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In the summer of 1932, a 21 year-old undergraduate at the London School of Economics, Ronald Coase, raised a question that may at first appear naive but in fact turned out to be fundamental: if the market is an efficient method of resource allocation, then why do so many transactions take place within firms? Coase developed verbal arguments for the existence of firms, in particular emphasizing haggling problems in decentralized market transactions, which he thought authority within firms could partly overcome. In other words, firms exist because there are costs to using the price mechanism: prices must become known, bargains must be made, contracts must be written. In his famous essay, Coase (1937) quotes the description of D. H. Robertson (1928, p. 85) that firms are "islands of conscious power in oceans of unconsciousness like lumps of butter coagulating in buttermilk." If markets are so good at allocating resources, then why do firms exist?

For a long time, these ideas were not part of models of the firm. Until the 1970s, the dominant theory of the firm was the neoclassical theory: namely, there are economies of scale (or scope) which justify that production activities up to some efficient scale (or up to efficient variety) be concentrated within one firm rather than scattered across multiple producers. But this approach raises a question: why can't one get around the diseconomies of scale or scope by creating new plants within the same firm?

Another view of the firm that was in fashion in the late 1970s and early 1980s was the agency view. A prominent example here is Jensen and Meckling (1976). A

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main theme of this work is that firms help to solve agency problems, whether these emanate from moral hazard (the agent's action or effort is unobservable by the principal) or from adverse selection (the agent's type is unobserved by the principal). In other words, it is easier for a firm owner, as a principal, to monitor an agent who is an employee than an agent who is an independent subcontractor. This approach typically did not seek to explore why such agency problems are different within and across firms.

In the 1970s and into the early 1980s, Oliver Williamson (for example, 1971, 1975, 1979) made further important steps in the theory of the firm with his theory of "transaction cost economics." In 2009, Williamson shared the Nobel Prize in economics "for his analysis of economic governance, especially the boundaries of the firm." One of Williamson's central examples points out that market transactions can become very costly when agents have to make relationship-specific investments. For example, suppose that an electricity generator has strong cost-based incentives to locate near a coal mine. Building a new generator involves a sunk investment. However, once this investment is sunk, the generator firm will find itself in a bilateral monopoly situation vis-à-vis the coal mine. The electricity generator can sign a contract with the coal mine before investing in a generator. However, after the generator is built, it becomes a sunk cost. The coal mine will have an incentive to seek some reinterpretation or renegotiation of the contract that would allow it to receive a higher price for coal. If the electricity generator anticipates this "hold-up" situation, it may simply decide not to make the investment (for example, Williamson, 1971, p. 116; see also Klein, Crawford, and Alchian, 1978, p. 301).

One can argue that the two parties could have written a complete contingent contract with adequate protections in place for both sides: for example, perhaps the generator firm is entitled to a minimum revenue share if it makes the sunk investment. However, Williamson also emphasizes the existence of bargaining costs, like those due to asymmetric information or moral hazard, which in turn generate inefficiencies even without initial sunk costs or relationship-specific investments. Vertical integration between the generator firm and the coal mine is then seen by Williamson as one way to eliminate the scope for opportunism after the contract is signed. However, Williamson's theory raises another possible question: Aren't there costs to vertical integration, not only benefits, which could explain why firms have boundaries and why not all transactions are taking place within a single firm?

Grossman and Hart (1986) used the theory of incomplete contracts to develop answers to the question "What is a firm, and what determines its boundaries?" in their path-breaking paper on the costs and benefits of vertical integration. Perhaps the central issue is that economic actors are only boundedly rational and cannot anticipate all possible contingencies. It might well be that certain states of nature or actions cannot be verified by third parties after they arise, like certain qualities of a good to be traded in the future, and thus cannot be written into an enforceable contract. When contracts are incomplete, and consequently not all uses of an asset can be specified in advance, any contract negotiated in advance must leave some discretion over the use of the assets; and the "owner" of the

firm is the party to whom the residual rights of control have been allocated at the contracting stage. Grossman and Hart argue persuasively that the optimal allocation of property rights—or governance structure—is one that minimizes efficiency losses. Thus, in a situation where party A's investment is more important than party B's investment, it is optimal to allocate property rights over the assets to party A, even if this discourages investment by party *B*. More generally, the incomplete contracts/property rights approach produces a theory of ownership and vertical integration. It also directly addresses the question of what is a firm. Grossman and Hart argue that a firm is a collection of assets over which the owner has residual control rights.

In the first section of this paper, we spell out Grossman and Hart's argument using a simple numerical example, then we show how the incomplete contracts approach can be extended beyond the firms' boundaries issue to analyze firms' internal organization; firms' financial decisions; the costs and benefits from privatization; and the organization of international trade between inter- and intrafirm trade. In the second section, we discuss several criticisms of the incomplete contracts/property rights methodology, especially what we call the "implementation criticism," and then we briefly review some recent developments of the incomplete contracts approach. We have deliberately chosen to be selective in our discussion of the literature, and thus we focus on a small number of contributions; for a more complete overview, interested readers might begin with the references in Bolton and Dewatripont (2004), Salanie (1997), and Tirole (2006).

