Information Gathering, Transaction Costs, and the Property Rights Approach

By PATRICK W. SCHMITZ*

The modern property rights approach to the theory of the firm, developed by Sanford J. Grossman and Oliver D. Hart (1986) and Hart and John Moore (1990), has received considerable attention in recent years.[1] Based on the assumption that contracts are incomplete, it is argued that ownership structures such as vertical integration are chosen in order to provide incentives for relationship-specific investments (i.e., to mitigate the hold-up problem). Ownership of alienable assets can enhance a party's incentives to make ex ante investments, because it improves the future default payoff that a party could realize on its own, and hence the party's position in ex post bargaining. A critical assumption of the standard property rights theory is that ex post bargaining is always efficient due to symmetric information. This assumption, which has recently been called "deeply problematic" by Oliver E. Williamson (2002, p. 188), will be relaxed in the present paper, where a party may acquire private information about its default payoff.

Consider a supplier who can produce an intermediate product with a physical asset. Should the potential buyer of the intermediate product own the asset (integration) or should the supplier be the owner (nonintegration)? According to the property rights theory, the party that has to make the more important ex ante investment decision should be the owner. In particular, if only the supplier has an investment opportunity, then integration can never be optimal. The reason is that ownership determines the default payoff that a party could realize if ex post bargaining failed. To be sure, under symmetric information, bargaining will always be successful. Nevertheless, the parties' default payoffs are relevant because they influence how the ex post surplus will be split between the parties. Since asset ownership improves the ex post bargaining position and hence the ex ante investment incentives, the supplier should own the asset when only he has to invest.

Assume now that, in contrast to the standard property rights model, a party may acquire better information than the other party about the default payoff that it could realize on its own. In this case, ex post bargaining may take place under asymmetric information. As a consequence, prominent implications of the property rights theory may be overturned. In particular, integration can be optimal even though only the supplier has an investment opportunity. It is true that nonintegration provides stronger ex ante incentives for the supplier to invest. However, nonintegration also induces the supplier to spend resources to gather private information about the default payoff, which is socially wasteful rent seeking. Moreover, as is well known from bargaining theory, ex post efficiency will not always be achieved in the presence of asymmetric information.[2] These drawbacks of nonintegration can be sufficiently strong to overcompensate the investment considerations on which the standard property rights model is focused. Hence, integration may well be optimal.

To the best of my knowledge, this is the first paper in which the property rights approach to the theory of the firm is extended by the possibility of endogenous information acquisition.[3]

* University of Cologne, Department of Economics, Albertus Magnus Platz, D-50923 Köln, Germany, and Centre for Economic Policy Research (e-mail: schmitz@131.220.43.1). I would like to thank Matthias Kräkel, Albrecht Morgenstern, Stephanie Rosenkranz, Urs Schweizer, Dirk Sliwka, Alexander Stremitzer, and two anonymous referees for their valuable comments and suggestions.

[1] See Hart (1995) for an excellent exposition of the basic property rights model. Jean Tirole (1999) surveys the literature on the incomplete contracting methodology. See also Schmitz (2001) for a nontechnical literature review.

[2] On bargaining theory, see Abhinay Muthoo (1999) and the literature discussed there.

[3] See, however, Michael H. Riordan (1990) and Klaus M. Schmidt (1996), who posit a link between ownership and information structure, in the tradition of Kenneth J. Arrow (1975). See also Tirole (1986), who studies a hold-up

This modification may help to bring the property rights theory one (admittedly small) step closer to transaction cost economics (see the seminal work of Williamson, 1975, 1985). Indeed, recently it has been pointed out by Williamson (2000, p. 605), that the "most consequential difference" between transaction cost economics and the property rights theory is the fact that the latter assumes ex post efficient bargaining under symmetric information.[4] Holmström (1999) has also argued that, in practice, the parties might need to exert effort in order to find out information, that bargaining may generate undesirable rent seeking, and that the assumption according to which both parties observe the default payoffs deserves more scrutiny.

It should be noted that there are also other variants of the property rights model which may explain ownership by a noninvesting party. Specifically, possible explanations include alternative kinds of investments (with cross-effects and multidimensional), alternative bargaining rules, and dynamic considerations.[5] These models, however, keep the assumption that information is symmetric. There are also several papers that analyze how ownership rights should be allocated in adverse selection models.[6] Yet, these papers do not consider investments and are less related to the property rights theory in the sense of Hart (1995). The literature on contractual solutions to the hold-up problem typically assumes complete information, but there are some exceptions (see William P. Rogerson, 1992; Benjamin E. Hermalin and Michael L. Katz, 1993; and Schmitz, 2002a, b).[7] In contrast to this literature, the present paper is closer to the property rights theory, where incomplete contracting means that ex ante the parties can specify only a simple ownership structure.

The remainder of the paper is organized as follows. In the next section, the basic model is introduced. The costs and benefits of integration are discussed in Section II, where it is shown that under asymmetric information, ownership by the investing party may not be optimal. The information structure is endogenized in Section III. A modified version of the model is briefly discussed in Section IV, while concluding remarks follow in Section V. Finally, some technical details have been relegated to the Appendix.

I. The Basic Model

Consider two risk-neutral parties, A and B, who can, by collaboration at some future date $t = 2$, generate a surplus $v(i) \geq 0$. The surplus can be produced only with a physical asset such as a production plant, which can be owned either by A or by B. At date $t = 0$, the parties agree on an ownership structure $o \in \{A, B\}$ over the physical asset. At date $t = 1$, party A chooses a noncontractible investment level $i \geq 0$, which is measured by its costs. Finally, at date $t = 2$, the parties bargain about whether or not to collaborate.

Following the incomplete contracting approach, it is assumed that at date $t = 0$, the parties agree on the ownership structure $o \in \{A, B\}$ that maximizes their expected total surplus (which they can divide between them by upfront payments). No further contractual arrangements are possible. In particular, it is assumed that while the investment level is observable, it cannot be verified in court. Moreover, the parties cannot commit ex ante to collaborate ex post.

For concreteness, suppose that party B is the potential user of an intermediate product that

problem with asymmetric information in the context of procurement.

[4] Bengt Holmström and John Roberts (1998) and Michael D. Whinston (2003) have also pointed out that transaction-cost economics emphasizes ex post haggling and maladaptation, while the standard property rights theory is narrowly focused on the underinvestment problem. It should be stressed that there are also other fundamental differences. In particular, as has been argued by David M. Kreps (1999), while bounded rationality is central to transaction-cost economics, its only role in the property rights theory is to motivate the incomplete contracting assumption.

