up' (e.g.) upstream division if desired

- c) Authority to employee: Like non-integration, no locked in contract, flexible dealings with outside (e.g.) supplier

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- Give your spouse control of your investments in case you are incapacitated?

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⇒ Will give control to the party whose ex-post incentives are more in line with maximizing total surplus.

(assumed preferable to strict ex-ante contract)

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Property Rights: The Grossman and Hart model

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- Offers an explanation for the scope of firms as well as their existence.

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 - Claim: Could adapt this to have integration yield only limited incentives without loss of generality
- Does this yield “crossing over”?

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⇒ !!A downside of integration!!

- Weakness of (PR) theory: Reverse extreme as under Rent Seeking – Employees are now assumed to have no incentives to work, nor can they be motivated through managers using ‘mechanisms’ to do so.
 - Claim: Could adapt this to have integration yield only limited incentives without loss of generality
- Does this yield “crossing over” ?
 - Perhaps if monitoring/incentives are more difficult for larger firms ... who “monitors the monitors”? Possible collusion.... (double markups in a sense?)

A Simple “complete” Model with noncontractible investment (From Goyal notes)

One downstream firm (D) and one upstream firm (U).

The upstream firm makes an input that is of value Q to the downstream firm. If they trade, D pays U a price (lowercase) p for this input.

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What are the terms of trade between U and D ?

We assume that firms U and D can observe P and Q and so a simple way to proceed is to assume that the two have equal bargaining power (standard Nash bargaining). This means that they equally split the surplus: the price is then given by $p^* = (P + Q)/2$.

Note: the total bargaining surplus (gains from trade) is $Q - P$.
Splitting this equally yields $\frac{Q-P}{2}$ bargaining surplus for each.

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At price $p^* = (P + Q)/2$, U's bargaining surplus is $S_U = \frac{(P+Q)}{2} - P = \frac{Q-P}{2}$.

Thus, the bargaining surplus is split equally.

Remember – bargaining surplus is defined *relative to outside option*.

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Assume that $Q = I_1 a_1 + \epsilon$, while $P = I_2 a_2 + \delta$, where ϵ and δ are, e.g., independently normally distributed with mean zero.

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We now examine incentives under integration and non-integration:

1. Non-Integration: If U sells to A it gets a price (upper-case) P . This possibility creates bargaining power for firm U and may induce investments that increase P even if this has no bearing on value of Q . To see this consider the case where Q is fixed in value ($I_1 = 0$) however P can be increased by investments $I_2 = 1$, i.e., $Q = \epsilon$, $P = a_2 + \delta$.

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U wants to maximize the price he receives minus his costs, i.e., $\frac{P+Q}{2} - c(a_1, a_2)$. Simple calculations then show that U will choose a^* such that $1/2 = c'(a^*)$, where $c(\cdot)$ is an increasing and convex cost function. This investment is simply a waste of resources since the surplus generated is $Q - c(a^*)$.

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It follows that integration will resolve this problem: a take-over of U by D will mean that U will have no power to sell to A and so will have no incentive to make investments in P , which are wasteful. In this setting, integration prevents U "holding up" D. If integrates, $P^* = 0$, $a_1 = a_2 = 0$

Note: Even under non-integration, U and D could agree on a price in advance and avoid this problem; but in an unanticipated contingency we are back to the case above.

Marriage analogy:

a_1 is like learning how to prepare nice meals for one's spouse, or learning about their interests

a_2 is like making oneself appealing to other suitors

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However, non-integration provides incentives to firm U, since it then gets a price $\frac{1}{2}(Q + P)$ (in the contingency), and so will choose an action \bar{a}_1 such that $1/2 = c'(\bar{a}_1)$.

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In such a case, if $Q(\bar{a}_1) - c(\bar{a}_1) > Q$, i.e., if the investment is technically efficient, then non-integration is optimal.

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- 4 Solving one hold up problem can potentially create another hold up problem
- 5 Integration may thus be worse than non-integration in some situations.

Elemental Property Rights Theory of the Firm (Grossman and Hart; Gibbons version)

Timing

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- 4 Negotiate/choose $d \in D$ (decision) ...*potential for hold-up* (Note efficient bargaining ex-post over choice of d)
- 5 Payoffs: $V_i \equiv U_i(a_1, a_2, s, d) + \text{transfers} - c_i(a_i)$

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Argument:

Control in stage 1 \implies Allocation of surplus in stage 4 \implies Investment in stage 2 \implies Surplus/Payoffs at end

Stage 4

Efficient decision:

$$\begin{aligned}d^*(a_1, a_2, s) &= \arg \max_{d \in D} [U_1(a_1, a_2, s, d) + U_2(a_1, a_2, s, d)] \\ \implies U_i^*(a_1, a_2, s) &\equiv U_i^*(a_1, a_2, s, d^*(a_1, a_2, s))\end{aligned}$$

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Preference asymmetry (of a certain sort) \implies

$$U_1^*(a_1, a_2, s) + U_2^*(a_1, a_2, s) > U_1^i(a_1, a_2, s) + U_2^i(a_1, a_2, s)$$

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\implies incentive to negotiate to attain d^*

Stage 4 'Nash' Bargaining

Nash bargaining basically maximizes the bargaining surplus and splits it evenly, or according to the bargaining weights.

