Incomplete Contracts and the Theory of the Firm

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1. INTRODUCTION

"The Nature of the Firm" (together with Coase's later paper, "The Problem of Social Cost") has had an enormous influence on the development of research in the theory of organization, even if for a long time it was, in Coase's words, "much cited and little used." The situation has changed in the last ten to fifteen years, however, with the publication of a number of contributions which have refined and extended Coase's ideas about the firm. My plan in this paper is to reflect on recent developments and to offer a perspective on where the field stands and also where it may be going. I will begin with a brief summary of the main ideas and issues as they have grown out of Coase's work.[1] I will then discuss how the firm as an institution can be thought of as arising from the incompleteness of contracts and the need to allocate residual control rights. Finally, I will return to a comparison of this view of the firm with others that have been advanced in the literature.

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1. For an excellent review of the literature which has followed Coase, see Joskow. The reader is also referred to the recent general survey of vertical integration by Perry. One very important topic considered by Perry (but ignored here) is the role of integration in permitting the exploitation of monopoly power in upstream or downstream markets.

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2. A BRIEF SUMMARY OF THE MAIN IDEAS

As many people have noted, standard neoclassical theory treats the firm as a black box. The firm is taken as given; no attention is paid to how it came into existence, the nature of its internal organization, or whether anything would change if two firms merged and called themselves a single firm.

Given this background, Coase's 1937 paper was a very refreshing development. Coase began to deal with the very questions that neoclassical theory had ignored. What is a firm? Where do the boundaries of one firm cease and those of another firm begin? What are the costs and benefits of integration? As is well known, Coase's answers are based on the idea that the benefit from firm A merging with firm B comes from the fact that the manager of firm A will have authority over the manager of firm B. That is, if B is an employee of A, A can (within limits) give B orders. In contrast, if firms A and B are separate entities, manager A must resort to persuading or enticing B to do what he wants by the use of prices (more generally, via a contract). In other words, integration effectively shifts the terms of the relationship from a price mode to a quantity mode. Coase's point is that in certain circumstances the quantity mode may be more efficient. Under these conditions, integration will occur.[2]

Put this way, the argument seems symmetric: we would also expect there to be cases where the quantity mode is *less* efficient than the price mode. That is, integration might be *un*desirable. Interestingly, however, Coase did not take this route. Rather he argued that the costs of integration come from increased bureaucracy and also from the greater likelihood of managerial error. That is, managers of large firms are simply likely to be less efficient than managers of small firms.

Perhaps one of the reasons it took time for Coase's work to catch on is that it is not at all obvious how to formalize or operationalize the benefits from being in the quantity mode. Moreover, as Alchian and Demsetz (1972) have pointed out, the quantity mode is not peculiar to transactions within the firm. In particular, given that most employment contracts are "at will," usually the most extreme penalty a boss can impose on an employee is to fire him. However, this option may also be available in an ordinary contractual relationship. For example, as Alchian and Demsetz (1972) note, a customer who decides to abandon his grocer and shop elsewhere may be interpreted to have "fired" him. That is, it is not clear that the benefit of moving to the quantity mode can only be achieved through integration.[3]

2. The discussion of price and quantity modes is suggestive of the later work of Weitzman, although the latter is not explicitly concerned with the structure of firms. See also Simon for an early formalization of the two modes.

3. Coase might well respond that the rights and duties that two parties have in an employment relation differ from those in a standard contractual relation by more than just the right to fire. This idea has been elaborated on recently by Masten, who argues that an employee has a duty of loyalty and a responsibility to disclose relevant information to an employer in a way that

The work which followed Coase has taken a rather different approach to the benefits of integration. A major development, due to Williamson (1975, 1979, 1985) and Klein, Crawford, and Alchian (1978), is the idea that integration is likely to be important in situations where relationship-specific investments are large, that is, where the investments the parties make have a much greater use inside the relationship than outside.[4] Once such relationship-specific investments have been made the parties are (at least partially) "locked in," and hence they are at each other's mercy and opportunistic behavior may rule.[5] Such behavior may cause an ex post division of surplus which does not appropriately reflect ex ante investment decisions, and, as a consequence, these decisions may be distorted. In the eyes of Williamson and Klein, Crawford, and Alchian, a benefit of integration is that the scope for opportunistic behavior may be reduced. For example, the ability of the supplier of an input to "hold up" a would-be purchaser may be lessened if the supplier is part of the same enterprise. This may be either because the buyer has greater control over the seller (for example, because of the shift to Coase's quantity mode) or because he is more informed about the seller's behavior; or because the seller's monetary incentives are different under integration.[6] Like Coase, however, Williamson and Klein, Crawford, and Alchian do not use the same theory to explain the costs of integration.[7] Rather the costs of integration are ascribed by Williamson to increased bureaucracy and are not discussed at any length by Klein, Crawford, and Alchian.

3. INCOMPLETE CONTRACTS AND RESIDUAL RIGHTS OF CONTROL

The work of Coase, Williamson, and Klein, Crawford, and Alchian is based on the idea that there are transaction costs of writing contracts. In a world where it was costless to think about, plan for, and write down provisions for future events, parties engaged in trade would write a "comprehensive" contract which specifies precisely what each of their obligations is in every conceivable state of the world. Under these conditions, there would never be any reason for the parties to modify or update their contract since everything would be anticipated and planned for in advance. Nor would any dis-

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an independent contractor does not. Coase's current view appears to be that the emphasis on the employee relationship as the archetype of the firm is a *weakness* of his 1937 paper. In Coase (1988), he argues that an essential aspect of the firm relationship is the multiplicity of contracts with different individuals who cooperate with each other.

4. Williamson has also emphasized the role of impacted information, bounded rationality, and opportunism. It is now apparent from Coase's correspondence that Coase considered the importance of specific investments as early as 1932. However, Coase was not persuaded of their significance and did not mention specific investments in his 1937 paper.

