Incomplete contract, bargaining and optimal divisional structure

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Abstract When complete contracting is not possible, allocating control structure becomes the second-best arrangement. This paper analyzes the design of optimal divisional structure within an organization where ex post bargaining between the potential divisional managers is possible. In much the same light as Aghion and Tirole (J Political Econ 105(1):1–29, 1997), we study the control problem in the context of search for projects. Our model shows that when the managers cannot bargain with one another, internal integration is preferred to internal separation. Where bargaining is possible, formal divisional structure defines both the ex post bargaining position of the two managers and their incentive to search ex ante. When the managers tend to arrive at a more favorable project to the principal via bargaining, the general leader of a firm may want to choose separation instead to increase the probability of bargaining, as the symmetrical incentive requires both managers to search and get informed.

Keywords Organizational design · Divisional structure · Incomplete contract · Bargaining

JEL Classification D23 · L22

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1 Introduction

Researchers in economics and business have long recognized the importance of organizational forms for the performance of teams, corporations, and economies. [Milgrom and Roberts \(1992\)](#) document how the decentralization of General Motors in the 1920's allowed it to surpass the more centralized Ford. [Maskin et al. \(2000\)](#) and [Qian et al. \(1999\)](#) attribute the striking divergence in the post-transitional economic performance for China and the former Soviet Union to the M-form (multidivisional form) and U-form (unitary form) decision-making structures in their respective government economic planning divisions.¹

Rather than compare multidivisional and unitary organizational forms, this paper takes an incomplete contract approach to the optimal decision between separate divisions or integration in an M-form organization. There is a large body of existent literature on divisional structure using the complete contract approach ([Rotemberg and Saloner 1993](#); [Poitevin 1995](#); [Maskin et al. 2000](#); [Mookherjee 2006](#)). The key problem addressed in each of these papers is the way in which the chief of a firm can write the optimal incentive contract for her division managers.

Our work studies the *internal* boundaries of the firm, namely the optimal decision between internal integration and separation within a firm. This follows the pattern used by [Grossman and Hart \(1986\)](#) for the integration (separation) between two firms when complete contracting is not feasible. Our model contains one general leader of the firm (called the “principal”) and two divisional managers (called the “agents”). The principal decides whether to have two separate divisions and make each agent the head of his respective division, or integrate the divisions with only one serving as the general manager. As in [Grossman and Hart \(1986\)](#), we also consider ex post bargaining between the agents and its impact on their ex ante incentives. We find that the agents do not take the principal's well-being into account when they bargain, and that the bargaining process can have a strong impact on the principal's optimal integration (separation) decision. One innovation in this paper is that we highlight the interplay between optimal divisional structure and bargaining. Integration generates an asymmetrical incentive for the two agents and therefore reduces the probability of bargaining, while separation generates greater symmetric incentive, and increases the probability of bargaining. Therefore the principal will optimally prohibit bargaining through the design of divisional structure if it generates worse outcomes for her than in the case of no bargaining.

The main results of this paper are as follows: (1) when bargaining is not possible, it is always better for the principal to adopt integration, and assign control rights to the most productive agent; (2) when bargaining is possible, formal divisional structure defines the ex post bargaining position of the two agents and their ex ante incentive to search. The principal may want to adopt separation when the agents generally agree with her on a more favorable project through bargaining. The reason is that both agents

¹ In organization literature, M-form (multidivisional form) means that tasks are organized based on self-contained divisions, such as an Oldsmobile division and a Chevrolet division in General Motors, and U-form (unitary form) means tasks are organized based on functions or specializations, such as sales, marketing and R&D departments.

need to be informed in order to bargain, and therefore bargaining is more likely when the two agents have symmetrical incentives (separation); while one agent's incentive to search will be undermined under integration.

This paper is organized as follows: Sect. 2 begins with a review of the relevant literature; Sect. 3 provides a motivating story; Sect. 4 presents the model setup; Sect. 5 discusses the benchmark case of a complete contract; Sect. 6 analyzes the model of an incomplete contract without bargaining; Sect. 7 analyzes the model with an incomplete contract and bargaining; and finally, Sect. 8 concludes.

2 Related literature

Our work is related to research comparing the efficiency of M-form and U-form organizations. [Puschke \(2009\)](#) points out that U-form organization enables cost savings due to specialization of tasks. Therefore the principal's choice of either M-form or U-form depends on the complementarity and substitutability of functions performed by the divisions (sales, accounting, marketing etc.). M-form is optimal when divisional functions are neither too complementary nor too substitutable. This paper studies the optimal separation-versus-integration decision in an M-form organization when the divisions conduct very similar functions. Therefore the complementarity of functions is not a concern in our paper.

Our work is also related to the complete contract literature on divisional structure, which can largely be subdivided into two categories: the communication models ([Argyres 1995](#); [Bolton and Dewatripont 1994](#); [Dessein 2002](#); [Dessein and Santos 2006](#); [van Zandt 1999](#)), which mainly concern the tradeoffs between coordination (or communication cost) and specialization (or local adaptation), and the incentive models ([Maskin et al. 2000](#); [Poitevin 1995](#); [Rotemberg and Saloner 1993](#)), which address the incentive schemes for division managers. For a more detailed discussion of this literature, [Mookherjee \(2006\)](#) provides an excellent survey.

