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# **Resource Allocation and Firm Scope**

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# 1. Introduction

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- Firms frequently rely on resources that may not be available on the market
  - Most importantly: specialized human resources
    - Linked to organizational procedures
    - Stock of human capital bound in existing firms
    - Firms are endowed with stock of human capital
  - When firms merge, human resources are pooled and can be allocated (redeployed) to their best use
- ⇒ Benefit of expansion of firm scope

# Control over skilled human resources as a merger rationale

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- Value creation through HR becoming increasingly important
- Labor markets have constrained capacity: rationale for merger in many industries, in particular, industries like engineering, law firms, IT
- *Companies like SAIC buy companies like Boeing IS because there is a shortage of skilled workers, said Bill Roper, chief financial officer of SAIC. Its one way to acquire highly skilled, well-educated people (washingtontechnology.com)*
- CEO of Cisco: *...in a high tech acquisition you really are acquiring only people. ... we are not acquiring market shares, we are acquiring futures (HBS case)*
- Recognized by strategic management literature: use of “unique resources” main justification for expansion of scope
- Chandler: top management’s allocation and coordination function for the emergence and growth of the multi-divisional firm
- Underlying consideration: do things by authority that you cannot do through trade/contracts

# Why can't you contract on some resources?

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1. Describability of resources?
  2. Leakage of information?
  3. Describability of use?
- Theoretically, 3 is most satisfying
  - Empirically, support for 2: SNC Lavalin, multi-billion engineering firm in Canada
  - Case study by Marcel Boyer: SNC Lavalin cooperated with an Indian firm
    - because of its skilled human resources availability, both in number and quality,
    - Integrated fully later on to properly protect its investments

# Costs of integration

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- Merge firms, pool resources, allocate to best division
- Positive effect on incentives: competition among managers
- Negative effect:
  - information about productivity resides with division managers
  - want division managers to communicate truthfully to top, but also want them to exert effort
  - only possible when giving each division manager a stake in the other division/the entire firm

## Costs of integration cont'd

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- We show that negative effect outweighs positive effect
- Exception: message-contingent contracts possible
  - two effects neutralize each other
  - then, integration is always optimal
- In general, existence of a tradeoff: better resource allocation vs more expensive incentives
- Both benefits and costs driven by the need to aggregate dispersed information

# Implications

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## ■ Allocation of authority over resources

- never optimal to give authority over resources to one of the division managers
- either pyramidal hierarchy with top manager as pure coordinator is optimal
- or horizontal exchange

## ■ Testable predictions

- When should two firms integrate?
- What consequences for size and structure of compensation structure of managers running the production units?

## 2. Related literature

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### 1. Theories of the firm

- Different role of information than in influence activity literature (Milgrom, Roberts, Meyer): Information is required input but this is also source for influence (lying about your project)
- Different role of authority (compared to Aghion and Tirole, Grossman and Hart): Authority in itself does *not mute* the incentives of people who do not have it. Importance of constraints on contract space.
- Multi-tasking.

### 2. Coordination in organizations

- Levitt-Snyder (1997): tradeoff communication-effort incentives.
- Athey-Roberts (2001): tradeoff effort incentives-externalities.
- Dessein-Garicano-Gertner (2006): tradeoff coordination-effort incentives
- Alonso-Dessein-Matouschek (2006): communication with unbiased coordinator

# Related literature (cont'd)

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3. Capital allocation in firms: large literature
  - Focus on efficiency of investments, not firm scope
  - Capital usually contractible => no meaningful theory of firm in our context
  - Most papers assume “empire building” behavior, we don’t