[5] Hart et al. (1997), Raghuram G. Rajan and Luigi Zingales (1998), and Schmitz and Dirk Sliwka (2001) discuss alternative forms of investments. Y. Stephen Chiu (1998) and David deMeza and Ben Lockwood (1998) assume "deal-me-out" bargaining. George Baker et al. (2002) analyze repeated games.

[6] See, e.g., William Samuelson (1985), Peter Cramton et al. (1987), Niko Matouschek (2002), and Richard D. McKelvey and Talbot Page (2002). This literature is based on Roger B. Myerson and Mark A. Satterthwaite (1983).

[7] See also Patrick Bajari and Steven Tadelis (2001), who compare cost-plus and fixed-price procurement contracts, and Joseph Farrell and Robert Gibbons (1995), who study how the hold-up problem with private information can be mitigated when the parties can assign bargaining powers.

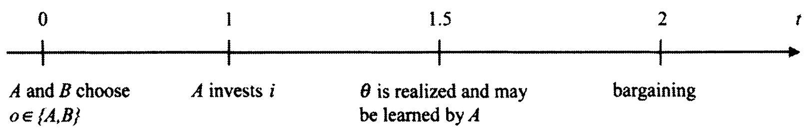

FIGURE 1. THE SEQUENCE OF EVENTS

can be produced only by party A. The physical asset under consideration is essential for the production of the intermediate product, the quality of which depends on party A's investment level, and can only be described ex post. The parties' default payoffs, i.e., what they receive if they fail to collaborate at date $t = 2$, depend on the ownership structure $o \in \{A, B\}$ as follows. If party B controls the physical asset ($o = B$, integration),[8] then both parties get zero when no agreement is reached at date $t = 2$ (party B cannot produce the intermediate product without party A's indispensable human capital, and party A has no access to the essential asset). If party A is the owner ($o = A$, nonintegration) and no agreement is reached, then party B receives zero (since party A is indispensable) and party A's payoff is $\theta v(i) \geq 0$, where $\theta \in [0, 1]$. In the latter case, party A can produce the intermediate product, but without party B's collaboration, party A can realize only a fraction θ of the value $v(i)$.

Hence, in accordance with the standard property rights model, collaboration is always ex post efficient. In contrast to the standard model, party A may acquire private information about the payoff which it can realize on its own.[9] Specifically, this is modelled by the state of the world θ, which is realized at date $t = 1.5$ and which can be learned only by party A, provided that party A decides to incur the information gathering costs $c \geq 0$. Note that if $c = 0$, party A will always be privately informed, while there will be symmetric information between the two parties (as in the standard property rights model) if c is prohibitively large.

At date $t = 2$, parties A and B bargain over whether or not to collaborate in order to realize the value $v(i)$. For analytical convenience, it is assumed that party A can make a take-it-or-leave-it offer with probability $\alpha \in (0, 1)$, and party B can make a take-it-or-leave-it offer with probability $1 - \alpha$. This is the simplest noncooperative bargaining game that is consistent with the standard property rights model.[10] The time structure of the model is illustrated in Figure 1.

As usual, it is assumed throughout that there are unique interior solutions. Specifically, the following technical assumptions are sufficient to justify the first-order approach in the basic model. Let v be a twice differentiable function with $v(0) = 0$, $v' > 0$, $v'' < 0$, $\lim_{i \to 0} v'(i) = \infty$, and $\lim_{i \to \infty} v'(i) = 0$. Moreover, let θ be distributed according to the distribution function $F(\theta)$ and let the corresponding density function $f(\theta)$ be strictly positive on the unit interval. Following most of the adverse selection literature, it is assumed that we are in Myerson's (1981) "regular case," so that $\theta + F(\theta)/f(\theta)$ is strictly increasing.[11] Finally, with the exception of the realization of θ, all components of the model are assumed to be common knowledge among the two parties.

The First-Best Solution.—In the first-best benchmark solution, the parties collaborate at date $t = 2$ (this is always ex post efficient since $\theta \leq 1$) and the ex ante efficient investment level $i = i^{FB}$ maximizes the total surplus $v(i) - i$.

[8] Note that ownership can be defined only with regard to physical (i.e., nonhuman) assets (party B cannot "own party A," i.e., its human capital). Hence, integration and nonintegration refer only to who controls the physical asset (or a set of such assets). In particular, following integration, A and B are still two distinct parties, each of whom has the inalienable right to its human capital.

[9] The fraction θ of the value $v(i)$ that party A can realize without party B could, e.g., depend on party A's ability to find alternative trading partners who might enter only after date $t = 2$. In any case, party A may obtain better information about its default payoff than party B, either at no cost or by costly information gathering.

[10] This simple bargaining game has recently also been used by Hart and Moore (1999) and Bajari and Tadelis (2001). If the parties are symmetrically informed, the bargaining game obviously leads to the generalized Nash bargaining solution, where α is party A's bargaining power.

[11] This assumption is implied by the standard monotone hazard rate condition according to which $F(\theta)/f(\theta)$ is increasing.

Under the assumptions made, the first-best investment level is thus characterized by the first-order condition $v'(i^{FB}) = 1$. Note that party A does not incur the information acquisition costs c in the first-best solution, i.e., information gathering is a socially wasteful rent-seeking activity.[12]

II. Symmetric versus Asymmetric Information

In this section, two special scenarios will be analyzed. In scenario I, the information gathering costs c are prohibitively large ($c = \infty$), so that there will never be asymmetric information between the two parties. In scenario II, information gathering is without costs ($c = 0$), so that party A will always have private information about the fraction θ of the surplus that it can realize on its own when it has access to the physical asset.

Consider first the case of integration ($o = B$). At date $t = 2$, the parties A and B bargain over whether to collaborate in order to generate the surplus $v(i)$. According to our simple noncooperative bargaining game, party A can make a take-it-or-leave-it offer to party B with probability α. In this case, party A demands the whole pie $v(i)$, which will be accepted by party B, because B's default payoff is zero. With probability $1 - \alpha$, party B can make a take-it-or-leave-it offer. In this case, party B will demand $v(i)$ for itself and party A accepts, because party A's default payoff is zero. Thus, party A's payoff at date $t = 2$ is given by $\alpha \cdot v(i) + (1 - \alpha) \cdot 0$. At date $t = 1$, party A will choose the investment level $i = i^B$ in order to maximize its payoff $u_A^B(i) = \alpha v(i) - i$.[13] The first-order condition is given by

$$\alpha v'(i^B) = 1$$

and the parties' expected total surplus is $S^B = v(i^B) - i^B$.