The communication models generally assume that separation brings benefit to the principal because it allows the agents to specialize, while integration reduces communication costs and enhances coordination. Where the benefit of specialization is more significant, separation is more advantageous, and vice versa. The incentive models usually consider different contracts between the CEO and divisional managers or the working style of a CEO (democratic or autocratic) and its impact on the managers' efforts. It is usually better for the principal to be more democratic and delegate more autonomy to the divisional managers, which thus gives the managers greater incentive to innovate. When the environment is not conducive to generating new ideas or innovation is unprofitable for the firm, it is better for the principal to have a more autocratic leadership style.

Our paper differs from both strands of literature as we abstract from the communication issue and the question of whether to delegate control. Rather, we investigate how the general leader should optimally design control structure between two divisional managers *after* the delegation decision has been made, specifically in the absence of complete contracting.

3 An illustrative story

We can illustrate the basic intuition behind our model through a situation commonly found in any university's school of economics. This logic can be applied to many similar settings. Suppose that the dean of a school of economics is very busy, and therefore must assign some decision-making power to the chair professors. There is a chair professor of microeconomics and a chair of macroeconomics. The dean can create one department of microeconomics and one of macroeconomics chaired by each of them respectively (separation), or create one general department of economics chaired by either one of them (integration). Each year, the school must recruit new faculty members from the job market. There are many tasks that are associated with this process, including searching for and evaluating candidates.

Let us suppose for a specific year, there are two vacancies in the school, and both chairs select candidates from the same pool. Each chair prefers candidates from his respective field, but he also prefers having a candidate from the other field to having no candidate at all, because some faculty members from the other field can teach courses for the whole school, regardless of their expertise. If the dean chooses separation, each of the chairs will be able to select the position for his respective department. If the dean chooses integration, the head of the entire department will be in charge of both positions. The chairs must thus exert effort to search and become informed about the candidates' quality. The more effort they invest, the more likely they will be to become informed. They will not make a choice by themselves when they are uninformed because this increases the chances of selecting a poor candidate unable to perform even basic jobs well. Therefore if neither party is informed, no candidate will be chosen. If one professor is informed and the other is not, the informed professor will propose (his preferred choice) to the uninformed one, and the uninformed one will accept, because having the other's favorite is better than having nobody. If both of them are informed, the one in control can overrule the other or engage in bargaining. For example, when the microeconomics professor is the department chair, and he finds that there is a candidate who is very strong in microeconomics, but has little expertise in macroeconomics, and another one who is slightly less competitive in microeconomics but very strong in macroeconomics, he can propose to the macroeconomics professor that he choose the second one for the position, and the macroeconomics professor can offer some future reciprocal favors (e.g., agreeing to a greater allocation of next year's seminar budget to microeconomic topics, or becoming a member of the micro professor's PhD student's committee). Here the candidate chosen from bargaining may not be one of the original favorites of either professor, but is more likely a good compromise. Generally speaking, the reward for searching is the increased probability of becoming informed and therefore the increased probability of choosing one's favorite when in control. Therefore the more positions one is in charge of, other things equal, the more motivated he is to exert search effort.

The dean does not know the specific information about the characteristics of the candidates, but she still has rational expectations of the average quality of a candidate chosen by either of the chairs, or by both of them jointly. When bargaining is not taken into account, and her preference is more similar to the chair of micro (macro) economics, she should always choose integration, and make the micro (macro) chair

Table 1 Projects and payoffs

Project\payoff	π_P	π_1	π_2
F_P	B	$\beta_1 b$	$\beta_2 b$
F_1	$\alpha_1 B$	b	$\gamma_2 b$
F_2	$\alpha_2 B$	$\gamma_1 b$	b

The columns are the situation in which the party's favorite project is chosen. The rows are the party's payoff given the project chosen in the column

the department head. Thus the head will be inclined to select her most-preferred candidate. When bargaining is considered, the candidate chosen from bargaining is usually a good compromise between the interests of the two chairs, but could be either better or worse for the dean than the default choice of the chair in charge. When the candidate chosen from bargaining is much better, separation might be an optimal arrangement, because only in this way can the dean have both of the chairs equally incentivized to search and become informed in order to bargain successfully.

4 The model setup

We now generalize and formalize the ideas in the above example. Our model contains one principal P (addressed as “she”), who is not directly productive, and two agents, A_1 and A_2 (we use “he” to address each of them). There might be two divisions D_1 and D_2 with $N \geq 3$ projects for each division. For simplicity, we assume that the distribution of projects for D_1 and D_2 is exactly the same. As in [Aghion and Tirole \(1997\)](#) and [Riyanto \(2000\)](#), we introduce interest congruence among the players. Each project $n \in \{1, 2, 3, \dots, N\}$ is associated with a profit B_n to P , and private benefit b_n^1 to A_1 , and b_n^2 to A_2 . We assume some projects yield “sufficiently negative” payoffs, so that an uninformed party will confess ignorance. When no project is chosen, each party receives 0. Each can receive a payoff from both D_1 and D_2 (there are spillover effects between the divisions).

The principal does not search, and agents search for information independently. By exerting effort e which costs $g(e)$, one agent can get fully informed with a probability $0 \leq e \leq 1$. We assume $g'(e) > 0$, $g''(e) > 0$.