# 3. Model:

## Basic setup and resources

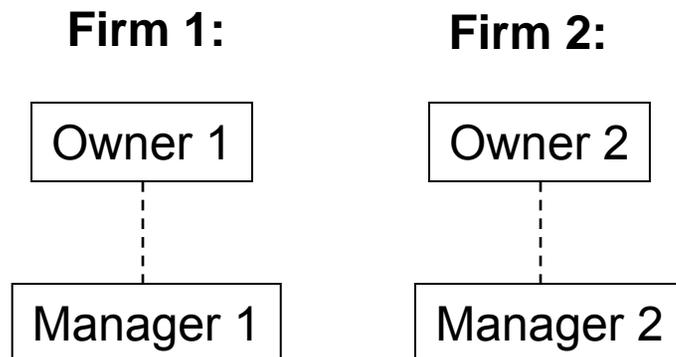
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- Two production units, each run by a manager (=agent)
- Each unit is endowed with one unit of resources
- Resources are specific to one unit but could be used in the other
  - No external market for resources
  - Spot contracting between firms too costly
- Under integration with centralized allocation, both units can be allocated to one or the other “division”

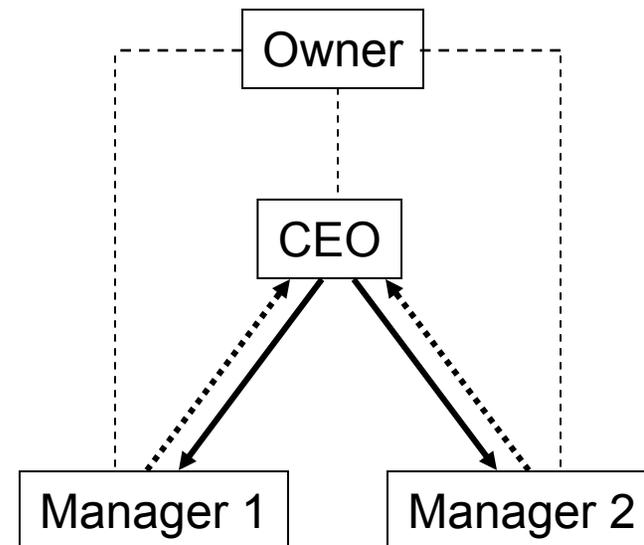
# We compare these structures:

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Non-integration =  
Independent firms:



Integrated firm:



----- Contracting  
.....> Communication  
————> Resource allocation

# Example: allocating resources at Airbus Industries

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- Different planes are developed by different units in the company
- Scarce resource: teams of aviation engineers, can be reallocated between Hamburg and Toulouse.
- Can do within the firm what is quite difficult across firms.
- Problem: what is the marginal value of putting an engineer on A320 or A380 production?
- Needed: private information of division managers; difficult to obtain.

# Timing: overview

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1. Contracting
2. Managers exert effort to create investment opportunities (“projects”), realized quality of project  $i$  is manager  $i$ 's private information
3. Resources allocated to projects
4. Project payoffs, wages

# Effort and projects

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- Manager  $i$  exerts high effort ( $e_i=1$ , at cost  $c$ ) or low effort ( $e_i=0$ , at cost 0)
- $e_i=1$  leads to good project ( $\theta_i=G$ ) with prob.  $p$  and bad one ( $\theta_i=B$ ) with prob.  $1 - p$ 
  - Same for low effort, with probability  $q < p$
  - $\theta_i$  is manager  $i$ 's private information

# Projects and payoffs

## (cf. Stein 1997)

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- Can invest either 1 or 2 units of resources in project
  - If project bad, expected profit is  $y_1$  or  $y_2$
  - If project good, expected profit is  $\varphi y_1$  or  $\varphi y_2$ ,  $\varphi > 1$
- Assume  $1 < y_1 < y_2 < 2$  and  $\varphi(y_2 - y_1) > y_1$
- ⇒ Efficient resource allocation  $k^*$ :
  - $k_1 = k_2 = 1$  if  $\theta_1 = \theta_2$
  - $k_1 = 2, k_2 = 0$  if  $\theta_1 = G$  and  $\theta_2 = B$ , and vice versa
- $y_2$ : returns to scale, or “relatedness”
- Actual profits are  $\mu$  or 0
  - e.g. Prob.(  $\tilde{z}_i = \mu$  ) =  $y_1/\mu$  if  $\theta_i = B$  and  $k_i = 1$