Next, consider the case of nonintegration ($o = A$). Assume first that the two parties are symmetrically informed (scenario I), i.e., no one knows the realization of θ. When party A can make the offer at date $t = 2$, it will demand the whole pie $v(i)$, which will be accepted by party B, because its default payoff is zero. When party B can make the offer, it will demand $v(i) - E[\theta]v(i)$, which party A will accept, because party A can realize the payoff $\theta v(i)$ on its own if no agreement with party B is reached. The investment level $i = i^A$ that party A chooses at date $t = 1$ in order to maximize its payoff $u_A^A(i) = \alpha v(i) + (1 - \alpha)E[\theta]v(i) - i$ is hence characterized by[14]

$$(\alpha + (1 - \alpha)E[\theta])v'(i^A) = 1$$

and the parties' expected total surplus is $S^A = v(i^A) - i^A$.

Assume now that party A privately learns the realization of the state of the world (scenario II). When party A can make the offer at date $t = 2$, it will still demand $v(i)$. When party B can make the offer, however, it must now take into consideration that party A has private information about its default payoff $\theta v(i)$. Without loss of generality,[15] suppose that party B offers $\lambda v(i)$ to party A. Party A will accept the offer whenever $\lambda \geq \theta$. Hence, party B chooses λ in order to maximize $[v(i) - \lambda v(i)]\Pr\{\theta \leq \lambda\}$. The first derivative of this expression with respect to λ is given by $[1 - \lambda]v(i)f(\lambda) - v(i)F(\lambda)$. Hence, party B will choose $\lambda = \lambda^*$, where $\lambda^* \in (0, 1)$ is uniquely defined by $\lambda^* + F(\lambda^*)/f(\lambda^*) = 1$. Party A's payoff at date $t = 2$ is $\alpha v(i) + (1 - \alpha)\max\{\lambda^*, \theta\}v(i)$, because party A will accept party B's offer to collaborate if and only if $\lambda^* \geq \theta$. At date $t = 1$, party A chooses the investment level $i = \bar{i}^A$ in order to maximize its payoff $\bar{u}_A^A(i) = \alpha v(i) + (1 - \alpha)E[\max\{\lambda^*, \theta\}]v(i) - i$, so that

$$(\alpha + (1 - \alpha)E[\max\{\lambda^*, \theta\}])v'(\bar{i}^A) = 1.$$

[12] Information gathering is also socially wasteful in Jacques Crémer and Fahad Khalil (1992, 1994) and Crémer et al. (1998b), where the information structure in complete contracting models is endogenized. In their wording, information acquisition is a strategic activity, since it is conducted only for the purpose of rent seeking.

[13] The superscript (A or B) always refers to the ownership structure ($o = A$ or $o = B$).

[14] Notice that the same result would be obtained if party A *and* party B learned the realization of θ. What is important here is only whether or not there is asymmetric information between A and B.

[15] In general, party B could make party A reveal θ with a direct revelation mechanism. Yet, it follows from standard Bayesian mechanism design (see, e.g., Myerson, 1981; John Riley and Richard Zeckhauser, 1983), that party B can achieve the same payoff with the simple posted-price mechanism analyzed here.

In this case, the parties' expected total surplus is given by the expression

$$\bar{S}^A = \alpha v(\bar{i}^A) + (1-\alpha)\left[F(\lambda^*) + \int_{\lambda^*}^{1} \theta\, dF(\theta)\right] v(\bar{i}^A) - \bar{i}^A,$$

since no agreement is reached if party B offers $\lambda^* < \theta$.

LEMMA 1: *The investment levels can be ordered as follows:*

$$i^B < i^A < \bar{i}^A < i^{FB}.$$

PROOF:

The lemma immediately follows from concavity of $v(i)$ and inspection of the first-order conditions.

In accordance with the prediction of the standard property rights model, party A's investment incentives are weaker under integration ($o = B$) than under nonintegration ($o = A$). In the latter case, it is interesting to note that party A has stronger incentives to invest in the presence of asymmetric information than under symmetric information. The intuition for this result is that in the case of nonintegration, even if party B has all the bargaining power, it must leave a rent to party A (i.e., party A will get more than its default payoff) when party A has private information. This improves party A's investment incentives in comparison to the case of symmetric information, where it would get its default payoff only if party B had all the bargaining power.

Now the main result can be stated as follows.

PROPOSITION 1: (a) *In scenario I (symmetric information), nonintegration* ($o = A$) *is the optimal ownership structure.* (b) *In scenario II (asymmetric information), integration* ($o = B$) *is optimal whenever* $S^B > \bar{S}^A$, *which must be the case if party A's bargaining power* α *is sufficiently large. If* α *is sufficiently small, nonintegration is optimal.*

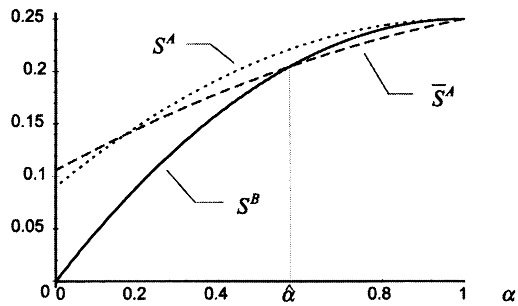

FIGURE 2. THE EXPECTED TOTAL SURPLUS

PROOF:

See the Appendix.

Intuitively, under symmetric information, the parties always agree on collaboration at date $t = 2$; i.e., ex post efficiency is always achieved. In accordance with the standard property rights theory, the parties will then choose nonintegration ($o = A$), because this ownership structure maximizes party A's investment incentives. If, however, bargaining at date $t = 2$ takes place under asymmetric information, ex post efficiency will not always be achieved. Integration ($o = B$) can then become optimal, because the weaker investment incentives can be overcompensated by the fact that ex post efficiency is ensured.