For each division, each party has a potential “favorite” project. The favorite project for P (denoted as F_P) gives her B , $\beta_1 b$ to A_1 and $\beta_2 b$ to A_2 . The favorite of agent A_i (denoted as F_i) gives this agent b , $\alpha_i B$ to the principal and $\gamma_j b$ to agent A_j for $i, j \in \{1, 2\}$, $i \neq j$. We also assume that $\alpha_1, \alpha_2, \beta_1, \beta_2, \gamma_1, \gamma_2$ are between 0 and 1, and strictly smaller than 1. All parameters are common knowledge.² We use π_P, π_1, π_2 to denote the payoff for the principal, agent 1 and agent 2. The information of the interest congruence is also illustrated in Table 1.

The principal does not search, and only has to decide on the allocation of control. She has to decide whether to have the two divisions controlled separately or jointly by a general manager (illustrated in Fig. 1). The characteristics of the candidates are

² This means that although P does not search, she still has a rough idea of what her payoff should be in each case based on comparison with the performance level of the industry as a whole.

Fig. 1 The Control Structures. The *left* one is the organization under separation of control. The *middle* one is the case of integration with control rights assigned to A_1 , and the *right* one is the case of integration with control rights assigned to A_2

“soft information”: the agents know these characteristics when they are informed, but they cannot convey this information to the principal. Therefore it is impossible for the principal to sign a complete contract with the agents specifying the effort levels and projects to be chosen. As in Grossman and Hart (1986), although A_1 and A_2 cannot make side agreements ex ante, they may bargain with each other ex post when they see opportunities for improvement of joint utility. In each division, when one agent is informed and the other is not, the uninformed party will agree to the informed party’s favorite because this is better than having no candidate. When both parties are informed, the party in control can decide whether to choose his favorite project, or can bargain with the other party. When the agents bargain, the result will be determined by Nash Bargaining: they choose the project that maximizes their joint payoff, and split the cooperative surplus equally.

For simplicity and practical relevancy, we assume $B \gg b$, $B + \beta_1 b + \beta_2 b > b + \alpha_i B + \gamma_j b$ always holds for $i, j \in \{1, 2\}$, $i \neq j$. The joint payoff for all three parties cannot be improved when the principal’s favorite project is chosen. The principal never has incentive to bargain with the agents, even when she is informed, because there is no cooperative surplus she can gain by doing so.

5 The benchmark case with complete contracting

We first consider the world without contract incompleteness, where the principal P can use contracts to ensure that her favorite project is chosen for both divisions when at least one agent is informed (in both divisions, $\pi_P = B$, $\pi_1 = \beta_1 b$, $\pi_2 = \beta_2 b$). Let e_1, e_2 be the efforts exerted by A_1 and A_2 , respectively. The probability that at least one agent is informed is $e_1 + e_2 - e_1 e_2$. The expected social welfare will be twice the sum of payoffs for all parties ($B + \beta_1 b + \beta_2 b$) when the principal’s favorite is chosen, multiplied by the probability that at least one agent is informed, minus the cost of searching ($g(e_1) + g(e_2)$).

$$\max_{e_1, e_2} 2(e_1 + e_2 - e_1 e_2)(B + \beta_1 b + \beta_2 b) - (g(e_1) + g(e_2))$$

The above equation shows that efforts are selected such that the expected social welfare is maximized. We use e_1^*, e_2^* to denote the level of the agents’ effort when social optimum is achieved. The first order conditions can be written as:

$$\begin{aligned}g'(e_1^*) &= 2(1 - e_2^*)(B + \beta_1 b + \beta_2 b) \\g'(e_2^*) &= 2(1 - e_1^*)(B + \beta_1 b + \beta_2 b)\end{aligned}$$

These first order conditions imply that the agents choose efforts such that the marginal cost of searching is equal to the marginal return to all three parties. Applying the implicit function theorem, we know: $\frac{\partial e_1^*}{\partial e_2^*} = -\frac{B+(\beta_1+\beta_2)b}{g''(e_1^*)} < 0$, $\frac{\partial e_2^*}{\partial e_1^*} = -\frac{B+(\beta_1+\beta_2)b}{g''(e_2^*)} < 0$. Therefore the efforts of the two agents are strategic substitutes. The effort as a response function of one agent decreases the effort of his counterpart.

If the principal purely maximizes her own payoff, her problem is even simpler:

$$\max_{e_1, e_2} 2(e_1 + e_2 - e_1 e_2)B$$

As a result she will choose $e_1 + e_2 - e_1 e_2 = 1 \Leftrightarrow (1 - e_1)(e_2 - 1) = 0$, which means that at least one of the agents will exert an effort of 1, and the principal will choose her favorite project.

6 Incomplete contract without bargaining

We now consider the case in which a complete contract cannot be written either between the principal and agents, or between the two agents. In the context of our school of economics example, the dean cannot sign a complete contract with the hiring committee on the choice of candidates. One reason for this incompleteness is that the quality of candidates is soft information, which cannot be conveyed to or verified by a third party such as a court. Therefore it is also not possible to sign a contract that can be enforced by a third party. When complete contracting is not possible, design of an authoritative structure is the second-best arrangement.

