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Managerial overload and organization design

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ABSTRACT

This paper considers a firm's choice between a "divisional structure" and a "functional structure." It shows that an increase in the number of projects which the firm can adopt creates a managerial overload, which favors the divisional structure.

1. Introduction

This paper studies a firm's choice between a "divisional structure" under which each project is assigned to a single division, and a "functional structure" under which different departments specialize in specific functions or tasks and perform them on all projects. Since the functional structure requires different functional departments to implement projects jointly, it gives rise to moral hazard in teams problem (e.g., Alchian and Demsetz, 1972). Under the divisional structure there is no such problem since each project is implemented by a singe division. However, the ex post inefficiency of the functional structure may induce the firm's manager to exert more effort in screening projects ex ante as he anticipates that costly projects which are still profitable under the divisional structure will be unprofitable under the functional structure and will therefore be rejected by the board of directors.[1] Hence, the optimal structure of the firm is chosen by trading off the ex post efficiency of the divisional structure in the implementation of projects against the ex ante efficiency of the functional structure in the selection of projects.

The study of organization designs was pioneered by Chandler (1962) who argues that as firms like DuPont, General Motors, Sears, and Standard Oil grew and adopted more diverse product lines, the difficulties in coordinating functions across product lines induced them to switch from the functional to the divisional structure. Williamson (1975, 1985) stresses that the main advantage of the divisional structure is that it alleviates work overload at the headquarters' level and frees up the headquarters' time to focus on long-term strategic issues. In the current paper, managerial overload arises because the marginal cost of screening projects is increasing with their number. Consequently, as the firm grows and adopts more projects, its manager will exert less effort in screening projects. This diminishes the advantage of the functional structure and therefore favors the ex post efficient divisional structure.

Several papers have already examined the choice between the functional and the divisional structures.[2] Of these papers, only Aghion and Tirole (1995) consider managerial overload. They show that an increase in managerial overload favors the divisional structure by inducing the manager to rely more often on the agents' decisions and this boosts the agents' incentives. The current paper adapts the model in Berkovitch et al. (2009) to study the effects of managerial overload on organizational structure. Both papers depart from the rest of the literature by endogenizing the firm's choice of projects.

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[1] This advantage of the functional structure is reminiscent of the idea that firms may issue debt which may lead to costly financial distress ex post in order to boost the incentives of their managers ex ante (see e.g., Grossman and Hart, 1982), and the idea that moral hazard in monitoring activity may prevent the refinancing of projects ex post but may improve projects' selection ex ante (Dewatripont and Maskin, 1995).

[2] These papers include Aghion and Tirole (1995), Rotemberg (1999), Qian et al. (2006), Maskin et al. (2000), Besanko et al. (2005), Harris and Raviv (2002), Corts (2007), and Berkovitch et al. (2009).

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2. The model

The model builds on Berkovitch et al. (2009). A firm which consists of a board of directors, a manager, and two agents (middle managers, business units, or simply employees) can adopt up to n projects. The timing is as follows: first, the manager screens projects and recommends them to the board of directors. If the board approves the manager's recommendation, the two agents need to perform two tasks on each project to enhance its chance to succeed. If the board rejects the manager's recommendation, the game ends.

2.1. Projects' selection

All projects yield a return R if they succeed and 0 otherwise. However, H-type projects require an initial investment $I\in(0, R)$, whereas L-type projects do not require any initial investment. The manager can always discover H-type projects, but can discover each L-type project only with probability α which is independent across projects. The manager can choose the value of α, but his cost of effort is increasing with α and is given by $\psi(n\phi(\alpha))$, where $\psi(\cdot)$ and $\phi(\cdot)$ are increasing and convex, and $\phi'(0)=0$ and $\phi'(1)=\infty$.

The manager receives a private benefit B for each adopted project, regardless of its type. Since the manager needs to exert effort to discover L-type projects but can costlessly discover H-type projects, we have a managerial moral hazard problem in projects' selection.[3] To focus on the incentive role of organization design, assume that monetary incentives alone (any equity stake the manager has plus wages and bonuses) are insufficient to induce the manager to exert effort optimally. Given this assumption, the manager's wage will simply equal his reservation wage which is normalized to 0.

The board of directors are perfect agents of outside investors and therefore approve projects if and only if their net expected value is positive.

2.2. Projects' implementation and organizational structure

Once projects are approved, the two agents perform two tasks, p and m, on each project to enhance its chance to succeed. Using e_p and e_m to denote the agents' efforts in tasks p and m, the probability that a project will succeed is

$$q\left(e_p, e_m\right) = e_p + e_m.$$

Assuming that each agent can complete n tasks and recalling that each project requires two tasks, it is clear that there are two main ways to allocate the n projects to the two agents. One possibility is to adopt a "divisional structure" and give each agent the full responsibility over $n/2$ projects. Let $N_1=\{1,\ldots, n/2\}$ and $N_2=\{n/2+1,\ldots, n\}$ be the sets of projects assigned to agents 1 and 2. Agent j's cost of effort is

$$C_j^d = \gamma\sum_{\ell\in \mathrm{N_j}}\left(e_{p\ell}^2 + e_{m\ell}^2\right), \quad j = 1,2, \tag{1}$$

where $e_{p\ell}$ and $e_{m\ell}$ are the efforts that agent j exerts in project ℓ, and $\gamma\geq 0$.