# Preferences and contracting assumptions

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- Managers are risk-neutral, protected by limited liability
  - $U_i = w_i - c e_i$
  - Res. wage low such that IR not binding
- Wages can be based only on profits of units/divisions
  - *cannot* be contingent on resource allocation, or on messages about project quality
  - But we'll see what happens when these are contractible

# Independent firms

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- Resource constraint:  $k_i \leq 1$
- Weakly optimal for owner to give manager authority over resources
- Remaining problem: choose large enough bonus  $\beta$  for  $\tilde{z}_i = \mu$  to induce high effort:

$$\max_{\beta} (1 - \beta) E_{\theta_i} [z_i(1, \theta_i) | e_i = 1]$$

$$\text{s.t.} \quad \beta E_{\theta_i} [z_i(1, \theta_i) | e_i = 1] - c \geq \beta E_{\theta_i} [z_i(1, \theta_i) | e_i = 0]$$

# Integrated firm

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- CEO has authority to allocate pooled resources
- We ignore agency problems at CEO level
- Stage 3:
  - (a) Managers send messages  $\hat{\theta}_i$  to CEO;
  - (b) CEO allocates resources s.t.  $k_1 + k_2 \leq 2$

# Contracting problem

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- Find contract that maximizes  $E[\text{total payoff} - \text{wages}]$ , such that
  1. Each manager chooses high effort (IC-e)
  2. Managers with any type of project report truthfully (IC-G, IC-B)
  3. CEO's resource allocation at stage 3 maximizes profit net of wages (RA)
  4. Limited liability (LL)

# Contracting assumptions, part 2

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## ■ General contracts:

- contingent on both divisions' payoffs => quadruple of wages
- Full analysis in paper, Appendix B

## ■ Additively separable contracts:

$$\tilde{w}_i(\tilde{z}_i, \tilde{z}_j) = \alpha + \beta\tilde{z}_i + \gamma\tilde{z}_j$$

- Same main results, simpler exposition
- Expected wage:  $w_i(z_i, z_j) = \alpha + \beta z_i + \gamma z_j$
- LL and non-binding IR: set  $\alpha = 0$

## 4. Analysis:

### 4.1 Independent firms

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- Optimal bonus for high payoff:

$$\beta^{ni} = \frac{c}{(p - q)(\varphi - 1)y_1}$$

- Assume high effort is optimal (= upper bound on  $c$ );  
cf. Lemma 2
  - Otherwise integration always optimal

## 4.2 “Competition effect” of integration on effort incentives

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**Proposition 1:** *With perfect information but unobservable effort, optimal contract has  $\beta^{pi} < \beta^{ni}$  (and  $\gamma^{pi}=0$ )*

- Centralized resource allocation *improves* effort incentives (Stein 2002 and others)
- Two reasons:
  1. Supermodularity of project quality and resources  
⇒ higher marginal benefit of effort (even for single manager)
  2. *Competition* between two managers for resources
    - “Conflicting tasks” as in Dewatripont-Tirole 1999

## 4.3 Competition effect vs. Information-rent effect

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- With private info, must reward  $\theta_i=B$  to get truthtelling  
=> weaker incentives for effort (Levitt-Snyder 1997)
- Which effect dominates, competition or *information-rent effect*?

**Proposition 2:** Any contract that satisfies (IC-e), (IC-B), (RA) leads to weakly higher wage costs than under non-integration.

