Expropriation and Incentives for Team Production*

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Abstract

Recent research suggests that expropriation by controlling shareholders of other shareholders is an important problem in both publicly held and closely held firms. This paper examines how partners in closely held firms can make control-right arrangements to mitigate expropriation and other incentive problems. We further analyze the interaction between revenue-sharing contracts and control-right arrangements and investigate how the former also helps in dealing with the aforementioned set of problems. Our theoretical results are consistent with the stylized facts that we find from a sample of 200 joint-venture contracts.

Keywords: Revenue sharing, Control right, Team production, Expropriation, Joint venture.

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1 Introduction

Recent research suggests that expropriation of minority shareholders by controlling shareholders is an important problem in publicly traded firms, perhaps more so than the conflict of interest between owners and managers (see La Porta *et al.*, 1999; Claessens *et al.,* 1999, and citations therein). For example, controlling shareholders may transfer profits to other companies they control, or sell the assets of the firm they control to another entity they own at below the market price. Such expropriation is more serious in those countries where legal protection for minority shareholders is weaker.

In closely held firms, expropriation of minority shareholders by controlling shareholders is even worse.[1] By relying on the principle of majority control and/or the business judgment rule, American courts have been reluctant to interfere in the internal affairs of closely held firms (O'Neal, 1987). In addition, the lack of an efficient and developed market for interests in closely held firms diminishes the informativeness of share prices. This makes it difficult for future investors to infer whether the controlling shareholders have engaged in expropriation, thereby weakening the reputation concerns of the controlling shareholders (O'Neal and Thompson, 1995). In contrast to publicly traded firms, however, there is more opportunity for private contracting in closely held firms because of the small numbers of shareholders involved (Thompson, 1990).

What mechanisms should be adopted through private contracting to counter expropriation? How do these mechanisms affect other incentive problems in team production? How do the theoretically optimal mechanisms correspond to empirical observations? This paper attempts to address these issues.

An essential condition for having expropriation is that ex ante contracts are incomplete and control rights are important. Thus we adopt the incomplete-contracts framework pioneered by Grossman, Hart, and Moore (GHM: Grossman and Hart, 1986; Hart and Moore, 1990; and Hart, 1995). Specifically, we consider a scenario where two parties, A and B, engage in a joint project. At date 0, the two partners sign a revenue-sharing contract and assign control rights (unilateral control or joint control) over the project. At date 1, they choose investments non-cooperatively. At date 3, some decision

[1] See O'Neal (1987), and O'Neal and Thompson (1995) for ample examples of oppression or squeeze-out of minority shareholders in closely held firms.

is made by the controlling partner (if there is any), and the project's verifiable revenue as well as the partners' private benefits are realized. At date 2, however, the two partners may bargain over the date 3 decision and make transfers between them.

Inspired by the literature on expropriation, we assume that a controlling partner can take actions for its own benefits as well as those in the interests of all parties involved. Specifically, we assume that the date 3 decision contains three possible dimensions of actions: (i) the one that increases partner A's private benefit at the expense of partner B's private benefit and the project's revenue (expropriation by A of B), (ii) the one that increases partner B's private benefit at the expense of partner A's private benefit and the project's verifiable revenue (expropriation by B of A), and (iii) the one that increases the project's revenue as well as both partners' private benefits (good action).

Expropriation generally causes efficiency loss, and will be renegotiated away in a closely held firm due to the small number of shareholders. The renegotiation requires redistribution of payoffs between the two partners, which in turn affects the incentive for team production. In other words, the threat of expropriation creates a holdup problem similar to the holdup problem related to the good action that is discussed in GHM. In contrast, in publicly held firms, renegotiation is difficult and therefore the cost of expropriation is more direct.

A controlling shareholder is less likely to increase his private benefits at the expense of the verifiable revenue and the other partner's private benefit (i.e., expropriate) if he has a larger share of the verifiable revenue. Therefore the interaction between revenue-sharing contracts and control-right arrangements is an important issue. With this consideration, we construct a framework where incentives are provided through both revenue-sharing contracts and control-right arrangements. This is in contrast to the existing theories of the firm, which focuses on either revenue-sharing contracts or control-right arrangements as the incentive device (Holmstrom, 1982; GHM).[2] In particular, departing from GHM, we assume that some verifiable revenue can be produced before any agreement is reached between the two partners about the date 3 decision. The ex ante revenue-sharing con-

[2] Holmstrom and Tirole (1991) also examine the interaction of control rights with incentive contracts. The contracts they consider are that between the seller and the agent of the seller and that between the buyer and the agent of the buyer, and the control right they focus on is that of designing the incentive contracts. They analyze how control-right assignment affects the choice of the contracts. In this paper, we examine the impact of control rights to make ex post decisions, both good and bad, on the provision of incentives for team production.

tracts are honored unless both partners agree to change them, and hence they affect the disagreement payoffs in date 2 bargaining along with the control-right arrangements.

We find that it is more difficult to provide *balanced* incentives to both parties under unilateral control than under joint control. This is because the controlling partner under unilateral control can threaten to expropriate the other partner, resulting in a lopsided distribution of payoffs. In contrast, under joint control, no expropriation can take place, and an even distribution of payoffs is obtained. Unilateral control also differs from joint control in the total incentive provided to the two partners. Under unilateral control, the controlling partner can take the good action, but he can also threaten to expropriate the other partner so as to enhance his bargaining power. Under joint control, neither good action nor expropriation can take place without the consent of both parties.

The trade-off of these effects determines the optimal control arrangement. If balanced incentives are important and the holdup problem related to the good action does not have too large a negative effect on the total level of incentives, joint control is optimal. This is likely to be the case when the partners' investments are both important and contain significant cooperative elements. In cases where each partner makes self investment that does not have any effect on the other partner's private benefit (but can have a positive effect on the verifiable revenue), the control-right arrangement has significant effect on the total level of incentives. Then, joint control is optimal if the holdup problem related to expropriation dominates that related to the good action, and unilateral control is optimal if the dominance is reversed.

Our results on the optimality of various control arrangements hold with or without revenue-sharing contracts. However, the presence of revenue-sharing contracts allows us to explore their interactions with control-right arrangements. Specifically, we address the question of whether or not the controlling partner should be given the majority of the project's revenue. The controlling partner may threaten to increase his own private benefit at the expense of the project's verifiable revenue and the other partner's private benefit. The cost of such expropriation to the controlling partner is higher if he has a higher share of the revenue. To the extent that the controlling partner's expropriation can be made an empty threat, he should be given a high share of the revenue for this purpose. Otherwise the other partner should be given a larger share of the revenue to balance incentives between the partners. Thus, revenue-sharing contracts

and control-right arrangements can be either complements or substitutes in the provision of incentives, depending on specific circumstances.[3]

Finally, we examine the empirical relevance of the theoretical results by using a unique sample of 200 joint-venture contracts. We find some stylized facts about incentive and control mechanisms in joint ventures. The division of revenue shares between the partners varies from firm to firm, but the number of directors allotted to a partner is generally proportional to his revenue shares. More importantly, within each firm, the decision-making rule varies from issue to issue, ranging from simple majority to unanimous voting. As a result, many important decisions are made jointly by the partners, while other decisions are made by one partner unilaterally.[4] These empirical findings are consistent with our theoretical results that control arrangements are made to mitigate expropriation and other incentive problems in team production.

The remainder of the paper is organized as follows. Section 2 lays out the theoretical model. The optimality of joint control vis-*a*-vis unilateral control is examined in two settings (Sections 3-4), and the interactions between revenue-sharing contracts and control-right arrangements are also investigated. In Section 5, we consider several special cases of our model and relate our results to those in the existing literature. Section 6 reports our empirical findings on joint ventures. The paper concludes with Section 7.

2 A Theoretical Framework

2.1 Model primitives

Two partners, A and B, engage in a joint project, which for simplicity is assumed to

[3]For a widely held firm, the one-share-one-vote rule ensures that controlling shareholders sell their stake to a corporate raider who can manage a higher security value of the firm but not his private benefit of control (Grossman and Hart, 1988; Harris and Raviv, 1988). The one-share-one-vote rule further ensures that the new controlling shareholder will not expropriate the minority shareholders (Burkart, Gromb and Panunzi, 1998).