A second possibility is to adopt a "functional structure." Here, each agent specializes in one task and performs it on all n projects. The cost that agent i incurs when performing task i on the n projects is

$$C_i^f = \gamma\sum_{\ell=1}^{n} e_{i\ell}^2, \quad i = p,m. \tag{2}$$

[3] In Berkovitch et al. (2009), the probability of discovering L-type projects, α, is an exogenous parameter rather than a choice variable for the manager, and the manager's preference for H-type projects is simply taken as given.

3. The expected gross profit per project under the two organizational structures

This section determines the expected profit per project, gross of the cost of investment, under the two structures, holding fixed the type of projects that the firm adopts. The selection of projects is considered in the next section.

Under the divisional structure, each project is assigned to one agent. Assuming that the agents' efforts are nonverifiable and the agents are wealth-constrained so their compensation cannot be negative, the firm will offer each agent compensation of W_ℓ if project ℓ succeeds, and 0 otherwise.[4] The contract offered to agent j is therefore characterized by the solution to the following problem:

$$\begin{aligned}
&\max_{\{e_{p\ell},e_{m\ell},W_\ell\}_{\ell\in \mathrm{N_j}}} \quad \sum\nolimits_{\ell\in \mathrm{N_j}} q_\ell(e_{p\ell}, e_{m\ell})(R - W_\ell)\\
&s.t. \quad e_{p\ell}, e_{m\ell}\in \underset{\hat{e}_{pi},\,\hat{e}_{mi}}{\arg\max} \sum\nolimits_{\ell\in \mathrm{N_j}} q_\ell\left(\hat{e}_{p\ell}, \hat{e}_{m\ell}\right)W_\ell - C_j^d, \quad j = 1,2,\\
&\qquad \sum\nolimits_{\ell\in \mathrm{N_j}} q_\ell\left(e_{p\ell}, e_{m\ell}\right)W_\ell - C_j^d\geq 0, \quad i = 1,2.
\end{aligned} \tag{3}$$

Solving the problem and substituting the solution in the top line of (3), the expected profit per project, gross of the cost of investment, is

$$\pi^d = \frac{R^2}{4\gamma}\ . \tag{4}$$

Under the functional structure, each agent specializes in one task and performs it on all n projects. Hence, each project requires the joint effort of the two agents. Using W_{ij} to denote the compensation of agent i ($i=p, m$) if project $j=1,\ldots, n$ succeeds, the contracts offered to the two agents are chosen to solve the following problem:

$$\begin{aligned}
&\max_{\{e_{ij},W_{ij}\}_{j=1,\ldots,n}^{i=p,m}} \quad \sum\nolimits_{j=1}^{n} q_j\left(e_{pj},e_{mj}\right)\left(R - W_{pj} - W_{mj}\right)\\
&s.t. \quad e_{pj},\ldots,e_{pn}\in\underset{\hat{e}_{p1},\hat{e}_{p2}}{\arg\max} \sum\nolimits_{j=1}^{n} q_j\left(\hat{e}_{pj},e_{mj}\right)W_{pj} - C_p^f\\
&\qquad e_{mj},\ldots,e_{mn}\in\underset{\hat{e}_{m1},\hat{e}_{m2}}{\arg\max} \sum\nolimits_{j=1}^{n} q_j\left(e_{pj},\hat{e}_{mj}\right)W_{mj} - C_m^f\\
&\qquad \sum\nolimits_{j=1}^{n} q_j\left(e_{pj},e_{mj}\right)W_{pj} - C_p^f \geq 0\\
&\qquad \sum\nolimits_{j=1}^{n} q_j\left(e_{pj},e_{mj}\right)W_{mj} - C_m^f \geq 0.
\end{aligned} \tag{5}$$

Solving the problem and substituting the solution in the top line of (5), the expected profit per project, gross of the cost of investment, is

$$\pi^f = \frac{R^2}{8\gamma}. \tag{6}$$

Clearly, $\pi^f<\pi^d$: holding fixed the type of projects that the firm adopts, the divisional structure is more profitable. The intuition is that under the functional structure, the agents' compensation depends on their joint effort, so there is a "moral hazard in teams" problem. Under the divisional structure, the success of each project depends on the effort of only one agent so there is no similar problem.

4. The optimal organizational structure

This section takes explicitly into account the effect of organization structure on the ex ante selection of projects. To this end, note that the

[4] The latter assumption implies that the agents' moral hazard problem cannot be solved by effectively "selling the firm to the agents." This assumption is not essential however: under the functional structure, each project is implemented jointly by two agents, so there is a team problem even when the firm can be "sold to the agents."