Incomplete Contracts and Vertical Integration: An Example

We now present an example that illustrates these issues in the spirit of the main arguments of Grossman and Hart (1986). It is also similar to the trading setting explored in Hart and Moore (1988).

Consider the relationship between a *B*(uyer) and a *S*(eller) of an intermediate good, which we will call a "widget." *B* can use the widget to produce a final good which can be sold to a consumer. The consumer values the final good at v. *S* can make a privately costly investment that makes the widget cheaper to produce. We can think of this as enhancing the widget-producing machine. If *S* makes the investment, which costs \$5, then the widget can be produced for \$10, otherwise it costs \$16 to produce. *B* can make a privately costly investment which makes the final good more valuable to the consumer. We can think of this as enhancing the final good–producing machine. This investment also costs \$5. If *B* makes the investment, then $v = \$40$; otherwise $v = \$32$. Note that only *B* can make the revenue enhancement investment, and only *S* can make the cost reduction investment. This assumption might be justified, for example, if *B* and *S* have different human capital characteristics.

B and *S* would like to write a contract that specifies that each party should make its respective investment, because that leads the total surplus in the relationship to

be 40 – 10 – 5 – 5 = 20—that is, the final good is sold for 40, it costs 10 to produce, and *B* and *S* each incur an investment cost of 5. But suppose that the two parties cannot contract on the widget, nor can they contract on a cost-sharing rule in advance, nor can they contract on the investments.[1]

Since *B* and *S* cannot contract on the widget nor on a sharing rule before investments are made, they will have to bargain about the price that *B* pays to *S* for the widget after the investment stage. Suppose that *B* and *S* are nonintegrated so that at the bargaining stage they split whatever surplus is generated 50:50.[2] In this situation, will B invest? No. If *B* does invest, *B* will bear a private cost of 5; but gets half of the increase in surplus of 40 – 32 = 8, or 4. Similarly, *S* bears a cost of 5 by investing, but gets an increased payoff of (16 – 10)/2 = 3 in the bargaining. So *S*, too, will not invest. When neither *B* nor *S* invests, total surplus is thus 32 – 16 = 16.

Now consider what happens if *B* and *S* are vertically integrated, with *S* owning *B*'s machine that produces the final good. *S* no longer needs to bargain with *B* because *S* owns the machine. Therefore, *S* will receive the entire increased surplus from investing in cost reduction (that is 16 – 10 – 5) and thus will be prepared to invest. However *B* will not invest as *B* will get none of the benefit of making the final good more valuable. *S* cannot compel *B* to invest, nor contract on *B* making the investment. Total surplus is thus 32 – 10 – 5 = 17; this is larger than under nonintegration, so forward vertical integration is desirable.

In fact, *B* ownership (backward integration), does better still. Now *B* invests, but *S* does not, yielding total surplus of 40 – 16 – 5 = 19. This is not as good as if contracting was possible (that would yield a surplus of 20), but it is better than the other possible ownership structures. What makes *B* ownership preferable to *S* ownership is that *B*'s investment is relatively more important (at the margin) than *S*'s. Both cost 5; but *B*'s has a benefit of 40 – 32 = 8; whereas *S*'s has a benefit of 16 – 10 = 6.

This example highlights two of the key Grossman–Hart (1986) insights. First, in a world of incomplete contracts, asset ownership can help to mitigate inefficiencies that would otherwise arise from underinvestment in productive activities. Second, the party whose marginal investment is more productive should own the assets.[3] Because asset ownership presumably can be contracted upon, we would expect *B* ownership to emerge as the equilibrium ownership structure as it maximizes joint

[1] In particular, although *B* and *S* can tell whether the investments have been made—these investments are "observable" to *B* and *S*—a third party like a court of law or an arbitrator cannot determine whether the investments have been made, and so the investments are not "verifiable." For example, the court or other third party does not have the requisite technical knowledge to determine whether the investments have been made.

[2] This split arises in a situation of Nash bargaining because *B* cannot produce the final good without the widget from *S*, and *S* has no use for the widget if it is not sold to *B*. Therefore, both *B* and *S* have zero outside options.

[3] The general rule is that control should be allocated to increase the investment by the party whose marginal investment is more productive, where the incentive for such investment is rooted in the difference in threat-point payoffs. In this example, both sides have a threat point of zero. That is, they can only choose not to participate. If one or more parties can threaten to take an alternative action with some positive value, then this choice will need to be taken into account.

economic surplus. This provides a theory of the nature and extent of vertical (and lateral) integration.