[4]There is a significant possibility of expropriation in joint ventures. Legal scholars (O'Neal, 1987; Shishido, 1987) have argued that the most effective way of protecting minority shareholders against squeeze-out is to include a provision requiring unanimity or a high vote for shareholder and director actions. The challenge is to protect minority shareholders from expropriation and at the same time preserve adaptability within the enterprise to changing business environments.

last for three periods. At date 0 they sign a revenue-sharing contract and assign control rights over the joint project. At date 1, A and B choose efforts, denoted by α and β, respectively. For ease of exposition, we also call a partner's effort his *investment* in the joint project. At date 3, a decision, denoted by δ, is made and the gains from trade are realized. After the investments but before the decision is made (at date 2), the two partners bargain over the date 3 decision.

The joint project produces a verifiable revenue R. In addition, each partner derives some private benefit P_j (where $j = A, B$) from the joint project that is not contractible. We assume that

$$\begin{aligned} R &= r(\delta)y(\alpha, \beta), \\ P_A &= a(\delta)y_A(\alpha, \beta), \\ P_B &= b(\delta)y_B(\alpha, \beta), \end{aligned}$$

where y is increasing and concave in (α, β), while y_A (or y_B) is increasing and concave in α (or β) but is nondecreasing in β (or α).[5] Without loss of generality, α and β are normalized to be the investment costs.

The investment of a partner (α or β) is often difficult to measure and then is not contractible. For example, the domestic partners in international joint ventures are often charged with recruiting local staff and procuring local inputs, the quality of which is difficult to specify ex ante and inspect ex post. To induce investment, at date 0 the two partners sign a contract linking the partners' income to the outcome of the joint project. Since the private benefits are not contractible, the incentive contract is only on verifiable revenue R. For simplicity, we focus on linear revenue-sharing rules. Denote partner A's revenue share by s and the lump-sum transfer from B to A by F. Then the contract gives A a revenue of $sR + F$ and B a revenue of $(1 - s)R - F$.

The date 3 decision, δ, is not contractible at date 0. For example, it is difficult to determine at the beginning of a joint venture whether the venture should be merged with another firm in the future. Such a decision is often made after new information arrives and the new information is difficult to contract on ex ante. Therefore, it is necessary to establish rules (or control-right arrangements) according to which the decision is to

[5] The relationship between this setup and that of GHM will be discussed in Section 2.2.

be made. Without loss of generality, the making of the ex post decision is assumed to require no costly effort.

We assume that the two partners assign control rights over the joint project at date 0. There are two possible arrangements: (1) unilateral control by either A or B, and (2) joint control by A and B. Under unilateral control, the controlling party can choose δ to maximize his own payoff instead of the total surplus, while under joint control, no decision other than the status quo ($\delta = 0$) can be made without the two parties agreeing to do something else. Therefore, in both cases, there is room for the parties to bargain to reach a more efficient decision. We assume that, at date 2, decision δ becomes contractible and there is no asymmetric information about the benefits. Then, under each arrangement, the two parties will bargain successfully at date 2 to reach an ex post efficient decision.

2.2 The ex post decision

Before we discuss in detail the partners' bargaining over the ex post decision δ, we make some assumptions about what the controlling partner can do with the decision-making power. First, the controlling partner can expropriate the revenue of the joint venture and the other partner's private benefit. Such expropriation can take a variety of forms. The controlling partner of a joint venture may sell the assets of the joint venture at below-the-market prices to another entity controlled by its parent company. It may finance the expansion of the venture by issuing new shares at favorable prices to its parent company to dilute the interests of the other shareholders. It may also sell products of the joint venture to (or buy inputs from) its parent company at below-the-market (or above-the-market) prices. Such self-dealing activities benefit the parent company of the controlling partner at the expense of the joint venture. For more and detailed examples, see O'Neal (1987), O'Neal and Thompson (1995), and Shishido (1987).

In addition to expropriation, we also assume that the controlling partner can use his power to enhance the value of the joint venture. In the example of selling the output or the assets, the controlling partner can use his discretion to sell to a third party at the highest possible price given the prevailing market condition.

To formalize the above discussion, we assume that the ex post decision consists of three dimensions of actions. The first dimension of actions, denoted by d_A, increases partner A's private benefit at the expense of the verifiable revenue and partner B's private benefit. Symmetric to this, the second dimension of actions, denoted by d_B, increases partner B's private benefit at the expense of the verifiable revenue and partner A's private benefit. In contrast, the third dimension of actions increases both partners' private benefits as well as the verifiable revenue. Hence we have $\delta = (d_A, d_B, d)$. It should be clarified that (d_A, d_B, d) are three dimensions of the same decision and cannot be assigned to different partners. As is clear from some of the examples we discussed in the last two paragraphs, if a partner is given the right to control d, then he cannot be prevented from controlling d_A and d_B.

For simplicity, we further impose the following structure on $r(\delta)$, $a(\delta)$, and $b(\delta)$:

$$\begin{aligned} r(d_A, d_B, d) &= r_1 - r_2 d_A - r_3 d_B + r_4 d, \\ a(d_A, d_B, d) &= a_1 + a_2 d_A - a_3 d_B + a_4 d, \\ b(d_A, d_B, d) &= b_1 - b_2 d_A + b_3 d_B + b_4 d, \end{aligned}$$

where r_i, a_i, and b_i are positive and d_A, d_B, $d \in [0, 1]$, with $(d_A, d_B, d) = (0, 0, 0)$ representing the status quo.

Remark: Expropriation by one partner of the other makes the former better off but the latter worse off than under the status quo. Thus we also call expropriation a bad action, in contrast to the good action discussed above, which makes no partner worse off than under the status quo. In GHM, the ex post decision is about who will have access to an asset. Specifically, the decision can be written as $\delta = (\delta_A, \delta_B)$, where $\delta_j = 0$ means partner j does not have access, and $\delta_j = 1$ means partner j has access, to the asset. $\delta = (0, 0)$ is the status quo in which no partner has access. As any access decision is no worse than the status quo, there is no bad action in GHM. It is this distinguishing feature of GHM's model that gives rise to the dominance of unilateral control over joint control. Furthermore, in GHM's setup, there are two dimensions of good actions, over which the two partners have conflicting preferences [A prefers $\delta = (1, 0)$ while B prefers $\delta = (0, 1)$]. This facilitates the comparison of A's unilateral control versus B's unilateral control. In our model, we fuse the two dimensions of good actions into one, which makes

unilateral control even more desirable. Our focus is on how the presence of bad actions as well as good actions affect the optimality of unilateral control versus joint control. In Section 5, we will further discuss how these differences between our model and that of GHM affect the predictions on asset ownership.

As a benchmark, note that the ex post efficient decision maximizes the sum of the two partners' payoffs. That is,

$$\begin{aligned}\max_{(d_A,d_B,d)} R + P_A + P_B = \quad & (r_1 y + a_1 y_A + b_1 y_B) \\ & +(r_4 y + a_4 y_A + b_4 y_B)d \\ & +(a_2 y_A - r_2 y - b_2 y_B)d_A \\ & +(b_3 y_B - r_3 y - a_3 y_A)d_B.\end{aligned}$$

Denote the ex post efficient choice by (d_A^*, d_B^*, d^*). It is clear that $d^* = 1$. We assume that expropriation is never efficient. That is,

$$\begin{aligned} a_2 y_A &< r_2 y + b_2 y_B, \\ b_3 y_B &< r_3 y + a_3 y_A. \end{aligned}$$

Then $(d_A^*, d_B^*) = (0, 0)$.

2.3 Specification of the bargaining game

We use the Nash bargaining solution to model the date 2 bargaining process between the partners. Suppose V_j is partner j's disagreement payoff, i.e., the payoff that partner j can guarantee without the other partner's cooperation, for $j = A, B$. Since the date 3 decision is usually inefficient without prior agreement, there is potential for efficiency gain from bargaining. We call this potential gain the *renegotiation surplus*, and it is given by

$$RS = \max_{\delta}(R + P_A + P_B) - (V_A + V_B).$$

Under the Nash bargaining solution, the payoff to partner j is

$$W_j = V_j + \lambda_j RS$$

for $j = A, B$, where λ_j is partner j's bargaining power and $\lambda_A + \lambda_B = 1$.