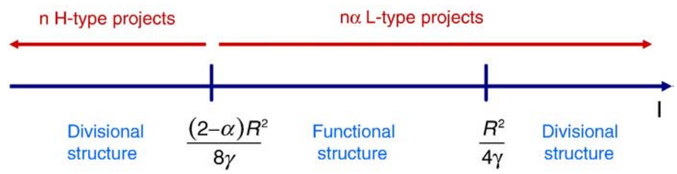

Fig. 1. The optimal organizational structure of the firm and the resulting selection of projects.

board of directors will always approve L-type projects as they require no initial investment, but will approve H-type projects under structure s ($s = d, f$) if and only if $I \leq \pi^s$. Anticipating the board's behavior, the manager, who gets the same private benefit B for each adopted project, will exert no effort in screening projects when $I \leq \pi^s$ and will simply recommend H-type projects which he can costlessly discover. If $I > \pi^s$, the manager realizes that H-type projects will be rejected and will therefore exert effort in trying to discover L-type projects. The following result which is similar to Proposition 1 in Berkovitch et al. (2009), characterizes the optimal structure of the firm for a given α:

Proposition 1. *Fixing* α,

(i) *the divisional structure is optimal if either* $I < \frac{(2-\alpha)R^2}{8\gamma}$ or $I > \frac{R^2}{4\gamma}$,

(ii) *the functional structure is optimal if* $\frac{(2-\alpha)R^2}{8\gamma} < I < \frac{R^2}{4\gamma}$.

Proof. Since $\pi^f < \pi^d$, there are three cases to consider. First, if $I < \pi^f = \frac{R^2}{8\gamma}$, the manager will only recommend H-type projects under both structures. Consequently, the firm will adopt the ex post efficient divisional structure.

Second, when $I > \pi^d = \frac{R^2}{4\gamma}$, the manager will exert effort under both structures, anticipating that H-type projects will be rejected. Again, the firm will adopt the ex post efficient divisional structure.

Finally, when $\frac{R^2}{8\gamma} < I < \frac{R^2}{4\gamma}$, the manager recommends H-type projects only under the divisional structure. The firm's profit is therefore $n(\pi^d - I) = n\left(\frac{R^2}{4\gamma} - I\right)$ under the divisional structure and $n\alpha\pi^f = \frac{n\alpha R^2}{8\gamma}$ under the functional structure. Comparing the two profits, the divisional structure is optimal if $I < \frac{(2-\alpha)R^2}{8\gamma}$ and the functional structure is optimal if $\frac{(2-\alpha)R^2}{8\gamma} < I < \frac{R^2}{4\gamma}$. □

Proposition 1 is illustrated in Fig. 1. The key observation here is that the firm is more likely to adopt the functional structure when α is large. The next step then is to study the manager's choice of α. To this end, note that the manager needs to exert effort only when the board of directors rejects H-type projects, i.e., whenever $I > \frac{(2-\alpha)R^2}{8\gamma}$. Since discovering L-type projects involves a sequence of n independent trials, each of which either succeeds or fails, the manager's expected payoff as a function of α is given by

$$U(\alpha) = \begin{cases} nB & I < \frac{(2-\alpha)R^2}{8\gamma}, \\ n\alpha B - \psi(n\phi(\alpha)) & I \geq \frac{(2-\alpha)R^2}{8\gamma}. \end{cases}$$

Since $\psi(\cdot)$ and $\phi(\cdot)$ are increasing and convex and $\phi'(0) = 0$ and $\phi'(1) = \infty$, the solution to the manager's problem is equal to $\alpha^* \in (0,1)$ where α^* is determined implicitly by the first order condition

$$B = \psi'(n\phi(\alpha))\phi'(\alpha), \tag{7}$$

provided that $I \geq \frac{(2-\alpha^*)R^2}{8\gamma}$, and is equal to 0 otherwise.

Recalling that the firm adopts the functional structure if and only if $\frac{(2-\alpha^*)R^2}{8\gamma} < I < \frac{R^2}{4\gamma}$, and noting from Eq. (7) that α^* is increasing with B and decreasing with n, and that the interval $\left[\frac{(2-\alpha^*)R^2}{8\gamma}, \frac{R^2}{4\gamma}\right]$ becomes wider when R is large (if we interpret R as a measure of competition, then large R means that the firm has a large degree of market power), yields the following result:

Proposition 2. *The firm is more likely to adopt the functional structure when B is large (the manager has large private benefits of control), n is small (the firm is small), and R is large (the firm has a large degree of market power).*

Proposition 2 implies that while the firm may adopt the functional structure when n is small, it may switch to the divisional structure when it grows and has more projects. This result supports Williamson's argument that an increase in firm's size which creates managerial overload may induce firms to switch from a functional to a divisional structure. Proposition 2 also shows that such a switch is more likely when the manager has small private benefits and when it faces more competition.

5. Conclusion

This paper advances the idea that organizational structure is chosen by trading off ex post efficiency in projects' implementation against ex ante efficiency in projects' screening. The functional structure which is ex post inefficient, may have the advantage of inducing the firm's manager to exert more effort in screening projects as he anticipates that costly projects may be unprofitable under the functional structure and will therefore be rejected by the board of directors. However, when the firm grows and adopts more projects, the manager becomes overloaded and as a result, he exerts less effort in screening each project. This diminishes the advantage of the functional structure and may therefore induce the firm to adopt the ex post efficient divisional structure.

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