The expected payoff to the agent A_i in the division which he controls will be b when he is informed (with a probability e_i), and $\gamma_i b$ when he is uninformed and the other agent is informed (with a probability $(1 - e_i)e_j$). The expected payoff to the agent A_i in the division he does not control will be $\gamma_i b$ when the other is informed (with a probability e_j), and b when he is informed and the other agent is not informed (with a probability $(1 - e_j)e_i$). We use π_i^l to represent the payoff for the divisions depending on control rights, superscript $l \in \{1, 2\}$ to represent the controlling party within the division, and subscript $i \in \{1, 2, P\}$ to represent the party receiving the payoff:

$$\begin{aligned}\pi_1^1 &= e_1 b + (1 - e_1)e_2 \gamma_1 b \\ \pi_1^2 &= e_2 \gamma_1 b + (1 - e_2)e_1 b \\ \pi_2^1 &= e_1 \gamma_2 b + (1 - e_1)e_2 b \\ \pi_2^2 &= e_2 b + (1 - e_2)e_1 \gamma_2 b \\ \pi_P^1 &= e_1 \alpha_1 B + e_2(1 - e_1)\alpha_2 B \\ \pi_P^2 &= e_2 \alpha_2 B + e_1(1 - e_2)\alpha_1 B\end{aligned}$$

We use SP , $IN1$, $IN2$ to represent the three divisional structures: separation, integration under the control of A_1 , and integration under the control of A_2 . Separation

means that A_1 controls only one division. Integration under A_1 means that A_1 controls both divisions. The case for A_2 is analogous. We use Π_i^K to represent the payoff for agent i when the divisional structure is K , $K \in \{SP, IN1, IN2\}$. Their payoffs in different regimes are as follows:

$$\begin{aligned}\Pi_1^{SP} &= \pi_1^1 + \pi_1^2 - g(e_1) \\ \Pi_2^{SP} &= \pi_2^1 + \pi_2^2 - g(e_2) \\ \Pi_1^{IN1} &= 2\pi_1^1 - g(e_1) \\ \Pi_2^{IN1} &= 2\pi_2^1 - g(e_2) \\ \Pi_1^{IN2} &= 2\pi_1^2 - g(e_1) \\ \Pi_2^{IN2} &= 2\pi_2^2 - g(e_2)\end{aligned}$$

The first order conditions for their efforts are:

$$\begin{aligned}g'(e_1^{SP}) &= b(2 - e_2^{SP} - \gamma_1 e_2^{SP}) \\ g'(e_2^{SP}) &= b(2 - e_1^{SP} - \gamma_2 e_1^{SP}) \\ g'(e_1^{IN1}) &= 2b(1 - \gamma_1 e_2^{IN1}) \\ g'(e_2^{IN1}) &= 2b(1 - e_1^{IN1}) \\ g'(e_1^{IN2}) &= 2b(1 - e_2^{IN2}) \\ g'(e_2^{IN2}) &= 2b(1 - \gamma_2 e_1^{IN2})\end{aligned}$$

From the monotonicity of function $g(e)$ we can see that $\frac{\partial e_i}{\partial \gamma_j} < 0$. The intuition is that the more one agent can obtain from the other agent's favorite project, the less incentivized he is to put in search effort and have his own favorite project selected.

Applying the implicit function theorem, we can easily deduce that the efforts of agents are strategic substitutes in these situations. An increase in one agent's effort invariably discourages the other agent. This result is also very intuitive, given that the effort of A_j has two effects: (1) it increases the opportunity cost for searching for A_i , as A_i can receive a non-negative payoff by free riding on the information of A_j (the *free-riding effect*) and (2) when A_j is in control, A_i 's favorite project can be overruled by A_j if A_j is informed (the *overruling effect*). Both effects raise the opportunity cost and reduce the marginal return on searching for A_i , undermining A_i 's incentive to search.

The value of the right-hand side of the equations in the first order conditions is usually between 0 and $2b$, and it is preferred that the solution for their efforts lie between 0 and 1. Without loss of generality, a natural way to normalize this is to assume the cost function takes the form $g(e) = e^2b$. So we have a linear equation (system) for the efforts, and the solution is always between 0 and 1. Thus, it is not difficult to arrive at:

$$\begin{aligned}e_1^{SP} &= \frac{2 - 2\gamma_1}{3 - \gamma_1 - \gamma_2 - \gamma_1\gamma_2}, & e_2^{SP} &= \frac{2 - 2\gamma_2}{3 - \gamma_1 - \gamma_2 - \gamma_1\gamma_2} \\ e_1^{IN1} &= 1, & e_2^{IN1} &= 0 \\ e_1^{IN2} &= 0, & e_2^{IN2} &= 1\end{aligned}$$

Fig. 2 The Principal's Payoff under Different Divisional Structures ($\gamma_1 = 0.1$, $\gamma_2 = 0.2$, $\alpha_1 = 0.5$). The horizontal axis is α_2 . The vertical axis is the payoff for the principal in terms of B . SP represents separation, IN1 is integration under the control of A_1 , and IN2 is integration under the control of A_2

Here we have an extreme case when divisions are integrated, the agent in control will have the largest incentive, and exert the maximum level of effort, while the agent losing control will simply exerts the minimal effort of zero. It is not difficult to prove that e_1^{SP}, e_2^{SP} lie between 0 and 1. Therefore based on $e_1^{IN1} > e_1^{SP} > e_1^{IN2}, e_2^{IN2} > e_2^{SP} > e_2^{IN1}$, the greater one's control rights, the greater his search effort, other things equal.