The specification of the disagreement payoffs has important implications for the role of the revenue-sharing contract; whether or not the revenue-sharing contract even has a role to play depends on whether or not any verifiable revenue can be produced before the partners reach an agreement about the date 3 decision.

If no verifiable revenue is produced at all before the partners reach an agreement about the date 3 decision, then the disagreement payoffs, V_A and V_B, are independent of the revenue-sharing contract. This is because, before an agreement is reached, there is no revenue to be shared. Consequently, RS does not depend on the revenue-sharing contract and neither do W_A and W_B. This implies that the revenue-sharing contract has no effect on investment incentives. GHM make this assumption about the verifiable revenue and analyze the role of ownership arrangements without considering the role of revenue-sharing contracts.

In this paper, we assume that some verifiable revenue can be produced before any agreement is reached between the partners about the date 3 decision. The ex ante revenue-sharing contract is honored unless both partners agree to change it. Hence the disagreement payoffs do depend on the revenue-sharing contract. As a result, the revenue-sharing contract affects the partners' final payoffs, W_A and W_B, and consequently their investment incentives. Note that, under our assumption, control-right arrangements still have their incentive effects by affecting the disagreement payoffs. Thus revenue-sharing contracts and control-right arrangements should be jointly determined to maximize their incentive effects.

We believe that each of the aforementioned assumptions about the verifiable revenue is reasonable under some circumstances. In a buyer-seller relationship with the quality of the goods determined only after investments are made, such as is often analyzed in GHM models, production cannot be carried out before an agreement about the quality of the goods is reached. In such a situation, it is reasonable to assume that there is no verifiable revenue (or cost) to be shared before an agreement is reached. However, in joint ventures, especially product joint ventures, the ex ante joint-venture contract provides enough details about the production plan so that some verifiable revenue can be produced without any new agreement between the partners, although such a plan can be modified by ex post decisions.

Remark: Using a strategic bargaining framework, we obtain similar results on the optimality of joint control versus unilateral control. There, control-right arrangements are made to ensure that revenue-sharing contracts are self-enforcing.

2.4 Bargaining game under various control arrangements

In the remainder of this section, we provide a detailed analysis of the bargaining outcome under various control-right assignments.

2.4.1 Unilateral control by partner A

Without successful bargaining at date 2, A chooses (d_A, d_B, d) at date 3 to maximize his own payoff, i.e.,

$$\begin{aligned}\max_{(d_A,d_B,d)} \quad & (a_1 + a_2 d_A - a_3 d_B + a_4 d) y_A(\alpha,\beta) \\ & + s(r_1 - r_2 d_A - r_3 d_B + r_4 d) y(\alpha,\beta).\end{aligned}$$

Specifically, A chooses $d_B = 0$; $d = 1$; and $d'_A = 0$ if $s \geq a_2 y_A(\alpha,\beta)/[r_2 y(\alpha,\beta)]$, and $d'_A = 1$ otherwise. A chooses $d = 1$ because d increases both the verifiable revenue and his own private benefit, and $d_B = 0$ because d_B decreases both the verifiable revenue and A's private benefit. The choice of d_A is less straightforward, as d_A increases A's private benefit at the expense of the verifiable revenue. Intuitively, A chooses to shift money from the verifiable revenue to his private benefit if he does not have a significant revenue share.

A's decision is not always ex post efficient. With costless bargaining at date 2, the two partners will choose the ex post efficient decision and generate a renegotiation surplus of

$$\begin{aligned}RS^A = \quad & (r_1 + r_4) y(\alpha,\beta) + (a_1 + a_4) y_A(\alpha,\beta) + (b_1 + b_4) y_B(\alpha,\beta) \\ & - (r_1 - r_2 d'_A + r_4) y(\alpha,\beta) - (a_1 + a_2 d'_A + a_4) y_A(\alpha,\beta) - (b_1 - b_2 d'_A + b_4) y_B(\alpha,\beta) \\ = \quad & d'_A [r_2 y(\alpha,\beta) + b_2 y_B(\alpha,\beta) - a_2 y_A(\alpha,\beta)].\end{aligned}$$

Assuming that they split the renegotiation surplus in the ratio of λ to $1-\lambda$, partners A and B have the following payoffs:

$$\begin{aligned} W_A^A = \; & (a_1 + a_2 d'_A + a_4) y_A(\alpha, \beta) \\ & + s(r_1 - r_2 d'_A + r_4) y(\alpha, \beta) + \lambda RS^A, \end{aligned} \tag{1}$$

$$\begin{aligned} W_B^A = \; & (b_1 - b_2 d'_A + b_4) y_B(\alpha, \beta) \\ & + (1-s)(r_1 - r_2 d'_A + r_4) y(\alpha, \beta) + (1-\lambda) RS^A, \end{aligned} \tag{2}$$

where superscript A represents unilateral control by partner A.

2.4.2 Unilateral control by partner B

Similar analysis can be carried out for the case that partner B has the unilateral control. Specifically, without successful bargaining at date 2, B chooses (d_A, d_B, d) to

$$\begin{aligned} \max_{(d_A, d_B, d)} \quad & (b_1 - b_2 d_A + b_3 d_B + b_4 d) y_B(\alpha, \beta) \\ & + (1-s)(r_1 - r_2 d_A - r_3 d_B + r_4 d) y(\alpha, \beta). \end{aligned}$$

His optimal choice is: $d_A = 0$; $d = 1$; and $d'_B = 0$ if $s \leq 1 - b_3 y_B(\alpha, \beta)/[r_3 y(\alpha, \beta)]$, and $d'_B = 1$ otherwise. Such decision by B could be inefficient. By making the ex post efficient decision, the two partners can increase the total surplus by

$$RS^B = d'_B (r_3 y + a_3 y_A - b_3 y_B),$$

and their respective payoffs are

$$\begin{aligned} W_A^B = \; & (a_1 - a_3 d'_B + a_4) y_A \\ & + s(r_1 - r_3 d'_B + r_4) y + \lambda RS^B, \end{aligned} \tag{3}$$

$$\begin{aligned} W_B^B = \; & (b_1 + b_3 d'_B + b_4) y_B \\ & + (1-s)(r_1 - r_3 d'_B + r_4) y + (1-\lambda) RS^B, \end{aligned} \tag{4}$$

where superscript B represents unilateral control by partner B.

2.4.3 Joint control by partners A and B

Under joint control, the two partners cannot agree to any decision [i.e., $(d_A, d_B, d) = (0, 0, 0)$] in the absence of bargaining at date 2. By making the ex post efficient decision, the two partners can increase the total surplus by

$$RS^J = \quad r_4 y + a_4 y_A + b_4 y_B,$$

and their payoffs are

$$W_A^J = \quad a_1 y_A + s r_1 y + \lambda RS^J, \tag{5}$$

$$W_B^J = \quad b_1 y_B + (1-s) r_1 y + (1-\lambda) RS^J, \tag{6}$$

where superscript J represents joint control by A and B.

The above analysis shows that both the revenue-sharing contract and the control-right arrangement affect investment incentives. In the remainder of this paper, we discuss the optimal choice of both revenue-sharing and control-right arrangements. We find that the control-right arrangement has two main incentive effects that are best illustrated by two special cases. Sections 3 and 4 analyze the special cases respectively.

3 Unbalanced Incentives

In this section, we consider a special case where $y_A(\alpha, \beta) = y_B(\alpha, \beta) = y(\alpha, \beta)$.[6] Under this specification, each partner's investment has a positive effect on the other partner's private benefit as well as on his own. In other words, the investment contains a cooperative element.[7] Our objective in this section is to illustrate there is a cost of unilateral control when a controlling partner can increase his private benefit at the expense of

[6] Given the freedom in the sizes of a's and b's relative to r's, this specification is not as restrictive as it may appear.

