

Empirical Strategies in Contract Economics: Information and the Boundary of the Firm

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What determines the boundaries of the firm? Over the past 25 years, many papers have examined this question. Benjamin Klein et al. (1978) and Oliver E. Williamson (1979, 1985) propose that firms integrate to avoid appropriation problems that arise when assets are specific. Empirical work since then has been generally supportive of the proposition that integration is correlated with asset specificity. More recently, other researchers, including Sanford Grossman and Oliver Hart (1986), and Bengt Holmstrom and Paul Milgrom (1994) have proposed theories in which firms' boundaries reflect contracting problems not contemplated by the earlier literature. Empirical work in these newer branches of contract economics has begun to emerge.

This paper discusses empirical strategies for examining some of the recent theoretical work on firms' boundaries.¹ Our discussion emphasizes the importance of testing theories' general propositions rather than specific models, the returns from field work in linking conceptual and institutional detail, and the promise of empirical strategies that rely on variation in the contracting environment. We focus on two seminal papers in this large literature: Grossman and Hart (1986) and Holmstrom and Milgrom (1994). We do not discuss the empirical literature on transaction-cost economics or its relationship to the more recent literature, a topic covered by Michael D. Whinston (2001) elsewhere in this session. We also do not discuss other important theoretical work, most prominently Raghuram G. Rajan and Luigi Zingales (1998). We suspect that some of our themes bear on this other work.

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¹ See P. A. Chiappori and B. Salante (2000) for a general survey of empirical work in contract economics.

I. Applying the Theory

Empirical testing strategies generally follow one of two plans of attack: empiricists can either attempt to test the theory in the specific context contemplated by the theorist or look for other implications suggested by a more general application of the theory's main ideas. The latter plan requires that empiricists apply the theory to their own specific context and generate testable propositions themselves, and then examine these propositions with data. The advantage of the latter alternative is that researchers can examine general propositions in a wider range of contexts. The disadvantage is that they have a more difficult applied theoretical task.

We anticipate that data availability will require applied work in contract economics to rely heavily on the second option. Thus, while we will motivate some of our discussion through Grossman and Hart's and Holmstrom and Milgrom's well-known specific models, our basic concern is with the task of testing the authors' general ideas in contexts not considered by them.

II. Examining Grossman and Hart (1986)

Grossman and Hart (1986) present a theory of asset ownership. Their crucial contribution is to provide a theoretically rigorous definition of what it means to own an asset, and to highlight the importance of contractual incompleteness. They define the owner of an asset as the holder of *residual control rights*: the right to determine how the asset is used in circumstances not covered by existing contracts, customs, or the law. The allocation of ownership rights reflects a second-best solution to incentive problems that arise because of contractual incompleteness. If firms are defined by clusters of commonly owned assets, Grossman and Hart's theory is

one of firms' boundaries. An important general idea from this work is that firms' boundaries reflect trade-offs surrounding the allocation of residual control rights.

Hart (1995) develops this idea in the context of a specific model in which there are two assets and two managers, each of whom makes an investment decision. At issue is how to allocate assets between these individuals. The trade-off in this context is that reallocating ownership rights strengthens one manager's incentives but weakens the other's.

Hart then derives a series of propositions from which two related empirical strategies follow:

- (i) exploit variation in individuals' marginal incentives, that is, the elasticity of effort to asset ownership;
- (ii) exploit variation in how individual behavior affects total surplus, that is, the elasticity of surplus to individuals' effort.

A central difficulty of these strategies is that the most important explanatory variables are difficult or impossible to observe. Consider Hart's (1995) canonical model. Exploiting the first strategy would require the researcher to assess each manager's marginal incentives given that the manager owns neither, one, and both assets. Although marginal incentives are unobservable, researchers may be able to provide a convincing case that ownership of one or both assets strengthens incentives. However, this alone would not generate testable propositions, because researchers would then have to compare the positive effect of allocating an asset to one individual to the negative effect of taking it away from others. This requires more than just signing asset ownership's effects on an individual's behavior; it is necessary to assess magnitudes. Analogous problems arise with strategy (ii). Although sometimes these strategies may be possible, the difficulty of observing and comparing the magnitude of marginal effects makes them hard to implement successfully.²

² Christopher Woodruff (1999) implements strategy (ii) in the context of Mexican shoe retailing. His careful, detailed depiction of how the marginal incentives of shoe

A. Contractibility Strategies

Fortunately, other strategies are available. These instead exploit differences in contractual incompleteness (or, more directly, information costs). An advantage of such strategies is that variation in contractibility is often more observable to researchers than differences in margins. Contractibility may vary due to differences or changes in laws or regulations or in the cost of information-gathering. Econometric problems remain; researchers still must provide evidence that correlations between contractibility and asset ownership reflect causal relationships. But the empirical analysis is facilitated by the fact that the most important independent variables are observed more directly.