Specifically, if party A has all the bargaining power, it can extract the total surplus and hence the first best is achieved regardless of the ownership structure. Yet, if party A's bargaining power α is reduced slightly below 1, then a first-order loss occurs under nonintegration (since ex post efficiency will not always be achieved), while only a second-order loss due to the reduced investment level occurs under integration. Hence, integration must be optimal if α is sufficiently large.

As an illustration, consider the example displayed in Figure 2.[16] The dotted curve depicts the expected total surplus under nonintegration as a function of party A's bargaining power α when there is symmetric information (S^A). The dashed curve shows the surplus under nonintegration when party A has private information

[16] In the example depicted in Figure 2, $v(i) = i^{1/2}$ and $F(\theta) = \theta^{1/4}$.

($\bar{S}^A$). Observe that the surplus in the case of asymmetric information can be larger than in the case of symmetric information, because inducing investments can be more important than avoiding ex post inefficiencies. The solid curve depicts the surplus under integration (S^B). If party B has all the bargaining power ($\alpha = 0$), then under integration, party A will always get zero, so that no investment is induced. Thus, integration cannot be optimal if α is sufficiently small. Yet, the figure illustrates that for values of α larger than a threshold level $\hat{\alpha}$, integration is optimal when party A has private information.

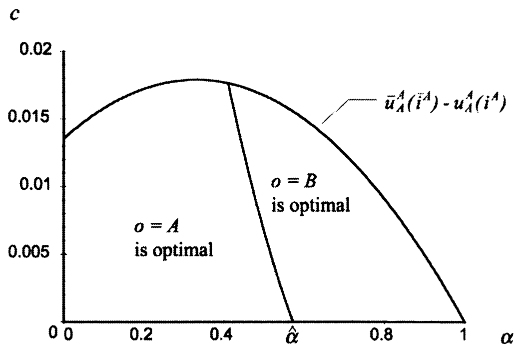

FIGURE 3. THE OPTIMAL OWNERSHIP STRUCTURE

III. Endogenous Information Gathering

A. *Observable Information Gathering*

In this section, the assumption that the information gathering costs c are either prohibitively large or zero will be dropped. Hence, party A's decision whether to gather information is no longer trivial. Recall that in the basic model, party B can observe if party A has invested c in order to learn the realization of the state of the world. In this case, the following result can be obtained.

COROLLARY 1: *(a) If* $c > \bar{u}_A^A(\bar{i}^A) - u_A^A(i^A)$, *then party A will not acquire private information, so that nonintegration* ($o = A$) *is optimal. (b) If* $c \leq \bar{u}_A^A(\bar{i}^A) - u_A^A(i^A)$, *then under nonintegration party A will acquire private information. Hence, integration* ($o = B$) *is optimal whenever* $S^B > \bar{S}^A - c$, *which is the case if party A's bargaining power* α *is sufficiently large.*

PROOF:

See the Appendix.

Party A will not gather private information if the costs of doing so are too large. In this case, we are back in scenario I (symmetric information). However, if party A's costs of information gathering are sufficiently small, it will become informed. Then the total surplus under nonintegration is $\bar{S}^A - c$, so that integration is optimal whenever $S^B > \bar{S}^A - c$. As an illustration, consider again the example that has been depicted in the previous section. In Figure 3, it is shown which ownership structure is optimal depending on the information gathering costs c and party A's bargaining power α. Note that if c is strictly positive, integration can be optimal even if $\alpha < \hat{\alpha}$. In comparison to the previous section, integration now has the additional advantage that it avoids costly rent seeking (i.e., resources that are wasted for purely redistributive purposes).

It should be noted that the effect of the information acquisition costs on the expected total surplus is ambiguous. In Figure 2, if α is very small, the largest surplus will be realized if $c = 0$. For intermediate values of α, making c larger than zero will initially decrease the surplus (as long as party A gathers information), but the maximal surplus is attained if c is sufficiently high (so that S^A becomes relevant). Finally, if α is very large, then increasing c initially has no effect as long as the parties choose $o = B$. Yet, once c is sufficiently high, so that party A will not gather information, the parties choose $o = A$ and the surplus attains its maximum.

B. *Unobservable Information Gathering*

Thus far, it has been assumed that party B can observe whether party A has invested c to gather private information. Dropping this assumption has no consequences if $\lambda^* = E[\theta]$, so that the offer that party B makes to party A under nonintegration does not depend upon whether or not B believes that A is privately informed.[17] Now consider distribution functions F such that $\lambda^* \neq E[\theta]$, where $(1 - \lambda)F(\lambda)$ is concave. The previous results still hold if the information gath-

[17] Note that this is the case for a prominent class of distribution functions, $F(\theta) = \theta^\kappa$ with $\kappa > 0$, where $\lambda^* = E[\theta] = \kappa/(1 + \kappa)$.

ering costs c are sufficiently small (large), so that under nonintegration, party A would always (never) gather information. For intermediate values of c, however, we must now take into consideration the possibility that party A might mix between gathering and not gathering information. While the details depend on whether λ^* is smaller or larger than $E[\theta]$ (see the Appendix), qualitatively the results of the basic model are still valid.

COROLLARY 2: *Assume that party B cannot observe whether party A has gathered information. If c is sufficiently large, it is still the case that nonintegration is optimal. Otherwise, under nonintegration there would be an ex post inefficiency due to asymmetric information with positive probability, so that for a sufficiently large α, integration is optimal.*

PROOF:
See the Appendix.

IV. A Remark on Robustness

So far, it has been assumed that after the relationship-specific investments are sunk, the surplus that the two parties can generate together, $v(i)$, is always larger than the default payoffs that the parties can realize on their own. This assumption is usually made both in the property rights approach to the theory of the firm and in transaction cost economics. Nevertheless, one might wonder whether the analysis can be generalized to situations in which the assumption does not hold.

For this purpose, consider the following modified model. If at date $t = 2$ the parties do not agree on collaboration, party A alone can generate $w(i, \theta)$ if it has access to the asset, while the default payoffs are still zero otherwise. The information parameter θ is distributed on $[\underline{\theta}, \bar{\theta}]$ according to the distribution function $F(\theta)$. Assume that $w_\theta > 0$ and $w(i, \underline{\theta}) < v(i) < w(i, \bar{\theta})$. Let the functions again be well-behaved such that there are unique interior solutions. Assume that party A always learns θ after the bargaining stage at no cost,[18] so that if party B has agreed to collaborate, party A will privately generate the surplus $x(i, \theta) = \max\{v(i), w(i, \theta)\}$. For instance, collaboration could mean here that party B reveals know-how, which will be used by party A if and only if $v(i) \geq w(i, \theta)$. The first-best investment level i^{FB} now maximizes the expected total surplus $E[x(i, \theta)] - i$. It turns out that the main insights of the analysis are robust with regard to this modification.