[7] See Che and Hausch (1999) for another discussion of cooperative investment.

the other partner's private benefit and the project's revenue. In particular, we will show that unilateral control makes it difficult to offer balanced incentives despite of the help from the revenue-sharing contracts. To focus on the issue of balanced incentives and also for ease of exposition, we carry out our analysis in the symmetric case where $y(\alpha, \beta) = y(\beta, \alpha)$, $a_1 = b_1$, $a_2 = b_3$, $a_3 = b_2$, $a_4 = b_4$, $r_2 = r_3$, and $\lambda = 1/2$. To highlight our main point, we also assume the following condition:

Assumption 1: $r_2 < a_2 < r_2 + b_2$.

Note that, in the symmetric case, Assumption 1 is the same as $r_3 < b_3 < r_3 + a_3$. Part of this assumption (i.e., $a_2 < r_2 + b_2$ or equivalently $b_3 < r_3 + a_3$) restates our earlier assumption that the ex post efficient decision is $(d_A^*, d_B^*, d^*) = (0, 0, 1)$. Under the ex post efficient decision, the total benefit of the joint venture is $k^* y(\alpha, \beta)$, where $k^* \equiv a_1 + b_1 + r_1 + a_4 + b_4 + r_4$. We define the second-best outcome — (c_A^{SB}, c_B^{SB}) — which solves

$$\begin{aligned} \max_{c_A, c_B} \quad & k^* y(\alpha, \beta) - \alpha - \beta \\ s.t. \quad & c_A + c_B = k^*, \\ & c_A \tfrac{\partial y(\alpha,\beta)}{\partial \alpha} = 1, \\ & c_B \tfrac{\partial y(\alpha,\beta)}{\partial \beta} = 1. \end{aligned}$$

The second-best is the best outcome the joint venture can achieve if each partner chooses his ex ante investment according to his self-interest but the ex post efficient decision is made automatically without bargaining. In our symmetric case, the second-best outcome is

$$c_A^{SB} = \frac{1}{2} k^* = a_1 + a_4 + \frac{1}{2}(r_1 + r_4).$$

Contrary to the assumption for the second-best, the ex post efficient decision cannot be made automatically without bargaining. If A is the controlling partner, he would choose $(d'_A, d'_B, d') = (1, 0, 1)$ in the absence of successful bargaining at date 2. Intuitively, A's cost of choosing $d'_A = 1$ comes from the decrease in the verifiable revenue (r_2), whereas the total cost $(r_2 + b_2)$ also includes the decrease in partner B's private benefit. When A's benefit from choosing $d'_A = 1$ (i.e., the increase in A's private benefit or a_2) is

in between his private cost and the social cost as implied by Assumption 1, there exists a divergence between A's decision and the ex post efficient one.[8] Similarly, if B is the controlling partner, he would choose $(d'_A, d'_B, d') = (0, 1, 1)$ in the absence of successful bargaining at date 2.

At date 1, partner A chooses α to maximize his payoff W_A^i net of investment cost α and partner B chooses β to maximize his payoff W_B^i net of investment cost β, where $i = A$, B, or J representing the specific control arrangement. The ex ante investments (α, β) are determined by

$$c_A^i \frac{\partial y(\alpha, \beta)}{\partial \alpha} = 1, \tag{7}$$

$$c_B^i \frac{\partial y(\alpha, \beta)}{\partial \beta} = 1, \tag{8}$$

where

$$\begin{aligned}
c_A^A &= (a_1 + a_2 + a_4) + s(r_1 - r_2 + r_4) + \lambda(r_2 + b_2 - a_2), \\
c_A^B &= (a_1 - a_3 + a_4) + s(r_1 - r_3 + r_4) + \lambda(r_3 + a_3 - b_3), \\
c_A^J &= a_1 + sr_1 + \lambda(r_4 + a_4 + b_4), \\
c_A^i &+ c_B^i = k^*.
\end{aligned}$$

Under the assumption of $y_A(\alpha, \beta) = y_B(\alpha, \beta) = y(\alpha, \beta)$, the two partners' payoffs are respectively $c_A^i y(\alpha, \beta)$ and $c_B^i y(\alpha, \beta)$, which implies that the partners' incentives are given by (7) and (8). Let us call a pair of incentive coefficients c_A^i and c_B^i an *ex post contract*. Note that, though the ex ante investments (α, β) may vary from one control arrangement to another, the sum of the incentive coefficients (i.e., $c_A^i + c_B^i$) is always equal to k^*. This is because the same ex post efficient decision [i.e., $(d_A^*, d_B^*, d^*) = (0, 0, 1)$] is taken as a result of bargaining at date 2 and $y_A(\alpha, \beta) = y_B(\alpha, \beta) = y(\alpha, \beta)$. Hence, all ex post contracts lie in the same *contract line*, $c_A^i + c_B^i = k^*$, independent of the ex ante revenue-sharing and control-right arrangements.

[8] Note that, under the specification of revenue and private benefits in this section, A's decision in the absence of successful bargaining at date 2 is independent of the ex ante investments (i.e., α and β).

However, the range of feasible (ex post) contracts within the contract line depends on the specific control-right arrangement. When A has unilateral control, he can choose the date 3 decision to increase his private benefit at the expense of B's, which results in payoff redistribution in favor of partner A. Hence A has higher incentive but B has lower incentive, moving the range of feasible contracts to the right along the contract line. When A's benefit from expropriation is too large relative to his cost of expropriation [see inequality (9) below for details], feasible contracts become so unbalanced that they do not include the second-best contract (Figure 1.1). A reverse effect exists under B's unilateral control. In contrast, with joint control, neither of the partners can threaten to expropriate the other and consequently, more balanced contracts prevail, including the second-best contract (Figure 1.2).

Specifically, under unilateral control by A, c_A^A is in the range $[c_A^A(s=0), c_A^A(s=1)]$, or

$$[a_1 + a_2 + a_4 + \frac{1}{2}(r_2 + a_3 - a_2),\ a_1 + a_2 + a_4 + (r_1 - r_2 + r_4) + \frac{1}{2}(r_2 + a_3 - a_2)]$$

as partner A's revenue share increases from zero to one. Under unilateral control by B, c_A^B is in the range $[c_A^B(s=0), c_A^B(s=1)]$, or

$$[a_1 - a_3 + a_4 + \frac{1}{2}(r_3 + a_3 - a_2),\ a_1 - a_3 + a_4 + (r_1 - r_3 + r_4) + \frac{1}{2}(r_3 + a_3 - a_2)].$$

Under joint control, c_A^J is in the range $[c_A^J(s=0), c_A^J(s=1)]$, or

$$[a_1 + a_4 + \frac{1}{2}r_4,\ a_1 + a_4 + r_1 + \frac{1}{2}r_4].$$

Clearly, the second-best c_A^{SB} is in the range of c_A^J. However, c_A^{SB} is neither in the range of c_A^A nor in the range of c_A^B if the following condition is satisfied:

$$c_A^A(s=0) > c_A^{SB} \qquad \text{and} \qquad c_A^B(s=1) < c_A^{SB},$$

or equivalently,

$$a_2 + a_3 > r_1 - r_2 + r_4. \tag{9}$$

Then, we have the following proposition.

Proposition 1: *In the symmetric case where* $y_A(\alpha,\beta) = y_B(\alpha,\beta) = y(\alpha,\beta)$, $y(\alpha,\beta) = y(\beta,\alpha)$, $a_1 = b_1$, $a_2 = b_3$, $a_3 = b_2$, $a_4 = b_4$, $r_2 = r_3$, *and* $\lambda = 1/2$, *under Assumption 1, the second-best can be implemented by joint control, but if*

$$a_2 + a_3 > r_1 - r_2 + r_{4,}$$

it cannot be implemented by unilateral control. Then, joint control is superior to unilateral control. Otherwise, joint control and unilateral control are equally efficient.

Proposition 1 says that, in the symmetric case, when expropriation causes sufficient benefit shifting ($a_2 + a_3 + r_2 > r_1 + r_4$), incentives under unilateral control are so unbalanced that the second-best cannot be implemented by unilateral control, but it can always be implemented by joint control.