As we will see in the next section, incomplete contract theory does more than that: it provides a framework for thinking about a host of issues where relationship-specific investments are important to economic efficiency.

Other Implications of the Incomplete Contracts Approach

Delegation and Authority in Organizations

When looking at the allocation of decision rights inside the firm, what matters primarily is not so much (or only) asset ownership, but more directly how formal and real authority are distributed down the hierarchy. What distinguishes real from formal authority is that taking decisions requires acquisition of information, which in turn requires time and effort. Thus, for example, the chief executive officer of a big holding can only devote limited attention to each unit, which in turn implies that more real authority will lie with downstream agents in each unit. More generally, the design of the organization, together with the allocation of formal decision rights, will determine how real authority is distributed within the firm. The issue of real versus formal authority and of the implications of this distinction for the optimal design of firms' organizations is addressed by Aghion and Tirole (1997) using an incomplete contracts approach.

Their basic framework involves two parties: P(principal) and A(agent). In this model, *formal authority* can be allocated contractually: for example, shareholders allocate formal authority to a board of directors. By contrast, *real authority* is exerted either by the party which enjoys formal authority if that party also has the information or by the other party if only the other party has the information. Contractual incompleteness is again key to the whole analysis: any formal agreement (that is, any contract signed) between P and A cannot specify particular project choices, as these are not verifiable by third parties.[4]

After the contract is signed, both P and A can invest in information acquisition: by investing effort $\frac{1}{2}E^2$, P acquires, with probability E, the relevant information to make a decision. Similarly, by investing effort $\frac{1}{2}e^2$, A acquires, with probability e, the relevant information to make a decision. An important parameter in the analysis of the costs and benefits of delegating formal (or real) authority to A, is the degree of congruence between P's and A's preferences. Let α denote the probability that P's preferred project is also A's preferred project (we say that there is "congruence" between the two parties' preferences), and suppose that a party gets utility zero if the other party chooses its preferred project and preferences are not congruent.

[4] This feature of the model makes it somewhat similar to the classic principal–agent (moral hazard) model (Mirrlees, 1999; Holmstrom, 1979), where the effort the agent takes is not observed by the principal. However, in moral hazard models, the effort choice is preassigned to the agent, whereas here control over the action choice can be allocated at the contracting stage to one or the other party.

Finally, we assume that an uninformed party will never pick a project at random, as this might be too risky.

The timing of moves is as follows. First, the two parties sign a contract that allocates formal authority to one party, either *P* or *A*. Then, both parties decide how much effort to invest in acquisition of information. Deciding to invest nothing in information is a possible choice. In the next step, the party with no formal authority proposes a project to the party with formal authority. If the party with formal authority has acquired information, then the party with formal authority picks its own preferred project. If the party with formal authority has not acquired information, then it accepts the project submitted by the party without formal authority. In this latter case, real authority differs from formal authority, since the party with formal authority is uninformed and therefore can only rubber-stamp the other party's project proposal.

In this setting, for a principal *P* to delegate formal authority to an agent *A* involves a cost and a benefit. The cost is that the agent may choose a project that the principal does not like. This is the *loss of control effect*. The benefit is that delegating formal authority to the agent encourages that agent to invest more effort in information acquisition. This is the *initiative effect*. Which effect dominates will depend on a key parameter: the extent of congruence between the preferences of the principal and the agent. If the preferences of the principal are not especially congruent with those of the agent, then the principal retains formal control; if their preferences are reasonably congruent, the principal is more likely to formally delegate authority.

The choices posed by the model as described to this point may be too stark: after all, most corporate principals do not completely hand over formal authority, but they do want their agents to carry out most of the information gathering. For example, it could be that delegating formal authority to *A* is potentially too costly for *P*, perhaps because of the real if small probability that *A* might take some very costly action. In that case, *P* will always want to retain formal authority and yet may want to commit not to invest too much in information acquisition, so as to preserve the agent's incentives to gather information, even though the agent recognizes the possibility of being overruled. One way to achieve such commitment is through the choice of span of control. A principal might deliberately limit how much effort he will devote to acquiring information on each particular activity, for example, by having a larger number of agents and activities under supervision. This in turn will encourage initiative by agents on each activity, as they anticipate that the principal will ignore their proposals less often. Of course, the choice of the optimal span of control by the principal is subject to the same trade-off as above, namely between the principal's loss of control and the agents' initiatives. This trade-off underlies not only the choice of span of control, but other features of organizational design, such as the role of intermediaries, the costs and benefits of having multiple principals on some activities, or the optimal combination of tasks within teams.