REMARK 1: *Consider the modified model and let the condition $v(i) \geq \max_\theta w(i, \theta)[1 - F(\theta)]$ be satisfied. Integration is optimal if party A privately learns the realization of θ at date $t = 1.5$ and if party A's bargaining power α is sufficiently large.*

PROOF:
See the Appendix.

Note that the condition in Remark 1 is significantly weaker than the standard assumption $v \geq w$. For example, if $w(i, \theta) = \theta v(i)$ and θ is uniformly distributed on $[0, \bar{\theta}]$, then the condition in Remark 1 requires only that $\bar{\theta} \leq 4$.[19]

Finally, it should be emphasized that, in practice, information gathering is not always a purely strategic activity undertaken only in order to obtain an information rent. Information gathering can also be productive. For instance, if the realization of θ is not always observed by party A before the surplus is generated, and if $w(i, \theta)$ can be larger than $v(i)$, then an ownership structure that encourages information acquisition may be more advantageous.[20]

V. Conclusion

What determines the boundaries of the firm? One answer to the classic question raised by Ronald Coase (1937) has been formalized by the property rights approach to the theory of the firm. Asset ownership improves a party's posi-

[18] Similar assumptions are made in complete contracting models with strategic information gathering. See Crémer and Khalil (1992, 1994) and Crémer et al. (1998b).

[19] If the condition is not satisfied, then an ex post inefficiency may occur, even under integration. The reason is that if party B can make the offer, it may demand a payment from party A that is larger than $v(i)$, which will be rejected by party A if θ is small (see the Appendix).

[20] See Crémer et al. (1998a) for a complete contracting model in which information gathering is a productive activity. Philippe Aghion and Tirole (1997) study productive information gathering in an incomplete contracting framework.

tion in ex post bargaining and hence influences the incentives to make ex ante investments. It has been demonstrated here, however, that prominent implications of the property rights theory can be overturned if a party can acquire private information about its default payoff. Socially wasteful rent seeking in the form of strategic information gathering, and the resulting ex post inefficiencies due to bargaining under asymmetric information, may be more important determinants of the optimal ownership structure than ex ante investment considerations.

In particular, it has been shown that ownership by party B can be optimal, even though only the indispensable party A makes an investment decision. It is straightforward to extend the present model to a more symmetric framework in which both parties have an investment opportunity. In this case, joint ownership (where either side can veto the use of the asset) may well be optimal, which is in contrast to the standard property rights approach.[21] The reason is that while sole ownership by party A or party B is good for the owner's investment incentives, it also induces the owner to gather information about the default payoff, so that bargaining under asymmetric information may lead to ex post inefficiencies. Under joint ownership, the default payoffs are known to be zero, so that there is no strategic information gathering and an ex post efficient agreement is always reached.[22]

The plausible assumption that a party can have superior information about the default payoff that it can realize on its own might be the most natural way to introduce asymmetric information into the property rights theory. Of course, one could easily imagine further ways to relax the assumption of the standard model that there is symmetric information. For example, the parties might also have asymmetric information about private benefits from collaboration, or the state of the world might be realized before the investments take place. More sophisticated bargaining procedures and more complex ownership structures or contractual responses could also be studied. While such extensions might be pursued in future research, they are unlikely to change the main message of the present analysis, according to which ex post inefficiencies as emphasized in Williamson's (1975, 1985) transaction cost theory can easily overturn the results of the standard property rights model that is exclusively focused on ex ante incentives.

[21] Holmström (1999) has pointed out that joint ventures are an important part of the corporate landscape, hence the prediction of the property rights theory that joint ownership never is optimal is counterfactual.

[22] For alternative explanations of joint ownership, see also Stephanie Rosenkranz and Schmitz (1999, 2003), Maija Halonen (2002), Hongbin Cai (2003), and Sergei Guriev (2003).

Appendix

PROOF OF PROPOSITION 1:

At date $t = 0$, the parties agree on the ownership structure that maximizes the expected total surplus.

(a) Consider, first, scenario I (symmetric information). Under integration ($o = B$), the expected total surplus is $S^B = v(i^B) - i^B$, while it is $S^A = v(i^A) - i^A$ under nonintegration. Concavity of $v(i) - i$ together with $i^B < i^A < i^{FB}$ (see Lemma 1) implies that $o = A$ leads to a larger expected total surplus than $o = B$.

(b) Now consider scenario II, so that party A has private information under nonintegration. The expected total surplus is then given by

$$\bar{S}^A = \left(\alpha + (1-\alpha)\left[F(\lambda^*) + \int_{\lambda^*}^{1} \theta \, dF(\theta)\right]\right) v(\bar{i}^A) - \bar{i}^A,$$

while the surplus under integration is still given by $S^B = v(i^B) - i^B$. It is straightforward to see that $o = A$ must be optimal ($\bar{S}^A > S^B$) if α is sufficiently small. When α goes to zero, then i^B and hence S^B go to zero, while $\bar{i}^A$ converges to $\tilde{i}^A > 0$, where $E[\max\{\lambda^*, \theta\}]v'(\tilde{i}^A) = 1$. On the other hand, if

α were equal to 1, then the first best would be achieved regardless of the ownership structure. In order to see that $S^B > \bar{S}^A$ if α is slightly smaller than 1, note that

$$\frac{di^B}{d\alpha} = -\frac{v'(i^B)}{\alpha v''(i^B)} > 0$$

and hence

$$\frac{dS^B}{d\alpha} = (v'(i^B) - 1)\frac{di^B}{d\alpha} \geq 0$$

for $\alpha \leq 1$. Moreover,

$$\frac{d\bar{i}^A}{d\alpha} = -\frac{1 - E[\max\{\lambda^*, \theta\}]}{\alpha + (1-\alpha)E[\max\{\lambda^*, \theta\}]}\frac{v'(\bar{i}^A)}{v''(\bar{i}^A)} > 0$$