4 Loss of Total Incentive Power

We have discussed the distribution of incentives between the two partners. The focus of this section is on the aggregate level of incentives that is to be distributed between the two partners. In other words, in the previous section we illustrated how the control-right arrangement moved feasible contracts along a given contract line, whereas in this section we will illustrate how it can cause the contract line to shift. For this purpose, we consider a case where a partner's private benefit depends only on his own investment and where the verifiable revenue is a linear combination of the partners' private benefits. In other words, each partner's investment is self-investment if we ignore its effect on the verifiable revenue. Specifically, $y_A(\alpha,\beta) = y_A(\alpha), y_B(\alpha,\beta) = y_B(\beta)$, and $y(\alpha,\beta) = y_A(\alpha) + \mu y_B(\beta)$, where $\mu > 0$ is a constant.

Note that, with the ex post efficient decision, $(d_A^*, d_B^*, d^*) = (0,0,1)$, the total net surplus (the sum of the two partners' payoffs net of their investment costs) becomes

$$\begin{aligned}&(r_1 + r_4)[y_A(\alpha) + \mu y_B(\beta)] + (a_1 + a_4)y_A(\alpha) + (b_1 + b_4)y_B(\beta) - \alpha - \beta \\ &= (r_1 + r_4 + a_1 + a_4)y_A(\alpha) + (\mu r_1 + \mu r_4 + b_1 + b_4)y_B(\beta) - \alpha - \beta.\end{aligned}$$

To facilitate exposition, for each pair of incentive coefficients (c_1, c_2), we define

$$\begin{aligned} U(c_1, c_2) = \quad & (r_1 + r_4 + a_1 + a_4) y_A(\alpha) + (\mu r_1 + \mu r_4 + b_1 + b_4) y_B(\beta) - \alpha - \beta \\ s.t. \quad & c_1 y_A'(\alpha) = 1, \\ & c_2 y_B'(\beta) = 1. \end{aligned}$$

Before comparing various control-right arrangements, we discuss the second-best outcome as a benchmark. Given a revenue-sharing contract, if the ex post efficient decision is made automatically without renegotiating the revenue-sharing contract, then the incentive coefficients are $c_1 = s(r_1 + r_4) + a_1 + a_4$ and $c_2 = (1-s)\mu(r_1 + r_4) + b_1 + b_4$, and the total net surplus is $U(c_1, c_2)$. As s increases from 0 to 1, the ex post contract (c_1, c_2) moves along a contract line of

$$\mu c_1 + c_2 = \mu(r_1 + r_4) + \mu(a_1 + a_4) + b_1 + b_4. \tag{10}$$

The sharing rule that maximizes $U(c_1, c_2)$ subject to constraint (10) is called the second-best sharing rule, or $s = s^{SB}$. The corresponding investments are $\alpha = \alpha^{SB}$ and $\beta = \beta^{SB}$. Figure 2 illustrates the second-best outcome with the help of the following lemma, both conditions of which are satisfied by the Cobb-Douglas function.

Lemma 1 *Suppose $(y_A')^{-1}(1/c_1)$ is convex and $y_A[(y_A')^{-1}(1/c_1)]$ is concave in c_1, and $(y_B')^{-1}(1/c_2)$ is convex and $y_B[(y_B')^{-1}(1/c_2)]$ is concave in c_2. Then $U(c_1, c_2)$ is a concave function of c_1 and c_2. Furthermore, $\partial U/\partial c_1 > 0$ if and only if $c_1 < r_1 + r_4 + a_1 + a_4$, and $\partial U/\partial c_2 > 0$ if and only if $c_2 < \mu r_1 + \mu r_4 + b_1 + b_4$.*[9]

Contrary to the assumption for the second-best outcome, the ex post efficient decision may not be possible without the partners' renegotiating the revenue-sharing contract. The final payoffs after the renegotiation depend on the control-right arrangement.

Joint Control by A and B

[9] Under the first-best outcome, the incentive coefficients for partners A and B are, respectively, $r_1 + r_4 + a_1 + a_4$ and $\mu r_1 + \mu r_4 + b_1 + b_4$.

Consider first joint control by A and B. By substituting $RS^J = r_4 y + a_4 y_A + b_4 y_B$ into (5) and (6), we get

$$W_A^J = a_1 y_A + s r_1 y + \lambda(r_4 y + a_4 y_A + b_4 y_B), \tag{5'}$$

$$W_B^J = b_1 y_B + (1-s) r_1 y + (1-\lambda)(r_4 y + a_4 y_A + b_4 y_B). \tag{6'}$$

Substituting $y(\alpha, \beta)$ by $y_A(\alpha) + \mu y_B(\beta)$ and differentiating W_A^J and W_B^J, respectively, with respect to α and β yield

$$\begin{aligned} \frac{\partial W_A^J}{\partial \alpha} &= (a_1 + s r_1 + \lambda r_4 + \lambda a_4) y_A'(\alpha), \\ \frac{\partial W_B^J}{\partial \beta} &= [b_1 + \mu(1-s) r_1 + \mu(1-\lambda) r_4 + (1-\lambda) b_4] y_B'(\beta). \end{aligned}$$

Thus the partners' incentive coefficients are $c_1 = s r_1 + \lambda r_4 + a_1 + \lambda a_4$ and $c_2 = \mu(1-s) r_1 + \mu(1-\lambda) r_4 + b_1 + (1-\lambda) b_4$, and the total net surplus under joint control is $U(c_1, c_2)$. As s increases from 0 to 1, the ex post contract (c_1, c_2) moves along a contract line of

$$\begin{aligned} \mu c_1 + c_2 &= \mu(r_1 + r_4) + \mu(a_1 + \lambda a_4) + b_1 + (1-\lambda) b_4 \\ &= \mu(r_1 + r_4) + \mu(a_1 + a_4) + b_1 + b_4 - \mu(1-\lambda) a_4 - \lambda b_4. \end{aligned} \tag{11}$$

The sharing rule that maximizes $U(c_1, c_2)$ subject to constraint (11) is the optimal sharing rule under the joint control, or $s = s^J$. However, as the contract line for joint control is below that for the second-best [(11) as compared to (10)], joint control is always worse than the second-best.

Proposition 2: *In the case where $y_A(\alpha, \beta) = y_A(\alpha), y_B(\alpha, \beta) = y_B(\beta), y(\alpha, \beta) = y_A(\alpha) + \mu y_B(\beta)$, joint control is always worse than the second-best.*

To understand the intuition for Proposition 2, compare equations (10) and (11). Let us call the right-hand side of each equation the *total incentive power* for the corresponding case. We can see that the total incentive power under joint control is less than that

under the second-best by $\mu(1-\lambda)a_4 + \lambda b_4$. The reason for this loss of total incentive power under joint control is as follows. Under joint control, the ex post efficient decision is only made after the two partners reach an agreement in their bargaining. A requirement for the agreement is a redistribution of benefits between the partners. One consequence of the redistribution is that part of B's private benefit goes to A's final payoff and vice versa. Indeed, equations (5′) and (6′) show that A's payoff contains $\lambda b_4 y_B$ and B's payoff contains $(1-\lambda)a_4 y_A$. Since neither of the partners cares about the other partner's private benefit, such redistribution of benefits reduce the total incentive power for the two partners. Under the second-best, however, the ex post efficient decision is made without renegotiation and thus there is no loss of total incentive power. It is this difference in the total incentive power that makes joint control less efficient than the second-best outcome.