We add a superscript N after the superscript indicating divisional structure to denote the case without bargaining. The principal's payoffs in these three cases are as follows:

$$\begin{aligned}\Pi_p^{SP,N} &= \frac{4(1-\gamma_1)(2-\gamma_1-\gamma_1\gamma_2)\alpha_1 + 4(1-\gamma_2)(2-\gamma_2-\gamma_1\gamma_2)\alpha_2}{(3-\gamma_1-\gamma_2-\gamma_1\gamma_2)}B \\ \Pi_p^{IN1,N} &= 2\alpha_1 B \\ \Pi_p^{IN2,N} &= 2\alpha_2 B\end{aligned}$$

We have the following proposition:

Proposition 1 *When there is no room for bargaining between agents, the payoff for the principal is always larger under integration than under separation.*

The proof for the proposition can be found in Appendix 1.

From this proposition we know that the principal will always choose integration rather than separation, provided that there is no ex post bargaining between the agents.

An illustrative figure can be found below where $\gamma_1 = 0.1$, $\gamma_2 = 0.2$. We let $\alpha_1 = 0.5$ so that Π_p^{IN1} is normalized to B (Fig. 2).

We can see that the payoff for the principal under separation is always lower than the maximum payoff under integration; thus separation cannot be optimal when bargaining is not possible.

7 Incomplete contract with bargaining

More realistically, agents in an organization will try to maximize and split the joint surplus when such opportunities arise ex post. We now introduce an ex post bargaining phase into the model à la Grossman and Hart (1986). The process of bargaining is as

follows: (1) the default payoff is determined by the payoff generated by the controlling party's favorite; (2) instead of choosing his own favorite, the controlling party proposes to the other party that he choose a candidate who maximizes the joint payoff of both parties; (3) the parties Nash bargain and split the cooperative surplus equally.

Let the project that maximizes the joint payoff be project k . Without loss of generality, we can assume that $b_k^1 + b_k^2 = (1 + \gamma_3)b$, $\gamma_3 \in [0, 1]$, $\gamma_3 \geq \max(\gamma_1, \gamma_2)$. Moreover, we assume that γ_3 is not very large, and $\gamma_3 \leq \min(3\gamma_1, \gamma_1 + 2\gamma_2)$ in order to have a reasonable analytical solution for efforts. Here bargaining is always beneficial to both parties; thus they will always bargain provided that both of them have searched and become informed.

We assume that this project generates an expected payoff of $\alpha_3 B$ to the principal, where α_3 is another parameter of interest congruence between 0 and 1, and will be derived analytically later for the symmetric case. α_3 can be larger or smaller than α_1, α_2 . Let the subscript h be the notation for the controlling party. We say that bargaining is *interest congruence-enhancing* if α_3 is larger than α_h , and *interest congruence-destructing* if α_3 is smaller than α_h . Here we can contextualize α_3 again in our school of economics story: suppose that there is integration under the control of the macroeconomics professor. The macro professor can hire two "pure macro" candidates. But he can also hire a candidate engaged in crossover research between micro and macroeconomics, and ask the microeconomics professor to transfer some benefit to him in return for the compromise. This crossover candidate is a favorable choice for both professors, enabling him to be selected through bargaining. If crossover research is more valuable to the dean than either pure macro or pure micro research, the bargaining will be more aligned with her interests, and if the dean prefers pure macro or micro research, bargaining may be unfavorable to her.

The expected payoff to the agent A_i in the division he controls will be b when he is informed (with a probability $e_i(1 - e_j)$), $b + \frac{1}{2}(\gamma_3 - \gamma_j)b$ when both are informed (with a probability $e_i e_j$) and $\gamma_i b$ when he is uninformed and the other agent is informed (with a probability $(1 - e_i)e_j$). The expected payoff to the agent A_i in the division that he does not control will be $\gamma_i b$ when he is uninformed and the other agent is informed (with a probability $e_j(1 - e_i)$), $\gamma_i b + \frac{1}{2}(\gamma_3 - \gamma_i)b$ when both are informed (with a probability $e_i e_j$) and b when he is informed and the other agent is not informed (with a probability $(1 - e_j)e_i$). We use π_i^l to represent the payoff in each division depending on the control right, superscript $l \in \{1, 2\}$ to represent the controlling party in the division, and subscript $i \in \{1, 2, P\}$ to represent who is receiving the payoff:

$$\begin{aligned}\pi_1^1 &= e_1(1 - e_2)b + e_1 e_2 \left(b + \frac{\gamma_3 - \gamma_2}{2} b \right) + e_2(1 - e_1)\gamma_1 b \\ \pi_2^1 &= e_1(1 - e_2)\gamma_2 b + e_1 e_2 \left(\gamma_2 b + \frac{\gamma_3 - \gamma_2}{2} b \right) + e_2(1 - e_1)b \\ \pi_1^2 &= e_2(1 - e_1)\gamma_1 b + e_1 e_2 \left(\gamma_1 b + \frac{\gamma_3 - \gamma_1}{2} b \right) + e_1(1 - e_2)b \\ \pi_2^2 &= e_2(1 - e_1)b + e_1 e_2 \left(b + \frac{\gamma_3 - \gamma_1}{2} b \right) + e_1(1 - e_2)\gamma_2 b \\ \pi_P^1 &= \pi_P^2 = e_1(1 - e_2)\alpha_1 B + e_1 e_2 \alpha_3 B + e_2(1 - e_1)\alpha_2 B\end{aligned}$$