and thus

$$\frac{d\bar{S}^A}{d\alpha} = \left(1 - F(\lambda^*) - \int_{\lambda^*}^1 \theta\, dF(\theta)\right)v(\bar{i}^A) + \left[\left(\alpha + (1-\alpha)\left[F(\lambda^*) + \int_{\lambda^*}^1 \theta\, dF(\theta)\right]\right)v'(\bar{i}^A) - 1\right]\frac{d\bar{i}^A}{d\alpha}$$

$$= \int_{\lambda^*}^1 [1-\theta]v(\bar{i}^A)dF(\theta) + (1-\alpha)[1-\lambda^*]F(\lambda^*)v'(\bar{i}^A)\frac{d\bar{i}^A}{d\alpha} > 0$$

where the first-order condition

$$\left(\alpha + (1-\alpha)\left[\lambda^* F(\lambda^*) + \int_{\lambda^*}^1 \theta\, dF(\theta)\right]\right)v'(\bar{i}^A) = 1$$

has been used. The fact that $S^B = \bar{S}^A$ if $\alpha = 1$ and the fact that

$$\left.\frac{dS^B}{d\alpha}\right|_{\alpha=1} = 0 < \left.\frac{d\bar{S}^A}{d\alpha}\right|_{\alpha=1}$$

together with continuity imply that $\bar{S}^A$ must be smaller than S^B if α is sufficiently close to 1.

PROOF OF COROLLARY 1:

Since party B can observe whether party A has invested c in information gathering, it will behave as discussed in Section II. If party A plans to gather information, its payoff is maximized by the investment level $\bar{i}^A$; otherwise it is maximized by the investment level i^A. Hence, it is easy to see that party A gathers information whenever its total payoff in this case, $\bar{u}_A^A(\bar{i}^A) - c$, is larger than $u_A^A(i^A)$, its payoff if it does not gather information. Given Proposition 1, the remainder of the Corollary follows immediately.

PROOF OF COROLLARY 2:

The analysis of the basic model is still valid in case of integration. Consider nonintegration. If party A can make the offer, it still demands the whole pie, $v(i)$. Assume now that party B can make the offer. If party B believes that party A has gathered information with probability π, party B's expected profit when it offers the fraction λ of the pie to party A is given by $\pi F(\lambda)(1-\lambda)v(i)$ if $\lambda < E\theta$ and by $[\pi F(\lambda) + 1 - \pi](1-\lambda)v(i)$ if $\lambda \geq E\theta$. Recall that $\lambda^* = \arg\max_{\lambda \in [0,1]} F(\lambda)(1-\lambda)$ and let $\tilde{\lambda}(\pi) = \arg\max_{\lambda \in [0,1]}[\pi F(\lambda) + 1 - \pi](1-\lambda)$, so that $\tilde{\lambda}(\pi) < \lambda^*$ for $\pi < 1$. Consider first the case $\lambda^* < E\theta$. It is optimal for party B to offer $\lambda = \lambda^*$ if $\pi F(\lambda^*)(1-\lambda^*) \geq [\pi F(E\theta) + 1 - \pi](1 - E\theta)$, and it is optimal for B to offer $\lambda = E\theta$ if $\pi F(\lambda^*)(1-\lambda^*) \leq [\pi F(E\theta) + 1 - \pi](1 - E\theta)$. Next, consider the case $\lambda^* > E\theta$. It is then optimal for party B to offer $\lambda = \max\{\tilde{\lambda}(\pi), E\theta\}$.

If party A believes that party B will offer λ, party A's expected payoff (after the investment costs i are sunk) is given by $[\alpha + (1-\alpha)\max\{E\theta, \lambda\}]v(i)$ if it does not gather information, and by $[\alpha + (1-\alpha)E[\max\{\theta, \lambda\}]]v(i) - c$ if it gathers information.

Consider the case $\lambda^* < E\theta$. If $c \leq (1-\alpha)[E[\max\{\theta, \lambda^*\}] - E\theta]v(i)$, then in equilibrium, party A gathers information ($\pi = 1$) and party B offers $\lambda = \lambda^*$.[23] If $c \geq (1-\alpha)E[\max\{\theta - E\theta, 0\}]v(i)$, then party A remains uninformed ($\pi = 0$) and party B offers $\lambda = E\theta$. Otherwise, party A gathers information with probability $\hat{\pi}$, while party B offers $\lambda = \lambda^*$ with probability ρ and $\lambda = E\theta$ with probability $1 - \rho$, where $\hat{\pi}F(\lambda^*)(1-\lambda^*) = [\hat{\pi}F(E\theta) + 1 - \hat{\pi}](1 - E\theta)$ and $c = (1-\alpha)[\rho E[\max\{\theta, \lambda^*\}] + (1-\rho)E[\max\{\theta, E\theta\}] - E\theta]v(i)$.

Next, consider the case $\lambda^* > E\theta$. If $c \leq (1-\alpha)E[\max\{\theta - \lambda^*, 0\}]v(i)$, then in equilibrium $\pi = 1$ and $\lambda = \lambda^*$. If $c \geq (1-\alpha)E[\max\{\theta - E\theta, 0\}]v(i)$, then $\pi = 0$ and $\lambda = E\theta$. Otherwise, party A gathers information with probability $\tilde{\pi}$ and $\lambda = \tilde{\lambda}(\tilde{\pi})$, where $c = (1-\alpha)[E[\max\{\theta, \tilde{\lambda}(\tilde{\pi})\}] - \max\{E\theta, \tilde{\lambda}(\tilde{\pi})\}]v(i)$.

At date $t = 1$, party A chooses the investment level i that maximizes its expected payoff, given the equilibrium behavior just characterized. In both cases, party A never gathers information if c is sufficiently large. Otherwise, under nonintegration there will be an ex post inefficient outcome due to asymmetric information with strictly positive probability. Hence, the corollary follows as in the basic model.

