Resource Allocation and Firm Scope

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1. Introduction

- 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

- 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 (washingtonotechnology.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?

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

- 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

- 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

- 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

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
   - Alonso-Dessein-Matouschek (2006): communication with unbiased coordinator
Related literature (cont’d)

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

- 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:

Non-integration = Independent firms:

<table>
<thead>
<tr>
<th>Firm 1:</th>
<th>Firm 2:</th>
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<tbody>
<tr>
<td>Owner 1</td>
<td>Owner 2</td>
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<td>Manager 1</td>
<td>Manager 2</td>
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Integrated firm:

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Contracting
Communication
Resource allocation
Example: allocating resources at Airbus Industries

- 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

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

- 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 ($\theta_i=\text{G}$) with prob. $p$ and bad one ($\theta_i=\text{B}$) 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)

- 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 $\varphi(y_2 - y_1) > y_1$
  \[ \Rightarrow \] 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. $\text{Prob.}(\tilde{z}_i = \mu) = y_1/\mu$ if $\theta_i = B$ and $k_i = 1$
Preferences and contracting assumptions

- 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

- 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:

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

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

- 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

- 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

- 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

- 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

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

- 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

- With private info, must reward $\theta_i = B$ to get truthtelling
  $\Rightarrow$ 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?

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

$$\overline{w}_i(B, G) \geq \frac{1}{\varphi} \overline{w}_i(G, G)$$
We get the same wage costs when...

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

**Proposition 3:** *With performance-based contracts, optimal contract pays* $\beta^\text{int} \in (\beta^p, \beta^n)$ *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.
  - $\Rightarrow$ Communication is link between synergies and effort incentives
Proposition 3 illustrated
General contracts

- 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 truth-telling at no additional cost with $\beta, \delta > 0$ and $\gamma=0$
  - arises iff $\delta$ has positive effect on (IC-B)
Optimal organizational choice

- Integration, high effort
- Non-integration, high effort
- Integration, low effort
5. Who gets authority? (Why need a CEO?)

- Two alternative structures:
  - Skewed hierarchy
  - Horizontal exchange

- Owner
- Manager 1
- Manager 2

- Owner
- Manager 1
- Manager 2

- Contracting
- Communication
- Resource allocation
Centralize authority

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

- Difference: managers in CEO hierarchy don’t know each other’s type, in alternative structures they do.
  \[ \Rightarrow \text{IC-B in CEO hierarchy tends to be weaker than corresponding resource-allocation constraints in alternative structures} \]

- 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

1. $y_2 =$ units’ “relatedness”:
   - Integration more likely the higher $y_2$

2. $\varphi =$ variability of division payoffs. Higher $\varphi =$
   - 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 $\varphi =$ In integrated firms, horizontal
   exchange of resources more likely
7. Contributions

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:

(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
(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

- 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