

What Determines Firm Boundaries in Biotech? - Comment

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What Determines Firm Boundaries in Biotech?

Comment

by

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Walter W. POWELL [1996] gives us a fascinating and insightful description of a complex industry. His central theme is that, in contrast to the old-line pharmaceutical industry, which is dominated by a small number of large firms that are relatively self-sufficient, the biotechnology industry is populated with a large number of small firms that collaborate with each other extensively and intimately. This pattern presents two broad questions for organizational theorists. First, what determines firm boundaries? In particular, why is there so much less vertical and horizontal integration in the new biotechnology industry than in the old-line pharmaceutical industry? Second, what is the nature of the contractual relationships between the many firms in this industry? Powell addresses both of these questions, but gives principal emphasis to the second. As to the first question – what determines firm boundaries? – Powell offers some intriguing observations but engages in little explicit theorizing. In my comments I shall reverse the emphasis, focusing principally on the determinants of the size and scope of firms. Of course, the two questions are closely related. In particular, the ability to adapt institutions from academic biology as mechanisms for managing interfirm contracting apparently contributes to the viability of small firms in biotech.

1. Incentives

Powell observes that the central actors in the biotechnology industry are modest sized firms, like the Biogen of his figure 1 (p. 201), that focus on research and contract out, in one form or another, most of the rest of the activity needed to bring a drug to market. A major reason for this structure, evidently, is to create strong and focused financial rewards for the scientists responsible for developing drugs. The closer that the size of the firm can be kept to the size of the research team responsible for developing a drug, the stronger the financial incentives facing that team. This is particularly true if, as is the case in this industry, the scientists are commonly given substantial equity participation in the firm.

Presumably these incentives are especially valuable in this industry because the research involved in developing a new drug requires substantial effort, skill, and creativity that is difficult to monitor, particularly by individuals who are not themselves engaged in the research. This is not to say that, in general, the productivity of individual scientific researchers or teams of researchers is difficult to measure. On the contrary, as Powell notes, and as we shall discuss further below, it apparently is not. Peer status and, more particularly, publications offer good general measures of productivity. The importance of concentrated financial incentives for a firm's scientists, then, may be not so much to assure that the researchers are productive, which can be judged well enough, as to assure that the scientists direct their creativity toward producing results of commercial value rather than those that are simply of social or academic value.

The old-line pharmaceutical industry, in contrast, which (as Powell describes) commonly employs brute force research methods involving massive searching, evidently has less need for creativity, and the incentives to foster it, and more need for large scale routine.

2. Measurability

It is far easier and more effective to have a market (or, more generally, a contractual) interface between two actors, rather than having those actors integrated into the same firm, when the things that those actors exchange are relatively easy to measure and specify in contracts. "Relatively" is an important word here. From Powell's description, there are many contractual interactions among firms in biotech that are intensely relational, involving complicated interchanges and continuing adjustments over time. Nevertheless, to coordinate activities, provide proper incentives, and apportion returns, separate firms that collaborate must be able, without undue effort, to reach some common accounting of each firm's contribution to, and benefit from, the collaboration. For this purpose, a degree of objective measurability is helpful.

On the output side, patent rights offer a reasonably measureable product. The property rights to a marketable drug, it appears, can often be encompassed by a modest number of key patents that can be produced by a relatively small team of researchers. A research firm presumably need integrate only so far as is necessary to encompass the research necessary to establish those patent rights. Once secured, they can then be easily sold or licensed to another firm. Consequently, the research firm that develops a drug need not manufacture and market the drug; rather, they can license the rights, or hire the manufacturing and marketing expertise, or sell their entire firm to another that will undertake production. This is in contrast to mainframe computers, for example, where, despite the high degree of technical invention involved in product design, a marketable product is not well defined by a small number, or even a large number, of patents, but rather by a complex design that utilizes many patents

of diverse origin and is closely integrated with manufacturing and servicing operations. The result, as Kenneth W. DAM [1996] points out in his comments, is that computer manufacturers, in contrast to biotech firms, routinely cross-license their most important patents and rely on non-patent means to secure their rights to the hardware and services they sell. Important among those means are highly integrated processes of design, manufacturing, and servicing, requiring firms of substantial scale and scope, in contrast with the small biotech firms.

On the input side, Powell observes that separate firms often engage in collaborative research. Why collaborate rather than integrate? Presumably because, as just suggested, integration dulls incentives. But with collaboration there is the question of determining the particular contribution of each firm. From Powell's description of the industry, it appears that this problem of measuring different firms' inputs to joint work is strongly facilitated by the fact that the significant contributions of the researchers involved are commonly published. A critical factor here, apparently, is that the research necessary to develop a marketable new drug is closely tied to basic scientific research. Consequently, the results of that research are publishable, and publications offer a measure of the results produced by specific individuals and teams. In using publications for this monitoring function, it is presumably important that the publishable unit of research in the relevant fields of biology is discreet and small, and that norms for indicating the contributions made by individuals to publications that are based on collective work had been well established among biological researchers in the academy prior to the advent of the commercial biotechnology industry.