PROOF OF REMARK 1:

Consider integration ($o = B$) first. If no one knows the state of the world at date $t = 2$, then with probability α, party A offers party B its default payoff zero, while with probability $1 - \alpha$ party B demands a payment $E[x(i, \theta)]$ from party A. Hence, agreement is always reached and party A invests $i^B = \arg\max_{i \geq 0}(\alpha E[x(i, \theta)] - i)$. Suppose now that party A has private information. Party A still offers zero to party B, but party B will now demand a payment $p(i)$, where $p(i) = v(i)$ if $v(i) \geq \max_\theta w(i, \theta)[1 - F(\theta)]$ and $p(i) = w(i, \mu^*(i))$ with $\mu^*(i) = \arg\max_{\mu \in [\underline{\theta}, \bar{\theta}]} w(i, \mu)[1 - F(\mu)]$ otherwise. Hence, party A invests $\bar{i}^B = \arg\max_{i \geq 0}(\alpha E[x(i, \theta)] + (1-\alpha)E[x(i, \theta) - p(i) | x(i, \theta) \geq p(i)]\Pr\{x(i, \theta) \geq p(i)\} - i)$. Note that if $v(i) \geq \max_\theta w(i, \theta)[1 - F(\theta)]$ for all i, an ex post efficient agreement is always reached and thus $\bar{i}^B = \arg\max_{i \geq 0}(\alpha E[x(i, \theta)] + (1-\alpha)E[x(i, \theta) - v(i)] - i)$.

Next, consider nonintegration ($o = A$). Under symmetric information, party A offers party B its default payoff zero for its collaboration, while party B demands $E[x(i, \theta) - w(i, \theta)]$, so that party A invests $i^A = \arg\max_{i \geq 0}(\alpha E[x(i, \theta)] + (1-\alpha)E[w(i, \theta)] - i)$. If party A has private information, it will still offer zero, while party B will demand the payment $v(i) - w(i, \lambda^*(i))$, where $\lambda^*(i) = \arg\max_{\lambda \in [\underline{\theta}, \bar{\theta}]}[v(i) - w(i, \lambda)]F(\lambda)$. Hence, party A rejects if $\theta > \lambda^*(i)$, so that there is an ex post inefficiency whenever $v(i) > w(i, \theta) > w(i, \lambda^*(i))$, and party A invests $\bar{i}^A = \arg\max_{i \geq 0}(\alpha E[x(i, \theta)] + (1-\alpha)E[\max\{w(i, \theta), w(i, \lambda^*(i))\}] - i)$.

It is now straightforward to see that the central results are qualitatively robust if $v(i) \geq \max_\theta w(i, \theta)[1 - F(\theta)]$. Consider the scenario with asymmetric information. Ex post efficiency is achieved if $o = B$, while there is an ex post inefficiency with positive probability if $o = A$. Hence, for α sufficiently close to 1 (where the first best is always attained), integration must be optimal. Formally, this follows from the fact that the derivative of the expected surplus $\bar{S}^B = E[x(\bar{i}^B, \theta)] - \bar{i}^B$ with respect

[23] Note that if $c = (1-\alpha)[E[\max\{\theta, \lambda^*\}] - E\theta]v(i)$, there are additional (inferior) equilibria, in which $\pi \in [\hat{\pi}, 1)$ and $\lambda = \lambda^*$, where $\hat{\pi}$ is defined below. For simplicity, similar knife-edge cases are ignored in what follows.

to α is zero at $\alpha = 1$, while the derivative of

$$\bar{S}^A = \alpha E[x(\bar{i}^A, \theta)] + (1 - \alpha)\left(\int_{\underline{\theta}}^{\lambda^*(i)} x(\bar{i}^A, \theta)\, dF(\theta) + \int_{\lambda^*(i)}^{\bar{\theta}} w(\bar{i}^A, \theta)\, dF(\theta)\right) - \bar{i}^A$$

with respect to α at $\alpha = 1$ is equal to

$$\int_{\lambda^*(i^{FB})}^{\bar{\theta}} x(i^{FB}, \theta) - w(i^{FB}, \theta)\, dF(\theta) = \int_{\lambda^*(i^{FB})}^{\tilde{\theta}(i^{FB})} x(i^{FB}, \theta) - w(i^{FB}, \theta)\, dF(\theta) > 0$$

where $w(i^{FB}, \tilde{\theta}(i^{FB})) = v(i^{FB})$. The strict inequality holds because $\lambda^*(i^{FB}) < \tilde{\theta}(i^{FB})$ and $x(i^{FB}, \theta) = v(i^{FB}) > w(i^{FB}, \theta)$ for $\theta < \tilde{\theta}(i^{FB})$.

REFERENCES

Aghion, Philippe and Tirole, Jean. "Formal and Real Authority in Organizations." *Journal of Political Economy*, 1997, *105*(1), pp. 1–29.

Arrow, Kenneth J. "Vertical Integration and Communication." *Bell Journal of Economics*, 1975, *6*(1), pp. 173–83.

Bajari, Patrick and Tadelis, Steven. "Incentives versus Transaction Costs: A Theory of Procurement Contracts." *RAND Journal of Economics*, 2001, *32*(3), pp. 387–407.

Baker, George; Gibbons, Robert and Murphy, Kevin J. "Relational Contracts and the Theory of the Firm." *Quarterly Journal of Economics*, 2002, *117*(1), pp. 39–84.

Cai, Hongbin. "A Theory of Joint Asset Ownership." *RAND Journal of Economics*, 2003, *34*(1), pp. 63–77.

Chiu, Y. Stephen. "Noncooperative Bargaining, Hostages, and Optimal Asset Ownership." *American Economic Review*, 1998, *88*(4), pp. 882–901.

Coase, Ronald H. "The Nature of the Firm." *Economica*, 1937, *4*(16), pp. 386–405.

Cramton, Peter; Gibbons, Robert and Klemperer, Paul. "Dissolving a Partnership Efficiently." *Econometrica*, 1987, *55*(3), pp. 615–32.

Crémer, Jacques and Khalil, Fahad. "Gathering Information before Signing a Contract." *American Economic Review*, 1992, *82*(3), pp. 566–78.

Crémer, Jacques and Khalil, Fahad. "Gathering Information before the Contract Is Offered: The Case with Two States of Nature." *European Economic Review*, 1994, *38*(3–4), pp. 675–82.

Crémer, Jacques; Khalil, Fahad and Rochet, Jean-Charles. "Contracts and Productive Information Gathering." *Games and Economic Behavior*, 1998a, *25*(2), pp. 174–93.

Crémer, Jacques; Khalil, Fahad and Rochet, Jean-Charles. "Strategic Information Gathering before a Contract Is Offered." *Journal of Economic Theory*, 1998b, *81*(1), pp. 163–200.

de Meza, David and Lockwood, Ben. "Does Asset Ownership Always Motivate Managers? Outside Options and the Property Rights Theory of the Firm." *Quarterly Journal of Economics*, 1998, *113*(2), pp. 361–86.