## What drives Prop. 2?

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- Let  $\bar{w}_i(\theta_i, \hat{\theta}_i) = i$ 's expected wage at stage 3a
- Proposition follows from (IC-e), (IC-B) and:

$$\bar{w}_i(B, G) \geq \frac{1}{\varphi} \bar{w}_i(G, G)$$

# We get the same wage costs when...

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1. Messages but not resources are contractible
  - ⇒ **Benefits of integration without additional costs**
  - ⇒ Integration then dominates
2. Resources but not messages are contractible
  - ⇒ Benefits of integration also through bilateral trade
  - ⇒ No need for integration (cf. internal capital markets)
3. Both contractible => No need for integration

## 4.4 Strategic communication: synergies-incentives tradeoff

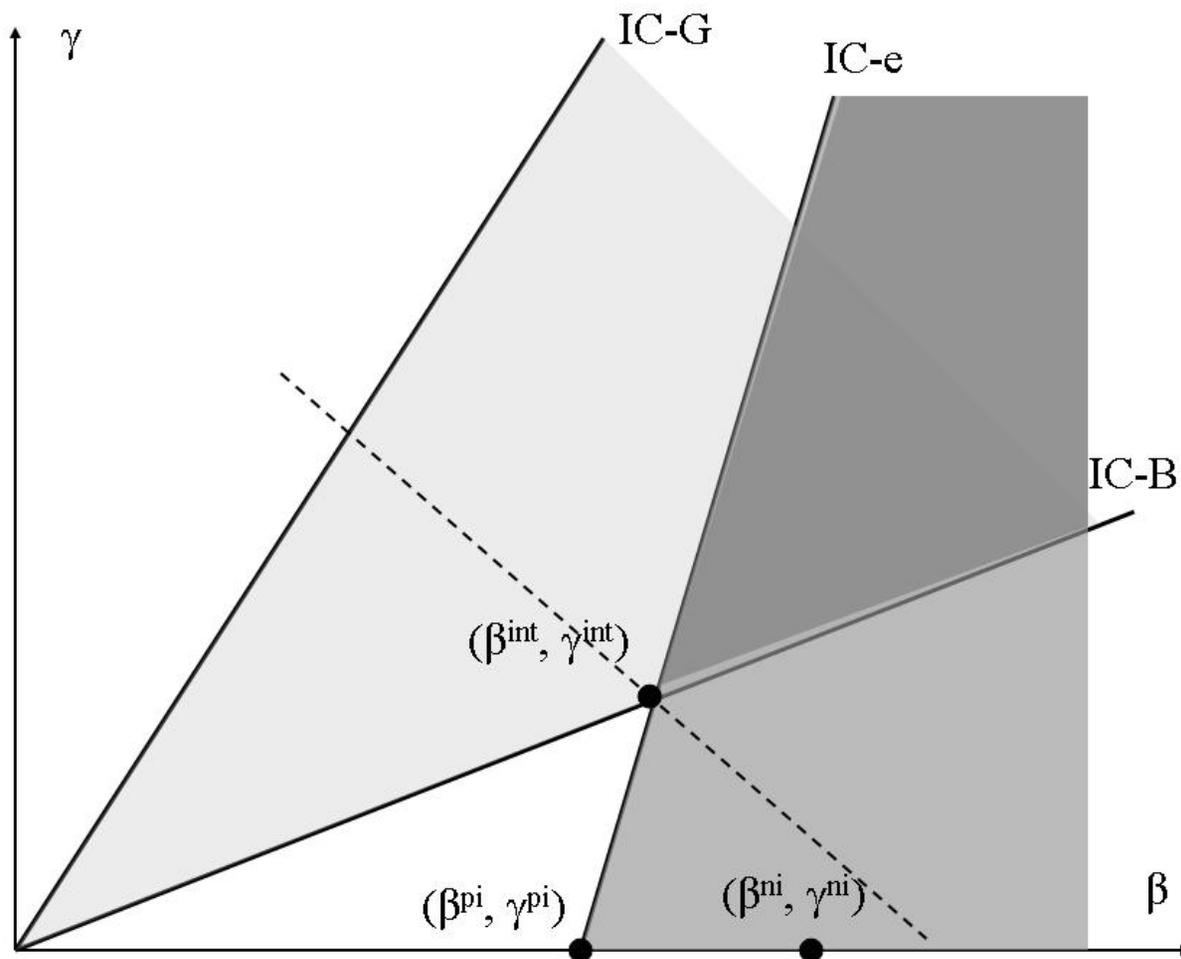
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**Proposition 3:** *With performance-based contracts, optimal contract pays  $\beta^{\text{int}} \in (\beta^{\text{pi}}, \beta^{\text{ni}})$  and  $\gamma^{\text{int}} > 0$ . Wage bill is strictly higher than under non-integration.*