Contractual incompleteness is central to Grossman and Hart's theory. But the degree of contractual incompleteness is something that they and most subsequent theorists take as fixed. Relaxing this assumption and allowing variation in what is and is not contractible can generate powerful empirical propositions. For example, consider again Hart's (1995) canonical model. Suppose one of the manager's investment decisions becomes contractible. Then in this context this manager should own fewer assets than before because there is no opportunity cost from allocating assets to the other manager. Note that this comparative static does not depend on quantification of marginal effects: a change in the contracting environment produces an unambiguous prediction about changes in asset ownership.

B. Moving Beyond Canonical Models

In Hart's (1995) simple formalization, each individual makes only one investment decision. Furthermore, investments are always socially valuable. These assumptions produce a model that abstracts from an important theme of the contract economics literature: individuals allocate effort across multiple dimensions, and channeling effort in productive directions is an important goal of incentives (Holmstrom and Milgrom, 1991, 1994; Baker, 1992).

manufacturers and retailers vary across different ownership patterns testifies to the demands of the strategy.

It is easy to allow for multidimensional effort in a model of residual control rights. Baker and Hubbard (2000a) is an example. Here there are two parties, a truck driver and a truck dispatcher. The driver makes two noncontractible decisions: how much effort to expend in productive activities, and how much effort to expend in rent-seeking activities. Unlike in Hart's simple model, asset ownership can promote both productive and unproductive behavior in the same individual. If it promotes too much unproductive behavior, it may be better to deny an individual ownership rights even if it would attenuate incentives for productive behavior.

This discussion illuminates an important general point relevant to testing models in contract economics: the details matter.³ Empirical tests that simply relate the general effect of contractual improvements to general changes in firms' boundaries are unlikely to say much about the empirical relevance of Grossman and Hart's (1986) basic idea. In a world where asset ownership reflects only trade-offs involving the allocation of residual control rights, contractual improvements can lead to more or less concentrated ownership of assets, depending on what the trade-offs are and which contracts are improved through the use of new information. It is doubtful that there are shortcuts around the difficult applied theoretical task of mapping the general idea to specific institutional contexts.

III. Asset Ownership as Part of an Incentive System

Holmstrom and Milgrom (1994) and Holmstrom (1999) propose models in which the optimal allocation of assets reflects *contractual externalities*. Contractual externalities exist when the incentives that influence one decision affect optimal incentives with respect to other decisions. Asset ownership may be part of a system of incentives designed to motivate various behaviors. Although asset ownership may reflect the sorts of trade-offs in Grossman and Hart (1986), it also may

reflect trade-offs that only directly affect other parts of the system.

Tests in this literature examine whether asset ownership reflects contractual externalities (see e.g., Margaret E. Slade, 1996). The general empirical question is: do factors that change the contracting environment of (and thus optimal incentives for) behaviors not directly related to asset ownership nevertheless affect asset ownership?

We elaborate through an example derived from Holmstrom and Milgrom (1994). Consider a model of industrial selling in which individual salesmen engage in two activities: sales and service. Managers have a single incentive instrument to motivate each of these activities. Performance incentives (commissions) motivate sales effort, while asset ownership (ownership of a list of people who have previously purchased the product) motivates service effort. If sales and service effort are substitutes in salesmen's effort supply function, then the two incentive instruments will be interrelated even if selling effort does not directly affect the returns from service effort and vice versa. Now consider a change that improves the precision with which managers can assess the value of selling effort. Any increase in the power of selling incentives will increase the marginal value of asset ownership: improvements in measurement will thus lead to *more* asset ownership by the sales force.

However, this is not the only way contractual externalities can affect asset ownership, even in the above context. If providing stronger sales incentives would induce a multitasking salesman to misallocate his effort, another solution is to change job design so that salesmen are specialized: split the job so that some individuals only sell products and others only service them. Increasing salesmen's commissions can lower the returns from giving them service responsibilities, thereby shifting service responsibilities and ownership of client lists to other individuals. If changes in job design are possible, increases in the precision with which managers can assess sales effort can lead salesmen to own *fewer* assets.

This discussion indicates that, as in the above discussion of Grossman and Hart (1986), the way new information affects asset ownership is sensitive to detail. What mattered in this

³ Whinston (2001) repeatedly highlights this observation and shows that lack of detail prevents the early empirical literature from shedding much light on Grossman and Hart's (1986) theory.

example was the ability of the organization to redesign jobs, but we could have made a similar point by changing other details. For instance, if sales and service effort were complements in the salesman's effort supply function, then improved measures of sales effort might lead to a decrease in asset ownership by salesmen. This point is striking because the context is relatively uncomplicated: the contractual externalities involve different decisions made by the same individual. It is clear that more complex cases exist, and that this sensitivity to detail is likely general.