Unilateral Control by A

Consider next unilateral control by A. To clearly illustrate the main points, we focus on two sets of parameter conditions under which d'_A does not depend on α and β.[10]

Case 1:

Suppose $s^{SB} \geq a_2/r_2$. Then $s^{SB} > a_2 y_A(\alpha)/\{r_2[y_A(\alpha) + \mu y_B(\beta)]\}$ for any α and β. This implies that, given $s = s^{SB}$, A will always choose $d'_A = 0$ regardless the values of α and β. In other word, the ex post efficient decision is made without any bargaining. As a result, the incentive coefficients are $c_1 = s(r_1 + r_4) + a_1 + a_4$ and $c_2 = (1-s)\mu(r_1 + r_4) + b_1 + b_4$, which are the same as those coefficients under the second-best. Hence, A and B will choose the second-best investments, α^{SB} and β^{SB}. Therefore, the second-best outcome is guaranteed under A's control. In summary, we have:

Proposition 3: *Suppose* $y_A(\alpha,\beta) = y_A(\alpha), y_B(\alpha,\beta) = y_B(\beta), y(\alpha,\beta) = y_A(\alpha) + \mu y_B(\beta)$. *Then, if* $a_2 \leq s^{SB} r_2$, A's *control can yield the second-best outcome and is thus better than joint control.*

[10] A complete analysis without these restrictions on the parameters yields qualitatively similar results, and the detailed proof is available upon request.

Proposition 3 says that unilateral control by A is better than joint control if A's gain in private benefit, a_2, is small relative to the total loss of verifiable revenue r_2 when A expropriates B.

This result is not surprising. When A cannot gain very much private benefit from his opportunistic behavior, the loss of his portion of the verifiable revenue dominates and he then has no incentive to engage in the opportunistic behavior. In the absence of opportunistic behavior, the second-best outcome prevails.

A result similar to Proposition 3 can also be derived for B's unilateral control. The suboptimality of joint control given in Proposition 3 corresponds to that derived from the GHM model. Section 5 contains more detailed comparison of our work with GHM's.

The next result concerns the relationship between revenue share and control-right arrangements.

Proposition 4: *Suppose* $y_A(\alpha,\beta) = y_A(\alpha), y_B(\alpha,\beta) = y_B(\beta), y(\alpha,\beta) = y_A(\alpha) + \mu y_B(\beta)$. *Further assume that* $a_2 = b_3$ *and* $r_2 = r_3$. *Then: (1) If* $min\{s^{SB}, 1-s^{SB}\} \geq a_2/r_2$, A's *control and* B's *control are equally efficient and are both better than joint control. (2) If* $min\{s^{SB}, 1-s^{SB}\} < a_2/r_2 \leq max\{s^{SB}, 1-s^{SB}\}$, *the partner with majority revenue share should have the control right. (3) In both cases,* $s = s^{SB}$ *and the second-best is achieved.*

Proposition 4 can be restated as follows. Suppose the effects of expropriation on the partner's own private benefit and on the verifiable revenue are the same across partners. Then: (1) If the gain in private revenue is small relative to the loss in verifiable revenue for both partners, unilateral control under each partner is better than joint control. (2) If the gain in private benefit is small relative to the loss in verifiable revenue for one partner but the opposite is true for the other partner, the first partner should be assigned both the control right and the majority of revenue share. (3) In both cases, the second-best can be achieved by giving the controlling partner the second-best level of revenue share.

Under the condition specified in Proposition 4(1), as a controlling partner, neither A nor B would choose an ex post inefficient decision. Thus the second-best outcome is obtained under each partner's unilateral control. Under the condition specified in

Proposition 4(2), however, the partner with a lower revenue share would choose an ex post inefficient decision while the partner with a higher revenue share would choose the ex post efficient decision. Thus, the second-best outcome is obtained only when the partner with a higher revenue share has the control rights. Intuitively, a controlling partner's cost of expropriating the other partner is higher if he has a higher share of the verifiable revenue. To the extent that the controlling partner's expropriation can be made an empty threat and hence the second-best outcome can be obtained, he should be given a larger share of the revenue for this purpose. In this case, revenue-sharing contracts and control-right arrangements are complements in the provision of incentive for team production.

Case 2:

Suppose $a_2 y_A(\alpha) > r_2[y_A(\alpha) + \mu y_B(\beta)]$ for all α and β. Then, for all s, we have $a_2 y_A(\alpha)/\{r_2[y_A(\alpha) + \mu y_B(\beta)]\} > 1 \geq s$. As a result, A will always choose $d'_A = 1$ regardless the values of α and β. By substituting $d'_A = 1$ into (1) and (2), we get

$$\begin{aligned} W_A^A &= (a_1 + a_2 + a_4)y_A + s(r_1 - r_2 + r_4)y + \lambda(r_2 y + b_2 y_B - a_2 y_A), \\ W_B^A &= (b_1 - b_2 + b_4)y_B + (1-s)(r_1 - r_2 + r_4)y + (1-\lambda)(r_2 y + b_2 y_B - a_2 y_A). \end{aligned}$$

Substituting $y(\alpha, \beta)$ by $y_A(\alpha) + \mu y_B(\beta)$ and differentiating W_A^A and W_B^A, respectively, with respect to α and β yield

$$\begin{aligned} \frac{\partial W_A^A}{\partial \alpha} &= [s(r_1 + r_4) + a_1 + a_4 + (\lambda - s)r_2 + (1-\lambda)a_2]y'_A(\alpha), \\ \frac{\partial W_B^A}{\partial \beta} &= [(1-s)\mu(r_1 + r_4) + b_1 + b_4 + (s - \lambda)\mu r_2 - \lambda b_2]y'_B(\alpha). \end{aligned}$$

Then, the incentive coefficients are $c_1 = s(r_1 + r_4) + a_1 + a_4 + (\lambda - s)r_2 + (1-\lambda)a_2$ and $c_2 = (1-s)\mu(r_1 + r_4) + b_1 + b_4 + (s - \lambda)\mu r_2 - \lambda b_2$. As s increases from 0 to 1, the ex post contract (c_1, c_2) moves along a contract line

$$\mu c_1 + c_2 = \mu(r_1 + r_4) + \mu(a_1 + a_4) + b_1 + b_4 + \mu(1-\lambda)a_2 - \lambda b_2. \tag{12}$$

If

$$\mu(r_1 + r_4) + \mu(a_1 + a_4) + b_1 + b_4 + \mu(1-\lambda)a_2 - \lambda b_2$$
$$< \mu(r_1 + r_4) + \mu(a_1 + \lambda a_4) + b_1 + (1-\lambda)b_4$$

or

$$\mu(1-\lambda)a_4 + \lambda b_4 < \lambda b_2 - \mu(1-\lambda)a_2$$

the contract line under unilateral control by A [i.e., (12)] is below that under joint control [i.e., (11)]. If we further assume that the optimal revenue-sharing contract under joint control, s^J, is *interior* (hence, the indifference curve passing through s^J is above the contract line under A's control), then unilateral control by A is worse than joint control. Therefore, we have

Proposition 5: *Suppose* $y_A(\alpha,\beta) = y_A(\alpha), y_B(\alpha,\beta) = y_B(\beta), y(\alpha,\beta) = y_A(\alpha) + \mu y_B(\beta)$, *and* $a_2 y_A(\alpha) > r_2[y_A(\alpha) + \mu y_B(\beta)]$ *for all* α *and* β. *Further assume that the optimal revenue-sharing contract under joint control,* s^J, *is interior. Then, if*

$$\mu(1-\lambda)a_4 + \lambda b_4 < \lambda b_2 - \mu(1-\lambda)a_2, \tag{13}$$

A's *control is worse than joint control.*

Proposition 5 says that, given the loss of efficiency under joint control $[\mu(1-\lambda)a_4 + \lambda b_4]$, A's control is worse than joint control if A's expropriation leads to a large reduction in B's private benefit (large b_2) relative to its benefit in terms of A's own private benefit (a_2).

The intuition for Proposition 5 is related to that for Proposition 2. Given that $a_2 y_A(\alpha) > r_2[y_A(\alpha) + \mu y_B(\beta)]$ for all α and β, A as the controlling partner will choose $d_A = 1$ unless he is bribed by B to do otherwise. The amount of bribe that B has to pay increases with A's potential gain, $a_2 y_A$, and B's potential loss, $b_2 y_B$, from $d_A = 1$. Therefore, A has higher, and B has lower, incentives for investment. However, the total incentive power is reduced by $\lambda b_2 - \mu(1-\lambda)a_2$ [or the right-hand side of (13)] compared with the second-best. If b_2 is very large, so that this loss of total incentive power is larger

than the loss of total incentive power under joint control [i.e., $\mu(1-\lambda)a_4 + \lambda b_4$, or the left-hand side of (13)], then the contract line under A's control is below that under joint control. This implies that unilateral control by A is worse than joint control, because s^J is interior.