The first order conditions for the optimal effort level in different divisional structures are:

$$\begin{aligned} g'(e_1^{SP}) &= 2 \left(1 - \frac{2 + 3\gamma_1 + \gamma_2 - 2\gamma_3}{4} e_2^{SP} \right) b \\ g'(e_2^{SP}) &= 2 \left(1 - \frac{2 + \gamma_1 + 3\gamma_2 - 2\gamma_3}{4} e_1^{SP} \right) b \\ g'(e_1^{IN1}) &= 2 \left(1 - (\gamma_1 + \frac{\gamma_2 - \gamma_3}{2}) e_2^{IN1} \right) b \\ g'(e_2^{IN1}) &= 2 \left(1 - (1 + \frac{\gamma_2 - \gamma_3}{2}) e_1^{IN1} \right) b \\ g'(e_1^{IN2}) &= 2 \left(1 - (1 + \frac{\gamma_1 - \gamma_3}{2}) e_2^{IN2} \right) b \\ g'(e_2^{IN2}) &= 2 \left(1 - (\gamma_2 + \frac{\gamma_1 - \gamma_3}{2}) e_1^{IN2} \right) b \end{aligned}$$

Using the monotonicity of function $g(e)$ and the implicit function theorem again, it is not difficult to show that $\frac{\partial e_i}{\partial \gamma_i} < 0$, $\frac{\partial e_i}{\partial \gamma_j} < 0$. The agents have less incentive to search if they can accrue greater benefit by free riding on the effort of others. They have greater incentive to search if bargaining can generate greater benefit. The efforts by agents are strategic substitutes under separation, but they can be either substitutes or complements under integration. On top of the free-riding effect and overruling effect we discussed in the last section, when bargaining can generate significant joint surplus, one agent can be encouraged to search more in order to increase his bargaining power vis-à-vis the other agent, particularly when he sees the other agent engaged in search. In other words, search is complementary to separation.

Imposing $g(e) = e^2 b$, we can solve for:

$$\begin{aligned} e_1^{SP} &= \frac{8 - 12\gamma_1 - 4\gamma_2 + 8\gamma_3}{16 - (2 + 3\gamma_1 + \gamma_2 - 2\gamma_3)(2 + \gamma_1 + 3\gamma_2 - 2\gamma_3)} \\ e_2^{SP} &= \frac{8 - 4\gamma_1 - 12\gamma_2 + 8\gamma_3}{16 - (2 + 3\gamma_1 + \gamma_2 - 2\gamma_3)(2 + \gamma_1 + 3\gamma_2 - 2\gamma_3)} \\ e_1^{IN1} &= \frac{2 - 2\gamma_1 - \gamma_2 + \gamma_3}{2 - (2 + \gamma_2 - \gamma_3)(2\gamma_1 + \gamma_2 - \gamma_3)} \\ e_2^{IN1} &= \frac{\gamma_3 - \gamma_2}{2 - (2 + \gamma_2 - \gamma_3)(2\gamma_1 + \gamma_2 - \gamma_3)} \\ e_1^{IN2} &= \frac{\gamma_3 - \gamma_1}{2 - (2 + \gamma_1 - \gamma_3)(\gamma_1 + 2\gamma_2 - \gamma_3)} \\ e_2^{IN2} &= \frac{2 - \gamma_1 - 2\gamma_2 + \gamma_3}{2 - (2 + \gamma_1 - \gamma_3)(\gamma_1 + 2\gamma_2 - \gamma_3)} \end{aligned}$$

All the solutions above are between 0 and 1. A detailed proof can be found in Mathematical Appendix 2. From simple calculation we can also see that: $e_1^{IN1} - e_2^{IN1} > 0$, $e_2^{IN2} - e_1^{IN2} > 0$.

We add a superscript B after the superscript indicating divisional structure to denote that this case contains bargaining. The principal's payoffs in these cases are as follows:

$$\begin{aligned}\Pi_P^{SP,B} &= [e_1^{SP}(1 - e_2^{SP})\alpha_1 + e_1^{SP}e_2^{SP}\alpha_3 + e_2^{SP}(1 - e_1^{SP})\alpha_2]B \\ \Pi_P^{IN1,B} &= [e_1^{IN1}(1 - e_2^{IN1})\alpha_1 + e_1^{IN1}e_2^{IN1}\alpha_3 + e_2^{IN1}(1 - e_1^{IN1})\alpha_2]B \\ \Pi_P^{IN2,B} &= [e_1^{IN2}(1 - e_2^{IN2})\alpha_1 + e_1^{IN2}e_2^{IN2}\alpha_3 + e_2^{IN2}(1 - e_1^{IN2})\alpha_2]B\end{aligned}$$

