Incomplete Contracts, Limited Liability, and the Optimality of Joint Ownership

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Patrick W. Schmitz*

University of Cologne, Germany, and CEPR, London, UK

Abstract

The property rights approach to the theory of the firm is the most prominent application of the incomplete contracting paradigm. A central conclusion of the standard model says that joint ownership is suboptimal. In this note, we analyze a modified version of the standard model that is tailored to the organization of R&D activities, where one of the parties is wealth-constrained and protected by limited liability. It turns out that joint ownership can be optimal, since it avoids wasteful rent-seeking activities when limited liability rents are necessary to induce high effort. Our results are in line with the fact that R&D activities are often conducted in research joint ventures.

Keywords: Property rights; incomplete contracts; limited liability; rent seeking; joint ownership

JEL classification: D86; D23; L24; L25; O32

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* University of Cologne, Staatswissenschaftliches Seminar, Albertus-Magnus-Platz, 50923 Köln, Germany. E-mail address: patrick.schmitz@uni-koeln.de.

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1 Introduction

The property rights approach to the theory of the firm based on the incomplete contracting paradigm has been one of the major advances in microeconomics in the past three decades (see Grossman and Hart, 1986; Hart and Moore, 1990; Hart, 1995).[1] By now, the property rights theory has been successfully applied in various fields such as industrial organization, international trade, corporate finance, organizational economics, political economy, and privatization theory. The starting point of the property rights approach is the observation that ownership allocations correspond to allocations of residual control rights; i.e., the owner has the right to make decisions in circumstances not covered by a prior contract.

A central conclusion of the basic model is that joint ownership (i.e, bilateral veto power) cannot be optimal. However, it has already been emphasized by Holmström (1999) that joint ventures are an important part of the corporate landscape, so the standard prediction that joint ownership cannot be optimal seems to be counterfactual. In particular, in the context of R&D activities, research joint ventures are a prominent organizational form.[2] In the present paper, we present a novel explanation for the optimality of joint ownership. In our model, one of the contractual parties has to exert effort to come up with an innovation. In line with Aghion and Tirole's (1994a,b) management-of-innovation setup, we suppose that this party has no resources and is protected by limited liability.

Specifically, we consider the relationship between a principal (say, a customer) and a wealth-constrained agent (say, a research unit). At the outset, the parties agree on a project, but a complete contract cannot yet be written. Subsequently, each party can invest effort to come up with modifications to

[1] The incomplete contracts approach is at the center of Oliver Hart's work, who has recently been awarded the Nobel Prize in Economic Sciences together with Bengt Holmström (cf. Nobel Prize Committee, 2016).

[2] See e.g. Caloghirou et al. (2003).

the project.[3] In line with Hart et al. (1997), we assume that the owner has the right to decide whether or not a modification is implemented. Finally, the principal offers a contract and the agent exerts unobservable effort, yielding either a successful innovation or a failure. In order to induce the agent to exert high effort, the principal must leave a limited-liability rent to the agent (cf. Laffont and Martimort, 2002, ch. 4).[4] The rent depends on the success probability when low effort is exerted, which in turn depends on which modification is implemented. When the principal is the owner, she will invest in modifications that reduce the agent's rent. When the agent is the owner, he will invest in modifications that increase his rent. Under joint ownership, no rent-seeking investments take place, because each party has veto power. Thus, joint ownership may be strictly optimal since it can avoid costly activities to influence the agent's limited-liability rent.

For example, consider a small wealth-constrained biotechnology firm and a large pharmaceutical company who want to develop a new combination medicine. Exerting high effort means testing all conceivable combinations, while exerting low effort means that only a few combinations are tested. Given low effort, experienced researchers have a larger success probability than inexperienced researchers, because they have a better intuition about which combinations are most promising. Given high effort, all combinations are tested, so the success probability is independent of whether the researchers are experienced or inexperienced. The owner has the right to make costly changes

[3] This aspect distinguishes our model from Aghion and Tirole's (1994a,b) setup, where joint ownership cannot be strictly optimal. Investments in modifications to a project have also been studied by Hart et al. (1997), yet they do not investigate the effects of limited liability.

[4] For early papers on the effects of limited liability, see Innes (1990) and Pitchford (1998). More recent papers on contracting under limited liability include e.g. Ohlendorf and Schmitz (2012), Kragl and Schöttner (2014), Pi (2014, 2018), Cato and Ishihara (2017), and Kräkel (2017). Yet, these papers are focused on complete contracting problems; i.e., the implications of different ownership allocations are not studied in this literature.

to the composition of a given research team consisting of both experienced and inexperienced researchers. Our model suggests that such changes will be made under sole ownership by either the biotechnology firm or the pharmaceutical company, but not in case of a joint venture. Since in equilibrium high effort will be exerted, costly reorganizations of the research team are wasteful rent-seeking activities, so a joint venture is optimal.