A special case of Proposition 5 deserves emphasis because it has an easy and useful interpretation.

Proposition 6: *Suppose* $y_A(\alpha,\beta) = y_A(\alpha), y_B(\alpha,\beta) = y_B(\beta), y(\alpha,\beta) = y_A(\alpha) + y_B(\beta)$, $\mu = 1, \lambda = 1/2$, *and* $a_2 y_A(\alpha) > r_2[y_A(\alpha) + \mu y_B(\beta)]$ *for all* α *and* β. *If* $a_4 = b_4 = 0$ *and* $a_2 < b_2$, *then* A's *unilateral control is dominated by the joint control.*

Proposition 6 says that joint control is better than unilateral control by A if the good action only affects the verifiable revenue (i.e., $a_4 = b_4 = 0$), and expropriation by A of B is rather inefficient in that the increase in A's private benefit is less than the decrease in B's private benefit (i.e., $a_2 < b_2$).

Intuitively, the problem with joint control is that the good action cannot be taken without both partners' agreement, which leads to renegotiation and payoff redistribution. When the good action affects only the verifiable revenue, however, the redistribution involves only verifiable revenue, which can be negated by adjusting the revenue-sharing contract and hence causes no loss of total incentive power compared with the second-best. In contrast, with unilateral control, A can change the payoff distribution in its favor by threatening to expropriate B. A's investment incentive is enhanced by the increase in its private benefit $[a_2 y_A(\alpha)]$, while B's investment incentive is lowered by the decrease in its private benefit $[b_2 y_B(\beta)]$. When $a_2 < b_2$, there is a net loss of total incentive power under A's control compared with the second-best. Taken together, under the specification of Proposition 6, joint control has no cost but unilateral control does, and hence the result.

Finally, we address the question of whether the controlling partner should be given the majority of revenue share. Without loss of generality, we consider a (partially) symmetric case where $\mu = 1, a_1 = b_1, a_4 = b_4, \lambda = 1/2$, and $y_A(\alpha) = y_B(\beta)$. The contract line under A's control is higher than that under joint control if condition (13) is violated (i.e., $a_2 - b_2 + a_4 + b_4 > 0$), and it is also higher than that under B's control if

$a_2 - b_2 + a_3 - b_3 > 0$. Meanwhile, in this symmetric case, the mid point of the contract line under A's control is the one closest to the first best, and it can be obtained by giving partner B a majority of revenue share if $a_2 + b_2 < 2(r_1 + r_4 - r_2)$. Intutively, under the last condition, it is impossible to prevent A from expropriating partner B. Thus, partner B should be given the majority of revenue share to achieve a balance in the provision of incentive. Here revenue-sharing contracts and control-right arrangements are substitutes, in contrast to the case of Proposition 4. We summarize the above results in Proposition 7.

Proposition 7: *Suppose* $y_A(\alpha, \beta) = y_A(\alpha)$, $y_B(\alpha, \beta) = y_B(\beta)$, $y_A(\alpha) = y_B(\beta)$, $y(\alpha, \beta) = y_A(\alpha) + y_B(\beta)$, $a_2 y_A(\alpha) > r_2[y_A(\alpha) + \mu y_B(\beta)]$ for all α and β, $a_1 = b_1$, $a_4 = b_4$, and $\lambda = 1/2$. *If* $a_2 - b_2 + a_4 + b_4 > 0$, $a_2 - b_2 + a_3 - b_3 > 0$, *and* $a_2 + b_2 < 2(r_1 + r_4 - r_2)$, *then* A's *control is uniquely optimal but the optimal revenue share for* A *is less than 50%.*

Proposition 7 says that if the benefits of the good action (a_4, b_4, and r_4) are large, unilateral control is better. If in addition the two partners are symmetric, the controlling partner should be given less revenue share to balance the incentives.

Results similar to Propositions 3 and 5-7 can also be derived for B's unilateral control.

5 Relations with the Existing Literature

As specified in Sections 2.2 and 2.3, this paper departs from the existing literature in two directions. First, we consider a wider range of ex post decisions. In particular, we consider the possibility of expropriation by the controlling partner of the other partner in addition to good actions that improve all partners' benefits. Second, we consider situations where ex ante revenue-sharing contracts as well as control arrangements are important in the provision of incentives. This allows us to explore the interactions between revenue-sharing contracts and control-right arrangements.

It can be checked that all of our results in Sections 3 and 4, except those on the interactions between revenue-sharing and control-right arrangements, still hold in the absence of any verifiable revenue. This enables us to isolate the effects of our first

departure from the existing literature — a wider range of ex post decisions. It turns out that, by restricting our analysis to some subsets of the ex post decisions, we can relate our results to those in the existing literature.

Suppose there are only good actions in our model (i.e., $a_2 = b_2 = r_2 = 0$ and $a_3 = b_3 = r_3 = 0$). Then, for the specification of private benefits in Section 4 [i.e., $y_A(\alpha, \beta) = y_A(\alpha)$, $y_B(\alpha, \beta) = y_B(\beta)$], the second-best outcome is obtained under unilateral control because the controlling partner voluntarily chooses the ex post efficient decision. Joint control, however, is inferior to the second-best, as shown in Proposition 2. Intuitively, there is no cost with unilateral control, since the controlling partner has no bad actions (expropriation of the other partner) to take. Joint control is inefficient because even the good actions cannot be taken without the agreement of both partners.

The results for the case that all actions are good ones resemble those of GHM. In their framework, the owner of an asset has the right to decide who can get access to the asset in the event of bargaining breakdown, which can be interpreted as the good action in our model.[11] By getting exclusive access to the asset, the owner can secure a high disagreement payoff, thereby having high investment incentive. Under joint control, however, neither party can get access to the asset in the event of bargaining breakdown, which results in low investment incentive for both parties. Clearly, joint control is inferior to unilateral control.

Suppose instead that there are only bad actions in our model (i.e., $a_4 = b_4 = r_4 = 0$). Then, for the specifications of private benefits in Section 4, the contract line for the joint control coincides with that for the second-best [$-\mu(1-\lambda)a_4 - \lambda b_4$ drops from (11)] and hence the efficiency of joint control.[12] Intuitively, an implication of joint control is that no action can be taken without the agreement of both partners. Given that all actions are bad ones, however, there is no inefficiency with joint control. In this case, the second-best outcome may or may not be obtained under unilateral control, depending on whether or not the controlling partner refrains from taking the bad action (modified Proposition 3 or 5 respectively). Thus joint control is weakly superior to unilateral control. Put in slightly different terms, our model shows that joint control curbs the

[11] More details about the difference in the assumption about the ex post decision between GHM and our model were given in Section 2.2.

[12] Note that this is a version of Proposition 2 modified for the new assumption that $a_4 = b_4 = 0$; the version stated in Section 4 is only valid under the assumption that $a_4 > 0$ and $b_4 > 0$.

partners' ability to expropriate each other and thereby mitigates the incentive problems caused by the threat of expropriation, while unilateral control may leave expropriation unchecked.

Our explanation for joint control is different from the existing ones. Among them, Cai (1999) is the most closely related to our story. He argues that, under unilateral control, the controlling partner overinvests in general human capital but underinvests in specific human capital to improve his disagreement payoff. Therefore, it is optimal to have joint control. Overinvesting in general human capital is in some sense a bad action. However, this bad action is taken in the investment stage (date 1 in terms of our model) and cannot be bargained away, whereas expropriation in our model only occurs after the investments are made (date 3) and can be bargained away. In their analysis of allocation of access as an incentive instrument, Rajan and Zingales (1998) also contains a similar argument about specific vs. general investment. Chiu (1998) and De Meza and Lockwood (1998) use a different bargaining game from that used by GHM and us, adopting the outside-option principle in bargaining. They argue that, under unilateral control, the controlling partner's outside option is so high that it becomes binding. Then he has very little incentive to invest, as his payoff depends only on his outside option, not on the total surplus. Under joint control, however, neither partner's outside option is binding, so that each partner gets half of the total surplus and each has some incentive to invest.