Intuitively, the difference between the incentives of agents should be smaller under separation than under integration. Therefore the product of their efforts (e_1e_2) should be greater under separation. If this is the case, we should have $\Pi_P^{SP,B} > \max(\Pi_P^{IN1,B}, \Pi_P^{IN2,B})$ when α_3 is very large. We have the following proposition:

Proposition 2 *When there is ex post bargaining, it may be optimal for the principal to choose internal separation when the types of projects agreed upon by the agents are generally favorable to her. When the two agents are completely symmetrical ($\gamma_1 = \gamma_2 = \gamma$, $\alpha_1 = \alpha_2 = \alpha$), and the interest congruence-enhancing effect of bargaining is large enough (α_3 is larger than a cutoff value, which is a function of α), the principal should always choose separation over integration.*

The proof of Proposition 2 for the symmetric case can be found in Appendix 3. For the general (non-symmetrical) case, we give a graphic illustration. Having tried many parameter settings, we find that there are generally regions where each scheme is optimal. Below is the figure for the case where $\alpha_1 = 0.5$, $\gamma_1 = 0.1$, $\gamma_2 = 0.2$, $\gamma_3 = 0.3$ (Fig. 3).

Separation is optimal when neither A_1 nor A_2 is very productive, and bargaining can promote the interest congruence between the principal and the agents. Integration is optimal when one agent is much more productive than the other: As a high-powered incentive, control should be assigned to the more productive agent.

These results show that bargaining has a very important impact on the optimal divisional structure that the principal should choose. However, we must also take into account the possibility that if agents tend to agree on some project deemed unfavorable by the principal, the principal would have an incentive to detect and forbid private bargaining.

For the symmetrical case we can prove that there is a cutoff value $\tilde{\alpha}_3$, which is a function of α , for $\alpha_3 > \tilde{\alpha}_3$, $\Pi_P^{SP,B} > \Pi_P^{IN,B}$ always holds.³ The mathematical details are located in Appendix 3. It is not difficult to imagine that if the principal sufficiently likes the projects chosen through bargaining, she should always choose separation over integration.

8 Concluding remarks

When complete contracting is not possible, allocation of authority becomes the second-best arrangement. This paper shows how incomplete contracts affect the decision of whether to use either internal integration or separation. Paralleling the seminal

³ For example, when $\gamma = 0.5$, $\gamma_3 = 0.8$, $\Pi_P^{SP,B} > \Pi_P^{IN,B}$ always holds when $\alpha_3 > 1.4240\alpha$.

Fig. 3 The optimal divisional structure with bargaining. The *horizontal axis* is the scale of α_2 , and the *vertical axis* is the scale of α_3

work of [Grossman and Hart \(1986\)](#) on external boundaries, we find that control rights constitute a very important source of incentives within an organization, and divisional structure plays a fundamental role in determining incentives for agents. We find that when bargaining is not possible, it is always better for the principal to adopt integration and assign the control rights to the most productive agent. When bargaining is possible, formal divisional structure defines the relative ex post bargaining positions of the two agents and, consequently, their incentive to search ex ante. The principal may want to adopt separation when the agents generally agree through bargaining on a project she deems more favorable. The reason is that both agents need to be informed in order to bargain, and therefore bargaining is more likely when the two agents have symmetrical incentives (separation); while one agent's incentive to search will be undermined in an integrated setting. The principal may optimally prohibit bargaining if the agents tend to agree on projects she finds unfavorable.

The principal plays an independent role in the allocation of control rights in this paper, as distinguished from the previous literature. First, the principal in our work is not a “searching (productive) principal” as in [Aghion and Tirole \(1997\)](#), since she does not search, and therefore does not decide upon each specific project. We restrict our focus to the principal's decision on the divisional structure, and leave out her role in the direct production process. This assumption can be applied to a number of real-life scenarios. For instance, it is not necessary for the president of a hospital to

treat numerous patients daily, or the president of a university to conduct research. It is more important for them to make decisions at the general management level, allocate control, and choose the optimal divisional structure to maximize the organization's efficiency. Secondly, she is not a "bargaining principal" as in the models focusing on the principal's choice between in-house production and out-sourcing (Hart et al. 1997). The principal in our model does not bargain directly with her agents, but is able to determine the bargaining powers of the agents.

We are aware that in the complete contracting literature, there is research comparing the efficiency of contracts under three kinds of organizational structures: separation, integration and nested departments (Baron and Besanko 1992; Melumad et al. 1995; Mookherjee and Tsumagari 2004; Severinov 2008). It should be noted that "separation" in the complete and incomplete contract situations has the same meaning, but the "integration" in this paper is more akin to the "nested departments" or "sub-contracting" in the complete contract settings. "Integration" is used in the complete contract literature only for cases in which departments are merged: one agent is made manager while the other agent is eliminated from the management process. The complete contract approach proffers different predictions from the incomplete contract approach, and therefore it may be interesting to test their predictions through laboratory experimentation, as was done by Fehr et al. (2010). It would be also interesting to study the interplay of richer organizational structures and bargaining protocols and its implications for optimal organizational design.