5. The link between relationship-specific investments and opportunistic behavior is stressed in Goldberg.

6. Or it could even be that the seller's feelings of loyalty change.

7. An exception is Williamson (1985, ch. 6). This will be discussed at greater length below.

putes ever occur since an outsider (for instance, a court) could (costlessly) determine whether one of the parties has been in breach of contract and impose an appropriate penalty.

In such a world, it is hard to see what the benefits (or costs) of integration could be. Take, for example, Coase's distinction between the price mode and the quantity mode. If there are no transaction costs, the quantity mode can be achieved directly by a contract: *B* can simply agree to take orders from *A* (within limits perhaps), while remaining a separate firm. There is no need for *A* to buy up *B* or make manager *B* an employee to achieve this outcome. Equally the price mode can be achieved, should this be desirable, even when *A* and *B* are part of the same firm (the parties can simply agree that *A cannot* give *B* orders). The general point is that with zero transaction costs, any rights that ownership may confer can be undone through a contract. Hence an optimal outcome can be achieved whether *A* and *B* are separate firms or part of the same firm: in an important sense, ownership is simply irrelevant.

Now it could, of course, be argued that ownership is a shorthand for a certain sort of contractual arrangement, and the fact that the same outcome can be achieved without ownership is just a matter of semantics. This argument is sometimes made for the case where it is efficient for moral hazard reasons, say, for one party to receive the residual income stream from an asset; it seems natural to call that person the asset owner. The problem with this point of view is that only rarely would we expect one person to receive 100 percent of a profit stream. In general we would predict that the parties will engage in profit sharing. But this means that this approach predicts *joint* ownership for most assets—a conclusion which is not only too vague to be useful but is also unrealistic.

Note that the argument that ownership is irrelevant under comprehensive contracting is robust to the introduction of asymmetric information, for example, in the form of moral hazard or adverse selection. Asymmetric information leads to departures from Arrow-Debreu contingent contracting, but it does not provide a role for ownership unless the limits to contracting are themselves sensitive to who owns what. In particular, under asymmetric information optimal contracts will still be "complete" in the sense that each party's obligations are fully specified in all eventualities; and hence it will be possible for any rights that ownership confers again to be contracted away. For example, if a seller *S* of an input has private information about his costs, then an optimal contract between *S* and a purchaser *P* will make the quantity of input to be traded and the price to be paid a function of *S*'s announced costs. In order to encourage truth-telling by *S*, the contract will typically involve some production inefficiency, that is, it will be "second-best."[8] However, the point is that this production inefficiency will be present whether *S* and *P* are separate firms or are integrated—it is a function of the asymmetry

8. See, *e.g.*, Hart and Holmstrom.

of information, not of who owns what. The only exception to this is if the asymmetry of information itself depends on the ownership structure; that is, a change in ownership affects what contingencies can be included in the contract and what cannot. However it is a strong assumption to suppose that the simple act of transferring the legal title of S's assets to P allows P to observe S's costs, which he could not observe as a separate entity.[9]

The above comments cover situations where transaction costs are zero and the parties can write a comprehensive contract. As Coase, Williamson, and Klein, Crawford, and Alchian have emphasized, however, this is very unrealistic: in practice, transaction costs are pervasive and large. A consequence of the presence of such costs is that the parties to a relationship will *not* write a contract that anticipates all the events that may occur and the various actions that are appropriate in these events. Rather they will write a contract that is *incomplete*, in the sense that it contains gaps or missing provisions; that is, the contract will specify some actions the parties must take but not others; it will mention what should happen in some states of the world, but not in others. A result of this incompleteness is that events will occur which make it desirable for the parties to act differently from the way specified in the contract.[10] As a consequence the parties will want to *revise* the contract. In addition the parties may sometimes disagree about what the contract really means; disputes may occur and third parties may be brought in to resolve them.

Incompleteness of contracts opens the door to a theory of ownership. In particular, when contracts are incomplete, it is no longer the case that any rights conferred by ownership can necessarily be contracted away—except by undoing the ownership itself—since it may be impossible to describe these rights unambiguously. This observation, of course, does not tell us what the rights of ownership *are*; however, it does reassure us that we may be able to develop a theory where ownership plays a non-trivial role.

In order to understand what the rights of ownership might be, it is useful to introduce the notion of *residual rights of control*. The idea is that if the contract the parties write is incomplete, there must be some mechanism by which the gaps are filled in as time passes. For example, suppose that I contract with you to supply a certain number of car bodies for my automobile manufacturing plant. Imagine that demand rises and I want to increase the quantity you supply. It seems reasonable that to the extent that the contract was silent about this (the increase in demand was a state that we did not plan for or at least did not explicitly include in the contract), I need to get

9. Two papers which do make this assumption are Arrow and Crocker. It should be noted that there may be indirect mechanisms by which changes in ownership lead to changes in information structure; see Grossman and Hart (1986, n. 3) and below.

10. These events may have been unanticipated by the parties, or they may have been anticipated, but the parties may have been unable to provide for them in advance in a clear (and enforceable) manner.

your agreement. That is, the status quo point in any contract renegotiation will be where you do *not* provide the extra supply; in other words you possess the residual rights of control in this case. As another example, suppose that you rent my house, and that a friend of yours moves in who hates the color of the bedroom. The decision to repaint would presumably be mine, not yours. That is, you would have to persuade me to repaint the room; you could not force me to do so (so in this example, I possess the residual rights of control). On the other hand, if the paint began to peel or an effluent of a neighboring factory reacted with it, it would probably be within your rights to insist that I repaint the room.

These examples suggest that residual rights of control may be closely connected to the issue of *ownership*. The reason I cannot force you to supply extra car bodies is that the body factory belongs to you and it is up to you how to operate it, except to the extent that you have explicitly contracted certain rights away. If I owned your body factory as well as my automobile plant, the story might well be different: I could insist that the extra bodies be supplied since I can decide how your factory is used. (Of course, you could quit, but I could then hire another manager to run the factory.) In the case of the house, the reason that you need to persuade me to repaint the room that is unattractive to your friend is because it is my house, not yours. However, as the last example shows, ownership is not absolute: sometimes a non-owner has some residual rights of control (these rights might be his under common or statutory law).