Farrell, Joseph and Gibbons, Robert. "Cheap Talk about Specific Investments." *Journal of Law, Economics, and Organization*, 1995, *11*(2), pp. 313–34.

Grossman, Sanford J. and Hart, Oliver D. "The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration." *Journal of Political Economy*, 1986, *94*(4), pp. 691–719.

Guriev, Sergei. "Incomplete Contracts with Cross-Investments." *Contributions to Theoretical Economics*, 2003, *3*(1), art. 5, pp. 1–30.

Halonen, Maija. "Reputation and the Allocation of Ownership." *Economic Journal*, 2002, *112*(481), pp. 539–58.

Hart, Oliver. *Firms, contracts, and financial structure*. Oxford: Clarendon Press, 1995.

Hart, Oliver and Moore, John. "Property Rights and the Nature of the Firm." *Journal of Political Economy*, 1990, *98*(6), pp. 1119–58.

Hart, Oliver and Moore, John. "Foundations of Incomplete Contracts." *Review of Economic Studies*, 1999, *66*(1), pp. 115–38.

Hart, Oliver; Shleifer, Andrei and Vishny, Robert W. "The Proper Scope of Government: Theory and an Application to Prisons." *Quarterly Journal of Economics*, 1997, *112*(4), pp. 1127–61.

Hermalin, Benjamin E. and Katz, Michael L. "Judicial Modification of Contracts between Sophisticated Parties: A More Complete View of Incomplete Contracts and Their Breach." *Journal of Law, Economics, and Organization*, 1993, *9*(2), pp. 230–55.

Holmström, Bengt. "The Firm as a Subeconomy." *Journal of Law, Economics, and Organization*, 1999, *15*(1), pp. 74–102.

Holmström, Bengt and Roberts, John. "The Boundaries of the Firm Revisited." *Journal of Economic Perspectives*, 1998, *12*(4), pp. 73–94.

Kreps, David M. "Markets and Hierarchies and (Mathematical) Economic Theory," in Glenn R. Carroll and David J. Teece, eds., *Firms, markets, and hierarchies: The transaction cost economics perspective*. Oxford: Oxford University Press, 1999, pp. 121–55.

Matouschek, Niko. "Information and the Optimal Ownership Structure of Firms." Center for Economic Policy Research, CEPR Discussion Papers: No. 3216, 2002.

McKelvey, Richard D. and Page, Talbot. "Status Quo Bias in Bargaining: An Extension of the Myerson–Satterthwaite Theorem with an Application to the Coase Theorem." *Journal of Economic Theory*, 2002, *107*(2), pp. 336–55.

Muthoo, Abhinay. *Bargaining theory with applications*. Cambridge: Cambridge University Press, 1999.

Myerson, Roger B. "Optimal Auction Design." *Mathematics of Operations Research*, 1981, *6*(1), pp. 58–73.

Myerson, Roger B. and Satterthwaite, Mark A. "Efficient Mechanisms for Bilateral Trading." *Journal of Economic Theory*, 1983, *29*(2), pp. 265–81.

Rajan, Raghuram G. and Zingales, Luigi. "Power in a Theory of the Firm." *Quarterly Journal of Economics*, 1998, *113*(2), pp. 387–432.

Riley, John and Zeckhauser, Richard. "Optimal Selling Strategies: When to Haggle, When to Hold Firm." *Quarterly Journal of Economics*, 1983, *98*(2), pp. 267–89.

Riordan, Michael H. "What Is Vertical Integration?" in Masahiko Aoki, Bo Gustafsson, and Oliver E. Williamson, eds., *The firm as a nexus of treaties*. London: Sage Publications, 1990, pp. 94–111.

Rogerson, William P. "Contractual Solutions to the Hold-up Problem." *Review of Economic Studies*, 1992, *59*(4), pp. 777–93.

Rosenkranz, Stephanie and Schmitz, Patrick W. "Know-How Disclosure and Incomplete Contracts." *Economics Letters*, 1999, *63*(2), pp. 181–85.

Rosenkranz, Stephanie and Schmitz, Patrick W. "Optimal Allocation of Ownership Rights in Dynamic R&D Alliances." *Games and Economic Behavior*, 2003, *43*(1), pp. 153–73.

Samuelson, William. "A Comment on the Coase Theorem," in Alvin E. Roth, ed., *Game-theoretic models of bargaining*. Cambridge: Cambridge University Press, 1985, pp. 321–39.

Schmidt, Klaus M. "The Costs and Benefits of Privatization: An Incomplete Contracts Approach." *Journal of Law, Economics, and Organization*, 1996, *12*(1), pp. 1–24.

Schmitz, Patrick W. "The Hold-up Problem and Incomplete Contracts: A Survey of Recent Topics in Contract Theory." *Bulletin of Economic Research*, 2001, *53*(1), pp. 1–17.

Schmitz, Patrick W. "On the Interplay of Hidden Action and Hidden Information in Simple Bilateral Trading Problems." *Journal of Economic Theory*, 2002a, *103*(2), pp. 444–60.

Schmitz, Patrick W. "Simple Contracts, Renegotiation under Asymmetric Information, and the Hold-up Problem." *European Economic Review*, 2002b, *46*(1), pp. 169–88.

Schmitz, Patrick W. and Sliwka, Dirk. "On Synergies and Vertical Integration." *International Journal of Industrial Organization*, 2001, *19*(8), pp. 1281–95.

Tirole, Jean. "Procurement and Renegotiation." *Journal of Political Economy*, 1986, *94*(2), pp. 235–59.

Tirole, Jean. "Incomplete Contracts: Where Do We Stand?" *Econometrica*, 1999, *67*(4), pp. 741–81.

Whinston, Michael D. "On the Transaction Cost Determinants of Vertical Integration." *Journal of Law, Economics, and Organization*, 2003, *19*(1), pp. 1–23.

Williamson, Oliver E. *Markets and hierarchies:*

Analysis and antitrust implications. New York: Free Press, 1975.

Williamson, Oliver E. *The economic institutions of capitalism*. New York: Free Press, 1985.

Williamson, Oliver E. "The New Institutional Economics: Taking Stock, Looking Ahead." *Journal of Economic Literature*, 2000, *38*(3), pp. 595–613.

Williamson, Oliver E. "The Theory of the Firm as Governance Structure: From Choice to Contract." *Journal of Economic Perspectives*, 2002, *16*(3), pp. 171–95.