Biotechnology firms can therefore use publications not only as a means of determining the productivity of their own researchers, but also as a means by which two or more firms can measure, with reasonable objectivity, the respective contributions that each firm's researchers have made to results they have produced jointly. Indeed, the striking willingness, and even enthusiasm, with which the biotech research firms encourage publication by their employees, in strong contrast to the secretive style of the old-line pharmaceutical companies, is perhaps understandable not just (as Powell suggests) as a concession that is required to attract good researchers, but also as a very useful means of measuring the productivity of the firm's employees and of other organizations with which the firm collaborates.

In sum, a firm's workable boundaries can be determined, to some extent, by the feasibility of measuring published research results coming in and patent rights going out. Indeed, it would be interesting to know if contracting in the biotechnology industry often explicitly takes the form that these observations suggest, with two or more collaborating research firms agreeing that, if a patentable product emerges, they will divide up the returns from exploiting the patent based, in part, on the published contributions of the researchers in the two different firms.

3. *One-Drug-One-Firm?*

The observations just offered might lead one to ask, not why the core biotech research firms are so small, but why they are not even smaller. Why not form a separate firm to pursue each project that has the potential for developing a drug, hiring individual researchers and contracting with specialized research laboratories to participate in the pursuit of the potential drug in question, and then dissolving the firm when either the drug has been successfully developed and patented or, alternatively, the project has run into a dead end. This is, for example, the way that Broadway plays are produced: a production of a given play is organized as a separate firm – usually a partnership – that obtains its own equity financing and contracts independently for production rights to the play, a director, a theater, actors, musicians, stage hands, and so forth. When the show's run stops, the firm is then dissolved (MOORE [1968]). In biotech as on Broadway, such microfirms would have the advantage of concentrating financial incentives intensely while permitting great flexibility in the assemblage of talent needed for the task at hand.

Perhaps there are some biotech firms that basically have this form – organized, say, as joint ventures among individuals and labs for the purpose of pursuing a specific potential drug. But it appears that generally the core firms are a good bit larger and more durable, pursuing a group of projects both simultaneously and sequentially. One can speculate on several reasons for this larger scale.

First, and most obviously, promising projects to develop potential drugs probably come and go so quickly that the transaction costs of organizing separate firms around each of them would be high. It is much simpler to give a group of researchers a stable home base where they can pursue and abandon a number of potential projects that arise over a protracted period.

Second, there is the role of finance. A team of researchers that pursues a portfolio of projects over a number of years can more easily develop a reputation that outside investors can rely upon when contributing capital. Moreover, a larger firm with a bigger portfolio of projects can bond itself more easily to its investors, both by effectively offering its reputation as a hostage and by providing actual security (or at least a further hostage) in the form of working laboratories and projects in the pipeline on which the investors can levy if the firm runs into difficulty. Without this security, there would be an incentive for the researchers to take the investor's money and play, rather than dissolving the firm, as soon as it becomes clear that the firm's original project has no likely payoff.

Third, there may be reputational scale economies in attracting and keeping research scientists. On the other hand, as we shall discuss next, reputational economies can also cut the other way, and this may itself be an important factor in limiting the scale and scope of the core biotech firms.

4. Reputation Among Researchers

A scientist has a strong incentive to work for a biotech firm in which the other scientists are as competent and productive as possible. There are several reasons for this. One is the exchange of knowledge that, as Powell observes, is such an important factor in this industry: a scientist learns from his coworkers, and he is likely to learn the most if his coworkers are of high quality. A second reason is that, since scientists in the biotech firms are commonly compensated in part by giving them an equity share in the firm, the financial returns that any given scientist gets from working with a particular firm will depend in important part on the average productivity of his fellow researchers. A third reason is that the quality of the firm at which a scientist works is a signal to *other* firms and researchers of his quality, and therefore affects his opportunities for collaborative work and for employment elsewhere.

The result is an incentive for researchers to work, not just where there are other top scientists, but where the *average* quality of the other researchers is as high as possible. This creates incentives for a matching game that has two related consequences for the nature of the firms (HANSMANN [1986]). First, firms (like university departments) will tend to stratify in terms of the quality of their researchers, with the researchers at a given firm all of roughly the same competence, and hence with the top researchers in a given field at one firm, the second stratum at another firm, and so forth. Second, firms are likely to be smaller than they otherwise would be, since having a larger number of scientists in a given field will generally mean having to include scientists of lower quality, thus lowering the average quality of the firm's researchers and making it more difficult for the firm to attract or retain scientists of high quality. For example, a biotech firm might well decide that, rather than drop the average quality of its scientists in order to bring a certain type of research capacity in house, it would be better to contract for that capacity from another firm, even if that means greater difficulties in coordination or in capturing the full returns to the firm's own research activities. Powell's report of citation rates is consistent with this pattern: strikingly, two biotech firms are among the five leading research institutions in citations *per paper*, indicating a very high *average* level of talent in these firms.

5. Conclusion

Elaborate norms and institutions for evaluating and attributing research results had been well developed in academic biology before the biotechnology industry developed. The highly collaborative forms of interfirm contracting that characterize the biotechnology industry, and the many small-scale firms that these forms of collaboration have permitted to prosper, appear to have been built with the aid of those pre-existing norms and institutions.

At the same time, the mechanisms available for measuring and rewarding the contributions of organizations and, particularly, individual researchers remain imperfect. As a consequence, not only is the reputation of firms based on the reputations of their researchers, but also vice-versa. The result is a matching and sorting process between organizations and individuals that itself has implications for the size of firms.

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