The idea that ownership is linked with residual rights of control forms the basis of a theory of integration developed in Grossman and Hart (1986). In fact this paper identifies ownership of an asset with the possession of residual rights of control over that asset, that is, the rights to use the asset in any way except to the extent that specific rights have been given away in an initial contract. The paper argues that in a world of incomplete contracts there is an optimal allocation of residual rights of control; to the extent that ownership goes together with residual rights of control, there is therefore an optimal allocation of asset ownership. The paper builds on the work of Williamson and Klein, Crawford, and Alchian in emphasizing asset specificity, quasi-rents, and hold-up problems as the key issues in an incomplete contracting relationship. That is, residual rights of control are important in influencing ex ante specific investment decisions. There are two important differences from previous work, however. First, the theory focuses on residual rights of control over *physical assets* (as opposed, say, to other aspects of the firm, such as employee decisions). Secondly, the theory uses the same concept of residual rights of control to explain the *costs* of integration as well as the benefits. That is, in contrast to (most) previous work, the disadvantages of integration are explained without resort to such notions as bureaucracy costs.

In the next section I will illustrate the way residual rights of control can

explain asset ownership with a few examples. These examples are in the spirit of the model presented in Grossman and Hart (1986); however, they are in some respects simpler (although they are also more special). Then in section 5 I will return to a comparison of the residual rights of control approach with others in the literature.

4. EXAMPLES OF THE COSTS AND BENEFITS OF ASSET OWNERSHIP

4.1. Example 1: Ownership of a Single Asset

It is useful to begin with an extremely simple case. Consider a machine which requires one operator or manager. If operated appropriately, the machine generates a perfectly certain profit. Assume that the operations of the machine impose no externality on anyone else—either positive or negative. Also suppose there are no other inputs apart from managerial effort. The question is, who should own the machine?

The answer seems intuitively clear: the manager should own the machine (assuming he can afford to buy it). While this seems trivial, it is not. Furthermore, any theory of integration *must* be able to explain this, since a simpler example of the advantages of ownership would be hard to find.

Note that the question being asked is *not* (at least directly) who should own the machine's profit stream. Standard moral hazard ideas tell us that the operator's incentives will be dulled if he does not earn the return from his activities. There is a distinction between asset ownership and return ownership, however. For example, it is frequently the case that workers or managers are put on an incentive scheme, so that they have an interest in their firm's performance. This does not automatically make them *owners* of the firm, however. (The net income of the CEO of GM is sensitive to GM's performance, but that does not make him a significant owner of GM.) In the case in question, for example, the machine could belong to an outsider who hires the manager as his employee and gives him a salary compensation package equal to the firm's profit. Would such an arrangement be as good as the one where the manager is the owner?

To see that it might not be, consider a two-period model where the manager must choose an action x at date 0 (which might represent an investment or effort level), and let this yield a total return $B(x)$ at date 1. Assume that the manager incurs a private cost (for example, a disutility of effort) equal to x. The action x is supposed to be observed only by the manager (so this is a classic case of moral hazard). We shall take $B(x)$ to be deterministic, although the analysis would easily generalize to the case where it is a random variable as long as the manager is risk neutral.[11]

11. $B(x)$ is assumed to have the usual neoclassical properties (e.g., strict concavity).

I will suppose that there is some action involving the asset which can be taken ex post at date 1 but which cannot be specified in the initial contract, for instance, because it is too complex.[12] Because of this incompleteness, residual rights of control will be important. It will not be necessary to model the ex post action in detail; it will be enough to assume that the right to control the asset in an unspecified way allows one to "cream off" a fraction $(1-\lambda)$ of the return $B(x)$, where $0 < \lambda < 1$.[13] An example of this would be where the machine is used in such a way as to benefit some other activity the controller is engaged in. For instance, if the controller is an outsider, he may employ the machine to increase the profit of another firm he owns; this other firm might be in a related business or might be an upstream supplier or downstream purchaser of the original asset's output.[14]

I will assume that the creamed-off component of return, $(1-\lambda)\,B(x)$, is *not* verifiable, but that the remaining return $\lambda\,B(x)$ *is*, so that contracts can be written on the latter. Finally, I assume that the manager has access to financial resources which he can use to boost the machine's profit on a dollar-for-dollar basis if this should suit him (and this boosting cannot be verified; moreover, no part of this boosted profit is subject to creaming off by the asset owner). In equilibrium, no boosting will occur but the possibility of it will put constraints on the form of the contract.

We have set things up so that the only variable that the parties can contract on is the asset's verifiable profit, $\pi = \lambda\,B(x)$. Thus a contract consists simply of a division rule $I = I(\pi)$, where I is the operator's remuneration as a function of π. We now argue that in the case where the manager owns the machine, an optimal contract can be devised to achieve the first-best, but this is impossible if an outsider owns the machine.

The first-best allocation consists of a level of x, x^* say, which maximizes social surplus, $B(x) - x$. If the manager owns the machine, this value x^* can be induced by giving the manager at the margin 100 percent of the firm's profit stream, that is, $I(\pi) = \pi - E = \lambda B(x) - E$, where E can be interpreted as an entry fee. Since the manager, as owner, receives the creamed-off portion of profit $(1-\lambda)B(x)$, his total return net of effort cost is

$$R = \lambda\,B(x) - E + (1-\lambda)B(x) - x = B(x) - E - x.$$

Maximization of this therefore yields the solution $x = x^*$.[15]

12. For more on this, see Grossman and Hart (1986).

13. We'll take λ to be deterministic, but again the analysis would easily generalize to the case where λ is stochastic.

14. An extreme case of an outsider creaming off profit at the expense of the manager is if he sells the machine and pockets the profit (to the extent that the original contract does not restrict this).