'Threat points' (when i has ownership):

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Nash bargaining axioms (with equal bargaining weights) \implies d and p maximize product of 'surpluses relative to threat points,' i.e., solve:

$$\max_{d \in D, p} [U_1(a_1, a_2, s, d) + p - U_1^i(a_1, a_2, s)]$$

$$\times [U_2(a_1, a_2, s, d) - p - U_2^i(a_1, a_2, s)]$$

where p is a (or) payment from 2 to 1 for which i agrees to choose d

Setting p to maximize this \implies

$$p = \frac{1}{2} \begin{pmatrix} [U_2(a_1, a_2, s, d) - U_2^i(a_1, a_2, s)] \\ -[U_1(a_1, a_2, s, d) - U_1^i(a_1, a_2, s)] \end{pmatrix}$$

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\implies (substituting into the previous expression)

$$d = \arg \max_{d \in D} \frac{1}{4} [U_1(a_1, a_2, s, d) + U_2(a_1, a_2, s, d) - U_1^i(a_1, a_2, s) - U_2^i(a_1, a_2, s)]^2$$

Setting p to maximize this \implies

$$p = \frac{1}{2} \left(\begin{array}{l} [U_2(a_1, a_2, s, d) - U_2^i(a_1, a_2, s)] \\ -[U_1(a_1, a_2, s, d) - U_1^i(a_1, a_2, s)] \end{array} \right)$$

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Since the latter terms are unaffected by d and the first 2 terms represent the surplus we have an efficient decision (note to maximize a squared term we must maximize its contents' absolute value):

$$d = d^*(a_1, a_2, s)$$

Noting the payment from 2 to 1 when i has control is

$$p^* = \frac{1}{2} \begin{pmatrix} [U_2^*(a_1, a_2, s) - U_2^i(a_1, a_2, s)] \\ -[U_1^*(a_1, a_2, s) - U_1^i(a_1, a_2, s)] \end{pmatrix}$$

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Whether I am 2 or 1, through p^* , I lose $\frac{1}{2}$ of my own (conditional on actions) optimal utility, but gain $\frac{1}{2}$ of other guys' (conditional) optimal utility; I also gain $\frac{1}{2}$ of my own threat point, but lose $\frac{1}{2}$ of other guy's threat point. These threat points (hence payoffs), depend on ownership ($i = 1$ or $i = 2$).

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$$\begin{aligned} NP_j^i(a_1, a_2, s) &\equiv \frac{1}{2} [U_j^*(a_1, a_2, s) + U_k^*(a_1, a_2, s)] \\ &\quad + \frac{1}{2} [U_j^i(a_1, a_2, s) - U_k^i(a_1, a_2, s)] - c_j(a_j) \\ &\equiv \frac{1}{2} ETS(a_1, a_2, s) + \frac{1}{2} TPD_j^i(a_1, a_2, s) - c_j(a_j) \end{aligned}$$

Where ETS is the "Efficient Total Surplus" and TPD_j^i is the "Threat Point Difference" (j 's threat point minus k 's).

$$NP_j^i(a_1, a_2, s) \equiv \frac{1}{2}ETS(a_1, a_2, s) + \frac{1}{2}TPD_j^i(a_1, a_2, s) - c_j(a_j)$$

So, in choosing a_j , each player j weighs the surplus (ETS) and the bargaining position (TPD_j^i) equally.

I.e., a player will act partly to 'manipulate the threat point.'

Gibbons: "we would like to find a governance structure such that the existing half strength incentives from [TPD] closely approximate the missing half-strength incentives from [ETS]"

Solving for (stage 2) actions:

Under player i 's ownership, each player j ($i = j$ or $i \neq j$) chooses a_j so that

$$a_j = \arg \max_{a_j \in A_j} E_s [NP_j^i(a_i, a_j, s)]$$

\implies Nash equilibrium actions $[a_1^{*(i)}, a_2^{*(i)}]$

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$$\implies TS^i = E_s [U_1^*(a_1^{*(i)}, a_2^{*(i)}, s) + U_2^*(a_1^{*(i)}, a_2^{*(i)}, s)] - c_1(a_1^{*(i)}) - c_2(a_2^{*(i)})$$

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Stage 1: Efficient negotiation will set ownership to maximize TS^i , comparing TS^1 and TS^2

Generally (speculation here), will want to give ownership to the party:

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- 4 **Key:** Under whose (selfishly) optimal decision investments have similar effects on threat points as their effects under the optimal decision. Hence if this party has ownership, each party, in trying to improve their threat point, will also tend to increase the total surplus.

Generally (speculation here), will want to give ownership to the party:

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Example of unverifiable situation: The Singing Frog

(<http://www.youtube.com/watch?v=2uZbq8z9vOk&feature=related>)