Related literature. To the best of my knowledge, the present paper is the first one showing that joint ownership can be optimal due to limited liability constraints, which often play a central role in the context of research activities (cf. the "R&D game" in Tirole, 1999, p. 745). The paper thus contributes to the literature that tries to explain the optimality of joint ownership in situations different from those studied in the original Grossman-Hart-Moore setup. For instance, other potential explanations for joint ownership include repeated interactions (Halonen, 2002), investment spillovers (Rosenkranz and Schmitz, 2003; Gattai and Natale, 2016; Hamada, 2017), sequential investments (Lülfesmann, 2004), adverse selection (Schmitz, 2006, 2008), and transaction costs (Müller and Schmitz, 2015). See Gattai and Natale (2017) for a comprehensive survey on explanations for the optimality of joint ownership in various departures from the original setup of the property rights approach to the theory of the firm.

2 The model

Consider two risk-neutral parties, an agent A and a principal P, who can work on a project in the future. The agent has no wealth and is protected by limited liability. The reservation utilities are zero. At date 0, an ownership structure $o \in \{A, P, J\}$ is fixed. Moreover, the basic characteristics of the project are specified. In line with the property rights approach to the theory of the firm, it is not yet possible to write more detailed contracts at date 0.

At date 1, each party $i \in \{A, P\}$ can invest effort $x_i \in \{0, 1\}$ in order to develop modifications to the project. Let the disutility of effort be given by $x_i k$, where $k > 0$. The investment decisions are observable but non-contractible. At date 2, modifications to the project can be implemented. Under agent-ownership ($o = A$), the agent has the right to implement modifications to the project. Under principal-ownership ($o = P$), the principal has the right to implement modifications to the project. Under joint ownership ($o = J$), both parties have veto power, so modifications can be implemented only if both parties agree.

At date 3, the principal offers a contract to the agent.[5] At date 4, the agent can exert unobservable effort $e \in \{0, 1\}$. The disutility of effort is ec, where $c > 0$. At date 5, there is either a success or a failure, which is verifiable. The success probabilities are p if $e = 1$ and q if $e = 0$, where $0 < q < p < 1$. If there is a success, the principal gets a revenue $R > 0$.

Let $q = q_0$ in the basic version of the project. At date 1, by incurring a disutility of effort k, each party can develop one of two modifications. Modification I means that the success probability given low effort is increased to $q = q_H \in (q_0, p)$. Modification II means that the success probability given low effort is reduced to $q = q_L \in (0, q_0)$. For simplicity, we assume that otherwise a modified project is identical to the basic project. It will turn out that the agent can only be interested in developing modification I, while the principal can only be interested in developing modification II.

We assume throughout that R is sufficiently large, such that at date 3 the principal always offers a contract that induces the agent to exert high effort.

Assumption 1. *Suppose that* $R > \frac{pc}{(p-q_H)^2}$.

[5] The simplifying assumption that one of the parties has all the bargaining power is often made in the related literature (see e.g. Hart and Moore, 1999, p. 119). It is straightforward to generalize our results to the case in which also the agent has some bargaining power (in analogy to the approach taken in the appendix of Hart and Moore, 1999).

3 Optimal ownership

First, consider agent-ownership ($o = A$). At date 3, the principal offers to make a payment $w_1 \geq 0$ to the agent if there will be a success at date 5, while otherwise the payment will be $w_0 \geq 0$. Note that at date 4 the agent will exert high effort ($e = 1$) whenever the incentive-compatibility constraint

$$pw_1 + (1-p)w_0 - c \geq qw_1 + (1-q)w_0$$

is satisfied. The principal's expected date-3 payoff is then given by $p(R - w_1) - (1-p)w_0$. It is straightforward to show that the principal will always set $w_0 = 0$. Hence, the principal will offer

$$w_1 = \frac{c}{p-q}.$$

As a consequence, at date 3 the expected continuation payoff of the principal is

$$u_P(q) = p\left(R - \frac{c}{p-q}\right),$$

while the agent's expected continuation payoff is

$$u_A(q) = \frac{qc}{p-q}.$$

Observe that $u_P(q)$ is a decreasing function, while $u_A(q)$ is an increasing function. Therefore, if at date 2 modification I is available, it will be implemented by the agent and hence $q = q_H$. Otherwise, the agent will stick to the basic version of the project, $q = q_0$.[6]

At date 1, the principal will not invest in modifications of the project, since only modification I would be implemented by the agent, which would reduce

[6] Note that at date 3 the principal will offer a contract that induces the agent to exert high effort, so q has no influence on the expected total surplus that the parties can generate from date 2 on. As a consequence, there is no scope for mutually beneficial renegotiation. At date 2, the modified projects yield the same expected surplus as the original project, even though the implications for the agent's rent differ.