15. The equilibrium value of E will depend on the relative bargaining strength of the two parties at the time the contract is written, which in turn will depend on how competitive the ex-ante market for contracts is. Our results are independent of how the ex-ante surplus is divided, and so we will not need to deal with the determination of E in what follows.

Consider next the case where an outsider owns the machine and receives the unverifiable component $(1-\lambda)B(x)$. Then the manager will maximize:

$$I(\pi) - x = I(\lambda B(x)) - x.$$

The first order conditions for this are

$$I'\lambda B'(x) = 1. \tag{1}$$

Note, however, that $I' \leq 1$, since otherwise the manager will have an incentive to boost profit by pumping in extra financial resources (if $I' > 1$, for each dollar that π goes up, the manager's income will increase by more than a dollar). Hence (1) implies that $B'(x) \geq 1/\lambda > 1$, from which it follows that $x = x^*$ cannot be sustained (since $B'(x^*) = 1$). The conclusion is that it is impossible to achieve the first-best in the case where there is outside ownership.[16]

The moral of this story is that in an externality-free world the person whose actions determine the profitability of an asset (assuming there is one such person) should also own the asset. Giving this person entitlement to the asset's profit stream will not be enough since an outside owner may be able to divert some of the asset's return for his own uses, thus dulling the manager's incentives. Note again the importance of contractual incompleteness for this conclusion.[17] Under complete contracting, it would be possible to achieve the first-best even with outside ownership by including a clause in the contract which explicitly rules out any profit-diverting uses of the asset.[18]

16. The argument generalizes to the case where I is not differentiable. The manager chooses his effort level, x, and the amount by which to boost profit, u, so as to maximize $I(\lambda B(x) + u) - x - u$. The solution to this *cannot* be $x = x^*$. To see this note that if the manager reduces x from x^* to $(x^* - \epsilon)$, and increases u to keep $\lambda B(x) + u$ constant, then I will remain constant while, for ϵ small, $(x + u)$ will fall (since $\frac{d}{d\epsilon}(x + u) = -1 + \lambda B'(x^*) = -1 + \lambda < 0$); hence the manager is better off.

17. The conclusion of this example should be contrasted with the standard result in the property rights literature that in an externality-free world private property is efficient (see, e.g., Demsetz). What drives the latter result is the idea that only if a property is privately owned, will a user get the full return from his activities and hence take socially efficient actions. In this literature, efficiency is achieved *whoever* owns the property—as long as the property right is well-defined and not too widely dispersed (so that negotiation costs between different owners are avoided). In contrast the present model takes as given the idea that assets are privately owned, and asks what the optimal ex-post allocation of assets is in a world of incomplete contracting. In spite of the difference between the approaches, the intellectual debt of the present study to the property rights literature should be apparent.

18. It is worth relating this example to the model presented in Grossman and Hart (1986). The creaming-off activity which the asset owner can engage in in the above example corresponds to the ex-ante noncontractible, ex-post contractible variable q in Grossman and Hart (1986). In that paper the owner of the asset did not generally have an incentive to choose q in an ex-post efficient manner, and so it was supposed that the parties negotiated an efficient choice of q at

4.2. Example 2: Complementary Activities

The case of an asset operated in a vacuum is obviously extreme. We consider now how our results change if we introduce a second asset, whose activities are complementary with those of the first. Examples might be the furniture department and hardware department in a department store, the compact car division and subcompact car division of an automobile manufacturer, and (to take a far-fetched but nonetheless illuminating example suggested by Klein, Crawford, and Alchian, 1978) the windows of the building and the rest of the building.

Let the return on asset 1's activities be $B_1(x,y)$ and that on asset 2's activities be $B_2(y)$, where x,y represent the date 0 actions (for example, effort levels or investment decisions) of the operators of assets 1 and 2 respectively. The presence of y in B_1 captures the idea of an externality: asset 1's return depends on manager 2's action as well as manager 1's (in this sense, the activities are complementary).[19]

As in example 1, we assume that the owner of each asset can siphon off a fraction $(1-\lambda)$ of the asset's return for himself in the form of unverifiable profit. Therefore the verifiable profits from the activities are given by

$$\begin{aligned} \pi_1 &= \lambda B_1(x,y), \\ \pi_2 &= \lambda B_2(y). \end{aligned} \tag{2}$$

As above, a contract consists of an agreed-upon division of the surplus, that is, a pair of functions $I_1(\pi_1,\pi_2)$, $I_2(\pi_1,\pi_2)$ where I_1, I_2 are the remunerations of the two operators and $I_1 + I_2 = \pi_1 + \pi_2$. We also make one additional assumption now: profit can be freely disposed of, that is, each manager can, if it suits him, reduce profit in an unverifiable way (the reduced profit is thrown away, however; it does not go to the manager). We continue to assume that a manager can boost profit (this applies to manager 2 as well as manager 1 now).[20]

We will be concerned with two situations. In the first, each manager owns his own asset (this can be interpreted as nonintegration). In the second, manager 2 owns both assets (which can be interpreted as integration).[21]

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date 1 via a new contract. In the present example (and those that follow), residual rights of control are always used efficiently by the person who exercises them (these rights affect only the distribution of ex-post surplus, not its size). There is therefore no role for any renegotiation or new contract at date 1.

19. A more general model would have a two-way externality.

20. The precise timing is that the managers choose their effort levels x,y and the amounts by which to boost profit u,v simultaneously and noncooperatively at date 0. At date 1, each is assumed to know the choice of his counterpart, and to have the chance to dispose of some of the profit on the asset he operates before π_1, π_2 are realized. The model is reminiscent of Alchian and Demsetz's theory of complementary production. See also Holmstrom.