An Economic Justification for Debt

Many firms are financed with a combination of equity and debt, and the choice of financial structure matters a lot in practice. However, a benchmark contribution

in corporate finance is the well-known Modigliani–Miller (1958) theorem, which says roughly that in a world without transaction costs and without taxes, the mix of debt and equity—and more generally the firm's financial structure—does not affect the total value of a firm. Ever since Modigliani and Miller stated their irrelevance result, economists have sought explanations for why financial structure matters after all. A common explanation is that (in violation of the Modigliani–Miller assumptions) debt has certain tax advantages, in that interest payments on debt are typically tax deductible, but dividend payments are not. However, this answer seems partial at best, because corporate debt was prevalent even before corporate income tax existed. Aghion and Bolton (1992) use the incomplete contracts approach to offer an alternative rationale for debt versus equity financing. In a nutshell, debt financing provides a contingent and thus more-flexible governance structure for firms, one which is more responsive to whether good or bad states of the world materialize in the future.

Consider the example of a family business that is run by an entrepreneur who has ideas but no wealth to finance them and therefore needs financing from an outside investor. The entrepreneur derives private benefits from running and expanding the family business—think of the entrepreneur as an empire builder. On the other hand, the investor seeks (short-run) monetary returns from investing in this business. Then one can look at the following three governance structures, which correspond to three different types of financial contracts: 1) full entrepreneur control, for example when the outside investor only holds nonvoting shares; 2) full investor control, when the investor holds all the voting equity in the firm; and 3) contingent control, whereby the entrepreneur has control if revenues are high (call it the good state of nature) and the investor has control if revenues are low (call it the bad state of nature). In the Aghion and Bolton (1992) model, the timing of the relationship between the entrepreneur and the investor can be described as follows: At the contracting stage, the two parties write a financial contract which allocates control rights. Then the state of nature is realized, and suppose that either a good state or a bad state can occur. The state of nature that occurs is verifiable by a third party. At this stage, an action must be chosen, like whether to pursue and expand the business or whether to close it down. If the good state arises, the entrepreneur will want to expand, whereas the investor may seek outright repayment. If the bad state arises and losses are occurring, the entrepreneur will still want to continue, whereas the investor will want to stop the losses, perhaps by liquidating the company. In other words, while both entrepreneurs and investors want to make money, entrepreneurs will often place a higher value on the continuation of the firm, while investors are more likely than the entrepreneur to prefer pulling money out of the firm in a good state or closing it down in a bad state.

Under full entrepreneur control, the investor faces the risk of incurring large losses if the bad state occurs. Anticipating this, the investor may simply refuse to finance the firm's investment through nonvoting shares. Under full investor control, the investor is protected against the risk of large losses if the bad state occurs (in particular, the investor can always decide to liquidate the firm in the bad

state). But the downside of full investor control is that the investor can also impose a suboptimal course of action in the good state (namely, the investor can prevent the entrepreneur from expanding the business in that state), and the wealth-constrained entrepreneur has no cash at its disposal to compensate the investor for not doing so.

Thus, contingent control through debt financing offers a good compromise, as it allows the entrepreneur to maintain control over the business in the good state, while in the bad state, control will be transferred to the investor who can then make sure that the firm will be liquidated in that state if losses from continuation become too large. Essentially, the investor receives protection against the investment leading to large losses in the bad state, while the entrepreneur has the security of keeping control, and therefore not having a suboptimal course of action imposed, in the good state.

Public versus Private Ownership

There is a long-standing dispute over whether government payment for a certain activity should imply government ownership of that activity. Most people agree that there are some things for which government should pay (such as infrastructure). Less clear, however, is why government should own things. For instance, schools could be owned by firms, and government could give students vouchers that pay for the cost of education. Prisons too could be owned by private firms. With some creativity, national defense and police services could be provided by private firms. On the other hand, Medicare and Medicaid services could also be provided by a network of government-employed doctors. Government ownership is highly prevalent in certain sectors of the economy, and almost absent in others. What factors determine the government make-or-buy decision?

Hart, Shleifer, and Vishny (1997) analyze an incomplete contracts/property rights model to address this issue.[5] They use the example of prisons to illustrate their reasoning. In their model, there are two possible investments that can be made in prisons: one reduces costs, the other improves quality. Improvements in quality might include rehabilitating prisoners, treating them humanely, and reducing the chance of escaping. Lower costs come with a trade-off: they involve somewhat lower quality. For example, perhaps reductions in cost make escapes or within-prison violence more likely. In a world of perfect contracting, the government and a private prison provider could write a contract that stipulates the desired level of investments in cost reduction and quality improvement. However, with contractual incompleteness, this choice is not possible.

Consider the case of a prison that is owned by a private contractor. In their model, the private contractor bears the investment costs. However, the contractor will only get benefits from cost reduction, whereas the government will suffer all the deterioration in quality that comes from cost reduction. The socially efficient levels of investment would involve equating the marginal benefits and marginal costs of

[5] Schmidt (1996) analyzes a model in which government ownership mitigates problems arising from asymmetric information.

these two kinds of investment. Yet, a privately owned prison will overemphasize cost reduction relative to the social optimum.