6 Empirical Findings

Finally, we examine the empirical relevance of the theoretical results by using a unique data set on joint ventures. The data set resulted from a series of efforts between 1997 and 1998. We started with a pilot sample of 20 international joint-venture contracts in China.[13] After studying these 20 contracts, we designed a questionnaire, which was

[13] To set up a joint venture, all parties must first reach an agreement on the project and sign a *contract* delineating each and every party's contributions to the proposed venture. This joint-venture contract specifies the equity-sharing arrangement and the composition of the board of directors. All parties must also agree on *articles of association* that specify the governance structure of the joint venture, including

then used to extract key contract clauses of 200 joint-venture contracts with the help of China's Ministry of Foreign Trade and Economic Cooperation. These contracts were signed in the period 1986-1996, with more than half concentrated in 1993-1994. The mean of registered capital is US$11.85 million. Of the 200 joint ventures, 97.5% involved one (173) or two (22) foreign partners. As in the overall population of joint ventures established in this period, the majority of the foreign partners in our sample were from Hong Kong/Macau/Taiwan (99), the United States/Canada (38), and Japan (25).

The joint venture is a means to utilize complementary skills of different corporations. Figure 3 depicts the pattern of task assignment to joint-venture partners. Obviously these tasks are complementary to one another. In addition, there is a clear pattern of task specialization between the foreign and domestic partners. The domestic partners are typically assigned to help the joint ventures secure production sites, hire local employees, and procure local inputs, whereas the foreign partners offer intellectual property, procure inputs from overseas market, provide staff training, and assist export.

Figure 4 reveals the distribution of the foreign partners' equity shares. In China, there is no upper limit on foreign ownership except in selected industries. To the contrary, there is a de facto lower limit on foreign ownership, as joint ventures with a minimum of 25% foreign ownership are entitled to preferential treatment with respect to corporate income tax (Rosen, 1999). This explains why there are 18 joint ventures (9% of the sample) in which the foreign partners hold 25% equity shares. It is also interesting to note that there are 43 joint ventures (21.5% of the sample) in which the foreign partners and domestic partners each hold 50% equity shares.

The *board of directors* is the highest decision-making body in a joint venture. The joint-venture partners can nominate candidates to sit on the board and represent their interests. As shown in Table 1, the number of board members nominated by the foreign partners in a joint venture is generally proportional to their equity shares. In only 8 out of 200 joint ventures do the majority equity holders not have the majority representation on the board of directors.

However, exercise of control rights in a joint venture depends on the voting rules as

the rights and voting rules of the board of directors. Hence, the term *joint-venture contract* in this paper refers to these two legal documents. For description of procedures for forming a joint venture in China, see Rosen (1999).

well as the board representation. There are thirteen important decisions concerning the operations of the joint ventures. As shown in Figure 5, in 198 of the 200 joint ventures, unanimous voting is required on the following issues: charter amendment, termination and dissolution of the venture, merger with other organizations, increase and transfer of registered capital. For other issues, a simple majority or a two-thirds majority or unanimous voting is required.

In addition to the four issues that must be decided unanimously by all the parties, which implies joint control for any nontrivial equity arrangements, there are many issues over which majority equity holders in a joint venture cannot exercise their control rights unilaterally without the other parties' agreement. Specifically, joint control is also in place (a) when a decision requires a simple majority but one of the partners has a board representation of exactly 1/2, (b) when a decision requires a two-thirds majority but one of the partners has a board representation between 1/3 and 2/3. Under each of the above circumstances, one partner in a joint venture can override the other partner's decisions. Figure 6 reveals that there is a high degree of joint control for a whole spectrum of issues ranging from profit/loss allocation to hiring and firing of CEO and senior staff. It should also be pointed out that there is no substantial difference in the degree of joint control between the 50-50 joint ventures and other joint ventures. These empirical findings are consistent with our theoretical results that control arrangements are made to mitigate expropriation and other incentive problems in team production.

7 Conclusion

This paper introduces postinvestment (*ex post*) expropriation by the controlling partner of the other partner (the bad action) into the analysis of control rights that was pioneered by GHM. We model expropriation as an action by the controlling partner that increases his own private benefit at the expense of the other partner's and the verifiable revenue. We also consider good actions that increase both private benefits and the verifiable revenue. Together, these actions form the multiple dimensions of the *ex post* decision. In the context of a closely held firm such as a joint venture, we analyze the

optimal allocation of control rights and other incentive mechanisms in the presence of the aforementioned actions.

We further incorporate the role of revenue-sharing contracts into the analysis and consider revenue-sharing and control-right arrangements in a unified model. The difference between our model and that by GHM that allows us to do so is that we assume that some verifiable revenue can be produced and the revenue-sharing contract is honored before the partners reach any agreement about the *ex post* decision. Because of this, the disagreement payoffs of the partners are affected not only by the control-right arrangement but also by the ex ante revenue-sharing contract.

With the variety of actions that the controlling party can choose ex post, each control-right arrangement has its costs and benefits despite the fact that the ex post efficient decision will ultimately be chosen through bargaining. Under unilateral control by one partner, the controlling partner can use the threat of expropriation to strengthen his own bargaining position and weaken the other partner's bargaining position. As a result, his own investment incentive becomes stronger and the other partner's investment incentive becomes weaker. One consequence is that it is difficult to offer balanced incentives for investment. Another consequence is that, when the weakening of the other partner's incentive dominates the strengthening of the controlling partner's incentive, the unilateral control affects not only the distribution of incentives but also the total level of incentives. Joint control also has its costs. Under joint control, the good action cannot be taken without the partners bargaining to reach an agreement. This need for bargaining and its resulting redistribution of benefits weaken both partners' ex ante investment incentives. The optimal control arrangement is determined by the trade-off of these effects.

Based on the above trade-off, we have the following results: (1) If both partners' investments are important and the holdup problem related to the good action does not have a very strong negative effect on the total level of incentives, it is best to have joint control by the two partners (Proposition 1). This is likely to be the case when each partner's investment contains a significant cooperative element. Next, suppose instead of cooperative investments, the partners make self-investments in that each of them does not have any effect on the other partner's private benefit (but can have an effect on the verifiable revenue). Then we have: (2) If the controlling partner's expropriation reduces the other partner's benefit by a lot more than it increases the controlling partner's own

private benefit, it is again best to have joint control (Propositions 5 and 6). (3) If the good action is very important, then unilateral control is better than joint control (Proposition 7). (4) If one partner's bad action increases his own private benefit by much less than it decreases the verifiable revenue, than he will have no incentive to take the action, and then unilateral control will have no cost. In this case, unilateral contract is better than joint control (Proposition 3). Furthermore, if the bad actions of the two partners have symmetric effects, the partner with the majority revenue share should be given the control right, because he is less likely to take the bad action than the minority shareholder (Proposition 4).

Besides our contribution to the general theory of the firm, this paper also provides a perspective on the organization of joint ventures. Here, a joint venture is considered as a means for pooling of complementary skills of different partners. Expropriation is an important problem in such team production, in addition to the other moral hazard problems. The revenue-sharing contract and control-right arrangement are designed jointly to mitigate these problems. Our view on the joint venture is complementary to the views proposed in two recent papers on the same topic (Halonen, 1997; Noldeke and Schmidt, 1998), both of which focus solely on ownership arrangements. The former discusses how joint ownership facilitates cooperation through reputation effects, and the latter shows that certain contingent ownership arrangements can induce optimal sequential investments.

Our theoretical findings are consistent with the stylized facts that we found from a sample of 200 joint-venture contracts. Specifically, the sample shows that both revenue-sharing contracts and control-right arrangements are used in each of the contracts. Furthermore, the contracts stipulate different rules for making different decisions, ranging from simple majority (corresponding to unilateral control by the majority shareholder) to unanimous voting (corresponding to joint control). When more elaborate data become available, future work should explore the difference in empirical implications between different theoretical views about joint ventures and test these implications empirically.

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