21. There is also the possibility that manager 1 owns both assets. Given our specification, this case is uninteresting.

Under separate asset ownership, the net returns of the two managers are given by

$$\begin{aligned} R_1 &= I_1(\pi_1,\pi_2) + (1\text{-}\lambda)B_1 - x \\ R_2 &= I_2(\pi_1,\pi_2) + (1\text{-}\lambda)B_2 - y, \end{aligned} \tag{3}$$

since the creamed-off profits go to the respective operators. On the other hand, if manager 2 owns both assets, he gets both sets of the creamed-off returns, and so we have

$$\begin{aligned} R_1 &= I_1(\pi_1,\pi_2) - x, \\ R_2 &= I_2(\pi_1,\pi_2) + (1\text{-}\lambda)B_1 + (1\text{-}\lambda)B_2 - y. \end{aligned} \tag{4}$$

To illustrate that integration may be superior to nonintegration, consider the case where the marginal return to 1's effort is very small—in fact zero, that is, $B_1(x,y) = \gamma(y)$. The first-best allocation consists of $x = x^*$, $y = y^*$, where

$$\begin{aligned} &x^* \text{ maximizes } \gamma(y) + B_2(y) - x, \text{ i.e., } x^* = 0 \\ &y^* \text{ maximizes } \gamma(y) + B_2(y) - y. \end{aligned}$$

This first-best allocation can be achieved in the case where manager 2 owns both assets by giving him (at the margin) 100 percent of both profit streams, that is, $I_2 = \pi_1 + \pi_2 - E$, $I_1 = E$. It is clear from (4) that 2 will then maximize $B_1 + B_2 - y$, which leads to the outcome $y = y^*$. On the other hand, manager 1 will set $x^* = 0$ since he gets no benefit from his asset.

In contrast, the first-best cannot be achieved under nonintegration. In this case, 2 maximizes:

$$I_2(\pi_1,\pi_2) + (1-\lambda)B_2(y) = I_2(\lambda\gamma(y), \lambda B_2(y)) + (1-\lambda)B_2(y) - y.$$

The first order conditions are:

$$\frac{\lambda\partial I_2}{\partial\pi_1}\gamma'(y) + \lambda\frac{\partial I_2}{\partial\pi_2}B'_2(y) + (1-\lambda)B'_2(y) = 1. \tag{5}$$

We know, however, that $\frac{\partial I_1}{\partial\pi_1} \geqslant 0$ and $\frac{\partial I_2}{\partial\pi_2} \leqslant 1$ since manager 1 can freely dispose of profit and manager 2 can, if it suits him, boost profit. Therefore $\frac{\partial I_2}{\partial\pi_1} \equiv 1 - \frac{\partial I_1}{\partial\pi_1} \leqslant 1$. It follows that the left-hand side of (5) is strictly less than $\gamma'(y) + B'_2(y)$ and hence $y = y^*$ cannot be a solution of (5) (y^* satisfies

$\gamma'(y) + B_2'(y) = 1$). We may conclude that $x = x^*$, $y = y^*$ cannot be implemented under nonintegration.[22/23]

The intuition behind this example is simple. Given the positive externality that manager 2 imposes on manager 1, manager 2 must be given a large fraction of asset 1's return in order to encourage him to exert appropriate effort. Providing 2 with a substantial part of 1's profit stream is not enough, however: without control of the activity (via ownership of the asset), the profit stream lacks "integrity."

The principle which operates here is exactly the same as in the first example. There manager 1's effort was important and so it was optimal for manager 1 to own asset 1, so that he could be assigned asset 1's return stream. In the present example, it is manager 2's effort that is important, and so he is made owner of asset 1 and is assigned its return stream. Note that the conclusion that 2 should own both assets generalizes to the case where 1's marginal product of effort is small (but positive), namely, $B_1(x,y) = \gamma(y) + \epsilon_1\delta(x)$, $B_2(x,y) = \eta(y) + \epsilon_2\zeta(x)$, where ϵ_1, ϵ_2 are small.

Of course, the example has been "fixed" to give the result. In general, 1's actions will be important as well as 2's. The choice between integration and nonintegration then involves a trade-off: giving 2 ownership dulls 1's incentives, while giving 1 ownership dulls 2's incentives. Which arrangement is optimal will depend on the parameters. The main point of the analysis remains true, however: the set of feasible allocations under integration is different from that under nonintegration.

4.3. Example 3: A Vertical Relationship

So far we have considered the case of an asset operated in isolation and two assets whose operations are complementary (they might be regarded as "lat-

22. As before, we do not require the differentiability of I_1, I_2 to reach this conclusion. Manager 2 chooses y and the amount by which he boosts profit, v, to maximize $R_2 = I_2(\lambda B_1(x,y) + u, \lambda B_2(y) + v) + (1-\lambda)B_2(y) - y - \text{Max}\,(v,0)$. (If v is negative, the manager is throwing away profit instead of adding to it.) Suppose $x = x^*$, $y = y^*$ is an equilibrium. Let manager 2 reduce y from y^* to $y^* + \Delta y$, where Δy is small and negative, and increase v by Δv to keep $\lambda B_2(y) + v$ constant. Then B_1 falls, but

$$\Delta R_2 \geq I_2(\lambda B_1 + \lambda\Delta B_1 + u, \lambda B_2(y^*) + v) - I_2(\lambda B_1 + u, \lambda B_2(y^*) + v) + (1-\lambda)\Delta B_2 - \Delta y - \Delta v$$

$$= \lambda\Delta B_1 - (I_1(\lambda B_1 + \lambda\Delta B_1 + u, \lambda B_2(y^*) + v) - I_1(\lambda B_1 + u, \lambda B_2(y^*) + v)) + (1 - \lambda)\Delta B_2 - \Delta y - \Delta v$$

$$\geq \lambda\Delta B_1 + (1 - \lambda)\Delta B_2 - \Delta y - \Delta v,$$

since $I_1(\lambda B_1 + \lambda\Delta B_1 + u, \lambda B_2(y^*) + v) \leq I_1(\lambda B_1 + u, \lambda B_2(y^*) + v)$ (otherwise manager 1 would have disposed of ΔB_1 himself by reducing u). However, the last expression is approximated by $(\lambda\gamma'(y^*) + B'_2(y^*) - 1)\Delta y$ when Δy is small, and this is positive (since $\Delta y < 0$). Hence $\Delta R_2 > 0$, i.e., manager 2 is better off. This contradicts the hypothesis that $x = x^*$, $y = y^*$ is an equilibrium.