Now consider government ownership with the contractor being an employee called the "warden." In this model, the warden again bears the investment costs (in time and effort) of maintaining a high-quality prison. However, with government ownership, the government and the warden split the benefits coming from cost reduction and quality innovation, and also split the deleterious effects that cost reductions have on quality. In this setting, because the warden bears the investment costs but receives only some of the benefits, both cost reduction effort and quality improvement effort are too low compared to the social optimum, but at least the contractor will underinvest in quality less than if the contractor had remained the private owner of the prison.

In this model, both private contracting and government ownership are suboptimal, albeit in different ways, and the choice between them will depend on how society perceives the relative benefits of quality and cost.

International Trade

Antras (2003) notes that around one-third of all international trade is intrafirm and that the bulk of that trade is in capital-intensive industries. This striking fact raises the question of why capital-intensive goods have a greater tendency to be traded within the boundaries of (multinational) firms, while labor-intensive goods have a greater tendency to be traded between firms.

In the Antras (2003) model, a final-good producer F decides how to organize production. Production of the final good y uses two specialized inputs: a capital-intensive input h and a labor-intensive input m. The final-good producer F supplies the capital-intensive input h and produces the final good y, whereas another agent denoted by S supplies the labor-intensive input m. The two agents are located in different countries: as one example, think of F as being located in the United States and S as located in China.

As in our example in the previous section, investments in h and m are not contractible. The initial contract determines the governance structure, which in this case will either involve ownership by F or outsourcing (this model does not consider ownership by S). Ownership in turn determines the outside options of F and S in bargaining after a contract has been signed. Under outsourcing, a contractual breach gives 0 to both agents; under integration, F can seize the input m, but this choice imposes a cost that reduces output.

As in the earlier example, the (constrained) efficient choice is to allocate ownership to the party undertaking the relatively more-important investment. It then follows that when production is labor-intensive, outsourcing is the optimal governance structure; when production is capital-intensive, vertical integration dominates. Thus, the model predicts a higher propensity to integrate suppliers in capital-intensive sectors, which in turn explains the observed positive cross-industry correlation between capital intensity and the share of intrafirm imports in total U.S. imports.

Antras (2005) uses a similar framework to explain why product cycles lead to "organizational cycles" whereby manufacturing first takes place within the boundaries of multinational enterprises before subsequently being outsourced to independent foreign firms. The intuition is as follows: in the early stage of a product cycle, the involvement of headquarters is important, and thus the potential gain from lower wages in southern China is not sufficient for the final producer to use manufacturing input m from China. Thus, both inputs will be supplied in the United States. At an intermediate stage of the product cycle, the U.S. headquarters will use input m from China but maintain ownership rights—and thus produce within a multinational enterprise. Eventually, when the product has become fully standardized, lower wages in China justify that m be supplied by China, and outsourcing will be more efficient than integration.

Foundations, Extensions, and Future Research

A basic premise of property rights theory is that there is some information that is observable to the contracting parties but not verifiable by a court, so that contracts are necessarily incomplete and property rights matter. This premise was sharply questioned by Maskin and Tirole (1999a, 1999b), who suggested that observable information can be made verifiable by the use of cleverly designed revelation mechanisms.[6] That is, the contracting parties can agree in advance to play a game where they have the appropriate incentives to reveal truthfully their private information in equilibrium. However, these mechanisms are never observed in practice, which begs the question: Why not?

In this section, we first discuss the robustness of incomplete contracts/property rights theory to using complex revelation mechanisms that seek to bring out true preferences. We then analyze incomplete contracts in a setting where parties have reference points as to what they believe is fair. Finally, we discuss attempts to make the degree of contractual completeness endogenous, potentially depending on factors like the learning ability of parties, bargaining power, discount rates, and other factors. Each of these approaches suggests possible avenues for future research.

Revelation Mechanisms

Here, we begin with an example of a revelation mechanism that is drawn from Aghion, Fudenberg, Holden, Kunimoto, and Tercieux (2010). There are two parties, a buyer B and a seller S of a single unit of an indivisible good. If trade occurs, then B's payoff is $V_B = \theta - p$; where θ is the value of the good to the buyer and p is the price. S's payoff is just $V_S = p$. The good can be of either high or low quality. If it is of high quality, then B values it at 14; if it is of low quality, then B values it at 10, thus $\theta \in \{10, -14\}$.

[6] The Maskin–Tirole criticism loses bite in models where agents have nontransferable utility and either are subject to wealth constraints or do not fully respond to monetary incentives—for example, in the Aghion–Tirole or Aghion–Bolton models mentioned above. See Bolton and Dewatripont (2004).