Empirical researchers investigating this strain of the theory therefore face three important tasks, two of which they must accomplish before even reaching the data. First, they must develop a detailed model (more detailed than those generally presented by the theorists themselves) of the phenomenon under study. Second they must take pains to understand the trade-offs and interactions between variables in this model: it is these interactions that drive the model's specific predictions. For each of these tasks, knowledge of institutional detail and some amount of field work are likely to be highly productive. Finally, they must turn to the data and examine whether the shifters of the relevant variables affect asset ownership.

IV. Trucking as a Laboratory for Research on Firms' Boundaries

During the past two years, we have used the trucking industry as a laboratory to examine propositions derived from Grossman-Hart and Holmstrom-Milgrom, and thus to investigate what determines firms' boundaries.

In Baker and Hubbard (2000a), we investigate what determines whether drivers own the trucks they operate. Our analytic framework draws from Grossman and Hart (1986). Truck ownership gives drivers a bundle of residual rights that leads them to internalize the effects of their actions on the value of the truck. But it also encourages them to engage in rent-seeking. All drivers theoretically can refuse hauls proposed by a dispatcher. But owner-operators have the right to use their trucks for other hauls. This gives them an incentive to explore opportunities for the use of their trucks, even when it only serves the purpose of improving their bar-

gaining position. The importance of this trade-off is reflected in the interviews we conducted at trucking firms: dispatchers consider owner-operators hard to control because they are more likely than employee-drivers to refuse hauls on the terms dispatchers propose.

Our main tests examine how truck ownership changes with the introduction of one type of on-board computer (OBC), a device that provides verifiable *ex post* information about how trucks were operated. We find that OBC adoption has shifted ownership away from drivers, particularly for hauls where driver ownership would encourage the most rent-seeking. Increases in contractibility have allowed good driving to be motivated in a way that avoids the costs associated with giving drivers residual control rights. This result supports Grossman and Hart's theory of integration: asset ownership and thus firms' boundaries reflect trade-offs surrounding the allocation of residual control rights.

In Baker and Hubbard (2000b), we investigate a different question: what determines whether shippers use internal (captive) fleets or for-hire carriers for a haul? As in our first paper, the question revolves around who holds the critical residual rights of control associated with scheduling the truck. In our first paper, these control rights lay either with a dispatcher or a driver. In our second paper, they always lie with a dispatcher, but the question is whose: a shipper's dispatcher or a for-hire carrier's dispatcher?

Field work uncovered several facts that suggest that this margin involves more complicated trade-offs than those surrounding driver ownership. First, the margin between shipper and carrier ownership of trucks reflects the level of service shippers desire, for example, whether drivers are available and willing to handle and sort the cargo they deliver. Shippers use internal fleets when they want high service levels from drivers.

Second, truck utilization tends to be higher in for-hire fleets than in private fleets. High utilization rates hinge on a firm's ability to line up a sequence of hauls for a truck, each of which begins close to and soon after the previous one ends. This task is generally performed by a dispatcher, who works for the shipper if the truck is part of a private fleet, or for a carrier if

it is part of a for-hire fleet.⁴ The benefits and drawbacks of each arise because of incomplete contracts: ownership of residual control rights over trucks provides strong incentives to find high-value matches but may encourage carriers' dispatchers to increase their leverage vis-à-vis shippers.

Third, high-service trucking interferes with the efficiency of search for backhauls. The promise of flexibility in scheduling that is part of high-service trucking creates uncertainty regarding when trucks will come free, making time-targeted search unproductive. This diminishes the incentive advantage associated with carrier ownership of trucks.

Fourth, motivating drivers to perform their jobs well is more difficult when they engage in high-service trucking. This is because drivers' optimal actions involve a more complex mix of tasks than when they just drive trucks.

Our theoretical model captures these features and yields the result that high-service trucking will be performed by private fleets. We then go on to generate two new propositions. One is that certain types of OBC's (those that only increase the verifiability of drivers' actions) should lead to more shipper ownership of trucks. This prediction concerns contractual externalities: although better information about *drivers'* actions does nothing to change the contracting environment between shippers and carriers, it nevertheless shifts asset ownership from carriers to shippers. It does so because better monitoring of drivers increases the returns to giving drivers more responsibilities, thereby increasing the optimal service level and decreasing the returns to giving for-hire carriers ownership rights in trucks.

Our second empirical proposition is that the additional capabilities of other OBC's, those that help dispatchers better locate trucks and communicate with distant drivers, should lead to less shipper ownership of trucks. These informational capabilities raise the productivity of search effort and differentially raise the returns to giving carriers residual control rights over trucks.

Our empirical work provides evidence consistent with these propositions. We conclude that

firms' boundaries in trucking reflect both the direct impact of the allocation of residual control rights (as emphasized by Grossman and Hart [1986]) and that of contractual externalities (as highlighted by Holmstrom and Milgrom [1994]).

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⁴ Dispatchers are sometimes aided by third-party brokers who collect information about hauls and available trucks.

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