23. As in Holmstrom, a third party would be useful; in fact, the first-best could then be achieved under nonintegration by setting $I_1 = \pi_1 + \frac{\pi_2}{\lambda}$, $I_2 = \frac{\pi_1}{\lambda} + \pi_2$. Standard collusion arguments can be used to justify the absence of a third party, however.

eral" activities). For our last example we consider a vertical relationship between the upstream supplier of an input and a downstream purchaser who uses this input in his own production process. As Williamson and Klein, Crawford, and Alchian have emphasized, contractual problems may be particularly severe in such situations, and it is important to know whether integration will provide an appropriate form of relief.

Let the manager of asset U (the upstream firm) produce the input (one unit of it) which is then supplied to the manager of asset D (the downstream firm). As above we consider a two-period model. At date 0, the managers take actions, while, at date 1, trade occurs and profit is realized. We suppose that after date 0 the two managers are locked into each other, that is, neither has an alternative trading partner.

The issue which we will focus on is the quality of the input. We suppose that this is determined by manager U at date 0, and denote it by x; hence, assuming that delivery of the input occurs (which it always will in equilibrium), 2's return depends on x, as well as on manager D's effort y: $B = B(x,y)$. We now ignore U's effort cost but assume that U faces a variable (dollar) cost of production at date 1, $C(x)$, which is increasing in quality (higher quality might require more labor or raw materials). Hence in the absence of a contract the net returns of the managers are $B(x,y) - y$, and $-C(x)$, respectively.

We suppose that quality is observable only to manager U. Hence the contract price cannot be conditional on quality; nor can a take-it-or-leave-it offer be used (since manager D doesn't observe quality). The only way to induce U to produce high-quality input is to reward him according to D's ultimate return, B.

We will not need to assume in this example that the owner of asset D can siphon off a fraction $(1-\lambda)$ of B for his own use. However, we *will* suppose that the owner of asset U has the ability to increase the variable costs attributable to asset U by an arbitrary amount and receive a fraction $0 < \mu < 1$ of those extra costs as an (unverifiable) private benefit. (In equilibrium, such cost manipulation will not occur, but, as in the previous examples, it constrains the form of the incentive contract.) For example, the owner may be able to use extra labor or raw materials to increase the profits of other projects he's engaged in rather than for the purpose of supplying manager D.[24]

An optimal contract rewards the two managers according to the verifiable returns $B(x,y)$, $C(x)$, that is, $I_U = I_U(B(x,y), C(x))$, $I_D = I_D(B(x,y), C(x))$, where $I_U + I_D \equiv B(x,y) - C(x)$. The net returns of the two managers are then, respectively:

24. The idea that the owner of an asset can manipulate the costs assigned to that asset has been emphasized by Williamson (1985, ch. 6). This idea is also the basis of the model of vertical integration in Holmstrom and Tirole.

$$\begin{aligned} R_U &= I_U(B(x,y),\ C(x)), \\ R_D &= I_D(B(x,y),\ C(x)) - y. \end{aligned} \tag{6}$$

Note that (6), which excludes the return from cost manipulation, applies whether the assets are integrated or not. There is an important difference between the two cases, however. If manager U owns asset U, then in equilibrium it must be that $\frac{\partial I_U}{\partial C} \leqslant -\mu$ since manager U will have access to the cost manipulation technology (if $\frac{\partial I_u}{\partial C} > -\mu$, manager U can make himself better off by raising costs by η and increasing his income by $\mu\eta + \frac{\partial I_U}{\partial C}\eta$). On the other hand, if manager D owns asset U, the corresponding condition is $\frac{\partial I_D}{\partial C} \leqslant -\mu$.

To see why ownership of both assets by D may be desirable, note that the first-best allocation consists of $x = x^*$, $y = y^*$, where

$$x^*,\ y^* \text{ maximize } B(x,y) - C(x) - y. \tag{7}$$

This can be achieved when D owns both assets by setting $I_U = 0$, $I_D = (B(x,y) - C(x))$, that is, U is recompensed for his variable costs and D receives the residual. The point is that this makes the objective function of manager D, $B(x,y) - C(x) - y$, while U is indifferent about his action; and thus, from (7), private and social incentives are aligned (U can be provided with a positive incentive to choose x^* by giving him a small fraction of net surplus, $B(x,y) - C(x)$).[25] Moreover, $\frac{\partial I_D}{\partial C} = -1 \leqslant -\mu$, that is, owner D will not have an incentive to manipulate costs.

However, such an arrangement is not feasible under nonintegration since $(\partial I_U/\partial C) = 0 > -\mu$, and so U *will* have an incentive to manipulate costs. To put it slightly differently, the first-order conditions corresponding to (6) are

$$\begin{aligned} \frac{\partial I_U}{\partial B}\frac{\partial B}{\partial x} + \frac{\partial I_U}{\partial C}C'(x) &= 0, \\ \frac{\partial I_D}{\partial B}\frac{\partial B}{\partial y} &= 1. \end{aligned} \tag{8}$$

25. This assumes that the objective function $B(x,y) - C(x) - y$ is concave.

However, at $x = x^*$, $y = y^*$, $\frac{\partial B}{\partial x} = C'(x)$ and $\frac{\partial B}{\partial y} = 1$. Hence, from (8), $\frac{\partial I_U}{\partial B} \equiv 1 - \frac{\partial I_D}{\partial B} = 0$, and so $\frac{\partial I_U}{\partial C} = 0$; in particular $\frac{\partial I_U}{\partial C} \leqslant -\mu$ is not satisfied.

What drives this example is the following. Getting U to choose efficient quality is not a problem as long as U's production cost $C(x)$ can be assigned to D. Such an arrangement is possible when D owns both assets since U's costs can be transferred to D without distortion (their "integrity" is preserved). However, such a transfer is impossible under nonintegration since if manager D agrees to pay manager U's costs, manager U will have an incentive to manipulate his costs at D's expense.