Suppose that the quality θ representing the true value of the good to the buyer is observable and common knowledge to both parties. Even though θ is not verifiable by a court, and therefore no initial contract between the two parties can be made credibly contingent upon θ, truthful revelation of θ by the buyer B can still be achieved through the following mechanism:

1. B announces θ to be either "high" or "low." If he announces "high," then B pays S a price equal to 14 and the game then stops.

2. If B announces "low" and S does not "challenge" B's announcement, then B pays a price equal to 10 and the game stops.

3. If S challenges B's announcement then:
   a) B pays a fine F to T (*a third party*), and
   b) B is offered the good for 6.
   c) If B accepts the good, then S receives F from T (and also the 6 from B) and we stop.
   d) If B rejects at stage 3b, then S pays F to T, and
   e) B and S Nash bargain 50:50 over the good.

When the true value of the good is common knowledge between B and S, this mechanism yields truth telling as the unique (subgame perfect) equilibrium. To see this, let the true valuation be 14; and let $F = 9$: If B announces "high," then B pays 14 and we stop. If, however, B announces "low," then S will challenge because, at stage 3a, B pays 9 to T and, this cost being sunk, B will still accept the good for 6 at stage 3b (because it is worth 14 and $14 - 6 = 8$ is greater than $14/2 = 7$, which is what B gets if it rejects the offer of 6). Anticipating this, S knows that by challenging B, S receives $9 + 6 = 15$, which is greater than the 10 that S would receive if S did not challenge. Moving back to stage 1, if B lies and announces $\theta = 10$ when the true state is $\theta = 14$, B gets $14 - 9 - 6 = -1$, whereas B gets $14 - 14 = 0$ if B tells the truth.

These kinds of revelation mechanisms are never observed in practice. Why not? One possible explanation is that these mechanisms are not robust to even small deviations from common knowledge. Strict common knowledge is a demanding requirement, and unlikely to be true in practice. It requires that party A knows it, party B knows it, party A knows that party B knows it, and so on ad infinitum, all with perfect certainty. In Aghion, Fudenberg, Holden, Kunimoto, and Tercieux (2010), we ask whether the above type of mechanism still works in a situation that is only close to common knowledge: that is, party A knows it, party B knows it, party A knows that party B knows it, and so on ad infinitum, but in each case only with *almost* perfect certainty. We show that if any mechanism can achieve truthful revelation as an equilibrium under common knowledge, then under approximate common knowledge, there must also exist an equilibrium with nontruthful revelation. In

other words, the above types of mechanisms are fragile in the sense that they depend crucially on delicate assumptions about higher-order beliefs.[7]

Of course, the existence of common knowledge or approximate common knowledge can have large effects on bargaining as well. Thus, an interesting direction for future research is to explore how an incomplete contracts/property rights model is affected by aspects of common knowledge, revelation mechanisms, and bargaining under asymmetric information. It seems plausible that these issues could lead to other reasons for inefficiency in investment, and property rights in the form of asset ownership may help to alleviate these inefficiencies.

Back to Asymmetric Information?

We have just argued that dynamic revelation mechanisms lose bite when moving only slightly away from common knowledge, thus, in particular, they lose bite when introducing only small amounts of private information. Now, consider the polar case where the valuation of the good is private information of the buyer. As before, B and S trade a single unit of an indivisible object. Time is discrete, with an investment period 0 and two consumption periods 1 and 2, and both players have a common discount factor δ. In each period, S makes a price offer to B, which can be accepted or rejected, and asset ownership may provide S with an outside option (such as being able to consume or sell to another buyer) s in subsequent bargaining. Finally, suppose that the buyer's valuation θ, which can be high or low, respectively $\overline{v}$ or $\underline{v}$, is private information of the buyer. In the absence of an outside option, we know from existing dynamic screening models (for example, see Bolton and Dewatripont, 2004), that if the seller's prior belief is that the buyer's valuation is high with sufficiently high probability, then it is optimal for the seller to sell with probability less than one in period 1 at price $p = \overline{v}$ in the first period in order to credibly continue to set $p = \overline{v}$ in the second period. However, this trade restriction becomes unnecessary once the outside option is introduced. More precisely, one can show that if the outside option lies strictly between $\overline{v}$ and $\underline{v}$, introducing the outside option leads to the following being the unique equilibrium: the seller sets $p = \overline{v}$ in period 1 and sells with probability one to a consumer that accepts a purchase at that price; otherwise, the seller exerts the outside option in period 2. To see this, note first that in period 2, if the seller does not exert the outside option, then the only credible alternative is to sell at price $p = \underline{v}$, which is dominated by S exerting the outside option. Now, moving back to period 1, anticipating that the seller will exert the outside option for sure if the buyer refuses the offer at $p = \overline{v}$ in period 1, a $\overline{v}$-type buyer will accept this offer for sure. Overall, ownership rights that guarantee the seller an outside option between $\overline{v}$ and $\underline{v}$ both reduce the scope for trade inefficiency (in period 1) and enhance the seller's investment incentives (in period 0).