- To get B-manager to tell truth, need to give him stake in benefit of allocating resources to other unit.  
⇒ Communication is link between synergies and effort incentives

# Proposition 3 illustrated

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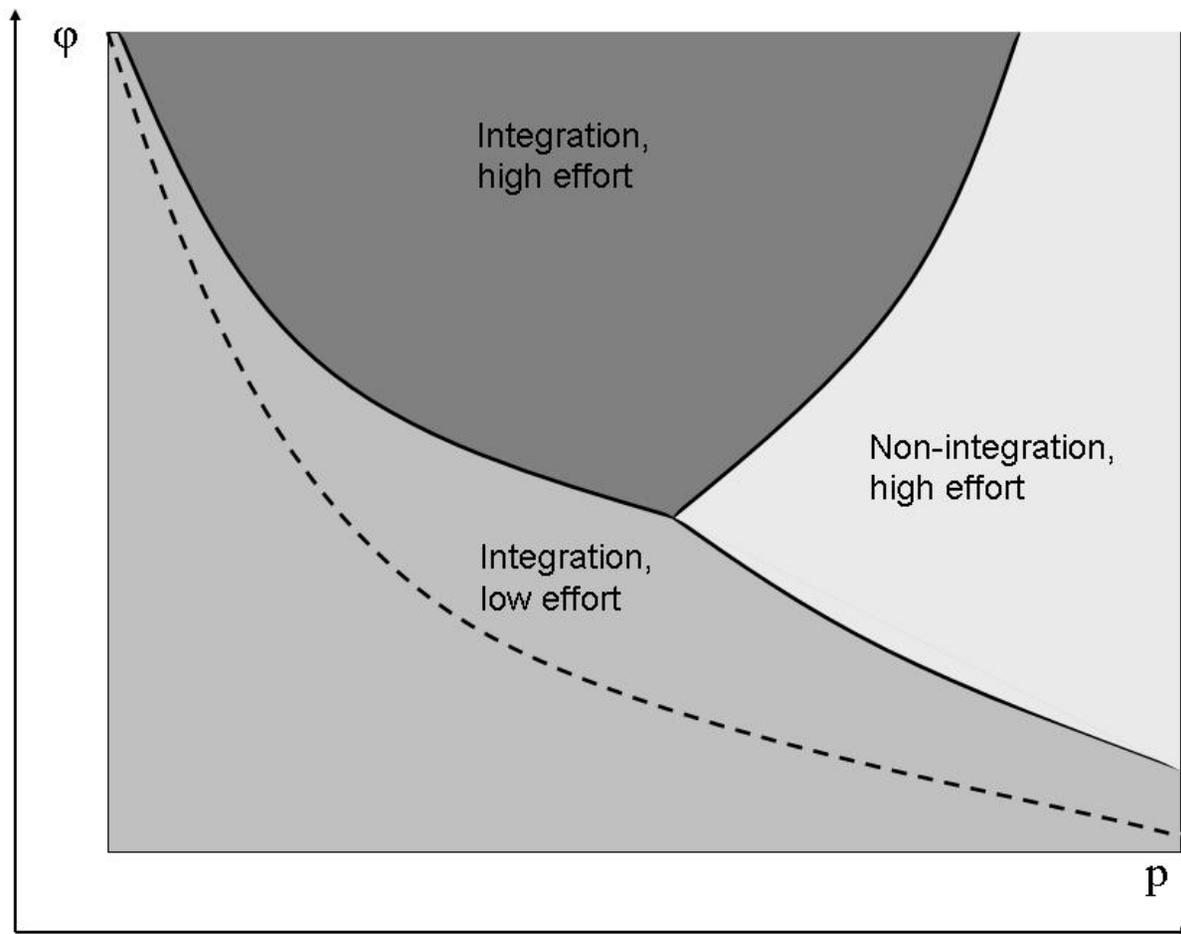
# General contracts