The principle here is no different from that in examples 1 and 2. In all three cases it is desirable for incentive reasons for some part of the overall return stream to be borne by one party. This can be achieved by transferring one asset's returns to that party (in the first two examples an asset's profits were transferred; in the last example its costs were). We saw, however, that if the transfer is attempted without a corresponding change in ownership or control rights, it will not be fully effective: some of the returns will be diverted by the owner, and the incentive effect will be diminished. Thus to resolve incentive problems, it is necessary not only to assign the various parts of the return scheme to the different managers efficiently, but also to allocate ownership and control rights to support this assignment.

5. DISCUSSION

I want to consider now how the notion of residual rights of control explored in the last section fits in with other ideas in the literature. I will argue that it is broadly consistent with other theories and that it provides a useful organizing framework. In addition, as I have mentioned above, it allows the costs and benefits of ownership to be addressed within the same theory.

Before embarking on this, however, let me remark that any theory of ownership worth its salt should be consistent with the following basic observations:

a. If one individual is entirely responsible for the return of an asset, he should own it.
b. If there are increasing returns to management, so that one person can manage two firms, then these firms should have a common owner—that is, we should see integration.
c. If firm D wishes to be supplied by firm U, but firm D's business with U is only a small fraction of both U's and D's total business, then we would expect to see D sign a (long-term) contract with U rather than D buy U up or U buy D up. (We are assuming here that the spot market solution is infeasible.)

d. If an industry is declining we would expect to see firms merge so as to save on overheads (their headquarters, advertising division, and so on), rather than stay independent and share these overhead activities via a long-term contract.

The theory described in the last section (more generally, that set out in Grossman and Hart, 1986) is consistent with all of the above (by the way, I am not suggesting that other theories are *inconsistent* with these observations). Observation (a) has already been discussed with reference to example 1; (b) is just an extension of the idea that a person who is responsible for the return of an asset should own it; now one manager is responsible for the returns of two assets. To understand (c), note that, while there can be benefits from D owning U and thereby controlling its operations, there will also be costs in the form of reduced incentives for U; these costs may result from D's ability to divert some of U's earnings in other activities to himself. The larger U's outside business is, the bigger these costs are likely to be. Hence if D's activities with U are a small fraction of U's total operations, we would expect the costs to outweigh the benefits and nonintegration to be superior. The same argument applies to U owning D if D's activities with U are a small fraction of D's total operations.

In (d), we have in mind a situation where two firms initially set up, each with a headquarters (or advertising division or marketing division), but now in a shrinking market there is a need for only one headquarters. The parties could stay independent, with one renting headquarter services from the other. However, the owner of the headquarters would then be in a good position to hold up his contractual partner by supplying low-quality services (or failing to supply at all), and so the costs of this arrangement might be large. One way to reduce such opportunistic behavior is to transfer to the firm with the headquarters the profit of its partner, an arrangement which, as we saw in section 4, is more easily accomplished under integration than under nonintegration. Hence we would expect to see the firms take advantage of the cost savings by merging.

Having drawn out some implications of the residual rights of control approach, let us turn to its relationship to the rest of the literature. As noted earlier, one difference with previous work is the emphasis on how integration changes control over physical assets. This is in contrast to Coase's 1937 paper which focuses on the way integration changes an ordinary contractual relationship into one where an employee accepts the authority of an employer (within limits). Note that these approaches are not contradictory. Authority and residual rights of control are very close and there is no reason why our analysis of the costs and benefits of allocating residual rights of control could not be extended to cover human, as well as physical, assets. In fact, residual rights of control over employees and over physical assets are likely to be related. In particular, an important difference between an employment con-

tract and a contract between independent parties is that the former allows the employer to retain the use of assets used by the employee in the event of a separation (he can hire another employee to operate them). In contrast, an independent contractor would typically own some of these assets and would be able to decide how they should be used if the relationship terminates.

The emphasis on control rights over assets also distinguishes the approach outlined here from that of Klein, Crawford, and Alchian, and Williamson. It would be impossible to do justice to the many writings of Williamson here. We can note, however, that for Williamson (and Klein, Crawford, and Alchian too), control over assets is only one aspect of the benefits of integration. Others which are important (see Williamson, 1975, 1979, 1985) include the ability of a party with authority to resolve disputes by fiat (as opposed to the parties going through litigation); the fact that asymmetries of information (which are a cause of contractual imperfection) can be reduced to the extent that it is easier for a firm to monitor or audit one of its subdivisions than to monitor or audit an independent contractor; and the fact a merger between firms A and B is likely to change the atmosphere and feelings of loyalty; for instance, now that the employees of B owe their allegiance to the enterprise as a whole they may be less likely to engage in opportunistic behavior against A.

Note that the first of these ideas seems consistent with the notion of residual rights of control (over human assets), as does the second (having residual rights of control over physical assets—such as an employee's office, files, etc.—may allow an employer to obtain information that would otherwise be unavailable). The last, however, may involve other considerations.[26]

In more recent work, Williamson has argued that a further benefit of integration comes from the increased ability to control accounting procedures (see Williamson, 1985, ch. 6). In particular, Williamson distinguishes between "high-powered" incentives provided by the market (in the form, for example, of a compensation system which rewards parties according to performance and makes each party the residual claimant to its profit stream) and "low-powered" incentives which are used more frequently within a firm (for example, in the form of a cost-plus arrangement). Williamson's point is that the use of these different incentive arrangements inside and outside the firm is not coincidental. In particular, it may be unattractive for a firm to sign a cost-plus arrangement with an independent supplier if the firm has no control over the supplier's accounting procedures. Equally a subsidiary may be unwilling to accept an arrangement in which it is compensated according to its profit given that it has little control over transfer prices. Note that

26. Milgrom has argued that a further cost of integration is that an employee may spend too much time trying to influence an employer who has control over him. This effect can also be understood in terms of residual rights of control.

example 3 in the last section is very much in the spirit of this idea, and in fact can be regarded as a formalization of it (for another formalization, see Holmstrom and Tirole, 1989). One difference is that in this example the ability to manipulate the accounts is traced to the residual rights of control over physical assets, rather than being taken as a primitive.