[7] Recent work by Aghion, Fehr, Holden, and Wilkening (2010) finds evidence in a laboratory experiment for small deviations from common knowledge leading to the breakdown of truth-telling in subgame perfect implementation.

Most incomplete contracts models follow the lead of Grossman and Hart (1986) in assuming symmetric information at the bargaining stage so that the Nash bargaining solution can be used, which simplifies the analysis. This subsection suggests, however, that allowing for asymmetric information at the bargaining stage may provide an alternative and also tractable approach to the role of ownership.[8]

Contracts as Reference Points?

In another attempt at responding to the Maskin–Tirole criticism, Hart and Moore (2008) develop a model of contracts as "reference points." In their model, contracting parties can agree on some aspects of performance but not on others. For example, it might be possible to agree on a contract to paint a house but not necessarily on whether the painting of the house is done in a timely manner. In their terminology, performance could be "consummate" (I paint your house, and quickly) or "perfunctory" (I paint it, but I take my time). In this incomplete contracting approach, only perfunctory performance is enforceable by a court or third party, while consummate performance is noncontractible.[9]

Suppose consummate rather than perfunctory performance is slightly more costly for the party performing the service but much more valuable to the party receiving the service. To extend the house-painting example, say that I have to vacate my house or suffer substantial disruption while it is being painted, but you, the painter, have little other work to do. Suppose that the party performing the service values being treated "well" and will perform consummately if treated "well." Hart and Moore (2008) assume that being treated well is equivalent to a party getting that to which the party feels entitled. This sense of entitlement creates a reference point, which in turn creates the possibility of one or another party feeling "aggrieved."

Suppose the *B*(uyer) of the service values it at 20, but it costs the *S*(eller) 10 to provide. *B* believes that there are lots of sellers like *S*—they are a-dime-a-dozen, and hence *B* feels entitled to pay no more than 10. Similarly, *S* thinks that there are a lot of potential buyers, and feels entitled to be paid what his or her services are worth to the buyers. But both are smart enough to realize that once they enter into an agreement they are in bilateral monopoly, or as Williamson (1979) puts it, the relationship undergoes a "fundamental transformation." *B* feels entitled to pay a price of 10, and *S* feels entitled to receive a price of 20. Despite these feelings of entitlement, both *B* and *S* realize there are gains from trade at any price between 10 and 20. But both *B* and *S* will become more perfunctory and hence less consummate as the price moves away from their entitlement point.

[8] In Aghion, Fudenberg, Holden, Kunimoto, and Tercieux (2010), we develop a simple variant of the above buyer–seller example, in which the optimal mechanism(s) involve the use of outside options. The basic idea is that introducing outside options, in particular giving the seller the option to sell the good to a third party, relaxes the buyer's incentive compatibility constraint.

[9] See Fehr, Hart, and Zehnder (forthcoming) for experimental evidence supporting Hart and Moore's (2008) reference point model.

Hart and Moore (2008) go on to show how shading induced by reference points can provide a rationale for simple ownership contracts. The point here is twofold: First, this theory is immune to the earlier critique that perhaps properly designed revelation mechanisms can overcome the problem of incomplete contracts, because mechanisms do not affect reference points. Second, the inefficiency that arises here does not take the form of underinvestment because either side would fear signing a contract, but instead it takes the form of underperformance because of feeling aggrieved after the contract is signed.

Of course, a model of incomplete contracting and property rights based on reference points and the potential for feeling aggrieved raises a number of questions: From where does the reference point come, and how can this be pinned down? Can the reference point change from the time of contracting to the time of performance, perhaps if market conditions change? How applicable is this theory to sophisticated parties, including many firms? Again, these seem like fruitful topics for future research.

Cognition and Endogenous Incomplete Contracts

Another recent development of the incomplete contracts paradigm has been to endogenize the degree of contractual incompleteness, in particular by analyzing how the equilibrium level of contractual incompleteness may depend upon determinants such as the parties' cognitive (or learning) ability; discount rates; the parties' ability to also rely upon relational contracting, bargaining powers, and competition; or other variables that affect the extent of the hold-up problem between the contracting parties. These papers are often referred to as the second-generation models of incomplete contracts.

As a prominent example, here we summarize the argument in Tirole (2009).[10] Consider two parties, a buyer and a seller, who contract over the delivery of a good. The standard specification of the good, over which there is common knowledge among the two parties, is denoted A. However, it may turn out that A does not suit the buyer after the contract is signed and that some alternative specification A', which is a priori undescribable in the initial contract, does the job instead. Moving from A to A' after the contract has been signed entails an extra cost, but doing so is assumed to be efficient because it increases the buyer's valuation by more than enough to offset the costs.