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- Pay  $\beta$  if only own unit has high payoff,  $\gamma$  if only other...,  $\delta$  if both have high payoff
- New complication: (RA) doesn't automatically implement  $k^*$ 
  - Incentive to misallocate if  $\beta$  or  $\delta$  too large
- **All main results (Props. 1-6) carry over!**
- Only exception: counterpart of Prop. 3:
  - If  $p < 1/(1+\phi)$ , can get truthtelling at no additional cost with  $\beta, \delta > 0$  and  $\gamma=0$
  - arises iff  $\delta$  has positive effect on (IC-B)

# Optimal organizational choice

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# Centralize authority

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**Propositions 5, 6:** *ICs at least as restrictive in alternative structures as in CEO hierarchy. Same wage bill under horizontal exchange if  $\phi^2 \geq y_1^2/(y_2-y_1)^2$ , otherwise CEO hierarchy strictly dominates.*

- Logic: equivalence between
  - misallocating resources over which a manager has authority, and
  - lying to CEO to achieve the same outcome in the CEO hierarchy

## Proposition 4 (cont'd)

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- Difference: managers in CEO hierarchy don't know other's type, in alternative structures they do  
⇒ IC-B in CEO hierarchy tends to be weaker than corresponding resource-allocation constraints in alternative structures
- Reminiscent of Dewatripont-Tirole (1999): running division and allocating resources are conflicting tasks
- Horizontal exchange: same constraints as in CEO hierarchy, plus one for manager with  $\theta_i=B$  to lend resource if  $\theta_i=G$  ⇒ stronger or weaker than (IC-B)

## 6. Predictions

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1.  $y_2$  = units' "relatedness":
  - Integration more likely the higher  $y_2$
2.  $\varphi$  = variability of division payoffs. Higher  $\varphi \Rightarrow$ 
  - Integration more likely
  - Lower compensation of division managers, lower  $\gamma / \beta$
3. Prop. 2 & 3  $\Rightarrow$  same predictions as 2., the more managers can be held accountable for what they say
4. higher  $y_2$  and  $\varphi \Rightarrow$  In integrated firms, horizontal exchange of resources more likely
  - "Peer groups" at BP, cf. Roberts (2004)

# 7. Contributions

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1. Simple theory of benefits and costs of integration
  - Benefits and costs originate from same problem: aggregation of information
  - Minimal assumption about underlying agency problems
  - Cf. Williamson 1985: weaker incentives under integration as answer to “selective-intervention” puzzle
2. Incentive-based argument for optimality of a top management specialized in resource allocation
3. Predictions about integration decisions, org. structure and wages

# Compare with:

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## (a) Influence-activity approach (Meyer-Milgrom-Roberts, Scharfstein-Stein):

- Does not spell out process of influence
- Here: communication is input into production and influence activity at same time



## (b) Incentive-system theory (Holmström-Milgrom-Tirole):

- In a way, communication is a second task, but..
- No effort substitution: cheap talk
- No measurement problems/ distortions
- Instead: team production with communication

# Compare with:

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(c) PRT/Authority in organizations (GHM, Aghion-Tirole, Dessein, Hart-Holmström '02, Hart-Moore '05):

- Typically: no incentive contracts
- Shifting authority from A to B reduces B's incentives, due to:
  1. complementarity of decision rights and incentives
  2. Divergence of preferences over decisions
- We have 1. but not 2.
- Perfect information: CEO's authority *improves* incentives; problem arises when information is private

# Concluding remarks

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## ■ General perspective:

- Focus on role of managers as coordinators to understand limits of organization
- What matters for the theory of the firm? Authority and incentives as usual, but also: dispersion of knowledge and communication

## ■ What about agency problems at the top?

- Certainly, but limits of organization exist even without those