In chapter 5 of his 1985 book, Williamson explores another interesting aspect of ownership. He presents a number of examples showing that ownership of an asset will often be assigned in order to minimize "lock-in" effects. For instance, consider a buyer who must make an investment in order to be supplied by a seller. Suppose that this investment is transferable by the buyer in the sense that it can be used in the event that this buyer switches to another seller. However, suppose that the investment is useless to the seller in the event of a separation. Then Williamson argues (and produces supporting evidence) that the buyer will own the investment. The idea is that this returns the relationship to a spot market one where lock-in is absent and contracts work well. Note that this is also consistent with the broad perspective provided by the notion of residual rights of control (although more with the model of Grossman and Hart, 1986, than with the examples presented here). If the seller owns the investment, his incentive to provide good service to the buyer will be diminished since the buyer cannot easily switch to another seller (he's locked in). This will allow the seller in effect to "hold up" the buyer and will distort the buyer's investment decision in the manner described in section 4. In contrast, if the buyer owns the investment, his ability to switch (costlessly) will keep the seller "honest," and he will realize the full return from his activities. Thus the buyer's investment is protected and an efficient outcome can be achieved. (To tell this story properly would require a model of a repeated relationship where, for some reason, perhaps reputation, the supplier's performance today is positively related to performance tomorrow.)

Up to now, when we have referred to the assets of the firm, we have had in mind its *physical* assets. However, a firm may also have intangible assets, such as good will or reputation. A recent attempt to get at the role of these intangibles can be found in the work of Kreps. Kreps models the firm as a hierarchical structure where an individual who enters into an employment relationship with the firm accepts (within broad limits) the firm's right (as expressed by the employee's supervisor) to specify how the employee's time will be used as contingencies arise. This view is reminiscent of Coase's. The difference is that what makes the employee prepared to grant this authority to the firm is that the firm is long-lived and wishes to maintain its reputation for fair dealing; to put it in Kreps's terms, the firm has an incentive to promote a particular "corporate culture."

Kreps, like Coase, stresses residual rights of control over employee actions rather than over physical assets as the key feature of ownership. One reason for doing this is that Kreps wants to explain how a firm can be a meaningful

entity even if its ownership of physical capital is quite limited. The idea is that reputation can be a substitute for physical assets. Kreps in fact considers the extreme case where the firm consists entirely of reputational capital: the firm is neither more nor less than its reputation for dealing with unanticipated (or at least uncontracted for) contingencies.

The view of the firm as a repository of reputation has some appeal and may be relevant for understanding the nature of investment banking or law firms (or some economics departments for that matter), whose physical assets are hard to identify. However, a satisfactory formalization requires an explanation of how the firm's reputational capital is sustained and what is distinctive about the firm as a carrier of reputation. One problem is that, while the firm may be long-lived, individual managers are not (or at least they have finite lives). Hence even if we can explain how one manager builds up a reputation for decent (and honest and competent) behavior, it is far from clear what is the process by which a firm acquires a reputation for decency, that is, one set of decent managers is succeeded by another. Kreps argues that one way to understand this is to suppose that the characteristic of decency in a manager is associated with a desire also to choose a decent successor. This seems a strong assumption on which to base the theory, however. A second problem is that it is unclear why a new institution—the firm—needs to be created as a repository of reputation. That is, given that individuals engaged in standard contractual relationships acquire reputations, what is distinctive about a firm as a carrier of reputation? To put it somewhat differently, the view that a firm is solely a repository of reputation does not seem consistent with the fact that a firm's reputation is often not homogeneous—a firm can have units or subdivisions with different reputations, and the question is why these do not count as separate firms. (An example would be Stanford Business School and Stanford Economics Department—both subdivisions of Stanford University—which are arguably different repositories of reputation.)

In conclusion, while Kreps's view of the firm is an interesting one, it leaves some questions unanswered. In particular, the issue of what it means for reputation to be embodied in an organization as opposed to an individual—and the extent to which an organization can be said to be characterized by its reputation—has still to be resolved.

6. CONCLUDING REMARKS

Coase's 1937 paper has unquestionably been a key development in the theory of organizations. As a result of his work and the more recent work of Williamson and others, we now have some answers to the question of what is a firm. In this paper I have argued that incomplete contracts and residual rights of control provide a useful organizing framework for thinking about the firm. Among other things, they permit the costs and benefits of integra-

tion to be examined in a unified manner; one does not require one theory to understand the benefits and another to understand the costs.

There is an enormous amount of work still to be done, however. A major limitation of the analysis presented here is that financial resource constraints are ignored and the owner of an asset is assumed to be a single individual. In particular, we supposed that if it is efficient for a manager to own an asset, he will purchase it; the possibility that he does not have the funds to do so was not considered. In reality, of course, managers or entrepreneurs often do not have the resources to finance projects themselves and they approach investors for assistance (another possibility is that they have the funds but do not wish to bear all the risk from the project themselves). External financing, however, introduces a further class of interested parties into the transaction: creditors or equity holders. This complicates the ownership puzzle greatly. Who should now have control rights in the firm? Should it be the firm's manager? Its investors? Some combination of the two? And if, say, equity holders have control rights, how are these to be exercised given that the shareholders may be a widely dispersed group?

Questions like these are just beginning to be addressed in the theoretical literature.[27] The answers should help us to gain a deeper understanding of the nature of organizations. There is every reason to be excited about the next fifty years.

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27. See, e.g., Aghion and Bolton, Grossman and Hart (1988), and Harris and Raviv. Note that giving managers or investors control is not the only possibility. Others include worker control (as in worker-managed firms) and consumer control (as in consumer cooperatives). For an interesting discussion of some of these possibilities, see Fama and Jensen, and Hansmann.

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