$u_P(q)$. However, the agent will invest in modification I provided that

$$k < u_A(q_H) - u_A(q_0) = \frac{q_H - q_0}{(p - q_0)(p - q_H)} pc.$$

Next, consider principal-ownership ($o = P$). The analysis of the decisions at dates 3 and 4 remains unchanged. Yet, if at date 2 modification II is available, it will now be implemented by the principal and hence $q = q_L$. Otherwise, the principal will stick to the basic version of the project, $q = q_0$. Thus, at date 1 the agent will not invest in modifications of the project, since only modification II would be implemented by the principal, which would reduce $u_A(q)$. The principal will invest in modification II provided that

$$k < u_P(q_L) - u_P(q_0) = \frac{q_0 - q_L}{(p - q_0)(p - q_L)} pc.$$

Finally, consider joint ownership ($o = J$). The analysis of dates 3 and 4 remains again unchanged. At date 2, the principal would always veto implementing modification I, while the agent would veto implementing modification II. As a consequence, the parties will stick to the basic version of the project, $q = q_0$. For this reason, no party will invest effort in developing modifications to the project at date 1.

Let the parties' expected total surplus be denoted by S^o. We can now state our main result.

Proposition 1 *(i) If* $k < \min\{\frac{q_H - q_0}{(p-q_0)(p-q_H)}, \frac{q_0 - q_L}{(p-q_0)(p-q_L)}\}pc$, *then* $o = J$ *is strictly better than* $o = A$ *and* $o = P$*. Specifically,* $S^J = pR - c > S^A = S^P = pR - c - k$.

(ii) If $\frac{q_H - q_0}{(p-q_0)(p-q_H)}pc < k < \frac{q_0 - q_L}{(p-q_0)(p-q_L)}pc$, *then* $o = A$ *and* $o = J$ *are strictly better than* $o = P$*. Specifically,* $S^A = S^J = pR - c > S^P = pR - c - k$.

(iii) If $\frac{q_0 - q_L}{(p-q_0)(p-q_L)}pc < k < \frac{q_H - q_0}{(p-q_0)(p-q_H)}pc$, *then* $o = P$ *and* $o = J$ *are strictly better than* $o = A$*. Specifically,* $S^P = S^J = pR - c > S^A = pR - c - k$.

(iv) If $k > \max\{\frac{q_H - q_0}{(p-q_0)(p-q_H)}, \frac{q_0 - q_L}{(p-q_0)(p-q_L)}\}pc$, *then the ownership structure does not matter, since* $S^A = S^P = S^J = pR - c$.

In particular, part (i) of the proposition shows that if the effort costs of coming up with modifications to the project are sufficiently small, then joint ownership is strictly better than both agent-ownership and principal-ownership, which is in contrast to the standard conclusion of the property rights theory. Intuitively, due to limited liability the principal must leave a rent to the agent in order to implement high effort. When the costs of modifying the project are sufficiently small, then under P-ownership the principal will invest effort to reduce the agent's rent, while under A-ownership the agent will invest effort to increase his rent. Joint ownership is optimal, since it avoids these wasteful rent-seeking activities.

4 The role of limited liability

It should be emphasized that our result that joint ownership can strictly outperform A-ownership and P-ownership depends on the assumption that the agent is protected by limited liability. To see this, suppose that there were no wealth constraints, so that payments to the agent could be negative. At date 3, the principal would then offer a contract $w_1 = R - [pR - c]$ and $w_0 = -[pR - c]$. At date 3, the expected continuation payoff of the principal is $pR - c$, and the agent's expected continuation payoff is zero (i.e., the agent does not get a rent). These payoffs do not depend on q, so regardless of the ownership structure no party would ever invest in modifications I or II of the project. Therefore, in the absence of limited liability, ownership would not matter in our model.[7]

[7] One could extend our model by allowing both parties to also make productive investments at date 1, such that in line with the standard Grossman-Hart-Moore setup joint ownership would be strictly suboptimal in the absence of limited liability constraints. In the presence of limited liability, joint ownership would then be optimal if the rent-seeking losses under A- and P-ownership were larger than the welfare gains generated by the productive investments.

5 Conclusion

In the standard property rights theory, joint ownership is suboptimal. We have considered an R&D setup where the agent is protected by limited liability. The principal and the agent can engage in rent-seeking activities in order to develop modifications to the project. Subsequently, the agent exerts unobservable effort to come up with an innovation. It has turned out that joint ownership can be optimal, since it avoids wasteful rent-seeking activities.

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