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Appendix 1: Proof of Proposition 1

We can demonstrate this through a straightforward calculation:

Because $e_1^{SP}, e_2^{SP} \in [0, \frac{1}{2}]$, $\Pi_p^{SP,N} = [e_1^{SP}\alpha_1 + (1 - e_1^{SP})e_2^{SP}\alpha_2 + e_2^{SP}\alpha_2 + (1 - e_2^{SP})e_1^{SP}\alpha_1]B \leq 2[e_1^{SP}\alpha_1 + e_2^{SP}\alpha_2]B \leq (\alpha_1 + \alpha_2)B \leq \max(2\alpha_1 B, 2\alpha_2 B)$.

Appendix 2: Proof of $e_1^{SP}, e_2^{SP}, e_1^{IN1}, e_2^{IN1}, e_1^{IN2}, e_2^{IN2} \in [0, 1]$

From the first order conditions and $g(e) = e^2b$, we have:

$$e_1^{SP} = 1 - \frac{2 + 3\gamma_1 + \gamma_2 - 2\gamma_3}{4}e_2^{SP}$$

$$\begin{aligned}
 e_2^{SP} &= 1 - \frac{2 + \gamma_1 + 3\gamma_2 - 2\gamma_3}{4} e_1^{SP} \\
 e_1^{IN1} &= 1 - \left(\gamma_1 + \frac{\gamma_2 - \gamma_3}{2} \right) e_2^{IN1} \\
 e_2^{IN1} &= 1 - \left(1 + \frac{\gamma_2 - \gamma_3}{2} \right) e_1^{IN1} \\
 e_1^{IN2} &= 1 - \left(1 + \frac{\gamma_1 - \gamma_3}{2} \right) e_2^{IN2} \\
 e_2^{IN2} &= 1 - \left(\gamma_2 + \frac{\gamma_1 - \gamma_3}{2} \right) e_1^{IN2}
 \end{aligned}$$

Let: $\phi = \frac{2+3\gamma_1+\gamma_2-2\gamma_3}{4}$, $\varphi = \frac{2+\gamma_1+3\gamma_2-2\gamma_3}{4}$, $\rho = \gamma_1 + \frac{\gamma_2-\gamma_3}{2}$, $\sigma = 1 + \frac{\gamma_2-\gamma_3}{2}$, $\lambda = 1 + \frac{\gamma_1-\gamma_3}{2}$, $\mu = \gamma_2 + \frac{\gamma_1-\gamma_3}{2}$. From the condition $\gamma_3 \leq \min(3\gamma_1, \gamma_1 + 2\gamma_2)$, we know $\phi, \varphi, \rho, \sigma, \lambda, \mu \in [0, 1]$. Then the solution can be rewritten as:

$$\begin{aligned}
 e_1^{SP} &= \frac{1 - \phi}{1 - \phi\varphi}, & e_2^{SP} &= \frac{1 - \varphi}{1 - \phi\varphi} \\
 e_1^{IN1} &= \frac{1 - \rho}{1 - \rho\sigma}, & e_2^{IN1} &= \frac{1 - \sigma}{1 - \rho\sigma} \\
 e_1^{IN2} &= \frac{1 - \lambda}{1 - \lambda\mu}, & e_2^{IN2} &= \frac{1 - \mu}{1 - \lambda\mu}
 \end{aligned}$$

We can see that both the numerator and the denominator are positive, and the numerator cannot be larger than the denominator, so these effort levels are between 0 and 1.

Appendix 3: Proof of the symmetric case for Proposition 2

When $\gamma_1 = \gamma_2 = \gamma$, $\alpha_1 = \alpha_2 = \alpha$:

$$\begin{aligned}
 e_1^{SP} &= e_2^{SP} = \frac{0.5 - \gamma + 0.5\gamma_3}{1 - (0.5 + \gamma - 0.5\gamma_3)^2} \\
 e_1^{IN1} &= e_2^{IN2} = \frac{0.5 - \gamma + 0.5\gamma_3}{1 - (1 + 0.5\gamma - 0.5\gamma_3)(1.5\gamma - 0.5\gamma_3)} \\
 e_2^{IN1} &= e_2^{IN2} = \frac{0.5\gamma_3 + 0.5\gamma_1}{1 - (1 + 0.5\gamma - 0.5\gamma_3)(1.5\gamma - 0.5\gamma_3)} \\
 \Pi_P^{SP,B} &= 2e_1^{SP}(1 - e_2^{SP})\alpha B + e_1^{SP}e_2^{SP}\alpha_3 B \\
 \Pi_P^{IN1,B} &= \Pi_P^{IN2,B} = \Pi_P^{IN,B} = (e_1^{IN1} + e_2^{IN1} - 2e_1^{IN1}e_2^{IN1})\alpha B + e_1^{IN1}e_2^{IN1}\alpha_3 B
 \end{aligned}$$

Based on the proof $(0.5 + \gamma - 0.5\gamma_3)^2 \geq (1 + 0.5\gamma - 0.5\gamma_3)(1.5\gamma - 0.5\gamma_3)$, it can be concluded that $e_1^{SP} + e_2^{SP} \geq e_1^{IN1} + e_2^{IN1}$, $e_1^{SP}e_2^{SP} \geq e_1^{IN1}e_2^{IN1}$. Therefore there is a cutoff value of $\tilde{\alpha}_3$, which is a function of α and for $\alpha_3 > \tilde{\alpha}_3$, $\Pi_P^{SP,B} > \Pi_P^{IN,B}$ always holds.

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