The seller has the possibility of holding up this renegotiation until it appropriates part of the gain from renegotiation. To avoid having to incur that hold-up cost, before the contract is signed, the buyer may decide to invest in cognitive effort to learn whether alternative A' is appropriate. If the buyer finds out that A' is

[10] As a second example, we have the work of Bolton and Faure-Grimaud (2009a), who first consider an individual decisionmaker who can incur delay costs in order to make a better decision. Bolton and Faure-Grimaud (2009b) embed this in a two-party contracting setting where decision rights are contractible. They show that the impatient party may transfer control to the more-patient party in order to arrive at a better/less-risky decision.

appropriate, then the buyer will disclose this to the seller at the contracting stage (because this avoids incurring a later adjustment cost and avoids the need for a hold-up premium paid to the seller). Otherwise, if the buyer does not find out about A' and yet A' turns out to be appropriate, renegotiation and the adjustment cost are unavoidable.

In this model, contractual incompleteness is measured by the equilibrium probability that the buyer learns about A'. Interestingly, even if the adjustment cost of actually changing the product was zero, the buyer has an incentive to invest in cognition, namely to avoid hold-up by the seller at the renegotiation stage. In this kind of model, contractual completeness will increase with the adjustment cost (the higher the adjustment cost, the higher the scope for hold-up by the seller); increase with the seller's bargaining power (the higher that bargaining power, the higher the scope for hold-up by the seller); or decrease with the seller's patience (or the seller's attachment to relational contracting with the buyer).

Concluding Remarks

In this essay, we have focused attention on theoretical debates around the incomplete contracts/property rights approach, but we would be remiss not to add that this theory has also spurred an empirical literature on firms' boundaries and organization. For example, Grossman and Hart (1986) predict underinvestment by parties that do not have ownership (and hence residual control rights). Acemoglu, Aghion, Griffith, and Zilibotti (2010) use U.K. firm-level panel data and input-output information about U.K. firms to show that more vertically integrated firms—firms that produce a higher fraction of their inputs in-house—also display higher R&D investment by final producers and lower R&D investment by supplying industries.

In another example of how ownership can address incomplete contracts, in the trucking industry, one ownership form is for the driver to own the truck directly, while another form is for a trucking company to own the truck and to hire the driver as an employee. Baker and Hubbard (2004) find that driver ownership provides an incentive to take care of the truck but means that the dispatcher will underinvest in planning how the truck should be used (in particular, in finding return trips to utilize capacity). It would be tricky to draw up an enforceable contract on either of these points: taking excellent care of the truck, or using the capacity of a truck as efficiently as possible. Thus, Baker and Hubbard find that driver ownership is more prevalent in long-haul settings, where truck maintenance is more important and where finding a return back-haul load is more likely. They also find that a technological shock—the introduction of onboard computers which can help monitor how well the truck is taken care of—leads to a decrease in driver ownership. Lafontaine and Slade (2007) offer a survey of the empirical literature on vertical integration.

In their analysis of delegation of authority within firms, Acemoglu, Aghion, Lelarge, Van Reenen, and Zilibotti (2007) use U.K. and French firm-level panel

data to show that more technologically advanced firms, more technology-intensive firms, younger firms, or firms that differ more (for example, in terms of input–output) from other firms in the same industry, tend to delegate authority more than other firms. Delegation of authority is measured either by the extent to which downstream units are organized as profit centers or by the extent to which middle managers have been eliminated. This in turn is consistent with Aghion and Tirole's (1997) idea that delegating authority allows headquarters to induce more information gathering by downstream agents.

As an example of how ownership structures of firms may evolve, Kaplan and Stromberg (2003) examine 230 deals between entrepreneurs and venture capitalists—mainly high-tech startups—to analyze the features of venture capital contracts. In line with Aghion and Bolton (1992), they find that venture capitalists tend to relinquish control as firms mature and thus accumulate wealth that can be used as collateral. Forbes and Lederman (2009) use data on the performance of regional airlines under different ownership structures (owned by a major airline or subcontracted). They find large positive effects of ownership on measures such as on-time departures. Moreover, they use instrumental variable techniques to obtain a plausibly causal inference.

We opened by noting that Coase (1937) asked a great question: if markets are so efficient, why do firms exist? So did Grossman and Hart (1986) when they began their paper with, "What is a firm?" As with Coase's question, it will take economists time to arrive at a fully satisfactory answer. But in the process, we have come to better understand what determines the size and boundaries of firms, their capital structure, their internal organizational structure, the importance of intrafirm trade in international trade, the role of government ownership, and more. And we have also learned from recent debates on the foundations of incomplete contract theory. Indeed, these debates have led to a new generation of incomplete contracts models that generate predictions on the very determinants of contractual incompleteness. May the next 25 years be as fruitful.

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